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Original Article

THE USE OF MOBILE ELECTRONIC DEVICES FOR PUBLIC HEALTH DATA COLLECTION AND SYNDROMIC SURVEILLANCE AT THE REPUBLIC OF SIERRA LEONE ARMED FORCES

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Abstract

Public health data collection methods in Sierra Leone were compared. First, a household health census was conducted with some interviewers using paper-based forms requiring later data entry and others using tablet computers for immediate electronic data inputting. Electronic data-entry surveys were more time-efficient and accurate than paper-based surveys. In a second evaluation, military Medical Inspection rooms (MIRs) sent syndromic surveillance reports to a central communications hub via cell phone or paper-based forms. The report compliance rate was 89% for daily SMS and 100% for weekly SMS versus 76% for weekly paper reports. Electronic data collection and reporting is feasible and cost-efficient in low-resource settings.

Keywords:
mobile phones, text messaging, database management systems, census methods, sentinel surveillance

Introduction

Public health data collection and surveillance are important mechanisms by which countries obtain information to improve the health and wellbeing of their residents. In low income countries, paper-based recording methods continue to be used for data collection even though paper-based surveys and surveillance efforts require considerable spending on printing, transportation, data entry, data cleaning, and record storage.

More importantly, the time required for manual entry of data into a computer prior to analysis precludes the ability to conduct real-time analysis and therefore limits the utility of the data.

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Because more than half of Africans have a mobile phone (compared to less than 2% with a fixed telephone line), including more than one-third of residents of Sierra Leone, where this study was based (ITU, 2011; van Heerden *et al.*, 2010), data collection using mobile technology is becoming more feasible even in rural and low-resource settings.

Timely collection and analysis of public health data is essential for syndromic surveillance (SS) systems, which normally act as an early warning system, detecting certain kinds of serious disease outbreaks days in advance of conventional surveillance systems (Chretien *et al.* 2008). The use of tablet computers for direct data entry can reduce data collection time when compared to paper-based data recording. Coupling SS systems with the use of mobile electronic devices (MEDs) connected to wireless networks, such as mobile phones, personal digital assistants, enterprise digital assistants, and handheld ultra-portable computers can further increase access to incidence data while decreasing reporting time delays (Fernandez *et al*. 2011).

This research project had two key goals. In the first analysis, we compared the efficiency of recording survey responses using paper-based methods or direct entry into tablet computers. In the second study, we assessed the use of daily mobile phone short message service (SMS) reports as part of syndromic surveillance.

Methods

In the first study, a door-to-door health census was conducted in 20 of the 68 sections of the city of Bo. Households within each section were identified during a community-participatory map-making process described elsewhere (Ansumana *et al*. 2010). For the first several weeks of data collection, a paper-based survey was used to record household- and individual-level responses during household visits, and the answers were later entered into a relational database. For the remaining weeks of data collection, responses were directly entered into a FilemakerGO database installed on Apple iPads (16 GB Wi-Fi, without a 3G mobile communication capability). The iPads were loaded with digital maps showing which households within a particular enumeration area were to be interviewed each day. The interviewers used the maps to locate the households and then used FileMaker database pages to directly enter data during the interview. For most questions, answers were recorded by selecting from a menu of responses on the touchscreen; for open-ended questions space was provided for typing in the response. The data entered into the iPads were downloaded each evening to a secure computer in a locked research facility; the data were then deleted from the iPads in order to ensure the protection of participants' privacy and confidentiality. The iPads were charged each night in a facility with a backup electrical supply in case of power outages.

The second study collected public health reports from military medical inspection rooms (MMIRs). MMIRs are facilities that provide first aid and basic medical care to military personnel and their families, referring patients to hospitals if an examination reveals that advanced care is required. MMIRs from across Sierra Leone (Figure 1) were asked to provide daily syndromic reports via mobile phone SMS

from October 2011 to October 2012. SMS is the cheapest way to use a phone, costing an average of 5 units per message at the time of this study. As a comparison, a 2-minute phone call would cost about 20 units. The primary sign, symptom, or complaint of each outpatient seen at an MMIR was used to assign each individual to a "syndrome" group, such as the febrile illness group (including malaria), gastrointestinal infection group, or skin infection group.

A coding system was devised in order to protect the privacy of the data and to ensure that no MMIR report would exceed 144 characters. For example, if on October 30, 2011, the 5th Brigade Headquarters diagnosed 15 cases of febrile illness, 3 cases of acute gastroenteritis, and 2 cases of acute respiratory infections, and the report was submitted by a person with the first and last initials "FL," the message would read "30102011 5BHQ FL A15B3E2," as per the code shown on Table 1. A central communications hub was created in Freetown using Frontline SMS (Short Message Service) on a Lenovo ThinkPad that had a Motorola L9i Phone with an Airtel simcard connected to it. MMIRs could use any type of mobile phone to send messages to the central communication hub.

The SMS data collection was done in two phases. In phase one, the SMS was tested against the paper-based method for 30 weeks, and the costs of traditional and SMS surveillance reporting were compared. Fourteen MMIRs submitted daily SMS reports, while 5 MMIRs continued to use traditional paper-based weekly reporting. In phase two, SMS was used by all 17 MMIRs from phase 1 plus 5 new MMIRs, for a total of 22 facilities. Compliance with sending of reports was assessed.

Results

In total, 4324 households participated in the Bo health census. Paper surveys were used for the first two municipal sections, which were home to 1027 households. Nine interviewers collected the data over a 16-day period, averaging about 7 interviews per interviewer per day. Electronic data collection was used for the remaining 18 sections, which were home to 3297 households. Ten interviewers working different shifts used five tablet computers to collect data over 80 days, averaging about 8 interviews per day. Electronic data collection did not significantly change the time required for an interview to be completed, averaging about 40 minutes for both data recording methods.

However, the data from the electronic interviews were available for use much sooner. It took about 3 months to enter the paper-based data into a Filemaker Pro database, with additional weeks spent cleaning the data. In total, more than 15 additional minutes were required for data entry of paper forms. In contrast, the iPad data did not require any additional time for data entry, and the data cleaning was simpler because the iPad forced all essential questions to be answered, restricted close-ended questions to certain pre-approved responses, and eliminated the challenges of deciphering poor handwriting. Thus, while the use of a tablet computer did not save a substantial amount of data collection time, the reduced burden of data entry and data cleaning represented a significant saving of time and hourly wages. Additionally, the money saved by not printing survey forms (about Le 200 per page, or Le 2000 for a 10-page survey) helped to offset the purchase price of the tablet computers.

Comparisons of reporting methods were also made for the data collected from MMIRs. Among the 17 MMIRs that were asked to send daily SS reports via SMS for the entire year, 4718 SMS messages were sent. Since 6 daily reports each week were expected over the 52 weeks of SMS reporting by the 17 SMS-only MMIRs, the compliance rate was 88.9% (4718/5304).

In contrast, the five control MMIRs that sent weekly (rather than daily) syndromic reports by radio and by postal delivery service sent 115 messages over the 30 weeks of the first phase of the study. They had been expected to send 150 reports total (30 reports from each of the 5 MMIRs), so the reporting compliance rate was 76%. In the second phase of the project, these 5 MMIRs were asked to send weekly (not daily) SMS reports. They were 100% compliant with submitting these weekly reports.

Using daily SMS rather than weekly paper reports increased the timeliness of reports, decreased the costs of reporting, reduced errors and confidentiality risks associated with communication via unsecured radio or telephone lines, and eliminated the challenges and risks associated with transporting weekly syndromic surveillance reports to military headquarters via unimproved roads.

The most common syndromes reported by the MMIRs were febrile infections (21.7%), musculoskeletal syndromes (21.0%), gastrointestinal infections (14.9%), and respiratory tract infections (13.9%) (Table 1). Additionally, in the months of July to October 2012, there was an outbreak of cholera in Sierra Leone and all MMIRs were used to monitor the occurrence of the cholera within their catchment area. The counts of cholera per MMIR are shown in Figure 2.

Discussion

This study's findings about the efficiency of using mobile data collection for tracking and improving public health are in line with those from previous studies in Africa. For example, Rotheram-Borus *et al.* (2012) reported success in a mobile phone-based data collection and peer-support intervention among resource-poor diabetic women in Southern Africa. Similarly, Tomlinson *et al.* (2009) reported the use of mobile phones to survey 39,665 households in Umlazi, South Africa, without any data loss (though the study lacked a control group). Lori *et al.* (2012) reported mobile phone usage for texting by nonliterate traditional midwives in rural Liberia after a 3-day cell phone training, though the skills gained during the training were not translated to a routine health intervention over a prolonged period. Andreatta (2011) also reported the use of mobile phones by professional and traditional birth attendants to report births in Ghana, but the integrity of the data was questionable. However, additional studies are required in order to develop and refine new methods for designing and implementing effective surveillance and reporting systems.

The data collected with our SMS reporting system suggests a high incidence of treatable communicable infections across Sierra Leone as well as a relatively high incidence of injuries (such as fractures and sprains). The public health response to these conditions may be enhanced by rapid reporting of emerging situations to health officials.

These studies further demonstrate that the use of tablet computers and mobile phones for data collection is possible in low income settings, and that mobile data collection increases the availability of health data while reducing the costs of data collection, data management, and reporting.

Timely reporting of population health assessments and syndromic surveillance data are critical for identifying health needs and disease trends, and real-time mobile data collection allows for the rapid implementation of responses to time-sensitive events such as outbreaks of infectious diseases or mass-casualty events with a significant number of injuries.

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