Combining Vital Events Registration, Verbal Autopsy and Electronic Medical Records in Rural Ghana for Improved Health Services Delivery

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Abstract

This paper describes the process of implementing a low-cost 'real-time' vital registration and verbal autopsy system integrated within an electronic medical record within the Millennium Village cluster in rural Ghana. Using MGV-Net, an open source health information architecture built around the OpenMRS platform, a total of 2378 births were registered between January 2007 and June 2009. The percentage of births registered in the health facility under supervision of a skilled attendant increased substantially over the course of the project from median of 35% in 2007 to 64% in 2008 and 85% midway through 2009. Building additional clinics to reduce distance to facility and using the CHEWs to refer women for delivery in the clinics are possible explanations for the success in the vital registration. The integration of vital registration and verbal autopsies with the MGV-Net information system makes it possible for rapid assessment of effectiveness and provides important feedback to local providers and the Millennium Villages Project.

Keywords:

Africa, Birth records, Community health information systems, Electronic health records, Ghana, Health information systems, OpenMRS, Verbal autopsy, Vital statistics.

Introduction

A global agenda to address the overlapping vulnerabilities of poverty, underdevelopment and ill-health has recently been articulated in the United Nations Millennium Development Goal (MDG) framework [1]. Reducing premature death among children and among women during childbirth have been identified as urgent priorities, with specific time-bound MDG targets. The Millennium Villages Project (MVP) has been previously described and involves the systematic delivery of a package of proven health and development interventions, with the aim of accelerating progress towards the Millennium Development Goals [2].

The MVP is among the first applications of a multi-sector community health and development intervention. Interventions in agriculture, infrastructure, economics, education and health are being simultaneously introduced to village units of 1,000-10,000 households. This intensity and scale, combined with the diversity of MVP contexts, provide an unprecedented opportunity for better understanding the contribution of economics, infrastructure and health to human development. Lessons learned from the project have enormous potential to inform policy and program development in Africa and elsewhere for the coming decades.

In parallel to enhancing access to proven interventions, global health gains require the generation of high quality health information that can be used to guide program delivery [3].

Recent calls for 'information reform' to improve bottom-up approaches to the generation and use of information has the potential to revitalize locally-based health information systems and provide data on access of care, and critical health outcomes that can be used directly to improve local practice and reduce deaths [4].

While addressing maternal and child death rates are overriding concerns of two of the MDG targets, tools for the systematic measurement of mortality have evolved relatively recently. Currently more than half of deaths in developing countries go unregistered. With vital registration data often missing, incomplete and inaccurate, informed decisions regarding how and where to best intervene are often difficult to make [5].

Vital registration (monitoring of births and deaths) and verbal autopsies have been put forth as a potential strategy to address the need for real-time information to inform the targeting and improve coverage with essential public health interventions. Verbal autopsies (VAs) are "a procedure to exploit the information provided by the relatives of a deceased person to reconstruct the events and symptoms that preceded the death so as to deduce a medically acceptable cause, or causes, of death" [6, 7].

Despite the potential for vital events monitoring and VAs to inform intervention strategies, there has been much less inter-

national experience in this regard [8]. VA data has limited use, because of long time delay between vital event identification, VA data collection, cause of death determination, and data aggregation/analysis. However, some important preliminary work has been undertaken in a diversity of settings including the use of VAs to inform programs to address diabetes in the Ukraine [9], assess care seeking for malaria in Tanzania [10], understanding health seeking behavior, to guide the targeting health system interventions to improve TB diagnosis and treatment initiation in South Africa [11], and to guide improvements in the quality of community and hospital care to reduce infant mortality in India [12].

Medical records are often a key source of information to obtain the complete picture about births and deaths. [13] Integration of vital registration with clinical systems such as hospital records has been suggested using linkage software. [14] However, the work required to implement vital registration systems in low resource, rural communities with historically low access and/or utilization of health delivery systems should not be underestimated. [15] Capturing the complete picture of vital events often requires integration of multiple sources including the community, health facilities and other sources. [16]

When viewed holistically, the importance of vital events information, the existence of multiple primary data sources, the resources required to implement the system, and the value in reusing the data to assist with program management and patient care, it is likely that integrating vital registration and verbal autopsies with electronic medical records close to the communities will be beneficial.

This paper describes the process of implementing a low-cost 'real-time' vital registration and VA system within the Millennium Village cluster in rural Ghana. Implementation is currently in progress; however, we present preliminary data from the system and underscore ways in which these data can be used to inform and strengthen health systems and service delivery.

Materials and Methods

MVP Bonsasso, Ghana

Bonsaaso Millennium Village is located in the Amansie West District in the Ashanti Region of Ghana. The village is an agglomeration of 30 communities with 5769 households and has an estimated population of 30,000 people, of which 23% are women with reproductive age (15-49 years). When the project started in 2006 there were only three health centers within the cluster. The nearest hospital where surgery could be performed is the Agroyesum Catholic Mission Hospital which is about 27 km away from the village. In Bonsaaso, the nurse-population ratio in 2006 was 1:5,452. At the Regional level, nurse-population ratio was 1:3,082 and the doctor-population ratio was 1: 31,477. Due to the dispersed nature of the communities, coupled with poor condition of roads, inadequate transport services, access to the health facility posed enormous challenge to the people at the beginning of the project.

Currently there are 7 clinics and a medical store operating in the village that have reduced the distances people have to travel to access health care (see Table 1). Other changes between 2006 and 2009 are also shown.

Table 1 – Comparison of infrastructure between 2006-2009

Infrastructure/Human Resources	2006	2009
Number of Clinics in Cluster	3	7 + store
Average Distance to Reach Clinic	8.5 km	3.5 km
Health Clinic Staff	3	71
Midwives	2	7
Community Health Ext. Workers	0	28

Overview of the MGV-Net Vital Registration and Verbal Autopsy (VRVA) System

The Millennium Global Village-Network (MGV-Net) has been described previously and is an open source health information architecture built around the OpenMRS platform. [17] In the Ghana MVP site, vital registration and verbal autopsies are being integrated into MGV-Net to provide this critical information at the community level to facilitate decision-making and assist in the delivery of care. The VRVA system has a number of components that will be highlighted briefly below:

- **Community Health Extension Workers (CHEWs):** In all MVP sites, CHWs or CHEWs have been introduced to maximize the delivery of health information and services to households in the project clusters. There currently a ratio of 1 CHW to every 100-200 households, with household visits taking place every 1-2 months. CHWs are supported by an MVP Health Coordinator (doctors or allied health professionals), and provide a spectrum of health interventions to target households. Furthermore, CHWs are aware of vital events in households (births and deaths) very quickly.

- **Verbal autopsy specialist:** the VA specialist is non-clinical health worker specially trained in the VA methodology. VA specialists have the primary responsibility for conducting VAs.

- **VRVA tools:** have been developed for adults/maternal deaths and child deaths with two main components:

    - *Birth registration form:* questions to evaluate the circumstances of child birth, including location, attendance of skilled professional, and condition of the child.

    - *Cause of death module:* questions to assess signs and symptoms experienced by the deceased in the time preceding death. The module was derived from previously validated VA tools and consists of both close and open-ended sections as per best-practice guidelines.

– *Social autopsy module:* a specific module has been developed to include details regarding the social circumstances surrounding death. It includes information on health seeking behavior, access barriers to health care, communication, transport, and economics.

- **Data entry and algorithmic assessment of cause of death/social autopsy diagnosis:** All VRVA forms are entered into an OpenMRS database monthly. In order to facilitate a rapid generation of critical information for targeting interventions, a series of algorithms has been employed. These are established, valid techniques for determining the probable cause of death [18-24]. Selection criteria for algorithm were sensitivity and specificity greater than 50% and 75%, respectively as well as an estimated cause specific mortality rates (given sensitivity and specificity) within 40% of prevailing rates. Additionally, algorithms to assess the social circumstances leading up to death are also employed. This innovation eliminates the need for dual physician-based assessments, which can be both expensive and create a long time delay in generating 'real time' information for program managers.

- **Community Morbidity & Mortality Rounds:** the broad aim of the system is to generate information on the cause and social circumstances surrounding death to inform the delivery of health and development interventions on the ground, in real-time. Data collected on cause of death will be compiled and form the basis of a community 'morbidity and mortality rounds' – conducted by clinic staff, VAS, and the CHWs. These meetings will provide a forum for engaging with the medical and social autopsy data with appropriate recommendations being made regarding the introductions of new health programs, modifications in the delivery or targeting of existing health programs, or the need to liaise with other sectors such as infrastructure, education or nutrition to address other remediable concerns.

Status of Implementation in Ghana

Prior to 2008, data on births and deaths were collected by community volunteers. In January 2008, data collection responsibilities were transferred to the CHWs. This data is currently collected on paper and transferred to OpenMRS using retrospective data entry. MVP has recently tested entry via forms submitted from a Java-enabled mobile phone using an application based on the JavaROSA platform. In addition, we are in the process of rolling out data entry via ChildCount+, based on RapidSMS, a UNICEF-sponsored, SMS-based client on mobile phones. Mobile-based data collection will hasten the transfer of data from the community to the clinic. In particular, mobile technologies will lessen the lag time between death identification and the verbal autopsy interview, which further promotes the 'real-time' utilization of community-based health information.

Clinical Integration

At the time of this article, vital registration information has been reviewed by MVP office and clinic staff in Ghana. It has yet to be integrated clinically with daily operations of MVP clinics. However, plans are already underway to use the newly available information to create alerts and reminders for childhood immunizations and for the care and follow-up of newly delivered mothers. Registration of pregnant women in the medical record will also allow for improved antenatal care as well as identification and referral at the time of delivery if necessary. The MGV-Net infrastructure, involving OpenMRS, SMS and other mHealth technologies, is also consistent with work being done elsewhere in Ghana by the Mailman School of Public Health, the Grameen Foundation and the Bill and Melinda Gates Foundation.

Results

Birth Registration

Our initial analysis of the Bonsasso data focused on birth registration. A total of 2378 births occurred in the project area between January 2007 and June 2009. These are shown in Figure 1. The sharp decrease in total births at the end of 2008 was thought to be due to increased family planning efforts earlier in the year.
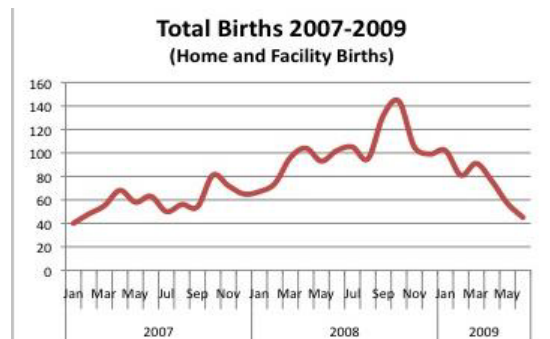

Figure 1- Total Births within the Bonsasso MVP cluster from 2007 through 2009.

According to community-based interviews administered to each new mother, the percentage of births within the project area that took place in a health facility increased substantially over the course of the project as shown in Figure 2 from a median of 35% in 2007 to 64% in 2008 and 85% midway through 2009.

Figure 2 - Percentage of all births occurring in a health facility versus home from 2007 through 2009.

In addition to MVP sponsored clients, the MVP clinics services patients from outside the intervention area. Seventy percent of facility-based births were to woman who resided within the MVP site and 30% were to woman who lived outside the cluster of villages as shown in Figure 3.

Figure 3 - Proportion of woman who gave birth in MVP facilities who lived in the MVP site at the time of birth.

Death Registration and Verbal Autopsies

At the time of this article, piloting of the death registration and verbal autopsy program is still ongoing while an external validation of mortality rates is undertaken. The likelihood of underreporting is very high given the emotional and social sensitivities of death within a household; therefore, a cross-sectional validation is recommended. Reporting of mortality and cause of death trends will be reported once implementation is completed and the results are validated.

Discussion

We present a novel application of a 'real-time' vital registration and VA system integrated within an open source electronic medical record in rural Ghana. This paper demonstrates the design and feasibility of the system as well as highlights its potential relevance as a tool to assist in monitoring intervention effects and facilitating improved coverage with essential maternal–child health services.

During implementation several challenges and limitations of the system were evident. Registration of births appears to be accurate and easy to implement given the modest cultural sensitivity; however, high community mobilization and awareness efforts of the CHEWs is required. Like many other community-based monitoring systems, CHEWs may underestimate deaths, particularly newborns, if families refuse to disclose them. Facility-based deaths that are included in the medical record will be more accurately reported, but most rural deaths happen at home. Home-based verbal autopsies may not provide a less complete picture of cause of death as clinic-based diagnoses, particularly pediatric deaths, which are often complex to assess. Further research and local validation of algorithms is needed. However, this VRVA system, including mobile death reporting, is valuable for quickly identifying patterns in the medical and social circumstances surrounding death.

In relation to the preliminary results presented, dramatic increase in skilled birth attendance can be attributed to several possible explanations. The construction and staffing of additional clinics in the MVP site and reducing the distance to the facility both seemed to contribute towards ensuring reliable supply of high quality care. It is also likely that training the CHEWs to refer women for delivery may have also had an effect on accelerating the demand for safe delivery services..

It is still too early to fully interrogate the potential of having detailed birth and death data available to MVP at the community level. The initial analyses of birth information have provided important detail about the numbers of births within the MVP site and the relative contribution of those living outside the cluster of villages. The marked reduction in overall births and the shifting of births from the home to skilled attendant deliveries in the clinics over the period of the project is encouraging. The impact of higher skilled birth attendance on child survival within the MVP site is currently under study. The integration of vital registration and verbal autopsies with the MGV-Net information system makes it possible for rapid assessment of effectiveness and provides important feedback to local providers and MVP. We hope that such timely and practical information will lead to improved quality of programming and of local delivery of care.

Acknowledgments

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