BOOK OF ABSTRACTS

DIGITAL HEALTH

IN EAST AFRICA

2019

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INTRODUCTION

Digital technology is influencing our daily lives in unprecedented ways, with its unquestionable power to positively transform individual and collective socioeconomic prosperity. The new health challenges that essentially emanate from global changes in demographics, mobility, migration, climate, and disease epidemiology, can be mitigated using digital technology. Digital Health, which lies at the intersection between health and information and communication technology (ICT), has been recognised as a powerful tool that can strengthen all aspects of the health sector. Digital Health can improve health governance as well as access to quality and effective delivery of health services, therefore improving health-care outcomes.

The rapid increase in access to mobile technology in Africa has fostered a conducive environment for the use of ICT in health. Over the last 15 years, East Africa has witnessed an expansion of Digital Health across the entire health sector. Among other benefits, Digital Health in East Africa has been used to examine the social dynamics of access and utilisation of health services; strengthen health systems governance; strengthen the continuous and ongoing analyses of health science data; and to facilitate the accessibility, sustainability, predictability, effectiveness, and quality of health-care services.

To improve the uptake and utilisation of Digital Health, the East African Health Research Commission (EAHRC) developed a 10-year Digital Regional East African Community Health Initiative (Digital REACH Initiative), which will have its strategic plan implemented from 2019 to 2028. In conjunction with the initiation of the Digital REACH Strategic Plan, the EAHRC has organised the 7th East African Health and Scientific Conference (EAHSC), under the main theme of, '**Technology for Health Systems Transformation and Attainment of the UN Sustainable Development Goals in East Africa**'. The 7th EAHSC brings together stakeholders from the region and beyond to share experiences and best practice related to Digital Health.

The Digital REACH Initiative and the 7th EAHSC will enhance the EAC's collective commitment towards institutionalising the application of Digital Health technologies in EAC health-care systems and facilitate collaboration and coordination among countries, the private sector, and donors.

During the conference sessions (plenary, parallel, parallel interactive, and symposia), participants will gain an in-depth understanding of the EAC partner states' national Digital Health policies, regulations, and health-related ICT utilisation status. Participants will build consensus and outline recommendations about national and regional approaches to supporting effective health systems

development through the successful application of digital technologies and maintaining an ecosystem that will facilitate the scaling up of Digital Health implementation.

To support in-depth discussions during the conference, the EAHRC has compiled literature that has been generated since the year 2000 in the EAC. This literature evokes the experiences that reflect specific East African characteristics. The sharing of these experiences will allow regional stakeholders to further optimise the transformation of the health system with specific consideration of unique regional characteristics.

I wish you pleasant reading and discussions,

Prof Gibson Kibiki, MD, MMed, PhD
Executive Secretary
East African Health Research Commission
East African Community

TECHNOLOGIES SUPPORTING DATA FOR HEALTH SYSTEM DECISION-MAKING

80 citations
(Sorted by Partner States)

Burundi

1. **Open Clinic GA Open Source Hospital Information System Enabled Universal Health Coverage Monitoring and Evaluation in Burundian Hospitals.**

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ABSTRACT

The Universal Health Coverage (UHC) is at the center of the 2030 Sustainable Development Goals agenda. In this study, the authors made an evaluation of the patient health coverage indicators in eight Burundian hospitals from 2011 to 2016. The relevant UHC indicators were calculated on the basis of patient administrative and health insurance data, collected via OpenClinic GA, an information and communication technology (ICT) supported health management information system (HMIS). The results show that the patient health services coverage rate was 70.8% for inpatients and 46.0% for outpatients. The patient health services payment rate as the proportion of total health service costs was above the 25% threshold recommended by WHO for inpatients (30.2%) and for outpatients (43.1%). The patient out-of-pocket payment was below the threshold of 180USD per patient per year for public hospitals. This study demonstrated the possibility to assess the degree of UHC in developing countries, by using routine data extracted automatically from the electronic HMIS.

key words: Developing Countries; Health; Health Expenditure; Insurance; Universal Coverage

2. Implementing Burundi's national e-health enterprise architecture: past, present and future.

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ABSTRACT

BACKGROUND AND PURPOSE: The Ministry of Health (MoH) of Burundi initiated in 2014 the development of a national e-health enterprise architecture aiming to reclaim its leadership in this field and to better align existing and future ICT implementations in the health domain with the strategic options defined by the National Plan for Health Development (PNDS).

METHODS: The Open Group Architecture Framework (TOGAF) was used as a method for developing Burundi's e-health enterprise architecture. A first part of the study consisted of a detailed analysis of regulatory documents and strategic plans related to the Burundian health system and health informatics development. In a second part, field visits and semi-structured interviews were organized with a representative sample of relevant health structures throughout the country. Thorough analysis of human resources, business processes, hardware, software, communication and networking infrastructure provided both a baseline and a target e-health situation. Finally, a strategic document was developed for planning the way forward for filling the functional and technical gaps that had been identified.

RESULTS: The preliminary study demonstrated the donor driven unequal distribution of hardware equipment over health administration components and health facilities. Internet connectivity was problematic and few health oriented business applications had found their way to the Burundian health system. Paper based instruments remained predominant in Burundi's health administration. The study also identified a series of problems introduced by the uncoordinated development of health ICT in Burundi such as the lack of standardization, data security risks, varying data quality, inadequate ICT infrastructures, an unregulated e-health sector and insufficient human capacity. The later architecture

development effort resulted in the production and validation of a national e-health strategy for Burundi for the period 2015-2019 (PNDIS). This strategy has been put into implementation by the Ministry of Public Health and Fight against Aids since 2015 with the help of the country's development partners.

CONCLUSIONS**:** The results demonstrated the challenging situation of the Burundian health information system but also revealed a series of important opportunities for the future: a political will to reclaim MoH leadership in the health information management domain based on the PNDIS, the readiness to develop e-health education and training programs and the opportunity to capitalize the experiences with DHIS2 deployment, results based financing monitoring and evaluation with OpenRBF and hospital information management systems implementation based on OpenClinic GA.

key words: e-Health enterprise architecture, TOGAF, Health information systems, Burundi

3. Human Factors Predicting Failure and Success in Hospital Information System Implementations in Sub-Saharan Africa.

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ABSTRACT

From 2007 through 2014, the authors participated in the implementation of open source hospital information systems (HIS) in 19 hospitals in Rwanda, Burundi, DR Congo, Congo-Brazzaville, Gabon, and Mali. Most of these implementations were successful, but some failed. At the end of a seven-year implementation effort, a number of risk factors, facilitators, and pragmatic approaches related to the deployment of HIS in Sub-Saharan health facilities have been identified. Many of the problems encountered during the HIS implementation process were not related to technical issues but human, cultural, and environmental factors. This study retrospectively evaluates the predictive value of 14 project failure factors and 15 success factors in HIS implementation in the Sub-Saharan region. Nine of the failure factors were strongly correlated with project failure, three were moderately correlated, and one weakly correlated. Regression analysis also confirms that eight factors were strongly correlated with project success, four moderately correlated, and two weakly correlated. The study results may help estimate the expedience of future HIS projects.

4. Geo-additive modelling of malaria in Burundi.

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ABSTRACT

BACKGROUND: Malaria is a major public health issue in Burundi in terms of both morbidity and mortality, with around 2.5 million clinical cases and more than 15,000 deaths each year. It is still the single main cause of mortality in pregnant women and children below five years of age. Because of the severe health and economic burden of malaria, there is still a growing need for methods that will help to understand the influencing factors. Several studies/researches have been done on the subject yielding different results as which factors are most responsible for the increase in malaria transmission. This paper considers the modelling of the dependence of malaria cases on spatial determinants and climatic covariates including rainfall, temperature and humidity in Burundi.

METHODS: The analysis carried out in this work exploits real monthly data collected in the area of Burundi over 12 years (1996-2007). Semi-parametric regression models are used. The spatial analysis is based on a geo-additive model using provinces as the geographic units of study. The spatial effect is split into structured (correlated) and unstructured (uncorrelated) components. Inference is fully Bayesian and uses Markov chain Monte Carlo techniques. The effects of the continuous covariates are modelled by cubic p-splines with 20 equidistant knots and second order random walk penalty. For the spatially correlated effect, Markov random field prior is chosen. The spatially uncorrelated effects are assumed to be i.i.d. Gaussian. The effects of climatic covariates and the effects of other spatial determinants are estimated simultaneously in a unified regression framework.

RESULTS: The results obtained from the proposed model suggest that although malaria incidence in a given month is strongly positively associated with the minimum temperature of the previous months, regional patterns of malaria that are related to factors other than climatic variables have been identified, without being able to explain them.

CONCLUSIONS: In this paper, semiparametric models are used to model the effects of both climatic covariates and spatial effects on malaria distribution in Burundi. The results obtained from the proposed models suggest a strong positive association between malaria incidence in a given month and the minimum temperature of the previous month. From the spatial effects, important spatial patterns of malaria that are related to factors other than climatic variables are identified. Potential explanations (factors) could be related to socio-economic conditions, food shortage, limited access to health care service, precarious housing, promiscuity, poor hygienic conditions, limited access to drinking water, land use (rice paddies for example), displacement of the population (due to armed conflicts).

5. Bayesian modelling of the effect of climate on malaria in Burundi.

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ABSTRACT

BACKGROUND: In Burundi, malaria is a major public health issue in terms of both morbidity and mortality with around 2.5 million clinical cases and more than 15,000 deaths each year. It is the single main cause of mortality in pregnant women and children below five years of age. Due to the severe health and economic cost of malaria, there is still a growing need for methods that will help to understand the influencing factors. Several studies have been done on the subject yielding different results as which factors are most responsible for the increase in malaria. The purpose of this study has been to undertake a spatial/longitudinal statistical analysis to identify important climatic variables that influence malaria incidences in Burundi.

METHODS: This paper investigates the effects of climate on malaria in Burundi. For the period 1996-2007, real monthly data on both malaria epidemiology and climate in the area of Burundi are described and analysed. From this analysis, a mathematical model is derived and proposed to assess which variables significantly influence malaria incidences in Burundi. The proposed modelling is based on both generalized linear models (GLM) and generalized additive mixed models (GAMM). The modelling is fully Bayesian and inference is carried out by Markov Chain Monte Carlo (MCMC) techniques.

RESULTS: The results obtained from the proposed models are discussed and it is found that malaria incidence in a given month in Burundi is strongly positively associated with the minimum temperature of the previous month. In contrast, it is

found that rainfall and maximum temperature in a given month have a possible negative effect on malaria incidence of the same month.

CONCLUSIONS: This study has exploited available real monthly data on malaria and climate over 12 years in Burundi to derive and propose a regression modelling to assess climatic factors that are associated with monthly malaria incidence. The results obtained from the proposed models suggest a strong positive association between malaria incidence in a given month and the minimum temperature (night temperature) of the previous month. An open question is, therefore, how to cope with high temperatures at night.

Kenya

6. **Factors influencing the adoption of electronic health records in public health facilities in Kisumu County, Kenya.**

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ABSTRACT

PURPOSE: The purpose of the research study was to determine the factors influencing the adoption of electronic health records in public health facilities in Kisumu County.

METHODOLOGY: The study adopted was cross-sectional design where it targeted 12 public hospitals with a sample size of 132 health care workers. Out of 132 health care workers who were sampled out from 12 public health facilities, 108 consented to take part in the study. Questionnaires with both structured and semi-structured questions were administered. Qualitative data was recorded, transcribed, coded then analyzed while quantitative data was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics of frequencies and percentages were used to summarize the data while inferential statistics applied Chi-square to test for the association between the dependent and independent variables. A p value which was less or equal to 0.05 was considered significant.

RESULTS: The study revealed that there was a significant statistical relationship between techno-organizational factors and existing EHR levels; Inadequate & non-functional EHR related infrastructure, weak internet connectivity and unstable power supply were the key technological factors while lack of adequate financial resources, inadequate training support by the hospital management, inadequate technical expertise, non-user involvement and lack of harmonized standard legal enforcement were the major organizational factors that contributed to low rate of EHR adoption. Individual factors had the least influence towards low rate of adoption. Two existing levels of EHR implementation were established; fully implemented and not implemented. Majority of the health facilities had not adopted the use of EHR system hence belonged to 'not implemented level'. Therefore, adoption of EHR has not yet attained its maximum potential as it is still low and unevenly effected across public hospitals.

Unique Contribution to Theory, Practice and Policy: The study recommended that in a move towards universal health coverage, it is necessary for health facilities to

streamline the techno-organizational structures that strengthen the adoption of health system projects like EHR towards the provision of improved and quality health services.

7. Institutional assessment of Clinical Research Capacity: Case study of Siaya County Referral Hospital.

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ABSTRACT

INTRODUCTION: Infrastructural inadequacies and research management expertise impedes optimal research participation by Ministry of Health facilities in Kenya. The East African Consortium for Clinical Research (EACCR-2), is a regional network of excellence by the European and Developing Countries Clinical Trials Partnership (EDCTP) mandated to strengthen research capacity in East Africa through partnership with local institutions to improve research output in the region. Siaya County Referral Hospital was evaluated for research capacity needs in preparation for future clinical trials.

METHODOLOGY: In April 2018, departmental in-charges or designees from administration, finance, clinical, data management, laboratory, records and information technology (IT) were interviewed using standardised assessment questionnaires.

RESULTS: Five out of the 7 respondents interviewed were males. Patient populations such as children, adolescents and pregnant mothers with unique characteristics are available for both inpatient and outpatient clinical trials. There is little clinical research exposure among clinical, data and laboratory staff despite receiving GCP/GCLP training. A local Institutional Review Board (IRB) exists and reviews/approves research proposals however members lack training in bioethics. Acute staff shortage, reagent stock-outs, space constraints and faulty equipment limits laboratory capacity. Insufficient IT support and internet access causes delays in data entry. A dearth in monitoring, data analysis and statistical expertise, financial management systems and library services were also identified.

CONCLUSION: The hospital's capacity to conduct clinical research is low. Assessment findings highlighted funding constraints faced at the referral hospital in a county burdened by disease. Local and international partnerships should be considered in addressing part of these gaps.

8. **Implementing an Open Source Electronic Health Record System in Kenyan Health Care Facilities: Case Study.**

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ABSTRACT

BACKGROUND: The Kenyan government, working with international partners and local organizations, has developed an eHealth strategy, specified standards, and guidelines for electronic health record adoption in public hospitals and implemented two major health information technology projects: District Health Information Software Version 2, for collating national health care indicators and a rollout of the KenyaEMR and International Quality Care Health Management Information Systems, for managing 600 HIV clinics across the country. Following these projects, a modified version of the Open Medical Record System electronic health record was specified and developed to fulfill the clinical and administrative requirements of health care facilities operated by devolved counties in Kenya and to automate the process of collating health care indicators and entering them into the District Health Information Software Version 2 system.

OBJECTIVE: We aimed to present a descriptive case study of the implementation of an open source electronic health record system in public health care facilities in Kenya.

METHODS: We conducted a landscape review of existing literature concerning eHealth policies and electronic health record development in Kenya. Following initial discussions with the Ministry of Health, the World Health Organization, and implementing partners, we conducted a series of visits to implementing sites to conduct semistructured individual interviews and group discussions with stakeholders to produce a historical case study of the implementation.

RESULTS: This case study describes how consultants based in Kenya, working with developers in India and project stakeholders, implemented the new system into several public hospitals in a county in rural Kenya. The implementation process

included upgrading the hospital information technology infrastructure, training users, and attempting to garner administrative and clinical buy-in for adoption of the system. The initial deployment was ultimately scaled back due to a complex mix of sociotechnical and administrative issues. Learning from these early challenges, the system is now being redesigned and prepared for deployment in 6 new counties across Kenya.

CONCLUSIONS: Implementing electronic health record systems is a challenging process in high-income settings. In low-income settings, such as Kenya, open source software may offer some respite from the high costs of software licensing, but the familiar challenges of clinical and administration buy-in, the need to adequately train users, and the need for the provision of ongoing technical support are common across the North-South divide. Strategies such as creating local support teams, using local development resources, ensuring end user buy-in, and rolling out in smaller facilities before larger hospitals are being incorporated into the project. These are positive developments to help maintain momentum as the project continues. Further integration with existing open source communities could help ongoing development and implementations of the project. We hope this case study will provide some lessons and guidance for other challenging implementations of electronic health record systems as they continue across Africa.

9. **Implementing eHealth Technology to Address Gaps in Early Infant Diagnosis Services: Qualitative Assessment of Kenyan Provider Experiences.**

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ABSTRACT

BACKGROUND: Literature suggests that electronic health (eHealth) interventions can improve the efficiency and accuracy of health service delivery and improve health outcomes and are generally well received by patients; however, there are limited data on provider experiences using eHealth interventions in resource-limited settings. The HIV Infant Tracking System (HITSystem) is an eHealth intervention designed to improve early infant diagnosis (EID) outcomes among HIV-exposed infants.

OBJECTIVE: We aimed to compare provider experiences with standard EID and HITSystem implementation at 6 Kenyan hospitals and 3 laboratories. The objective of this study was to better understand provider experiences implementing and using the HITSystem in order to assess facilitators and barriers that may impact adoption and sustainability of this eHealth intervention.

METHODS: As part of a randomized controlled trial to evaluate the HITSystem, we conducted semi-structured interviews with 17 EID providers at participating intervention and control hospitals and laboratories.

RESULTS: Providers emphasized the perceived usefulness of the HITSystem, including improved efficiency in sample tracking and patient follow-up, strengthened communication networks among key stakeholders, and improved capacity to meet patient needs compared to standard EID. These advantages were realized from an intervention that providers saw as easy to use and largely compatible with workflow. However, supply stock outs and patient psychosocial factors (including fear of HIV status disclosure and poverty) provided ongoing challenges to EID service provision. Furthermore, slow or sporadic internet access and heavy workload prevented real-time HITSystem data entry for some clinicians.

CONCLUSIONS: Provider experiences with the HITSystem indicate that the usefulness of the HITSystem, along with the ease with which it is able to be incorporated into hospital workflows, contributes to its sustained adoption and use in Kenyan hospitals. To maximize implementation success, care should be taken in intervention design and implementation to ensure that end users see clear advantages to using the technology and to account for variations in workflows, patient populations, and resource levels by allowing flexibility to suit user needs.

10. EAIDSNet Information Communication Technology (ICT) Survey and Web Portal Development: Lesson learnt.

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ABSTRACT

An important objective of EAIDSNet was to improve the flow and quality of data on communicable diseases and sharing of information to improve the health outcomes of the East African population. We sought to conduct an Information Communication Technology (ICT) situation analysis among the participating EAIDSNet institutions with a view to determine level of usage among health care providers. Secondly, development and piloting of a web data portal that would

link existing human and animal disease surveillance reporting systems along the health faculties EAC cross border districts.

Findings from the survey was suggestive that computer literacy among health workers was high. Routine reporting of surveillance data was paper-based with the exception of Zanzibar and the Republic of Rwanda where an electronic system was in use. Open-source software was commonly used over propriety software due to license issues. Other partner states were at various stages of implementing IDSR software unique to their requirements. As part of preparatory activities towards development of a web data portal, a number of consultative meetings with healthcare managers, inter-government agencies, ICT solution providers and telecommunication operators were held where ten (10) public-health priority diseases were identified. A web-portal using the PHP web-authoring software (AdobeTM DreamweavierTM CS3) was designed capturing the 10 public-health priority diseases . We incorporated ArcView GIS-9TM and HealthMapperTM software for mapping into the web portal. As part of the pilot phase, health personnel from the national disease surveillance units of the Ministries of Health in partner states captured data into the web portal. Challenges included existence of country-specific reporting requirements; late submission of weekly epidemiological data from field stations to central units; data validation process too lengthy; and too many diverse agencies requiring different data pieces. This created a "burn-out" effect on the data personnel at the national level.

The EAIDSNet web-portal was successful in mapping trends over time for human diseases for selected regions. Cross-border health personal were able to view epidemiological maps real-time. However, a more user-friendly portal that could auto-populate data from existing country-specific and regional systems is essential to ensure sustained use of the EAIDSNet web portal.

11. **Spatial models for the rational allocation of routinely distributed bed nets to public health facilities in Western Kenya.**

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ABSTRACT

BACKGROUND: In high to moderate malaria transmission areas of Kenya, long-lasting insecticidal nets (LLINs) are provided free of charge to pregnant women and infants during routine antenatal care (ANC) and immunization respectively. Quantities of LLINs distributed to clinics are quantified based on a combination of monthly consumption data and population size of target counties. However, this approach has been shown to lead to stock-outs in targeted clinics. In this study, a

novel LLINs need quantification approach for clinics in the routine distribution system was developed. The estimated need was then compared to the actual allocation to identify potential areas of LLIN over- or under-allocation in the high malaria transmission areas of Western Kenya.

METHODS: A geocoded database of public health facilities was developed and linked to monthly LLIN allocation. A network analysis approach was implemented using the location of all public clinics and topographic layers to model travel time. Estimated travel time, socio-economic and ANC attendance data were used to model clinic catchment areas and the probability of ANC service use within these catchments. These were used to define the number of catchment population who were likely to use these clinics for the year 2015 equivalent to LLIN need. Actual LLIN allocation was compared with the estimated need. Clinics were then classified based on whether allocation matched with the need, and if not, whether they were over or under-allocated.

RESULTS: 888 (70%) public health facilities were allocated 591,880 LLINs in 2015. Approximately 682,377 (93%) pregnant women and infants were likely to have attended an LLIN clinic. 36% of the clinics had more LLIN than was needed (over-allocated) while 43% had received less (under-allocated). Increasing efficiency of allocation by diverting over supply of LLIN to clinics with less stock and fully covering 43 clinics that did not receive nets in 2015 would allow for complete matching of need with distribution.

CONCLUSION: The proposed spatial modelling framework presents a rationale for equitable allocation of routine LLINs and could be used for quantification of other maternal and child health commodities applicable in different settings. Western Kenya region received adequate LLINs for routine distribution in line with government of Kenya targets, however, the model shows important inefficiencies in the allocation of the LLINs at clinic level.

12. People, Process and Technology: Strategies for Assuring Sustainable Implementation of EMRs at Public-Sector Health Facilities in Kenya.

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ABSTRACT

The Ministry of Health (MoH) rollout of electronic medical record systems (EMRs) has continuously been embraced across health facilities in Kenya since 2012. This has been driven by a government led process supported by PEPFAR that

recommended standardized systems for facilities. Various strategies were deployed to assure meaningful and sustainable EMRs implementation: sensitization of leadership; user training, formation of health facility-level multi-disciplinary teams; formation of county-level Technical Working Groups; data migration; routine data quality assessments; point of care adoption; successive release of software upgrades; and power provision. Successes recorded include goodwill and leadership from the county management (22 counties), growth in the number of EMR trained users (2561 health care workers), collaboration in among other things, data migration(90 health facilities completed) and establishment of county TWGs (13 TWGs). Sustenance of EMRs demand across facilities is possible through; county TWGs oversight, timely resolution of users' issues and provision of reliable power.

13. An assessment of information communication technology content, context and process dimensions in public health facilities in Machakos and Nairobi counties.

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ABSTRACT

BACKGROUND: Information Communication Technology serves as the backbone in driving all sectors of national economy. ICT has therefore become increasingly important aspect in the Health Care sector because health services are information-intensive. Despite huge investment by the health sector in ICT, there is scanty information on how the different ICT dimensions affect the upscaling of ICT in the health facilities. Objective: To establish the level of ICT related content, context and process dimensions vis a vis the up scaling of ICT in health care facilities in Nairobi and Machakos counties.

METHODS: Design: a cross sectional study. Setting: Machakos and Nairobi counties levels 4-6 hospitals. Subjects: Seventy three (73) respondents drawn from the health facilities were interviewed.

RESULTS: ICT content variables studied were operations computerized, ICT facilities provided and breakdown-replacement protocol. Context variables included on-job ICT trainings, ICT training sponsorships by facility and presence of institutional ICT induction program. The process variables were staff involvement in design of ICT aspects and presence of ICT policy. Among contextual factors, presence of institutional induction training program on ICT was relatively high compared to ICT training on job and ICT training sponsorship offered by facility (χ= 28.15, d.f=2,

p<0.001 at 95%CI). Under process dimensions, presence of ICT policy at facility was higher compared to staff involvement in design of ICT aspects (χ =15.03, d.f =2 and p<0.001). Among the content factors, the ICT facilities provided was relatively high in all the facilities compared to levels of services operations computerized and breakdown-replacement protocol (χ=18.4, d.f =6 and p<0.005). Under the challenges, reliability of ICT infrastructure posed the greatest challenge towards up scaling of ICT among the content factors (χ=10.79, d.f. = 4, p-value=0.029). Process factor related challenges also had major impact on up scaling of ICT i.e. less up scaling of ICT that was attributed to lack of support from hospital top management team (χ 9.44, d.f.=4 and p=0.005). Comparing levels 5 and 6 facilities, the context dimension; presence of institutional induction training on ICT was the main factor that affected both facilities equally in relation to up scaling of ICT (p-value=0.021). Comparing level 4 facilities to level 6, process and content dimensions were the main factors that determined ICT uptake specifically availability of ICT policies in the institutions (p=0.011) and the levels of services operations that have been computerized (p=0.010) respectively.

CONCLUSION: The study findings showed that content and process dimensions were the major aspects that were critical for positive up scaling of ICT in public health facilities. These factors were setting-dependent on the classification of the facility levels, in this study the level 4 facilities had poor up scaling of ICT compared to level 5 and level 6. The specific key attributes included: Strong management involvement in ICT related matters (process dimensions), availability and implementation of an ICT policy especially among level 4(process dimension), presence of an institutional induction training program on ICT (context dimension), type of ICT support provided and its reliability (content dimension) and level of services operations computerized (content). The major challenges that hindered up scaling of ICT were reliability of ICT infrastructure under the content factors and lack of support from hospital top management team under the process related factors.

14. A scorecard for assessing functionality of community health unit in Kenya.

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ABSTRACT

INTRODUCTION: in 2005, Kenya's Ministry of Health (MOH) in its quest to improve health outcomes developed the Community Health Strategy (CHS) as a key approach. The MOH and partners grappled with the challenge of managing the functionality of the Community Health Units (CHUs). Amref Health Africa in Kenya

developed a replicable CHUs Functionality Scorecard for measuring and managing the functionality of CHUs.

METHODS: we designed and piloted the CHU Functionality Scorecard at 114 CHUs in Rift valley province in Kenya. The scorecard categorized CHUs as Functional, Semi-functional, or Non-Functional. We used before and after design to assess the functionality of the CUs.

RESULTS: over seven quarters (January 2012 to September 2013). The proportion of functional CHU increased from 3.5% to 82.9%, Semi-Functional reduced from 39% to 13% while Non-Functional reduced from 58% to 4%. The greatest improvements were noted in Community Health Volunteers (CHVs) receiving stipends, CHVs with referral booklets, monthly dialogue days, actions planning, chalk boards, and CHVs reporting rates.

CONCLUSION: the CHU functionality scorecard is a valuable tool for the management of performance, resource allocation, and decision making. We recommend the adoption of the Functionality Scorecard by the Kenya Government for country-wide application. We recommend: further work in defining Advanced Functionality and incorporating the same into the scorecard; and implementation research on long term sustainability of CHUs.

15. Lessons learned from implementing the HIV infant tracking system (HITSystem): A web-based intervention to improve early infant diagnosis in Kenya.

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ABSTRACT

OBJECTIVES: Guided by the RE-AIM model, we describe preliminary data and lessons learned from multiple serial implementations of an eHealth intervention to improve early infant diagnosis (EID) of HIV in Kenya.

METHODS: We describe the reach, effectiveness, adoption, implementation and maintenance of the HITSystem, an eHealth intervention that links key stakeholders to improve retention and outcomes in EID. Our target community includes mother-infant pairs utilizing EID services and government health care providers and lab personnel. We also explore our own role as program and research personnel supporting the dissemination and scale up of the HITSystem in Kenya.

RESULTS: Key findings illustrate the importance of continual adaptation of the HITSystem interface to accommodate varied stakeholders' workflows in different settings. Surprisingly, technology capacity and internet connectivity posed minimal short-term challenges. Early and sustained ownership of the HITSystem among stakeholders proved critical to reach, effectiveness and successful adoption, implementation and maintenance.

CONCLUSIONS: Preliminary data support the ability of the HITSystem to improve EID outcomes in Kenya. Strong and sustained collaborations with stakeholders improve the quality and reach of eHealth public health interventions.

16. **Using information communication technologies to increase the institutional capacity of local health organisations in Africa: a case study of the Kenya Civil Society Portal for Health**.

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ABSTRACT

INTRODUCTION: Achieving the healthcare components of the United Nations' Millennium Development Goals is significantly premised on effective service delivery by civil society organisations (CSOs). However, many CSOs across Africalack the necessary capacity to perform this role robustly. This paper reports on an evaluation of the use, and perceived impact, of acknowledge management tool upon institutional strengthening among CSOs working in Kenya's health sector.

METHODS: Three methods were used: analytics data; user satisfaction surveys; and a furtherkey informant survey.

RESULTS: Satisfaction with the portal was consistently high, with 99% finding the quality and relevance of the content very good or good for institutional strengthening standards, governance, and planning and resource mobilisation. Critical facilitators to the success of knowledge management for CSO institutional

strengthening were identified as people/culture (developed resources and organisational narratives) and technology (easily accessible, enabling information exchange, tools/resources available, access to consultants/partners). Critical barriers were identified as people/culture (database limitations, materials limitations, and lack of active users), and process (limited access, limited interactions, and limited approval process).

CONCLUSION: This pilot study demonstrated the perceived utility of a web-based knowledge management portal among developing nations' CSOs, with widespread satisfaction across multiple domains, which increased over time. Providing increased opportunities for collective mutual learning, promoting a culture of data use for decision making, and encouraging all health organisations to be learning institutions should be a priority for those interested in promoting sustainable long-term solutions for Africa.

17. Using Information and Communications Technology in a National Population-Based Survey: The Kenya AIDS.

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ABSTRACT

BACKGROUND: With improvements in technology, electronic data capture (EDC) for large surveys is feasible. EDC offers benefits over traditional paper-based data collection, including more accurate data, greater completeness of data, and decreased data cleaning burden.

METHODS: The second Kenya AIDS Indicator Survey (KAIS 2012) was a population-based survey of persons aged 18 months to 64 years. A software application was designed to capture the interview, specimen collection, and home-based testing and counseling data. The application included interview translations for local languages; options for single, multiple, and fill-in responses; and automated participant eligibility determination. Data quality checks were programmed to automate skip patterns and prohibit outlier responses. A data sharing architecture was developed to transmit the data in real-time from the field to a central server over a virtual private network.

RESULTS: KAIS 2012 was conducted between October 2012 and February 2013. Overall, 68,202 records for the interviews, specimen collection, and home-based testing and counseling were entered into the application. Challenges arose during implementation, including poor connectivity and a systems malfunction that created duplicate records, which prevented timely data transmission to the central server. Data cleaning was minimal given the data quality control measures.

CONCLUSIONS: KAIS 2012 demonstrated the feasibility of using EDC in a population-based survey. The benefits of EDC were apparent in data quality and minimal time needed for data cleaning. Several important lessons were learned, such as the time and monetary investment required before survey implementation, the importance of continuous application testing, and contingency plans for data transmission due to connectivity challenges.

18. The impact of routine data quality assessments on electronic medical record data quality in Kenya.

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ABSTRACT

Routine Data Quality Assessments (RDQAs) were developed to measure and improve facility-level electronic medical record (EMR) data quality. We assessed if RDQAs were associated with improvements in data quality in Kenya EMR, an HIV care and treatment EMR used at 341 facilities in Kenya. RDQAs assess data quality by comparing information recorded in paper records to Kenya EMR. RDQAs are conducted during a one-day site visit, where approximately 100 records are randomly selected and 24 data elements are reviewed to assess data completeness and concordance. Results are immediately provided to facility staff and action plans are developed for data quality improvement. For facilities that had received more than one RDQA (baseline and follow-up), we used generalized estimating equation models to determine if data completeness or concordance improved from the baseline to the follow-up RDQAs.27 facilities received two RDQAs and were included in the analysis, with 2369 and 2355 records reviewed from baseline and follow-up RDQAs, respectively. The frequency of missing data in Kenya EMR declined from the baseline (31% missing) to the follow-up (13% missing) RDQAs. After adjusting for facility characteristics, records from follow-up RDQAs had 0.43-times the risk (95% CI: 0.32-0.58) of having

at least one missing value among nine required data elements compared to records from baseline RDQAs. Using a scale with one point awarded for each of 20 data elements with concordant values in paper records and Kenya EMR, we found that data concordance improved from baseline (11.9/20) to follow-up (13.6/20) RDQAs, with the mean concordance score increasing by 1.79 (95% CI: 0.25-3.33).This manuscript demonstrates that RDQAs can be implemented on a large scale and used to identify EMR data quality problems. RDQAs were associated with meaningful improvements in data quality and could be adapted for implementation in other settings.

19. Source Data Verification: A Process for Ensuring Data Quality and Integrity in a TB Vaccine Clinical Trial Enrolling Infants in Western Kenya.

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BACKGROUND: ICH GCP requires that data quality and integrity are upheld while conducting clinical trials. Advances in technology led to increase in use of electronic data capture systems (EDCs). Source Data Verification (SDV) is a process of comparing edata to source documents to ensure that data is verifiable to the source.

OBJECTIVE: To determine the effectives of Source Data Verification in ensuring data validity, quality and integrity.

MATERIALS AND METHODS: Data is entered into EDCs by the clinical/nursing officers and automatically sent to data center. After data entry, Data and QC staff performs 100% SDV on all subjects. In the first week of enrollment, QA officers perform 100% SDV, thereafter 20-50% SDV. This is over and above checks done by Data and QC teams. Any inconsistencies and errors found are flagged, entered on SDV tracker and respective staff makes the required corrections. A weekly report for error rates and resolution status is generated. AERAS data management team also analyzes data and post queries on the system which are responded to by clinical officers.

RESULTS: For all completed study visits, 100% SDV was done on all subjects by Data staff. A total of 551 errors were discovered. Overall, the approximate time for SDV was 9 months by 3 Data staff and 1 QA officer. The data reviewed by the monitors was found to be mostly clean except few transcription and errors reduced significantly.

DISCUSSION: SDV is a simple step that can dramatically improve data quality. Due to the SDV process, Data staffing has thus evolved from entry to cleaning.

CONCLUSION AND RECOMMENDATION: Adequate Data and QC staff capacity to perform SDV can help in reducing errors. The process would be more efficient if the staff doing SDV had a special interface to facilitate flagging of errors.

20. Impact of a decision-support tool on decision making at the district level in Kenya.

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ABSTRACT

BACKGROUND: In many countries, the responsibility for planning and delivery of health services is devolved to the subnational level. Health programs, however, often fall short of efficient use of data to inform decisions. As a result, programs are not as effective as they can be at meeting the health needs of the populations they serve. In Kenya, a decision-support tool, the District Health Profile (DHP) tool was developed to integrate data from health programs, primarily HIV, at the district level and to enable district health management teams to review and monitor program progress for specific health issues to make informed service delivery decisions.

METHODS: Thirteen in-depth interviews were conducted with ten tool users and three non-users in six districts to qualitatively assess the process of implementing the tool and its effect on data-informed decision making at the district level. The factors that affected use or non-use of the tool were also investigated. Respondents were selected via convenience sample from among those that had been trained to use the DHP tool except for one user who was self-taught to use the tool. Selection criteria also included respondents from urban districts with significant resources as well as respondents from more remote, under-resourced districts.

RESULTS: Findings from the in-depth interviews suggest that among those who used it, the DHP tool had a positive effect on data analysis, review, interpretation, and sharing at the district level. The automated function of the tool allowed for faster data sharing and immediate observation of trends that facilitated data-informed decision making. All respondents stated that the DHP tool assisted them to better target existing services in need of improvement and to plan future services, thus positively influencing program improvement.

CONCLUSIONS: This paper stresses the central role that a targeted decision-support tool can play in making data aggregation, analysis, and presentation easier and faster. The visual synthesis of data facilitates the use of information in health decision making at the district level of a health system and promotes program improvement. The experience in Kenya can be applied to other countries that face challenges making district-level, data-informed decisions with data from fragmented information systems.

21. National Roll out of District Health Information Software (DHIS 2) in Kenya, 2011 – Central Server and Cloud based Infrastructure.

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ABSTRACT

Recent years have seen an increasing focus on the strengthening of Health Information Systems (HIS) in countries. On the ground, however, HIS development in Africa has proved difficult due to; 1) poor and unevenly developed infrastructure, 2) fragmented health programs and donor initiatives and 3) poor capacity. In this paper, we present the case study of Kenya, where a web based system for data management was developed using the free and open source DHIS2 platform and rolled out countrywide during 2011. This case study shows that with the improvement of Information and Communication Technology (ICT) infrastructure, it is possible to deploy web based systems countrywide in Africa using central server and "cloud" based infrastructure. Further, by demonstrating success, rapid deployment and increasing data reporting rates, additional health programs and donor initiatives are now joining forces, and thereby helping integrating the previously fragmented HIS. The lessons regarding capacity development is that the instant access to own data, from "anywhere" and at "any time", has greatly improved the sense of "ownership" to the data and the system and thereby enabling important learning-by-doing processes significantly complementing the formal training and support activities. Users across Kenya are now able to access the system online through modems over the mobile Internet and web enabled mobile telephones. The new HTML 5 web standard is adding to this positive technology development through increased memory in the browsers, which makes it possible to capture data "offline" and thereby better handling fluctuations in connectivity and poor Internet.

22. Spatial Modelling of Soil-Transmitted Helminth Infections in Kenya: A Disease Control Planning Tool.

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ABSTRACT

BACKGROUND: Implementation of control of parasitic diseases requires accurate, contemporary maps that provide intervention recommendations at policy-relevant spatial scales. To guide control of soil transmitted helminths (STHs), maps are required of the combined prevalence of infection, indicating where this prevalence exceeds an intervention threshold of 20%. Here we present a new approach for mapping the observed prevalence of STHs, using the example of Kenya in 2009.

METHODS AND FINDINGS: Observed prevalence data for hookworm, Ascaris lumbricoides and Trichuris trichiura were assembled for 106,370 individuals from 945 cross-sectional surveys undertaken between 1974 and 2009. Ecological and climatic covariates were extracted from high-resolution satellite data and matched to survey locations. Bayesian space-time geostatistical models were developed for each species, and were used to interpolate the probability that infection prevalence exceeded the 20% threshold across the country for both 1989 and 2009. Maps for each species were integrated to estimate combined STH prevalence using the law of total probability and incorporating a correction factor to adjust for associations between species. Population census data were combined with risk models and projected to estimate the population at risk and requiring treatment in 2009. In most areas for 2009, there was high certainty that endemicity was below the 20% threshold, with areas of endemicity =20% located around the shores of Lake Victoria and on the coast. Comparison of the predicted distributions for 1989 and 2009 show how observed STH prevalence has gradually decreased over time. The model estimated that a total of 2.8 million school-age children live in districts which warrant mass treatment.

CONCLUSIONS: Bayesian space-time geostatistical models can be used to reliably estimate the combined observed prevalence of STH and suggest that a quarter of Kenya's school-aged children live in areas of high prevalence and warrant mass treatment. As control is successful in reducing infection levels, updated models can be used to refine decision making in helminth control.

23. **Utilization of ICTs for Accessing Health Information by Medical Professionals in Kenya: A Case Study of Kenyatta National Hospital.**

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ABSTRACT

BACKGROUND: The study was conceived with the aim of investigating the availability and utilization of information and communication technology for accessing health information by medical professionals in Kenya. The study started from the premise that access to relevant information and knowledge is critical to the delivery of effective healthcare services.

OBJECTIVES: These were to: identify the information needs of the medical professionals; determine the sources and channels of information used by the medical professionals; identify the factors for which they require ICT support in accessing health information; establish the extent of the current usage and level of adoption of ICTs among the medical professionals; determine the potential challenges and prospects of utilization of ICTs in health information access; and suggest and recommend measures to be taken into account in the improvement, adoption and use of ICTs in health information access by the medical professionals.

DESIGN: Semi-structured qualitative interview study. Data were collected on individual occurrences of the phenomenon. Grounded theory approach was used as an analytical tool.

SETTING: The research was exploratory in nature and used Kenyatta National Hospital as a case study.

RESULTS: Major themes that emerged from the data are highlighted. The key findings of the study were that: medical professionals needed information continuously in the course of their clinical work. Clinical governance, care of patients and professional updating on the current medical practices were the main reasons for needing and seeking information. When the medical professionals needed clinical information, they turned to colleagues. Text books and journals were also frequently used sources of information. However, there was a substantial preference for e-searching for information from the internet and e-journals. The findings revealed lack of library and information services, inadequate access and use of electronic information resources and inadequate ICT skills among the medical professionals.

CONCLUSIONS: Many critical information needs of the medical professionals were not being met adequately. Improved usage of ICT was viewed as the only realistic strategy for enhancing information access and information sharing among the medical professionals at the hospital. Recommendations for enhancing access to health information at KNH include: establishment of a hospital library and information services; appointment of information professionals with skills and capabilities to conduct online information searches to assist in clinical decision-making and ability to train clinicians in ICT skills; formulation of ICT strategies and policy; capital investments in the form of internet and supporting ICT infrastructure; involvement of all stakeholders; and allocation of adequate financial resources for improved access to health information by the medical professionals. A framework for establishing an e-health library was proposed and presented.

24. A spatial national health facility database for public health sector planning in Kenya in 2008.

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ABSTRACT

BACKGROUND: Efforts to tackle the enormous burden of ill-health in low-income countries are hampered by weak health information infrastructures that do not support appropriate planning and resource allocation. For health information systems to function well, a reliable inventory of health service providers is critical. The spatial referencing of service providers to allow their representation in a geographic information system is vital if the full planning potential of such data is to be realized.

METHODS: A disparate series of contemporary lists of health service providers were used to update a public health facility database of Kenya last compiled in 2003. These new lists were derived primarily through the national distribution of antimalarial and antiretroviral commodities since 2006. A combination of methods, including global positioning systems, was used to map service providers. These spatially-referenced data were combined with high-resolution

population maps to analyze disparity in geographic access to public health care.

FINDINGS: The updated 2008 database contained 5,334 public health facilities (67% ministry of health; 28% mission and nongovernmental organizations; 2% local authorities; and 3% employers and other ministries). This represented an overall increase of 1,862 facilities compared to 2003. Most of the additional facilities belonged to the ministry of health (79%) and the majority were dispensaries (91%). 93% of the health facilities were spatially referenced, 38% using global positioning systems compared to 21% in 2003. 89% of the population was within 5 km Euclidean distance to a public health facility in 2008 compared to 71% in 2003. Over 80% of the population outside 5 km of public health service providers was in the sparsely settled pastoralist areas of the country.

CONCLUSION: We have shown that, with concerted effort, a relatively complete inventory of mapped health services is possible with enormous potential for improving planning. Expansion in public health care in Kenya has resulted in significant increases in geographic access although several areas of the country need further improvements. This information is key to future planning and with this paper we have released the digital spatial database in the public domain to assist the Kenyan Government and its partners in the health sector.

25. The AMPATH Medical Record System: Creating, Implementing, and Sustaining an Electronic Medical Record System to Support HIV/AIDS Care in Western Kenya.

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ABSTRACT

Providing high-quality HIV/AIDS care requires high-quality, accessible data on individual patients and visits. These data can also drive strategic decision-making by health systems, national programs, and funding agencies. One major obstacle to HIV/AIDS care in developing countries is lack of electronic medical record systems (EMRs) to collect, manage, and report clinical data. In 2001, we implemented a simple primary care EMR at a rural health centre in western Kenya. This EMR evolved into a comprehensive, scalable system serving 19 urban and rural health centres. To date, the AMPATH Medical Record System contains 10 million observations from 400,000 visit records on 45,000 patients. Critical

components include paper encounter forms for adults and children, technicians entering/managing data, and modules for patient registration, scheduling, encounters, clinical observations, setting user privileges, and a concept dictionary. Key outputs include patient summaries, care reminders, and reports for program management, operating ancillary services (e.g., tracing patients who fail to return for appointments), strategic planning (e.g., hiring health care providers and staff), reports to national AIDS programs and funding agencies, and research.

26. Spatial relationship between adult malaria vector abundance and environmental factors in western Kenya highlands.

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ABSTRACT

Information on the spatial relationships between disease vectors and environmental factors is fundamental to vector-borne disease control. Although it is well known that mosquito abundance is associated with the amount of rainfall and thus the number of larval breeding sites, the spatial relationship between larval habitat availability and adult mosquito abundance is not clear. We investigated the impact of environmental heterogeneity and larval habitats on the spatial distribution of Anopheles *gambiae s. s.* and *An. funestus* adult mosquitoes, the most important malaria vectors in the highlands of western Kenya. Mosquito sampling was conducted in May, August, and November 2002, and February 2003. Geographic information system layers of larval habitats, land use type, human population distribution, house structure, and hydrologic schemes were overlaid with adult mosquito abundance. Correlography was used to determine the spatial autocorrelation in adult mosquito abundance among houses and the cross-correlation between adult mosquito abundance and environmental factors. Getis' G(i)(*)(d) index was used to define focal adult mosquito abundance clusters. We found a significant autocorrelation in the vector population and a significant cross-correlation between the vector population and larval habitat availability. The threshold distances of both autocorrelation and cross-correlation were significantly varied among seasons. Focal clustering analysis revealed that the adult vector population was concentrated along the Yala River Valley where most larval habitats were found. Regression analysis found that distance of a house to the Yala River, age of the house, elevation, house structure, and tree canopy coverage significantly affected adult mosquito abundance. Our results suggest that vector control targeted at malaria transmission hotspots and supplemented by larval control

may be an effective approach for epidemic malaria control in the western Kenya highlands.

27. Evaluation of existing District Health Management Information Systems: A case study of the District Health Systems in Kenya.

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ABSTRACT

INTRODUCTION: This paper discusses some of the issues and challenges of implementing appropriate and coordinated District Health Management Information System (DHMIS) in environments dependent on external support especially when insufficient attention has been given to the sustainability of systems. It also discusses fundamental issues which affect the usability of DHMIS to support District Health System (DHS), including meeting user needs and user education in the use of information for management; and the need for integration of data from all health-providing and related organizations in the district.

METHODS: This descriptive cross-sectional study was carried out in three DHSs in Kenya. Data was collected through use of questionnaires, focus group discussions and review of relevant literature, reports and operational manuals of the studied DHMISs.

RESULTS: Key personnel at the DHS level were not involved in the development and implementation of the established systems. The DHMISs were fragmented to the extent that their information products were bypassing the very levels they were created to serve. None of the DHMISs was computerized. Key resources for DHMIS operation were inadequate. The adequacy of personnel was 47%, working space 40%, storage space 34%, stationery 20%, 73% of DHMIS staff were not trained, management support was 13%. Information produced was 30% accurate, 19% complete, 26% timely, 72% relevant; the level of confidentiality and use of information at the point of collection stood at 32% and 22% respectively and information security at 48%. Basic DHMIS equipment for information processing was not available. This inhibited effective and efficient provision of information services.

CONCLUSIONS: An effective DHMIS is essential for DHS planning, implementation, monitoring and evaluation activities. Without accurate, timely, relevant and complete information the existing information systems are not capable of facilitating the DHS managers in their day-today operational management. The

existing DHMISs were found not supportive of the DHS managers' strategic and operational management functions. Consequently DHMISs were found to be plagued by numerous designs, operational, resources and managerial problems. There is an urgent need to explore the possibilities of computerizing the existing manual systems to take advantage of the potential uses of microcomputers for DHMIS operations within the DHS. Information system designers must also address issues of cooperative partnership in information activities, systems compatibility and sustainability.

28. Empirical modelling of government health service use by children with fevers in Kenya.

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ABSTRACT

An understanding of spatial patterns of health facility use allows a more informed approach to the modelling of catchment populations. In the absence of patient use data, an intuitive and commonly used approach to the delineation of facility catchment areas is Thiessen polygons. This study presents a series of methods by which the validity of these assumptions can be tested directly and hence the suitability of a Thiessen polygon catchment model explicitly assessed. These methods are applied to paediatric out-patient origin data from a sample of 81 government health facilities in four districts of Kenya. A geographical information system was used to predict the location of the catchment boundary along a transect between each pair of neighbouring facilities based on patient choice patterns. The mean location of boundaries between facilities of different type was found to be significantly displaced from the Thiessen boundary towards the lower-order facility. The affect of distance on within-catchment utilization rate

was assessed by using exclusion buffers to remove the effect of neighbouring facilities. Utilization rate was found to exhibit a slight but steady decrease with distance up to 6 km from a facility. The accuracy of the future modelling of unsampled facility catchments can be increased by the incorporation of these trends.

29. Creating spatially defined databases for equitable health service planning in low-income countries: the example of Kenya.

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ABSTRACT

Equity is an important criterion in evaluating health system performance. Developing a framework for equitable and effective resource allocation for health depends upon knowledge of service providers and their location in relation to the population they should serve. The last available map of health service providers in Kenya was developed in 1959. We have built a health service provider database from a variety of traditional government and opportunistic non-government sources and positioned spatially these facilities using global positioning systems, hand-drawn maps, topographical maps and other sources. Of 6674 identified service providers, 3355 (50%) were private sector, employer-provided or specialist facilities and only 39% were registered in the Kenyan Ministry of Health database during 2001. Of 3319 public service facilities supported by the Ministry of Health, missions, not-for-profit organizations and local authorities, 84% were registered on a Ministry of Health database and we were able to acquire co-ordinates for 92% of these. The ratio of public health services to population changed from 1:26,000 in 1959 to 1:9300 in 1999–2002.There were 82% of the population within 5 km of a public health facility and resident in 20% of the country. Our efforts to recreate a comprehensive, spatially defined list of health service providers has identified a number of weaknesses in existing national health management information systems, which with an increased commitment and minimal costs can be redressed. This will enable geographic information systems to exploit more fully facility-based morbidity data, population distribution and health access models to target resources and monitor the ability of health sector reforms to achieve equity in service provision.

30. Information Support for the Ambulant Health Worker.

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ABSTRACT

Health workers are trained to work in information-rich environments. Nineteen medical students evaluated 2700 patients in four villages in Kenya where there was no power or phone. A model of information support included personal digital assistants (PDA), electronic medical records (EMR), satellite telecommunications, medical software, and solar power. The students promptly found the advantages of PDA over paper. By using software for decision support and interacting with the EMR data for medical expertise, very few live telemedicine consults were needed. The cost of this information support was only $0.28 per patient visit. We conclude information resources can be provided in remote environments at reasonable cost.

31. Defining approaches to settlement mapping for public health management in Kenya using medium spatial resolution satellite imagery.

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ABSTRACT

This paper presents an appraisal of satellite imagery types and texture measures for identifying and delineating settlements in four Districts of Kenya chosen to represent the variation in human ecology across the country. Landsat Thematic Mapper (TM) and Japanese Earth Resources Satellite-1 (JERS-1) synthetic aperture radar (SAR) imagery of the four districts were obtained and supervised per-pixel classifications of image combinations tested for their efficacy at

settlement delineation. Additional data layers including human population census data, land cover, and locations of medical facilities, villages, schools and market centres were used for training site identification and validation. For each district, the most accurate approach was determined through the best correspondence with known settlement and non-settlement pixels. The resulting settlement maps will be used in combination with census data to produce medium spatial resolution population maps for improved public health planning in Kenya.

32. Defining equity in physical access to clinical services using geographical information systems as part of malaria planning and monitoring in Kenya.

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ABSTRACT

SUMMARY: Distance is a crucial feature of health service use and yet its application and utility to health care planning have not been well explored, particularly in the light of large-scale international and national efforts such as Roll Back Malaria. We have developed a high-resolution map of population-to-service access in four districts of Kenya. Theoretical physical access, based upon national targets, developed as part of the Kenyan health sector reform agenda, was compared with actual health service usage data among 1668 paediatric patients attending 81 sampled government health facilities. Actual and theoretical use were highly correlated. Patients in the larger districts of Kwale and Makueni, where access to government health facilities was relatively poor, travelled greater mean distances than those in Greater Kisii and Bondo. More than 60% of the patients in the four districts attended health facilities within a 5-km range. Interpolated physical access surfaces across districts highlighted areas of poor access and large differences between urban and rural settings. Users from rural communities travelled greater distances to

health facilities than those in urban communities. The implications of planning and monitoring equitable delivery of clinical services at national and international levels are discussed.

33. The Mosoriot medical record system: design and initial implementation of an outpatient electronic record system in rural Kenya.

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ABSTRACT

Mosoriot Health Center is a rural primary care facility situated on the outskirts of Eldoret, Kenya in sub-Saharan Africa. The region is characterised by widespread poverty and a very poor technology infrastructure. Many houses do not have electricity, telephones or tap water. The health center does have electricity and tap water. In a collaborative project between Indiana University and the Moi University Faculty of Health Sciences (MUFHS), we designed a core electronic medical record system within the Mosoriot Health Center, with the intention of improving the quality of health data collection and, subsequently, patient care. The electronic medical record system will also be used to link clinical data from the health center to information collected from the public health surveys performed by medical students participating in the public health research programs of Moi University. This paper describes the processes involved in the development of the computer-based Mosoriot medical record system (MMRS) up to the point of implementation. It particularly focuses on the decisions and trade-offs that must be made when introducing this technology into an established health care system in a developing country.

34. A geographic information system applied to a malaria field study in western Kenya.

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ABSTRACT

This paper describes use of the global positioning system (GPS) in differential mode (DGPS) to obtain highly accurate longitudes, latitudes, and altitudes of 1,169 houses,

15 schools, 40 churches, four health care centers, 48 major mosquito breeding sites, 10 borehole wells, seven shopping areas, major roads, streams, the shore of Lake Victoria, and other geographic features of interest associated with a longitudinal study of malaria in 15 villages in western Kenya. The area mapped encompassed approximately 70 km2 and included 42.0 km of roads, 54.3 km of streams, and 15.0 km of lake shore. Location data were entered into a geographic information system for map production and linkage with various databases for spatial analyses. Spatial analyses using parasitologic and entomologic data are presented as examples. Background information on DGPS is presented along with estimates of effort and expense to produce the map information.

PIP:The global positioning satellite (GPS) network system is comprised of 24 satellites orbiting at an altitude of about 10,900 miles. The authors describe how a simple modification of GPS known as differential GPS (DGPS) can be used to produce a highly accurate base map in a tropical area. DGPS circumvents the effects of selective availability (SA) error, an intentional error component added for security purposes at each satellite, to yield a highly accurate position fix. This paper documents the use of DGPS to obtain highly accurate longitudes, latitudes, and altitudes of 1169 houses, 15 schools, 40 churches, 4 health care centers, 48 major mosquito breeding sites, 10 borehole wells, 7 shopping areas, major roads, streams, the shore of Lake Victoria, and other geographic features of interest associated with a longitudinal study of malaria in 15 villages in western Kenya. 70 sq. km were mapped, including 42.0 km of roads, 54.3 km of streams, and 15.0 km of lake shore. Location data were entered into a geographic information system for map production and linkage with various databases for spatial analyses. Spatial analyses using parasitologic and entomologic data are presented as examples. Less than $25,000 was spent upon this project, of which $15,000 was for hardware and software.

35. Health care technology in public health institutions in Kenya.

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ABSTRACT

OBJECTIVE: To highlight the role of technology in the practice of medicine and the delivery of health care in public hospitals, the problems encountered and suggested solutions.

DESIGN: The article reviews the process of technology planning, acquisition, management and assessment. Analysis of results and observations leads to recommendation and suggestions.

SETTING: Health care technology assessment in hospitals in Kenya and South Africa 1998.

INSTITUTIONS: Twenty four hospitals in Kenya and 54 hospitals in South Africa.

RESULTS: Technology assessment as a health policy instrument and planning tool has not gained recognition in Kenya; acquisition of health care equipment is not done on the basis of evidence from relative advantage outcome, cost of ownership or returns on investment; tender boards lack the technical expertise to make clinical and technical evaluations of health care equipment and; health care is compromised due to poor equipment acquisition.

CONCLUSION: The planning, deployment, management and assessment of technology should be fully integrated into health policy and planning. Policy guidelines should include the regulation, control and utilisation of health care technologies.

36. Health information for district level planning: a cross-sectional household survey in rural Kenya.

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ABSTRACT

Health care planning and management in sub-Saharan Africa is being decentralised, and health information systems need to meet new needs. This study in rural Kenya explored the feasibility of a cross-sectional household health interview survey to help district-level health planning. Heads of 390 households were interviewed about health-related factors like housing standard, water supply, sanitation, recent illness, and health care use. Half of all households lived on farming. Access to water sources was poor, but latrine coverage was high. Of all disease episodes 26% were respiratory, 18% gastrointestinal and 10.5% malaria. Rates of illness episodes were low (1.0 day of illness/person/30 days), and 40% of episodes were taken to a modern service provider like a dispensary, health centre or hospital. The survey generated much information on household characteristics, illness episodes and action taken, data that was not available through the routine health information system. Survey costs were estimated at 15 US cents per resident in the project area, a large proportion of which was absorbed by computerized data processing, but may be reduced to about half. If conducted once every three or four years, a survey of this kind would be affordable within the ordinary recurrent district health budget and would provide useful planning and management information.

Rwanda

37. The impact of an mHealth monitoring system on health care utilization by mothers and children: an evaluation using routine health information in Rwanda.

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ABSTRACT

Maternal and child mortality rates remain unacceptably high globally, particularly in sub-Saharan Africa. A popular approach to counter these high rates is interventions delivered using mobile phones (mHealth). However, few mHealth interventions have been implemented nationwide and there has been little evaluation of their effectiveness, particularly at scale. Therefore, we evaluated the Rwanda RapidSMS programme-one of the few mHealth programmes in Africa that is currently operating nationwide. Using interrupted time series analysis and monthly data routinely reported by public health centres (n = 461) between 2012 and 2016, we studied the impact of RapidSMS on four indicators: completion of four antenatal care visits, deliveries in a health facility, postnatal care visits and malnutrition screening. We stratified all analyses based on whether the district received concurrent additional supports, including staff and equipment (10 out of 30 Districts). We found that community health workers in Rwanda sent more than 9.3 million messages using RapidSMS, suggesting the programme was successfully implemented. We found that the implementation of the RapidSMS system combined with additional support including training, supervision and equipment provision increased the use of maternal and child health services. In contrast, implementing the RapidSMS system alone was ineffective. This suggests that mHealth programmes alone may be insufficient to improve the use of health services. Instead, they should be considered as a part of more comprehensive interventions that provide the necessary equipment and health system capacity to support them.

38. Measuring ability to assess claims about treatment effects: a latent trait analysis of items from the 'Claim Evaluation Tools' database using Rasch modelling.

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ABSTRACT

BACKGROUND: The Claim Evaluation Tools database contains multiple-choice items for measuring people's ability to apply the key concepts they need to know to be able to assess treatment claims. We assessed items from the database using Rasch analysis to develop an outcome measure to be used in two randomised trials in Uganda. Rasch analysis is a form of psychometric testing relying on Item Response Theory. It is a dynamic way of developing outcome measures that are valid and reliable.

OBJECTIVES: To assess the validity, reliability and responsiveness of 88 items addressing 22 key concepts using Rasch analysis.

PARTICIPANTS: We administrated four sets of multiple-choice items in English to 1114 people in Uganda and Norway, of which 685 were children and 429 were adults (including 171 health professionals). We scored all items dichotomously. We explored summary and individual fit statistics using the RUMM2030 analysis package. We used SPSS to perform distractor analysis.

RESULTS: Most items conformed well to the Rasch model, but some items needed revision. Overall, the four item sets had satisfactory reliability. We did not identify significant response dependence between any pairs of items and, overall, the magnitude of multidimensionality in the data was acceptable. The items had a high level of difficulty.

CONCLUSION: Most of the items conformed well to the Rasch model's expectations. Following revision of some items, we concluded that most of the items were suitable for use in an outcome measure for evaluating the ability of children or adults to assess treatment claims.

39. Consensus-based approach to develop a measurement framework and identify a core set of indicators to track implementation and progress towards effective coverage of facility-based Kangaroo Mother Care.

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ABSTRACT

BACKGROUND: As efforts to scale up the delivery of Kangaroo Mother Care (KMC) in facilities are increasing, a standardized approach to measure implementation and progress towards effective coverage is needed. Here, we describe a consensus-based approach to develop a measurement framework and identify a core set of indicators for monitoring facility-based KMC that would be feasible to measure within existing systems.

METHODS**:** The KMC measurement framework and core list of indicators were developed through: 1) scoping exercise to identify potential indicators through literature review and requests from researchers and program implementers; and 2) face-to-face consultations with KMC and measurement experts working at country and global levels to review candidate indicators and finalize selection and definitions.

RESULTS**:** The KMC measurement framework includes two main components: 1) service readiness, based on the WHO building blocks framework; and 2) service delivery action sequence covering identification, service initiation, continuation to discharge, and follow-up to graduation. Consensus was reached on 10 core indicators for KMC, which were organized according to the measurement

framework. We identified 4 service readiness indicators, capturing national level policy for KMC, availability of KMC indicators in HMIS, costed operational plans for KMC and availability of KMC services at health facilities with inpatient maternity services. Six indicators were defined for service delivery, including weighing of babies at birth, identification of those ≤2000 g, initiation of facility-based KMC, monitoring the quality of KMC, status of babies at discharge from the facility and levels of follow-up (according to country-specific protocol).

CONCLUSIONS**:** These core KMC indicators, identified with input from a wide range of global and country-level KMC and measurement experts, can aid efforts to strengthen monitoring systems and facilitate global tracking of KMC implementation. As data collection systems advance, we encourage program managers and evaluators to document their experiences using this framework to measure progress and allow indicator refinement, with the overall aim of working towards sustainable, country-led data systems.

40. Effect of pentavalent rotavirus vaccine introduction on hospital admissions for diarrhoea and rotavirus in children in Rwanda: a time-series analysis.

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ABSTRACT

BACKGROUND**:** In May, 2012, Rwanda became the first low-income African country to introduce pentavalent rotavirus vaccine into its routine national immunisation programme. Although the potential health benefits of rotavirus vaccination are huge in low-income African countries that account for more than half the global deaths from rotavirus, concerns remain about the performance of oral rotavirus vaccines in these challenging settings.

METHODS**:** We conducted a time-series analysis to examine trends in admissions to hospital for non-bloody diarrhoea in children younger than 5 years in Rwanda between Jan 1, 2009, and Dec 31, 2014, using monthly discharge data from the Health Management Information System. Additionally, we reviewed the registries in the paediatric wards at six hospitals from 2009 to 2014 and abstracted the number of total admissions and admissions for diarrhoea in children younger than 5 years by admission month and age group. We studied trends in admissions specific to rotavirus at one hospital that had undertaken active rotavirus surveillance from 2011 to 2014. We assessed changes in rotavirus epidemiology by use of data from eight active surveillance hospitals.

FINDINGS**:** Compared with the 2009-11 prevaccine baseline, hospital admissions for non-bloody diarrhoea captured by the Health Management Information System fell by 17-29% from a pre-vaccine median of 4051 to 2881 in 2013 and 3371 in 2014, admissions for acute gastroenteritis captured in paediatric ward registries decreased by 48-49%, and admissions specific to rotavirus captured by active surveillance fell by 61-70%. The greatest effect was recorded in children age-eligible to be vaccinated, but we noted a decrease in the proportion of children with diarrhoea testing positive for rotavirus in almost every age group.

INTERPRETATION**:** The number of admissions to hospital for diarrhoea and rotavirus in Rwanda fell substantially after rotavirus vaccine implementation, including among older children age-ineligible for vaccination, suggesting indirect protection through reduced transmission of rotavirus. These data highlight the benefits of routine vaccination against rotavirus in low-income settings.

41. **The Role of Hospital Information Systems in Universal Health Coverage Monitoring in Rwanda.**

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ABSTRACT

In this retrospective study, the authors monitored the patient health coverage in 6 Rwandan hospitals in the period between 2011 and 2014. Among the 6 hospitals, 2 are third level hospitals, 2 district hospitals and 2 private hospitals. Patient insurance and financial data were extracted and analyzed from OpenClinic GA, an open source hospital information system (HIS) used in those 6 hospitals. The percentage of patients who had no health insurer globally decreased from 35% in 2011 to 15% in 2014. The rate of health insurance coverage in hospitals varied between 75% in private hospitals and 84% in public hospitals. The amounts paid by the patients for health services decreased in private hospitals to 25% of the total costs in 2014 (-7.4%) and vary between 14% and 19% in public hospitals. Although the number of insured patients has increased and the patient share decreased over the four years of study, the patients' out-of-pocket payments increased especially for in-patients. This study emphasizes the value of integrated hospital information systems for this kind of health economics research in developing countries.

42. **Human Factors Predicting Failure and Success in Hospital Information System Implementations in Sub-Saharan Africa.**

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ABSTRACT

From 2007 through 2014, the authors participated in the implementation of open source hospital information systems (HIS) in 19 hospitals in Rwanda, Burundi, DR Congo, Congo-Brazzaville, Gabon, and Mali. Most of these implementations were successful, but some failed. At the end of a seven-year implementation effort, a number of risk factors, facilitators, and pragmatic approaches related to the

deployment of HIS in Sub-Saharan health facilities have been identified. Many of the problems encountered during the HIS implementation process were not related to technical issues but human, cultural, and environmental factors. This study retrospectively evaluates the predictive value of 14 project failure factors and 15 success factors in HIS implementation in the Sub-Saharan region. Nine of the failure factors were strongly correlated with project failure, three were moderately correlated, and one weakly correlated. Regression analysis also confirms that eight factors were strongly correlated with project success, four moderately correlated, and two weakly correlated. The study results may help estimate the expedience of future HIS projects.

43. **Health Informatics: Developing a Master's Programme in Rwanda based on the IMIA Educational Recommendations and the IMIA Knowledge Base.**

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ABSTRACT

Since 2011, the Regional e-Health Center of Excellence in Rwanda (REHCE) has run an MSc in Health Informatics programme (MSc HI). A programme review was commissioned in February 2014 after 2 cohorts of students completed the post-graduate certificate and diploma courses and most students had started preparatory activity for their master dissertation. The review developed a method for mapping course content on health informatics competences and knowledge units. Also the review identified and measured knowledge gaps and content redundancy. Using this method, we analyzed regulatory and programme documents combined with stakeholder interviews, and demonstrated that the existing MSc HI curriculum did not completely address the needs of the Rwandan health sector. Teaching strategies did not always match students' expectations. Based on a detailed Rwandan health informatics needs assessment, International Medical Informatics Association (IMIA)'s Recommendations on Education in Biomedical and Health Informatics and the IMIA Health Informatics Knowledge Base, a new curriculum was developed and provided a better competences match for the specifics of healthcare in the Central African region. The new approved curriculum will be implemented in the 2014/2015 academic year and options for regional extension of the programme to Eastern DRC (Bukavu) and Burundi (Bujumbura) are being investigated.

44. Toward utilization of data for program management and evaluation: quality assessment of five years of health management information system data in Rwanda.

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ABSTRACT

BACKGROUND**:** Health data can be useful for effective service delivery, decision making, and evaluating existing programs in order to maintain high quality of healthcare. Studies have shown variability in data quality from national health management information systems (HMISs) in sub-Saharan Africa which threatens utility of these data as a tool to improve health systems. The purpose of this study is to assess the quality of Rwanda's HMIS data over a 5-year period.

METHODS**:** The World Health Organization (WHO) data quality report card framework was used to assess the quality of HMIS data captured from 2008 to 2012 and is a census of all 495 publicly funded health facilities in Rwanda. Factors assessed included completeness and internal consistency of 10 indicators selected based on WHO recommendations and priority areas for the Rwanda national health sector. Completeness was measured as percentage of non-missing reports. Consistency was measured as the absence of extreme outliers, internal consistency between related indicators, and consistency of indicators over time. These assessments were done at the district and national level.

RESULTS**:** Nationally, the average monthly district reporting completeness rate was 98% across 10 key indicators from 2008 to 2012. Completeness of indicator data increased over time: 2008, 88%; 2009, 91%; 2010, 89%; 2011, 90%; and 2012, 95% (p<0.0001). Comparing 2011 and 2012 health events to the mean of the three preceding years, service output increased from 3% (2011) to 9% (2012). Eighty-three percent of districts reported ratios between related indicators (ANC/DTP1, DTP1/DTP3) consistent with HMIS national ratios. Conclusion and policy implications: Our findings suggest that HMIS data quality in Rwanda has been improving over time. We recommend maintaining these assessments to identify remaining gaps in data quality and that results are shared publicly to support increased use of HMIS data.

key words: Rwanda; data quality; data use; global health; health management information system; quality improvement

45. Nationwide implementation of integrated community case management of childhood illness in Rwanda.

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ABSTRACT

BACKGROUND**:** Between 2008 and 2011, Rwanda introduced integrated community case management (iCCM) of childhood illness nationwide. Community health workers in each of Rwanda's nearly 15,000 villages were trained in iCCM and equipped for empirical diagnosis and treatment of pneumonia, diarrhea, and malaria; for malnutrition surveillance; and for comprehensive reporting and referral services.

METHODS: We used data from the Rwanda health management information system (HMIS) to calculate monthly all-cause under-5 mortality rates, health facility use rates, and community-based treatment rates for childhood illness in each district. We then compared a 3-month baseline period prior to iCCM implementation with a seasonally matched comparison period 1 year after iCCM implementation. Finally, we compared the actual changes in all-cause child mortality and health facility use over this time period with the changes that would have been expected based on baseline trends in Rwanda.

RESULTS: The number of children receiving community-based treatment for diarrhea and pneumonia increased significantly in the 1-year period after iCCM implementation, from 0.83 cases/1,000 child-months to 3.80 cases/1,000 child-months (P=.01) and 0.25 cases/1,000 child-months to 5.28 cases/1,000 child-months (P<.001), respectively. On average, total under-5 mortality rates declined significantly by 38% (P<.001), and health facility use declined significantly by 15% (P=.006). These decreases were significantly greater than would have been expected based on baseline trends.

CONCLUSIONS: This is the first study to demonstrate decreases in both child mortality and health facility use after implementing iCCM of childhood illness at a national level. While our study design does not allow for direct attribution of these changes to implementation of iCCM, these results are in line with those of prior studies conducted at the sub-national level in other low-income countries.

46. Can routinely collected national data on childhood morbidity and mortality from diarrhea be used to monitor health impact of rotavirus vaccination in Africa? Examination of pre-vaccine baseline data from Rwanda.

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ABSTRACT

BACKGROUND: As rotavirus vaccine is introduced into routine childhood immunization programs in Africa, understanding its impact on diarrheal disease burden is important. The objective of this analysis was to determine whether routinely collected health information on national diarrhea hospitalizations, in-hospital deaths and outpatient visits would be useful to monitor rotavirus vaccine impact.

METHODS**:** We analyzed data for all-cause, nonbloody diarrheal disease among children <5 years of age from the routine health management information system (HMIS) in Rwanda from January 2008 through December 2011. We described trends in absolute numbers of inpatient admissions, in-hospital deaths and outpatient visits by year, age and setting.

RESULTS**:** All-cause, nonbloody diarrheal hospitalizations and outpatient visits among children <5 years of age in Rwanda from 2008 to 2011 peaked during the June to August dry season, coinciding with the rotavirus season. The bulk of the diarrheal disease burden occurred in children <1 year of age. Health centers provided many care to children with diarrhea including 60-72% of hospitalizations and 97-99% of outpatient visits. Many in-hospital diarrheal deaths (84%) occurred in district hospitals.

DISCUSSION**:** Given the stable and consistent trends and the prominent seasonality consistent with that of rotavirus, HMIS data should provide a useful baseline to monitor rotavirus vaccine impact on the overall diarrheal disease burden in Rwanda. Active, sentinel surveillance for rotavirus diarrhea will help interpret changes in diarrheal disease trends following vaccine introduction. Other countries planning rotavirus vaccine introduction should explore the availability and quality of their HMIS data.

47. Improving health information systems for decision making across five sub-Saharan African countries: Implementation strategies from the African Health Initiative.

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Collaborators (38)

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ABSTRACT

BACKGROUND**:** Weak health information systems (HIS) are a critical challenge to reaching the health-related Millennium Development Goals because health

systems performance cannot be adequately assessed or monitored where HIS data are incomplete, inaccurate, or untimely. The Population Health Implementation and Training (PHIT) Partnerships were established in five sub-Saharan African countries (Ghana, Mozambique, Rwanda, Tanzania, and Zambia) to catalyze advances in strengthening district health systems. Interventions were tailored to the setting in which activities were planned.

COMPARISONS ACROSS STRATEGIES: All five PHIT Partnerships share a common feature in their goal of enhancing HIS and linking data with improved decision-making, specific strategies varied. Mozambique, Ghana, and Tanzania all focus on improving the quality and use of the existing Ministry of Health HIS, while the Zambia and Rwanda partnerships have introduced new information and communication technology systems or tools. All partnerships have adopted a flexible, iterative approach in designing and refining the development of new tools and approaches for HIS enhancement (such as routine data quality audits and automated troubleshooting), as well as improving decision making through timely feedback on health system performance (such as through summary data dashboards or routine data review meetings). The most striking differences between partnership approaches can be found in the level of emphasis of data collection (patient versus health facility), and consequently the level of decision making enhancement (community, facility, district, or provincial leadership).

DISCUSSION: Design differences across PHIT Partnerships reflect differing theories of change, particularly regarding what information is needed, who will use the information to affect change, and how this change is expected to manifest. The iterative process of data use to monitor and assess the health system has been heavily communication dependent, with challenges due to poor feedback loops. Implementation to date has highlighted the importance of engaging frontline staff and managers in improving data collection and its use for informing system improvement. Through rigorous process and impact evaluation, the experience of the PHIT teams hope to contribute to the evidence base in the areas of HIS strengthening, linking HIS with decision making, and its impact on measures of health system outputs and impact.

48. Experience in implementing the OpenMRS medical record system to support HIV treatment in Rwanda.

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ABSTRACT

The challenge of scaling up HIV treatment in Africa has led to a new emphasis on improving health systems in impoverished areas. One aspect of this is the development and deployment of electronic medical record systems to support HIV and TB treatment. In this paper we describe the design and implementation of a new medical record architecture to support an HIV treatment program in rural Rwanda. The architecture is called OpenMRS and it has been developed to address the problem of configuring EMR systems to suit new sites, languages and diseases. OpenMRS uses a data dictionary called the concept dictionary to represent all the possible data items that can be collected. This allows new items to be added to the system by non-programmers. In addition, there are form creation tools that use drag and drop web technologies to simplify form construction. The OpenMRS system was first implemented in Kenya in February 2006 and then in Rwanda in August 2006. The system is now functioning well and we are developing extensions to improve the support for the clinic. These include improved, easy to use reporting tools, support for additional clinical problems including nutrition and child health, better database synchronization tools, and modules to collect laboratory data and support the pharmacy. The system is also in use in South Africa and Lesotho and is being deployed in Tanzania and Uganda.

Tanzania

49. Insights from a Text Messaging-Based Sexual and Reproductive Health Information Program in Tanzania (m4RH): Retrospective Analysis.

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ABSTRACT

BACKGROUND: Many mobile health (mHealth) interventions have the potential to generate and store vast amounts of system-generated participant interaction data that could provide insight into user engagement, programmatic strengths, and areas that need improvement to maximize efficacy. However, despite the popularity of mHealth interventions, there is little documentation on how to use these data to monitor and improve programming or to evaluate impact.

OBJECTIVE: This study aimed to better understand how users of the Mobile for Reproductive Health (m4RH) mHealth intervention engaged with the program in Tanzania from September 2013 to August 2016.

METHODS: We conducted secondary data analysis of longitudinal data captured by system logs of participant interactions with the m4RH program from 127 districts in Tanzania from September 2013 to August 2016. Data cleaning and analysis was conducted using Stata 13. The data were examined for completeness and "correctness." No missing data was imputed; respondents with missing or incorrect values were dropped from the analyses.

RESULTS: The total population for analysis included 3,673,702 queries among 409,768 unique visitors. New users represented roughly 11.15% (409,768/3,673,702) of all queries. Among all system queries for new users, 46.10% (188,904/409,768) users accessed the m4RH main menu. Among these users, 89.58% (169,218/188,904) accessed specific m4RH content on family planning, contraceptive methods, adolescent-specific and youth-specific information, and clinic locations after first accessing the m4RH main menu. The majority of these users (216,422/409,768,

52.82%) requested information on contraceptive methods; fewer users (23,236/409,768, 5.67%) requested information on clinic location. The conversion rate was highest during the first and second years of the program when nearly all users (11,246/11,470, 98.05%, and 33,551/34,830, 96.33%, respectively) who accessed m4RH continued on to query more specific content from the system. The rate of users that accessed m4RH and became active users declined slightly from 98.05% (11,246/11,470) in 2013 to 87.54% (56,696/64,765) in 2016. Overall, slightly more than one-third of all new users accessing m4RH sent queries at least once per month for 2 or more months, and 67.86% (278,088/409,768) of new and returning users requested information multiple times per month. Promotional periods were present for 15 of 36 months during the study period.

CONCLUSIONS: The analysis of the rich data captured provides a useful framework with which to measure the degree and nature of user engagement utilizing routine system-generated data. It also contributes to knowledge of how users engage with text messaging (short message service)-based health promotion interventions and demonstrates how data generated on user interactions could inform improvements to the design and delivery of a service, thereby enhancing its effectiveness.

50. **Use of an electronic Partograph: feasibility and acceptability study in Zanzibar, Tanzania.**

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ABSTRACT

BACKGROUND: The ePartogram is a tablet-based application developed to improve care for women in labor by addressing documented challenges in partograph use. The application is designed to provide real-time decision support, improve data entry, and increase access to information for appropriate labor management. This study's primary objective was to evaluate the feasibility and acceptability of ePartogram use in resource-constrained clinical settings.

METHODS: The ePartogram was introduced at three facilities in Zanzibar, Tanzania. Following 3 days of training, skilled birth attendants (SBAs) were

observed for 2 weeks using the ePartogram to monitor laboring women. During each observed shift, data collectors used a structured observation form to document SBA comfort, confidence, and ability to use the ePartogram. Results were analyzed by shift. Short interviews, conducted with SBAs (n = 82) after each of their first five ePartogram-monitored labors, detected differences over time. After the observation period, in-depth interviews were conducted (n = 15). A thematic analysis of interview transcripts was completed.

RESULTS: Observations of 23 SBAs using the ePartogram to monitor 103 women over 84 shifts showed that the majority of SBAs (87-91%) completed each of four fundamental ePartogram tasks-registering a client, entering first and subsequent measurements, and navigating between screens-with ease or increasing ease on their first shift; this increased to 100% by the fifth shift. Nearly all SBAs (93%) demonstrated confidence and all SBAs demonstrated comfort in using the ePartogram by the fifth shift. SBAs expressed positive impressions of the ePartogram and found it efficient and easy to use, beginning with first client use. SBAs noted the helpfulness of auditory reminders (indicating that measurements were due) and visual alerts (signaling abnormal measurements). SBAs expressed confidence in their ability to interpret and act on these reminders and alerts.

CONCLUSIONS: It is feasible and acceptable for SBAs to use the ePartogram to support labor management and care. With structured training and support during initial use, SBAs quickly became competent and confident in ePartogram use. Qualitative findings revealed that SBAs felt the ePartogram improved timeliness of care and supported decision-making. These findings point to the ePartogram's potential to improve quality of care in resource-constrained labor and delivery settings.

51. Design and implementation of an m-health data model for improving health information access for reproductive and child health services in low resource settings using a participatory action research approach.

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ABSTRACT

BACKGROUND: Information and Communication Technologies (ICTs) have been utilised globally for advancing social and economic development. As information

becomes key to enlightening development initiatives, the role of mobile technology-based ICT services is becoming more significant. The aim of this study was to design and implement a mHealth data model with an intention of improving mothers' knowledge of Reproductive and Child Health (RCH) services in rural environments and to remind mothers who do not have access to mobile phones to attend antenatal care.

METHODS: The methodology adopted in this research was participatory action research. A phased approach was utilised to answer the research question. The phases were: diagnosis of the problem, action planning, action taking, evaluation and reflection. The study was conducted in Chamwino district of Dodoma region, Tanzania. Reproductive and Child Health sections of Buigiri dispensary and Chamwino health centre were purposively selected. Data were collected through key informant interviews, document review, focus group discussion and observation. Content analysis methods were utilised during analysis. Consequently, the data model was designed, implemented and evaluated.

RESULTS: Challenges of information dissemination in low resource settings noted in this study are: mobile phone ownership and access of mothers, vertical coordination of health services and low staffing levels of health workers. Mothers who do not own mobile phones can leverage phone ownership of community leaders, TBAs, CHWs and relatives. This in turn facilitates communication of health messages to mothers.

CONCLUSIONS: Although this study was conducted in a low resource setting, mobile network coverage was good and thus SMS technology could be used. Research should be conducted on how to disseminate similar information in remote areas without mobile coverage.

52. Impact of smartphone-assisted prenatal home visits on women's use of facility delivery: Results from a cluster-randomized trial in rural Tanzania.

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ABSTRACT

BACKGROUND: About half of births in rural Tanzania are assisted by skilled providers. Point-of-care mobile phone applications hold promise in boosting job support for community health workers aiming to ensure safe motherhood through increased facility delivery awareness, access and uptake. We conducted a controlled comparison to evaluate a smartphone-based application designed to assist community health workers with data collection, education delivery, gestational danger sign identification, and referrals.

METHODS: Community health workers in 32 randomly selected villages were cluster-randomized to training on either smartphone (intervention) or paper-based (control) protocols for use during household visits with pregnant women. The primary outcome measure was postnatal report of delivery location by 572 women randomly selected to participate in a survey conducted by home visit. A mixed-effects model was used to account for clustering of subjects and other measured factors influencing facility delivery.

FINDINGS: The smartphone intervention was associated with significantly higher facility delivery: 74% of mothers in intervention areas delivered at or in transit to a health facility, versus 63% in control areas. The odds of facility delivery among women counseled by smartphone-assisted health workers were double the odds among women living in control villages (OR, 1.96; CI, 1.21-3.19; adjusted analyses). Women in intervention areas were more likely to receive two or more visits from a community health worker during pregnancy than women in the control group (72% vs. 60%; chi-square = 6.9; p < 0.01). Previous facility delivery, uptake of antenatal care, and distance to the nearest facility were also strong independent predictors of facility delivery.

INTERPRETATION: Community health worker use of smartphones increased facility delivery, likely through increased frequency of prenatal home visits. Smartphone-based job aids may enhance community health worker support and effectiveness as one component of intervention packages targeting safe motherhood.

53. Data and tools to integrate climate and environmental information into public health.

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ABSTRACT

BACKGROUND: During the last 30 years, the development of geographical information systems and satellites for Earth observation has made important progress in the monitoring of the weather, climate, environmental and anthropogenic factors that influence the reduction or the reemergence of vector-borne diseases. Analyses resulting from the combination of geographical information systems (GIS) and remote sensing have improved knowledge of climatic, environmental, and biodiversity factors influencing vector-borne diseases (VBDs) such as malaria, visceral leishmaniasis, dengue, Rift Valley fever, schistosomiasis, Chagas disease and leptospirosis. These knowledge and products developed using remotely sensed data helped and continue to help decision makers to better allocate limited resources in the fight against VBDs.

MAIN BODY: Because VBDs are linked to climate and environment, we present here our experience during the last four years working with the projects under the, World Health Organization (WHO)/ The Special Programme for Research and Training in Tropical Diseases (TDR)-International Development Research Centre (IDRC) Research Initiative on VBDs and Climate Change to integrate climate and environmental information into research and decision-making processes. The following sections present the methodology we have

developed, which uses remote sensing to monitor climate variability, environmental conditions, and their impacts on the dynamics of infectious diseases. We then show how remotely sensed data can be accessed and evaluated and how they can be integrated into research and decision-making processes for mapping risks, and creating Early Warning Systems, using two examples from the WHO TDR projects based on schistosomiasis analysis in South Africa and Trypanosomiasis in Tanzania.

CONCLUSIONS: The tools presented in this article have been successfully used by the projects under the WHO/TDR-IDRC Research Initiative on VBDs and Climate Change. Combined with capacity building, they are an important piece of work which can significantly contribute to the goals of WHO Global Vector Control Response and to the Sustainable Development Goals especially those on health and climate action.

54. Cost-effectiveness of an electronic clinical decision support system for improving quality of antenatal and childbirth care in rural Tanzania: an intervention study.

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ABSTRACT

BACKGROUND: QUALMAT project aimed at improving quality of maternal and newborn care in selected health care facilities in three African countries. An electronic clinical decision support system was implemented to support providers comply with established standards in antenatal and childbirth care. Given that health care resources are limited and interventions differ in their potential impact on health and costs (efficiency), this study aimed at assessing cost-effectiveness of the system in Tanzania.

METHODS: This was a quantitative pre- and post- intervention study involving 6 health centres in rural Tanzania. Cost information was collected from health provider's perspective. Outcome information was collected through observation of the process of maternal care. Incremental cost-effectiveness ratios for antenatal and childbirth care were calculated with testing of four models where the system was compared to the conventional paper-based approach to care. One-way sensitivity analysis was conducted to determine whether changes in process quality score and cost would impact on cost-effectiveness ratios.

RESULTS: Economic cost of implementation was 167,318 USD, equivalent to 27,886 USD per health center and 43 USD per contact. The system improved antenatal process quality by 4.5% and childbirth care process quality by 23.3% however these improvements were not statistically significant. Base-case incremental cost-effectiveness ratios of the system were 2469 USD and 338 USD per 1% change in process quality for antenatal and childbirth care respectively. Cost-effectiveness of the system was sensitive to assumptions made on costs and outcomes.

CONCLUSIONS: Although the system managed to marginally improve individual process quality variables, it did not have significant improvement effect on the overall process quality of care in the short-term. A longer duration of usage of the electronic clinical decision support system and retention of staff are critical to the efficiency of the system and can reduce the invested resources. Realization of gains from the system requires effective implementation and an enabling healthcare system.

55. Impact of an electronic clinical decision support system on workflow in antenatal care: the QUALMAT eCDSS in rural health care facilities in Ghana and Tanzania.

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ABSTRACT

BACKGROUND: The implementation of new technology can interrupt established workflows in health care settings. The Quality of Maternal Care (QUALMAT) project has introduced an electronic clinical decision support system (eCDSS) for antenatal care (ANC) and delivery in rural primary health care facilities in Africa.

OBJECTIVE: This study was carried out to investigate the influence of the QUALMAT eCDSS on the workflow of health care workers in rural primary health care facilities in Ghana and Tanzania.

DESIGN: A direct observation, time-and-motion study on ANC processes was conducted using a structured data sheet with predefined major task categories. The duration and sequence of tasks performed during ANC visits were observed, and changes after the implementation of the eCDSS were analyzed.

RESULTS: In 24 QUALMAT study sites, 214 observations of ANC visits (144 in Ghana, 70 in Tanzania) were carried out at baseline and 148 observations (104 in Ghana, 44 in Tanzania) after the software was implemented in 12 of those sites. The median time spent combined for all centers in both countries to provide ANC at baseline was 6.5 min [interquartile range (IQR) =4.0-10.6]. Although the time spent on ANC increased in Tanzania and Ghana after the eCDSS implementation as compared to baseline, overall there was no significant increase in time used for ANC activities (0.51 min, p=0.06 in Ghana; and 0.54 min, p=0.26 in Tanzania) as compared to the control sites without the eCDSS. The percentage of medical history taking in women who had subsequent examinations increased after eCDSS implementation from 58.2% (39/67) to 95.3% (61/64) p<0.001 in Ghana but not in Tanzania [from 65.4% (17/26) to 71.4% (15/21) p=0.70].

CONCLUSIONS: The QUALMAT eCDSS does not increase the time needed for ANC but partly streamlined workflow at sites in Ghana, showing the potential of such a system to influence quality of care positively.

56. New Algorithm for Managing Childhood Illness Using Mobile Technology (ALMANACH): A Controlled Non-Inferiority Study on Clinical Outcome and Antibiotic Use in Tanzania.

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ABSTRACT

INTRODUCTION: The decline of malaria and scale-up of rapid diagnostic tests calls for a revision of IMCI. A new algorithm (ALMANACH) running on mobile technology was developed based on the latest evidence. The objective was to ensure that ALMANACH was safe, while keeping a low rate of antibiotic prescription.

METHODS: Consecutive children aged 2-59 months with acute illness were managed using ALMANACH (2 intervention facilities), or standard practice (2 control facilities) in Tanzania. Primary outcomes were proportion of children cured at day 7 and who received antibiotics on day 0.

RESULTS: 130/842 (15·4%) in ALMANACH and 241/623 (38·7%) in control arm were diagnosed with an infection in need for antibiotic, while 3·8% and 9·6% had malaria. 815/838 (97·3%;96·1-98.4%) were cured at D7 using ALMANACH versus 573/623 (92·0%;89·8-94·1%) using standard practice (p<0·001). Of 23 children not cured at D7 using ALMANACH, 44% had skin problems, 30% pneumonia, 26% upper respiratory infection and 13% likely viral infection at D0. Secondary hospitalization occurred for one child using ALMANACH and one who eventually died using standard practice. At D0, antibiotics were prescribed to 15·4% (12·9-17·9%) using ALMANACH versus 84·3% (81·4-87·1%) using standard practice (p<0·001). 2·3% (1·3-3.3) versus 3·2% (1·8-4·6%) received an antibiotic secondarily.

CONCLUSION: Management of children using ALMANACH improve clinical outcome and reduce antibiotic prescription by 80%. This was achieved through more accurate diagnoses and hence better identification of children in need of antibiotic treatment or not. The building on mobile technology allows easy access and rapid update of the decision chart.

57. Can mobile phones help control neglected tropical diseases? Experiences from Tanzania.

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ABSTRACT

The increasing proliferation of mobiles offers possibilities for improving health systems in developing countries. A case in point is Tanzania which has piloted a mobile phone-based Management Information System (MIS) for the control of neglected tropical diseases (NTDs) where village health workers (VHWs) were given mobile phones with web-based software to test the feasibility of using frontline health workers to capture data at point of source. Based on qualitative case study research carried out in 2011, we found that providing mobile phones to VHWs has helped to increase the efficiency of routine work boosting the motivation and self-esteem of VHWs. However, despite these advantages, the information generated from the mobile phone-based NTD MIS has yet to be used to support decentralised decision-making. Even with improved technology and political will, the biggest hindrance to local usage of information for health planning is the lack of synthesised and analysed health information from the district and national levels to the villages. Without inculcating a culture of providing health information feedback to frontline workers and community organisations, the benefits of the intervention will be limited. If not addressed, this will mean that mobiles have maintained the one-way upward flow of information for NTD control and simply made reporting more hi-tech.

58. A cross-sectional pilot study assessing needs and attitudes to implementation of Information and Communication Technology for rational use of medicines among healthcare staff in rural Tanzania.

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ABSTRACT

BACKGROUND: In resource-poor countries access to essential medicines, suboptimal prescribing and use of medicines are major problems. Health workers lack updated medical information and treatment support. Information and Communication Technology (ICT) could help tackle this. The impact of ICT on health systems in resource-poor countries is likely to be significant and transform the practice of medicine just as in high-income countries. However, research for finding the best way of doing this is needed. We aimed to assess current approaches to and use of ICT among health workers in two rural districts of Tanzania in relation to the current drug distribution practices, drug stock and continuing medical information (CME), as well as assessing the feasibility of using ICT to improve ordering and use of medicines.

METHODS: This pilot study was conducted in 2010–2011, mapping the drug distribution chain in Tanzania, including problems and barriers. The study was conducted in Bunda and Serengeti districts, both part of the ICT4RD (ICT for rural development) project. Health workers involved in drug procurement and use at 13 health facilities were interviewed on use and knowledge of ICT, and their attitudes to its use in their daily work. They were also shown and interviewed about their thoughts on an android tablet application prototype for drug stock inventory and drug ordering, based on the Tanzanian Medical Stores Department (MSD) current paper forms.

RESULTS: The main challenge was a stable supply of essential medicines. Drug supplies were often delayed and incomplete, resulting in stock-outs. All 20

interviewed health workers used mobile phones, 8 of them Smartphones with Internet connection. The Health workers were very positive to the tablet application and saw its potential in reducing drug stock-outs. They also expressed a great need and wish for CME by distance.

CONCLUSION: The tablet application was easily used and appreciated by health workers, and thus has the potential to save time and effort, reduce transportation costs and minimise drug stock-outs. Furthermore, the android tablet could be used to reach out with CME programs to health care workers at remote health facilities, as well as those in towns.

59. **Improving health information systems for decision making across five sub-Saharan African countries: Implementation strategies from the African Health Initiative.**

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ABSTRACT

BACKGROUND: Weak health information systems (HIS) are a critical challenge to reaching the health-related Millennium Development Goals because health systems performance cannot be adequately assessed or monitored where HIS data are incomplete, inaccurate, or untimely. The Population Health Implementation and Training (PHIT) Partnerships were established in five sub-Saharan African countries (Ghana, Mozambique, Rwanda, Tanzania, and Zambia) to catalyze advances in strengthening district health systems. Interventions were tailored to the setting in which activities were planned.

FINDINGS: All five PHIT Partnerships share a common feature in their goal of enhancing HIS and linking data with improved decision-making, specific strategies varied. Mozambique, Ghana, and Tanzania all focus on improving the quality and use of the existing Ministry of Health HIS, while the Zambia and Rwanda partnerships have introduced new information and communication technology systems or tools. All partnerships have adopted a flexible, iterative approach in designing and refining the development of new tools and approaches for HIS enhancement (such as routine data quality audits and automated troubleshooting), as well as improving decision making through timely feedback on health system performance (such as through summary data dashboards or routine data review meetings). The most striking differences between partnership approaches can be found in the level of emphasis of data collection (patient versus health facility), and consequently the level of decision making enhancement (community, facility, district, or provincial leadership).

DISCUSSION: Design differences across PHIT Partnerships reflect differing theories of change, particularly regarding what information is needed, who will use the information to affect change, and how this change is expected to manifest. The iterative process of data use to monitor and assess the health system has been heavily communication dependent, with challenges due to poor feedback loops. Implementation to date has highlighted the importance of engaging frontline staff and managers in improving data collection and its use for informing system improvement. Through rigorous process and impact evaluation, the experience of the PHIT teams hope to contribute to the evidence base in the areas of HIS strengthening, linking HIS with decision making, and its impact on measures of health system outputs and impact.

60. Management of Childhood Illness (IMCI) protocol in Tanzania.

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ABSTRACT

BACKGROUND: Poor adherence to the Integrated Management of Childhood Illness (IMCI) protocol reduces the potential impact on under-five morbidity and

mortality. Electronic technology could improve adherence; however there are few studies demonstrating the benefits of such technology in a resource-poor settings. This study estimates the impact of electronic technology on adherence to the IMCI protocols as compared to the current paper-based protocols in Tanzania.

METHODS: In four districts in Tanzania, 18 clinics were randomly selected for inclusion. At each site, observers documented critical parts of the clinical assessment of children aged 2 months to 5 years. The first set of observations occurred during examination of children using paper-based IMCI (pIMCI) and the next set of observations occurred during examination using the electronic IMCI (eIMCI). Children were re-examined by an IMCI expert and the diagnoses were compared. A total of 1221 children (671 paper, 550 electronic) were observed.

RESULTS: For all ten critical IMCI items included in both systems, adherence to the protocol was greater for eIMCI than for pIMCI. The proportion assessed under pIMCI ranged from 61% to 98% compared to 92% to 100% under eIMCI ($p < 0.05$ for each of the ten assessment items).

CONCLUSIONS: Use of electronic systems improved the completeness of assessment of children with acute illness in Tanzania. With the before-after nature of the design, potential for temporal confounding is the primary limitation. However, the data collection for both phases occurred over a short period (one month) and so temporal confounding was expected to be minimal. The results suggest that the use of electronic IMCI protocols can improve the completeness and consistency of clinical assessments and future studies will examine the long-term health and health systems impact of eIMCI.

61. Bridging the gaps in the Health Management Information System in the context of a changing health sector.

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ABSTRACT

BACKGROUND**:** The Health Management Information System (HMIS) is crucial for evidence-based policy-making, informed decision-making during planning, implementation and evaluation of health programs; and for appropriate use of resources at all levels of the health system. This study explored the gaps and factors influencing HMIS in the context of a changing health sector in Tanzania.

METHODS**:** A cross sectional descriptive study was conducted in 11 heath facilities in Kilombero district between January and February 2008. A semi-structured questionnaire was used to interview 43 health workers on their knowledge, attitude, practice and factors for change on HMIS and HMIS booklets from these facilities were reviewed for completeness.

RESULTS**:** Of all respondents, 81% had never been trained on HMIS, 65% did not properly define this system, 54% didn't know who is supposed to use the information collected and 42% did not use the collected data for planning, budgeting and evaluation of services provision. Although the attitude towards the system was positive among 91%, the reviewed HMIS booklets were never completed in 25% - 55% of the facilities. There were no significant differences in knowledge, attitude and practice on HMIS between clinicians and nurses. The most common type of HMIS booklets which were never filled were those for deliveries (55%). The gaps in the current HMIS were linked to lack of training, inactive supervision, staff workload pressure and the lengthy and laborious nature of the system.

CONCLUSIONS**:** This research has revealed a state of poor health data collection, lack of informed decision-making at the facility level and the factors for change in the country's HMIS. It suggests need for new innovations including incorporation of HMIS in the ongoing reviews of the curricula for all cadres of health care providers, development of more user-friendly system and use of evidence-based John Kotter's eight-step process for implementing successful changes in this system.

62. Strategies for Developing Human Resource Capacity to Support Sustainability of ICT Based Health Information Systems: A Case Study from Tanzania.

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ABSTRACT

Information and Communication Technologies (ICTs) are typically introduced in organizations with the promise to help manage resources, increase efficiency, increase work productivity and reduce workload. In the context of developing countries, the lure of these promises is magnified given the existing conditions and inefficiencies. International aid agencies play an important role in shaping this promise. However, introduction and use of ICTs in developing countries has proven problematic due to failures or unsustainability resulting from many factors. One important factor is the lack of appropriate human resources both with

respect to quantity and quality. This paper emphasizes that human resource capacity building in developing countries is an urgent issue of concern for the sustainability of ICTs. Drawing on concepts of sustainability, ICT literacy, and human capacity building, this paper analyzes challenges related to human resources in health information systems (HISs) and ICTs in the health sector of Tanzania and suggests some strategies to address the problem. Specifically, the paper focuses on initiation of ICT based HIS in the context of the health sector and argues for human resources with a mix of skills to understand the meaning of data, information, and the use of computers.

63. Analysing the hindrance to the use of information and technology for improving efficiency of health care delivery system in Tanzania.

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ABSTRACT

Information Technologies (IT) have been described as offering tremendous opportunity to improve health services as well as in meeting broader developmental goals which have an impact on health. Through the use of IT, healthcare sectors can potentially plan, monitor and evaluate health services as well as communicate more effectively within and across organizational hierarchies. However, a number of studies suggest several hindrances where the use of IT to bring critical change in the health sector of Tanzania has been problematic. Despite the lack of appropriate use of the existing IT resources in the health sector, donors and government have continued helping the health sector to acquire up-to-date IT resources while however placing little emphasis on long term IT training, data management and effective utilization of information resulting into wasted of such resources hence little improvement in health services delivery. This study is based on the Health Information System Programme (HISP), an action research project aimed at improving health information system in developing countries with the use of IT and information for local action. Under the project, the district health information software which is customizable, open source and freely distributed has been implemented in five pilot districts in Tanzania. The lessons learned from HISP project and other levels of the health sector in general indicate the lack of skills for data interpretation and utilisation, policy guidelines on information and human capacity building as well as a lack of flexible system.

64. The challenge to avoid anti-malarial medicine stock-outs in an era of funding partners: the case of Tanzania.

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ABSTRACT

BACKGROUND: Between 2007 and 2013, the Tanzanian public sector received 93.1 million doses of first-line anti-malarial artemisinin-based combination therapy (ACT) in the form of artemether-lumefantrine entirely supplied by funding partners. The introduction of a health facility ACT stock monitoring system using SMS technology by the National Malaria Control Programme in mid 2011 revealed a high frequency of stock-outs of ACT in primary care public health facilities. The objective of this study was to determine the pattern of availability of ACT and possible causes of observed stock-outs across public health facilities in Tanzania since mid-2011.

METHODS: Data were collected weekly by the mobile phone reporting tool SMS for Life on ACT availability from over 5,000 public health facilities in Tanzania starting from September 2011 to December 2012. Stock data for all four age-dose levels of ACT across health facilities were summarized and supply of ACT at the national level was also documented.

RESULTS: Over the period of 15 months, on average 29% of health facilities in Tanzania were completely stocked out of all four-age dose levels of the first-line anti-malarial with a median duration of total stock-out of six weeks. Patterns of total stock-out by region ranged from a low of 9% to a high of 52%. The ACT stock-outs were most likely caused by: a) insufficient ACT supplies entering Tanzania (e.g. in 2012 Tanzania received 10.9 million ACT doses compared with a forecast demand of 14.4 million doses); and b) irregular pattern of ACT supply (several months with no ACT stock).

CONCLUSION: The reduced ACT availability and irregular pattern of supply were due to cumbersome bureaucratic processes and delays both within the country and from the main donor, the Global Fund to Fight AIDS, Tuberculosis and Malaria. Tanzania should invest in strengthening both the supply system and the health information system using mHealth solutions such as SMS for Life. This will continue to assist in tracking ACT availability across the country where all partners work towards more streamlined, demand driven and accountable procurement and supply chain systems.

65. Upgrading Supply Chain Management Systems to Improve Availability of Medicines in Tanzania: Evaluation of Performance and Cost Effects.

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ABSTRACT

BACKGROUND: To address challenges in public health supply chain performance, Tanzania invested in a national logistics management unit (LMU) and a national electronic logistics management information system (eLMIS). This evaluation examined the impact of those 2 key management upgrades approximately 1 year after they were introduced.

METHODS: We used a non experimental pre-post study design to compare the previous system with the upgraded management system. We collected baseline data from August to November 2013. We conducted round 1 of post-implementation data collection during April and May 2015, about 1 year after implementation of the upgrades. We evaluated key indicators of data use and reporting; supply chain management practices such as storage and supervision; supply chain performance including stock-out and expiry rates; and supply chain cost and savings. We analyzed the data using a range of techniques including statistical testing of baseline and round-1 results, and cost, cost-effectiveness, and return on investment analysis.

RESULTS: The upgrades were associated with improvements in data use, accessibility, visibility, and transparency; planning, control, and monitoring; support for quantification; stock-out rates; stock-out duration; commodity expiry; and forecast error. The upgraded system was more costly, but it was also more efficient, particularly when adjusting for the performance improvements. The upgrades also generated substantial savings that defrayed some, but not all, of the investment costs.

CONCLUSION: Upgrades to Tanzania's supply chain management systems created multiple and complex pathways to impact. One year after implementation, the LMU and eLMIS brought about performance improvements through better data use and through improvements in some, but not all, management practices. Furthermore, the upgrades-while not inexpensive-contributed to greater system efficiency and modest savings.

Uganda

66. A usability design checklist for Mobile electronic data capturing forms: the validation process.

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ABSTRACT

BACKGROUND: New Specific Application Domain (SAD) heuristics or design principles are being developed to guide the design and evaluation of mobile applications in a bid to improve on the usability of these applications. This is because the existing heuristics are rather generic and are often unable to reveal a large number of mobile usability issues related to mobile specific interfaces and characteristics. Mobile Electronic Data Capturing Forms (MEDCFs) are one of such applications that are being used to collect health data particularly in hard to reach areas, but with a number of usability challenges especially when used in rural areas by semi literate users. Existing SAD design principles are often not used to evaluate mobile forms because their focus on features specific to data capture is minimal. In addition, some of these lists are extremely long rendering them difficult to use during the design and development of the mobile forms. The main aim of this study therefore was to generate a usability evaluation checklist that can be used to design and evaluate Mobile Electronic Data Capturing Forms in a bid to improve their usability. We also sought to compare the novice and expert developers' views regarding usability criteria.

METHODS: We conducted a literature review in August 2016 using key words on articles and gray literature, and those with a focus on heuristics for mobile applications, user interface designs of mobile devices and web forms were eligible for review. The data bases included the ACM digital library, IEEE-Xplore and Google scholar. We had a total of 242 papers after removing duplicates and a total of 10 articles which met the criteria were finally reviewed. This review resulted in an initial usability evaluation checklist consisting of 125 questions that

could be adopted for designing MEDCFs. The questions that handled the five main categories in data capture namely; form content, form layout, input type, error handling and form submission were considered. A validation study was conducted with both novice and expert developers using a validation tool in a bid to refine the checklist which was based on 5 criteria. The criteria for the validation included utility, clarity, question naming, categorization and measurability, with utility and measurability having a higher weight respectively. We then determined the proportion of participants who agreed (scored 4 or 5), disagreed (scored 1 or 2) and were neutral (scored 3) to a given criteria regarding a particular question for each of the experts and novice developers. Finally, we selected questions that had an average of 85% agreement (scored 4 or 5) across all the 5 criteria by both novice and expert developers. 'Agreement' stands for capturing the same views or sentiments about the perceived likeness of an evaluation question.

RESULTS: The validation study reduced the initial 125 usability evaluation questions to 30 evaluation questions with the form layout category having the majority questions. Results from the validation showed higher levels of affirmativeness from the expert developers compared to those of the novice developers across the different criteria; however, the general trend of agreement on relevance of usability questions was similar across all the criteria for the developers. The evaluation questions that were being validated were found to be useful, clear, properly named and categorized, however the measurability of the questions was found not to be satisfactory by both sets of developers. The developers attached great importance to the use of appropriate language and to the visibility of the help function, but in addition expert developers felt that indication of mandatory and optional fields coupled with the use of device information like the Global Positioning System (GPS) was equally important. And for both sets of developers, utility had the highest scores while measurability scored least.

CONCLUSION: The generated checklist indicated the design features the software developers found necessary to improve the usability of mobile electronic data collection tools. In the future, we thus propose to test the effectiveness of the measure for suitability and performance based on this generated checklist and test it on the end users (data collectors) with a purpose of picking their design requirements. Continuous testing with the end users will help refine the checklist to include only that which is most important in improving the data collectors' experience.

67. The validity of an area-based method to estimate the size of hard-to reach populations using satellite images: the example of fishing populations of Lake Victoria.

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ABSTRACT

BACKGROUND: Information on the size of populations is crucial for planning of service and resource allocation to communities in need of health interventions. In resource limited settings, reliable census data are often not available. Using publicly available Google
Earth Pro and available local household survey data from fishing communities (FC) on Lake Victoria in Uganda, we compared two simple methods (using average population density) and one simple linear regression model to estimate populations of small rural FC in Uganda. We split the dataset into two sections; one to obtain parameters and one to test the validity of the models.

RESULTS: Out of 66 FC, we were able to estimate populations for 47. There were 16 FC in the test set. The estimates for total population from all three methods were similar, with errors less than 2.2%. Estimates of individual FC populations were more widely discrepant.
CONCLUSIONS: In our rural Ugandan setting, it was possible to use a simple area-based model to get reasonable estimates of total population. However, there were often large errors in estimates for individual villages.

68. Digital health technologies to support access to medicines and pharmaceutical services in the achievement of sustainable development goals.

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ABSTRACT

OBJECTIVES: The objective of this study was to describe the conceptual and implementation approach of selected digital health technologies that were tailored in various resource-constrained countries. To provide insights from a donor-funded project implementer perspective on the practical aspects based on local context and recommendations on future directions.

METHODS: Drawing from our multi-year institutional experience in more than 20 high disease-burden countries that aspire to meet the 2030 United Nations Sustainable Development Goal 3, we screened internal project documentation on various digital health tools that provide clarity in the conceptual and implementation approach. Taking into account geographic diversity, we provide a descriptive review of five selected case studies from Bangladesh (Asia), Mali (Francophone Africa), Uganda (East Africa), Mozambique (Lusophone Africa), and Namibia (Southern Africa).

FINDINGS: A key lesson learned is to harness and build on existing governance structures. The use of data for decision-making at all levels needs to be cultivated and sustained through multi-stakeholder partnerships. The next phase of information management development is to build systems for triangulation of data from patients, commodities, geomapping, and other parameters of the pharmaceutical system. A well-defined research agenda must be developed to determine the effectiveness of the country- and regional-level dashboards as an early warning system to mitigate stock-outs and wastage of medicines and commodities.

CONCLUSION**:** The level of engagement with users and stakeholders was resource-intensive and required an iterative process to ensure successful implementation. Ensuring user acceptance, ownership, and a culture of data use for decision-making takes time and effort to build human resource capacity. For future United Nations voluntary national reviews, countries and global stakeholders must establish appropriate measurement frameworks to enable the compilation of disaggregated data on Sustainable Development Goal 3 indicators as a precondition to fully realize the potential of digital health technologies.

69. Developing and implementing national health identifiers in resource limited countries: why, what, who, when and how?

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ABSTRACT

Many resource-limited countries are scaling up health services and health-information systems (HISs). The HIV Cascade framework aims to link treatment

services and programs to improve outcomes and impact. It has been adapted to HIV prevention services, other infectious and non-communicable diseases, and programs for specific populations. Where successful, it links the use of health services by individuals across different disease categories, time and space. This allows for the development of longitudinal health records for individuals and de-identified individual level information is used to monitor and evaluate the use, cost, outcome and impact of health services. Contemporary digital technology enables countries to develop and implement integrated HIS to support person centred services, a major aim of the Sustainable Development Goals. The key to link the diverse sources of information together is a national health identifier (NHID). In a country with robust civil protections, this should be given at birth, be unique to the individual, linked to vital registration services and recorded every time that an individual uses health services anywhere in the country: it is more than just a number as it is part of a wider system. Many countries would benefit from practical guidance on developing and implementing NHIDs. Organizations such as ASTM and ISO, describe the technical requirements for the NHID system, but few countries have received little practical guidance. A WHO/UNAIDS stake-holders workshop was held in Geneva, Switzerland in July 2016, to provide a 'road map' for countries and included policy-makers, information and healthcare professionals, and members of civil society. As part of any NHID system, countries need to strengthen and secure the protection of personal health information. While often the technology is available, the solution is not just technical. It requires political will and collaboration among all stakeholders to be successful.

70. Assessment of health provider readiness for telemedicine services in Uganda.

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ABSTRACT

BACKGROUND**:** There are few telemedicine projects in Africa that have reached scale. One of the reasons proposed for this has been failure to assess health provider readiness for telemedicine prior to implementation.

OBJECTIVE**:** assess health provider readiness for implementation and integration of telemedicine services at three levels of Uganda's health facilities, namely, a national referral hospital (NRH), regional referral hospitals (RRHs) and level 4 health centres (HC-IVs) and to investigate factors associated with readiness for telemedicine.

METHOD: A cross-sectional descriptive study was conducted at public healthcare facilities in Uganda. One RRH and HC-IV was identified from each of the Western, Eastern and Northern regions using a multistage random sampling technique. Mulago Hospital, which doubles as an RRH and HC-IV in the central region, was purposively identified for the study. After validation, a questionnaire was distributed for self-administration to senior administrators and doctors selected at the NRH, RRHs and HC-IVs. Data were analysed using bivariate associations between the outcome and the potential independent variables.

RESULTS: In total, 114 healthcare workers completed the questionnaire. Of the respondents, 24 (21%) were from HC-IVs, 44 (39%) were from RRHs, and 46 (40%) from NRH. Doctors made up 45.8% (11) of respondents at HC-IVs, 59% (26) at RRHs, and 30.4% (14) at NRH. Administrators across all health facility levels were more likely to integrate telemedicine into the healthcare system than doctors (odd ratio = 1.39 [95% confidence interval = 0.38-4.95]). A significant association existed between the state of readiness and type of health facility, $p < 0.001$. The NRH and RRHs are more likely to integrate telemedicine into their systems than the HC-IVs. Among the factors investigated (job title, health facility, technology type, reason for referral and frequency of electronic communication), the level of health facility and title or role of healthcare worker were found to have a significant statistical association with being ready to integrate telemedicine into the healthcare system.

CONCLUSION: Health provider readiness to integrate telemedicine services varies at the different levels of the health facility and job title or role. However, referral hospitals and administrators were more likely to integrate telemedicine than HC-IVs and doctors, respectively. While this study shows physicians and administrators are ready, other sectors (nurses, allied healthcare workers, public) will also need to be assessed.

71. A feasibility study of a mobile phone supported family centred ADL intervention, F@ce™, after stroke in Uganda.

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ABSTRACT

BACKGROUND**:** There is a lack of evidence-based health services to reduce the impact of stroke in low-income countries at a personal, family or community level. The aim was to evaluate the feasibility of i) a mobile phone supported family-centred intervention (F@ce™), and ii) the study design for evaluating the effects of the intervention on the perceived impact of stroke; perceived participation in everyday life; and self-efficacy in everyday activities amongst persons with stroke and their families in Uganda.

METHODS**:** The study comprised a pre-post design with an intervention group (IG) receiving the F@ce™ and a control group (CG). The inclusion criteria were: a) confirmed stroke diagnosis, b) access to and ability to use a mobile phone, c) ability to communicate in English and/or Luganda, d) > 18 years, e) residents in Kampala, and f) a Modified Rankin Scale level 2 to 4. The aim of the F@ce™ was to increase functioning in daily activities for persons living with the consequences of stroke, and participation in everyday life for persons with stroke and their families. The F@ce™ was an eight-week family-centred intervention, which entailed goal setting and problem-solving strategies, daily reminders and self-rated follow-ups of performance by short message service (SMS). Data were collected in the participants' home environment at baseline and after eight weeks. Data on acceptability of the F@ce™ and study procedures were collected by log-books and the responses of the SMS follow ups on the server. The primary outcomes were performance and satisfaction of valued daily activities in

everyday life using the Canadian Occupational Performance Measure (COPM), self-efficacy in performance of activities in daily life.

RESULTS**:** The IG comprised n = 13 and the CG n = 15. There were differences between the IG and CG in changes between baseline and follow-up in the primary outcomes COPM (performance component) and self-efficacy in favour of F@ce™. Overall with minor modifications the intervention and the study design were feasible for all participants involved.

CONCLUSION**:** The results support the need for further research to rigorously evaluate the effects of F@ce™ since the intervention appears to be feasible for persons with stroke and their family members.

72. Use of information and communication technology and retention of health workers in rural post-war conflict Northern Uganda: findings from a qualitative study.

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ABSTRACT

BACKGROUND**:** Information and communication technologies have become a vital infrastructural asset for use in the retention of rural health workers. However, little is known about the potential influence of ICT use, perceptions of health workers on ICT in healthcare delivery, and contribution of ICT to health care providers' retention in rural and remote areas in rural post-war and conflict situations of northern Uganda.

METHODS**:** Data from interviews were transcribed, coded and thematically analysed.

RESULTS**:** Participants generally exhibited low confidence, knowledge and low ICT skills. Majority of participants, however, perceived ICT as beneficial in relation to job performance and health care provider retention in rural areas. Common barriers for the implementation and use of ICT in health centres were inadequate ICT knowledge and skills, poor Internet networks, inadequate computers,

inadequate power supply, lack of Internet Modems and expensive access to outside computer centres.

CONCLUSIONS**:** This qualitative study showed low confidence, poor knowledge and skills in ICT usage but positive perceptions about the benefits and contributions of ICT. These findings suggest the need for specific investment in ICT infrastructural development for health care providers in remote rural areas of northern Uganda.

73. Beyond pilotitis: taking digital health interventions to the national level in China and Uganda.

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ABSTRACT

BACKGROUND**:** Innovation theory has focused on the adoption of new products or services by individuals and their market-driven diffusion to the population at large. However, major health sector innovations typically emerge from negotiations between diverse stakeholders who compete to impose or at least prioritise their preferred version of that innovation. Thus, while many digital health interventions have succeeded in terms of adoption by a substantial number of providers and patients, they have generally failed to gain the level of acceptance required for their integration into national health systems that would promote sustainability and population-wide application. The area of innovation considered here relates to a growing number of success stories that have created considerable enthusiasm among donors, international agencies, and governments for the potential role of ICTs in transforming weak national health information systems in middle- and low-income countries. This article uses a case study approach to consider the assumptions, institutional as well as technical, underlying this enthusiasm and explores possible ways in which outcomes might be improved.

METHODS**:** Literature review and case study analysis.

RESULTS**:** The two systems considered have had considerable success in terms of gaining and maintaining government support and addressing the concerns of providers without compromising their core elements. In Uganda, the system has flourished despite severe resource constraints, using a participatory approach that has encouraged a high level of community engagement. In China, concern

with past failures generated the political will to build a high-quality surveillance system, using the latest technology and drawing on a highly skilled human resource base.

CONCLUSIONS**:** Both examples stress the importance of recognising the political, social and historical context within which information systems have to function. Implementers need to focus as much on the perceptions, attitudes and needs of stakeholders as on the technology. Implementers should distinguish between factors which may influence engagement at an institutional level and those aimed at supporting and supervising individuals within those institutions. Finally, we would suggest that designing interoperability into systems at the outset, rather than assuming that this can be achieved at some point in the future, may prove far easier in the longer term.

74. Barriers and opportunities to implementation of sustainable e- Health programmes in Uganda: A literature review.

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ABSTRACT

BACKGROUND**:** Most developing countries, including Uganda, have embraced the use of e-Health and m-Health applications as a means to improve primary healthcare delivery and public health for their populace. In Uganda, the growth in the information and communications technology industry has benefited the rural communities and also created opportunities for new innovations, and their application into healthcare has reported positive results, especially in the areas of disease control and prevention through disease surveillance. However, most are mere proof-of-concepts, only demonstrated in use within a small context and lack sustainability. This study reviews the literature to understand e-Health's current implementation status within Uganda and documents the barriers and opportunities to sustainable e-Healthintervention programmes in Uganda.

METHODS**:** A structured literature review of e-Health in Uganda was undertaken between May and December 2015 and was complemented with hand searching and a document review of grey literature in the form of policy documents and reports obtained online or from the Ministry of Health's Resource Centre.

RESULTS: The searches identified a total of 293 resources of which 48 articles met the inclusion criteria of being in English and describing e-Health implementation in Uganda. These were included in the study and were examined in detail.

CONCLUSION: Uganda has trialled several e-Health and m-Health solutions to address healthcare challenges. Most were donor funded, operated in silos and lacked sustainability. Various barriers have been identified. Evidence has shown that e-Health implementations in Uganda have lacked prior planning stages that the literature notes as essential, for example strategy and need readiness assessment. Future research should address these shortcomings prior to introduction of e-Health innovations.

75. Maternal Attitudes about Objectively Monitored Bednet Use in Rural Uganda.

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ABSTRACT

Insecticide-treated bednets (ITNs) are a mainstay of malaria prevention, yet poor adherence poses a major barrier to effective prevention. Self-reports of bednet use suffer from recall and social desirability biases. We have designed a device that electronically records ITN usage longitudinally. SmartNet consists of circuits made from a conductive fabric interwoven into the sides and top of a rectangular ITN. Digital sampling of the state of these circuits allows for determining whether the SmartNet is deployed for use or folded up. We conducted a study among pregnant women and women with children <5 years in Uganda to determine attitudes about objective bednet monitoring and SmartNet. Fifty women were interviewed with an average age of 27 years and 2.3 children. Twenty-two percent were pregnant. Ninety-five percent had used a bednet and 90% reported having a bednet at home. After displaying a SmartNet, 92% thought it would be easy to use and 100% expressed interest in using SmartNet. Concerns about SmartNet included washing the net, worries about being monitored while asleep, and worries about users removing the device

components. Objective monitoring of ITN use appears to be acceptable among women in rural Uganda, setting the stage for further SmartNet field testing.

76. Tackling malaria, village by village: a report on a concerted information intervention by medical students and the community in Mifumi, Eastern Uganda.

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ABSTRACT

BACKGROUND: Can an information intervention facilitated by information technology and carried out by an interdisciplinary team comprising medical students, technical experts, and the community itself make a positive contribution in reducing the burden of malaria at the village level? In Mifumi village in Eastern Uganda, MIFUMI Project, Makerere University College of Health Sciences Community Based Education and Service program (COBES), and the U.S. National Library of Medicine carried out a series of activities between 2007 and 2010.

METHODS: The team surveyed the community's knowledge of malaria prevention and treatment; implemented a health information intervention using tutorials in a variety of media; and observed the community's use of previously distributed insecticide treated nets (ITNs) using a digital pen application.

RESULTS: As a result of concerted education and outreach, the village residents have a good understanding of malaria prevention and treatment seeking behaviors. Leveraging the power of information technology and interdisciplinary teamwork, medical students and the denizens of a rural community were able to engage in an interactive experience of health education and promotion.

CONCLUSION: Preliminary observations suggest that a health information intervention in concert with a collaborative community effort of education and prevention can build capacity within a community to take control of its own health.

77. Strengthening district-based health reporting through the district health management information software system: the Ugandan experience.

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ABSTRACT

BACKGROUND**:** Untimely, incomplete and inaccurate data are common challenges in planning, monitoring and evaluation of health sector performance, and health service delivery in many sub-Saharan African settings. We document Uganda's experience in strengthening routine health data reporting through the roll-out of the District Health Management Information Software System version 2 (DHIS2).

METHODS**:** DHIS2 was adopted at the national level in January 2011. The system was initially piloted in 4 districts, before it was rolled out to all the 112 districts by July 2012. As part of the roll-out process, 35 training workshops targeting 972 users were conducted throughout the country. Those trained included Records Assistants (168, 17.3%), District Health Officers (112, 11.5%), Health Management Information System Focal Persons (HMIS-FPs) (112, 11.5%), District Biostatisticians (107, 11%) and other health workers (473, 48.7%). To assess improvements in health reporting, we compared data on completeness and timeliness of outpatient and inpatient reporting for the period before (2011/12) and after (2012/13) the introduction of DHIS2. We reviewed data on the reporting of selected health service coverage indicators as a proxy for improved health reporting, and documented implementation challenges and lessons learned during the DHIS2 roll-out process.

RESULTS**:** Completeness of outpatient reporting increased from 36.3% in 2011/12 to 85.3% in 2012/13 while timeliness of outpatient reporting increased from 22.4% to 77.6%. Similarly, completeness of inpatient reporting increased from 20.6% to 57.9% while timeliness of inpatient reporting increased from 22.5% to 75.6%. There was increased reporting on selected health coverage indicators (e.g. the reporting of one-year old children who were immunized with three doses of pentavelent vaccine increased from 57% in 2011/12 to 87% in 2012/13). Implementation challenges included limited access to computers and internet (34%), inadequate technical support (23%) and limited worker force (18%).

CONCLUSION**:** Implementation of DHIS2 resulted in improved timeliness and completeness in reporting of routine outpatient, inpatient and health service usage data from the district to the national level. Continued onsite support supervision and mentorship and additional system/infrastructure enhancements, including internet connectivity, are needed to further enhance the performance of DHIS2.

78. Spatial distribution of underweight, overweight and obesity among women and children: results from the 2011 Uganda Demographic and Health Survey.

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ABSTRACT

While undernutrition and infectious diseases are still persistent in developing countries, overweight, obesity, and associated comorbidities have become more prevalent. Uganda, a developing sub-Saharan African country, is currently experiencing the public health paradox of undernutrition and overnutrition. We utilized the 2011 Uganda Demographic and Health Survey (DHS) to examine risk factors and hot spots for underweight, overweight, and obesity among adult females (N = 2,420) and their children (N = 1,099) using ordinary least squares and multinomial logit regression and the ArcGIS Getis-Ord Gi* statistic. Overweight and obese women were significantly more likely to have overweight children, and overweight was correlated with being in the highest wealth class (OR = 2.94, 95% CI = 1.99-4.35), and residing in an urban (OR = 1.76, 95% CI = 1.34-2.29) but not a conflict prone (OR = 0.48, 95% CI = 0.29-0.78) area. Underweight clustered significantly in the Northern and North eastern regions, while overweight females and children clustered in the Southeast. We demonstrate that the DHS can be used to assess geographic clustering and burden of disease, thereby allowing for targeted programs and policies. Further, we pinpoint specific regions and population groups in Uganda for targeted preventive measures and treatment to reduce the burden of overweight and chronic diseases in Uganda.

79. An exploratory GIS based method to identify and characterise landscapes with an elevated epidemiological risk of Rhodesian human African trypanosomiasis.

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ABSTRACT

BACKGROUND: Specific land cover types and activities have been correlated with Trypanosoma brucei rhodesiense distributions, indicating the importance of landscape for epidemiological risk. However, methods proposed

to identify specific areas with elevated epidemiological risk (i.e. where transmission is more likely to occur) tend to be costly and time consuming. This paper proposes an exploratory spatial analysis using geo-referenced human African trypanosomiasis (HAT) cases and matched controls from Serere hospital, Uganda (December 1998 to November 2002) to identify areas with an elevated epidemiological risk of HAT.

METHODS: Buffers 3 km from each case and control were used to represent areas in which village inhabitants would carry out their daily activities. It was hypothesised that the selection of areas where several case village buffers overlapped would enable the identification of locations with increased risk of HAT transmission, as these areas were more likely to be frequented by HAT cases in several surrounding villages. The landscape within these overlap areas should more closely relate to the environment in which transmission occurs as opposed to using the full buffer areas. The analysis was carried out for each of four annual periods, for both cases and controls, using a series of threshold values (number of overlapping buffers), including a threshold of one, which represented the benchmark (e.g. use of the full buffer area as opposed to the overlap areas).

RESULTS: A greater proportion of the overlap areas for cases consisted of seasonally flooding grassland and lake fringe swamp, than the control overlap areas, correlating well with the preferred habitat of the predominant tsetse species within the study area (Glossina fuscipes fuscipes). The use of overlap areas also resulted in a greater difference between case and control landscapes, when compared with the benchmark (using the full buffer area).

CONCLUSIONS: These results indicate that the overlap analysis has enabled the selection of areas more likely to represent epidemiological risk zones than similar analyses using full buffer areas. The identification of potential epidemiological risk zones using this method requires fewer data than other proposed methods and further development may provide vital information for the targeting of control measures.

80. Internet use among Ugandan adolescents: implications for HIV intervention.

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ABSTRACT

BACKGROUND: The Internet is fast gaining recognition as a powerful, low-cost method to deliver health intervention and prevention programs to large numbers of young people across diverse geographic regions. The feasibility and

accessibility of Internet-based health interventions in resource-limited settings, where cost-effective interventions are most needed, is unknown. To determine the utility of developing technology-based interventions in resource-limited settings, availability and patterns of usage of the Internet first need to be assessed.

METHODS AND FINDINGS: The Uganda Media and You Survey was a cross-sectional survey of Internet use among adolescents (ages 12-18 years) in Mbarara, Uganda, a municipality mainly serving a rural population in sub-Saharan Africa. Participants were randomly selected among eligible students attending one of five participating secondary day and boarding schools in Mbarara, Uganda. Of a total of 538 students selected, 93% (500) participated. Of the total respondents, 45% (223) reported ever having used the Internet, 78% (175) of whom reported going online in the previous week. As maternal education increased, so too did the odds of adolescent Internet use. Almost two in five respondents (38% [189]) reported already having used a computer or the Internet to search for health information. Over one-third (35% [173]) had used the computer or Internet to find information about HIV/AIDS, and 20% (102) had looked for sexual health information. Among Internet users, searching for HIV/AIDS information on a computer or online was significantly related to using the Internet weekly, emailing, visiting chat rooms, and playing online games. In contrast, going online at school was inversely related to looking for HIV/AIDS information via technology. If Internet access were free, 66% (330) reported that they would search for information about HIV/AIDS prevention online.

CONCLUSIONS: Both the desire to use, and the actual use of, the Internet to seek sexual health and HIV/AIDS information is high among secondary school students in Mbarara. The Internet may be a promising strategy to deliver low-cost HIV/AIDS risk reduction interventions in resource-limited settings with expanding Internet access.

TECHNOLOGIES FOR DISEASE SURVEILLANCE, DISEASE OUTBREAK DETECTION AND RESPONSE, AND CROSS BORDER MOBILITY AND DISEASE TRACKING

67 citations
(Sorted by Partner States)

Burundi

1. **Spatiotemporal distribution and population at risk of soil-transmitted helminth infections following an eight-year school-based deworming programme in Burundi, 2007-2014.**

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ABSTRACT

BACKGROUND: Investigating the effect of successive annual deworming rounds on the spatiotemporal distribution of infection prevalence and numbers at risk for soil-transmitted helminths (STHs) can help identify communities nearing elimination and those needing further interventions. In this study, we aim to quantify the impact of an 8-year mass drug administration (MDA) programme (from 2007 to 2014) on the spatiotemporal distribution of prevalence of STH infections and to estimate the number of school-aged children infected with STHs in Burundi.

METHODS: During annual longitudinal school-based surveys in Burundi between 2007 and 2011, STH infection and anthropometric data for a total of 40,656 children were collected; these data were supplemented with data from a national survey conducted in 2014. Bayesian model based geostatistics (MBG) were used to generate predictive prevalence maps for each STH species and year. The numbers of children at-risk of infection per district between 2008 and

2014 were estimated as the product of the predictive prevalence maps and population density maps.

RESULTS: Overall, the degree of spatial clustering of STH infections decreased between 2008 and 2011; in 2014 the geographical clusters of all STH infections reappeared. The reduction in prevalence was small for Ascaris lumbricoides and Trichuris trichiura in the centre and central north of the country. Our predictive prevalence maps for hookworm indicate a reduction in prevalence along the periphery of the country. The predicted number of children infected with any STH species decreased substantially between 2007 and 2011, but in 2014 there was an increase in the predicted number of children infected with A. lumbricoides and T. trichiura. In 2014, the districts with the highest predicted number of children infected with A. lumbricoides, T. trichiura and hookworms were Kibuye district (n = 128,903), Mabayi district (n = 35,302) and Kiremba (n = 87,511), respectively.

CONCLUSIONS: While the MDA programme in Burundi resulted in a reduction in STH prevalence, this reduction was spatiotemporally heterogeneous, with some pockets of high prevalence remaining, suggesting that treatment coverage and complementary interventions should be evaluated to improve impact.

key words: Number of infections; Predictive risk mapping; Soil-transmitted helminths; Spatiotemporal modelling

2. **Potential of household environmental resources and practices in eliminating residual malaria transmission: a case study of Tanzania, Burundi, Malawi and Liberia.**

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ABSTRACT

BACKGROUND: The increasing protection gaps of insecticide-treated nets and indoor-residual spraying methods against malaria have led to an emergence of

residual transmission in sub-Saharan Africa and thus, supplementary strategies to control mosquitoes are urgently required.

OBJECTIVE: To assess household environmental resources and practices that increase or reduce malaria risk among children under-five years of age in order to identify those aspects that can be adopted to control residual transmission.

METHODS: Household environmental resources, practices and malaria test results were extracted from Malaria Indicators Survey datasets for Tanzania, Burundi, Malawi and Liberia with 16,747 children from 11,469 households utilised in the analysis. Logistic regressions were performed to quantify the contribution of each factor to malaria occurrence.

RESULTS: Cattle rearing reduced malaria risk between 26%-49% while rearing goats increased the risk between 26%-32%. All piped-water systems reduced malaria risk between 30%-87% (Tanzania), 48%-95% (Burundi), 67%-77% (Malawi) and 58%-73 (Liberia). Flush toilets reduced malaria risk between 47%-96%. Protected-wells increased malaria risk between 19%-44%. Interestingly, boreholes increased malaria risk between 19%-75%. Charcoal use reduced malaria risk between 11%-49%.

CONCLUSION: Vector control options for tackling mosquitoes were revealed based on their risk levels. These included cattle rearing, installation of piped-water systems and flush toilets as well as use of smokeless fuels.

key words: household environmental resources and practices; indoor-residual spraying; insecticide-treated nets; malaria risk; residual transmission

3. **Spatial co-distribution of neglected tropical diseases in the east African great lakes region: revisiting the justification for integrated control.**

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ABSTRACT

OBJECTIVE: To determine spatial patterns of co-endemicity of schistosomiasis mansoni and the soil-transmitted helminths (STHs) Ascaris lumbricoides, Trichuris trichiura and hookworm in the Great Lakes region of East Africa, to help plan integrated neglected tropical disease programmes in this region.

METHOD: Parasitological surveys were conducted in Uganda, Tanzania, Kenya and Burundi in 28 213 children in 404 schools. Bayesian geostatistical models were used to interpolate prevalence of these infections across the study area. Interpolated prevalence maps were overlaid to determine areas of co-endemicity.

RESULTS: In the Great Lakes region, prevalence was 18.1% for Schistosoma mansoni, 50.0% for hookworm, 6.8% for A. lumbricoides and 6.8% for T. trichiura. Hookworm infection was ubiquitous, whereas S. mansoni, A. lumbricoides and T. trichiura were highly focal. Most areas were endemic (prevalence >or=10%) or hyperendemic (prevalence >or=50%) for one or more STHs, whereas endemic areas for schistosomiasis mansoni were restricted to foci adjacent large perennial water bodies.

CONCLUSION: Because of the ubiquity of hookworm, treatment programmes are required for STH throughout the region but efficient schistosomiasis control should only be targeted at limited high-risk areas. Therefore, integration of schistosomiasis with STH control is only indicated in limited foci in East Africa.

4. **Predictive and epidemiologic modeling of the spatial risk of human onchocerciasis using biophysical factors: a case study of Ghana and Burundi.**

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ABSTRACT

Although recent efforts taken have substantially contained human onchocerciasis in many African countries, published reports indicate a recrudescence of the disease. To understand this problem, biophysical factors that favor the establishment of human onchocerciasis in Ghana and Burundi-countries identified as threat locations of recrudescence for neighboring countries-were analyzed. Data pertaining to the prevalence of human onchocerciasis in both countries was obtained from published sources. Findings in this study suggest that there was a gradient in prevalence of onchocerciasis in geographic locations near the water streams. The predictive models suggest that rainfall, humidity, and elevation were statistically significant for Burundi data while in Ghana, only the effect of elevation was highly significant (p<0.0001). In 2010, the estimated at-risk population was 4,817,280 people (19.75% of the total population) and 522,773 people (6.23% of the total population) in Ghana and

Burundi, respectively. Findings can help in the effective design of preventive control measures.

5. Spatial analysis of HIV infection and associated individual characteristics in Burundi: indications for effective prevention.

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ABSTRACT

BACKGROUND: Adequate resource allocation is critical in the battle against HIV/AIDS, especially in Africa. The determination of the location and nature of HIV services to implement must comply with the geographic, social and behavioral characteristics of patients. We therefore investigated the spatial heterogeneity of HIV prevalence in Burundi and then assessed the association of social and behavioral characteristics with HIV infection accounting for the spatial heterogeneity.

METHODS: We used data from the 2010 Demographic and Health Survey. We analyzed these data with a geostatistical approach (which takes into account spatial autocorrelation) by i) interpolating HIV data using the kernel density estimation, ii) identifying the spatial clusters with high and low HIV prevalence using the Kulldorff spatial scan statistics, and then iii) performing a multivariate spatial logistic regression.

RESULTS: Overall HIV prevalence was 1.4 %. The interpolated data showed the great spatial heterogeneity of HIV prevalence (from 0 to 10 %), independently of administrative boundaries. A cluster with high HIV prevalence was found in the capital city and adjacent areas (3.9 %; relative risk 3.7, $p < 0.001$) whereas a cluster with low prevalence straddled two southern provinces (0 %; $p = 0.02$). By multivariate spatial analysis, HIV infection was significantly associated with the female sex (posterior odds ratio [POR] 1.36, 95 % credible interval [CrI] 1.13-1.64),

an older age (POR 1.97, 95 % CrI 1.26-3.08), the level of education (POR 1.50, 95 % CrI 1.22-1.84), the marital status (POR 1.86, 95 % CrI 1.23-2.80), a higher wealth index (POR 2.11, 95 % CrI 1.77-2.51), the sexual activity (POR 1.76, 95 % CrI 1.04-2.96), and a history of sexually transmitted infection (POR 2.03, 95 % CrI 1.56-2.64).

CONCLUSIONS: Our study, which shows where and towards which populations HIV resources should be allocated, could help national health policy makers develop an effective HIV intervention in Burundi. Our findings support the strategy of the Joint United Nations Programme on HIV/AIDS (UNAIDS) for country-specific, in-depth analyses of HIV epidemics to tailor national prevention responses**.**

6. **Spatial analysis of HIV infection and associated individual characteristics in Burundi: indications for effective prevention.**

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ABSTRACT

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METHODS: We used data from the 2010 Demographic and Health Survey. We analyzed these data with a geostatistical approach (which takes into account spatial autocorrelation) by i) interpolating HIV data using the kernel density estimation, ii) identifying the spatial clusters with high and low HIV prevalence using the Kulldorff spatial scan statistics, and then iii) performing a multivariate spatial logistic regression.

RESULTS: Overall HIV prevalence was 1.4 %. The interpolated data showed the great spatial heterogeneity of HIV prevalence (from 0 to 10 %), independently of administrative boundaries. A cluster with high HIV prevalence was found in the capital city and adjacent areas (3.9 %; relative risk 3.7, $p < 0.001$) whereas a cluster with low prevalence straddled two southern provinces (0 %; $p = 0.02$). By multivariate spatial analysis, HIV infection was significantly associated with the female sex (posterior odds ratio [POR] 1.36, 95 % credible interval [CrI] 1.13-1.64), an older age (POR 1.97, 95 % CrI 1.26-3.08), the level of education (POR 1.50, 95 % CrI 1.22-1.84), the marital status (POR 1.86, 95 % CrI 1.23-2.80), a higher wealth index (POR 2.11, 95 % CrI 1.77-2.51), the sexual activity (POR 1.76, 95 % CrI 1.04-2.96), and a history of sexually transmitted infection (POR 2.03, 95 % CrI 1.56-2.64).

CONCLUSIONS: Our study, which shows where and towards which populations HIV resources should be allocated, could help national health policy makers develop an effective HIV intervention in Burundi. Our findings support the strategy of the Joint United Nations Programme on HIV/AIDS (UNAIDS) for country-specific, in-depth analyses of HIV epidemics to tailor national prevention responses.

key words: HIV, Prevalence, Heterogeneity, Spatial, Factors

Kenya

7. The Kibera Health and Demographic Surveillance System (KiberaHDSS).

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ABSTRACT

BACKGROUND: Health and demographic surveillance systems (HDSS) provide important longitudinal data on population dynamics, disease burden, and mortality in settings where accurate routine administrative data are lacking.

OBJECTIVE: To present data from a HDSS within Kibera, a large informal settlement in Nairobi, Kenya.

METHODS: Kibera HDSS was established in 2015 in two villages (Soweto West and Gatwekera),covering 0.42km[2]. Since 2005, area residents have participated in Population- Based Infectious Disease Surveillance (PBIDS), which included biweekly household visits; in 2015, PBIDS household visits ceased and consent was sought from household heads for participation in HDSS for eligible individuals (resident for =120 days). HDSS households are visited by trained fieldworkers every 6 months. Demographic (pregnancies, births, migrations, deaths, socio-economic information)and health (recent illness, healthcare- seeking, immunization status of children <5 years) data are collected using netbooks/tablets. Verbal autopsy interviews are conducted for all reported deaths.

FINDINGS: Since 21/10/2015, 27,601 individuals from 4,690 households were enrolled, with 21,112active participants as of 31/10/2018.Median number of individuals per household is5.The male: female ratio is0.95.Children <5 years constitute11.6% of the population; those aged 10-24 years constitute 38.3%.The most common ethnicity is Luo(69.3%).Among adults, 56.5% are married/ cohabiting and 56.2% had at least primary-level education. As   of 31/12/2017,crude birth rate was 22.8/1000 person-years-observation and crude death rate was 3.8/1000.Neonataland under-5 mortality ratioswere14.7 and 40.0/1000 live births, respectively. The general fertility rate was 59 births/1,000 women aged 15-49.Crude out- and in-migration rates were 70.0/1000 and 16.0/1000 respectively. Of 21,366surveyed July- December 2017, 6.4% reported cough, 1.1% difficulty breathing, 1.2% diarrhea, and 4.7% fever within prior 14 days.

CONCLUSIONS: Report of recent illness is common and under-5 mortality is high. As part of Universal health coverage, interventions targeting common illnesses and under-5 mortality are key in this setting.

8. **Establishing an Urban Health and Demographic Surveillance System in an informal settlement, initial experiences and findings of first two years, Manyatta-Kisumu.**

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ABSTRACT

BACKGROUND: Health and demographic surveillance systems (HDSS) are important sources for health planning and policy implementation in many low and middle income countries. They provide longitudinal data regarding health and vital statistics in countries where vital registration systems perform poorly. Most HDSS sites are set up in rural settings. Through the support of the Child Health and Mortality Prevention Surveillance network, the Kenya Medical Research Institute set up an urban HDSS in Manyatta informal settlement area of Kisumu town, western Kenya. The HDSS was set up primarily to assist in identifying child deaths, provide denominators for cause specific mortality as well as follow up on public health interventions. We present experiences and findings of the first two years of setting up and operation.

METHOD: Manyatta site was mapped and numbered into 121 villages. Consent was obtained from household heads before the enumeration exercise. . Household data was collected by trained Community Interviewers and Community Health Volunteers. Supervisors conducted random, repeat interviews in 5% of households for quality checks. Half yearly cohort follow- ups were conducted to record information on vital events. Flexible working hours allowed for households visits. Data analysis was conducted using Stata 14.

RESULTS: Baseline enumeration registered a population of 77,061, distributed in 31,000 households. Females made up 39,221 (50.9%).Sex ratios were 96 males per 100 females. The average household size was 3. There were 11,699 (15%) under five years children. Refusal rate stood at 0.03% and revisits 11% .Observing working time flexibility, security, respect for diverse cultures and religion is key.

CONCLUSIONS: Findings demonstrate feasibility of setting up and operating a HDSS and to collect accurate and reliable data in an informal urban setting such as Manyatta. The urban setting has unique characteristics and challenges that require flexibility and modification of strategies that ordinarily apply in rural settings.

9. Implementing Maternal Death Surveillance and Response in Kenya: Incremental Progress and Lessons Learned.

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ABSTRACT

Maternal death surveillance and response (MDSR) constitutes a quality improvement approach to identify how many maternal deaths occur, what the underlying causes of death and associated factors are, and how to implement actions to reduce the number of preventable stillbirths and maternal and neonatal deaths. This requires a coordinated approach, ensuring both national- and district-level stakeholders are enabled and supported and can implement MDSR in a "no name, no blame" environment. This field action report from Kenya provides an example of how MDSR can be implemented in a "real-life" setting by summarizing the experiences and challenges faced thus far by maternal death assessors and Ministry of Health representatives in implementing MDSR. Strong national leadership via a coordinating secretariat has worked well in Kenya. However, several challenges were encountered including underreporting of data, difficulties with reviewing the data, and suboptimal aggregation of data on cause of death. To ensure progress toward a full national enquiry of all maternal deaths, we recommend improving the notification of maternal deaths, ensuring regular audits and feedback at referral hospitals lead to continuous quality improvement, and strengthening community linkages with health facilities to expedite maternal death reporting. Ultimately, both a top-down and bottom-up approach is needed to ensure success of an MDSR system. Perinatal death surveillance and response is planned as a next phase of MDSR implementation in Kenya. To ensure the process continues to evolve into a full national enquiry of all maternal deaths, we recommend securing longer-term budget allocation and financial commitment from the ministry, securing a national legal framework for MDSR, and improving processes at the subnational level.

10. A Smartphone App (AfyaData) for Innovative One Health Disease Surveillance from Community to National Levels in Africa: Intervention in Disease Surveillance.

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ABSTRACT

BACKGROUND: We describe the development and initial achievements of a participatory disease surveillance system that relies on mobile technology to promote Community Level One Health Security (CLOHS) in Africa.

OBJECTIVE: The objective of this system, Enhancing Community-Based Disease Outbreak Detection and Response in East and Southern Africa (DODRES), is to empower community-based human and animal health reporters with training and information and communication technology (ICT)-based solutions to contribute to disease detection and response, thereby complementing strategies to improve the efficiency of infectious disease surveillance at national, regional, and global levels. In this study, we refer to techno-health as the application of ICT-based solutions to enhance early detection, timely reporting, and prompt response to health events in human and animal populations.

METHODS: An EpiHack, involving human and animal health experts as well as ICT programmers, was held in Tanzania in 2014 to identify major challenges facing early detection, timely reporting, and prompt response to disease events. This was followed by a project inception workshop in 2015, which brought together key stakeholders, including policy makers and community representatives, to refine the objectives and implementation plan of the DODRES project. The digital ICT tools were developed and packaged together as the AfyaData app to support One Health disease surveillance. Community health reporters (CHRs) and officials from animal and human health sectors in Morogoro and Ngorongoro

districts in Tanzania were trained to use the AfyaData app. The AfyaData supports near- to real-time data collection and submission at both community and health facility levels as well as the provision of feedback to reporters. The functionality of the One Health Knowledge Repository (OHKR) app has been integrated into the AfyaData app to provide health information on case definitions of diseases of humans and animals and to synthesize advice that can be transmitted to CHRs with next step response activities or interventions. Additionally, a WhatsApp social group was made to serve as a platform to sustain interactions between community members, local government officials, and DODRES team members.

RESULTS: Within the first 5 months (August-December 2016) of AfyaData tool deployment, a total of 1915 clinical cases in livestock (1816) and humans (99) were reported in Morogoro (83) and Ngorongoro (1832) districts.

CONCLUSIONS: These initial results suggest that the DODRES community-level model creates an opportunity for One Health engagement of people in their own communities in the detection of infectious human and animal disease threats. Participatory approaches supported by digital and mobile technologies should be promoted for early disease detection, timely reporting, and prompt response at the community, national, regional, and global levels.

11. Using remote sensing environmental data to forecast malaria incidence at a rural district hospital in Western Kenya.

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ABSTRACT

Malaria surveillance data provide opportunity to develop forecasting models. Seasonal variability in environmental factors correlate with malaria transmission,

thus the identification of transmission patterns is useful in developing prediction models. However, with changing seasonal transmission patterns, either due to interventions or shifting weather seasons, traditional modelling approaches may not yield adequate predictive skill. Two statistical models,a general additive model (GAM) and GAMBOOST model with boosted regression were contrasted by assessing their predictive accuracy in forecasting malaria admissions at lead times of one to three months. Monthly admission data for children under five years with confirmed malaria at the Siaya district hospital in Western Kenya for the period 2003 to 2013 were used together with satellite derived data on rainfall, average temperature and evapotranspiration(ET). There was a total of 8,476 confirmed malaria admissions. The peak of malaria season changed and malaria admissions reduced overtime. The GAMBOOST model at 1-month lead time had the highest predictive skill during both the training and test periods and thus can be utilized in a malaria early warning system.

12. Surveillance of HIV assisted partner services using routine health information systems in Kenya.

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ABSTRACT

BACKGROUND: The utilization of routine health information systems (HIS) for surveillance of assisted partner services (aPS) for HIV in sub-Saharan is sub-optimal, in part due to poor data quality and limited use of information technology. Consequently, little is known about coverage, scope and quality of HIV aPS. Yet, affordable electronic data tools, software and data transmission infrastructure are now widely accessible in sub-Saharan Africa.

METHODS: We designed and implemented a cased-based surveillance system using the HIV testing platform in 18 health facilities in Kenya. The components of this system included an electronic HIV Testing and Counseling (HTC) intake form, data transmission on the Global Systems for Mobile Communication (GSM), and

data collection using the Open Data Kit (ODK) platform. We defined rates of new HIV diagnoses, and characterized HIV-infected cases. We also determined the proportion of clients who reported testing for HIV because a) they were notified by a sexual partner b) they were notified by a health provider, or c) they were informed of exposure by another other source. Data collection times were evaluated.

RESULTS: Among 4351 clients, HIV prevalence was 14.2 %, ranging from 4.4–25.4 % across facilities. Regardless of other reasons for testing, only 107 (2.5 %) of all participants reported testing after being notified by a health provider or sexual partner. A similar proportion, 1.8 % (79 of 4351), reported partner notification as the only reason for seeking an HIV test. Among 79 clients who reported HIV partner services as the reason for testing, the majority (78.5 %), were notified by their sexual partners. The majority (52.8 %) of HIV-infected patients initiated their HIV testing, and 57.2 % tested in a Voluntary Counseling and Testing (VCT) site co-located in a health facility. Median time for data capture was 4 min (IQR: 3–15), with a longer duration for HIV-infected participants, and there was no reported data loss.

CONCLUSION: aPS surveillance using new technologies is feasible, and could be readily expanded into HIV registries in Kenya and other sub-Saharan countries. Partner services are under-utilized in Kenya but further documentation of coverage and implementation gaps for HIV and aPS services is required.

13. Innovative tools and OpenHDS for health and demographic surveillance on Rusinga Island, Kenya.

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ABSTRACT

BACKGROUND: Health in low and middle income countries is on one hand characterized by a high burden associated with preventable communicable diseases and on the other hand considered to be under-documented due to

improper basic health and demographic record-keeping. health and demographic surveillance systems (HDSSs) have provided researchers, policy makers and governments with data about local population dynamics and health related information. In order for an HDSS to deliver high quality data, effective organization of data collection and management are vital. HDSSs impose a challenging logistical process typically characterized by door to door visits, poor navigational guidance, conducting interviews recorded on paper, error prone data entry, an extensive staff and marginal data quality management possibilities.

METHODS: A large trial investigating the effect of odour-baited mosquito traps on malaria vector populations and malaria transmission on Rusinga Island, western Kenya, has deployed an HDSS. By means of computer tablets in combination with Open Data Kit and OpenHDS data collection and management software experiences with time efficiency, cost effectiveness and high data quality are illustrate. Step by step, a complete organization of the data management infrastructure is described, ranging from routine work in the field to the organization of the centralized data server.

RESULTS AND DISCUSSION: Adopting innovative technological advancements has enabled the collection of demographic and malaria data quickly and effectively, with minimal margin for errors. Real-time data quality controls integrated within the system can lead to financial savings and a time efficient work flow.

CONCLUSION: This novel method of HDSS implementation demonstrates the feasibility of integrating electronic tools in large-scale health interventions.

14. Not too far to walk": the influence of distance on place of delivery in a western Kenya health demographic surveillance system.

Emily Mwaliko[1], Raymond Downing[1], Wendy O'Meara[1], Dinah Chelagat[1], Andrew Obala[1], Timothy Downing[1], Chrispinus Simiyu[1], David Odhiambo[1], Paul Ayuo[1], Diana Menya[1], Barasa Khwa-Otsyula[1].

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ABSTRACT

BACKGROUND: Maternal health service coverage in Kenya remains low, especially in rural areas where 63% of women deliver at home, mainly because health facilities are too far away and/or they lack transport. The objectives of the present study were to (1) determine the association between the place of

delivery and the distance of a household from the nearest health facility and (2) study the demographic characteristics of households with a delivery within a demographic surveillance system (DSS).

METHODS: Census sampling was conducted for 13,333 households in the Webuye health and demographic surveillance system area in 2008–2009. Information was collected on deliveries that had occurred during the previous 12 months. Digital coordinates of households and sentinel locations such as health facilities were collected. Data were analyzed using STATA version 11. The Euclidean distance from households to health facilities was calculated using WinGRASS version 6.4. Hotspot analysis was conducted in ArcGIS to detect clustering of delivery facilities. Unadjusted and adjusted odds ratios were estimated using logistic regression models. P-values less than 0.05 were considered significant.

RESULTS: Of the 13,333 households in the study area, 3255 (24%) reported a birth, with 77% of deliveries being at home. The percentage of home deliveries increased from 30% to 80% of women living within 2km from a health facility. Beyond 2km, distance had no effect on place of delivery (OR 1.29, CI 1.06–1.57, p?=?0.011). Heads of households where women delivered at home were less likely to be employed (OR 0.598, CI 0.43–0.82, p?=?0.002), and were less likely to have secondary education (OR 0.50, CI 0.41–0.61, p?<?0.0001). Hotspot analysis showed households having facility deliveries were clustered around facilities offering comprehensive emergency obstetric care services.

CONCLUSION: Households where the nearest facility was offering emergency obstetric care were more likely to have a facility delivery, but only if the facility was within 2km of the home. Beyond the 2-km threshold, households were equally as likely to have home and facility deliveries. There is need for further research on other factors that affect the choice of place of delivery, and their relationships with maternal mortality.

15. Using mobile phone text messaging for malaria surveillance in rural Kenya.

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ABSTRACT

BACKGROUND: Effective surveillance systems are required to track malaria testing and treatment practices. A 26-week study "SMS for Life" was piloted in five rural districts of Kenya to examine whether SMS reported surveillance data could

ensure real-time visibility of accurate data and their use by district managers to impact on malaria case-management.

METHODS: Health workers from 87 public health facilities used their personal mobile phones to send a weekly structured SMS text message reporting the counts of four basic surveillance data elements to a web-based system accessed by district managers. Longitudinal monitoring of SMS reported data through the web-based system and two rounds of cross-sectional health facility surveys were done to validate accuracy of data.

RESULTS: Mean response rates were 96% with 87% of facilities reporting on time. Fifty-eight per cent of surveillance data parameters were accurately reported. Overall mean testing rates were 37% with minor weekly variations ranging from 32 to 45%. Overall test positivity rate was 24% (weekly range: 17-37%). Ratio of anti-malarial treatments to test positive cases was 1.7:1 (weekly range: 1.3:1-2.2:1). District specific trends showed fluctuating patterns in testing rates without notable improvement over time but the ratio of anti-malarial treatments to test positive cases improved over short periods of time in three out of five districts.

CONCLUSIONS: The study demonstrated the feasibility of using simple mobile phone text messages to transmit timely surveillance data from peripheral health facilities to higher levels. However, accuracy of data reported was suboptimal. Future work should focus on improving quality of SMS reported surveillance data.

16. **Results from the first six years of national sentinel surveillance for influenza in Kenya, July 2007-June 2013**.

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ABSTRACT

BACKGROUND: Recent studies have shown that influenza is associated with significant disease burden in many countries in the tropics, but until recently national surveillance for influenza was not conducted in most countries in Africa.

METHODS: In 2007, the Kenyan Ministry of Health with technical support from the CDC-Kenya established a national sentinel surveillance system for influenza. At 11 hospitals, for every hospitalized patient with severe acute respiratory illness (SARI), and for the first three outpatients with influenza-like illness (ILI) per day, we collected both nasopharyngeal and oropharyngeal swabs. Beginning in 2008, we

conducted in-hospital follow-up for SARI patients to determine outcome. Specimens were tested by real time RT-PCR for influenza A and B. Influenza A-positive specimens were subtyped for H1, H3, H5, and (beginning in May 2009) A(H1N1)pdm09.

RESULTS: From July 1, 2007 through June 30, 2013, we collected specimens from 24,762 SARI and 14,013 ILI patients. For SARI and ILI case-patients, the median ages were 12 months and 16 months, respectively, and 44% and 47% were female. In all, 2,378 (9.6%) SARI cases and 2,041 (14.6%) ILI cases were positive for influenza viruses. Most influenza-associated SARI cases (58.6%) were in children <2 years old. Of all influenza-positive specimens, 78% were influenza A, 21% were influenza B, and 1% were influenza A/B confections. Influenza circulated in every month. In four of the six years influenza activity peaked during July-November. Of 9,419 SARI patients, 2.7% died; the median length of hospitalization was 4 days.

CONCLUSIONS: During six years of surveillance in Kenya, influenza was associated with nearly 10 percent of hospitalized SARI cases and one-sixth of outpatient ILI cases. Most influenza-associated SARI and ILI cases were in children <2 years old; interventions to reduce the burden of influenza, such as vaccine, could consider young children as a priority group.

17. A comparison of smartphones to paper-based questionnaires for routine influenza sentinel surveillance, Kenya, 2011-2012.

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ABSTRACT

BACKGROUND: For disease surveillance, manual data collection using paper-based questionnaires can be time consuming and prone to errors. We introduced smartphone data collection to replace paper-based data collection for an influenza sentinel surveillance system in four hospitals in Kenya. We compared the quality, cost and timeliness of data collection between the smartphone data collection system and the paper-based system.

METHODS: Since 2006, the Kenya Ministry of Health (MoH) with technical support from the Kenya Medical Research Institute/Centers for Disease Control and Prevention (KEMRI/CDC) conducted hospital-based sentinel surveillance for influenza in Kenya. In May 2011, the MOH replaced paper-based collection with an electronic data collection system using Field Adapted Survey Toolkit (FAST) on HTC Touch Pro2 smartphones at four sentinel sites. We compared 880 paper-based questionnaires dated Jan 2010-Jun 2011 and 880 smartphone questionnaires dated May 2011-Jun 2012 from the four surveillance sites. For each site, we compared the quality, cost and timeliness of each data collection system.

RESULTS: Incomplete records were more likely seen in data collected using pen-and-paper compared to data collected using smartphones (adjusted incidence rate ratio (aIRR) 7, 95% CI: 4.4-10.3). Errors and inconsistent answers were also more likely to be seen in data collected using pen-and-paper compared to data collected using smartphones (aIRR: 25, 95% CI: 12.5-51.8). Smartphone data was uploaded into the database in a median time of 7 days while paper-based data took a median of 21 days to be entered (p?<?0.01). It cost USD 1,501 (9.4%) more to establish the smartphone data collection system ($17,500) than the pen-and-paper system (USD $15,999). During two years, however, the smartphone data collection system was $3,801 (7%) less expensive to operate ($50,200) when compared to pen-and-paper system ($54,001).

CONCLUSIONS: Compared to paper-based data collection, an electronic data collection system produced fewer incomplete data, fewer errors and inconsistent responses and delivered data faster. Although start-up costs were higher, the overall costs of establishing and running the electronic data collection system were lower compared to paper-based data collection system. Electronic data collection using smartphones has potential to improve timeliness, data integrity and reduce costs.

18. Health & demographic surveillance system profile: The Kombewa health and demographic surveillance system (Kombewa HDSS).

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ABSTRACT

The Kombewa Health and Demographic Surveillance System (HDSS) grew out of the Kombewa Clinical Research Centre in 2007 and has since established itself as

a platform for the conduct of regulated clinical trials, nested studies and local disease surveillance. The HDSS is located in a rural part of Kisumu County, Western Kenya, and covers an area of about 369 km(2) along the north-eastern shores of Lake Victoria. A dynamic cohort of 141 956 individuals drawn from 34 718 households forms the HDSS surveillance population. Following a baseline survey in 2011, the HDSS continues to monitor key population changes through routine biannual household surveys. The intervening period between set-up and baseline census was used for preparatory work, in particular Global Positioning System (GPS) mapping. Routine surveys capture information on individual and households including residency, household relationships, births, deaths, migrations (in and out) and causes of morbidity (syndromic incidence and prevalence) as well as causes of death (verbal autopsy). The Kombewa HDSS platform is used to support health research activities, that is clinical trials and epidemiological studies evaluating diseases of public health importance including malaria, HIV and global emerging infectious diseases such as dengue fever.

19. Home Based Counseling and Testing in Health Demographic Surveillance System areas in western Kenya.

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ABSTRACT

INTRODUCTION: Home Based Counseling and Testing (HBCT) is a strategy which has proved effective in increasing uptake of voluntary HIV counselling and testing (KAIS, 2007). HBCT rapidly increases access and utilization of counseling and testing services for the entire household and provides an excellent opportunities for referral and disclosure. Objective: To determine coverage, access and utilization of counseling and testing services to entire family members.

METHODS: After consenting, eligible persons v(adults and adolescents > 13 years and children <12 years whose biological mothers were HIVinfected or deceased) were tested for HIV in their own homes by trained HBCT counselors using rapid test strips in parallel. Standardized data collection tools which assessed previous HIV testing, sexual and health seeking behaviors were completed for all individuals.

FINDINGS: 52,629 individuals who were offered the test accepted HBCT services. 65% percent of all participants had never had a previous HIV while 57% of HIV-infected participants did not know they had HIV until HBCT. Among those tested, overall HIV prevalence rates were 13.2% while Prevalence among first time testers was 8.9%. HIV-discordance among those tested as a couple was 10.5%. HIV rates

were high among those who were widowed and remarried at 38% and separated at 32%. Low perception of risk is major barrier to HIV testing while planning for future is the main motivation to test.

CONCLUSIONS: HBTC was well-received by the community and increased knowledge of HIV status, low perception of HIV risk is major reason for not testing, HIV rate was higher among widowed and inherited compared to other adults and HBCT present an opportunity for prevention effort through skill building and safe sex negotiation for couples.

20. KEMRI/CDC Health and Demographic Surveillance System (HDSS) in Research and Program Implementation.

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ABSTRACT

BACKGROUND: In 2001 to 2002, the HDSS was started in Asembo and Gem in Nyanza Province, western Kenya. In 2007 we expanded to include Karemo and Siaya District Hospital. The HDSS currently follows over 220,000 people.

OBJECTIVES: To investigate whether childhood mortality could be associated with the geospatial distribution of determinants. To use the HDSS to track internally displaced persons (IDP) entry and exit from the surveillance area and associated morbidity or mortality. To describe the penetration of HIV care and ART services in the HDSS area.

METHODS: We carry out Demographic surveys every 4 months, collect data on Socio-economic and educational status every 2 years and collect information on immunization status. We carry out Verbal autopsies and collect specimens for malaria, influenza and rotavirus surveillance. We do home based HIV counselling and testing, and use personal digital assistants (PDAs) to collect data.

RESULTS: High mortality villages occurred in clusters. Higher mortality was associated with living further away from a public road, living closer to streams at lower elevations and lower population densities. 16,000 IDPs came into the HDSS area. This resulted in a high burden of outpatient and inpatient pediatric sick visits, and we observed an increase in the rate of malaria admissions. By the end 2008, 29% of the approximately 17,000 HIV+ adults in the HDSS had enrolled into care services.

CONCLUSIONS: Studies that link population demographic information with health facility and GPS data provide rich and useful information that can guide policy making decisions, and HDSS sites can readily be used to evaluate the roll-out of new vaccines like the pneumococcal conjugate vaccine and the rotavirus vaccine.

21. Profile: the KEMRI/CDC Health and Demographic Surveillance System--Western Kenya.

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ABSTRACT

The KEMRI/Centers for Disease Control and Prevention (CDC) Health and Demographic Surveillance System (HDSS) is located in Rarieda, Siaya and Gem Districts (Siaya County), lying northeast of Lake Victoria in Nyanza Province, western Kenya. The KEMRI/CDC HDSS, with approximately 220 000 inhabitants, has been the foundation for a variety of studies, including evaluations of insecticide-treated bed nets, burden of diarrhoeal disease and tuberculosis, malaria parasitaemia and anaemia, treatment strategies and immunological correlates of malaria infection, and numerous HIV, tuberculosis, malaria and diarrhoeal disease treatment and vaccine efficacy and effectiveness trials for more than a decade. Current studies include operations research to measure the uptake and effectiveness of the programmatic implementation of integrated malaria control strategies, HIV services, newly introduced vaccines and clinical trials. The HDSS provides general demographic and health information (such as population age structure and density, fertility rates, birth and death rates, in- and out-migrations, patterns of health care access and utilization and the local economics of health care) as well as disease- or intervention-specific information. The HDSS also collects verbal autopsy information on all deaths. Studies take advantage of the sampling frame inherent in the HDSS, whether at individual, household/compound or neighbourhood level.

22. Health and Demographic Surveillance System in the Western and Coastal Areas of Kenya: An Infrastructure for Epidemiologic Studies in Africa.

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BACKGROUND: The Health and Demographic Surveillance System (HDSS) is a longitudinal data collection process that systematically and continuously monitors population dynamics for a specified population in a geographically defined area that lacks an effective system for registering demographic information and vital events.

METHODS: HDSS programs have been run in 2 regions in Kenya: in Mbita district in Nyanza province and Kwale district in Coast Province. The 2 areas have different disease burdens and cultures. Vital events were obtained by using personal digital assistants and global positioning system devices. Additional health-related surveys have been conducted bimonthly using various PDA-assisted survey software.

RESULTS: The Mbita HDSS covers 55 929 individuals, and the Kwale HDSS covers 42 585 individuals. In the Mbita HDSS, the life expectancy was 61.0 years for females and 57.5 years for males. Under-5 mortality was 91.5 per 1000 live births, and infant mortality was 47.0 per 1000 live births. The total fertility rate was 3.7 per woman. Data from the Kwale HDSS were not available because it has been running for less than 1 year at the time of this report.

CONCLUSIONS: Our HDSS programs are based on a computer-assisted survey system that provides a rapid and flexible data collection platform in areas that lack an effective basic resident registration system. Although the HDSS areas are not representative of the entire country, they provide a base for several epidemiologic and social study programs, and for practical community support programs that seek to improve the health of the people in these areas.

23. Rotavirus Surveillance in a Health and Demographic Surveillance System (HDSS) – Siaya, Kenya.

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ABSTRACT

BACKGROUND: The KEMRI/CDC Health and Demographic Surveillance System (HDSS) has been conducting hospital surveillance in selected health facilities in Asembo, Gem and Karemo areas in Siaya County since 2001. Diarrhea is one of the leading causes of morbidity and mortality in this area. Previous studies have shown high levels of diarrhea are attributable to rotavirus among children. Rotavirus vaccine studies have demonstrated high efficacy in the first year of life with majority of the western countries adopting it for routine immunization. Due to the imminent introduction of the vaccine in Kenya, there is need for continued surveillance of rotavirus so as to measure the impact of vaccine or other intervention introductions and thus inform national and international policy.

OBJECTIVES: The study was aimed at; establishing baseline population-based data on rotavirus disease to facilitate evaluation of rotavirus vaccine impact; use rotavirus surveillance data in combination with population denominators from the HDSS to estimate the hospitalization and mortality rates of rotavirus gastroenteritis in children under 5 years; evaluate shifts in rotavirus genotype distribution over time; share rotavirus surveillance data with the Kenyan Ministries of Health and WHO/AFRO.

METHODOLOGY: The HDSS undertakes active hospital surveillance at Siaya District Hospital and Ting'wang'i Health Centre (both in Karemo) and Njejra Health Centre (in Gem). The current population is approximately 225,000 (Gem, Karemo and Asembo). For the period January 2010 to August 2010, structured questionnaires encompassing demographic, treatment history, diagnosis and laboratory investigations to be undertaken were administered to all enrolled patients under the age of 12 coming to these health facilities. Data was collected electronically by trained personnel during the routine patient management. Patients aged below five years who meet the criteria for acute

gastroenteritis provide a stool sample for rotavirus testing at our labs using ELISA methods.

RESULTS: Based on the 8 months of surveillance, we noted that among admissions for children under 5 years, 21% to 32% were due to acute gastroenteritis. Out of the samples collected and tested, we had a rotavirus positivity of between 19% and 37% per month. In the outpatient, one tenth of all under 5 sick visits were due to acute gastroenteritis with a rotavirus positivity of up to 30%. The most common virus strains were the G8/G3 P(4).Preliminary rate calculations showed that rotavirus accounts for 94 deaths per 100,000 children under 5 years in this area, and 358 hospitalizations per 100,000 children under 5 years.

DISCUSSION/CONCLUSION: Rotavirus is a major health burden in our population. There is need for continued surveillance and genotyping so as to establish the strains circulating in this population and the actual rotavirus burden. The HDSS will help to monitor rotavirus vaccine introduction and other related interventions, by measuring impact on both morbidity and mortality in the population. We will in future link rotavirus data collected to the routine HDSS data to enable analysis of risk factors, household transmission, spatial distribution and modeling of infection in the community.

24. Fingerprinting in the KEMRI/CDC Health & Demographic Surveillance System (HDSS), Western Kenya, 2010.

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ABSTRACT

BACKGROUND: The western Kenya KEMRI/CDC HDSS faces challenges in the re-identification of individuals resident in the HDSS due to similar names, imprecise identifiers such as age, and high mobility within the area. These challenges have resulted in double enumerations and failed linkages between household and clinical data. We implemented a fingerprinting system for individual identification. We sought to evaluate public acceptability of fingerprinting as a mode of individual identification.

METHODOLOGY: We implemented a fingerprint identification system using Graiule fingerprint SDK as a platform. We used the Secugen Hamster Plus fingerprint reader and accompanying system to capture fingerprints of the HDSS and the non-HDSS participants at the households in the HDSS. Children less than1

year of age were enrolled by referencing them to the parents or guardians. We assessed acceptability by seeking consent before enrolling the individuals.

RESULTS: From July 2010 through December 2010, we targeted a total of 326,741 individuals; 115,074(35%) individuals of the target could not be reached due to migration, death or were unknown to the individuals leaving in the compound, 33,538(10%) individuals required a revisit, 8,842(3%) individuals refused to be consent, 165,287(51%) individuals consented and their fingerprints were attempted to be taken of which 155,108 (94%) individuals were successfully enrolled. During enrollment, a 2% sample of individuals successfully enrolled was revisited to re-identify the individuals. We found that 68% of the individuals were successfully re-identified. The challenges encountered included difficulty in capturing clear fingerprints of children less than 5 years of age and adults over 60 years of age.

CONCLUSION: Although our data are preliminary, the fingerprint system appears to be acceptable and largely reliable. Fingerprinting will likely improve the re-identification of individuals in the HDSS, thus potentially facilitating more accurate and efficient linkages between health facility and household surveillance data. Such linkages can be used for important public health analyses and design of interventions.

25. Health-seeking patterns among participants of population-based morbidity surveillance in rural western Kenya: implications for calculating disease rates

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ABSTRACT

BACKGROUND: Calculation of disease rates in developing countries using facility-based surveillance is affected by patterns of health utilization. We describe temporal patterns in health care seeking by syndrome as part of population-based morbidity surveillance in rural western Kenya.

METHODS: From July 2006 to June 2008, health utilization data were collected from 27 171 participants at biweekly home visits and at Lwak Hospital, the designated referral clinic where free care provided by dedicated study clinical staff was available. Ill persons were asked if and where they sought care. Proportions seeking care for children and adults with fever, acute respiratory infection (ARI), acute lower respiratory infection (ALRI), and diarrhea were

compared by Chi-square test. Care-seeking by distance was evaluated by logistic regression.

RESULTS: While care-seeking outside the home was common for all syndromes (>50%), only 18–38% of care-seeking was to health facilities. Children were more likely than adults to visit health facilities for all syndromes. Of ill persons visiting Lwak Hospital, 45–54% had previously sought care elsewhere, mostly from informal drug sellers, and 11–24% with fever, ARI, or ALRI had already taken an antimalarial or antibiotic. The distance from the participant's home to Lwak Hospital was the most common reason (71%) for ill participants not seeking care there. The likelihood of visiting Lwak decreased with increasing distance of residence (p < 0.001) and fluctuated significantly over the study period.

CONCLUSIONS: Even in a study setting where free and reliable care is offered, health utilization is affected by other factors, such as distance. Health utilization data in population-based surveillance are important in adjusting disease rates.

26. Mortality and health among internally displaced persons in western Kenya following post-election violence, 2008: novel use of demographic surveillance.

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ABSTRACT

OBJECTIVE: To evaluate mortality and morbidity among internally displaced persons (IDPs) who relocated in a demographic surveillance system (DSS) area in western Kenya following post-election violence.

METHODS: In 2007, 204 000 individuals lived in the DSS area, where field workers visit households every 4 months to record migrations, births and deaths. We collected data on admissions among children < 5 years of age in the district hospital and developed special questionnaires to record information on IDPs. Mortality, migration and hospitalization rates among IDPs and regular DSS residents were compared, and verbal autopsies were performed for deaths.

FINDINGS: Between December 2007 and May 2008, 16 428 IDPs migrated into the DSS, and over half of them stayed 6 months or longer. In 2008, IDPs aged 15-49 years died at higher rates than regular residents of the DSS (relative risk, RR: 1.34; 95% confidence interval, CI: 1.004-1.80). A greater percentage of deaths from human immunodeficiency virus (HIV) infection occurred among IDPs aged > 5

years (53%) than among regular DSS residents (25-29%) (P < 0.001). Internally displaced children < 5 years of age did not die at higher rates than resident children but were hospitalized at higher rates (RR: 2.95; 95% CI: 2.44-3.58).

CONCLUSION: HIV-infected internally displaced adults in conflict-ridden parts of Africa are at increased risk of HIV-related death. Relief efforts should extend to IDPs who have relocated outside IDP camps, particularly if afflicted with HIV infection or other chronic conditions.

27. Implementing school malaria surveys in Kenya: towards a national surveillance system.

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ABSTRACT

OBJECTIVE: To design and implement surveys of malaria infection and coverage of malaria control interventions among school children in Kenya in order to contribute towards a nationwide assessment of malaria.

METHODS: The country was stratified into distinct malaria transmission zones based on a malaria risk map and 480 schools were visited between October 2008 and March 2010. Surveys were conducted in two phases: an initial opportunistic phase whereby schools were selected for other research purposes; and a second phase whereby schools were purposively selected to provide adequate spatial representation across the country. Consent for participation was based on passive, opt-out consent rather than written, opt-in consent because of the routine, low-risk nature of the survey. All children were diagnosed for Plasmodium infection using rapid diagnostic tests, assessed for anaemia and were interviewed about mosquito net usage, recent history of illness, and socio-economic and household indicators. Children's responses were entered electronically in the school and data transmitted nightly to Nairobi using a mobile phone modem connection. RDT positive results were corrected by microscopy and all results were adjusted for clustering using random effect regression modelling.

RESULTS: 49,975 children in 480 schools were sampled, at an estimated cost of US$ 1,116 per school. The overall prevalence of malaria and anaemia was 4.3% and 14.1%, respectively, and 19.0% of children reported using an insecticide-treated net (ITN). The prevalence of infection showed marked variation across the country, with prevalence being highest in Western and

Nyanza provinces, and lowest in Central, North Eastern and Eastern provinces. Nationally, 2.3% of schools had reported ITN use >60%, and low reported ITN use was a particular problem in Western and Nyanza provinces. Few schools reported having malaria health education materials or ongoing malaria control activities.

CONCLUSION: School malaria surveys provide a rapid, cheap and sustainable approach to malaria surveillance which can complement household surveys, and in Kenya, show that large areas of the country do not merit any direct school-based control, but school-based interventions, coupled with strengthened community-based strategies, are warranted in western and coastal Kenya. The results also provide detailed baseline data to inform evaluation of school-based malaria control in Kenya.

28. Landscape determinants and remote sensing of anopheline mosquito larval habitats in the western Kenya highlands.

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ABSTRACT

BACKGROUND: In the past two decades the east African highlands have experienced several major malaria epidemics. Currently there is a renewed interest in exploring the possibility of anopheline larval control through environmental management or larvicide as an additional means of reducing malaria transmission in Africa. This study examined the landscape determinants of anopheline mosquito larval habitats and usefulness of remote sensing in identifying these habitats in western Kenya highlands.

METHODS: Panchromatic aerial photos, Ikonos and Landsat Thematic Mapper 7 satellite images were acquired for a study area in Kakamega, western Kenya. Supervised classification of land-use and land-cover and visual identification of

aquatic habitats were conducted. Ground survey of all aquatic habitats was conducted in the dry and rainy seasons in 2003. All habitats positive for anopheline larvae were identified. The retrieved data from the remote sensors were compared to the ground results on aquatic habitats and land-use. The probability of finding aquatic habitats and habitats with Anopheles larvae were modelled based on the digital elevation model and land-use types.

RESULTS: The misclassification rate of land-cover types was 10.8% based on Ikonos imagery, 22.6% for panchromatic aerial photos and 39.2% for Landsat TM 7 imagery. The Ikonos image identified 40.6% of aquatic habitats, aerial photos identified 10.6%, and Landsate TM 7 image identified 0%. Computer models based on topographic features and land-cover information obtained from the Ikonos image yielded a misclassification rate of 20.3–22.7% for aquatic habitats, and 18.1–25.1% for anopheline-positive larval habitats.

CONCLUSION: One-metre spatial resolution Ikonos images combined with computer modelling based on topographic land-cover features are useful tools for identification of anopheline larval habitats, and they can be used to assist to malaria vector control in western Kenya highlands.

29. Health and demographic surveillance in rural Western Kenya: a platform for evaluating interventions to reduce morbidity and mortality from infectious diseases.

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ABSTRACT

We established a health and demographic surveillance system in a rural area of western Kenya to measure the burden of infectious diseases and evaluate public health interventions. After a baseline census, all 33,990 households were visited every four months. We collected data on educational attainment, socioeconomic status, pediatric outpatient visits, causes of death in children, and

malaria transmission. The life expectancy at birth was 38 years, the infant mortality rate was 125 per 1000 live births, and the under-five mortality rate was 227 per 1,000 live births. The increased mortality rate in younger men and women suggests high human immunodeficiency virus/acquired immunodeficiency syndrome–related mortality in the population. Of 5,879 sick child visits, the most frequent diagnosis was malaria (71.5%). Verbal autopsy results for 661 child deaths (1 month to <12 years) implicated malaria (28.9%) and anemia (19.8%) as the most common causes of death in children. These data will provide a basis for generating further research questions, developing targeted interventions, and evaluating their impact.

Rwanda

30. Impact of routine rotavirus vaccination on all-cause and rotavirus hospitalizations during the first four years following vaccine introduction in Rwanda.

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ABSTRACT

BACKGROUND: Rwanda introduced pentavalent rotavirus vaccine into its national immunization program in 2012. To determine the long-term impact of rotavirus vaccine on disease burden in a high burden setting, we examined trends in rotavirus and all-cause diarrhea hospitalizations in the first four years following rotavirus vaccine introduction.

METHODS: We used data from an active surveillance system, from a review of pediatric ward registries, and from the Health Management Information System to describe trends in rotavirus and all-cause diarrhea hospitalizations from January 2009 through December 2016. Percent reductions were calculated to compare the number of all-cause and rotavirus diarrhea hospitalizations pre- and post-rotavirus vaccine introduction.

RESULTS: The proportion of diarrhea hospitalizations due to rotavirus declined by 25-44% among all children <5 years of age during 2013-2015 with a shift in rotavirus hospitalizations to older age groups. The proportion of total hospitalizations due to diarrhea among children <5 years of age decreased from 19% pre-vaccine introduction to 12-13% post-vaccine introduction. In the national hospital discharge data, substantial decreases were observed in all-cause diarrhea hospitalizations among children <5 years of age in 2013 and 2014 but these gains lessened in 2015-2016.

DISCUSSION: Continued monitoring of long-term trends in all-cause diarrhea and rotavirus hospitalizations is important to ensure that the impact of the vaccination program is sustained over time and to better understand the changing age dynamics of diarrhea and rotavirus hospitalizations in the post-vaccine introduction era.

31. Spatio-temporal dynamics of schistosomiasis in Rwanda between 2001 and 2012: impact of the national Neglected Tropical Disease control programme.

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ABSTRACT

Schistosomiasis is recognised as a major public health problem in Rwanda. We aimed to identify the spatio-temporal dynamics of its distribution at a fine-scale spatial resolution and to explore the impact of control programme interventions. Incidence data of Schistosoma mansoni infection at 367 health facilities were obtained for the period 2001-2012. Disease cluster analyses were conducted using spatial scan statistics and geographic information systems. The impact of control interventions was assessed for three distinct sub-periods. Findings demonstrated persisting, emerging and re-emerging clusters of schistosomiasis infection across space and time. The control programme initially caused an abrupt increase in incidence rates during its implementation phase. However, this was followed by declining and disappearing clusters when the programme was fully in place. The findings presented should contribute to a better understanding of the dynamics of schistosomiasis distribution to be used when implementing future control activities, including prevention and elimination efforts.

32. High road utilizers surveys compared to police data for road traffic crash hotspot localization in Rwanda and Sri Lanka

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ABSTRACT

BACKGROUND: Road traffic crashes (RTCs) are a leading cause of death. In low and middle income countries (LMIC) data to conduct hotspot analyses and safety audits are usually incomplete, poor quality, and not computerized. Police data are often limited, but there are no alternative gold standards. This project evaluates high road utilizer surveys as an alternative to police data to identify RTC hotspots.

METHODS: Retrospective police RTC data was compared to prospective data from high road utilizer surveys regarding dangerous road locations. Spatial analysis using geographic information systems was used to map dangerous locations and identify RTC hotspots. We assessed agreement (Cohen's Kappa), sensitivity/specificity, and cost differences.

RESULTS: In Rwanda police data identified 1866 RTC locations from 2589 records while surveys identified 1264 locations from 602 surveys. In Sri Lanka, police data identified 721 RTC locations from 752 records while survey data found 3000 locations from 300 surveys. There was high agreement (97 %, 83 %) and kappa (0.60, 0.60) for Rwanda and Sri Lanka respectively. Sensitivity and specificity are 92 % and 95 % for Rwanda and 74 % and 93 % for Sri Lanka. The cost per crash

location identified was $2.88 for police and $2.75 for survey data in Rwanda and $2.75 for police and $1.21 for survey data in Sri Lanka.

CONCLUSION: Surveys to locate RTC hotspots have high sensitivity and specificity compared to police data. Therefore, surveys can be a viable, inexpensive, and rapid alternative to the use of police data in LMIC.

33. The epidemiology of road traffic injury hotspots in Kigali, Rwanda from police data.

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ABSTRACT

BACKGROUND: Road traffic injuries (RTIs) are the eighth-leading cause of death worldwide, with low- and middle-income countries sharing a disproportionate number of fatalities. African countries, like Rwanda, carry a higher burden of these fatalities and with increased economic growth, these numbers are expected to rise. We aim to describe the epidemiology of RTIs in Kigali Province, Rwanda and create a hotspot map of crashes from police data.

METHODS: Road traffic crash (RTC) report data from January 1, 2013 to December 31, 2013 was collected from Kigali Traffic Police. In addition to analysis of descriptive data, locations of RTCs were mapped and analyzed through exploratory spatial data analysis to determine hotspots.

RESULTS: A total of 2589 of RTCs were reported with 4689 total victims. The majority of victims were male (94.7 %) with an average age of 35.9 years. Cars were the most frequent vehicle involved (43.8 %), followed by motorcycles (14.5 %).

Motorcycles had an increased risk of involvement in grievous crashes and pedestrians and cyclists were more likely to have grievous injuries. The hotspots identified were primarily located along the major roads crossing Kigali and the two busiest downtown areas.

CONCLUSIONS: Despite significant headway by the government in RTC prevention, there continue to be high rates of RTIs in Rwanda, specifically with young males and a vulnerable road user population, such as pedestrians and motorcycle users. Improvements in police data and reporting by laypersons could prove valuable for further geographic information system analysis and efforts towards crash prevention and targeting education to motorcycle taxis could help reduce RTIs in a severely affected population.

34. Epidemiology of injuries and outcomes among trauma patients receiving prehospital care at a tertiary teaching hospital in Kigali, Rwanda.

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ABSTRACT

INTRODUCTION: Injury accounts for 9.6% of the global mortality burden, disproportionately affecting those living in low- and middle-income countries. In an effort to improve trauma care in Rwanda, the Ministry of Health developed a prehospital service, Service d'Aide Médicale Urgente (SAMU), and established an emergency medicine training program. However, little is known about

patients receiving prehospital and emergency trauma care or their outcomes. The objective was to develop a linked prehospital-hospital database to evaluate patient characteristics, mechanisms of injury, prehospital and hospital resource use, and outcomes among injured patients receiving acute care in Kigali, Rwanda.

METHODS: A retrospective cohort study was conducted at University Teaching Hospital - Kigali, the primary trauma centre in Rwanda. Data was included on all injured patients transported by SAMU from December 2012 to February 2015. SAMU's prehospital database was linked to hospital records and data were collected using standardised protocols by trained abstractors. Demographic information, injury characteristics, acute care, hospital course and outcomes were included.

RESULTS: 1668 patients were transported for traumatic injury during the study period. The majority (77.7%) of patients were male. The median age was 30 years. Motor vehicle collisions accounted for 75.0% of encounters of which 61.4% involved motorcycles. 48.8% of patients sustained injuries in two or more anatomical regions. 40.1% of patients were admitted to the hospital and 78.1% required surgery. The overall mortality rate was 5.5% with nearly half of hospital deaths occurring in the emergency centre.

CONCLUSION: A linked prehospital and hospital database provided critical epidemiological information describing trauma patients in a low-resource setting. Blunt trauma from motor vehicle collisions involving young males constituted the majority of traumatic injury. Among this cohort, hospital resource utilization was high as was mortality. This data can help guide the implementation of interventions to improve trauma care in the Rwandan setting.

35. Development of a trauma and emergency database in Kigali, Rwanda.

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ABSTRACT

INTRODUCTION: Injuries account for 10% of the global burden of disease, resulting
in approximately 5.8 million deaths annually. Trauma registries are an important
tool in the development of a trauma system; however, limited resources in low-
and middle-income countries (LMIC) make the development of high-quality
trauma registries challenging. We describe the development of a LMIC trauma
registry based on a robust retrospective chart review, which included data
derived from prehospital, emergency centre and inpatient records.

METHODS: This paper outlines our methods for identifying and locating patients
and their medical records using pragmatic and locally appropriate record
linkage techniques. A prehospital database was queried to identify patients
transported to University Teaching Hospital – Kigali, Rwanda from December 2012
through February 2015. Demographic information was recorded and used to
create a five-factor identification index, which was then used to search
OpenClinic GA, an online open source hospital information system. The medical
record number and archive number obtained from OpenClinic GA were then
used to locate the physical medical record for data extraction.

RESULTS: A total of 1668 trauma patients were transported during the study
period. 66.7% were successfully linked to their medical record numbers and
archive codes. 94% of these patients were successfully linked to their medical
record numbers and archive codes were linked by four or five of the five pre-set
identifiers. 945 charts were successfully located and extracted for inclusion in the
trauma registry. Record linkage and chart extraction took approximately 1256 h.

CONCLUSION: The process of record linkage and chart extraction was a resource-intensive process; however, our unique methodology resulted in a high linkage rate. This study suggests that it is feasible to create a retrospective trauma registry in LMICs using pragmatic and locally appropriate record linkage techniques.

36. Leveraging community health worker system to map a mountainous rural district in low resource setting: a low-cost approach to expand use of geographic information systems for public health.

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ABSTRACT

BACKGROUND: Geographic Information Systems (GIS) have become an important tool in monitoring and improving health services, particularly at local levels. However, GIS data are often unavailable in rural settings and village-level mapping is resource-intensive. This study describes the use of community health workers' (CHW) supervisors to map villages in a mountainous rural district of Northern Rwanda and subsequent use of these data to map village-level variability in safe water availability.

METHODS: We developed a low literacy and skills-focused training in the local language (Kinyarwanda) to train 86 CHW Supervisors and 25 nurses in charge of community health at the health center (HC) and health post (HP) levels to collect the geographic coordinates of the villages using Global Positioning Systems (GPS). Data were validated through meetings with key stakeholders at the sub-district and district levels and joined using ArcMap 10 Geo-processing tools. Costs were calculated using program budgets and activities' records, and compared with the estimated costs of mapping using a separate, trained GIS team. To demonstrate the usefulness of this work, we mapped drinking water sources (DWS) from data collected by CHW supervisors from the chief of the village. DWSs were categorized as safe versus unsafe using World Health Organization definitions.

RESULT: Following training, each CHW Supervisor spent five days collecting data on the villages in their coverage area. Over 12 months, the CHW supervisors mapped the district's 573 villages using 12 shared GPS devices. Sector maps were produced and distributed to local officials. The cost of mapping using CHW supervisors was $29,692, about two times less than the estimated cost of mapping using a trained and dedicated GIS team ($60,112). The availability of

local mapping was able to rapidly identify village-level disparities in DWS, with lower access in populations living near to lakes and wetlands (p < .001).

CONCLUSION**:** Existing national CHW system can be leveraged to inexpensively and rapidly map villages even in mountainous rural areas. These data are important to provide managers and decision makers with local-level GIS data to rapidly identify variability in health and other related services to better target and evaluate interventions.

37. Dynamics of cholera outbreaks in Great Lakes region of Africa, 1978-2008.

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ABSTRACT

Cholera outbreaks have occurred in Burundi, Rwanda, Democratic Republic of Congo, Tanzania, Uganda, and Kenya almost every year since 1977-1978, when the disease emerged in these countries. We used a multiscale, geographic information system-based approach to assess the link between cholera outbreaks, climate, and environmental variables. We performed time-series analyses and field investigations in the main affected areas. Results showed that cholera greatly increased during El Nino warm events (abnormally warm El Ninos) but decreased or remained stable between these events. Most epidemics occurred in a few hotspots in lakeside areas, where the weekly incidence of cholera varied by season, rainfall, fluctuations of plankton, and fishing activities. During lull periods, persistence of cholera was explained by outbreak dynamics, which suggested a metapopulation pattern, and by endemic foci around the lakes. These links between cholera outbreaks, climate, and lake environments need additional, multidisciplinary study.

38. An updated atlas of human helminth infections: the example of East Africa.

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ABSTRACT

BACKGROUND: Reliable and updated maps of helminth (worm) infection distributions are essential to target control strategies to those populations in greatest need. Although many surveys have been conducted in endemic countries, the data are rarely available in a form that is accessible to policy makers and the managers of public health programmes. This is especially true in sub-Saharan Africa, where empirical data are seldom in the public domain. In an attempt to address the paucity of geographical information on helminth risk, this article describes the development of an updated global atlas of human helminth infection, showing the example of East Africa.

METHODS: Empirical, cross-sectional estimates of infection prevalence conducted since 1980 were identified using electronic and manual search strategies of published and unpublished sources. A number of inclusion criteria were imposed for identified information, which was extracted into a standardized database. Details of survey population, diagnostic methods, sample size and numbers infected with schistosomes and soil-transmitted helminths were recorded. A unique identifier linked each record to an electronic copy of the source document, in portable document format. An attempt was made to identify the geographical location of each record using standardized geolocation procedures and the assembled data were incorporated into a geographical information system.

RESULTS: At the time of writing, over 2,748 prevalence surveys were identified through multiple search strategies. Of these, 2,612 were able to be geolocated and mapped. More than half (58%) of included surveys were from grey literature or unpublished sources, underlining the importance of reviewing in-country sources. 66% of all surveys were conducted since 2000. Comprehensive, countrywide data are available for Burundi, Rwanda and Uganda. In contrast, information for Kenya and Tanzania is typically clustered in specific regions of the country, with few records from areas with very low population density and/or environmental conditions which are unfavourable for helminth transmission. Information is presented on the prevalence and geographical distribution for the major helminth species.

CONCLUSION**:** For all five countries, the information assembled in the current atlas provides the most reliable, up-to-date and comprehensive source of data on the distribution of common helminth infections to guide the rational implementation of control efforts.

39. Rapid deployment of electronic medical records for ARV rollout in rural Rwanda.

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ABSTRACT

While most people with AIDS do not yet have access to anti-retroviral drugs (ARVs), large ARV treatment programs are being rolled out in many areas in Sub-Saharan Africa. ARV programs have substantial data management needs, which electronic medical record systems (EMRs) are helping to address. While most sophisticated EMRs in low-income regions are in large cities, where infrastructure and staffing needs are more easily met, Partners In Health (PIH) has pioneered web-based EMRs for HIV and TB treatment in rural areas. The HIV-EMR, developed in Haiti [1], was de-ployed in two Rwandan health districts starting in Au-gust 2005. The addition of new features and adaptation to local needs is happening concurrently with the rapid scale-up and evolution of the medical program itself.

Tanzania

40. Global positioning system data-loggers: a tool to quantify fine-scale movement of domestic animals to evaluate potential for zoonotic transmission to an endangered wildlife population.

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ABSTRACT

Domesticated animals are an important source of pathogens to endangered wildlife populations, especially when anthropogenic activities increase their overlap with humans and wildlife. Recent work in Tanzania reports the introduction of Cryptosporidium into wild chimpanzee populations and the increased risk of ape mortality associated with SIVcpz-Cryptosporidium co-infection. Here we describe the application of novel GPS technology to track the mobility of domesticated animals (27 goats, 2 sheep and 8 dogs) with the goal of identifying potential routes for Cryptosporidium introduction into Gombe National Park. Only goats (5/27) and sheep (2/2) were positive for Cryptosporidium. Analysis of GPS tracks indicated that a crop field frequented by both chimpanzees and domesticated animals was a potential hotspot for Cryptosporidium transmission. This study demonstrates the applicability of GPS data-loggers in studies of fine-scale mobility of animals and suggests that domesticated animal-wildlife overlap should be considered beyond protected boundaries for long-term conservation strategies.

41. Crowdsourcing Vector Surveillance: Using Community Knowledge and Experiences to Predict Densities and Distribution of Outdoor-Biting Mosquitoes in Rural Tanzania.

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ABSTRACT

Lack of reliable techniques for large-scale monitoring of disease-transmitting mosquitoes is a major public health challenge, especially where advanced geo-information systems are not regularly applicable. We tested an innovative crowd-sourcing approach, which relies simply on knowledge and experiences of residents to rapidly predict areas where disease-transmitting mosquitoes are most abundant. Guided by community-based resource persons, we mapped boundaries and major physical features in three rural Tanzanian villages. We then selected 60 community members, taught them basic map-reading skills, and offered them gridded maps of their own villages (grid size: 200m×200m) so they could identify locations where they believed mosquitoes were most abundant, by ranking the grids from one (highest density) to five (lowest density). The ranks were interpolated in ArcGIS-10 (ESRI-USA) using inverse distance weighting (IDW) method, and re-classified to depict areas people believed had high, medium and low mosquito densities. Finally, we used odor-baited mosquito traps to compare and verify actual outdoor mosquito densities in the same areas. We repeated this process for 12 months, each time with a different group of 60 residents. All entomological surveys depicted similar geographical stratification of mosquito densities in areas classified by community members as having high, medium and low vector abundance. These similarities were observed when all mosquito species were combined, and also when only malaria vectors were considered. Of the 12,412 mosquitoes caught, 60.9% (7,555) were from areas considered by community members as having high mosquito densities, 28% (3,470) from medium density areas, and 11.2% (1,387) from low density areas. This study provides evidence that we can rely on community knowledge and experiences to identify areas where mosquitoes are most abundant or least abundant, even without entomological surveys. This crowd-sourcing method

could be further refined and validated to improve community-based planning of mosquito control operations at low-cost.

42. Towards improved health service quality in Tanzania: An approach to increase efficiency and effectiveness of routine supportive supervision.

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ABSTRACT

Effective supportive supervision of healthcare services is crucial for improving and maintaining quality of care. However, this process can be challenging in an environment with chronic shortage of qualified human resources, overburdened healthcare providers, multiple roles of district managers, weak supply chains, high donor fragmentation and inefficient allocation of limited financial resources. Operating in this environment, we systematically evaluated an approach developed in Tanzania to strengthen the implementation of routine supportive supervision of primary healthcare providers. The approach included a systematic quality assessment at health facilities using an electronic tool and subsequent result dissemination at council level. Mixed methods were used to compare the new supportive supervision approach with routine supportive supervision. Qualitative data was collected through in-depth interviews in three councils. Observational data and informal communication as well as secondary data complemented the data set. Additionally, an economic costing analysis was carried out in the same councils. Compared to routine supportive supervision, the new approach increased healthcare providers' knowledge and skills, as well as quality of data collected and acceptance of supportive supervision amongst stakeholders involved. It also ensured better availability of evidence for follow-up actions, including budgeting and planning, and higher stakeholder motivation and ownership of subsequent quality improvement measures. The new approach reduced time and cost spent during supportive supervision. This increased feasibility of supportive supervision and hence the likelihood of its implementation. Thus, the results presented together with previous findings

suggested that if used as the standard approach for routine supportive supervision the new approach offers a suitable option to make supportive supervision more efficient and effective and therewith more sustainable. Moreover, the new approach also provides informed guidance to overcome several problems of supportive supervision and healthcare quality assessments in low- and middle income countries.

43. Enhancing the routine health information system in rural southern Tanzania: successes, challenges and lessons learned.

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ABSTRACT

OBJECTIVE: To describe and evaluate the use of handheld computers for the management of Health Management Information System data.

METHODS: Electronic data capture took place in 11 sentinel health centres in rural southern Tanzania. Information from children attending the outpatient department (OPD) and the Expanded Program on Immunization vaccination clinic was captured by trained local school-leavers, supported by monthly supervision visits. Clinical data included malaria blood slides and haemoglobin colour scale results. Quality of captured data was assessed using double data entry. Malaria blood slide results from health centre laboratories were compared to those from the study's quality control laboratory.

RESULTS: The system took 5 months to implement, and few staffings or logistical problems were encountered. Over the following 12 months (April 2006-March 2007), 7056 attendances were recorded in 9880 infants aged 2-11 months, 50% with clinical malaria. Monthly supervision visits highlighted incomplete recording of information between OPD and laboratory records, where on average 40% of laboratory visits were missing the record of their corresponding OPD visit. Quality of microscopy from health facility laboratories was lower overall than that from the quality assurance laboratory.

CONCLUSIONS: Electronic capture of HMIS data was rapidly and successfully implemented in this resource-poor setting. Electronic capture alone did not resolve issues of data completeness, accuracy and reliability, which are essential for management, monitoring and evaluation; suggestions to monitor and improve data quality are made.

44. Experience implementing electronic health records in three East African countries.

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ABSTRACT

INTRODUCTION: Efficient use of health care resources in low-income countries by providers and local and national managers requires timely access to patient data.

OBJECTIVE: To implement electronic health records (EHRs) in HIV clinics in Kenya, Tanzania, and Uganda.

RESULTS: We initially developed and implemented an EHR in Kenya through a mature academic partnership. The EHR was then implemented in six HIV clinics in Tanzania and Uganda in collaboration with their National AIDS Control Programmes. All implementations were successful, but the system's use and sustainability varied depending on who controlled clinic funding.

CONCLUSIONS: Successful EHR use and sustainability were enhanced by local control of funds, academic partnerships (mainly by leveraging research funds), and in-country technology support.

45. Deployment and use of mobile phone technology for real-time reporting of fever cases and malaria treatment failure in areas of declining malaria transmission in Muheza district north-eastern Tanzania.

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ABSTRACT

BACKGROUND: Early detection of febrile illnesses at community level is essential for improved malaria case management and control. Currently, mobile phone-based technology has been commonly used to collect and transfer health information and services in different settings. This study assessed the applicability of mobile phone-based technology in real-time reporting of fever cases and management of malaria by village health workers (VHWs) in north-eastern Tanzania.

METHODS: The community mobile phone-based disease surveillance and treatment for malaria (ComDSTM) platform, combined with mobile phones and web applications, was developed and implemented in three villages and one dispensary in Muheza district from November 2013 to October 2014. A baseline census was conducted in May 2013. The data were uploaded on a web-based database and updated during follow-up home visits by VHWs. Active and passive case detection (ACD, PCD) of febrile cases were done by VHWs and cases found positive by malaria rapid diagnostic test (RDT) were given the first dose of artemether-lumefantrine (AL) at the dispensary. Each patient was visited at home by VHWs daily for the first 3 days to supervise intake of anti-malarial and on day 7 to monitor the recovery process. The data were captured and transmitted to the database using mobile phones.

RESULTS: The baseline population in the three villages was 2934 in 678 households. A total of 1907 febrile cases were recorded by VHWs and 1828 (95.9%) were captured using mobile phones. At the dispensary, 1778 (93.2%) febrile cases were registered and of these, 84.2% were captured through PCD. Positivity rates were 48.2 and 45.8% by RDT and microscopy, respectively. Nine cases had treatment failure reported on day 7 post-treatment and adherence to treatment was 98%. One patient with severe febrile illness was referred to Muheza district hospital.

CONCLUSION: The study showed that mobile phone-based technology can be successfully used by VHWs in surveillance and timely reporting of fever episodes and monitoring of treatment failure in remote areas. Further optimization and

scaling-up will be required to utilize the tools for improved malaria case management and drug resistance surveillance.

46. Lymphatic filariasis patient identification in a large urban area of Tanzania: An application of a community-led mHealth system.

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ABSTRACT

BACKGROUND: Lymphatic filariasis (LF) is best known for the disabling and disfiguring clinical conditions that infected patients can develop; providing care for these individuals is a major goal of the Global Programme to Eliminate LF. Methods of locating these patients, knowing their true number and thus providing care for them, remains a challenge for national medical systems, particularly when the endemic zone is a large urban area.

METHODOLOGY/PRINCIPLE FINDINGS: A health community-led door-to-door survey approach using the SMS reporting tool MeasureSMS-Morbidity was used to rapidly collate and monitor data on LF patients in real-time (location, sex, age, clinical condition) in Dar es Salaam, Tanzania. Each stage of the phased study carried out in the three urban districts of city consisted of a training period, a patient identification and reporting period, and a data verification period, with refinements to the system being made after each phase. A total of 6889 patients were reported (133.6 per 100,000 population), of which 4169 were reported to have hydrocoele (80.9 per 100,000), 2251 lymphoedema-elephantiasis (LE) (43.7 per 100,000) and 469 with both conditions (9.1 per 100,000). Kinondoni had the highest number of reported patients in absolute terms (2846, 138.9 per 100,000), followed by Temeke (2550, 157.3 per 100,000) and Ilala (1493, 100.5 per 100,000). The number of hydrocoele patients was almost twice that of LE in all three districts. Severe LE patients accounted for approximately a quarter (26.9%) of those reported, with the number of acute attacks increasing with reported LE severity (1.34 in mild cases, 1.78 in moderate cases, 2.52 in severe). Verification checks supported these findings.

CONCLUSIONS/SIGNIFICANCE: This system of identifying, recording and mapping patients affected by LF greatly assists in planning, locating and prioritising, as well as initiating, appropriate morbidity management and disability prevention (MMDP) activities. The approach is a feasible framework that could be used in other large urban environments in the LF endemic areas.

47. Mobile technologies for disease surveillance in humans and animals.

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ABSTRACT

A paper-based disease reporting system has been associated with a number of challenges. These include difficulties to submit hard copies of the disease surveillance forms because of poor road infrastructure, weather conditions or challenging terrain, particularly in the developing countries. The system demands re-entry of the data at data processing and analysis points, thus making it prone to introduction of errors during this process. All these challenges contribute to delayed acquisition, processing and response to disease events occurring in remote hard to reach areas. Our study piloted the use of mobile phones in order to transmit near to real-time data from remote districts in Tanzania (Ngorongoro and Ngara), Burundi (Muyinga) and Zambia (Kazungula and Sesheke). Two technologies namely, digital and short messaging services were used to capture and transmit disease event data in the animal and human health sectors in the study areas based on a server-client model. Smart phones running the Android operating system (minimum required version: Android 1.6), and which supported open source application, Epicollect, as well as the Open Data Kit application, were used in the study. These phones allowed collection of geo-tagged data, with the opportunity of including static and moving images related to disease events. The project supported routine disease surveillance systems in the ministries responsible for animal and human health in Burundi, Tanzania and Zambia, as well as data collection for researchers at the Sokoine University of Agriculture, Tanzania. During the project implementation period between 2011 and 2013, a total number of 1651 diseases event-related forms were submitted, which allowed reporters to include GPS coordinates and photographs related to the events captured. It was concluded that the new technology-based surveillance system is useful in providing near to real-time data, with potential for enhancing timely response in rural remote areas of Africa. We recommended adoption of

the proven technologies to improve disease surveillance, particularly in the developing countries.

48. PGMS: a case study of collecting PDA-based geo-tagged malaria-related survey data.

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ABSTRACT

Using mobile devices, such as personal digital assistants (PDAs), smartphones, tablet computers, etc., to electronically collect malaria-related field data is the way for the field questionnaires in the future. This case study seeks to design a generic survey framework PDA-based geo-tagged malaria-related data collection tool (PGMS) that can be used not only for large-scale community-level geo-tagged electronic malaria-related surveys, but also for a wide variety of electronic data collections of other infectious diseases. The framework includes two parts: the database designed for subsequent cross-sectional data analysis and the customized programs for the six study sites (two in Kenya, three in Indonesia, and one in Tanzania). In addition to the framework development, we also present our methods used when configuring and deploying the PDAs to 1) reduce data entry errors, 2) conserve battery power, 3) field install the programs onto dozens of handheld devices, 4) translate electronic questionnaires into local languages, 5) prevent data loss, and 6) transfer data from PDAs to computers for future analysis and storage. Since 2008, PGMS has successfully accomplished quite a few surveys that recorded 10,871 compounds and households, 52,126 persons, and 17,100 bed nets from the six sites. These numbers are still growing.

49. Emerging viral infectious disease threat: Why Tanzania is not in a safe zone.

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ABSTRACT

Emerging diseases are global threat towards human existence. Every country is exposed to potentially emergence of infectious diseases. Several factor such as changes in ecology, climate and human demographics play different roles in a complex mechanism contributing to the occurrence of infectious diseases. Important aspects towards control in case of outbreaks are surveillance, preparedness and early response. Tanzania should therefore take opportunity of the calm situation currently present, to prepare. Except for HIV/AIDS, Tanzania has not experienced a major public health threat. However, the question is, is the country safe from emerging and re-emerging infectious diseases? In this article we try to explore the danger of emerging infectious disease (EID) epidemics in Tanzania and the risks attached if an outbreak is to occur. The aim is to formulate recommendations to the government, responsible authorities and general population of what can be done to improve the level of EID preparedness in the country. In conclusion, it is important to strengthen the capacity of community and healthcare staffs on how to respond to potential infectious disease outbreaks. Community-based surveillance systems should be incorporated into the national systems for early detection of public health events. It is also critical to enhance one health approach to increase cross-sectoral information sharing, surveillance and interventional strategies as regards to preparedness and response to disease outbreaks.

50. Regional Initiatives in Support of Surveillance in East Africa: The East Africa Integrated Disease Surveillance Network (EAIDSNet). Experience.

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ABSTRACT

The East African Integrated Disease Surveillance Network (EAIDSNet) was formed in response to a growing frequency of cross-border malaria outbreaks in the 1990s and a growing recognition that fragmented disease interventions, coupled with weak laboratory capacity, were making it difficult to respond in a timely manner to the outbreaks of malaria and other infectious diseases. The East Africa Community (EAC) partner states, with financial support from the Rockefeller Foundation, established EAIDSNet in 2000 to develop and strengthen the communication channels necessary for integrated cross-border disease surveillance and control efforts. The objective of this paper is to review the regional EAIDSNet initiative and highlight achievements and challenges in its implementation. Major accomplishments of EAIDSNet include influencing the establishment of a Department of Health within the EAC Secretariat to support a regional health agenda; successfully completing a regional field simulation exercise in pandemic influenza preparedness; and piloting a web-based portal for linking animal and human health disease surveillance. The strategic direction of EAIDSNet was shaped, in part, by lessons learned following a visit to the more established Mekong Basin Disease Surveillance (MBDS) regional network. Looking to the future, EAIDSNet is collaborating with the East, Central and Southern Africa Health Community (ECSA-HC), EAC partner states, and the World Health Organization to implement the World Bank-funded East Africa Public Health Laboratory Networking Project (EAPHLNP). The network has also begun lobbying East African countries for funding to support EAIDSNet activities.

51. Perceived improvement in integrated management of childhood illness implementation through use of mobile technology: qualitative evidence from a pilot study in Tanzania.

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ABSTRACT

This study examined health care provider and caretaker perceptions of electronic Integrated Management of Childhood Illness (eIMCI) in diagnosing and treating childhood illnesses. The authors conducted semi-structured interviews among caretakers (n = 20) and health care providers (n = 11) in the Pwani region of Tanzania. This qualitative study was nested within a larger quantitative study measuring impact of eIMCI on provider adherence to IMCI protocols. Caretakers and health care workers involved in the larger study provided their perceptions of eIMCI in comparison with the conventional paper forms. One health care provider from each participating health center participated in qualitative interviews; 20 caretakers were selected from 1 health center involved in the quantitative study. Interviews were conducted in Swahili and lasted 5-10 min each. Providers expressed positive opinions of eIMCI, noting that the personal digital assistants were faster and easier to use than were the paper forms and encouraged adherence to IMCI procedures. Caretakers also held a positive view of eIMCI, noting improved service from providers, more thorough examination of their child, and a perception that providers who used the personal digital assistants were more knowledgeable. Research indicates widespread nonadherence to IMCI guidelines, suggesting improved methods for implementing IMCI are necessary. The authors conclude that eIMCI represents a promising method for improving health care delivery because it improves health care provider and caretaker perception of the clinical encounter. Further investigation into this technology is warranted.

52. Quantifying cross-border movements and migrations for guiding the strategic planning of malaria control and elimination .

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ABSTRACT

BACKGROUND**:** Identifying human and malaria parasite movements is important for control planning across all transmission intensities. Imported infections can reintroduce infections into areas previously free of infection, maintain 'hotspots' of transmission and import drug resistant strains, challenging national control programmes at a variety of temporal and spatial scales. Recent analyses based on mobile phone usage data have provided valuable insights into population and likely parasite movements within countries, but these data are restricted to sub-national analyses, leaving important cross-border movements neglected.

METHODS**:** National census data were used to analyse and model cross-border migration and movement, using East Africa as an example. 'Hotspots' of origin-specific immigrants from neighbouring countries were identified for Kenya, Tanzania and Uganda. Populations of origin-specific migrants were compared to distance from origin country borders and population size at destination, and regression models were developed to quantify and compare differences in migration patterns. Migration data were then combined with existing spatially-referenced malaria data to compare the relative propensity for cross-border malaria movement in the region.

RESULTS**:** The spatial patterns and processes for immigration were different between each origin and destination country pair. Hotspots of immigration, for example, were concentrated close to origin country borders for most immigrants to Tanzania, but for Kenya, a similar pattern was only seen for Tanzanian and Ugandan immigrants. Regression model fits also differed between specific

migrant groups, with some migration patterns more dependent on population size at destination and distance travelled than others. With these differences between immigration patterns and processes, and heterogeneous transmission risk in East Africa and the surrounding region, propensities to import malaria infections also likely show substantial variations.

CONCLUSION**:** This was a first attempt to quantify and model cross-border movements relevant to malaria transmission and control. With national census available worldwide, this approach can be translated to construct a cross-border human and malaria movement evidence base for other malaria endemic countries. The outcomes of this study will feed into wider efforts to quantify and model human and malaria movements in endemic regions to facilitate improved intervention planning, resource allocation and collaborative policy decisions.

53. Are we prepared for emerging and re-emerging diseases? Experience and lessons from epidemics occurred in Tanzania during the last five decades.

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ABSTRACT

This paper reviews preparedness for containing and controlling emerging and re-emerging diseases drawing lessons from disease events that occurred in animal and human populations in the last five decades (1961-2011). A comprehensive analysis based on retrieval and analysis of grey and published literature as well as reported cases was carried out to document type and trend of occurrence of emerging and re-emerging infectious diseases in different parts of Tanzania. Overall, the majority of diseases reported in the country were viral in nature followed by bacterial diseases. The trend for the occurrence shows a number of new emerging diseases as well as re-occurrence of old diseases in both animal (domestic and wild) and human populations. In humans, the major disease epidemics reported in the last five decades include cholera, influenza A H1N1, plague and rubella. In animals, the major epidemic diseases reported were Contagious Bovine Pleuropneumonia, Contagious Caprine Pleuropneumonia, Peste des petits ruminants and Giraffe Ear and Skin Diseases. Some epidemics have been reported in both human and animal populations including Rift Valley

fever and anthrax. The emergence of the 'fit-for purpose' approaches and technologies such as the discipline of One Health, use of participatory epidemiology and disease surveillance and mobile technologies offers opportunity for optimal use of limited resources to improve early detection, diagnosis and response to disease events and consequently reduced impact of such diseases in animal and human populations.

54. Towards One Health disease surveillance: The Southern African Centre for Infectious Disease Surveillance approach.

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ABSTRACT

Africa has the highest burden of infectious diseases in the world and yet the least capacity for its risk management. It has therefore become increasingly important to search for 'fit-for-purpose' approaches to infectious disease surveillance and thereby targeted disease control. The fact that the majority of human infectious diseases are originally of animal origin means we have to consider One Health (OH) approaches which require inter-sectoral collaboration for custom-made infectious disease surveillance in the endemic settings of Africa. A baseline survey was conducted to assess the current status and performance of human and animal health surveillance systems and subsequently a strategy towards OH surveillance system was developed. The strategy focused on assessing the combination of participatory epidemiological approaches and the deployment of mobile technologies to enhance the effectiveness of disease alerts and surveillance at the point of occurrence, which often lies in remote areas. We selected three study sites, namely the Ngorongoro, Kagera River basin and Zambezi River basin ecosystems. We have piloted and introduced the next-generation Android mobile phones running the EpiCollect application developed by Imperial College to aid geo-spatial and clinical data capture and transmission of this data from the field to the remote Information Technology (IT) servers at the research hubs for storage, analysis, feedback and reporting. We expect that the combination of participatory epidemiology and technology will significantly improve OH disease surveillance in southern Africa.

55. Development of Health Information System in Zanzibar: Practical Implications.

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ABSTRACT

The Ministry of Health in Zanzibar has embarked on Health Information System development with the aim of streamlining health data collection, storage, analysis and reporting in order to attain data-driven informed decision-making. The project involved two aspects: development of essential health data sets and implementation of a computerised data-storage and analysis tool. From January 2005 to December 2007 during the implementation of the project data were collected through a triangulation of qualitative methods: interviews, participant observation, document analysis, software development and training workshops. The study indicates that carefully-planned leadership of a project, clearly-stated goals and distinction between the roles of technical and sponsor networks strengthen an ICT project immeasurably. Lessons drawn include the use of local, culturally-immersed leaders to spearhead the project and the use of flexible open-source software as translators of the primary actor's interest in achieving the goals through enrolling other actors.

56. Enhancing Disease Surveillance at The Site of Outbreak Using Mobile Phone Technology: The Case of Ngorongoro District Arusha, Tanzania.

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http://repository.out.ac.tz/924/1/KUYA_MSc_Zoology.pdf .

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ABSTRACT

A study was carried out to assess the status and performance of human and animal health disease surveillance systems in Tanzania using Ngorongoro district in Arusha region, Tanzania as a case example. The acceptability and reliability of the use of Android mobile phones in the "one health" community- based

surveillance system was assessed. The evaluation of the performance of the surveillance systems through visiting and retrieval of disease surveillance forms submitted from the village health facilities to the district medical office (DMO) and district veterinary office (DVO) in Ngorongoro was carried out. A total number of 14 wards of Ngorongoro district were visited and all livestock field officers (LFO) were interviewed. The study also collected data from 13 health facilities, representing approximately 62% of all health facilities in Ngorongoro district. It was further observed that there is poor surveillance in both human and animal health sectors as evidenced by less than 50% submission of reports to DMO/DVO. Major symptoms identified by the Community Health Reporters (CHRs) included Diarrhoea (66.7%), coughing (50%), sores in the mouth (44.4%) and headache (39%). In livestock, the major signs were coughing (61%), lameness and sores in the mouth (33%), and swollen of lymphnodes (31%). The acceptability of android phones was 57%, 77.8% and 75% for the communities, human health officials and LFOs, respectively. Infrastructure problems, lack of reliable transport and remoteness of livestock and human health facilities were mentioned as the major challenges in disease surveillance in the study area. It can be concluded that android mobile phones have the potential to improve surveillance systems under 'one health' approach.

Uganda

57. Spatial-temporal distribution of Anopheles larval habitats in Uganda using GIS /remote sensing technologies.

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ABSTRACT

BACKGROUND**:** Anopheles mosquitoes impose an immense burden on the African population in terms of both human health and comfort. Uganda, in particular, boasts one of the highest malaria transmission rates in the world and its entire population is at risk for infection. Despite the immense burden these mosquitoes pose on the country, very few programmes exist that directly combat the issue at the vector control level and even fewer programmes focus on the vector in its most vulnerable juvenile stages. This study utilizes remote sensing techniques and spatial autocorrelation models to identify and prioritize the most prolific Anopheline larval habitats for control purposes in a rural community in Uganda.

METHODS**:** A community-based mosquito surveillance programme was developed and implemented in Papoli Parish in Eastern Uganda over a 4-month period. Each day, a trained field team sampled the larval habitats of Anopheles mosquitoes within the population-dense areas of the community. Habitats and their productivity were identified and plotted spatially on a daily basis. Daily output was combined and displayed as a weekly habitat time-series. Additional spatial analysis was conducted using the Global and Anselin's Local Moran's I statistic to assess habitat spatial autocorrelation.

RESULTS**:** Spatial models were developed to identify highly significant habitats and dictated the priority of these habitats for larval control purposes. Weekly time-series models identified the locations and productivity of each habitat, while Local Moran's I cluster maps identified statistically significant clusters (Cluster: High) and outliers (High Outlier) that were then interpreted for control priority. Models were stitched together in a temporal format to visually demonstrate the spatial shift of statically significant, high priority habitats over the entire study period.

DISCUSSION**:** The findings show that the spatial outcomes of productive habitats can be made starkly apparent through initial habitat modelling and resulting time-series output. However, mosquito control resources are often limited, and it is at this point that the Local Moran's I statistics demonstrates its value. Focusing on habitats identified as Cluster: High and High Outlier outputs allow for the identification of the most influential larval habitats. Utilizing this method for malaria control allows for the optimization of control resources in a real time, community driven, fashion, as well as providing a framework for future control practices.

58. Feasibility, Acceptability, and Adoption of Digital Fingerprinting During Contact Investigation for Tuberculosis in Kampala, Uganda: A Parallel-Convergent Mixed-Methods Analysis.

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ABSTRACT

BACKGROUND**:** In resource-constrained settings, challenges with unique patient identification may limit continuity of care, monitoring and evaluation, and data integrity. Biometrics offers an appealing but understudied potential solution.

OBJECTIVE**:** The objective of this mixed-methods study was to understand the feasibility, acceptability, and adoption of digital fingerprinting for patient identification in a study of household tuberculosis contact investigation in Kampala, Uganda.

METHODS**:** Digital fingerprinting was performed using multispectral fingerprint scanners. We tested associations between demographic, clinical, and temporal characteristics and failure to capture a digital fingerprint. We used generalized

estimating equations and a robust covariance estimator to account for clustering. In addition, we evaluated the clustering of outcomes by household and community health workers (CHWs) by calculating intraclass correlation coefficients (ICCs). To understand the determinants of intended and actual use of fingerprinting technology, we conducted 15 in-depth interviews with CHWs and applied a widely used conceptual framework, the Technology Acceptance Model 2 (TAM2).

RESULTS: Digital fingerprints were captured for 75.5% (694/919) of participants, with extensive clustering by household (ICC=.99) arising from software (108/179, 60.3%) and hardware (65/179, 36.3%) failures. Clinical and demographic characteristics were not markedly associated with fingerprint capture. CHWs successfully fingerprinted all contacts in 70.1% (213/304) of households, with modest clustering of outcomes by CHWs (ICC=.18). The proportion of households in which all members were successfully fingerprinted declined over time (ρ=.30, P<.001). In interviews, CHWs reported that fingerprinting failures lowered their perceptions of the quality of the technology, threatened their social image as competent health workers, and made the technology more difficult to use.

CONCLUSIONS: We found that digital fingerprinting was feasible and acceptable for individual identification, but problems implementing the hardware and software lead to a high failure rate. Although CHWs found fingerprinting to be acceptable in principle, their intention to use the technology was tempered by perceptions that it was inconsistent and of questionable value. TAM2 provided a valuable framework for understanding the motivations behind CHWs' intentions to use the technology. We emphasize the need for routine process evaluation of biometrics and other digital technologies in resource-constrained settings to assess implementation effectiveness and guide improvement of delivery.

59. A randomized trial to assess retention rates using mobile phone reminders versus physical contact tracing in potential HIV vaccine efficacy population of fishing communities around Lake Victoria, Uganda.

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ABSTRACT

BACKGROUND: High retention (follow-up) rates improve the validity and statistical power of outcomes in longitudinal studies and the effectiveness of programs with prolonged administration of interventions. We assessed participant retention in potential HIV vaccine trials population of fishing communities along Lake Victoria, Uganda.

METHODS: In a community-based individual randomized trial, 662 participants aged 15-49 years were randomized to either mobile phone or physical contact tracing reminders and followed up at months 1, 2, 3, 6, 12 and 18 post-enrolment. The visit schedules aimed at mimicking a vaccine efficacy trial representing an early interval (months 1-6) where most vaccinations would be administered and a later period of post-vaccination follow-up. The primary outcome was retention measured as the proportion of post-baseline follow up visits completed by a participant. Retention was estimated in early and later follow-up intervals, and overall for all the six follow-up visits. Adjusted differences in retention between the study arms were determined by multivariable logistic regression using Stata® 14. One participant was later dropped from the analysis because of age ineligibility discovered after enrolment.

RESULTS: Of the expected total follow up visits of 3966 among 661 participants, 84.1% (3334) were attained; 82.1% (1626/1980) in the phone arm and 86% (1708/1986) in the physical tracing arm (p = 0.001). No statistically significant differences in retention were observed between the study arms in the first 6 months but thereafter, retention was significantly higher for physical contact reminders than mobile phones; 91.5% versus 82.1% (p < 0.0001) at month 12 and 82.8% versus 75.4%, (p = 0.021) at month 18. Controlling for sex, age, education, occupation, community location, length of stay and marital status, the odds of good retention (completing 5 out of 6 follow-up visits) were 1.56 (95% CI;1.08-2.26, p = 0.018) for physical contact tracing compared to mobile phone tracing. Other statistically significant predictors of good retention were residing on islands and having stayed in the fishing communities for 5 or more years.

CONCLUSIONS: Among fishing communities of Lake Victoria, Uganda, 84% of follow-up visits can be attained and participant retention is higher using physical contact reminders than mobile phones.

60. Malaria diagnosis and mapping with m-Health and geographic information systems (GIS): evidence from Uganda.

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ABSTRACT

BACKGROUND: Rural populations experience several barriers to accessing clinical facilities for malaria diagnosis. Increasing penetration of ICT and mobile-phones and subsequent m-Health applications can contribute overcoming such obstacles.

METHODS: GIS is used to evaluate the feasibility of m-Health technologies as part of anti-malaria strategies. This study investigates where in Uganda: (1) malaria affects the largest number of people; (2) the application of m-Health protocol based on the mobile network has the highest potential impact.

RESULTS: About 75% of the population affected by Plasmodium falciparum malaria have scarce access to healthcare facilities. The introduction of m-Health technologies should be based on the 2G protocol, as 3G mobile network coverage is still limited. The western border and the central-Southeast are the regions where m-Health could reach the largest percentage of the remote population. Six districts (Arua, Apac, Lira, Kamuli, Iganga, and Mubende) could have the largest benefit because they account for about 28% of the remote population affected by falciparum malaria with access to the 2G mobile network.

CONCLUSIONS: The application of m-Health technologies could improve access to medical services for distant populations. Affordable remote malaria diagnosis could help to decongest health facilities, reducing costs and contagion. The combination of m-Health and GIS could provide real-time and geo-localized data transmission, improving anti-malarial strategies in Uganda. Scalability to other countries and diseases looks promising.

61. Development and Assessment of a Geographic Knowledge-Based Model for Mapping Suitable Areas for Rift Valley Fever Transmission in Eastern Africa.

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ABSTRACT

Rift Valley fever (RVF), a mosquito-borne disease affecting ruminants and humans, is one of the most important viral zoonoses in Africa. The objective of the present study was to develop a geographic knowledge-based method to map the areas suitable for RVF amplification and RVF spread in four East African countries, namely, Kenya, Tanzania, Uganda and Ethiopia, and to assess the predictive accuracy of the model using livestock outbreak data from Kenya and Tanzania. Risk factors and their relative importance regarding RVF amplification and spread were identified from a literature review. A numerical weight was calculated for each risk factor using an analytical hierarchy process. The corresponding geographic data were collected, standardized and combined based on a weighted linear combination to produce maps of the suitability for RVF transmission. The accuracy of the resulting maps was assessed using RVF outbreak locations in livestock reported in Kenya and Tanzania between 1998 and 2012 and the ROC curve analysis. Our results confirmed the capacity of the geographic information system-based multi-criteria evaluation method to synthesize available scientific knowledge and to accurately map (AUC = 0.786; 95% CI [0.730-0.842]) the spatial heterogeneity of RVF suitability in East Africa. This approach provides users with a straightforward and easy update of the maps according to data availability or the further development of scientific knowledge.

62. Using the lives saved tool (LiST) to model mHealth impact on neonatal survival in resource-limited settings.

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ABSTRACT

While the importance of mHealth scale-up has been broadly emphasized in the mHealth community, it is necessary to guide scale up efforts and investment in ways to help achieve the mortality reduction targets set by global calls to action such as the Millennium Development Goals, not merely to expand programs. We used the Lives Saved Tool (LiST)--an evidence-based modeling software--to identify priority areas for maternal and neonatal health services, by formulating six individual and combined interventions scenarios for two countries, Bangladesh and Uganda. Our findings show that skilled birth attendance and increased facility delivery as targets for mHealth strategies are likely to provide the biggest mortality impact relative to other intervention scenarios. Although further validation of this model is desirable, tools such as LiST can help us leverage the benefit of mHealth by articulating the most appropriate delivery points in the continuum of care to save lives.

63. The role of viral introductions in sustaining community-based HIV epidemics in rural Uganda: evidence from spatial clustering, phylogenetics, and egocentric transmission models.

Grabowski MK[1], Lessler J[1], Redd AD[2], Kagaayi J[3], Laeyendecker O[4], Ndyanabo A[3], Nelson MI[5], Cummings DA[1], Bwanika JB[3], Mueller AC[6], Reynolds SJ[7], Munshaw S[6], Ray SC[6], Lutalo T[3], Manucci J[6], Tobian AA[8], Chang LW[9], Beyrer C[1], Jennings JM[6], Nalugoda F[3], Serwadda D[10], Wawer MJ[11], Quinn TC[12], Gray RH[11]; Rakai Health Sciences Program.

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ABSTRACT

BACKGROUND**:** It is often assumed that local sexual networks play a dominant role in HIV spread in sub-Saharan Africa. The aim of this study was to determine the extent to which continued HIV transmission in rural communities--home to two-thirds of the African population--is driven by intra-community sexual networks versus viral introductions from outside of communities.

METHODS AND FINDINGS: We analyzed the spatial dynamics of HIV transmission in rural Rakai District, Uganda, using data from a cohort of 14,594 individuals within 46 communities. We applied spatial clustering statistics, viral phylogenetics, and probabilistic transmission models to quantify the relative contribution of viral introductions into communities versus community- and household-based transmission to HIV incidence. Individuals living in households with HIV-incident (n=189) or HIV-prevalent (n=1,597) persons were 3.2 (95% CI: 2.7-3.7) times more likely to be HIV infected themselves compared to the population in general, but spatial clustering outside of households was relatively weak and was confined to distances <500 m. Phylogenetic analyses of gag and env genes suggest that chains of transmission frequently cross community boundaries. A total of 95 phylogenetic clusters were identified, of which 44% (42/95) were two individuals sharing a household. Among the remaining clusters, 72% (38/53) crossed community boundaries. Using the locations of self-reported sexual partners, we estimate that 39% (95% CI: 34%-42%) of new viral transmissions occur within stable household partnerships, and that among those infected by extra-household sexual partners, 62% (95% CI: 55%-70%) are infected by sexual partners from outside their community. These results rely on the representativeness of the sample and the quality of self-reported partnership data and may not reflect HIV transmission patterns outside of Rakai.

CONCLUSIONS: Our findings suggest that HIV introductions into communities are common and account for a significant proportion of new HIV infections acquired outside of households in rural Uganda, though the extent to which this is true elsewhere in Africa remains unknown. Our results also suggest that HIV prevention efforts should be implemented at spatial scales broader than the community and should target key populations likely responsible for introductions into communities.

64. Academic Medical Centres as digital health catalysts.

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ABSTRACT

Emerging digital technologies offer enormous potential to improve quality, reduce cost, and increase patient-centeredness in healthcare. Academic Medical Centres (AMCs) play a key role in advancing medical care through cutting-edge medical research, yet traditional models for invention, validation and commercialization at AMCs have been designed around biomedical initiatives and are less well suited for new digital health technologies. Recently, two large bi-coastal Academic Medical Centres, the University of California, San Francisco (UCSF) through the Center for Digital Health Innovation (CDHI) and Partners Healthcare through the Centre for Connected Health (CCH) have launched centres focused on digital health innovation. These centers show great promise but are also subject to significant financial, organizational, and visionary challenges. We explore these AMC initiatives, which share the following characteristics: a focus on academic research methodology; integration of digital technology in educational programming; evolving models to support "clinician innovators"; strategic academic-industry collaboration and emergence of novel revenue models.

65. Validation of a remote sensing model to identify Simulium damnosum s.l. breeding sites in Sub-Saharan Africa.

Jacob BG[1], Novak RJ, Toe LD, Sanfo M, Griffith DA, Lakwo TL, Habomugisha P, Katabarwa MN, Unnasch TR.

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ABSTRACT

BACKGROUND: Recently, most onchocerciasis control programs have begun to focus on elimination. Developing an effective elimination strategy relies upon accurately mapping the extent of endemic foci. In areas of Africa that suffer from a lack of infrastructure and/or political instability, developing such accurate maps has been difficult. Onchocerciasis foci are localized near breeding sites for the black fly vectors of the infection. The goal of this study was to conduct ground validation studies to evaluate the sensitivity and specificity of a remote sensing model developed to predict S. damnosum s.l. breeding sites.

METHODOLOGY/PRINCIPAL FINDINGS: Remote sensing images from Togo were analyzed to identify areas containing signature characteristics of S. damnosum s.l. breeding habitat. All 30 sites with the spectral signature were found to contain S. damnosum larvae, while 0/52 other sites judged as likely to contain larvae were found to contain larvae. The model was then used to predict breeding sites in Northern Uganda. This area is hyper-endemic for onchocerciasis, but political instability had precluded mass distribution of ivermectin until 2009. Ground validation revealed that 23/25 sites with the signature contained S. damnosum larvae, while 8/10 sites examined lacking the signature were larvae free. Sites predicted to have larvae contained significantly more larvae than those that lacked the signature.

CONCLUSIONS/SIGNIFICANCE: This study suggests that a signature extracted from remote sensing images may be used to predict the location of S. damnosum s.l. breeding sites with a high degree of accuracy. This method should be of assistance in predicting communities at risk for onchocerciasis in areas of Africa where ground-based epidemiological surveys are difficult to implement.

66. Impact of an mHealth intervention for peer health workers on AIDS care in rural Uganda: a mixed methods evaluation of a cluster-randomized trial.

Chang LW[1], Kagaayi J, Arem H, Nakigozi G, Ssempijja V, Serwadda D, Quinn TC, Gray RH, Bollinger RC, Reynolds SJ.
PMID: 21739286 PMCID: PMC3265752 DOI: 10.1007/s10461-011-9995-x [Indexed for MEDLINE]

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ABSTRACT

Mobile phone access in low and middle-income countries is rapidly expanding and offers an opportunity to leverage limited human resources for health. We conducted a mixed methods evaluation of a cluster-randomized trial exploratory sub study on the impact of a mHealth (mobile phone) support intervention used by community-based peer health workers (PHW) on AIDS care in rural Uganda. 29 PHWs at 10 clinics were randomized by clinic to receive the intervention or not. PHWs used phones to call and text higher level providers with patient-specific clinical information. 970 patients cared for by the PHWs were followed over a 26-month period. No significant differences were found in patients' risk of virologic failure. Qualitative analyses found improvements in patient care and logistics and broad support for the mHealth intervention among patients, clinic staff, and PHWs. Key challenges identified included variable patient phone access, privacy concerns, and phone maintenance.

67. Suit for Automated Global Electronic bio Surveillance, free software tools for Disease surveillance in developing countries.

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ABSTRACT:

BACKGROUND: Public health surveillance is undergoing phenomenal changes due to advances in Information and Communication Technology (ICT). The Suite for Automated Global Electronic bioSurveillance (SAGES), is an open-source collection of modular, flexible, freely-available software tools for electronic disease surveillance that can be used in resource-limited settings. The SAGES tools are interoperable, can interface with existing surveillance systems and provide a platform for efficient resource use and better compliance with WHO International Health Regulations. The objective of the study was to describe SAGES system that

can interface with existing surveillance systems and provide a platform for efficient resource use.

METHODOLOGY**:** The SAGES tools comprise of three stages; data collection, analysis, and visualization and communication. These are compatible with surveillance needs and different ICT infrastructure levels. SAGES is designed to work with a simple cell phone, or an Android smartphone placed at health facilities. Aggregate data that is normally summarized in a logbook, is sent via SMS to a receiver Android smartphone, and fed into a database on a server. A customized version of the Open Electronic Surveillance System for Early Notification of Community based Epidemics (OpenESSENCE) data analysis and visualization application, is used to monitor disease syndromes and diagnoses to help rapid identification of unusual disease events in the population.

RESULTS**:** Results from the pilot health facility indicated that the major symptoms above were fever/chills, cough and headaches, with these affecting mostly children. Pilot activities provided valuable insight into how electronic disease surveillance systems can be successful in resource limited environments. The system can send patient information daily to the headquarters via SMS, using standardized texting protocols and abbreviations at a minimal cost.

CONCLUSION**:** The SAGES system is intended to enhance electronic disease surveillance capacity in resource-limited settings. This suite of tools will improve and provide real-time disease reporting and timely response.

INNOVATIVE TECHNOLOGIES AND SOLUTIONS FOR APPLICATION IN, AND IMPROVEMENT OF HEALTHCARE SERVICE DELIVERY AND HEALTH OUTCOMES

107 Citanions
(Sorted by Partner States)

Burundi

1. **Role of polymorphisms of toll-like receptor (TLR) 4, TLR9, toll-interleukin 1 receptor domain containing adaptor protein (TIRAP) and FCGR2A genes in malaria susceptibility and severity in Burundian children.**

Susanna Esposito,[1] Claudio Giuseppe Molteni,[1] Alberto Zampiero,[1] Elena Baggi,[1] Anna Lavizzari,[1] Margherita Semino,[1] Cristina Daleno,[1] Michela Groppo,[1] Alessia Scala,[1] Leonardo Terranova,[1] Monica Miozzo,[2] Claudio Pelucchi,[3] Nicola Principi[1].

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ABSTRACT

BACKGROUND: Malaria caused by *Plasmodium falciparum* is one of the leading causes of human morbidity and mortality from infectious diseases, predominantly in tropical and sub-tropical countries. As genetic variations in the toll-like receptors (TLRs)-signalling pathway have been associated with either susceptibility or resistance to several infectious and inflammatory diseases, the supposition is that single nucleotide polymorphisms (SNPs) of TLR2, TLR4, TLR9, Toll-interleukin 1 receptor domain containing adaptor protein (TIRAP) and FCGR2A could modulate malaria susceptibility and severity.

METHODS: This study was planned to make a further contribution to solving the problem of the real role of the most common polymorphisms of TLR4, TLR9, TIRAP and FCGR2A genes in modulating the risk of malaria and disease severity in children from Burundi, Central Africa. All the paediatric patients aged six months to 10 years admitted to the hospital of Kiremba, Burundi, between February 2011 and September 2011, for fever and suspicion of acute malaria were screened for malaria parasitaemia by light microscopy of thick and thin blood smears. In children with malaria and in uninfected controls enrolled during the study period in the same hospital, blood samples were obtained on filter paper and TLR4 Asp299Gly rs4986790, TLR9 G1174A rs352139, T-1486 C rs187084 TLR9 T-1237 C rs5743836, TIRAP Ser180Leu rs8177374 and the FCGR2A His131Arg rs1801274 polymorphisms were studied using an ABI PRISM 7900 HT Fast Real-time instrument.

RESULTS: A total of 602 patients and 337 controls were enrolled. Among the malaria cases, 553 (91.9 %) were considered as suffering from uncomplicated and 49 (8.1 %) from severe malaria. TLR9 T1237C rs5743836CC was associated with an increased risk of developing malaria ($p = 0.03$), although it was found with the

same frequency in uncomplicated and severe malaria cases. No other differences were found in all alleles studied and in genotype frequencies between malaria cases and uninfected controls as well as between uncomplicated and severe malaria cases.

CONCLUSIONS: TLR9 T1237C seems to condition susceptibility to malaria in Burundian children but not its severity, whereas none of the assessed SNPs of TLR4, TIRAP and FCGR2A seem to influence susceptibility to malaria and disease severity in this population.

key words: Children, cerebral malaria, FCGR2A, malaria, SNPs, toll-like receptors, TIRAP, TLR4, TLR9, uncomplicated malaria

2. **Screening for mental disorders in post-conflict regions using computer apps - a feasibility study from Burundi.**

A. Crombach[1], C. Nandi[1], M. Bambonye[2], M. Liebrecht[3], R. Pryss[3], M. Reichert[3], T. Elbert[4], R. Weierstall[1].

In: XIII Congress of European Society of Traumatic Stress Studies (ESTSS) Conference, June 5-9, 2013, Bologna, Italy.

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ABSTRACT

A high level of psychosocial functioning is essential for survival in many resource-poor countries and is needed for development in these regions. Organized violence, often in combination with other stressors such as poverty and familial conflict, however, result in a range of mental disorders and damage socio-economic progress. An efficient assessment of mental health is a prerequisite for prevention and intervention measures. However, this may require considerable resources that are difficult to obtain in resource-poor countries. We present new methods for the efficient and effective assessment of mental, especially trauma- and stress-related disorders that can easily be administered by trained local paramedics. For decades, Burundi has been a staging ground for armed conflicts leaving behind many survivors with trauma-related illness. In a study with over 900 combatants and veterans from the military as well as former rebels in Burundi, we used a tablet-computer (ipad)-based survey for the assessment of trauma-related syndromes, especially PTSD, in need for

treatment. All participants reported the experience of serious traumatic stressors and a substantial portion presented severe symptoms of the trauma-spectrum. Based on the PSS-I and other standardized screening instruments, an ipad app guided the semi structured clinical interviews. Psychologists from the University of Konstanz, the Burundian military as well as psychologist students from the University Lumie` re, Bujumbura, Burundi carried out the interviews. In this contribution, we use the Burundian example to portray the logistics and technology of data acquisition and present respective data. We demonstrate the feasibility of using a computerbased screening approach in the field and in clinical settings. We provide evidence, that the computerized assessment of clinical symptoms can be a useful tool for mental health assessment and screenings, both in research and practice.

3. Combined use of an antigen and antibody detection enzyme-linked immunosorbent assay for cysticercosis as tools in an epidemiological study of epilepsy in Burundi.

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ABSTRACT

OBJECTIVE: To evaluate the benefits of the detection of both circulating antibodies (Ab) and antigens (Ag) for the diagnosis of cysticercosis in people with epilepsy. Neurocysticercosis is a cause of neurological diseases world-wide, especially epilepsy. The clinical symptoms of neurocysticercosis are non-specific and diagnosis is often difficult.

METHODS: Serum samples were collected from subjects in a matched case–control study for epilepsy in the Kiremba 303; =   area, Burundi, between March and April 2001 (epileptic cases 606). The enzyme-linked immunosorbent assay   = controls without epilepsy (ELISA) was used for the detection of antibodies (Ab-ELISA) and circulating Ag (Ag-ELISA).

RESULTS**:** The Ab-ELISA revealed 58.7% positivity in epilepsy cases and 31.4% in healthy controls; and Ag-ELISA revealed 38.3% positivity in epilepsy cases and 20.0% in controls. The matched odds ratios were 3.6 (95%CI: 2.5–4.9) for Ab-ELISA, and 2.9 (95%CI: 2.1–4.3) for Ag-ELISA.

CONCLUSION**:** Both Ag- and Ab-ELISA detected a significantly higher number of seropositives among people with epilepsy than among controls. The risk of epilepsy was high in cases with a positive Ag-ELISA, although less important than in cases with positivity for Ab-ELISA. Dead or degenerating cysticerci appear to be more frequently associated with epilepsy than living cysts. The high number of people with circulating Ag of *Taenia solium* suggests that the study area is a focus of active transmission of the parasite.

4. **Half of Rifampicin-resistant *Mycobacterium tuberculosis* complex isolated from tuberculosis patients in Sub-Saharan Africa have concomitant resistance to pyrazinamide.**

Ngabonziza JCS[1,2], Diallo AB[3], Tagliani E[4], Diarra B[5], Kadanga AE[6], Togo ACG[5], Thiam A[3], de Rijk WB[2], Alagna R[4], Houeto S[7], Ba F[8], Dagnra AY[6], Ivan E[1], Affolabi D[7], Schwoebel V[9], Trebucq A[9], de Jong BC[2], Rigouts L[2,10], Daneau G[2,11]; "Union short MDR-TB regimen study group".

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ABSTRACT

BACKGROUND**:** Besides inclusion in 1st line regimens against tuberculosis (TB), pyrazinamide (PZA) is used in 2nd line anti-TB regimens, including in the short regimen for multidrug-resistant TB (MDR-TB) patients. Guidelines and expert opinions are contradictory about inclusion of PZA in case of resistance. Moreover, drug susceptibility testing (DST) for PZA is

not often applied in routine testing, and the prevalence of resistance is unknown in several regions, including in most African countries.

METHODS**:** Six hundred and twenty-three culture isolates from rifampicin-resistant (RR) patients were collected in twelve Sub-Saharan African countries. Among those isolates, 71% were from patients included in the study on the Union short-course regimen for MDR-TB in Benin, Burkina Faso, Burundi, Cameroon, Central Africa Republic, the Democratic Republic of the Congo, Ivory Coast, Niger, and Rwanda PZA resistance, and the rest (29%) were consecutive isolates systematically stored from 2014–2015 in Mali, Rwanda, Senegal, and Togo. Besides national guidelines, the isolates were tested for PZA resistance through *pncA* gene sequencing.

RESULTS: Over half of these RR-TB isolates (54%) showed a mutation in the *pncA* gene, with a significant heterogeneity between countries. Isolates with fluoroquinolone resistance (but not with injectable resistance or XDR) were more likely to have concurrent PZA resistance. The pattern of mutations in the *pncA* gene was quite diverse, although some isolates with an identical pattern of mutations in *pncA* and other drug-related genes were isolated from the same reference center, suggesting possible transmission of these strains.

CONCLUSION**:** Similar to findings in other regions, more than half of the patients having RR-TB in West and Central Africa present concomitant resistance to PZA. Further investigations are needed to understand the relation between resistance to PZA and resistance to fluoroquinolones, and whether continued use of PZA in the face of PZA resistance provides clinical benefit to the patients.

5. **Potential adoption of mobile health technologies for public healthcare in Burundi.**

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ABSTRACT

Mobile health (or mHealth) describes the utilisation of wireless mobile communications devices in public and private healthcare. These include, but are not limited to, mobile telephones, personal digital assistants, and patient monitoring devices. Although the outcomes of mHealth interventions in developing countries have generally been assessed as positive, there is a need for designing mHealth interventions that are specifically tailored to the context of

individual countries. It is in this context that this research investigates the potential adoption of mHealth technologies to provide healthcare services in Burundi from the institutional level point of view (Burundi's Ministry of Health and Fight Against AIDS (MoH&A) and the Ministry of Communication (MoC)), users point of view (primary healthcare professionals) and mobile technology point of view (mobile technology providers). Using three theoretical frameworks i.e. the Capabilities Approach (CA) model, the Diffusion of Innovation (DOI) theory and the Unified Theory of Acceptance and Use of Technology (UTAUT), this research firstly identifies the determinants and impediments to mHealth adoption in Burundi. It further describes how mHealth could be used to address the current challenges that the Burundi's Ministry of Health faces in terms of providing public healthcare services. It further proposes a framework for the adoption of mHealth in Burundi. At the institutional level and mobile technology point of view, semi-structured interviews were held with civil servants from the two Ministries and with mobile technology services providers. At the users' level, a survey was conducted with primary healthcare professionals from 47 primary healthcare centres. Findings reveal that mHealth adoption can contribute to disease prevention, disease management and the provision of quality healthcare in Burundi. Although there is limited knowledge of mHealth capabilities within the Burundi's public healthcare sector, there is a general willingness towards the adoption of mHealth notwithstanding challenges associated with its adoption. Although DOI construct-related factors such as relative advantage, compatibility, trialability and observability significantly influence the adoption of mHealth in Burundi, complexity does not. In addition, performance expectancy, effort expectancy and facilitating conditions are UTAUT constructs that significantly influence the adoption of mHealth adoption. The research advocates for an integrated and collaborative approach to addressthe impediments to mHealth adoption in Burundi.

6. **Levels of Growth Factors and IgA in the Colostrum of Women from Burundi and Italy**.

Munblit D[1,2,3], Abrol P[4], Sheth S[5], Chow LY[6], Khaleva E[7,8], Asmanov A[9], Lauriola S[10], Padovani EM[11], Comberiati P[12], Boner AL[13], Warner JO[14,15], Boyle RJ[16,17], Peroni DG[18,19].

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ABSTRACT

Colostrum is produced in the first days postpartum. It is a known source of immune mediators for a newborn within the first week of life. Although it is still unclear if colostrum composition varies between populations, recent data suggest differences. Hepatocyte growth factor (HGF); transforming growth factor-β (TGF-β) 1, 2, and 3; and immunoglobulin A (IgA) are key immunological components of colostrum that stimulate neonatal gastrointestinal and immune system development. We aimed to investigate the differences in the concentration between immune markers in the colostrum of mothers living in Burundi and Italy, and to identify the factors associated with differences. In this cross-sectional birth cohort study, a total of 99 colostrum samples from Burundian ($n = 23$) and Italian ($n = 76$) women were collected at 0 to 6 days postpartum. A clinical chemistry analyser was used for IgA quantification and electro-chemiluminescence, for HGF and TGFβ1-3 assessment. A univariate analysis and multivariate linear regression model were used for statistical testing. The concentrations of TGF-β2 ($p = 0.01$) and IgA ($p < 0.01$) were significantly higher in the colostrum from the women residing in Burundi than in Italy, both in a univariate analysis and upon the adjustment for confounding factors. A similar trend is seen for HGF, reaching statistical significance upon a multivariate analysis. We found a moderate to strong positive correlation between the TGF-β isoforms and IgA concentration in both countries ($p < 0.01$), with stronger concentration in the colostrum from Burundi. The results of this study are in support of previous data, suggesting that concentration of the immune active molecules is higher in the human milk of women residing in developing countries. However, with a small sample size, caution must be applied, as the findings require further confirmation. Future work should also be focused on other factors (e.g., lipid and microbial composition), as well as the investigation into colostrum and between populations comparison, adjusting for potential confounders.

key words: HGF; IgA; TGF-β; breast milk; colostrum; geographical location; growth factors; human milk

7. Microbiota network and mathematic microbe mutualism in colostrum and mature milk collected in two different geographic areas: Italy versus Burundi.

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ABSTRACT

Human milk is essential for the initial development of newborns, as it provides all nutrients and vitamins, such as vitamin D, and represents a great source of commensal bacteria. Here we explore the microbiota network of colostrum and mature milk of Italian and Burundian mothers using the auto contractive map (AutoCM), a new methodology based on artificial neural network (ANN) architecture. We were able to demonstrate the microbiota of human milk to be a dynamic, and complex, ecosystem with different bacterial networks among different populations containing diverse microbial hubs and central nodes, which change during the transition from colostrum to mature milk. Furthermore, a greater abundance of anaerobic intestinal bacteria in mature milk compared with colostrum samples has been observed. The association of complex mathematic systems such as ANN and AutoCM adopted to metagenomics analysis represents an innovative approach to investigate in detail specific bacterial interactions in biological samples.

8. **Prevalence and diagnostics of congenital malaria in rural Burundi, a cross-sectional study.**

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ABSTRACT

BACKGROUND: Congenital malaria, defined as the presence of asexual forms of malaria parasites in the peripheral blood during the first 7 days of life, remains a neglected area of research. Knowledge gaps exist about prevalence and management of malaria in this age group. The objective of this study was to evaluate the prevalence of congenital malaria and the validity of a rapid diagnostic test (RDT) for its diagnosis in rural Burundi.

METHODS: A cross-sectional study was conducted in a meso-endemic malaria context in Burundi among 290 mothers, and their newborns (n = 303), who delivered at the maternity departments of Kirundo and Mukenke Hospitals during March and April 2014. Peripheral blood samples were collected from all mothers/newborns pairs in order to examine the presence of malaria parasites with two RDT (SD-Bioline HRP2 and Carestart pan-pLDH) and a blood slide. In addition, quantitative real-time polymerase chain reaction (PCR) was performed from the newborn peripheral sample. Frequencies and proportions were calculated for categorical variables. Sensitivity and specificity were calculated with a 95 % confidence interval (CI).

RESULTS: None of the newborns were found positive by PCR (0/303; 95 % CI 0.0-1.3). The prevalence in newborns born from microscopy-positive mothers was 0 % (0/44; 95 % CI 0.0-8.0). Two newborns were positive with SD-Bioline HRP2 (0.7 %, 95 % CI 0.2-2.4) but none with Carestart pan-pLDH or microscopy. Sensitivity of the diagnostic tests could not be evaluated as no congenital malaria was detected. Specificity of SD-Bioline HRP2, Carestart pan-pLDH and microscopy to detect congenital malaria was 99.3 % (95 % CI 97.6-99.8), 100.0 % (95 % CI 98.3-100.0) and 100.0 % (95 % CI 98.8-100.0), respectively.

CONCLUSION: In Burundi or the Central African region, no recent prevalence studies for congenital malaria have been carried out. This study found that the prevalence of congenital malaria in two hospitals in Kirundo province is zero. RDT showed to have an excellent specificity and, therefore, can be used to rule out congenital malaria: the risk of overtreatment is low. However, as no cases of congenital malaria were detected, the study was not able to draw conclusions about the sensitivity of the RDT, nor about risk factors for congenital malaria. Further studies evaluating the sensitivity of RDT for diagnosis of congenital malaria are needed.

key words: Burundi; Congenital malaria; Diagnosis; Prevalence; Rapid diagnostic test

9. **Genotypes and subtypes of hepatitis C virus in Burundi: a particularity in sub-Saharan Africa.**

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ABSTRACT

INTRODUCTION: Hepatitis C virus (HCV) infection is a major public health issue. HCV genotype identification is clinically important to tailor the dosage and duration of treatment. Indeed, distinct therapeutic approaches are required for each genotype. Up to now, there is no study assessing HCV genotypes and subtypes in Burundi. The aim of the study was to determine HCV genotypes and subtypes in Burundi and to highlight the difficulties related to LiPA Method, widely used for African samples.

METHODS: In this study, a total of 179 samples contained anti-HCV antibodies were tested for HCV RNA, genotyping and subtyping. The analysis had been made in Cerba laboratory, Paris, France.

RESULTS: 166 patients (92.7%) were genotype 4; 10 patients (5.6%) were genotype 1 and 3 patients (1.7%) were genotype 3. It was possible to determine subtypes for 51 HCV-4 (30.7%) patients. Among these, 25 (49.1%) had 4h subtype; 11 (21.6%) had 4e subtype; 2 (3.9%) had 4k subtype and 13 patients (25.5%) had 4a/4c/4d subtype. The LiPA method failed to subtype 115 (69.3%) HCV-4 and to separate the three subtype: 4a, 4c and 4d.

CONCLUSION: Genotype 4 and subtype 4h followed by 4e are the widespread in Burundi.

key words: Hepatitis C virus; genotype; genotype 4; subtype

10. HIV Type 1 Diversity and Antiretroviral Drug Resistance Mutations in Burundi.

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ABSTRACT

In 2002, an HIV surveillance study was performed among more than 5500 individuals representing the general population of urban and rural districts in Burundi. In this report, we genetically characterized a subset of the HIV-1-positive samples identified during this survey, including all the HIV-positive samples from Bujumbura, the capital city, and samples from one semi urban and one rural district. One hundred and nineteen samples were genetically characterized in the V3–V5 region of the env gene and/or in the protease and reverse transcriptase region of the *pol* gene. Phylogenetic analysis of 101 *env/pol* sequences revealed that the HIV-1 epidemic in Burundi was driven by subtype C (81.2%), followed by subtype A (7.9 %) and *polC/env*A recombinants (5.9%). One major mutation associated with resistance to antiretroviral drugs (ARVs) in the *pol* gene, as defined by the International AIDS Society Resistance Testing-USA panel, was observed in one individual, but many minor resistance-associated mutations were also present in the majority of the samples.

Kenya

11. Innovative open source approaches to automating clinical data management for a large multi-centre cohort study.

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ABSTRACT

BACKGROUND: Data management for multi-centre cohort studies is challenging, especially when the sites are geographically dispersed and have varying technical and manpower capacity. Ensuring data quality, prompt resolution of data discrepancies and generating progress summary reports for such studies need to be accurate, systematic and timely. The Childhood Acute Illness and Nutrition Network (CHAIN) is a multi-centre cohort study recruiting from nine hospitals in Africa and Asia. Highly detailed data are collected across many biological and social domains. The cohort has adopted Research Electronic Data Capture (REDCap), an open-source, web-based, metadata-driven system. In this paper, we outline how we have used REDCap efficiently in conjuction with the open-source R software to automate the data management workflow for the CHAIN study.

METHODS: We used REDCap, RStudio Server, and Shiny Server to set up a secure, interactive web-based dashboard accessible only by study staff across the nine CHAIN sites using authenticated credentials. Study reports and progress information are visible to site teams on the dashboard. Using custom data cleaning and report generating R scripts running as shiny applications, we leveraged REDCap's Application Programming Interface module to schedule automated data extraction and processing from within R studio server for cleaning, visualization and outputing summary reports.

RESULTS: The CHAIN study database is large (~ 4000 records and ~2000 variables), normally requiring considerable time to extract data. With our automation, the data extraction processing is seamless. Sites now have access to listings of site-specific data queries to be resolved and customised progress reports. This has reduced reliance on the CHAIN central coordination team as they can now follow their data queries on the dashboard. Real-time study progress information helps in planning recruitment in relation to targets. Overall, communication with sites and data quality has improved which is paramount to the success of this large cohort study.

CONCLUSION: Our experience with CHAIN has demonstrated that blending REDCap and R software makes data management for a large multi-site study

efficient. In addition, it offers interactive real-time monitoring of a wide range of data quality checks, which help ensure high quality and reliable study data.

12. Using mobile transport vouchers to improve access to skilled delivery.

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ABSTRACT

INTRODUCTION: Reducing maternal death remains a challenge in many low-income countries. Preventing maternal deaths depends significantly on the presence of a skilled birth attendant at child delivery. The main objective of this study was to find out whether use of mobile transport vouchers would result in an increased number of pregnant women choosing to deliver at a health facility rather than at home.

METHOD: A total of 86 expectant mothers living in Samburu County (Kenya), all having access to a mobile phone with Safaricom mobile SIM card, were enrolled into the project. Mixed methods research design was used to generate quantitative data on the voucher transactions and qualitative data from telephone interviews on technical usability of the transport voucher.

RESULTS: The study demonstrated that the mobile transport voucher was a major driver for pregnant women to access healthcare facilities for skilled delivery. Illiteracy and resource scarcity were the main challenges experienced during implementation.

CONCLUSION: Mobile technology can be successfully used in remote rural settings in Africa for targeting funds and guiding individuals towards better health care. The combination of such technology with communication agents (community health volunteers, ambulance drivers) proved particularly effective.

13. Expanding the Capacity of Otolaryngologists in Kenya through Mobile Technology.

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ABSTRACT

OBJECTIVE: To determine if reliable, objective audiologic data can be obtained by nonotolaryngology and nonaudiology practitioners using novel mobile technology in an effort to expand the capacity for early identification and treatment of disabling hearing loss in the developing world.

STUDY DESIGN: Cross-sectional, proof-of-concept pilot study.

SETTING: screenings took place during an annual 2-week otolaryngology surgical mission in October 2016 in semirural Malindi, Kenya.

SUBJECT AND METHODS: Eighty-seven patients (174 total ears) were included from 2 deaf schools (n = 12 and 9), a nondeaf school (n = 9), a tuberculosis ward (n = 8), and a walk-in otology clinic at a local hospital (n = 49). An automated, tablet-based, language-independent, clinically validated, play audiometry system and wireless otoscopic endoscopy via an iPhone or laptop platform was administered by Kenyan community health workers (CHWs) and nursing staff.

RESULTS: Various degrees of hearing loss and otologic pathology were identified, including 1 child presumed to be deaf who was found to have unilaterally normal hearing. Other pathology included 2 active perforations, 2 healed perforations, 2 middle ear effusions, and 1 cholesteatoma. CHWs and nursing staff demonstrated proficiency performing audiograms and endoscopy. Patients screened in a deaf school were more likely to complete an unreliable audiogram than patients screened in other settings (P < .01).

CONCLUSION: This study demonstrates the feasibility of a non-otolaryngology-based hearing screening program. This may become an important tool in reducing the impact of hearing loss and otologic pathology in areas bereft of otolaryngologists and audiologists by allowing CHWs to gather important patient data prior to otolaryngologic evaluation.

14. **A mobile health technology platform for quality assurance and quality improvement of malaria diagnosis by community health workers.**

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ABSTRACT

BACKGROUND: Community health workers (CHWs) play an important role in improving access to services in areas with limited health infrastructure or workforce. Supervision of CHWs by qualified health professionals is the main link between this lay workforce and the formal health system. The quality of services provided by lay health workers is dependent on adequate supportive supervision. It is however one of the weakest links in CHW programs due to logistical and resource constraints, especially in large scale programs. Interventions such as point of care testing using malaria rapid diagnostic tests (RDTs) require real time monitoring to ensure diagnostic accuracy. In this study, we evaluated the utility of a mobile health technology platform to remotely monitor malaria RDT (mRDT) testing by CHWs for quality improvement.

METHODS: As part of a large implementation trial involving mRDT testing by CHWs, we introduced the Fionet system composed of a mobile device (Deki Reader, DR) to assist in processing and automated interpretation of mRDTs, which connects to a cloud-based database which captures reports from the field in real time, displaying results in a custom dashboard of key performance indicators. A random sample of 100 CHWs were trained and provided with the Deki Readers and instructed to use it on 10 successive patients. The CHWs interpretation was compared with the Deki Reader's automatic interpretation, with the errors in processing and interpreting the RDTs recorded. After the CHW entered their interpretation on the DR, the DR provided immediate, automated feedback and interpretation based on its reading of the same cassette. The study team monitored the CHW performance remotely and provided additional support.

RESULTS: A total of 1251 primary and 113 repeat tests were performed by the 97 CHWs who used the DR. 91.6% of the tests had agreement between the DR and the CHWs. There were 61 (4.9%) processing and 52 (4.2%) interpretation errors among the primary tests. There was a tendency towards lower odds of errors with increasing number and frequency of tests, though not statistically significant. Of the 62 tests that were repeated due to errors, 79% achieved concordance between the CHW and the DR. Satisfaction with the use of the DR by the CHWs was high.

CONCLUSIONS: Use of innovative mHealth strategies for monitoring and quality control can ensure quality within a large scale implementation of community level testing by lay health workers.

15. Effect of a voice recognition system on pediatric outpatient medication errors at a tertiary healthcare facility in Kenya.

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ABSTRACT

BACKGROUND: Medication-related errors account for one out of every 131 outpatient deaths, and one out of 854 inpatient deaths. The risk is threefold greater in the pediatric population. In sub-Saharan Africa, research on medication-related errors has been obscured by other health priorities and poor recognition of harm attributable to such errors. Our primary objective was to assess the effect of introduction of a voice recognition system (VRS) on the prevalence of medication errors. The secondary objective was to describe characteristics of observed medication errors and determine acceptability of VRS by clinical service providers.

METHODS: This was a before-after intervention study carried out in a Pediatric Accident and Emergency Department of a private not-for-profit tertiary referral hospital in Kenya.

RESULTS: A total of 1196 handwritten prescription records were examined in the pre-VRS phase and 501 in the VRS phase. In the pre-VRS phase, 74.3% of the prescriptions (889 of 1196) had identifiable errors compared with 65.7% in the VRS phase (329 of 501).More than half (58%) of participating clinical service providers expressed preference for VRS prescriptions compared with handwritten prescriptions.

CONCLUSIONS: VRS reduces medication prescription errors with the greatest effect noted in reduction of incorrect medication dosages. More studies are needed to explore whether more training, user experience and software enhancement would minimize medication errors further. VRS technology is acceptable to physicians and pharmacists at a tertiary care hospital in Kenya.

16. Short Message Service (SMS) Surveys Assessing Pre-exposure Prophylaxis (PrEP) Adherence and Sexual Behavior are Highly Acceptable Among HIV-Uninfected Members of Serodiscordant Couples in East Africa: A Mixed Methods Study.

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ABSTRACT

Short message service (SMS) surveys are a promising data collection method and were used to measure sexual behavior and adherence to HIV pre-exposure prophylaxis (PrEP) among HIV-uninfected partners of serodiscordant couples enrolled in a sub-study of the Partners Demonstration Project (an open-label study of integrated antiretroviral therapy and PrEP for HIV prevention in Kenya and Uganda). Questionnaires were completed by 142 participants after study exit. Median age was 29 years; 69% were male. Ninety-five percent (95%) felt SMS surveys were "easy" or "very easy", 74% reported no challenges, and 72% preferred SMS surveys over in-

person study visits. Qualitative interviews involving 32 participants confirmed the ease of responding to SMS surveys. Participants also indicated that surveys acted as reminders for adherence to PrEP and condom use and were experienced as support from the study. SMS surveys were generally found to be acceptable in this population and provided real-time context of PrEP use.

17. Smartphone-based screening for visual impairment in Kenyan school children: a cluster randomised controlled trial.

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ABSTRACT

BACKGROUND: Childhood visual impairment is a major public health concern that requires effective screening and early intervention. We investigated the effectiveness of Peek school eye health, a smartphone-based sight test and referral system (comprising Peek Acuity test, sight simulation referral cards, and short message service [SMS] reminders), versus standard care (Snellen's Tumbling-E card and written referral).

METHODS: We initially compared the performance of both the Snellen Tumbling-E card and the Peek Acuity test to a standard backlit EDTRS LogMAR visual acuity test chart. We did a cluster randomised controlled trial to compare the Peek school eye health system with standard school screening care, delivered by school teachers. Schools in Trans Nzoia County, Kenya, were eligible if they did not have an active screening programme already in place. Schools were randomly allocated (1:1) to either the Peek school eye health screening and referral programmes (Peek group) or the standard care screening and referral programme (standard group). In both groups, teachers tested vision of children in years 1-8. Pupils with visual impairment (defined as vision less than 6/12 in either eye) were referred to hospital for treatment. Referred children from the standard

group received a written hospital referral letter. Participants and their teachers in the Peek group were shown their simulated sight on a smartphone and given a printout of this simulation with the same hospital details as the standard referral letter to present to their parent or guardian. They also received regular SMS reminders to attend the hospital. The primary outcome was the proportion of referred children who reported to hospital within 8 weeks of referral. Primary analysis was by intention to treat, with the intervention effect estimated using odds ratios. This trial is registered with Pan African Clinical Trial Registry, number PACTR201503001049236.

FINDINGS: Sensitivity was similar for the Peek test and the standard test (77% [95% CI 64·8-86·5] vs 75% [63·1-85·2]). Specificity was lower for the Peek test than the standard test (91% [95% CI 89·3-92·1] vs 97·4% [96·6-98·1]). Trial recruitment occurred between March 2, 2015, and March 13, 2015. Of the 295 eligible public primary schools in Trans Nzoia County, 50 schools were randomly selected and assigned to either the Peek group (n=25) or the standard group (n=25). 10?579 children were assessed for visual impairment in the Peek group and 10?284 children in the standard group. Visual impairment was identified in 531 (5%) of 10?579 children in the Peek group and 366 (4%) of 10?284 children in the standard care group. The proportion of pupils identified as having visual impairment who attended their hospital referral was significantly higher in the Peek group (285 [54%] of 531) than in the standard group (82 [22%] of 366; odds ratio 7·35 [95% CI 3·49-15·47]; p<0·0001).

INTERPRETATION: The Peek school eye health system increased adherence to hospital referral for visual impairment assessment compared with the standard approach among school children. This indicates the potential of this technology package to improve uptake of services and provide real-time visibility of health service delivery to help target resources.

18. Use of Mobile Technology in Data Collection: A Case Study of The Mapafu Application (APP).

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ABSTRACT

INTRODUCTION: Mapafu App is a generic version of the ODK based data collection app with slight improvements and modifications. It applies form logic, entry constraints, and repeating sub-structures. It supports geo locations which helps in identifying the clusters. The App was developed for the BOLD study for easy of data collection, real time relay of results and timely quality control.

METHOD: It is a mobile App developed using Excel format for designing forms.(ODK XLS form design) where the skip logics and constricts were implemented., the form was converted from XLS format to Extensible Markup Language (XML)format so that it could be readable . It runs on an android platform, that supports electronic questionnaires. The App was used by the clinicians to collect data from participants in the randomly selected households. Filled in forms were submitted to the private cloud server and new forms downloaded from the server

RESULTS: The mobile App allowed inclusive daily real-time supervision of the data collected, with no data loss. In addition it also allowed the identification of how many households were visited daily with real-time quality control .The BOLD field staff have good uptake of the use of the App. However there where several challenge which include; missing skip patterns. These errors have been corrected.

CONCLUSION: During the BOLD pilot study, this App was found to be portable, time saving and ensure that all variable were captured. Timely relay of the data captured from the field was ensured which is important for real time quality control.

19. Operationalizing mHealth to improve patient care: a qualitative implementation science evaluation of the WelTel texting intervention in Canada and Kenya.

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ABSTRACT

BACKGROUND: Mobile health (mHealth) applications have proliferated across the globe with much enthusiasm, although few have reached scale and shown public health impact. In this study, we explored how different contextual factors influenced the implementation, effectiveness and potential for scale-up of WelTel, an easy-to-use and evidence-based mHealth intervention. WelTel uses two-way SMS communication to improve patient adherence to medication and engagement in care, and has been developed and tested in Canada and Kenya.

METHODS: We used a comparative qualitative case study design, which drew on 32 key informant interviews, conducted in 2016, with stakeholders involved in six WelTel projects. Our research was guided by the Consolidated Framework for Implementation Research (CFIR), a meta-theoretical framework, and our analysis relied on a modified approach to grounded theory, which allowed us to compare findings across these projects.

RESULTS: We found that WelTel had positive influences on the "culture of care" at local clinics and hospitals in Canada and Kenya, many of which stretched beyond the immediate patient-client relationship to influence wider organizational systems. However, these were mediated by clinician norms and practices, the availability of local champion staff, the receptivity and capacity of local management, and the particular characteristics of the technology platform, including the ability for adaptation and co-design. We also found that scale-up was influenced by different forms of data and evidence, which played important roles in legitimization and partnership building. Even with robust research evidence, scale-up was viewed as a precarious and uncertain process, embedded within the wider politics and financing of Canadian and Kenyan health systems. Challenges included juggling different interests, determining

appropriate financing pathways, maintaining network growth, and "packaging" the intervention for impact and relevance.

CONCLUSIONS: Our comparative case study, of a unique transnational mobile health research network, revealed that moving from mHealth pilots to scale is a difficult, context-specific process that couples social and technological innovation. Fostering new organizational partnerships and ways of learning are paramount, as mHealth platforms straddle the world of research, industry and public health. Partnerships need to avoid the perils of the technological fix, and engage the structural barriers that mediate people's health and access to services.

20. Assessing Mobile Phone Access and Perceptions for Texting-Based mHealth Interventions Among Expectant Mothers and Child Caregivers in Remote Regions of Northern Kenya: A Survey-Based Descriptive Study.

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ABSTRACT

BACKGROUND: With a dramatic increase in mobile phone use in low- and middle-income countries, mobile health (mHealth) has great potential to connect health care services directly to participants enrolled and improve engagement of care. Rural and remote global settings may pose both significant challenges and opportunities.

OBJECTIVE: The objective of our study was to understand the demographics, phone usage and ownership characteristics, and feasibility among patients in

rural and remote areas of Kenya of having text messaging (short messaging service, SMS)-based mHealth intervention for improvements in antenatal care attendance and routine immunization among children in Northern Kenya.

METHODS: A survey-based descriptive study was conducted between October 2014 and February 2015 at 8 health facilities in Northern Kenya as part of a program to scale up an mHealth service in rural and remote regions. The study was conducted at 6 government health facilities in Isiolo, Marsabit, and Samburu counties in remote and northern arid lands (NAL). Two less remote health facilities in Laikipia and Meru counties in more populated central highlands were included as comparison sites.

RESULTS: A total of 284 participants were surveyed; 63.4% (180/284) were from NAL clinics, whereas 36.6% (104/284) were from adjacent central highland clinics. In the NAL, almost half (48.8%, 88/180) reported no formal education and 24.4% (44/180) self-identified as nomads. The majority of participants from both regions had access to mobile phone: 99.0% (103/104) of participants from central highlands and 82.1% (147/180) of participants from NAL. Among those who had access to a phone, there were significant differences in network challenges and technology literacy between the 2 regions. However, there was no significant difference in the proportion of participants from NAL and central highlands who indicated that they would like to receive a weekly SMS text message from their health care provider (90.0% vs 95.0%; P=.52). Overall, 92.0% (230/250) of participants who had access to a telephone said that they would like to receive a weekly SMS text message from their health care provider. Most phone users already spent the equivalent of 626 SMS text messages on mobile credit for personal use.

CONCLUSIONS: Despite the remoteness of northern Kenya's NAL, the results indicate that the majority of pregnant women or care givers attending the maternal, newborn, and child health clinics have access to mobile phone and would like to receive text messages from their health care provider. mHealth programs, if designed appropriately for these settings, may be an innovative way for engaging women in care for improved maternal and newborn child health outcomes in order to achieve sustainable development goals.

21. Use of cellular phone contacts to increase return rates for immunization services in Kenya.

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ABSTRACT

INTRODUCTION: in Kenya, failure to complete immunization schedules by children who previously accessed immunization services is an obstacle to ensuring that children are fully immunized. Home visit approaches used to track defaulting children have not been successful in reducing the drop-out rate.

METHODS: this study tested the use of phone contacts as an approach for tracking immunization defaulters in twelve purposively-selected facilities in three districts of western Kenya. For nine months, children accessing immunization services in the facilities were tracked and caregivers were asked their reasons for defaulting.

RESULTS: in all of the facilities, caregiver phone ownership was above 80%. In 11 of the 12 facilities, defaulter rates between pentavalent1 and pentavalent3 vaccination doses reduced significantly to within the acceptable level of < 10%. Caregivers provided reliable contact information and health workers positively perceived phone-based defaulter communications. Tracking a defaulter required on average 2 minutes by voice and Ksh 6 ($ 0.07). Competing tasks and concerns about vaccinating sick children and side-effects were the most cited reasons for caregivers defaulting. Notably, a significant number of children categorised as defaulters had been vaccinated in a different facility (and were therefore "false defaulters").

CONCLUSION: use of phone contacts for follow-up is a feasible and cost-effective method for tracking defaulters. This approach should complement traditional home visits, especially for caregivers without phones. Given communication-related reasons for defaulting, it is important that immunization programs scale-up community education activities. A system for health facilities to share details of defaulting children should be established to reduce "false defaulters".

22. **Assessing the feasibility of eHealth and mHealth: a systematic review and analysis of initiatives implemented in Kenya.**

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ABSTRACT

BACKGROUND: The growth of Information and Communication Technology in Kenya has facilitated implementation of a large number of eHealth projects in a bid to cost-effectively address health and health system challenges. This systematic review aims to provide a situational analysis of eHealth initiatives being implemented in Kenya, including an assessment of the areas of focus and geographic distribution of the health projects. The search strategy involved peer and non-peer reviewed sources of relevant information relating to projects under implementation in Kenya. The projects were examined based on strategic area of implementation, health purpose and focus, geographic location, evaluation status and thematic area.

RESULTS: A total of 114 citations comprising 69 eHealth projects fulfilled the inclusion criteria. The eHealth projects included 47 mHealth projects, 9 health information system projects, 8 eLearning projects and 5 telemedicine projects. In terms of projects geographical distribution, 24 were executed in Nairobi whilst 15 were designed to have a national coverage but only 3 were scaled up. In terms of health focus, 19 projects were mainly on primary care, 17 on HIV/AIDS and 11 on maternal and child health (MNCH). Only 8 projects were rigorously evaluated under randomized control trials.

CONCLUSION: This review discovered that there is a myriad of eHealth projects being implemented in Kenya, mainly in the mHealth strategic area and focusing mostly on primary care and HIV/AIDs. Based on our analysis, most of the projects were rarely evaluated. In addition, few projects are implemented in marginalised areas and least urbanized counties with more health care needs, notwithstanding the fact that adoption of information and communication technology should aim to improve health equity (i.e. improve access to health care particularly in remote parts of the country in order to reduce geographical inequities) and contribute to overall health systems strengthening.

23. App-Supported Promotion of Child Growth and Development by Community Health Workers in Kenya: Feasibility and Acceptability Study.

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ABSTRACT

BACKGROUND: Early childhood is a critical phase of development. In low resource settings, monitoring this stage of development and providing appropriate and timely feedback is a challenge. Community-based service providers play a key role in promoting early childhood development in areas where government services are weak. These community-based service providers are also tasked with the collection of monitoring and evaluation data for donors and local government. Usually, collection of these data aims to provide accountability, learning, and correction leading to improvement. However, such data is rarely used beyond the accountability stage.

OBJECTIVE: The purpose of this study was to test the feasibility and acceptability of the Information for Action (IFA) mobile phone app. The IFA app was designed for use by community health volunteers (CHVs), and repackages routinely collected data about children into useful, offline decision support for caregivers and program managers.

METHODS: The IFA app was tested with a convenience sample of 10 CHVs in West Katweng'a, a sublocation of Rarieda subcounty in western Kenya. CHVs used the IFA app for 5 months as part of their regular home visits to households containing children aged 0 to 5 years, after which a qualitative assessment of the app was conducted. A total of 16 caregivers who received services from the CHVs were randomly selected to participate in 1 of 2 focus group discussions about their experience.

RESULTS: The app was reported to help facilitate interactive dialog between CHVs and caregivers, leading to improved quality of home visits. Caregivers

described the app as shifting the relationship from feeling harassed by CHVs to experiencing genuine interest from CHVs. CHVs reported feasibility challenges primarily related to infrastructure. The limited battery life of mobile phones combined with the lack of readily available electricity made it difficult to keep the phones charged. CHVs reported initial anxiety as first-time mobile phones users, including concerns about using the IFA app. With time, increased levels of confidence were seen.

CONCLUSIONS: Acceptability was high with both CHVs and caregivers, who reported an improvement in their client-provider relationship. A number of feasibility challenges were experienced.

24. Acceptability, Usability, and Views on Deployment of Peek, a Mobile Phone mHealth Intervention for Eye Care in Kenya: Qualitative Study.

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ABSTRACT

BACKGROUND: The Portable Eye Examination Kit (Peek) is a mobile phone–based ophthalmic testing system that has been developed to perform comprehensive eye examinations. Shortages in ophthalmic personnel, the high cost, and the difficulty in transporting equipment have made it challenging to offer services, particularly in rural areas. Peek offers a solution for overcoming barriers of limited access to traditional ophthalmic testing methods and has been pilot tested on adults in Nakuru, Kenya, and compared with traditional eye examination tools.

OBJECTIVE: This qualitative study evaluated the acceptability and usability of Peek in addition to perceptions regarding its adoption and nationwide deployment.

METHODS: Semistructured interviews were conducted with patients and analyzed using a framework approach. This included analysis of interviews from 20 patients, 8 health care providers (HCPs), and 4 key decision makers in ophthalmic health care provision in Kenya. The participants were purposefully sampled. The coding structure involved predefined themes for assessing the following: (1) the context,

that is, environment, user, task, and technology; (2) patient acceptability, that is, patients' perceived benefits, patient preference, and patient satisfaction; (3) usability, that is, efficiency, effectiveness, learnability, and flexibility and operability of Peek; and (4) the benefits of Peek in strengthening eye care provision, that is, capabilities enhancer, opportunity creator, social enabler, and knowledge generator. Emerging themes relating to the objectives were explored from the data using thematic analysis.

RESULTS: Patients found Peek to be acceptable because of its benefits in overcoming the barriers to accessing ophthalmic services. Most thought it to be fast, convenient, and able to reach a large population. All patients expressed being satisfied with Peek. The HCPs perceived it to satisfy the criteria for usability and found Peek to be acceptable based on the technology acceptance model. Peek was also found to have features required for strengthening ophthalmic delivery by aiding detection and diagnosis, provision of decision support, improving communication between provider and patient and among providers, linking patients to services, monitoring, and assisting in education and training. Some of the deployment-related issues included the need for government and community involvement, communication and awareness creation, data protection, infrastructure development including capacity creation, and training and maintenance support.

CONCLUSIONS: According to all parties interviewed, Peek is an acceptable solution, as it provides a beneficial service, supports patients' needs, and fulfills HCPs' roles, overall contributing to strengthening eye health.

25. Clinical Validation of a Smartphone-Based Adapter for Optic Disc Imaging in Kenya.

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ABSTRACT

IMPORTANCE: Visualization and interpretation of the optic nerve and retina are essential parts of most physical examinations.

OBJECTIVE: To design and validate a smartphone-based retinal adapter enabling image capture and remote grading of the retina.

DESIGN, SETTING, AND PARTICIPANTS: This validation study compared the grading of optic nerves from smartphone images with those of a digital retinal camera. Both image sets were independently graded at Moorfields Eye Hospital Reading Centre. Nested within the 6-year follow-up (January 7, 2013, to March 12, 2014) of the Nakuru Eye Disease Cohort in Kenya, 1460 adults (2920 eyes) 55 years and older were recruited consecutively from the study. A subset of 100 optic disc images from both methods were further used to validate a grading app for the optic nerves. Data analysis was performed April 7 to April 12, 2015. Main Outcomes and Measures Vertical cup-disc ratio for each test was compared in terms of agreement (Bland-Altman and weighted ?) and test-retest variability.

RESULTS: A total of 2152 optic nerve images were available from both methods (also 371 from the reference camera but not the smartphone, 170 from the smartphone but not the reference camera, and 227 from neither the reference camera nor the smartphone). Bland-Altman analysis revealed a mean difference of 0.02 (95% CI, -0.21 to 0.17) and a weighted ? coefficient of 0.69 (excellent agreement). The grades of an experienced retinal photographer were compared with those of a lay photographer (no health care experience before the study), and no observable difference in image acquisition quality was found.

CONCLUSIONS AND RELEVANCE: Nonclinical photographers using the low-cost smartphone adapter were able to acquire optic nerve images at a standard that enabled independent remote grading of the images comparable to those acquired using a desktop retinal camera operated by an ophthalmic assistant. The potential for task shifting and the detection of avoidable causes of blindness in the most at-risk communities makes this an attractive public health intervention.

26. Feasibility of an innovative electronic mobile system to assist health workers to collect accurate, complete and timely data in a malaria control programme in a remote setting in Kenya.

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ABSTRACT

BACKGROUND: The cornerstone of decision making aimed at improving health services is accurate and timely health information. The Ministry of Public Health and Sanitation in Kenya decided to pilot feasibility of Fionet, an innovation that integrates diagnostics, data capture and cloud services, in its malaria control programme to demonstrate usability and feasibility by primary level workers in a remote setting in Kenya.

METHODS: Eleven sites comprising one sub-district hospital, ten health centres and dispensaries were selected in three districts of Kisumu County to participate. Two health workers per site were selected, trained over a two-day period in the use of the Deki Reader™ to undertake rapid diagnostic testing (RDT) for malaria and data capture of patients' records. Health managers in the three districts were trained in the use of Fionet™ portal (web portal to cloud based information) to access the data uploaded by the Deki Readers. Field Support was provided by the Fio Corporation representative in Kenya.

RESULTS: A total of 5812 malaria RDTs were run and uploaded to the cloud database during this implementation research study. Uploaded data were automatically aggregated into predetermined reports for use by service managers and supervisors. The Deki Reader enhanced the performance of the health workers by not only guiding them through processing of a malaria RDT test, but also by doing the automated analysis of the RDT, capturing the image, determining whether the RDT was processed according to guidelines, and capturing full patient data for each patient encounter. Supervisors were able to perform remote Quality assurance/Quality control (QA/QC) activities almost in real time.

CONCLUSION: Quality, complete and timely data collection by health workers in a remote setting in Kenya is feasible. This paperless innovation brought unprecedented quality control and quality assurance in diagnosis, care and data capture, all in the hands of the health worker at point of care in an integrated way.

27. **If you text them, they will come: using the HIV infant tracking system to improve early infant diagnosis quality and retention in Kenya.**

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ABSTRACT

OBJECTIVE: The objective of this study is to evaluate the impact of the HIV Infant Tracking System (HITSystem) for quality improvement of early infant diagnosis (EID) of HIV services.

DESIGN AND SETTING: This observational pilot study compared 12 months of historical pre-intervention EID outcomes at one urban and one peri-urban government hospital in Kenya to 12 months of intervention data to assess retention and time throughout the EID cascade of care. PARTICIPANTS: Mother-infant pairs enrolled in EID at participating hospitals before (n = 320) and during (n = 523) the HITSystem pilot were eligible to participate.

INTERVENTION: The HITSystem utilizes Internet-based coordination of the multistep PCR cycle, automated alerts to trigger prompt action from providers and laboratory technicians, and text messaging to notify mothers when results are ready or additional action is needed.

MAIN OUTCOME MEASURES: The main outcome measures were retention throughout EID services, meeting time-sensitive targets and improving results turn-

around time, and increasing early antiretroviral therapy (ART) initiation among HIV-infected infants.

RESULTS: The HITSystem was associated with an increase in the proportion of HIV-exposed infants retained in EID care at 9 months postnatal (45.1-93.0% urban; 43.2-94.1% peri-urban), a decrease in turn-around times between sample collection, PCR results and notification of mothers in both settings, and a significant increase in the proportion of HIV-infected infants started on antiretroviral therapy at each hospital(14 vs. 100% urban; 64 vs. 100% peri-urban).

CONCLUSION: The HITSystem maximizes the use of easily accessible technology to improve the quality and efficiency of EID services in resource-limited settings.

28. Pilot Results of a Telemedicine Social Franchise in Rural Kenya: Evidence of Sustainable Livelihood Creation?

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ABSTRACT

MASHAVU: Networked Health Solutions increases access to pre-primary health services, provides personal health information tracking, and income-generation opportunities to women in rural Kenya. The aim of this paper is to explore the potential of Mashavu, a healthcare social franchise, to create sustainable livelihoods for its employees in rural Kenya. The research team conducted two pilots of the Mashavu system in a rural Kenyan community. While the initial pilot protected Mashavu Health Workers (MHWs) from the financial risks of taking a new service to the market, the second pilot removed employee income subsidies. The removal of subsidies after the conclusion of the first pilot led to a divergence in monthly wages for the MHWs. While one MHW retained consistent monthly income by increasing the number of days worked monthly and the number of clients seen, a second MHW retained a largely consistent schedule without significantly increasing the number of clients daily and experienced a 600 KSH (29%) decrease in monthly wages. Following a period of employee incubation from financial risk, the MHWs consistently involved in the program were able to continue to generate income through Mashavu.

29. Perceived value of applying Information Communication Technology to implement guidelines in developing countries; an online questionnaire study among public health workers.

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ABSTRACT

INTRODUCTION: Practice guidelines can be used to support healthcare decision making. We sought to identify the use, and barriers to the implementation, of electronic based guidelines to support decision-making in maternal and child healthcare (MCH) and the rational use of medicines, in developing countries.

METHODS: Graduates who had gained the Master of Public Health degree through the Peoples-uni (postgraduate public health education in developing countries) were sent an online survey questionnaire which had been piloted. Two reminders were sent to non-respondents at intervals of 10 days. Results were explored using descriptive analyses.

RESULTS: 44 of the potential 48 graduates from 16 countries responded - most were from Africa. 82% and 89% of respondents were aware of guidelines on MCH and the rational use of medicines respectively. Electronic guidelines were more available in university hospitals than in provincial hospitals or rural care. All respondents thought that guidelines could improve the delivery of quality care, and 42 (95%) and 41 (93%) respectively thought that computers and mobile or smartphones could increase the use of guidelines in service delivery. Lack of access to computers, need to buy phone credit, need for training in the use of either computerized or phone based guidelines and fear of increased workload were potential barriers to use.

CONCLUSION: There is support for the use of electronic guidelines despite limited availability and barriers to use in developing countries. These findings, and other literature, provide a guide as to how the further development of ICT based guidelines may be implemented to improve health care decision making.

30. Mobile health for early retention in HIV care: a qualitative study in Kenya (WelTel Retain).

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ABSTRACT

Many people newly diagnosed with HIV are lost to follow-up before timely initiation of antiretroviral therapy (ART). A randomised controlled trial (RCT), WelTel Kenya1, demonstrated the effectiveness of the WelTel text messaging intervention to improve clinical outcomes among patients initiating ART. In preparation for WelTel Retain, an RCT that will evaluate the effect of the intervention to retain patients in care immediately following HIV diagnosis, we conducted an informative qualitative study with people living with HIV (n = 15) and healthcare providers (HCP) (n = 5) in October 2012. Study objectives included exploring the experiences of people living with HIV who have attempted to engage in HIV care, the use of cell phones in everyday life, and perceptions of communicating via text message with HCP. Participants were recruited through convenience sampling. Semi-structured, qualitative interviews were conducted and recorded, transcribed verbatim and analysed using NVivo software. Analysis was guided by the Theory of Reasoned Action and the Technology Acceptance Model. Results indicate that while individuals have many motivators for engaging in care after diagnosis, structural and individual barriers including poverty, depression and fear of stigma prevent them from doing so. All participants had access to a mobile phone, and most were comfortable communicating through text messages, or were willing to learn. Both people living with HIV and HCP felt that increased communication via the text messaging intervention has the potential to enable early identification of problems, leading to timely problem solving that may improve retention and engagement in care during the first year after diagnosis.

31. Ownership and use of mobile phones among health workers, caregivers of sick children and adult patients in Kenya: cross-sectional national survey.

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ABSTRACT

BACKGROUND: The rapid growth in mobile phone penetration and use of Short Message Service (SMS) has been seen as a potential solution to improve medical and public health practice in Africa. Several studies have shown effectiveness of SMS interventions to improve health workers' practices, patients' adherence to medications and availability of health facility commodities. To inform policy makers about the feasibility of facility-based SMS interventions, the coverage data on mobile phone ownership and SMS use among health workers and patients are needed.

METHODS: In 2012, a national, cross-sectional, cluster sample survey was undertaken at 172 public health facilities in Kenya. Outpatient health workers and caregivers of sick children and adult patients were interviewed. The main outcomes were personal ownership of mobile phones and use of SMS among phone owners. The predictors analysis examined factors influencing phone ownership and SMS use.

RESULTS: The analysis included 219 health workers and 1,177 patients' respondents (767 caregivers and 410 adult patients). All health workers possessed personal mobile phones and 98.6% used SMS. Among patients' respondents, 61.2% owned phones and 71.4% of phone owners used SMS. The phone ownership and SMS use was similar between caregivers of sick children and adult patients. The respondents who were male, more educated, literate and living in urban area were significantly more likely to own the phone and use SMS. The youngest respondents were less likely to own phones, however when the phones were owned, younger age groups were more likely to use SMS. Respondents living in wealthier areas were more likely to own phones; however when phones are owned no significant association between the poverty and SMS use was observed.

CONCLUSIONS: Mobile phone ownership and SMS use is ubiquitous among Kenyan health workers in the public sector. Among patients they serve the coverage in phone ownership and SMS use is lower and disparities exist with respect to gender, age, education, literacy, urbanization and poverty. Some of

the disparities on SMS use can be addressed through the modalities of mHealth interventions and enhanced implementation processes while further growth in mobile phone penetration is needed to reduce the ownership gap.

32. Reducing stock-outs of life saving malaria commodities using mobile phone text-messaging: SMS for life study in Kenya.

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ABSTRACT

BACKGROUND: Health facility stock-outs of life saving malaria medicines are common across Africa. Innovative ways of addressing this problem are urgently required. We evaluated whether SMS based reporting of stocks of artemether-lumefantrine (AL) and rapid diagnostic tests (RDT) can result in reduction of stock-outs at peripheral facilities in Kenya.

METHODS/FINDINGS: All 87 public health facilities in five Kenyan districts were included in a 26 week project. Weekly facility stock counts of four AL packs and RDTs were sent via structured incentivized SMS communication process from health workers' personal mobile phones to a web-based system accessed by district managers. The mean health facility response rate was 97% with a mean formatting error rate of 3%. Accuracy of stock count reports was 79% while accuracy of stock-out reports was 93%. District managers accessed the system 1,037 times at an average of eight times per week. The system was accessed in 82% of the study weeks. Comparing weeks 1 and 26, stock-out of one or more AL packs declined by 38 percentage-points. Total AL stock-out declined by 5 percentage-points and was eliminated by the end of the project. Stock-out declines of individual AL packs ranged from 14 to 32 percentage-points while decline in RDT stock-outs was 24 percentage-points. District managers responded to 44% of AL and 73% of RDT stock-out signals by redistributing commodities between facilities. In comparison with national trends, stock-out declines in study areas were greater, sharper and more sustained.

CONCLUSIONS: Use of simple SMS technology ensured high reporting rates of reasonably accurate, real-time facility stock data that were used by district managers to undertake corrective actions to reduce stock-outs. Future work on stock monitoring via SMS should focus on assessing response rates without use of

incentives and demonstrating effectiveness of such interventions on a larger scale.

33. There are some questions you may not ask in a clinic: Providing contraception information to young people in Kenya using SMS?

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ABSTRACT

OBJECTIVE: To evaluate the acceptability, information access, and potential behavioral impact of providing contraception information via text message on mobile phones to young people in Kenya.

METHODS: Three methods of data collection were implemented during the 17-month pilot period for the Mobile for Reproductive Health (m4RH) program in Kenya: automatic logging of all queries to the m4RH system; demographic and behavior change questions sent via short message service protocol (SMS) to everyone who used m4RH during the pilot period; and telephone interviews with a subset of m4RH users.

RESULTS: During the pilot period, 4817 unique users accessed m4RH in Kenya. Of these, 82% were 29 years of age and younger, and 36% were male. Condom and natural family-planning information was accessed most frequently, although users queried all methods. One in 5 used the m4RH system to locate nearby clinics. Respondents liked the simple language and confidentiality of receiving health information via mobile phone, and reported increased contraceptive knowledge and use after using m4RH.

CONCLUSION: Providing contraception information via mobile phone is an effective strategy for reaching young people. More research is needed to learn how to link young people to youth-friendly services effectively.

34. Daily Short Message Service Surveys to Measure Sexual Behavior and Pre-exposure Prophylaxis Use Among Kenyan Men and Women.

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ABSTRACT

Pre-exposure prophylaxis (PrEP) is a novel HIV prevention strategy which requires high adherence. We tested the use of daily short message service (i.e., SMS/text message) surveys to measure sexual behavior and PrEP adherence in Kenya. Ninety-six HIV-uninfected adult individuals, taking daily oral PrEP in a clinical trial, received daily SMS surveys for 60 days. Most participants (96.9 %) reported taking PrEP on =80 % days, but 69.8 % missed at least one dose. Unprotected sex was reported on 4.9 % of days; however, 47.9 % of participants reported unprotected sex at least once. Unprotected sex was not correlated with PrEP use (OR = 0.95). Participants reporting more sex were less likely to report PrEP non-adherence and those reporting no sex were most likely to report missing a PrEP dose (adjusted OR = 1.87). PrEP adherence was high, missed doses were correlated with sexual abstinence, and unprotected sex was not associated with decreased PrEP adherence.

35. Use of Telemedicine to Diagnose Tinea in Kenyan Schoolchildren.

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ABSTRACT

OBJECTIVE: Internet-based telemedicine has the potential to alleviate the problem of limited access to healthcare in developing countries. The Mashavu

project aims to deploy kiosks that transmit health data and pictures from patients in underdeveloped countries who have no immediate access to healthcare to clinics for analysis by trained personnel. To test this principle, we investigated whether dermatophytic fungal infections (tinea) could be diagnosed by Kenyan clinicians solely from pictures of the lesions.

SUBJECTS AND METHODS: Six physicians, five physician assistants, and five nurses from Nyeri Provincial Hospital took a test consisting of 15 pictures of potassium hydroxide (KOH) prep–confirmed tinea lesions and 15 pictures of KOH prep–negative lesions obtained from local children.

RESULTS: The mean (standard deviation) sensitivity and specificity for the whole group were 73% (19%) and 83% (11%), respectively. The physicians had the highest sensitivity and specificity, although only sensitivity reached statistical significance when compared with physician assistants.

CONCLUSIONS: These results suggest that telemedicine can be used to diagnose simple skin conditions in a low resource setting with reasonable sensitivity and specificity.

36. The effect of weekly short message service communication on patient retention in care in the first year after HIV diagnosis: study protocol for a randomised controlled trial (WelTel Retain).

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ABSTRACT

INTRODUCTION: Interventions to improve retention in care after HIV diagnosis are necessary to optimise the timely initiation of antiretroviral therapy (ART) and

HIV/AIDS control outcomes. Widespread mobile phone use presents new opportunities to engage patients in care. A randomised controlled trial (RCT), WelTel Kenya1, demonstrated that weekly text messages led to improved ART adherence and viral load suppression among those initiating ART. The aim of this study was to determine whether the WelTel intervention is an effective and cost-effective method of improving retention in care in the first year of care following HIV diagnosis.

METHODS AND ANALYSIS: WelTel Retain is an open, parallel group RCT that will be conducted at the Kibera Community Health Centre in Nairobi, Kenya. Over a 1-year period, we aim to recruit 686 individuals newly diagnosed with HIV who will be randomly allocated to an intervention or control arm (standard care) at a 1:1 ratio. Intervention arm participants will receive the weekly WelTel SMS 'check-in' to which they will be instructed to respond within 48 h. An HIV clinician will follow-up and triage any problems that are identified. Participants will be followed for 1 year, with a primary endpoint of retention in care at 12 months. Secondary outcomes include retention in stage 1 HIV care (patients return to the clinic to receive their first CD4 results) and timely ART initiation. Cost-effectiveness will be analysed through decision-analytic modelling.

ETHICS AND DISSEMINATION: Ethical approval has been obtained from the University of British Columbia and the African Medical and Research Foundation. This trial will test the effectiveness and cost-effectiveness of the WelTel intervention to engage patients during the first year of HIV care. Trial results and economic evaluation will help inform policy and practice on the use of WelTel in the early stages of HIV care.

37. Exploring the use of mobile phone technology for the enhancement of the prevention of mother-to-child transmission of HIV program in Nyanza, Kenya: a qualitative study.

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ABSTRACT

BACKGROUND: Community-based mobile phone programs can complement gaps in clinical services for prevention of mother-to-child transmission (PMTCT) of HIV in

areas with poor infrastructure and personnel shortages. However, community and health worker perceptions on optimal mobile phone communication for PMTCT are underexplored. This study examined what specific content and forms of mobile communication are acceptable to support PMTCT.

METHODS: Qualitative methods using focus groups and in-depth interviews were conducted in two district hospitals in Nyanza Province, Kenya. A total of 45 participants were purposefully selected, including HIV-positive women enrolled in PMTCT, their male partners, community health workers, and nurses. Semi-structured discussion guides were used to elicit participants' current mobile phone uses for PMTCT and their perceived benefits and challenges. We also examined participants' views on platform design and gender-tailored short message service (SMS) messages designed to improve PMTCT communication and male involvement.

RESULTS: Most participants had access to a mobile phone and prior experience receiving and sending SMS, although phone sharing was common among couples. Mobile phones were used for several health-related purposes, primarily as voice calls rather than texts. The perceived benefits of mobile phones for PMTCT included linking with health workers, protecting confidentiality, and receiving information and reminders. Men and women considered the gender-tailored SMS as a catalyst for improving PMTCT male involvement and couples' communication. However, informative messaging relayed safely to the intended recipient was critical. In addition, health workers emphasized the continual need for in-person counseling coupled with, rather than replaced by, mobile phone reinforcement. For all participants, integrated and neutral text messaging provided antenatally and postnatally was most preferred, although not all topics or text formats were equally acceptable.

CONCLUSIONS: Given the ubiquity of mobile phones in Kenya and current health-related uses of mobile phones, a PMTCT mobile communications platform holds considerable potential. This pre-intervention assessment of community and health worker preferences yielded valuable information on the complexities of design and implementation. An effective PMTCT mobile platform engaging men and women will need to address contexts of non-disclosure, phone sharing, and linkages with existing community and facility-based services.

38. Community based weighing of newborns and use of mobile phones by village elders in rural settings in Kenya: a decentralised approach to health care provision.

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ABSTRACT

BACKGROUND: Identifying every pregnancy, regardless of home or health facility delivery, is crucial to accurately estimating maternal and neonatal mortality. Furthermore, obtaining birth weights and other anthropometric measurements in rural settings in resource limited countries is a difficult challenge. Unfortunately for the majority of infants born outside of a health care facility, pregnancies are often not recorded and birth weights are not accurately known. Data from the initial 6 months of the Maternal and Neonatal Health (MNH) Registry Study of the Global Network for Women and Children's Health study area in Kenya revealed that up to 70% of newborns did not have exact weights measured and recorded by the end of the first week of life; nearly all of these infants were born outside health facilities.

METHODS: To more completely obtain accurate birth weights for all infants, regardless of delivery site, village elders were engaged to assist in case finding for pregnancies and births. All elders were provided with weighing scales and mobile phones as tools to assist in subject enrollment and data recording. Subjects were instructed to bring the newborn infant to the home of the elder as soon as possible after birth for weight measurement.

The proportion of pregnancies identified before delivery and the proportion of births with weights measured were compared before and after provision of weighing scales and mobile phones to village elders. Primary outcomes were the percent of infants with a measured birth weight (recorded within 7 days of birth) and the percent of women enrolled before delivery.

RESULTS: The recorded birth weight increased from 43 ± 5.7% to 97 ± 1.1. The birth weight distributions between infants born and weighed in a health facility and those born at home and weighed by village elders were similar. In addition, a significant increase in the percent of subjects enrolled before delivery was found.

CONCLUSIONS: Pregnancy case finding and acquisition of birth weight information can be successfully shifted to the community level.

39. Improving Maternal Labor Monitoring in Kenya: Using Digital Pen Technology: A User Evaluation.

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ABSTRACT

Paper-based systems for monitoring maternal labor have been shown to reduce life-threatening complications in low-resource environments; however, significant barriers exist to the use of these tools in developing countries. This paper presents the PartoPen – a digital pen system that enhances a common labormonitoring form known as the partograph. The PartoPen system provides real-time data feedback and reinforces birth attendant training, while retaining the paper-andpen interface currently used by most healthcare workers.In this paper, the results from a preliminary user evaluation of the system in a Kenyan hospital are described. The qualitative results collected in this study indicate that the PartoPen system is easy to use, and addresses many of the current barriers facing effective partograph use in developing countries.

40. Improving service delivery through information and communication technology: an early infant diagnosis experience in Kenya.

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ABSTRACT

BACKGROUND: Early diagnosis of HIV-1 in infants in Kenya is conducted in support of the National AIDS and STIs Control program (NASCOP) by four central laboratories at Kenya Medical Research Institute (KEMRI), Centers for Disease Control and Prevention (CDC) and The United States Army Medical Research. It takes approximately 15 days to collect samples at peripheral sites, send them to the central labs for testing, and for the labs to dispatch results back to peripheral health facilities (some as far as 450Kms). At the beginning data was managed manually using Microsoft Excel and later Microsoft Access. The results were

dispatched to sites via a dedicated courier service however; the results could take upto one month to reach clinicians. Reducing the Turn Around times between sample collection and result delivery has been a key challenge to effective service delivery.

OBJECTIVE: The objective of our study was to assemble the information technology infrastructure required to deliver results in real time.

METHODS: University undergraduate students volunteered and developed a database application that uses cloud computing to improve the data tracking process and make test results available online, as well as via SMS/GSM-enabled printers in real time. The HP Office of Global Social Innovation funded the installation of datacenters in KEMRI Nairobi, NASCOP and KEMRI Alupe to support this endeavour. The Clinton Health Access initiative provided GSM/SMS printers for selected remote sites in Kenya to benefit from this approach.

RESULTS: The database application has allowed real time analysis of data generated, active interventions and the geographical coverage of the program. Additionally, the database is used to communicate with rural health centers via SMS (short message service) regarding the status of test results. In Kangemi and Kitui the turn-around times dropped from an average of 14 days to 5 days using GSM/SMS printers.

CONCLUSION: Technological innovation holds the breakthrough for the challenges involved in timely delivery of results and availability of information for evidence-based policy making by stakeholders. Information technology has improved access to HIV results for infants significantly. This paradigm could be adopted for several other health service deliveries that are centralized due to the complexity of the testing technology.

41. Text messaging to improve attendance at post-operative clinic visits after adult male circumcision for HIV prevention: a randomized controlled trial.

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ABSTRACT

BACKGROUND: Following male circumcision for HIV prevention, a high proportion of men fail to return for their scheduled seven-day post-operative visit. We

evaluated the effect of short message service (SMS) text messages on attendance at this important visit.

METHODOLOGY: We enrolled 1200 participants >18 years old in a two-arm, parallel, randomized controlled trial at 12 sites in Nyanza province, Kenya. Participants received daily SMS text messages for seven days (n = 600) or usual care (n = 600). The primary outcome was attendance at the scheduled seven-day post-operative visit. The primary analysis was by intention-to-treat.

PRINCIPAL FINDINGS: Of participants receiving SMS, 387/592 (65.4%) returned, compared to 356/596 (59.7%) in the control group (relative risk [RR] = 1.09, 95% confidence interval [CI] 1.00-1.20; p = 0.04). Men who paid more than US$1.25 to travel to clinic were at higher risk for failure to return compared to those who spent = US$1.25 (adjusted relative risk [aRR] 1.35, 95% CI 1.15-1.58; p<0.001). Men with secondary or higher education had a lower risk of failure to return compared to those with primary or less education (aRR 0.87, 95% CI 0.74-1.01; p = 0.07).

CONCLUSIONS: Text messaging resulted in a modest improvement in attendance at the 7-day post-operative clinic visit following adult male circumcision. Factors associated with failure to return were mainly structural, and included transportation costs and low educational level.

42. Reliability of a Telemedicine System Designed for Rural Kenya.

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ABSTRACT

OBJECTIVE: Access to health care in rural areas of developing nations is hindered by both the lack of physicians and the preference of many physicians to practice in urban settings. As a result, rural patients often choose not to sacrifice wages or time to visit distant health care providers. A telemedicine system, Mashavu: Networked Health Solutions, designed to increase access to preprimary health care in rural areas, was field-tested in rural Kenya. This study aims to examine the reliability of the system compared to the traditional face-to-face method of health care delivery.

METHOD: Reliability of the telemedicine system was tested using a modified intraobserver concordance study. Community health workers operated the system in various remote locations. Patient health information including chief complaint, medical history, and vital statistics were sent via Internet to a consulting nurse. After patients completed the telemedicine consultation, they

also met in-person with the same nurse. Subsequently, the nurse's advice during the in-person session was compared with his feedback provided through the telemedicine consultation.

RESULTS: When comparing the nurse's advice given through the telemedicine system with the advice given through more traditional face-to-face, in-person consultation, the nurse provided consistent medical feedback in 78.4% of the cases (n = 102). The nurse's advice regarding patient action (eg, clinical referrals or no further care necessary) was the same in 89.2% of the cases (n = 91).

CONCLUSION: The study found that this telemedicine system was able to provide patients with approximately the same quality of care and advice as if the patient had physically travelled to a clinic to see a nurse. In rural areas of developing nations where there are high logistical and economical barriers to accessing health care, this telemedicine system successfully increased the ease and lowered the cost of connecting rural patients with nurses to provide preprimary care.

43. Developing a data collection network of traditional birth attendants on birth at home in the Mbita health and demographic surveillance system.

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ABSTRACT

BACKGROUND: Monitoring vital events is essential to evaluate mother and child health (MCH) programs especially since neonatal death rate is the most sensitive indicator to monitor MCH. Reduction of neonatal mortality is important in achieving Millennium Development Goal 4 hence it is vital to have accurate data on neonatal deaths in the HDSS.

OBJECTIVE: Our main objective was to complement and evaluate data on missing pregnancies, births and neonatal deaths through organizing a network of

TBAs. This system has been and will be running concurrently with routine data collection in the HDSS by field workers.

METHODOLOGY: TBAs were identified and trained on how to record data. TBAs that can neither read nor write are assisted by their relatives and their clients to record data. Data collection is done once within six weeks and the data is linked with HDSS data to identify records that may have been left out during our surveys. This evaluation was done for the period between April 1st 2010 and September 16th 2010.

RESULTS: Among 439 live births and 509 pregnancies obtained by the HDSS during the study period, the TBA data collection system identified 20 births (4.6% of total live births), 72 pregnancies (13.4%), 10 neonatal deaths (none of which had been recorded by the HDSS) missing from the routine HDSS data collection.

CONCLUSION: Networking of TBAs to collect data is a beneficial complementary system to improve the quality of HDSS data in the area where cultural or religious barriers exist and hinder the capture of pregnancies and neonatal deaths. This network can capture neonatal death events which could otherwise remain hidden if not captured early enough while babies that survive can be captured by the subsequent routine surveys. Pregnancy events captured by this network are also useful since it is possible to follow up the outcome of pregnancies.

44. A randomized controlled trial comparing the effects of counseling and alarm device on HAART adherence and virologic outcomes.

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ABSTRACT

BACKGROUND: Behavioral interventions that promote adherence to antiretroviral medications may decrease HIV treatment failure. Antiretroviral treatment programs in sub-Saharan Africa confront increasing financial constraints to provide comprehensive HIV care, which include adherence interventions. This study compared the impact of counseling and use of an alarm device on adherence and biological outcomes in a resource-limited setting.

METHODS AND FINDINGS: A randomized controlled, factorial designed trial was conducted in Nairobi, Kenya. Antiretroviral-naïve individuals initiating free highly active antiretroviral therapy (HAART) in the form of fixed-dose combination pills (d4T,

3TC, and nevirapine) were randomized to one of four arms: counseling (three counseling sessions around HAART initiation), alarm (pocket electronic pill reminder carried for 6 months), counseling plus alarm, and neither counseling nor alarm. Participants were followed for 18 months after HAART initiation. Primary study endpoints included plasma HIV-1 RNA and CD4 count every 6 months, mortality, and adherence measured by monthly pill count. Between May 2006 and September 2008, 400 individuals were enrolled, 362 initiated HAART, and 310 completed follow-up. Participants who received counseling were 29% less likely to have monthly adherence <80% (hazard ratio [HR]?=?0.71; 95% confidence interval [CI] 0.49–1.01; p?=?0.055) and 59% less likely to experience viral failure (HIV-1 RNA =5,000 copies/ml) (HR 0.41; 95% CI 0.21–0.81; p?=?0.01) compared to those who received no counseling. There was no significant impact of using an alarm on poor adherence (HR 0.93; 95% CI 0.65–1.32; p?=?0.7) or viral failure (HR 0.99; 95% CI 0.53–1.84; p?=?1.0) compared to those who did not use an alarm. Neither counseling nor alarm was significantly associated with mortality or rate of immune reconstitution.

CONCLUSIONS: Intensive early adherence counseling at HAART initiation resulted in sustained, significant impact on adherence and virologic treatment failure during 18-month follow-up, while use of an alarm device had no effect. As antiretroviral treatment clinics expand to meet an increasing demand for HIV care in sub-Saharan Africa, adherence counseling should be implemented to decrease the development of treatment failure and spread of resistant HIV.

45. Evaluating the Uptake, Acceptability, and Effectiveness of Uliza! Clinicians' HIV Hotline: A Telephone Consultation Service in Kenya.

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ABSTRACT

INTRODUCTION: Many clinical sites that serve patients who are HIV positive face challenges of insufficient staffing levels and staff training and have limited access to consultation resources including specialists on site. Uliza! (Swahili for "ask") Clinicians' HIV Hotline was launched in April 2006 in Nyanza province in Kenya as a HIV telephone consultation service for healthcare providers. Hotline users called an Uliza! consultant who discussed the patients' problems and helped the caller work through a solution, as well as reinforced national guidelines. This objective of this study was to evaluate the uptake, acceptability, and effectiveness of Uliza!

MATERIALS AND METHODS: Consultants completed a form with details of each call, and healthcare workers completed satisfaction surveys during site visits. All

available medical records were audited to determine whether the advice given by the consultant was implemented.

RESULTS: After a year of service, Uliza! responded to 296 calls. Clinical officers (64%) followed by nurses (21%) most frequently used the service. Most callers had questions regarding antiretroviral therapy (36%) or tuberculosis (18%). Thirty-six percent of all consults were pediatric questions. Ninety-four percent of users rated the service as useful. Advice given to providers was implemented and documented in the medical records in 72% of the charts audited.

CONCLUSION: Healthcare providers in HIV clinics will use a telephone consultation service when easily accessible. Clinicians using Uliza! found it useful, and advice given was usually implemented. Uliza! increased access to current information for quality care in a rural and resource limited setting and has potential for scale-up to a national level.

46. Preventing clinical trial co-enrollment through biometric participant identification: the experience of 3 HIV prevention trials in Nyanza Province.

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ABSTRACT

BACKGROUND: Participant co-enrollment in simultaneous biomedical intervention trials can be unsafe and scientifically problematic, but is difficult to prevent. Three HIV prevention trials in Nyanza Province undertook a novel collaboration, using identical biometric methods for participant identification and periodic intra-study database merging, to prevent and/or identify co-enrollment by participants.

METHODS: All studies implemented identical hardware, software, and methodologies for fingerprinting to identify study participants at each study visit. Study-specific biometric identifier databases for participants were developed; these did not include other identifying information and did not store fingerprint images directly (to protect confidentiality). Databases from each site were

merged at regular intervals to determine if participants had been screened and/or enrolled in one study before participating in another. All activities were IRB-approved from all relevant authorities for each study.

RESULTS: Following initial challenges in standardizing fingerprint capture methodology across sites and optimizing accuracy of database merging procedures, the team was able to successfully determine retrospectively that 2 out of 4891 participants had been screened for more than one study. 1 out of 1488 participants was found to be enrolled in two studies simultaneously, and the study teams are working together with one another, their protocol teams, and the affected participants/couples to resolve this situation.

CONCLUSION: Biometric participant identification using fingerprinting offers great potential for prevention of co-enrollment in intervention trials with overlapping recruitment areas and study eligibility criteria. Care must be taken to ensure consistency of procedures across sites/studies and to validate if database merging and querying for co-participation is effective and timely in order to prospectively prevent participants from enrolling in multiple studies. Issues of participant autonomy, safety, scientific validity, confidentiality and research ethics must be carefully managed when implementing such novel collaborations between studies.

47. Use of personal digital assistants for data collection in a multi-site AIDS stigma study in rural South Nyanza, Kenya.

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ABSTRACT

OBJECTIVES: To describe the development, cost effectiveness and implementation of a PDA based electronic system to collect, verify and manage data from a multi-site study on HIV/AIDS stigma and pregnancy in a rural, resource-poor area.

METHODS: We worked within a large prevention of mother-to-child- transmission (PMTCT) program in nine rural health facilities to implement a PDA-based data collection system and to study the feasibility of its use in a multisite HIV research study in rural Kenya. The PDAs were programmed for collecting screening and eligibility data, and responses to structured interviews on HIV/AIDS stigma and violence in three local languages.

RESULTS: Between November 2007 and December 2008, nine PDAs were used by Clinic and Community Health Assistants to enrol 1,270 participants on to the PMTCT program. Successes included: capacity-building of interviewers, low cost of implementation, quick turnaround time of data entry with good data quality, and convenience.

CONCLUSION: Our study demonstrated the feasibility of utilizing PDAs for data collection in a multi-site observational study on HIV/AIDS stigma conducted in remote rural health facilities in Kenya. However, appropriate and frequent data backup protocols need to be established and paper forms are still needed as backup tools in resource-poor settings.

48. Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders.

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ABSTRACT

OBJECTIVE: There is limited evidence on whether growing mobile phone availability in sub-Saharan Africa can be used to promote high adherence to antiretroviral

therapy (ART). This study tested the efficacy of short message service (SMS) reminders on adherence to ART among patients attending a rural clinic in Kenya.

DESIGN: A randomized controlled trial of four SMS reminder interventions with 48 weeks of follow-up.

METHODS: Four hundred and thirty-one adult patients who had initiated ART within 3 months were enrolled and randomly assigned to a control group or one of the four intervention groups. Participants in the intervention groups received SMS reminders that were either short or long and sent at a daily or weekly frequency. Adherence was measured using the medication event monitoring system. The primary outcome was whether adherence exceeded 90% during each 12-week period of analysis and the 48-week study period. The secondary outcome was whether there were treatment interruptions lasting at least 48 h.

RESULTS: In intention-to-treat analysis, 53% of participants receiving weekly SMS reminders achieved adherence of at least 90% during the 48 weeks of the study, compared with 40% of participants in the control group (P = 0.03). Participants in groups receiving weekly reminders were also significantly less likely to experience treatment interruptions exceeding 48 h during the 48-week follow-up period than participants in the control group (81 vs. 90%, P = 0.03).

CONCLUSION: These results suggest that SMS reminders may be an important tool to achieve optimal treatment response in resource-limited settings.

49. Electronic Data Capture for randomised controlled trials and pharmacovigilance in resource limited settings: a pilot study proposal.

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ABSTRACT

BACKGROUND: Historically, data collection for clinical trials is a very manual process involving use of pen and paper which is slow and labour intensive. Electronic data capture (EDC) is not a new concept, yet it has taken long to be

adopted. It encompasses several types of technology depending on who is using it; from electronic replacement for paper case report forms (CRF's) to interactive voice response (IVR) systems meaning that patients can report information over the phone to electronic diaries or patient reported outcomes using personal digital assistants (PDA's).

OBJECTIVE: To demonstrate potential advantages of using EDC in resource limited settings for clinical trials and pharmacovigilance studies and identify solutions to potential challenges in implementing it through a pilot study.

METHODS: Pilot studies will be undertaken in two Visceral Leishmaniasis clinical trial sites, in relatively remote locations of Kenya and North Sudan. We aim to design EDC systems using open-source software such as OpenClinica and Epicollect and train local staff to use them. We will also evaluate technical challenges and solutions to implementation and maintenance, for example, data security, extent of technical support required and availability of internet connectivity.

RESULTS: We hope to measure the reduction in time and cost, to achieving key milestones such as production of a data cleaning audit trail and analysis reports, with minimal time spent on data entry and validation without a reduction in data quality.

CONCLUSIONS: With full implementation, EDC will significantly shorten the time taken to have clean data ready for analysis as well as being cost effective in the long run and hence the time taken to inform treatment decisions and policies. Study sites will also feel more ownership through involvement in data collection and capture process. It is important that the whole process assures continuity, integrity, accuracy and at the same time increase confidence in the final results that come out of the process.

50. The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: a cluster randomised trial.

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ABSTRACT

BACKGROUND: Health workers' malaria case-management practices often differ from national guidelines. We assessed whether text-message reminders sent to

health workers' mobile phones could improve and maintain their adherence to treatment guidelines for outpatient paediatric malaria in Kenya.

METHODS: From March 6, 2009, to May 31, 2010, we did a cluster-randomised controlled trial at 107 rural health facilities in 11 districts in coastal and western Kenya. With a computer-generated sequence, health facilities were randomly allocated to either the intervention group, in which all health workers received text messages on their personal mobile phones on malaria case-management for 6 months, or the control group, in which health workers did not receive any text messages. Health workers were not masked to the intervention, although patients were unaware of whether they were in an intervention or control facility. The primary outcome was correct management with artemether-lumefantrine, defined as a dichotomous composite indicator of treatment, dispensing, and counselling tasks concordant with Kenyan national guidelines. The primary analysis was by intention to treat. The trial is registered with Current Controlled Trials, ISRCTN72328636.

FINDINGS: 119 health workers received the intervention. Case-management practices were assessed for 2269 children who needed treatment (1157 in the intervention group and 1112 in the control group). Intention-to-treat analysis showed that correct artemether-lumefantrine management improved by 23·7 percentage-points (95% CI 7·6-40·0; p=0·004) immediately after intervention and by 24·5 percentage-points (8·1-41·0; p=0·003) 6 months later.

INTERPRETATION: In resource-limited settings, malaria control programmes should consider use of text messaging to improve health workers' case-management practices.

FUNDING: The Wellcome Trust.

51. Piloting the use of personal digital assistants for tuberculosis and human immunodeficiency virus surveillance, Kenya, 2007.

Auld, AF[1], Wambua, N[2], Onyango, J[2], Marston, B[1], Namulanda, G[1], Ackers, M[2], Oluoch, T[2], Karisa, A[2], Hightower, A[2], Shiraishi, RW[1], Nakashima, A[1], Sitienei, J[3].

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ABSTRACT

SETTING: Improved documentation of human immunodeficiency virus (HIV) testing and care among tuberculosis (TB) patients is needed to strengthen TB-HIV

programs. In 2007, Kenya piloted the use of personal digital assistants (PDAs) instead of paper registers to collect TB-HIV surveillance data from TB clinics.

OBJECTIVE: To evaluate the acceptability, data quality and usefulness of PDAs.

DESIGN: We interviewed four of 31 district coordinators who collected data in PDAs for patients initiating TB treatment from April to June 2007. In 10 of 93 clinics, we randomly selected patient records for comparison with corresponding records in paper registers or PDAs. Using Cochran-Mantel-Haenszel tests, we compared missing data proportions in paper registers with PDAs. We evaluated PDA usefulness by analyzing PDA data from all 93 clinics.

RESULTS: PDAs were well accepted. Patient records were more frequently missing (28/97 vs. 1/112, $P < 0.001$) and data fields more frequently incomplete (148/1449 vs. 167/2331, $P = 0.03$) in PDAs compared with paper registers. PDAs, however, facilitated clinic-level analyses: 48/93 (52%) clinics were not reaching the targets of testing =80% of TB patients for HIV, and 8 (9%) clinics were providing <80% of TB-HIV co-infected patients with cotrimoxazole (CTX).

CONCLUSION: PDAs had high rates of missing data but helped identify clinics that were undertesting for HIV or underprescribing CTX.

52. A comparison of paper-based questionnaires with PDA for behavioral surveys in Africa: Findings from a behavioral monitoring survey in Kenya.

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ABSTRACT

BACKGROUND: The concept of using personal data assistant (PDA) software for survey data collection is not new. However, usage is not widespread, especially in sub-Saharan Africa where paper-based questionnaires remain the main data collection tool. In 2007, FHI1 conducted a behavioural survey among high-risk groups in three provinces of Kenya. To assess the strengths and weaknesses of different data collection methodologies, paper questionnaires were used in one province and PDAs were used in two others.

METHODOLOGY: The PDA-based questionnaire was designed using Visual CE, with controls to guide data entry and reduce errors. Additional resources required

included PDA equipment and accessories, necessary software and design applications to suit the survey, and PCs for downloading and backing-up data.

RESULTS: Use of touch-screen PDAs revealed several challenges, including power outages, slow downloading in database format, accidental loss of data or damage of equipment, and security of PDAs. However, quality of data from PDAs was better and more quickly available for analysis than from paper questionnaires. Using PDAs was more expensive, but startup costs could be reduced over time as rental or purchase fees are spread among many surveys or other uses. Significant differences in managing PDA and paper questionnaire by data collection teams were identified. Main lessons were the need to design relational databases ahead of time, download data in text format, develop or adapt manuals and standard operating procedures for data management, procure sufficient supplies of back-up batteries and accessories, and strengthen technical skills of the data collectors.

CONCLUSION: This experiment showed that PDAs may be successfully used in implementing surveys in the African context.Use of PDAs speeds data collection, improves completeness and, most importantly, increases data quality. If all PDA challenges were addressed ahead of time, their use, as opposed to paper-based questionnaires, may cut down the cost and processing time needed to get to the report-writing stage.

53. Developing Geostatistical Space–Time Models to Predict Outpatient Treatment Burdens from Incomplete National Data.

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ABSTRACT

Basic health system data such as the number of patients utilizing different health facilities and the types of illness for which they are being treated are critical for managing service provision. These data requirements are generally addressed with some form of national Health Management Information System (HMIS), which coordinates the routine collection and compilation of data from national health facilities. HMIS in most developing countries are characterized by widespread underreporting. Here we present a method to adjust incomplete data to allow prediction of national outpatient treatment burdens. We demonstrate this method with the example of outpatient treatments for malaria

within the Kenyan HMIS. Three alternative modeling frameworks were developed and tested in which space–time geostatistical prediction algorithms were used to predict the monthly tally of treatments for presumed malaria cases (MC) at facilities where such records were missing. Models were compared by a cross-validation exercise and the model found to most accurately predict MC incorporated available data on the total number of patients visiting each facility each month. A space–time stochastic simulation framework to accompany this model was developed and tested in order to provide estimates of both local and regional prediction uncertainty. The level of accuracy provided by the predictive model, and the accompanying estimates of uncertainty around the predictions, demonstrate how this tool can mitigate the uncertainties caused by missing data, substantially enhancing the utility of existing HMIS data to health-service decision makers.

54. Improving national data collection systems from voluntary counselling and testing centres in Kenya.

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ABSTRACT

PROBLEM: Voluntary counselling and testing (VCT) data from the registered sites in Kenya have been fraught with challenges, leading to insufficient statistics in the national office for planning purposes. An exercise was carried out to determine the barriers to the flow of data in VCT sites in Kenya.

APPROACH: A record-based survey was conducted at 332 VCT sites in Kenya. Data from on-site records were compared with those in the national office. The exercise was conducted in 2004 between 5 September and 15 October.

LOCAL SETTING: All registered VCT sites in Kenya.

RELEVANT CHANGES: After the exercise, various measures to enhance VCT data collection and reporting were implemented. They include the provision of a uniform data collection and reporting tool to all the districts in the country, the

strengthening of a feedback mechanism to update provinces and districts on their reporting status and increased support to the data component of the national quality assurance for VCT.

LESSONS LEARNED: Periodical field visits by the national officials to offer on-the-job training about data management to data collectors and to address data quality issues can dramatically improve the quality and completeness of VCT reports. The perceived relevance of the data and the data collection process to those working at the sites is the critical factor for data quality and timeliness of reporting.

55. A computer-based medical record system and personal digital assistants to assess and follow patients with respiratory tract infections visiting a rural Kenyan health centre.

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ABSTRACT

BACKGROUND: Clinical research can be facilitated by the use of informatics tools. We used an existing electronic medical record (EMR) system and personal data assistants (PDAs) to assess the characteristics and outcomes of patients with acute respiratory illnesses (ARIs) visiting a Kenyan rural health center.

METHODS: We modified the existing EMR to include details on patients with ARIs. The EMR database was then used to identify patients with ARIs who were prospectively followed up by a research assistant who rode a bicycle to patients' homes and entered data into a PDA.

RESULTS: A total of 2986 clinic visits for 2009 adult patients with respiratory infections were registered in the database between August 2002 and January 2005; 433 patients were selected for outcome assessments. These patients were followed up in the villages and assessed at 7 and 30 days later. Complete follow-up data were obtained on 381 patients (88%) and merged with data from the enrollment visit's electronic medical records and subsequent health center visits to assess duration of illness and complications. Symptoms improved at 7 and 30 days, but a substantial minority of patients had persistent symptoms. Eleven percent of patients sought additional care for their respiratory infection.

CONCLUSION: EMRs and PDA are useful tools for performing prospective clinical research in resource constrained developing countries.

56. A computer-based medical record system and personal digital assistants to assess and follow patients with respiratory tract infections visiting a rural Kenyan health centre.

Lameck Diero[1], Joseph K Rotich, John Bii, Burke W Mamlin, Robert M Einterz, Irene Z Kalamai, William M Tierney.

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ABSTRACT

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CONCLUSION: EMRs and PDA are useful tools for performing prospective clinical research in resource constrained developing countries.

57. The role of low-bandwidth telemedicine in surgical prescreening?

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ABSTRACT

PURPOSE: Low-bandwidth, Internet-based telemedicine is an inexpensive technology that could help deliver heath care in medically underserved areas. The purpose of this study was to evaluate the usefulness of low-bandwidth telemedicine in remote surgical evaluation.

METHODS: A group of surgeons and nurses traveled to Mombasa, Kenya to provide surgical assistance at the Coast Province General Hospital (CPGH). Before the visit of the surgical team, surgeons evaluated patients via low-bandwidth telemedicine. Prescreening was performed through use of an Internet-based desktop computer system that was supported technically by the Virginia Commonwealth University (VCU) Medical Informatics and Technology Applications Consortium (MITAC) telemedicine laboratory. Surgical patients were evaluated remotely regarding appropriateness of surgical intervention by reviewing e-mails that included the patient's age, history, physical examination, digital images of the patient, and digital images of pertinent radiographs.

RESULTS: Fifty-one patients, including 7 pediatric patients, were prescreened. Thirty-three of the 51 patients (65%) were deemed inappropriate for surgery before this trip because of advanced disease or absence of necessary local medical resources. Of the 18 patients determined to be appropriate candidates for surgery by remote prescreening, 18 (100%) were operated on successfully during the relief effort. Sixty patients including 9 (15%) pediatric patients underwent surgery over the course of 5 days in CPGH. Pediatric cases included various laparoscopic, oncologic, and soft tissue reconstruction.

CONCLUSIONS: Low-bandwidth, Internet-based telemedicine is a cost-effective technology that can efficiently and effectively prescreen surgical patients in remote areas.

58. Installing and implementing a computer-based patient record system in sub-Saharan Africa: the Mosoriot Medical Record System.

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ABSTRACT

The authors implemented an electronic medical record system in a rural Kenyan health center. Visit data are recorded on a paper encounter form, eliminating duplicate documentation in multiple clinic logbooks. Data are entered into an MS-Access database supported by redundant power systems. The system was initiated in February 2001, and 10,000 visit records were entered for 6,190 patients in six months. The authors present a summary of the clinics visited, diagnoses made, drugs prescribed, and tests performed. After system implementation, patient visits were 22% shorter. They spent 58% less time with providers (p < 0.001) and 38% less time waiting (p = 0.06). Clinic personnel spent 50% less time interacting with patients, two thirds less time interacting with each other, and more time in personal activities. This simple electronic medical record system has bridged the "digital divide." Financial and technical sustainability by Kenyans will be key to its future use and development.

59. Palm computer demonstrates a fast and accurate means of burn data collection.

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ABSTRACT

Manual biomedical data collection and entry of the data into a personal computer is time-consuming and can be prone to errors. The purpose of this study

was to compare data entry into a hand-held computer versus hand written data followed by entry of the data into a personal computer. A Palm (3Com Palm IIIx, Santa, Clara, Calif) computer with a custom menu-driven program was used for the entry and retrieval of burn-related variables. These variables were also used to create an identical sheet that was filled in by hand. Identical data were retrieved twice from 110 charts 48 hours apart and then used to create an Excel (Microsoft, Redmond, Wash) spreadsheet. One time data were recorded by the Palm entry method, and the other time the data were handwritten. The method of retrieval was alternated between the Palm system and handwritten system every 10 charts. The total time required to log data and to generate an Excel spreadsheet was recorded and used as a study endpoint. The total time for the Palm method of data collection and downloading to a personal computer was 23% faster than hand recording with the personal computer entry method (P < 0.05), and 58% fewer errors were generated with the Palm method.) The Palm is a faster and more accurate means of data collection than a handwritten technique.

60. Assessing the ability of health information systems in hospitals to support evidence-informed decisions in Kenya.

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ABSTRACT

BACKGROUND: Hospital management information systems (HMIS) is a key component of national health information systems (HIS), and actions required of hospital management to support information generation in Kenya are articulated in specific policy documents. We conducted an evaluation of core functions of

data generation and reporting within hospitals in Kenya to facilitate interpretation of national reports and to provide guidance on key areas requiring improvement to support data use in decision making.

DESIGN: The survey was a cross-sectional, cluster sample study conducted in 22 hospitals in Kenya. The statistical analysis was descriptive with adjustment for clustering.

RESULTS: Most of the HMIS departments complied with formal guidance to develop departmental plans. However, only a few (3/22) had carried out a data quality audit in the 12 months prior to the survey. On average 3% (range 1–8%) of the total hospital income was allocated to the HMIS departments. About half of the records officer positions were filled and about half (13/22) of hospitals had implemented some form of electronic health record largely focused on improving patient billing and not linked to the district HIS. Completeness of manual patient registers varied, being 90% (95% CI 80.1–99.3%), 75.8% (95% CI 68.7–82.8%), and 58% (95% CI 50.4–65.1%) in maternal child health clinic, maternity, and pediatric wards, respectively. Vital events notification rates were low with 25.7, 42.6, and 71.3% of neonatal deaths, infant deaths, and live births recorded, respectively. Routine hospital reports suggested slight over-reporting of live births and under-reporting of fresh stillbirths and neonatal deaths.

CONCLUSIONS: Study findings indicate that the HMIS does not deliver quality data. Significant constraints exist in data quality assurance, supervisory support, data infrastructure in respect to information and communications technology application, human resources, financial resources, and integration.

61. Modelling distances travelled to government health services in Kenya.

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ABSTRACT

OBJECTIVE: To systematically evaluate descriptive measures of spatial access to medical treatment, as part of the millennium development goals to reduce the burden of HIV/AIDS, tuberculosis and malaria.

METHODS: We obtained high-resolution spatial and epidemiological data on health services, population, transport network, topography, land cover and paediatric fever treatment in four Kenyan districts to develop access and use models for government health services in Kenya. Community survey data were used to model use of government health services by febrile children. A model based on the transport network was then implemented and adjusted for actual use patterns. We compared the predictive accuracy of this refined model to that of Euclidean distance metrics.

RESULTS: Higher-order facilities were more attractive to patients (54%, 58% and 60% in three scenarios) than lower-order ones. The transport network model, adjusted for competition between facilities, was most accurate and selected as the best-fit model. It estimated that 63% of the population of the study districts were within the 1 h national access benchmark, against 82% estimated by the Euclidean model.

CONCLUSIONS: Extrapolating the results from the best-fit model in study districts to the national level shows that approximately six million people are currently incorrectly estimated to have access to government health services within 1 h. Simple Euclidean distance assumptions, which underpin needs assessments and against which millennium development goals are evaluated, thus require reconsideration.

Rwanda

62. Market-testing a smartphone application for family planning: assessing potential of the CycleBeads app in seven countries through digital monitoring.

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ABSTRACT

BACKGROUND: The advent of new technological approaches to family planning has the potential to address unmet need in low- and middle-income countries. Provision of fertility awareness-based apps have the ability to provide accessible, direct-to-user fertility information to help women achieve their reproductive goals. The CycleBeads app, a digital platform for the Standard Days Method (SDM), a modern method of family planning, helps women achieve or prevent pregnancy, or track their cycles using the only their period start dates.

METHODS: Brief social marketing campaigns were launched by the app developer to monitor cost and distribution of the CycleBeads app, understand the user profile, and assess user experience. Monitoring and evaluation through in-app micro surveys occurred over a 6-cycle period in seven countries: Egypt, Ghana, India, Jordan, Kenya, Nigeria, and Rwanda. In-app micro-surveys were utilized to collect data around demographics, mode of use of the app, prior experiences with family planning, and satisfaction to better understand women's interactions with the apps, and the possibility for meeting unmet need. Analyzes focused on women who were using the app to prevent pregnancy or track their cycles.

RESULTS: Social media campaigns proved to be an easy, low-cost approach to advertising the CycleBeads app. As a result, 356,520 women downloaded the app, and the cost to the advertiser per download ranged from $0.17-0.69. A majority of app users were between 20-29 years old, married or in exclusive relationships. Overall, 39.9% of users were using the app to prevent pregnancy, 38.5% to plan a pregnancy, and 21.6% were tracking their cycles. Among the users preventing pregnancy, 64.1% of women had not used a family planning method 3 months before downloading the CycleBeads app. One-third of users who were using the app to track their cycles, reported that they had not been using any form of family planning. In all seven countries, nearly 60% of women reported that they would definitely recommend the CycleBeads app to a friend, indicating their satisfaction with the app.

CONCLUSIONS: Our main findings indicate that a social media campaign is a low-cost approach to making the CycleBeads app accessible to women. The app addresses multiple reproductive intentions and attracts a diverse demographic of users across different life stages. For many women the app was the first modern method they used in the last 3 months, showing that fertility awareness-based apps have the potential to address an unmet need. Future studies should focus on changes in behavior during the fertile window, partner communication, and future family planning intentions.

key words: CycleBeads app monitoring; fertility app; market test of app

63. **Using mobile health technology and community health workers to identify and refer caesarean-related surgical site infections in rural Rwanda: a randomised controlled trial protocol.**

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ABSTRACT

INTRODUCTION: Surgical site infections (SSIs) are a significant cause of morbidity and mortality in low-income and middle-income countries, where rates of SSIs can reach 30%. Due to limited access, there is minimal follow-up postoperatively. Community health workers (CHWs) have not yet been used for surgical patients in most settings. Advancements in telecommunication create an opportunity for mobile health (mHealth) tools to support CHWs. We aim to evaluate the use of mHealth technology to aid CHWs in identification of SSIs and promote referral of patients back to healthcare facilities.

METHODS AND ANALYSIS: Prospective randomised controlled trial conducted at Kirehe District Hospital, Rwanda, from November 2017 to November 2018. Patients ≥18 years who undergo caesarean section are eligible. Non-residents of Kirehe District or patients who remain in hospital >10 days postoperatively will be excluded. Patients will be randomised to one of three arms. For arm 1, a CHW will visit the patient's home on postoperative day 10 (±3 days) to administer an SSI screening protocol (fever, pain or purulent drainage) using an electronic tablet.

For arm 2, the CHW will administer the screening protocol over the phone. For both arms 1 and 2, the CHW will refer patients who respond 'yes' to any of the questions to a health facility. For arm 3, patients will not receive follow-up care. Our primary outcome will be the impact of the mHealth-CHW intervention on the rate of return to care for patients with an SSI.

ETHICS AND DISSEMINATION: The study has received ethical approval from the Rwandan National Ethics Committee and Partners Healthcare. Results will be disseminated to Kirehe District Hospital, Rwanda Ministry of Health, Rwanda Surgical Society, Partners In Health, through conferences and peer-reviewed publications.

key words: mobile health; surgery; surgical site infections

64. Assessing the perspectives of users and beneficiaries of a community health worker mHealth tracking system for mothers and children in Rwanda.

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ABSTRACT

INTRODUCTION: Mobile Health (mHealth) programs have increasingly been used to tackle maternal and child health problems in low and middle income countries. However, few studies have evaluated how these programs have been perceived by intended users and beneficiaries. Therefore, we explored perceptions of healthcare officials and beneficiaries regarding RapidSMS

Rwanda, an mHealth system used by Community Health Workers (CHWs) that was scaled up nationwide in 2013.

METHODS**:** We conducted key informant interviews and focus group discussions with key stakeholders, providers, and beneficiaries of maternal and child health services at both the national and community levels. Semi-structured interviews were used to assess perceptions about the impact of and challenges facing the RapidSMS system. Interviews and focus group discussions were recorded (with the exception of one), transcribed verbatim, and analyzed.

RESULTS**:** We conducted a total of 28 in-depth interviews and 10 focus group discussions (93 total participants). A majority of respondents believed that RapidSMS contributed to reducing maternal and child mortality rates. RapidSMS was generally accepted by both CHWs and parents. Participants identified insufficient training, a lack of equipment, and low CHW motivation as the main challenges facing RapidSMS.

CONCLUSION**:** Our findings suggest that an mHealth program can be well accepted by both policymakers, health providers, and the community. We also found significant technical challenges that have likely reduced its impact. Addressing these challenges will serve to strengthen future mHealth programs.

65. Point-of-Care Ultrasound Use, Accuracy, and Impact on Clinical Decision Making in Rwanda Hospitals.

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ABSTRACT

OBJECTIVES**:** Few studies of point-of-care ultrasound training and use in low resource settings have reported the impact of examinations on clinical

management or the longer-term quality of trainee-performed studies. We characterized the long-term effect of a point-of-care ultrasound program on clinical decision making, and evaluated the quality of clinician-performed ultrasound studies.

METHODS**:** We conducted point-of-care ultrasound training for physicians from Rwandan hospitals. Physicians then used point-of-care ultrasound and recorded their findings, interpretation, and effects on patient management. Data were collected for 6 months. Trainee studies were reviewed for image quality and accuracy.

RESULTS**:** Fifteen participants documented 1158 ultrasounds; 590 studies (50.9%) had matched images and interpretations for review. Abdominal ultrasound for free fluid was the most frequently performed application. The mean image quality score was 2.36 (95% confidence interval, 2.28-2.44). Overall sensitivity and specificity for trainee-performed examinations was 94 and 98%. Point-of-care ultrasound use most commonly changed medications administered (42.4%) and disposition (30%).

CONCLUSIONS**:** A point-of-care ultrasound training intervention in a low-resource setting resulted in high numbers of diagnostic-quality studies over long-term follow-up. Ultrasound use routinely changed clinical decision making.
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key words: education; global health; point of care; ultrasound

66. Improving accuracy and usability of growth charts: case study in Rwanda.

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ABSTRACT

OBJECTIVES: We evaluate and compare manually collected paper records against electronic records for monitoring the weights of children under the age of 5.

SETTING: Data were collected by 24 community health workers (CHWs) in 2 Rwandan communities, 1 urban and 1 rural.

PARTICIPANTS: The same CHWs collected paper and electronic records. Paper data contain weight and age for 320 boys and 380 girls. Electronic data contain weight and age for 922 girls and 886 boys. Electronic data were collected over 9 months; most of the data is cross-sectional, with about 330 children with time-series data. Both data sets are compared with the international standard provided by the WHO growth chart.

PRIMARY AND SECONDARY OUTCOME MEASURES: The plan was to collect 2000 individual records for the electronic data set—we finally collected 1878 records. Paper data were collected by the same CHWs, but most data were fragmented and hard to read. We transcribed data only from children for whom we were able to obtain the date of birth, to determine the exact age at the time of measurement.

RESULTS: Mean absolute error (MAE) and mean absolute percentage error (MAPE) provide a way to quantify the magnitude of the error in using a given model. Comparing a model, log(weight)=a+b log(age), shows that electronic records provide considerable improvements over paper records, with 40% reduction in both performance metrics. Electronic data improve performance over the WHO model by 10% in MAPE and 7% in MAE. Results are statistically significant using the Kolmogorov-Smirnov test at $p < 0.01$.

CONCLUSIONS: This study demonstrates that using modern electronic tools for health data collection is allowing better tracking of health indicators. We have demonstrated that electronic records facilitate development of a country-specific model that is more accurate than the international standard provided by the WHO growth chart.

67. Using Electronic Medical Record Data to Improve HIV Patient Monitoring, Clinical Decision-Making, and Quality Improvement: Lessons from Rwanda.

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ABSTRACT

In developing countries, clinical guidelines and patient follow-up are primarily paper-based. We describe the use of Electronic Medical Record data for evidence-based clinical decisions and improved HIV patients monitoring in rural Rwanda.

key words: Electronic Medical Records; HIV; Viral load

68. Mobile Health Approaches to Non-Communicable Diseases in Rwanda.

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ABSTRACT

Rwanda is affected by a substantial dual burden of a rapid epidemiological rise in non-communicable diseases (NCDs) against the backdrop of high infectious disease rates. The Global Burden of Disease study showed that premature deaths due to NCDs such as diabetes and hypertension are increasing, accounting for 30% of all deaths in Rwanda in 2010. The usefulness of mHealth interventions has been shown for reducing adverse effects of diabetes and hypertension. Because Rwanda RapidSMS system is already successfully operating in maternal, neonatal and child health, it would be cost-effective to leverage

this infrastructure and adapt it for the NCD domain. However, rigorous evaluations of the efficacy of mHealth intervention in the area of NCDs are limited. Hence, developing a robust mHealth intervention study is urgent through a contextual combination of quantitative and qualitative study designs.This paper highlights the significance of the problem of NCDs, usefulness of mHealth interventions for stemming diabetes and hypertension, and an urgent need for research on using mHealth interventions for prevention of NCDs in Rwanda. Carefully conducted research on the efficacy and effectiveness of mHealth intervention will have ramifications for the evidence based policy, decision making, practice and research in other LMICs.

69. A smartphone dongle for diagnosis of infectious diseases at the point of care.

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ABSTRACT

This work demonstrates that a full laboratory-quality immunoassay can be run on a smartphone accessory. This low-cost dongle replicates all mechanical, optical, and electronic functions of a laboratory-based enzyme-linked immunosorbent assay (ELISA) without requiring any stored energy; all necessary power is drawn from a smartphone. Rwandan health care workers used the dongle to test whole blood obtained via fingerprick from 96 patients enrolling into care at prevention of mother-to-child transmission clinics or voluntary counseling and testing centers. The dongle performed a triplexed immunoassay not currently available in a single test format: HIV antibody, treponemal-specific antibody for syphilis, and

nontreponemal antibody for active syphilis infection. In a blinded experiment, health care workers obtained diagnostic results in 15 min from our triplex test that rivaled the gold standard of laboratory-based HIV ELISA and rapid plasma reagin (a screening test for syphilis), with sensitivity of 92 to 100% and specificity of 79 to 100%, consistent with needs of current clinical algorithms. Patient preference for the dongle was 97% compared to laboratory-based tests, with most pointing to the convenience of obtaining quick results with a single fingerprick. This work suggests that coupling microfluidics with recent advances in consumer electronics can make certain laboratory-based diagnostics accessible to almost any population with access to smartphones.

70. Local use of geographic information systems to improve data utilization and health services: mapping caesarean section coverage in rural Rwanda.

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ABSTRACT

OBJECTIVES: To show the utility of combining routinely collected data with geographic location using a Geographic Information System (GIS) in order to facilitate a data-driven approach to identifying potential gaps in access to emergency obstetric care within a rural Rwandan health district.

METHODS: Total expected births in 2009 at sub-district levels were estimated using community health worker collected population data. Clinical data were extracted from birth registries at eight health centres (HCs) and the district hospital (DH). C-section rates as a proportion of total expected births were mapped by cell. Peri-partum foetal mortality rates per facility-based births, as well as the rate of uterine rupture as an indication for C-section, were compared between areas of low and high C-section rates.

RESULTS: The lowest C-section rates were found in the more remote part of the hospital catchment area. The sector with significantly lower C-section rates had significantly higher facility-based peri-partum foetal mortality and incidence of uterine rupture than the sector with the highest C-section rates (P < 0.034).

CONCLUSIONS: This simple approach for geographic monitoring and evaluation leveraging existing health service and GIS data facilitated evidence-based decision making and represents a feasible approach to further strengthen local data-driven decisions for resource allocation and quality improvement.

71. Designing and Implementing an Innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda.

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ABSTRACT:

INTRODUCTION**:** With the continuous growth of mobile network coverage and unprecedented penetration of mobile devices in the developing world, several mHealth initiatives are being implemented in developing countries. This paper aims to describe requirements for designing and implementing a mobile phone-based communication system aiming at monitoring pregnancy and reducing bottlenecks in communication associated with maternal and newborn deaths; and document challenges and lessons learned.

METHODS**:** An SMS-based system was developed to improve maternal and child health (MCH) using RapidSMS(®), a free and open-sourced software development framework. To achieve the expected results, the RapidSMS-MCH system was customized to allow interactive communication between a community health worker (CHW)following mother-infant pairs in their community, a national centralized database, the health facility and in case of an emergency alert, the ambulance driver. The RapidSMS-MCH system was piloted in Musanze district, Nothern province of Rwanda over a 12-month period.

RESULTS**:** A total of 432 CHW were trained and equipped with mobile phones. A total of 35,734 SMS were sent by 432 CHW from May 2010 to April 2011. A total of 11,502 pregnancies were monitored. A total of 362 SMS alerts for urgent and life threatening events were registered. We registered a 27% increase in facility based delivery from 72% twelve months before to 92% at the end of the twelve months pilot phase. Major challenges were telephone maintenance and replacement. District heath team capacity to manage and supervise the system was strengthened by the end of pilot phase. Highly committed CHWs and effective coordination by the District health team were critical enablers.

CONCLUSION**:** We successfully designed and implemented a mobile phone SMS-based system to track pregnancy and maternal and child outcomes in limited resources setting. Implementation of mobile-phone systems at community level could contribute to improving emergency obstetric and neonatal care, yet it requires a well-organized community health structure in limited resource settings.

key words: Maternal and Child Health; RapidSMS; SMS; eHealth; mHealth

72. Using electronic medical records for HIV care in rural Rwanda.

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ABSTRACT

Partners In Health (PIH) implemented an electronic medical record (EMR) system in Rwanda in 2005 to support and improve HIV and TB patient care. The system holds detailed patient records, accessible to clinicians through printed reports or directly via a computer in the consultation rooms. Ongoing assessment of data quality and clinical data use has led multiple interventions to be put in place. One such evaluation cycle led to the implementation of a system which identified 15 previously undiagnosed pediatric patients with HIV. Another cycle led to an EMR intervention which helped to decrease the proportion of completed critical CD4 lab results that did not reach clinicians by 34.2% (p=.002). Additionally an automated data quality improvement system reduced known errors by 92% by providing local data officers a tool and training to allow them to easily access and correct data errors. Electronic systems can be used to support care in rural resource-poor settings, and frequent assessment of data quality and clinical use of data can be used to support that goal.

73. Training software developers for electronic medical records in Rwanda.

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ABSTRACT

In many developing countries, electronic medical record (EMR) systems are being implemented in resource-poor settings. Essential to such implementations are software developers with a high technical capacity, a good understanding of medical informatics and an awareness of local clinical needs. This paper describes a training program which has been run in Rwanda to enable local computer science graduates to play a significant role in that country's forthcoming implementation of a national EMR system. Such a training program is unique in that region of Africa and we discuss the challenges inherent in such an undertaking. We describe the development of the curriculum and the evolution of the teaching methodologies over the course of the year and discuss its potential integration with academic institutions in Rwanda. Finally we propose

that training programs of this nature which produce local software developers who are familiar with medical informatics are a requirement for successful and sustainable eHealth implementations in the developing world.

74. Expanding an electronic medical record to support community health worker and nutritional support programs in rural Rwanda.

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ABSTRACT

Scaling up HIV and TB treatment rapidly in a resource poor setting is greatly facilitated when community health workers can monitor patient well-being and ensure that patients adhere to medication. In addition, it is almost essential that patients receive a food package while being treated for HIV and TB, since medication can be ineffective if patient is undernourished. However, a community health worker program and food program can add significant administrative overhead, particularly if reporting or evaluation is required. By expanding an Electronic Medical Record to cover these programs in addition to treatment programs, it becomes easier to administer them and combine interesting data from different sources.

75. Rapid deployment of electronic medical records for ARV rollout in rural Rwanda.

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ABSTRACT

While most people with AIDS do not yet have access to anti-retroviral drugs (ARVs), large ARV treatment programs are being rolled out in many areas in Sub-Saharan Africa. ARV programs have substantial data management needs, which electronic medical record systems (EMRs) are helping to address. While most sophisticated EMRs in low-income regions are in large cities, where infrastructure and staffing needs are more easily met, Partners In Health (PIH) has pioneered web-based EMRs for HIV and TB treatment in rural areas. The HIV-EMR, developed in Haiti [1], was de-ployed in two Rwandan health districts starting in Au-gust 2005. The addition of new features and adaptation to local needs is happening concurrently with the rapid scale-up and evolution of the medical program itself.

Tanzania

76. "I Was Relieved to Know That My Baby Was Safe": Women's Attitudes and Perceptions on Using a New Electronic Fetal Heart Rate Monitor during Labor in Tanzania.

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ABSTRACT

To increase labor monitoring and prevent neonatal morbidity and mortality, a new wireless, strap-on electronic fetal heart rate monitor called Moyo was introduced in Tanzania in 2016. As part of the ongoing evaluation of the introduction of the monitor, the aim of this study was to explore the attitudes and perceptions of women who had worn the monitor continuously during their most recent delivery and perceptions about how it affected care. This knowledge is important to identify barriers towards adaptation in order to introduce new technology more effectively. We carried out 20 semi-structured individual interviews post-labor at two hospitals in Tanzania. A thematic content analysis was used to analyze the data. Our results indicated that the use of the monitor positively affected the women's birth experience. It provided much-needed reassurance about the wellbeing of the child. The women considered that wearing Moyo improved care due to an increase in communication and attention from birth attendants. However, the women did not fully understand the purpose and function of the device and overestimated its capabilities. This highlights the need to improve how and when information is conveyed to women in labor.

77. Tanzania Health Information Technology (T-HIT) System: Pilot Test of a Tablet-Based System to Improve Prevention of Mother-to-Child Transmission of HIV.

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ABSTRACT

BACKGROUND: The prevention of mother-to-child transmission (PMTCT) of HIV requires innovative solutions. Although routine monitoring is effective in some areas, standardized and easy-to-scale solutions to identify and monitor pregnant women, test them for HIV, and treat them and their children is still lacking. Mobile health (mHealth) offers opportunities for surveillance and reporting in rural areas of low- and middle-income countries.

OBJECTIVE: The aim of this study was to document the preliminary impacts of the Tanzania Health Information Technology (T-HIT) system mHealth intervention aimed at health workers for PMTCT care delivery and capacity building in a rural area of Tanzania.

METHODS: We developed T-HIT as a tablet-based system for an electronic data collection system designed to capture and report PMTCT data during antenatal, delivery, and postnatal visits in Misungwi, Tanzania. T-HIT was tested by health workers in a pilot randomized trial comparing seven sites using T-HIT assigned at random to seven control sites; all sites maintained standard paper record-keeping during the pilot intervention period. We compared numbers of antenatal visits, number of HIV tests administered, and women testing positive across all sites.

RESULTS: Health workers recorded data from antenatal visits for 1530 women; of these, 695 (45.42%) were tested for HIV and 3.59% (55/1530) tested positive. Health workers were unable to conduct an HIV test for 103 women (6.73%, 103/1530) because of lack of reagent, which is not captured on paper logs. There was no difference in the activity level for testing when comparing sites T-HIT to non-T-HIT sites. We observed a significant postintervention increase in the numbers of women testing positive for HIV compared with the preintervention period (P=.04), but this was likely not attributable to the T-HIT system.

CONCLUSIONS: T-HIT had a high degree of acceptability and feasibility and is perceived as useful by health workers, who documented more antenatal visits during the pilot intervention compared with a traditional system of paper logs, suggesting potential for improvements in antenatal care for women at risk for HIV.

78. An evaluation of a family planning mobile job aid for community health workers in Tanzania.

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ABSTRACT

OBJECTIVES: The global rapid growth in mobile technology provides unique opportunities to support community health workers (CHWs) in providing family planning (FP) services. FHI 360, Pathfinder International and D-tree International developed an evidence-based mobile job aid to support CHW counseling, screening, service provision and referrals, with mobile forms for client and service data, and text-message reporting and reminders. The purpose of this study is to evaluate the acceptability and potential benefits to service quality from the perspective of CHWs and their clients.

STUDY DESIGN: The mobile job aid was piloted in Dar es Salaam, Tanzania. Data collection tools included a demographic survey of all 25 CHWs trained to use the mobile job aid, in-depth interviews with 20 of the CHWs after 3 months and a survey of 176 clients who received FP services from a CHW using the mobile job aid after 6 months.

RESULTS: Both CHWs and their clients reported that the mobile job aid was a highly acceptable FP support tool. CHWs perceived benefits to service quality, including timelier and more convenient care; better quality of information; increased method choice; and improved privacy, confidentiality and trust with clients. Most clients discussed multiple FP methods with CHWs; only 1 in 10 clients reported discussion of all 9 methods.

CONCLUSIONS: This research suggests that mobile phones can be effective tools to support CHWs with FP counseling, screening and referrals, data collection and reporting, and communication. Challenges remain to support informed contraceptive choice. Future research should focus on implementation, including scale-up and sustainability.

IMPLICATIONS: Mobile job aids can uniquely enhance FP service provision at the community level through adherence to standard protocols, real-time feedback and technical assistance, and provision of confidential care. This study can inform future efforts to support and expand the role of CHWs in increasing FP access and informed contraceptive choice.

79. Family Planning Counseling in Your Pocket: A Mobile Job Aid for Community Health Workers in Tanzania.

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ABSTRACT

To address low contraceptive use in Tanzania, a pilot intervention using a mobile job aid was developed to guide community health workers (CHWs) to deliver integrated counseling on family planning, HIV, and other sexually transmitted infections (STIs). In this article, we describe the process of developing the family planning algorithms and implementation of the mobile job aid, discuss how the job aid supported collection of real-time data for decision making, and present the cost of the overall system based on an evaluation of the pilot. The family planning algorithm was developed, beginning in June 2011, in partnership with the Tanzania Ministry of Health and Social Welfare based on a combination of evidence-based tools such as the Balanced Counseling Strategy Plus Toolkit. The pilot intervention and study was implemented with 25 CHWs in 3 wards in Ilala district in Dar es Salaam between January 2013 and July 2013. A total of 710 family planning users (455 continuing users and 255 new users) were registered and counseled using the mobile job aid over the 6-month intervention period. All users were screened for current pregnancy, questioned on partner support for contraceptive use, counseled on a range of contraceptives, and screened for

HIV/STI risk. Most new and continuing family planning users chose pills and male condoms (59% and 73%, respectively). Pills and condoms were provided by the CHW at the community level. Referrals were made to the health facility for pregnancy confirmation, injectable contraceptives, long-acting reversible contraceptives and HIV/STI testing. Follow-up visits with clients were planned to confirm completion of the health facility referral. The financial cost of implementing this intervention with 25 CHWs and 3 supervisors are estimated to be US$26,000 for the first year. For subsequent years, the financial costs are estimated to be 73% lower at $7,100. Challenges such as limited client follow-up by CHWs and use of data by supervisors identified during the pilot are currently being addressed during the scale-up phase by developing accountability and incentive mechanisms for CHWs and dashboards for data access and use.

80. Characterization of drug authenticity using thin-layer chromatography imaging with a mobile phone.

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ABSTRACT

Thin-layer chromatography (TLC) has a myriad of separation applications in chemistry, biology, and pharmacology due to its simplicity and low cost. While benchtop laboratory sample application and detection systems for TLC provide accurate quantitation of TLC spot positions and densities, there are many applications where inexpensive and portable instruments would greatly expand the applicability of the technology. In this work, we demonstrate identity verification and concentration determination of pharmaceutical compounds via TLC using a custom 3D-printed cradle that interfaces with an ordinary mobile phone. The cradle holds the mobile phone's internal, rear-facing camera in a

fixed position relative to a UV lamp and a TLC plate that includes a phosphor in the stationary phase. Analysis of photographs thus reveals the locations and intensities of principal spots of UV--absorbing drugs. Automated image analysis software determines the center location and density of dark spots, which, using integrated calibration spots of known drug compounds and concentrations, can be used to determine if a drug has been diluted or substituted. Two independent image processing approaches have been developed that may be selected based upon the processing capabilities of the smartphone. Each approach is able to discern 5% drug concentration differences. Using single-component solutions of nevirapine, amodiaquine, and paracetamol that have been manually applied, the mobile phone-based detection instrument provides measurements that are equivalent to those obtained with a commercially available lab-based desktop TLC densitometer.

81. Mobile phones as a health communication tool to improve skilled attendance at delivery in Zanzibar: a cluster-randomised controlled trial.

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ABSTRACT

OBJECTIVE: To examine the association between a mobile phone intervention and skilled delivery attendance in a resource-limited setting.

DESIGN: Pragmatic cluster-randomised controlled trial with primary healthcare facilities as the unit of randomisation.

SETTING: Primary healthcare facilities in Zanzibar.

POPULATION: Two thousand, five hundred and fifty pregnant women (1311 interventions and 1239 controls) who attended antenatal care at one of the selected primary healthcare facilities were included at their first antenatal care

visit and followed until 42 days after delivery. All pregnant women were eligible for study participation.

METHODS: Twenty-four primary healthcare facilities in six districts in Zanzibar were allocated by simple randomisation to either mobile phone intervention (n = 12) or standard care (n = 12). The intervention consisted of a short messaging service (SMS) and mobile phone voucher component.

MAIN OUTCOME MEASURES: Skilled delivery attendance.

RESULTS: The mobile phone intervention was associated with an increase in skilled delivery attendance: 60% of the women in the intervention group versus 47% in the control group delivered with skilled attendance. The intervention produced a significant increase in skilled delivery attendance amongst urban women (odds ratio, 5.73; 95% confidence interval, 1.51-21.81), but did not reach rural women.

CONCLUSIONS: The mobile phone intervention significantly increased skilled delivery attendance amongst women of urban residence. Mobile phone solutions may contribute to the saving of lives of women and their newborns and the achievement of Millennium Development Goals 4 and 5, and should be considered by maternal and child health policy makers in developing countries.

82. Results from 2011 for the transportMYpatient program for overcoming transport costs among women seeking treatment for obstetric fistula in Tanzania.

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ABSTRACT

BACKGROUND: The Comprehensive Community Based Rehabilitation in Tanzania (CCBRT) Disability Hospital program transportMYpatient was launched in 2009 to address transport costs, which are a major barrier to patients accessing CCBRT health services. The initiative uses mobile phone technology to transfer funds to cover transport costs.

METHODS: Data were reviewed for fistula patients using the transportMYpatient scheme in 2011, noting region of referral. Average costs of using the scheme were calculated and the location of "ambassadors" by region was recorded.

RESULTS: Between 2005 and 2009, CCBRT repaired approximately 170 fistulas annually, increasing to 286 in 2010 and 339 in 2011. In 2011, the transportMYpatient initiative transported 166 fistula patients from almost all regions in Tanzania, accounting for 49% of total repairs.

CONCLUSION: The increase in referrals to CCBRT during 2011 as a result of the transportMYpatient program shows that transport costs are a real barrier to accessing care. Analysis of geographic referral data informs outreach and community sensitization initiatives, concentrating on regions of low referral. The use of mobile phone technology to transfer funds represents an innovative means of overcoming a major barrier to healthcare access for patients in low-income countries.

83. Point-of-care mobile digital microscopy and deep learning for the detection of soil-transmitted helminths and Schistosoma haematobium.

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ABSTRACT

BACKGROUND: Microscopy remains the gold standard in the diagnosis of neglected tropical diseases. As resource limited, rural areas often lack laboratory equipment and trained personnel, new diagnostic techniques are needed. Low-cost, point-of-care imaging devices show potential in the diagnosis of these diseases. Novel, digital image analysis algorithms can be utilized to automate sample analysis.

OBJECTIVE: Evaluation of the imaging performance of a miniature digital microscopy scanner for the diagnosis of soil-transmitted helminths and Schistosoma haematobium, and training of a deep learning-based image analysis algorithm for automated detection of soil-transmitted helminths in the captured images.

METHODS: A total of 13 iodine-stained stool samples containing Ascaris lumbricoides, Trichuris trichiura and hookworm eggs and 4 urine samples

containing Schistosoma haematobium were digitized using a reference whole slide-scanner and the mobile microscopy scanner. Parasites in the images were identified by visual examination and by analysis with a deep learning-based image analysis algorithm in the stool samples. Results were compared between the digital and visual analysis of the images showing helminth eggs.

RESULTS: Parasite identification by visual analysis of digital slides captured with the mobile microscope was feasible for all analyzed parasites. Although the spatial resolution of the reference slide-scanner is higher, the resolution of the mobile microscope is sufficient for reliable identification and classification of all parasites studied. Digital image analysis of stool sample images captured with the mobile microscope showed high sensitivity for detection of all helminths studied (range of sensitivity = 83.3-100%) in the test set (n = 217) of manually labeled helminth eggs.

CONCLUSIONS: In this proof-of-concept study, the imaging performance of a mobile, digital microscope was sufficient for visual detection of soil-transmitted helminths and Schistosoma haematobium. Furthermore, we show that deep learning-based image analysis can be utilized for the automated detection and classification of helminths in the captured images.

84. Covering the Last Kilometer: Using GIS to Scale-Up Voluntary Medical Male Circumcision Services in Iringa and Njombe Regions, Tanzania.

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ABSTRACT

BACKGROUND: Based on the established protective effect of voluntary medical male circumcision (VMMC) in reducing female-to-male HIV transmission, Tanzania's Ministry of Health and Social Welfare (MOHSW) embarked on the scale-up of VMMC services in 2009. The Maternal and Child Health Integrated Project (MCHIP) supported the MOHSW to roll out VMMC services in Iringa and Njombe, 2 regions of Tanzania with among the highest HIV and lowest

circumcision prevalence. With ambitious targets of reaching 264,990 males aged 10-34 years with VMMC in 5 years, efficient and innovative program approaches were necessary.

PROGRAM DESCRIPTION: Outreach campaigns, in which mobile teams set up temporary services in facilities or non-facility settings, are used to reach lesser-served areas with VMMC. In 2012, MCHIP began using geographic information systems (GIS) to strategically plan the location of outreach campaigns. MCHIP gathered geocoded data on variables such as roads, road conditions, catchment population, staffing, and infrastructure for every health facility in Iringa and Njombe. These data were uploaded to a central database and overlaid with various demographic and service delivery data in order to identify the VMMC needs of the 2 regions.

FINDINGS: MCHIP used the interactive digital maps as decision-making tools to extend mobile VMMC outreach to "the last kilometer." As of September 2014, the MOHSW with MCHIP support provided VMMC to 267,917 men, 259,144 of whom were men were aged 10-34 years, an achievement of 98% of the target of eligible males in Iringa and Njombe. The project reached substantially more men through rural dispensaries and non-health care facilities each successive year after GIS was introduced in 2012, jumping from 48% of VMMCs performed in rural areas in fiscal year 2011 to 88% in fiscal year 2012 and to 93% by the end of the project in 2014.

CONCLUSION: GIS was an effective tool for making strategic decisions about where to prioritize VMMC service delivery, particularly for mobile and outreach services. Donors may want to consider funding mapping initiatives that support numerous interventions across implementing partners to spread initial start-up costs.

85. Measuring Patient Adherence to Malaria Treatment: A Comparison of Results from Self-Report and a Customised Electronic Monitoring Device.

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ABSTRACT

BACKGROUND**:** Self-report is the most common and feasible method for assessing patient adherence to medication, but can be prone to recall bias and social desirability bias. Most studies assessing adherence to artemisinin-based combination therapies (ACTs) have relied on self-report. In this study, we use a novel customised electronic monitoring device—termed smart blister packs—to examine the validity of self-reported adherence to artemether-lumefantrine (AL) in southern Tanzania.

METHODS**:** Smart blister packs were designed to look identical to locally available AL blister packs and to record the date and time each tablet was removed from packaging. Patients obtaining AL at randomly selected health facilities and drug stores were followed up at home three days later and interviewed about each dose of AL taken. Blister packs were requested for pill count and extraction of smart blister pack data.

RESULTS**:** Data on adherence from both self-report verified by pill count and smart blister packs were available for 696 of 1,204 patients. There was no difference between methods in the proportion of patients assessed to have completed treatment (64% and 67%, respectively). However, the percentage taking the correct number of pills for each dose at the correct times (timely completion) was higher by self-report than smart blister packs (37% vs. 24%; $p<0.0001$). By smart blister packs, 64% of patients completing treatment did not take the correct number of pills per dose or did not take each dose at the correct time interval.

CONCLUSION**:** Smart blister packs resulted in lower estimates of timely completion of AL and may be less prone to recall and social desirability bias. They may be useful when data on patterns of adherence are desirable to evaluate treatment outcomes. Improved methods of collecting self-reported data are needed to minimise bias and maximise comparability between studies.

86. Evaluating feasibility, reach and potential impact of a text message family planning information service in Tanzania.

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ABSTRACT

BACKGROUND: The objective of this research was to evaluate the feasibility, reach and potential behavioral impact of providing automated family planning information via mobile phones to the general public in Tanzania.

STUDY DESIGN: Data from users of the Mobile for Reproductive Health (m4RH) program were collected during the 10-month pilot period. First, contraceptive methods queried by each user were electronically logged by the mobile phone system. Second, four text questions assessing gender, age, promotion point and potential family planning impact were sent to every user.

RESULTS: During the pilot period, 2870 unique users accessed m4RH in Tanzania, resulting in 4813 queries about specific contraceptive methods. Among those responding to text questions, 56% were female and approximately 60% were 29 or younger years in age. A variety of changes in family planning use were mentioned after using m4RH, with reported changes consistent with where users are in their reproductive life cycle.

CONCLUSIONS: Reaching younger people, women and men of reproductive age with family planning information delivered via mobile phone is recommended.

87. transportMYpatient: An initiative to overcome the barrier of transport costs for patients accessing treatment for obstetric fistulae and cleft lip in Tanzania.

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ABSTRACT

Those with disabilities are often among the poorest and most vulnerable. Even when health care is provided free, transport costs may pose an insurmountable barrier to accessing treatment. This report outlines a new initiative in Tanzania which utilizes mobile phone technology to transfer funds covering transport costs for patients with obstetric fistulae or cleft lip and/or palate. The transportMYpatient initiative surpassed the set targets and saw a 65% increase in the number of fistulae repairs performed in 2010 compared with the year before and almost triple the number of cleft lip/palate repairs. Using mobile phone technology to transfer funds is an innovative way of overcoming a significant barrier to health-care access for patients in developing countries.

88. Improving Standards of Care with Mobile Applications in Tanzania.

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ABSTRACT

In this paper, we present D-tree International's work with medical algorithms and mobile applications to improve the standards of care in clinical and community settings. In particular, we present a mobile phone-based application called CommCare which helps community health workers (CHWs) to provide home-based care and social support to HIV, tuberculosis and other chronic patients. The application guides the CHWs through a series of questions which they answer using the phone's number pad. The data then can be submitted directly to a central database over a cellular GPRS network.

We report on our experience developing and testing the application in Tanzania, including the iterative development process with the CHWs and training them to use the program. We include an account of some of the hardware and software issues encountered and resolved during the process, and some initial reactions from the first CHWs and clients to use the program. While the formal evaluation of the program is still in progress, initial findings show that the phone based system is generally viewed positively by the users and by the clients as more discreet and better for privacy than the paper-based system.

89. **SMS for Life: a pilot project to improve anti-malarial drug supply management in rural Tanzania using standard technology.**

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ABSTRACT

BACKGROUND: Maintaining adequate supplies of anti-malarial medicines at the health facility level in rural sub-Saharan Africa is a major barrier to effective management of the disease. Lack of visibility of anti-malarial stock levels at the health facility level is an important contributor to this problem.

METHODS: A 21-week pilot study, 'SMS for Life', was undertaken during 2009-2010 in three districts of rural Tanzania, involving 129 health facilities. Undertaken through a collaborative partnership of public and private institutions, SMS for Life used mobile telephones, SMS messages and electronic mapping technology to facilitate provision of comprehensive and accurate stock counts from all health facilities to each district management team on a weekly basis. The system covered stocks of the four different dosage packs of artemether-lumefantrine (AL) and quinine injectable.

RESULTS: Stock count data was provided in 95% of cases, on average. A high response rate (≥ 93%) was maintained throughout the pilot. The error rate for composition of SMS responses averaged 7.5% throughout the study; almost all errors were corrected and messages re-sent. Data accuracy, based on surveillance visits to health facilities, was 94%. District stock reports were accessed on average once a day. The proportion of health facilities with no stock of one or more anti-malarial medicine (i.e. any of the four dosages of AL or quinine injectable) fell from 78% at week 1 to 26% at week 21. In Lindi Rural district, stock-outs were eliminated by week 8 with virtually no stock-outs

thereafter. During the study, AL stocks increased by 64% and quinine stock increased 36% across the three districts.

CONCLUSIONS: The SMS for Life pilot provided visibility of anti-malarial stock levels to support more efficient stock management using simple and widely available SMS technology, via a public-private partnership model that worked highly effectively. The **SMS** for Life system has the potential to alleviate restricted availability of anti-malarial drugs or other medicines in rural or under-resourced areas.

90. A Smartphone App (AfyaData) for Innovative One Health Disease Surveillance from Community to National Levels in Africa: Intervention in Disease Surveillance.

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ABSTRACT

BACKGROUND: We describe the development and initial achievements of a participatory disease surveillance system that relies on mobile technology to promote Community Level One Health Security (CLOHS) in Africa.

OBJECTIVE: The objective of this system, Enhancing Community-Based Disease Outbreak Detection and Response in East and Southern Africa (DODRES), is to empower community-based human and animal health reporters with training and information and communication technology (ICT)–based solutions to contribute to disease detection and response, thereby complementing strategies to improve the efficiency of infectious disease surveillance at national, regional, and global levels. In this study, we refer to techno-health as the application of ICT-based solutions to enhance early detection, timely reporting, and prompt response to health events in human and animal populations.

METHODS: An EpiHack, involving human and animal health experts as well as ICT programmers, was held in Tanzania in 2014 to identify major challenges facing early

detection, timely reporting, and prompt response to disease events. This was followed by a project inception workshop in 2015, which brought together key stakeholders, including policy makers and community representatives, to refine the objectives and implementation plan of the DODRES project. The digital ICT tools were developed and packaged together as the AfyaData app to support One Health disease surveillance. Community health reporters (CHRs) and officials from animal and human health sectors in Morogoro and Ngorongoro districts in Tanzania were trained to use the AfyaData app. The AfyaData supports near- to real-time data collection and submission at both community and health facility levels as well as the provision of feedback to reporters. The functionality of the One Health Knowledge Repository (OHKR) app has been integrated into the AfyaData app to provide health information on case definitions of diseases of humans and animals and to synthesize advice that can be transmitted to CHRs with next step response activities or interventions. Additionally, a WhatsApp social group was made to serve as a platform to sustain interactions between community members, local government officials, and DODRES team members.

RESULTS: Within the first 5 months (August-December 2016) of AfyaData tool deployment, a total of 1915 clinical cases in livestock (1816) and humans (99) were reported in Morogoro (83) and Ngorongoro (1832) districts.

CONCLUSIONS: These initial results suggest that the DODRES community-level model creates an opportunity for One Health engagement of people in their own communities in the detection of infectious human and animal disease threats. Participatory approaches supported by digital and mobile technologies should be promoted for early disease detection, timely reporting, and prompt response at the community, national, regional, and global levels.

91. **Deployment and use of mobile phone technology for real-time reporting of fever cases and malaria treatment failure in areas of declining malaria transmission in Muheza district north-eastern Tanzania.**

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ABSTRACT

BACKGROUND: Early detection of febrile illnesses at community level is essential for improved malaria case management and control. Currently, mobile phone-

based technology has been commonly used to collect and transfer health information and services in different settings. This study assessed the applicability of mobile phone-based technology in real-time reporting of fever cases and management of malaria by village health workers (VHWs) in north-eastern Tanzania.

METHODS: The community mobile phone-based disease surveillance and treatment for malaria (ComDSTM) platform, combined with mobile phones and web applications, was developed and implemented in three villages and one dispensary in Muheza district from November 2013 to October 2014. A baseline census was conducted in May 2013. The data were uploaded on a web-based database and updated during follow-up home visits by VHWs. Active and passive case detection (ACD, PCD) of febrile cases were done by VHWs and cases found positive by malaria rapid diagnostic test (RDT) were given the first dose of artemether-lumefantrine (AL) at the dispensary. Each patient was visited at home by VHWs daily for the first 3 days to supervise intake of anti-malarial and on day 7 to monitor the recovery process. The data were captured and transmitted to the database using mobile phones.

RESULTS: The baseline population in the three villages was 2934 in 678 households. A total of 1907 febrile cases were recorded by VHWs and 1828 (95.9%) were captured using mobile phones. At the dispensary, 1778 (93.2%) febrile cases were registered and of these, 84.2% were captured through PCD. Positivity rates were 48.2 and 45.8% by RDT and microscopy, respectively. Nine cases had treatment failure reported on day 7 post-treatment and adherence to treatment was 98%. One patient with severe febrile illness was referred to Muheza district hospital.

CONCLUSION: The study showed that mobile phone-based technology can be successfully used by VHWs in surveillance and timely reporting of fever episodes and monitoring of treatment failure in remote areas. Further optimization and scaling-up will be required to utilize the tools for improved malaria case management and drug resistance surveillance.

92. Using an eIMCI-Derived Decision Support Protocol to Improve Provider-Caretaker Communication for Treatment of Children Under 5 in Tanzania.

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ABSTRACT

In Tanzania, significant effort has been made to reduce under-5 mortality rates, and has been somewhat successful in recent years. Many factors have contributed to this, such as using standard treatment protocols for sick children. Using mobile technology has become increasingly popular in health care delivery. This study examines whether the use of mobile technology can leverage a standardized treatment protocol to improve the impact of counseling for children's caretakers and result in better understanding of what needs to be done at home after the clinical visit. A randomized cluster design was utilized in clinics in Dar es Salaam, Tanzania. Children were treated using either test electronic protocols (eIMCI) or control paper (pIMCI) protocols. Providers using the eIMCI protocol were shown to counsel the mother significantly more frequently than providers using the pIMCI protocol. Caretakers receiving care by providers using the eIMCI protocol recalled significantly more

problems and advice when to return and medications than those receiving care by providers using the pIMCI protocol. There was no significant difference among caretakers regarding the frequency and duration to administer medications. This study indicates the use of mobile technology as an important aide in increasing the delivery and recall of counseling messages.

93. Electronic monitoring of treatment adherence and validation of alternative adherence measures in tuberculosis patients: A pilot study.

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ABSTRACT

To assess adherence to community-based directly observed treatment (DOT) among Tanzanian tuberculosis patients using the Medication Event Monitoring System (MEMS) and to validate alternative adherence measures for resource-limited settings using MEMS as a gold standard. This was a longitudinal pilot study of 50 patients recruited consecutively from one rural hospital, one urban hospital and two urban health centres. Treatment adherence was monitored with MEMS and the validity of the following adherence measures was assessed: isoniazid urine test, urine colour test, Morisky scale, Brief Medication Questionnaire, adapted AIDS Clinical Trials Group (ACTG) adherence questionnaire, pill counts and medication refill visits. The mean adherence rate in the study population was 96.3% (standard deviation, SD: 7.7). Adherence was less than 100% in 70% of the patients, less than 95% in 21% of them, and less than 80% in 2%. The ACTG adherence questionnaire and urine colour test had the highest sensitivities but lowest specificities. The Morisky scale and refill visits had the highest specificities but lowest sensitivities. Pill counts and refill visits combined, used in routine practice, yielded moderate sensitivity and specificity, but sensitivity improved when the ACTG adherence questionnaire was added. Patients on community-based DOT showed good adherence in this study. The combination of pill counts, refill visits and the ACTG adherence questionnaire could be used to monitor adherence in settings where MEMS is not affordable. The findings with regard to adherence and to the validity of simple adherence measures should be confirmed in larger populations with wider variability in adherence rates.

94. A systematic review of portable electronic technology for health education in resource-limited settings.

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ABSTRACT

OBJECTIVE**:** The objective of this study is to conduct a systematic review of the literature of how portable electronic technologies with offline functionality are perceived and used to provide health education in resource-limited settings.

METHODS**:** Three reviewers evaluated articles and performed a bibliography search to identify studies describing health education delivered by portable electronic device with offline functionality in low- or middle-income countries. Data extracted included: study population; study design and type of analysis; type of technology used; method of use; setting of technology use; impact on caregivers, patients, or overall health outcomes; and reported limitations.

RESULTS**:** Searches yielded 5514 unique titles. Out of 75 critically reviewed full-text articles, 10 met inclusion criteria. Study locations included Botswana, Peru, Kenya, Thailand, Nigeria, India, Ghana, and Tanzania. Topics addressed included: development of healthcare worker training modules, clinical decision support tools, patient education tools, perceptions and usability of portable electronic technology, and comparisons of technologies and/or mobile applications. Studies primarily looked at the assessment of developed educational modules on trainee health knowledge, perceptions and usability of technology, and comparisons of technologies. Overall, studies reported positive results for portable electronic device-based health education, frequently reporting increased provider/patient knowledge, improved patient outcomes in both quality of care and management, increased provider comfort level with technology, and an environment characterized by increased levels of technology-based, informal learning situations. Negative assessments included high investment costs, lack of technical support, and fear of device theft.

CONCLUSIONS**:** While the research is limited, portable electronic educational resources present promising avenues to increase access to effective health education in resource-limited settings, contingent on the development of culturally adapted and functional materials to be used on such devices.

Uganda

95. The use of low-cost Android tablets to train community health workers in Mukono, Uganda, in the recognition, treatment and prevention of pneumonia in children under five: a pilot randomized controlled trial.

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ABSTRACT

BACKGROUND: Since 2012, The World Health Organization and UNICEF have advocated for community health workers (CHWs) to be trained in Integrated Community Case Management (iCCM) of common childhood illnesses, such as pneumonia. Despite the effectiveness of iCCM, CHWs face many barriers to accessing training. This pilot study compares traditional training with using locally made videos loaded onto low-cost Android tablets to train CHWs on the pneumonia component of iCCM.

METHODS: We conducted a pilot randomised controlled trial with CHWs in the Mukono District of Uganda. The unit of randomisation was the sub-county level, and the unit of analysis was at the level of the individual CHW. Eligible CHWs had completed basic iCCM training but had not received any refresher training on the pneumonia component of iCCM in the preceding 2 years. CHWs in the control group received training in the recognition, treatment, and prevention of pneumonia as it is currently delivered, through a 1-day, in-person workshop. CHWs allocated to the intervention group received training via locally made educational videos hosted on low-cost Android tablets. The primary outcome was change in knowledge acquisition, assessed through a multiple-choice questionnaire before and after training, and a post-training clinical assessment. The secondary outcome was a qualitative evaluation of CHW experiences of using the tablet platform.

RESULTS**:** In the study, 129 CHWs were enrolled, 66 and 63 in the control and intervention groups respectively. CHWs in both groups demonstrated an improvement in multiple choice question test scores before and after training; however, there was no statistically significant difference in the improvement between groups (t = 1.15, p = 0.254). There was a statistically significant positive correlation (Pearson's r = 0.26, p = 0.03) linking years of education to improvement in test scores in the control group, which was not present in the intervention group. The majority of CHWs expressed satisfaction with the use of tablets as a training tool; however, some reported technical issues (n = 9).

CONCLUSION**:** Tablet-based training is comparable to traditional training in terms of knowledge acquisition. It also proved to be feasible and a satisfactory means of delivering training to CHWs. Further research is required to understand the impacts of scaling such an intervention.

96. Using a mobile phone-based application to increase awareness and uptake of sexual and reproductive health services among the youth in Uganda. A randomized controlled trial.

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ABSTRACT

BACKGROUND**:** Several cost-effective programs are being implemented around the world that use mobile technology to improve Sexual and Reproductive Health (SRH) uptake and awareness among youth. Mobile phone applications are a viable and effective means of increasing access to SRH services and tools in low and middle-income countries. This paper presents a protocol for a pilot study of a novel program, a mobile phone-based sexual and reproductive health services awareness and delivery application with the objective of increasing the demand for SRH services amongst the youth in Uganda.

METHODS**:** The study employs rigorous evaluation methods to ascertain the impact of the mobile application. We propose a randomized control trial study to determine the causal effect of the mobile phone app in creating awareness and increasing uptake of sexual and reproductive health services in Uganda. The main outcome of the impact evaluation is the percentage change in the SRH services and tools uptake, SRH knowledge and sexual behavior. We will also conduct a model-based incremental cost-effectiveness analysis (CEA) and

budget impact analysis (BIA). The main outcomes of the economic evaluation will be the average cost per app user, cost per app service and tool provided. We will also test the in-app advertising model as a way to generate revenue to sustain the program subsidies and related costs.

DISCUSSION: The study seeks to establish the proof of concept of using a mobile application to increase create awareness and increaseuptake of SRH tools and services among youth in Uganda. The study results will lead to the development of a demand-driven, culturally-relevant, and easy-to-use mobile app to enhance the uptake of SRH services among the youth in Uganda and globally.

97. Improvement of early detection of breast cancer through collaborative multi-country efforts: Medical physics component.

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ABSTRACT

PURPOSE: The International Atomic Energy Agency (IAEA) through a Coordinated Research Project on "Enhancing Capacity for Early Detection and Diagnosis of

Breast Cancer through Imaging", brought together a group of mammography radiologists, medical physicists and radiographers; to investigate current practices and improve procedures for the early detection of breast cancer by strengthening both the clinical and medical physics components. This paper addresses the medical physics component.

METHODS: The countries that participated in the CRP were Bosnia and Herzegovina, Costa Rica, Egypt, India, Kenya, the Frmr. Yug. Rep. of Macedonia, Mexico, Nigeria, Pakistan, Philippines, Slovenia, Turkey, Uganda, United Kingdom and Zambia. Ten institutions participated using IAEA quality control protocols in 9 digital and 3 analogue mammography equipment. A spreadsheet for data collection was generated and distributed. Evaluation of image quality was done using TOR MAX and DMAM2 Gold phantoms.

RESULTS: QC results for analogue equipment showed satisfactory results. QC tests performed on digital systems showed that improvements needed to be implemented, especially in thickness accuracy, signal difference to noise ratio (SDNR) values for achievable levels, uniformity and modulation transfer function (MTF). Mean glandular dose (MGD) was below international recommended levels for patient radiation protection. Evaluation of image quality by phantoms also indicated the need for improvement.

CONCLUSIONS: Common activities facilitated improvement in mammography practice, including training of medical physicists in QC programs and infrastructure was improved and strengthened; networking among medical physicists and radiologists took place and was maintained over time. IAEA QC protocols provided a uniformed approach to QC measurements.

98. Digital adherence technologies for the management of tuberculosis therapy: mapping the landscape and research priorities.

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ABSTRACT

Poor medication adherence may increase rates of loss to follow-up, disease relapse and drug resistance for individuals with active tuberculosis (TB). While TB programmes have historically used directly observed therapy (DOT) to address adherence, concerns have been raised about the patient burden, ethical limitations, effectiveness in improving treatment outcomes and long-term feasibility of DOT for health systems. Digital adherence technologies (DATs)-which include feature phone-based and smartphone-based technologies, digital pillboxes and ingestible sensors-may facilitate more patient-centric approaches for monitoring adherence, though available data are limited. Depending on the specific technology, DATs may help to remind patients to take their medications, facilitate digital observation of pill-taking, compile dosing histories and triage patients based on their level of adherence, which can facilitate provision of individualised care by TB programmes to patients with varied levels of risk. Research is needed to understand whether DATs are acceptable to patients and healthcare providers, accurate for measuring adherence, effective in improving treatment outcomes and impactful in improving health system efficiency. In this article, we describe the landscape of DATs that are being used in research or clinical practice by TB programmes and highlight priorities for research.

99. Maternal Attitudes about Objectively Monitored Bednet Use in Rural Uganda.

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ABSTRACT

Insecticide-treated bednets (ITNs) are a mainstay of malaria prevention, yet poor adherence poses a major barrier to effective prevention. Self-reports of bednet use suffer from recall and social desirability biases. We have designed a device that electronically records ITN usage longitudinally. SmartNet consists of circuits made from a conductive fabric interwoven into the sides and top of a rectangular ITN. Digital sampling of the state of these circuits allows for determining whether the SmartNet is deployed for use or folded up. We conducted a study among pregnant women and women with children <5 years in Uganda to determine attitudes about objective bednet monitoring and SmartNet. Fifty women were interviewed with an average age of 27 years and 2.3 children. Twenty-two percent were pregnant. Ninety-five percent had used a bednet and 90% reported having a bednet at home. After displaying a SmartNet, 92% thought it would be easy to use and 100% expressed interest in using SmartNet. Concerns about SmartNet included washing the net, worries about being monitored while asleep, and worries about users removing the device components. Objective monitoring of ITN use appears to be acceptable among women in rural Uganda, setting the stage for further SmartNet field testing.

100. Assessing Commitment and Reporting Fidelity to a Text Message-Based Participatory Surveillance in Rural Western Uganda.

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ABSTRACT

Syndromic surveillance, the collection of symptom data from individuals prior to or in the absence of diagnosis, is used throughout the developed world to provide rapid indications of outbreaks and unusual patterns of disease. However, the low cost of syndromic surveillance also makes it highly attractive for the developing world. We present a case study of electronic participatory syndromic surveillance, using participant-mobile phones in a rural region of Western Uganda, which has a high infectious disease burden, and frequent local and regional outbreaks. Our platform uses text messages to encode a suite of symptoms, their associated durations, and household disease burden, and we explore the ability of participants to correctly encode their symptoms, with an average of 75.2% of symptom reports correctly formatted between the second and 11th reporting timeslots. Concomitantly we identify divisions between participants able to rapidly adjust to this unusually participatory style of data collection, and those few for whom the study proved more challenging. We then perform analyses of the resulting syndromic time series, examining the clustering of symptoms by time and household to

identify patterns such as a tendency towards the within-household sharing of respiratory illness.

101. Feasibility and cost of a medical student proxy based mobile teledermatology consult service with Kisoro, Uganda, and Lake Atitlán, Guatemala.

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ABSTRACT

BACKGROUND: The expansion of mobile technology and coverage has unveiled new means for delivering medical care to isolated and resource-poor communities. Teledermatology, or dermatology consultation from a distance using technology, is gaining greater acceptance among physicians and patients.

OBJECTIVES: To evaluate feasibility and cost of a smartphone based teledermatology consult service utilizing a designated medical student proxy to facilitate all consults on site, and to evaluate the service's effect upon diagnosis and management.

METHODS: An IRB-approved smartphone-based teledermatology consult service was established to serve two rural communities in the developing world: Kisoro, Uganda, and Lake Atitlán, Guatemala. Fourth-year medical students were recruited as proxies for each site, responding to consults by local doctors and transmitting photographs and clinical information via a smartphone application to a dermatology resident and attending in the USA over an encrypted website. At the Ugandan site, when indicated, the medical student performed skin biopsies under supervision, and rotating Montefiore residents transported specimens back to the USA.

RESULTS: From October 2011 to August 2012, 93 cases were evaluated by the consult service (57 from Uganda and 36 from Guatemala). Initial diagnoses changed completely in 55.9% (52 of 93) of cases, and management changes were recommended in 89.2% (83 of 93) of cases. The estimated total cost of supplies and technology was 42.01 USD per consult and 64.24 USD per biopsy (including processing). Given fixed upfront costs, the cost per consult decreased with each additional case.

CONCLUSION**:** Smartphone-based systems for teledermatology consultation using a medical student proxy are feasible for delivery of care in the developing world at relatively little cost. Optimization and sustainability of this system requires and deserves further investigation in larger studies.

102. Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: a review.

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ABSTRACT

BACKGROUND**:** Mobile health (mHealth) describes the use of portable electronic devices with software applications to provide health services and manage patient information. With approximately 5 billion mobile phone users globally, opportunities for mobile technologies to play a formal role in health services, particularly in low- and middle-income countries, are increasingly being recognized. mHealth can also support the performance of health care workers by the dissemination of clinical updates, learning materials, and reminders, particularly in underserved rural locations in low- and middle-income countries where community health workers deliver integrated community case management to children sick with diarrhea, pneumonia, and malaria.

OBJECTIVE**:** Our aim was to conduct a thematic review of how mHealth projects have approached the intersection of cellular technology and public health in low- and middle-income countries and identify the promising practices and experiences learned, as well as novel and innovative approaches of how mHealth can support community health workers.

METHODS**:** In this review, 6 themes of mHealth initiatives were examined using information from peer-reviewed journals, websites, and key reports. Primary mHealth technologies reviewed included mobile phones, personal digital assistants (PDAs) and smartphones, patient monitoring devices, and mobile telemedicine devices. We examined how these tools could be used for education and awareness, data access, and for strengthening health information systems. We also considered how mHealth may support patient monitoring, clinical decision making, and tracking of drugs and supplies. Lessons from mHealth trials and studies were summarized, focusing on low- and middle-income countries and community health workers.

RESULTS: The review revealed that there are very few formal outcome evaluations of mHealth in low-income countries. Although there is vast documentation of project process evaluations, there are few studies demonstrating an impact on clinical outcomes. There is also a lack of mHealth applications and services operating at scale in low- and middle-income countries. The most commonly documented use of mHealth was 1-way text-message and phone reminders to encourage follow-up appointments, healthy behaviors, and data gathering. Innovative mHealth applications for community health workers include the use of mobile phones as job aides, clinical decision support tools, and for data submission and instant feedback on performance.

CONCLUSIONS: With partnerships forming between governments, technologists, non-governmental organizations, academia, and industry, there is great potential to improve health services delivery by using mHealth in low- and middle-income countries. As with many other health improvement projects, a key challenge is moving mHealth approaches from pilot projects to national scalable programs while properly engaging health workers and communities in the process. By harnessing the increasing presence of mobile phones among diverse populations, there is promising evidence to suggest that mHealth can be used to deliver increased and enhanced health care services to individuals and communities, while helping to strengthen health systems.

103. Prediction of width of un-erupted incisors, canines and premolars in a Ugandan population: a cross sectional study.

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ABSTRACT

BACKGROUND: Accurate prediction of the space forms an important part of an orthodontic assessment in the mixed dentition. However, the most commonly used methods of space analysis are based on data developed on Caucasian populations. In order to provide more accurate local data, we set out to develop a formula for predicting the widths of un-erupted canines and premolars for a Ugandan population and to compare the predicted widths of the teeth from this formula with those obtained from Moyers' tables, and Tanaka and Johnston's equations.

METHODS: Dental casts were prepared using mandibular and maxillary arch impressions of 220 children (85 boys/135 girls) aged 12-17 years recruited from

schools in Kampala, Uganda. The mesio-distal width of the mandibular incisors, mandibular and maxillary canines and premolars were measured with a pair of digital callipers. Based on regression analysis, predictive equations were derived, and the findings were compared with those presented in Moyers' probability tables, and Tanaka and Johnston's equations.

RESULTS**:** There were no statistically significant differences between the tooth widths predicted by our equations and those from Moyers' probability tables at the 65th and 75th percentile probabilities for the girls and at 75th level in boys in the mandibular arch. While in the maxillary arch no statistically significant differences at the 75th and 95th levels were noted in girls. There were statistically significant differences between predicted tooth sizes using equations from the present study and those predicted from the Tanaka and Johnston regression equations.

CONCLUSIONS**:** In this Ugandan population, Moyers' probability tables could be used to predict tooth widths at specific percentile probabilities, but generally, Tanaka and Johnston technique tends to overestimate the tooth widths.

104. Use of an innovative, affordable, and open-source short message service-based tool to monitor malaria in remote areas of Uganda.

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ABSTRACT

Quality health management requires timely and accurate data, and paper-based reporting does not fill this role adequately. The introduction of malaria rapid diagnostic tests and the availability of wireless communications present an opportunity to open direct data transmission and feedback between peripheral health workers and central managers. In November 2009, the Uganda Ministry of Health deployed a short message service-based reporting system in two districts. At a set-up cost of $100/health facility, local technician support of $ 400 per month, and a cost of $0.53/week/clinic, the SMS reporting system was started at more than 140 clinics. Positivity rates for rapid diagnostic tests and artemisinin combination therapy stock outs were 48% and 54% in Kabale and 71% and 54% in Gulu, among other reports, at more

than 85% health facilities reporting weekly and without monetary incentives or additional supervision. The SMS-based reporting systems have potential to improve timeliness in reporting of specific, time-sensitive metrics at modest cost, while by-passing current bottlenecks in the flow of data. With the development of specific capacity to manage stock data at district level, the availability of timely data offers potential to address commodity distribution problems and reduce stock-outs.

105. **Data and image transfer using mobile phones to strengthen microscopy-based diagnostic services in low- and middle-income country laboratories.**

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ABSTRACT

BACKGROUND**:** The emerging market of mobile phone technology and its use in the health sector is rapidly expanding and connecting even the most remote areas of world. Distributing diagnostic images over the mobile network for knowledge sharing, feedback or quality control is a logical innovation.

OBJECTIVE**:** To determine the feasibility of using mobile phones for capturing microscopy images and transferring these to a central database for assessment, feedback and educational purposes.

METHODS**:** A feasibility study was carried out in Uganda. Images of microscopy samples were taken using a prototype connector that could fix a variety of mobile phones to a microscope. An Information Technology (IT) platform was set up for data transfer from a mobile phone to a website, including feedback by text messaging to the end user.

RESULTS**:** Clear images were captured using mobile phone cameras of 2 megapixels (MP) up to 5MP. Images were sent by mobile Internet to a website where they were visualized, and feedback could be provided to the sender by means of text message.

CONCLUSION**:** The process of capturing microscopy images on mobile phones, relaying them to a central review website and feeding back to the sender is feasible and of potential benefit in resource poor settings. Even though the system needs further optimization, it became evident from discussions with stakeholders that there is a demand for this type of technology.

106. Using Personal Digital Assistants to Improve Healthcare Delivery in Uganda

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ABSTRACT

Effective Health Systems make service provision easy for health workers, especially if they have access to the latest guidelines in a dynamic profession where new technologies are ever emerging. However, available data indicates that the health system in Uganda is constrained and still using old technologies despite the availability of newer technologies. As a result, this study sought to investigate the adoptability, cost effectiveness, and sustainability with regard to Personal Digital Assistants. The study, which was cross sectional in nature, was carried out in Mbale District in Eastern Uganda between 2008 and 2010. In depth interviews were conducted with health workers and key informants. Also, published and unpublished literature about the Uganda Health Information Network was reviewed. The findings revealed that the use of Personal Digital Assistants also known as handheld computers can go a long way towards improving healthcare delivery in countryside health facilities. To health workers in remote places, the PDAs are a source of the latest clinical care guidelines for several diseases including HIV and AIDS as well as malaria. Health information systems have been improved and data collection and reporting have been eased by this technology. However, while evidence of viability of this technology exists, it still has challenges like power and delays in software updates among others.

107. Telecommunications and health Care: an HIV/AIDS warmline for communication and consultation in Rakai, Uganda.

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ABSTRACT

Hotlines and warmlines have been successfully used in the developed world to provide clinical advice; however, reports on their replicability in resource-limited

settings are limited. A warmline was established in Rakai, Uganda, to support an antiretroviral therapy program. Over a 17-month period, a database was kept of who called, why they called, and the result of the call. A program evaluation was also administered to clinical staff. A total of 1303 calls (3.5 calls per weekday) were logged. The warmline was used mostly by field staff and peripherally based peer health workers. Calls addressed important clinical issues, including the need for urgent care, medication side effects, and follow-up needs. Most clinical staff felt that the warmline made their jobs easier and improved the health of patients. An HIV/AIDS warmline leveraged the skills of a limited workforce to provide increased access to HIV/AIDS care, advice, and education.

108. Using mobile phones to improve clinic attendance amongst an antiretroviral treatment cohort in rural Uganda: a cross-sectional and prospective study.

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ABSTRACT

We aimed to assess the patterns and dynamics of mobile phone usage amongst an antiretroviral treatment (ART) cohort in rural Uganda and ascertain its feasibility for improving clinic attendance. A cross-sectional study of clients on ART exploring their access to mobile phones and patterns of use was employed. Clinic attendances for antiretroviral drug refills were then monitored prospectively over 28 weeks in 176 patients identified in the cross-sectional survey who had access to mobile phones and had given consent to be contacted. Patients were contacted via voice calls or text messages to remind them about their missed clinic appointments. Of the 276 patients surveyed, 177 (64%) had access to mobile phones with all but one were willing to be contacted for missed visits reminders. Of the 560-total scheduled clinic appointments, 62 (11%) were missed visits. In 79% of episodes in which visits were missed, patients presented for treatment within a mean duration of 2.2 days (SD = 1.2 days) after mobile phone recall. Access to mobile phones was high in this setting. Privacy and confidentiality issues were not considered deterrents. Mobile phones have a potential for use in resource-constrained settings to substantially improve the clinical management of HIV/AIDS.

109. Use of Interactive SMS Reminders to Improve Reporting Timeliness at Health Facilities.

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ABSTRACT

BACKGROUND**:** There is increasing demand for real-time, data-driven decisions and timeliness is one of the five US Agency for International Development (USAID) data quality standards. The Ministry of Health in Uganda requires that, health facility monthly reports submitted to the district by the 7th day of the subsequent month, monthly reports entered into the DHIS2 database by the 15th day of the subsequent month. HIWA, USAID/Uganda HIV/Health Initiatives in Workplaces Activity is a 5-year national program implemented in 50 districts of Uganda and supports 18 health facilities to implement and report on a comprehensive package of health services. From October 2015 to June 2016, an average of 33% of the facilities were reporting on time. To address this challenge, in July 2016 HIWA implemented interactive SMS reminders.

METHODOLOGY**:** Monthly SMS reminders are sent on the 30th of the completed month and the 1st of the new month and messages are sent to both records officers and health facility in-charges because messages are interactive, we are able to communicate with health facilities and quickly understand which health facilities have completed compiling reports, how many health facilities have submitted to the district level, why some health facilities may delay in compiling and/or submitting reports

RESULTS**:** The project has been able to view, download and use data from these facilities from as early as the 7th day of the new month. As such, errors and inconsistencies in the reports can be rectified before the DHIS2 system closes and issues that require follow up are acted upon promptly.

CONCLUSION**:** The HIWA monthly interactive SMS reminders improve timeliness of submitted health facility reports. Timely submission of the health facility reports is necessary for real-time data-driven decision-making. This approach should be considered for scale up by the Ministry of Health to non-HIWA supported localities.

110. Using Mobile Health Interventions to Improve Compliance to Appointments and Retention in care among HIV+ clients on Antiretroviral Therapy.

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ABSTRACT

INTRODUCTION: Uganda's adult (15-49 years) HIV prevalence rate of 6.2% (1.2 million) and 67% adults are on the lifesaving antiretroviral drugs. 59.6% prevalence of viral load suppression (VLS) among HIV-positive adults (15 - 64 years). Supported facilities mainly serve a mobile population. Challenges in having clients honor their facility appointment visits & retaining them in care. The overall objective is to improve their lives through increased availability and accessibility of HIV and other health services, increased quality of these services, and increased uptake of the services.

METHODOLOGY: The mHealth-ART intervention was rolled out in May 2016 in Arua, Jinja, Masaka, Mbale, Naguru, Nsambya Police Health centers. HIV positive clients with access to mobile phones were identified and their contact details including names and phone numbers were collected and entered an Interactive SMS platform called RapidPro and informed consent for mobile health support was sought. SMS reminders on health facility appointment dates, Mobile health content on positive living as an HIV positive person. 24/7 access to a licensed and trained medical doctor through a toll-free phone number. An SMS reminding them about their health facility return dates was sent 2 days & on the expected visit date. Mobile health content on positive living as an HIV positive person was scheduled to go out at an interval of one SMS per week. And on a quarterly basis, these clients received a voice call from the health workers checking with their general wellbeing, honoring health facility appoint dates and other health concerns.

RESULTS: 1,010 (70.3%) ART clients consented for mHealth support from May 2016 to December 2017. Females 586 (58%) and Males 424(42%). The median age was 40 years (IQR: 20-50 years). Noticeable improvement in compliance to health facility appointment visits from 75% to 95% with implementation of SMS reminders.

CONCLUSION: mHealth interventions were acceptable and adopted by the ART clients. SMS reminders on health facility appointment dates fosters compliance to scheduled visit dates. Availing modalities of real time remote consultations to health workers by ART clients enables real time resolution of inquiries that would

otherwise impact on adherence. Integration such mobile health interventions in other public health programs would help in addressing similar challenges in VL monitoring, EID among others.

111. Using automated attendance-tracking tools to strengthen management of health worker absenteeism in the health sector.

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BACKGROUND: Health worker absenteeism is a key barrier to providing quality health care leading to reduced health worker productivity, disruption of health care delivery and poor access to health care services. This contributes to low access to key services in that when people go to a health facility and there is no one to treat them it is an indication of poor performance. For example, health facility deliveries stood at 58.1% while Antenatal Care four visits stood at 37% in 2017 (MOH AHSPR, 2017).

METHODOLOGY: Basically, health workers scan their finger at the beginning and end of their shift, data is sent from the biometric scanner to a local computer and the computer conducts analysis automatically using biometric scanner software. The automated system feed into a nationwide integrated human resources information system (iHRIS, uploaded into servers at Ministry of Health (MOH) using the national ID numbers that were registered earlier to help records in iHRIS. This enables analysis from management offices at each level such that the in-charges, district and managers at the ministry can be able to know who is present or absent. The iHRIS with a record of health workers in Uganda, generates reports against online duty rosters in the MOH and IntraHealth to show who was supposed to be in the facility, who is supposed to be on leave. Then the data can be integrated to understand who is absent without authorization and able to take higher-level action.

RESULTS: The causes of absenteeism in health facilities include; Leave (all forms of leave: study leave, sick leave, maternity leave, etc.), Official assignments, Trainings/Workshops, and Work climate factors (e.g. weak leadership & management (governance), delayed pay, lack of equipment, tools and supplies, lack of accommodation), Personal leave such as family responsibilities, burials, pregnancy and others. The project data for February 2017 show that absenteeism is around 78% but huge decrease of abseentism in the bigger and higher-level facilities and management. Interestingly, the PNFP generally have higher attendance than the public facilities, however it does not tell us the reasons for the difference.

CONCLUSION: Generally, the automated attendance monitoring tool has improved tracking and timely generation of credible evidence on absenteeism of health workers and help managers to act. It has increased availability of skilled healthcare providers at the health facilities which is one of our ultimate goals.

COSTING AND FINANCING HEALTH: THE ROLE OF DIGITAL HEALTH, INTERNATIONAL REMITTANCES, UNIVERSAL HEALTH CARE, AND EAC STATUS ON THE UN SDG

10 Citations
(Sorted by Partner States)

Burundi

1. **Design, Development, Deployment of a Telemedicine System in a Developing Country: Dealing with Organizational and Social Issues.**

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ABSTRACT:

Telemedicine means delivering health care services to remote locations by ICT (Information and Communication Technology). Several types of telemedicine systems exist: by this paper, we focus on teleconsulting systems. We report here about a telemedicine project in one of the poorest country worldwide, Burundi. After gathering the requirements, which strongly differ from the requirements of a telemedicine project in a developed country, we designed, implemented, and deployed a prototype aimed at providing local physicians of the Hospital of Ngozi, Burundi, with expert second opinions from their colleagues in the University of Verona, Italy, on interpreting ECG signals, ultrasound and X-ray images. We considered in a seamless way both process- and data-related requirements. Besides the more technical aspects, we also report on some organizational and social issues we faced during the project.

2. **Mapping multi-sector actions in Burundi and Myanmar: Towards more effective coordination.**

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ABSTRACT

BACKGROUND**:** Multi-stakeholder mapping is intended to provide an overview of actions being implemented to address malnutrition. The mapping exercise aims

to identify who is doing what, where and how to provide a comprehensive picture of interventions in terms of geographic and population coverage. Such information places national governments in a better position to lead data-driven, multi-sector, multi-stakeholder discussions to accelerate progress towards national nutrition targets.

REACH (Renewed Efforts against Child Hunger and Undernutrition)[1] has been working since 2008 to use effective tools, such as the Stakeholder and Nutrition Action Mapping Tool[2], to support a range of actors across multiple sectors to engage with nutrition. In 2017 the tool was put into a web platform, making it more compatible with information systems such as District Health Information Systems (DHIS, Version 2). To date, the mapping exercise has been conducted in 15 countries and is currently underway in a further six.

This article describes the use of this tool in two very different contexts: Burundi in East Africa and Myanmar in south-east Asia.

BURUNDI: Burundi is a small, landlocked country in East Africa with just over 10.5 million inhabitants. It has high levels of malnutrition, including stunting prevalence of 58 per cent and wasting prevalence of 6 per cent[3] in children under five years of age (CU5).

The Government of Burundi (GoB), through its SUN Secretariat managed by the SUN Focal Point, expressed interest in conducting the mapping exercise to gain a better understanding of the country's nutrition landscape. Launched in January 2018 with the support of the UN Network Secretariat, the multi-sector mapping is enabling the GoB to gather valuable coverage data, by stakeholder and programme coverage.

This, in turn, enables the GoB to identify gaps, duplication and opportunities to coordinate nutrition actions across sectors and stakeholders more effectively. Where there is duplication, the mapping exercise will enable the government (and those supporting it) to reallocate scarce resources to other localities with a high malnutrition burden but which are receiving less attention. The GoB also hopes to attract increased investment for nutrition by pursuing this more efficient approach to scale-up.

ENGAGING DIFFERENT SECTORS: The mapping exercise has also provided an entry point for engaging a notable number of sectors, including staff from seven ministries: Health; Agriculture; Trade and Industry; Planning and Finance; Environment; Local Development; and Social Security and Human Rights. Such wide-ranging engagement and government support has given rise to a dynamic mapping process in Burundi, which is being championed by the SUN Focal Point. The efforts are being coordinated by the Office of the Second Vice President, where the SUN Focal Point is based, and supported by a national mapping team. To date, more than 30 stakeholders have submitted data.

The mapping exercise can also contribute to creating a demand for multi-sector collaboration and instil this new way of working among sector-specific actors. Some actors reportedly do not see how their 'regular' work is related to nutrition or how it can be made more nutrition-sensitive. Others are preoccupied with their 'regular' sector work and struggle to devote time to multi-sector processes. Such challenges also include extending a multi-sector process to the provincial level[4]. The formulation of the new National Strategic Plan on Nutrition and Food Security (2019-2023) offers another opportunity to reinforce a multi-sector approach to nutrition. Key findings from the mapping process have been timed to feed into the review of the GoB's strategic plan.

For example, a new multi-sector approach to implementing nutrition interventions is being implemented in two southern provinces, Makamba and Rutana. This combines the efforts of public administrative actors, NGOs, local civil society and religious authorities, grouping these stakeholders into a Steering Committee and Technical Committee. The Steering Committee, chaired by the SUN Focal Point, is responsible for monitoring the implementation of nutrition interventions and for better mobilisation of the various actors.

REMAINING CHALLENGES: It was important to emphasise the purpose of mapping when collecting data to overcome problems with sharing data, since some actors initially perceived the exercise as a means to control their work. The exercise also highlighted the need to better account for the coverage of interventions that are delivered through varying approaches (e.g. one-off campaigns versus routine services).

3. **Accessing advanced computational resources in Africa through Cloud Computing.**

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 ABSTRACT

BACKGROUND: Low resources in many African locations do not allow many African scientists and physicians to access the latest advances in technology. This deficiency hinders the daily life of African professionals that often cannot afford, for instance, the cost of internet fees or software licenses. The AFRICA BUILD project, funded by the European Commission and formed by four European and four African institutions, intends to provide advanced computational tools to

African institutions in order to solve current technological limitations. In the context of AFRICA BUILD we have carried out, a series of experiments to test the feasibility of using Cloud Computing technologies in two different locations in Africa: **Egypt and Burundi**. The project aims to create a virtual platform to provide access to a wide range of biomedical informatics and learning resources to professionals and researchers in Africa.

Kenya

4. **The feasibility of using mobile-phone based SMS reminders and conditional cash transfers to improve timely immunization in rural Kenya?**

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ABSTRACT

BACKGROUND: Demand-side strategies could contribute to achieving high and timely vaccine coverage in rural Africa, but require platforms to deliver either messages or conditional cash transfers (CCTs). We studied the feasibility of using short message services (SMS) reminders and mobile phone-based conditional cash transfers (CCTs) to reach parents in rural Western Kenya.

METHODS: In a Health and Demographic Surveillance System (HDSS), mothers with children aged 0–3 weeks old were approached to determine who had access to a mobile phone. SMS reminders were sent three days prior to and on the scheduled day of immunization for 1st (age 6 weeks) and 2nd doses (age 10 weeks) of DTP-HepB-Hib (Pentavalent) vaccine, using open-source Rapid SMS software. Approximately $2.00 USD was sent as cash using mPESA, a mobile money transfer platform (2/3 of mothers), or airtime (1/3 of mothers) via phone if the child was vaccinated within 4 weeks of the scheduled date. Follow-up surveys were done when children reached 14 weeks of age.

RESULTS: We approached 77 mothers; 72 were enrolled into the study (26% owned a phone and 74% used someone else's). Of the 63 children with known vaccination status at 14 weeks of age, 57 (90%) received pentavalent1 and 54 (86%) received pentavalent2 within 4 weeks of their scheduled date. Of the 61 mothers with follow-up surveys administered at 14 weeks of age, 55 (90%) reported having received SMS reminders. Of the 54 women who reported having received SMS reminders and answered the CCT questions on the survey, 45 (83%) reported receiving their CCT. Most (89%) of mothers in the mPESA group obtained their cash within 3 days of being sent their credit via mobile phone. All mothers stated they preferred CCTs as cash via mobile phone rather than airtime. Of the 9 participants who did not vaccinate their children at the designated clinic 2(22%) cited refusals by husbands to participate in the study.

CONCLUSION: The data show that in rural Western Kenya mobile phone-based strategies are a potentially useful platform to deliver reminders and cash transfers. Follow-up studies are needed that provide evidence for the effectiveness of these strategies in improving vaccine coverage and timeliness.

Rwanda

5. **The Economic Burden Attributable to a Child's Inpatient Admission for Diarrheal Disease in Rwanda.**

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ABSTRACT

BACKGROUND: Diarrhea is one of the leading causes of childhood morbidity and mortality. Hospitalization for diarrhea can pose a significant burden to health systems and households. The objective of this study was to estimate the economic burden attributable to hospitalization for diarrhea among children less than five years old in Rwanda. These data can be used by decision-makers to assess the impact of interventions that reduce diarrhea morbidity, including rotavirus vaccine introduction.

METHODS: This was a prospective costing study where medical records and hospital bills for children admitted with diarrhea at three hospitals were collected to estimate resource use and costs. Hospital length of stay was calculated from medical records. Costs incurred during the hospitalization were abstracted from the hospital bills. Interviews with the child's caregivers provided data to estimate household costs which included transport costs and lost income. The portion of medical costs borne by insurance and household were reported separately. Annual economic burden before and after rotavirus vaccine introduction was estimated by multiplying the reported number of diarrhea hospitalizations in

public health centers and district hospitals by the estimated economic burden per hospitalization. All costs are presented in 2014 US$.

RESULTS: Costs for 203 children were analyzed. Approximately 93% of the children had health insurance coverage. Average hospital length of stay was 5.3 ± 3.9 days. Average medical costs for each child for the illness resulting in a hospitalization were $44.22 ± $23.74 and the total economic burden was $101, of which 65% was borne by the household. For households in the lowest income quintile, the household costs were 110% of their monthly income. The annual economic burden to Rwanda attributable to diarrhea hospitalizations ranged from $1.3 million to $1.7 million before rotavirus vaccine introduction.

CONCLUSION: Households often bear the largest share of the economic burden attributable to diarrhea hospitalization and the burden can be substantial, especially for households in the lowest income quintile.

6. **Evaluating the impact of ICT-tools on health care delivery in sub-Saharan hospitals.**

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ABSTRACT

This research explores to what extent Information and Communication Technology (ICT)-based information management methods can help to improve efficiency and effectiveness of health services in sub-Saharan hospitals and how clinical information can be made available for secondary use enabling non-redundant reporting of health- and care performance indicators. In the course of a 6 years research effort between 2006 and 2012, it was demonstrated that patient identification, financial management and structured reporting improved dramatically after implementation of well adapted ICT-tools in a set of 19 African health facilities. Real-time financial management metrics helped hospitals to quickly identify fraudulent practices and defective invoicing procedures. Out-patient case load significantly increased compared to the national average, average length of stay has been shortened in 15 of 19 health facilities and global hospital mortality decreased. Hospital workforce-evaluated impact of hospital information system implementation on local working conditions and quality of care was very positive. It was demonstrated that local sub-Saharan health professionals strongly believe in the importance of health information systems.

7. Capitalizing on the characteristics of mHealth to evaluate its impact.

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ABSTRACT

The field of mHealth has made significant advances in a short period of time, demanding a more thorough and scientific approach to understanding and evaluating its progress. A recent review of mHealth literature identified two primary research needs in order for mHealth to strengthen health systems and promote healthy behaviors, namely health outcomes and cost-benefits (Mechael et al., 2010). In direct response to the gaps identified in mHealth research, the aim of this paper is to present the study design and highlight key observations and next steps from an evaluation of the mHealth activities within the electronic health (eHealth) architecture implemented by the Millennium Villages Project (MVP) by leveraging data generated through mobile technology itself alongside complementary qualitative research and costing assessments. The study, funded by the International Development and Research Centre (IDRC) as part of the Open Architecture Standards and Information Systems research project (OASIS II) (Sinha, 2009), is being implemented on data generated by 14 MVP sites in 10 Sub-Saharan African countries including more in-depth research in Ghana, Rwanda, Tanzania, and Uganda. Specific components of the study include rigorous quantitative case-control analyses and other epidemiological approaches (such as survival analysis) supplemented by in-depth qualitative interviews spread out over 18 months, as well as a costing study to assess the impact of mHealth on health outcomes, service delivery, and efficiency.

Tanzania

8. **The Role of Digital Strategies in Financing Health Care for Universal Health Coverage in Low- and Middle-Income Countries.**

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ABSTRACT

Countries finance health care using a combination of 3 main functions: raising resources for health, pooling resources, and purchasing health services. In this paper, we examine how digital health technologies can be used to enhance these health financing functions in low- and middle-income countries and can thus contribute to progress toward universal health coverage. We illustrate our points by presenting some recent innovations in digital technologies for financing health care, identifying their contributions and their limits. Some examples include a mobile-health wallet application used in Kenya that encourages households to put money aside for future health expenses; an online software platform developed by a startup in Tanzania in partnership with a private insurance provider to give individuals and families the opportunity to choose among different health coverage options; and digital maps by a number of startups that bring together data on health facility locations and capacity, including equipment, staff, and types of services offered. We also sketch an agenda for future research and action for digital strategies for health financing. The development and adoption of effective solutions that align well with the universal health coverage agenda will require strong partnerships between stakeholders and enough proactive stewardship by authorities.

9. **Determinants for Effective Implementation of Electronic Payment System by Hospitals in Tanzania: A Case of the Kilimanjaro Christian Medical Centre.**

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ABSTRACT

The era of rapid growth of the internet has witnessed the exponential growth of electronic payment systems (EPS); consequently, business transactions are

constantly shifting from cash-based to electronic-based system. This paper is a product of a research conducted to explore factors that could influence effective adoption and implementation of the EPS among hospitals in Tanzania and the challenges associated with its adoption. The study used the KCMC as a case in point. The case study design was used. In this study we sampled 152 respondents randomly who included clients at the outpatient clinics of the hospital. The data were gathered using a structured questionnaire consistent with the Technology Acceptance Model (TAM). The findings suggest that the majority of the clients preferred to use EPS whereas, intention to use EPS, previous experience in the use of EPS, and being banked were significant factors influencing both preference of EPS and intention to use EPS. It is recommended that in order to hasten adoption of EPS in Tanzania it is important to address the identified barriers and also to encourage clients to keep their money in and use the services of banks.

10. Tanzania's countdown to 2015: an analysis of two decades of progress and gaps for reproductive, maternal, newborn, and child health, to inform priorities for post-2015.

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ABSTRACT

BACKGROUND: Tanzania is on track to meet Millennium Development Goal (MDG) 4 for child survival, but is making insufficient progress for newborn survival and maternal health (MDG 5) and family planning. To understand this mixed progress and to identify priorities for the post-2015 era, Tanzania was selected as a Countdown to 2015 case study.

METHODS: We analysed progress made in Tanzania between 1990 and 2014 in maternal, newborn, and child mortality, and unmet need for family planning, in

which we used a health systems evaluation framework to assess coverage and equity of interventions along the continuum of care, health systems, policies and investments, while also considering contextual change (eg, economic and educational). We had five objectives, which assessed each level of the health systems evaluation framework. We used the Lives Saved Tool (LiST) and did multiple linear regression analyses to explain the reduction in child mortality in Tanzania. We analysed the reasons for the slower changes in maternal and newborn survival and family planning, to inform priorities to end preventable maternal, newborn, and child deaths by 2030.

FINDINGS: In the past two decades, Tanzania's population has doubled in size, necessitating a doubling of health and social services to maintain coverage. Total health-care financing also doubled, with donor funding for child health and HIV/AIDS more than tripling. Trends along the continuum of care varied, with preventive child health services reaching high coverage (≥85%) and equity (socioeconomic status difference 13-14%), but lower coverage and wider inequities for child curative services (71% coverage, socioeconomic status difference 36%), facility delivery (52% coverage, socioeconomic status difference 56%), and family planning (46% coverage, socioeconomic status difference 22%). The LiST analysis suggested that around 39% of child mortality reduction was linked to increases in coverage of interventions, especially of immunisation and insecticide-treated bednets. Economic growth was also associated with reductions in child mortality. Child health programmes focused on selected high-impact interventions at lower levels of the health system (eg, the community and dispensary levels). Despite its high priority, implementation of maternal health care has been intermittent. Newborn survival has gained attention only since 2005, but high-impact interventions are already being implemented. Family planning had consistent policies but only recent reinvestment in implementation.

INTERPRETATION: Mixed progress in reproductive, maternal, newborn, and child health in Tanzania indicates a complex interplay of political prioritisation, health financing, and consistent implementation. Post-2015 priorities for Tanzania should focus on the unmet need for family planning, especially in the Western and Lake regions; addressing gaps for coverage and quality of care at birth, especially in rural areas; and continuation of progress for child health.

HEALTH KNOWLEDGE MANAGEMENT THROUGH DIGITAL TECHNOLOGIES AND SOLUTIONS IN EAST AFRICA: HEALTH RESEARCH, TRAINING, AND CARE

25 Citations

(Sorted by Partner States)

Kenya

1. **Experiences, Challenges and Lessons Learnt in the Development of KEMRI Research Visualization Dashboard.**

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ABSTRACT

INTRODUCTION: Research publications visualization represents a paradigm shift in the knowledge management (KM) and knowledge transfer (KT) targeting various stakeholders. Through visualization, dashboards provide adaptability, availability, cost efficiency, flexibility, scalability, and configurable data options. Data visualization deployed using customized online dashboards have enjoyed rapid growth around the world. However, the adoption of this emerging technology for the purpose of supporting knowledge management and knowledge translation in research institutions, especially in developing countries, is still in its infancy with limited documentation.

OBJECTIVE: To document experiences, challenges and lessons learnt in the development of KEMRI's research publications visualization dashboard.

METHOD: Research publication visualization was carried out by first developing website pages using JoomlaTM which is a free open-source content management system (CMS). PHP codes were added into the existing institutional website. Content Map which contains plugins and module for JoomlaTM made it easy for the team to insert Google Maps into the existing KEMRI website. KEMRI website is supported by a COMODO SSL certificate which generates the URL over HTTPS, which creates a secure channel over an insecure network giving reasonable protection against intruders and ensured that the server certificate is verified and trusted. For data mining, the team developed MESH search terms to facilitate locating previous publications from various online and offline database. These publications were classified into geographical zones where the research had been carried out. For data analytics, grouping of publications was carried using key parameters namely disease domains by county.

LESSONS LEARNT: KEMRI website was hosted by KENET, a contracted Internet Service Provider (ISP) which offers stable internet connectivity through fiber connectivity at a transfer rate of 70Mbps, adequate for the deployment of the KM platform. There was availability of critical mass of a knowledge management multi-disciplinary team who supported the back-end processes. In addition, KEMRI has a strong institutional policies and frameworks that support knowledge management and knowledge transfer.

2. **Challenges and lessons learned in an e-health application for an online cancer registry dashboard.**

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ABSTRACT

BACKGROUND: Kenya is a middle income country bearing a heavy burden of HIV and cancer. Infectious diseases mortality ranks highest in Kenya, with cancer risen to become the third leading cause of death. There is currently limited data on Kenya's cancer burden. Currently, there are various cancer registries being established including national cancer registry. The National Cancer Act in Kenya made cancer a notifiable disease, yet there still exists a significant gap in data on its incidence. This is due to many factors including, screening, policy implementation and limited data capture. A functional online registry will address some of these gaps. Objective To determine current data sources and collection methods as well as cancer services at two county referral hospitals in Kenya.

METHODS: We employed 3 C's for creative design in e-Health interventions. "Clarity in design", "Consistency" and "Content" which was achieved by conducting key informant interviews at two county hospitals. Using Semi structured questionnaires, 16 key informants who included management, service providers from the records, CCC. This was to establish continuum-of-care, service gaps and utilization of technology for data capture. Phase two of the study will pilot the e-system to link data on HIV patients presenting with cancer to a central dashboard.

RESULTS: Data on influencers of HIV and Cancer service delivery was analyzed. Three themes emerged as influencing delivery framework 1- Record maintenance, 2- Diagnostic infrastructure and 3- Governance. In record maintenance, record reconciliation was inadequate. At one facility, cervical cancer screening among HIV positive women was offered but results rarely reached the patient files on time nor was it in a usable format for the health records department. On diagnostic infrastructure, many patients are referred outside. One facility pointed out "MRI equipment only identifies a suspected cancer cases and additional histology tests needed and these were not readily available." On governance, one hospital administrator noted lack of policy to operationalize cancer screening among HIV positive individuals. They recommended that "the National Cancer Institute create stronger presence with health facilities in facilitate policy."

CONCLUSION: The barriers within the facilities will require tackling in phase 2 to bridge some of the gaps. The information on the current gaps will help in aligning the design and operationalization of the e-Health intervention to boost national planning and policy implementation.

3. Use of performance dashboards in health care project management: a case of an international health development organization in Kenya.

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AFRICA Health Agenda International Journal (AHAIJ), 2018.

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ABSTRACT

In this paper we document the use of dashboards in health care project management in an international health non-governmental organization. All projects at the organization monitor output performance on specific indicators against set targets and report these as project outputs performance report every month. In addition, projects prepare quality improvement report, compliance report and financial report. The four reports are then used to generate the monthly integrated performance monitoring and management dashboard which is shared with all staff and used by project managers and programme directors to review projects performance in the 4 parameters of measure and then used to provide appropriate technical support. We conducted a client satisfaction survey among staff to assess their levels of satisfaction with the dashboard and it came out that staff consider the dashboard as a "must have" monthly project management tool as it results in timely measurement of projects' financial performance, programmatic performance, quality of service performance and compliance performance at a glance without the need to go through detailed reports. Programme directors and project managers use the dashboard to quickly identify hotspots, detect outliers in indicators of measure in a project and use this to deeply analyse possible causes of poor performance in projects for targeted technical assistance.

4. The operation criteria of a health management information system

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East African Medical Journal: Journal Home > Vol 93, No 7 (2016).

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ABSTRACT

BACKGROUND: An iterative process before implementing any health management information system is needed, in that changes identified during the process must be evaluated to determine their effect on completed analyses. In order to achieve maximum returns on an investment or intervention evaluation should be from the outset. The process must consider system life cycle management and the organization's policy and budget as important integral factors.

OBJECTIVE: To evaluate the operation phase of the implemented Health Management Information System at Kenyatta National Hospital.

DESIGN: A descriptive cross-sectional study.

SETTING: Kenyatta National Hospital.

SUBJECTS: Forty (40) healthcare workers who were involved in the implementation of the Health Management Information System.

RESULTS: The response rate was more than 90%. The main indicator used in evaluating the electronic HMIS in KNH was performance 17 (53.1%), Other indicators that were commonly applied in HMIS evaluation in KNH were connectivity 9 (28.1 %) and durability 7 (21.9%), all these indicators are major items to consider and evaluate in an effective HMIS, although not at a good scale it can be concluded that the HMIS at KNH was fair since it's the first time KNH is adopting the concept.Most health workers17 (53.1%) felt that the electronic HMIS in KNH had achieved its objectives while the rest 16 (46.9%) were for the opinion that the electronic HMIS in KNH had not achieved its objectives. From the findings in the operation criteria the benefits of the electronic HMIS included improved efficiency and reduced workload. Other areas that were impacted on by the electronic HMIS were costs, and ICT skills or training.

CONCLUSIONS: From the findings in the operation criteria, the indicators showing successful implementation were: routine use of HMIS in healthcare activities, managerial support for HMIS, changes in hospital structure and integrated managerial processes, HMIS advocacy, data collection, analysis and interpretation and potential for ICT expansion. For the remaining indicators respondent did not strongly agree or agree that implementation had been

successful. The area in which implementation was not judged successful were: effective and fair distribution of computers, partial HMIS implementation, inadequate numbers of skilled and trained staff, and inadequate ICT infrastructure. Lastly the goal of monitoring and evaluation is not to focus on what is wrong and condemn it; rather, it is to highlight the positive aspects of the system that make it work, as well as to identify what went wrong as a basis for improving the system From the findings most health workers (53.1%) felt that the electronic HMIS in KNH had achieved its objectives which will in return lead to effective utilisation of HMIS and better healthcare service delivery.

5. Use of mobile learning technology among final year medical students in Kenya.

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ABSTRACT

INTRODUCTION: mobile phone penetration has increased exponentially over the last decade as has its application in nearly all spheres of life including health and medical education. This study aimed at assessing the use of mobile learning technology and its challenges among final year undergraduate students in the College of Health sciences, University of Nairobi.

METHODS: this was a cross-sectional descriptive study conducted among final year undergraduate students at the University of Nairobi, College of Health Sciences. Self-administered, anonymous questionnaires were issued to all final year students in their lecture rooms after obtaining informed consent. Data on demographics, mobile device ownership and mobile learning technology use and its challenges was collected. Data entry and analysis was done using SPSS®. Chi-square and t-test were used for bivariate analysis.

RESULTS: we had 292 respondents; 62% were medical students, 16% were nursing students, 13% were pharmacy students and 9% were dental surgery students. The majority were female (59%) and the average age was 24 years. Eighty eight percent (88%) of the respondents owned a smart device and nearly all of them

used it for learning. 64% of the respondents used medical mobile applications. The main challenges were lack of a smart device, lack of technical know-how in accessing or using apps, sub-optimal internet access, cost of acquiring apps and limited device memory.

CONCLUSION: mobile learning is increasingly popular among medical students and should be leveraged in promoting access and quality of medical education.

6. Current Status of E-Health in Kenya and Emerging Global Research Trends.

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ABSTRACT

Healthcare delivery is being transformed by advances in e-Health which is now recognized as an essential enabler for support of health systems across the world, acting not only as an agent for reforming healthcare systems, but also as an enabling tool to share resources among countries with similar challenges without having to duplicate efforts. Lack of interoperable health systems and consensus on data standards is one of the major barriers to the use of health information. Mobile phone use has seen tremendous growth across the developing world offering opportunities to engage e-Health applications. This paper looks at the status of e-Health in Kenya exploring the efforts the government has put in place to create a conducive environment for e-Health and also explores the global research trends in e-Health. The study is carried out through an examination of scientific research papers in journals and conference proceedings. Additionally, telephone interviews with the Ministries of Health, and Public Health and Sanitation is carried out to gauge the level of adoption. The study seems to reveal that though e-Health in Kenya is still in its infancy, the potential for its growth is enormous. This is fuelled by the rapid penetration of mobile phone use, an educated and entrepreneurial populace, and conducive legal, regulatory, and infrastructural environments.

7. **Information for decision making from imperfect national data: tracking major changes in health care use in Kenya using geostatistics.**

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ABSTRACT

BACKGROUND: Most Ministries of Health across Africa invest substantial resources in some form of health management information system (HMIS) to coordinate the routine acquisition and compilation of monthly treatment and attendance records from health facilities nationwide. Despite the expense of these systems, poor data coverage means they are rarely, if ever, used to generate reliable evidence for decision makers. One critical weakness across Africa is the current lack of capacity to effectively monitor patterns of service use through time so that the impacts of changes in policy or service delivery can be evaluated. Here, we present a new approach that, for the first time, allows national changes in health service use during a time of major health policy change to be tracked reliably using imperfect data from a national HMIS.

METHODS: Monthly attendance records were obtained from the Kenyan HMIS for 1 271 government-run and 402 faith-based outpatient facilities nationwide between 1996 and 2004. A space-time geostatistical model was used to compensate for the large proportion of missing records caused by non-reporting health facilities, allowing robust estimation of monthly and annual use of services by outpatients during this period.

RESULTS: We were able to reconstruct robust time series of mean levels of outpatient utilisation of health facilities at the national level and for all six major provinces in Kenya. These plots revealed reliably for the first time a period of steady nationwide decline in the use of health facilities in Kenya between 1996 and 2002, followed by a dramatic increase from 2003. This pattern was consistent across different causes of attendance and was observed independently in each province.

CONCLUSION: The methodological approach presented can compensate for missing records in health information systems to provide robust estimates of national patterns of outpatient service use. This represents the first such use of HMIS data and contributes to the resurrection of these hugely expensive but underused systems as national monitoring tools. Applying this approach to Kenya has yielded output with immediate potential to enhance the capacity of decision makers in monitoring nationwide patterns of service use and assessing the impact of changes in health policy and service delivery.

8. **The accuracy of human population maps for public health application.**

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ABSTRACT

OBJECTIVES: Human population totals are used for generating burden of disease estimates at global, continental and national scales to help guide priority setting in international health financing. These exercises should be aware of the accuracy of the demographic information used.

METHODS: The analysis presented in this paper tests the accuracy of five large-area, public-domain human population distribution data maps against high spatial resolution population census data enumerated in Kenya in 1999. We illustrate the epidemiological significance, by assessing the impact of using these different human population surfaces in determining populations at risk of various levels of climate suitability for malaria transmission. We also describe how areal weighting, pycnophylactic interpolation and accessibility potential interpolation techniques can be used to generate novel human population distribution surfaces from local census information and evaluate to what accuracy this can be achieved.

RESULTS: We demonstrate which human population distribution surface performed best and which population interpolation techniques generated the most accurate bespoke distributions. Despite various levels of modelling complexity, the accuracy achieved by the different surfaces was primarily determined by the spatial resolution of the input population data. The simplest technique of areal weighting performed best.

CONCLUSIONS: Differences in estimates of populations at risk of malaria in Kenya of over 1 million persons can be generated by the choice of surface, highlighting the importance of these considerations in deriving per capita health metrics in public health. Despite focusing on Kenya the results of these analyses have general application and are discussed in this wider context.

Rwanda

9. **Conclusions of the digital health hub of the Transform Africa Summit (2018): sustainable scale up of digital health in Africa.**

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ABSTRACT

BACKGROUND**:** The use of digital technologies to improve access to health is gaining momentum in Africa. This is more pertinent with the increasing penetration of mobile phone technology and internet use, and calls for innovative strategies to support implementation of the health-related Sustainable Development Goals and Universal Health Coverage on the continent. However, the huge potential benefits of digital health to advance health services delivery in Africa is yet to be fully harnessed due to critical challenges such as proliferation of pilot projects, poor coordination, inadequate preparedness of the African health workforce for digital health, lack of interoperability and inadequate sustainable financing, among others. To discuss these challenges and propose the way forward for rapid, cost-effective and sustainable deployment of digital health in Africa, a Digital Health Hub was held in Kigali from 8th to 9th May 2018 under the umbrella of the Transform Africa Summit 2018.

METHODS**:** The hub was organized around five thematic areas which explored the status, leadership, innovations, sustainable financing of digital health and its deployment for prevention and control of Non-Communicable Diseases in Africa. It was attended by over 200 participants from Ministries of Health and Information and Communication Technology, Private Sector, Operators, International Organizations, Civil Society and Academia.

CONCLUSIONS**:** The hub concluded that while digital health offers major opportunities for strengthening health systems towards the attainment of the Sustainable Development Goals including Universal Health Coverage in Africa, there is need to move from Donor-driven pilot projects to more sustainable and longer term nationally owned programmes to reap its benefits. This would require the use of people-centred approaches which are demand, rather than supply-driven in order to avoid fragmentation and wastage of health resources. Government leadership is also critical in ensuring the availability of an enabling

environment including national digital health strategies, regulatory, coordination, sustainable financing mechanisms and building of the necessary partnerships for digital health.

RECOMMENDATIONS**:** We call on the Smart Africa Secretariat, African Ministries in charge of health, information and communication technology and relevant stakeholders to ensure that the key recommendations of the hub are implemented.

key words: Africa; Conference proceedings; Digital health; Digital health hub; E-health; Transform Africa summit 2018

10. Impact of a district-wide health center strengthening intervention on healthcare utilization in rural Rwanda: Use of interrupted time series analysis.

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ABSTRACT

BACKGROUND**:** Evaluations of health systems strengthening (HSS) interventions using observational data are rarely used for causal inference due to limited data availability. Routinely collected national data allow use of quasi-experimental designs such as interrupted time series (ITS). Rwanda has invested in a robust electronic health management information system (HMIS) that captures monthly healthcare utilization data. We used ITS to evaluate impact of an HSS intervention to improve primary health care facility readiness on health service utilization in two rural districts of Rwanda.

METHODS**:** We used controlled ITS analysis to compare changes in healthcare utilization at health centers (HC) that received the intervention (n = 13) to propensity score matched non-intervention health centers in Rwanda (n = 86) from January 2008 to December 2012. HC support included infrastructure renovation, salary support, medical equipment, referral network strengthening, and clinical training. Baseline quarterly mean outpatient visit rates and population density were used to model propensity scores. The intervention began in May 2010 and was implemented over a twelve-month period. We used monthly healthcare utilization data from the national Rwandan HMIS to study changes in the (1) number of facility deliveries per 10,000 women, (2) number of referrals for high risk pregnancy per 100,000 women, and (3) the number of outpatient visits performed per 1,000 catchment population.

RESULTS**:** PHIT HC experienced significantly higher monthly delivery rates post-HSS during the April-June season than comparison (3.19/10,000, 95% CI: [0.27, 6.10]). In 2010, this represented a 13% relative increase, and in 2011, this represented a 23% relative increase. The post-HSS change in monthly rate of high-risk pregnancies referred increased slightly in intervention compared to control HC (0.03/10,000, 95% CI: [-0.007, 0.06]). There was a small immediate post-HSS increase in outpatient visit rates in intervention compared to control HC (6.64/1,000, 95% CI: [-13.52, 26.81]).

CONCLUSION**:** We failed to find strong evidence of post-HSS increases in outpatient visit rates or referral rates at health centers, which could be explained by small sample size and high baseline nation-wide health service coverage. However, our findings demonstrate that high quality routinely collected health facility data combined with ITS can be used for rigorous policy evaluation in resource-limited settings.

11. Newspaper coverage of maternal health in Bangladesh, Rwanda and South Africa: a quantitative and qualitative content analysis.

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ABSTRACT

OBJECTIVE: To examine newspaper coverage of maternal health in three countries that have made varying progress towards Millennium Development

Goal 5 (MDG 5): Bangladesh (on track), Rwanda (making progress, but not on track) and South Africa (no progress).

DESIGN: We analysed each country's leading national English-language newspaper: Bangladesh's The Daily Star, Rwanda's The New Times/The Sunday Times, and South Africa's Sunday Times/The Times. We quantified the number of maternal health articles published from 1 January 2008 to 31 March 2013. We conducted a content analysis of subset of 190 articles published from 1 October 2010 to 31 March 2013.

RESULTS: Bangladesh's The Daily Star published 579 articles related to maternal health from 1 January 2008 to 31 March 2013, compared to 342 in Rwanda's The New Times/The Sunday Times and 253 in South Africa's Sunday Times/The Times over the same time period. The Daily Star had the highest proportion of stories advocating for or raising awareness of maternal health. Most maternal health articles in The Daily Star (83%) and The New Times/The Sunday Times (69%) used a 'human-rights' or 'policy-based' frame compared to 41% of articles from Sunday Times/The Times.

CONCLUSIONS: In the three countries included in this study, which are on different trajectories towards MDG 5, there were differences in the frequency, tone and content of their newspaper coverage of maternal health. However, no causal conclusions can be drawn about this association between progress on MDG 5 and the amount and type of media coverage of maternal health.

key words: Bangladesh; Millennium Development Goal 5; Newspaper; Pregnancy and childbirth; Rwanda; South Africa

12. Paediatric pharmacovigilance: use of pharmacovigilance data mining algorithms for signal detection in a safety dataset of a paediatric clinical study conducted in seven African countries.

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ABSTRACT

BACKGROUND: Pharmacovigilance programmes monitor and help ensuring the safe use of medicines which is critical to the success of public health programmes. The commonest method used for discovering previously unknown safety risks is spontaneous notifications. In this study we examine the use of data mining algorithms to identify signals from adverse events reported in a phase IIIb/IV clinical trial evaluating the efficacy and safety of several Artemisinin-based combination therapies (ACTs) for treatment of uncomplicated malaria in African children.

METHODS: We used paediatric safety data from a multi-site, multi-country clinical study conducted in seven African countries (Burkina Faso, Gabon, Nigeria, Rwanda, Uganda, Zambia, and Mozambique). Each site compared three out of four ACTs, namely amodiaquine-artesunate (ASAQ), dihydroartemisinin-piperaquine (DHAPQ), artemether-lumefantrine (AL) or chlorproguanil/dapsone and artesunate (CD+A). We examine two pharmacovigilance signal detection methods, namely proportional reporting ratio and Bayesian Confidence Propagation Neural Network on the clinical safety dataset.

RESULTS: Among the 4,116 children (6-59 months old) enrolled and followed up for 28 days post treatment, a total of 6,238 adverse events were reported resulting into 346 drug-event combinations. Nine signals were generated both by proportional reporting ratio and Bayesian Confidence Propagation Neural Network. A review of the manufacturer package leaflets, an online Multi-Drug Symptom/Interaction Checker (DoubleCheckMD) and further by therapeutic area experts reduced the number of signals to five. The ranking of some drug-adverse reaction pairs on the basis of their signal index differed between the two methods.

CONCLUSIONS: Our two data mining methods were equally able to generate suspected signals using the pooled safety data from a phase IIIb/IV clinical trial. This analysis demonstrated the possibility of utilising clinical studies safety data for key pharmacovigilance activities like signal detection and evaluation. This approach can be applied to complement the spontaneous reporting systems which are limited by under reporting.

13. Is HINARI appropriate for medical students in the developing world?

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ABSTRACT

The Health InterNetwork Access to Research Initiative (HINARI), which arose in response to medical literature needs in developing countries, gives online access to scientific information to a variety of institutions throughout the world. This is a great resource; however, little research has been performed on the effectiveness and usefulness of HINARI, specifically to medical schools. Our study sought to find out whether the textbooks (e-books) available on HINARI could form a virtual library that would cover the curriculum of a medical school. After categorising and reviewing the medically relevant e-books on HINARI, we found that they were insufficient in providing adequate subject material relevant to medical school curricula from Rwanda, the United Kingdom and the United States. This literature gap could be closed by additional medical textbooks being made available from contributing publishers. An increase of only 14% in HINARI e-book resources would provide material for the entire medical school curriculum.

Tanzania

14. Improving Sexual Health Education Programs for Adolescent Students through Game-Based Learning and Gamification.

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ABSTRACT

An effective innovative pedagogy for sexual health education is required to meet the demands of technology savvy digital natives. This study investigates the extent to which game-based learning (GBL) and gamification could improve the sexual health education of adolescent students. We conducted a randomized control trial of GBL and gamification experimental conditions. We made a comparison with traditional teaching as a control condition in order to establish differences between the three teaching conditions. The sexual health education topics were delivered in a masked fashion, 40-min a week for five weeks. A mixed-method research approach was uses to assess and analyze the results for 120 students from a secondary school in Dar Es Salaam, Tanzania. Students were divided into groups of 40 for each of the three teaching methods: GBL, gamification, and the control group (the traditional teaching method). The average post-test scores for GBL (Mean = 79.94, SD = 11.169) and gamification (Mean = 79.23, SD = 9.186) were significantly higher than the control group Mean = 51.93, SD = 18.705 (F (2, 117) = 54.75, p = 0.001). Overall, statistically significant differences (p ≤ 0.05) were found for the constructs of Motivation, Attitude, Knowledge, and Engagement (MAKE). This study suggests that the two innovative teaching approaches can be used to improve the sexual health education of adolescent students. The methods can potentially contribute socially, particularly in improving sexual health behaviour and adolescents' knowledge in regions plagued by years of sexual health problems, including HIV/AIDS.

15. **Tanzania Health Information Technology (T-HIT) System: Pilot Test of a Tablet-Based System to Improve Prevention of Mother-to-Child Transmission of HIV.**

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ABSTRACT

BACKGROUND: The prevention of mother-to-child transmission (PMTCT) of HIV requires innovative solutions. Although routine monitoring is effective in some areas, standardized and easy-to-scale solutions to identify and monitor pregnant women, test them for HIV, and treat them and their children is still lacking. Mobile health (mHealth) offers opportunities for surveillance and reporting in rural areas of low- and middle-income countries.

OBJECTIVE: The aim of this study was to document the preliminary impacts of the Tanzania Health Information Technology (T-HIT) system mHealth intervention aimed at health workers for PMTCT care delivery and capacity building in a rural area of Tanzania.

METHODS: We developed T-HIT as a tablet-based system for an electronic data collection system designed to capture and report PMTCT data during antenatal, delivery, and postnatal visits in Misungwi, Tanzania. T-HIT was tested by health workers in a pilot randomized trial comparing seven sites using T-HIT assigned at random to seven control sites; all sites maintained standard paper record-keeping during the pilot intervention period. We compared numbers of antenatal visits, number of HIV tests administered, and women testing positive across all sites.

RESULTS: Health workers recorded data from antenatal visits for 1530 women; of these, 695 (45.42%) were tested for HIV and 3.59% (55/1530) tested positive. Health workers were unable to conduct an HIV test for 103 women (6.73%, 103/1530) because of lack of reagent, which is not captured on paper logs. There was no difference in the activity level for testing when comparing sites T-HIT to non-T-HIT sites. We observed a significant post intervention increase in the numbers of women testing positive for HIV compared with the pre intervention period (P=.04), but this was likely not attributable to the T-HIT system.

CONCLUSIONS: T-HIT had a high degree of acceptability and feasibility and is perceived as useful by health workers, who documented more antenatal visits during the pilot intervention compared with a traditional system of paper logs, suggesting potential for improvements in antenatal care for women at risk for HIV.

16. **Evaluation of an E-Learning Course for Clubfoot Treatment in Tanzania: A Multicenter Study.**

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ABSTRACT

In total, 80% of clubfoot cases occur in low- and middle-income countries, where lack of clinical knowledge of the Ponseti method of treatment presents as a major barrier to treatment. This study aims to determine the effectiveness of an electronic learning course to teach clinicians in Tanzania Ponseti method theory. A total of 30 clinicians were recruited from clinics with high referral rates for clubfoot patients and invited to 1 of 3 training sites: Mbeya (n = 15), Zanzibar (n = 10), and Mwanza (n = 5). Baseline knowledge, measured through a pretest, was compared to performance on a posttest after e-learning course completion. Scores for Mbeya and Zanzibar participants improved from 44 ± 12.5 to 69.8 ± 16.5 (P < .0001) and 44.3 ± 14.0 to 67.9 ± 21.4 (P = .01), respectively. Our results suggest that an e-learning course may be an effective method of disseminating Ponseti method theory in Tanzania. Successful implementation requires an understanding of the device availability and technology literacy of the users.

17. Introducing eHealth strategies to enhance maternal and perinatal health care in rural Tanzania.

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ABSTRACT

BACKGROUND: Globally, eHealth has attracted considerable attention as a means of supporting maternal and perinatal health care. This article describes best practices, gains and challenges of implementing eHealth for maternal and perinatal health care in extremely remote and rural Tanzania.

METHODS: Teleconsultation for obstetric emergency care, audio teleconferences and online eLearning systems were installed in ten upgraded rural health centres, four rural district hospitals and one regional hospital in Tanzania. Uptake of teleconsultation and teleconference platforms were evaluated retrospectively. A cross sectional descriptive study design was applied to assess performance and adoption of eLearning.

RESULTS: In 2015 a total of 38 teleconsultations were attended by consultant obstetricians and 33 teleconferences were conducted and attended by 40 health care providers from 14 facilities. A total of 240 clinical cases mainly caesarean sections (CS), maternal and perinatal morbidities and mortalities were discussed and recommendations for improvement were provided. Four modules were hosted and 43 care providers were registered on the eLearning system. For a period of 18–21 months total views on the site, weekly conference forum, chatroom and learning resources ranged between 106 and 1,438. Completion of learning modules, acknowledgment of having acquired and utilized new knowledge and skills in clinical practice were reported in 43–89% of 20 interviewed health care providers. Competencies in using the eLearning system were demonstrated in 62% of the targeted users.

CONCLUSIONS: E-Health presents an opportunity for improving maternal health care in underserved remote areas in low-resource settings by broadening knowledge and skills, and by connecting frontline care providers with consultants for emergency teleconsultations.

18. Do surveys with paper and electronic devices differ in quality and cost? Experience from the Rufiji Health and demographic surveillance system in Tanzania.

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ABSTRACT

BACKGROUND: Data entry at the point of collection using mobile electronic devices may make data-handling processes more efficient and cost-effective, but there is little literature to document and quantify gains, especially for longitudinal surveillance systems.

OBJECTIVE: To examine the potential of mobile electronic devices compared with paper-based tools in health data collection.

METHODS: Using data from 961 households from the Rufiji Household and Demographic Survey in Tanzania, the quality and costs of data collected on paper forms and electronic devices were compared. We also documented, using qualitative approaches, field workers, whom we called 'enumerators', and households' members on the use of both methods. Existing administrative records were combined with logistics expenditure measured directly from comparison households to approximate annual costs per 1,000 households surveyed.

RESULTS: Errors were detected in 17% (166) of households for the paper records and 2% (15) for the electronic records (p < 0.001). There were differences in the types of errors (p = 0.03). Of the errors occurring, a higher proportion were due to accuracy in paper surveys (79%, 95% CI: 72%, 86%) compared with electronic surveys (58%, 95% CI: 29%, 87%). Errors in electronic surveys were more likely to be related to completeness (32%, 95% CI 12%, 56%) than in paper surveys (11%, 95% CI: 7%, 17%).The median duration of the interviews ('enumeration'), per household was 9.4 minutes (90% central range 6.4, 12.2) for paper and 8.3 (6.1, 12.0) for electronic surveys (p = 0.001). Surveys using electronic tools, compared with paper-based tools, were less costly by 28% for recurrent and 19% for total costs. Although there were technical problems with electronic devices, there was good acceptance of both methods by enumerators and members of the community.

CONCLUSIONS: Our findings support the use of mobile electronic devices for large-scale longitudinal surveys in resource-limited settings.

19. Addressing research capacity for health equity and the social determinants of health in three African countries: the INTREC programme.

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ABSTRACT

BACKGROUND: The importance of tackling economic, social and health-related inequities is increasingly accepted as a core concern for the post-Millennium Development Goal framework. However, there is a global dearth of high-quality, policy-relevant and actionable data on inequities within populations, which means that development solutions seldom focus on the people who need them most. INTREC (INDEPTH Training and Research Centres of Excellence) was established with this concern in mind. It aims to provide training for researchers from the INDEPTH network on associations between health inequities, the social determinants of health (SDH), and health outcomes, and on presenting their findings in a usable form to policy makers.

OBJECTIVE: As part of a baseline situation analysis for INTREC, this paper assesses the current status of SDH training in three of the African INTREC countries - Ghana, Tanzania, and South Africa - as well as the gaps, barriers, and opportunities for training.

METHODS: SDH-related courses from the three countries were identified through personal knowledge of the researchers, supplemented by snowballing and online searches. Interviews were also conducted with, among others, academics engaged in SDH and public health training in order to provide context and complementary material. Information regarding access to the Internet, as a possible INTREC teaching medium, was gathered in each country through online searches.

RESULTS: SDH-relevant training is available, but 1) the number of places available for students is limited; 2) the training tends to be public-health-oriented rather than inclusive of the broader, multi-sectoral issues associated with SDH; and 3) insufficient funding places limitations on both students and on the training institutions themselves, thereby affecting participation and quality. We also identified rapidly expanding Internet connectivity in all three countries, which opens up opportunities for e-learning on SDH, though the current quality of the Internet services remains mixed.

CONCLUSIONS: SDH training is currently in short supply, and there is a clear role for INTREC to contribute to the training of a critical mass of African researchers on the topic. This work will be accomplished most effectively by building on pre-existing networks, institutions, and methods.

20. A Critical Review of eLearning Research Trends in Tanzania.

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ABSTRACT:

This study adopted bibliometric and content analysis methods to explore research trends on eLearning implementation in Tanzania between 2007 and 2017. A total of 74 articles from electronic databases, conference proceedings, and selected electronic journals were reviewed. The study found out that there is an increasing interest in eLearning research with the majority of studies conducted by researchers from three universities. Quantitative research design was found to be the most preferred research design by eLearning researchers in Tanzania mostly engaging students' population. Despite the proliferation of mobile telephony in Tanzania, this study revealed that mobile and game-based learning were the least investigated eLearning technologies. The study also shows that Internet access and lack of support were the most ranked challenges

hindering eLearning implementation in Tanzania. The research gaps identified in this study are crucial for decision makers in both looking for better ways to stimulate further research in more strategic ways and in setting strategies to overcome barriers that hinder eLearning implementation in Tanzania.

21. **Replacing paper data collection forms with electronic data entry in the field: findings from a study of community-acquired bloodstream infections in Pemba, Zanzibar.**

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ABSTRACT

BACKGROUND: Entering data on case report forms and subsequently digitizing them in electronic media is the traditional way to maintain a record keeping system in field studies. Direct data entry using an electronic device avoids this two-step process. It is gaining in popularity and has replaced the paper-based data entry system in many studies. We report our experiences with paper- and PDA-based data collection during a fever surveillance study in Pemba Island, Zanzibar, Tanzania.

METHODS: Data were collected on a 14-page case report paper form in the first period of the study. The case report paper forms were then replaced with handheld computers (personal digital assistants or PDAs). The PDAs were used for screening and clinical data collection, including a rapid assessment of patient eligibility, real time errors, and inconsistency checking.

RESULTS: A comparison of paper-based data collection with PDA data collection showed that direct data entry via PDA was faster and 25% cheaper. Data was more accurate (7% versus 1% erroneous data) and omission did not occur with electronic data collection. Delayed data turnaround times and late error detections in the paper-based system which made error corrections difficult were avoided using electronic data collection.

CONCLUSIONS: Electronic data collection offers direct data entry at the initial point of contact. It has numerous advantages and has the potential to replace paper-based data collection in the field. The availability of information and communication technologies for direct data transfer has the potential to improve the conduct of public health research in resource-poor settings.

22. A medical birth registry at Kilimanjaro Christian Medical Centre.

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ABSTRACT

OBJECTIVE: To establish a medical birth registry intended to serve clinical, administrative and research purposes.

METHODS: Starting in July 2000, every birth at Kilimanjaro Christian Medical Centre (KCMC) in Moshi, Tanzania has been recorded in a separate database. The information is obtained through personal interviews with each mother, conducted by specially trained midwives, and supplied with data from the medical records. A secretary enters the data into the electronic file. Data are collected about the mother and father: education, occupation and living conditions, mother's health before and during present pregnancy, expected date of delivery, smoking and drinking (alcohol) habits, use of drugs, plus HIV and syphilis status (if known). This is followed by particulars on the delivery: spontaneous or induced, and complications; the child or children: weight, height and Apgar score, malformations and other diagnoses. Mode of birth: spontaneous or operative intervention. If perinatal death: when? Transfer to intensive neonatal unit? The mother's reproductive history (births, miscarriages, ectopic pregnancies) is also recorded, with outcomes.

RESULTS: We describe the process based on more than six years' experience, including obstacles and how they were overcome. The registry serves as a monitoring tool, with a set of key activities and events being issued monthly,

indicating changes and trends in, e.g., bleeding complications, caesarean section rates and perinatal mortality, as early warning signs. Monthly reports on key issues are presented. Confidentiality and data protection are key issues. Day-to-day recording of births is vulnerable to personnel shortage, whether from disease or holidays.

CONCLUSIONS: Validation and quality checks leave the overall impression that the database is largely accurate and credible. There are plenty of opportunities for research. Clinicians and epidemiologists will profit from using the database to test hypotheses and clarify problem issues, to the ultimate benefit of labouring women and their children.

Uganda

23. Prioritizing integrated mHealth strategies for universal health coverage.

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ABSTRACT

As countries strive toward universal health coverage, mobile wireless technologies—mHealth tools—in support of enumeration, registration, unique identification, and maintenance of health records will facilitate improved health system performance. Electronic forms and registry systems will enable routine monitoring of the coverage of essential interventions for individuals within relevant target populations. A cascading model is presented for prioritizing and operationalizing the role of integrated mHealth strategies.

24. Perceptions and acceptability of mHealth interventions for improving patient care at a community-based HIV/AIDS clinic in Uganda: a mixed methods study.

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ABSTRACT

Mobile technologies for health (mHealth) represent a growing array of tools being applied in diverse health care settings. mHealth interventions for improving HIV/AIDS care is a promising strategy, but its evidence base is limited. We conducted a formative research evaluation to inform the development of novel mHealth HIV/AIDS care interventions to be used by community health workers (CHWs) in Kampala, Uganda. A mixed methods formative research approach was utilized. Qualitative methods included 20 in-depth interviews (IDIs) and six focus groups with CHWs, clinic staff, and patients. Thematic analysis was performed, and selected quotations used to illustrate themes. Quantitative methods consisted of a survey administered to CHWs and clinic staff, using

categorical and Likert scale questions regarding current mobile phone and internet access and perceptions on the potential use of smartphones by CHWs. Qualitative results included themes on significant current care challenges, multiple perceived mHealth benefits, and general intervention acceptability. Key mHealth features desired included tools to verify CHWs' task completions, clinical decision support tools, and simple access to voice calling. Inhibiting factors identified included concerns about CHWs' job security and unrealistic expectations of mHealth capabilities. Quantitative results from 27 staff participants found that 26 (96%) did not have internet access at home, yet only 2 (7.4%) did not own a mobile phone. Likert scale survey responses (1-5, 1 = Strongly Disagree, 5 = Strongly Agree) indicated general agreement that smartphones would improve efficiency (Mean = 4.35) and patient care (4.31) but might be harmful to patient confidentiality (3.88) and training was needed (4.63). Qualitative and quantitative results were generally consistent, and, overall, there was enthusiasm for mHealth technology. However, a number of potential inhibiting factors were also discovered. Findings from this study may help guide future design and implementation of mHealth interventions in this setting, optimizing their chances for success.

25. Experience implementing electronic health records in three East African Countries.

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ABSTRACT

INTRODUCTION: Efficient use of health care resources in low-income countries by providers and local and national managers requires timely access to patient data.

OBJECTIVE: To implement electronic health records (EHRs) in HIV clinics in Kenya, Tanzania, and Uganda.

RESULTS: We initially developed and implemented an EHR in Kenya through a mature academic partnership. The EHR was then implemented in six HIV clinics in Tanzania and Uganda in collaboration with their National AIDS Control Programmes. All implementations were successful, but the system's use and sustainability varied depending on who controlled clinic funding.

CONCLUSIONS: Successful EHR use and sustainability were enhanced by local control of funds, academic partnerships (mainly by leveraging research funds), and in-country technology support.

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