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The Use of Mobile Phone as a Tool for Capturing Patient Data in Southern Rural Tamil Nadu, India

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Abstract: The present pilot study was conducted to investigate the effectiveness and efficiency gains in collect outpatient health information from primary health centres and health sub centres through mobile applications for detecting disease outbreaks in near-real-time. The researchers were also interested in evaluating the difficulties in implementing mobile health technology with health workers of lesser technical experience in electronically submitting patient data. "Evaluating a Real Time Biosurveillance Program: A pilot project" was conducted in Thiruppathur block of Sivaganga district in southern rural Tamil Nadu in India from July 2008 to July 2010. During the first year, the researchers and technicians interacted with the health workers to develop the technology. Thereafter, digital data submission using the mHealthSurvey, from the 28 rural health care centres, began in June 2009. The digitized data was analysed for unusual patterns using the TCWI (T-Cube Web Interface). Adverse events detected through TCWI were disseminated via SMS, Email, and Web with the Sahana Alerting Broker web-based software. Averages of 217 health records were collected each day for detection of adverse epidemiological events. A major advantage of the mobile phone patient data collection method was the improved timeliness for real-time detection of any disease outbreak. Besides the delays of digitizing data because of the parallel routine labor intensive paper work, the health workers in Tamil Nadu were able to submit reliable patient health data using mobile phone, which makes it a friendly, efficient, and cost effective tool of data collection.

Keywords. mobile phones, mHealth, electronic health records, public health, early warnings, India

1. Introduction

Health records management is conventionally done using paper and pen at the primary health centres (PHC) and health sub centres (HSC) in India. The health officials and health workers use outpatient registers to record and extract aggregated morbidity reports. Standard paper templates of Form P (Presumptive Surveillance) and Form S (Syndromic Surveillance) are used for reporting the communicable and non communicable diseases. The statistics pertaining to the area is submitted to the Integrated Disease Surveillance Program (IDSP) located at the district level Deputy

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Director of Health Services (DDHS) office. The IDSP staff, then collate the collected information and enter those records, first in to an excel sheet for district level trend analysis of a selected few diseases, followed by transmitting the aggregated results through the National Informatics Center (NIC) hosted Directorate of Public Health and Preventive Medicine (DPH & PM) website to the state and national levels. These tasks are carried out by the data entry operators under the supervision of data manager specifically appointed by IDSP.

Normally this entire paper based system and labour intensive process takes a single district a minimum of one month to compile the statistics for all the associated health centres of the respective district. This manual process does not provide a mechanism for a human-eye to identify the occurrence of any unusual event or increase of similar cases over a geographical spread in a given period. In addition to the latencies, this paper method incur huge cost towards transportation of filled in data forms by the health inspector who claims travelling and daily allowance for submitting the forms to the district level office on every Monday. The cost is involved at the data entry points.

The limitation in the paper based method has encouraged the development of electronic methods of data collection that might decrease the cost and raise the efficiency of the data collected (UNSCECE 2005). From the early 1990s, Personal Digital Assistants (PDAs) have been used in medical environment to assess the levels of patient care and access near or real time patient information at the point of care (Lutner et al. 1991, Roizen et al. 1992, Goldstein et al. 2002, VanDenKerkhof et al. 2003, VanDenKerkhof et al. 2005, Andrew et al. 2007 & Vishwanath Anantraman et al.), but there are some problems associated with this such as battery drains out within a short period of time. To overcome this, health workers were forced to carry spare batteries. Certain technical issues resulted in data loss with these hand held computers transmitting the data from the PDA from the field, to a laptop at the central clinic was difficult with unreliable internet connections. Therefore, data collected from PDA could not be analyzed immediately as it required physically connecting the PDA to the laptop or computer. The relative cost of a PDA is higher than commonly used standard mobile phones (James et al. 2008, Simon Pierre Teganga et al. 2009 & Guy Haller et al. 2009). Although emerging information technology has given ample opportunity for data transmission from PDAs through the Internet, for GPRS enabled PDAs in the field, no research studies exists as of now (Lalan 2005).

Mobile phones can now overcome these challenges. Mobile phone users in rural areas are increasing rapidly because of the availability and affordability of the technology. In India, mobile phone users account for 95 per cent of telephone subscribers. The recent statistics from Telecom Regulatory Authority of India indicated that the number of wireless mobile phone subscribers has reached 706.69 million as on October 2010 which is the second largest wireless market in the word second only to China (TRAI 2010).

Some of the studies conducted in India investigated the use of mobile phone in reminding patients with tuberculosis and HIV to take medicines (Vodafone Group 2006 & PMS 2008), farmers seeking agricultural related queries and transmission of image of the crop to the experts (Anusha Lall & Swati Sahi 2009), seeking primary healthcare information (Rafael Anta et al. 2009), as a data collection tools in household survey

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(Mark Tomlinson et al. 2009), evaluation of National Rural Employment Guarantee Act (RTBI 2009) and asking questions regarding sexually transmitted infections and HIV (www.learningaboutliving.com) and reporting monthly mobile phone based health information system (Mukherjee et al. 2010). However, no study has been done in India on the development of mobile phone as a tool for the collecting patient health information in real time basis for epidemiology. Technology expansion to rural areas make possible the capture and transmission of health records as an alternative to paper based method and PDAs. Our study focused on capturing patient health information using mobile phone and analyse the unusual event for disseminating the information in order to prevent the disease spreading to other areas.

2. Materials and Methods

The field implementation study was conducted between June 2009 and July 2010 in the primary health centers and its health sub centers in Thiruppathur block of Sivaganga district in Tamil Nadu. Sivaganga district is one of the most economically backward districts, spreads over 4,189 km with the total population of 11,50,753 with male population 56,559, and female 585,159, according to the 2001 census. The geographical position of the district is between 9.43' and 10.2' North Latitude and between 77.30' and 77.47' and 78.49' East Longitude. The primary healthcare system in this district is relatively well structured. There are 47 PHCs and 275 HSCs in this district. Each PHC serves a population of 20,000 and HSCs serve a population between 3,000 to 5,000. A PHC comprise several paramedical staff and medical doctors while HSC is staffed by only one village health nurse. The PHC is the first referral point for commonly occurring diseases in primary care and the HSC is primarily responsible for the maternal and child health along with healthcare of pregnant and nursing mothers and children under five years old.

The Real-Time Biosurveillance Program (RTBP) developed the mHealthSurvey application to work on any Java-enabled mobile phone to collect and transmit digitized patient health records. The data collected using mHealthSurvey is submitted through GPRS (General Pocket Radio Service), which is readily available in standard mobile phones now. The mHealthSurvey application was built to store the data on the mobile phone memory in the absence of GPRS connectivity (termed as offline mode) and later transmit when a connection is established (Figure 1). Each health record takes as little as 2 Kilobytes of memory and does not pose a threat of overloading the mobile phone's memory (i.e. can easily store hundreds of records). Besides the mobile phone memory can be increased if larger quantity of data needs to be stored in the offline storage. To this day connectivity has not been a shortcoming with health workers being able to transmit data; thus the offline storage has been unnecessary.

A typical mHealthSurvey record consisted of the patients' name (not mandatory), gender, age group, location, disease, signs, symptoms, case-status (referred and treated). Additionally, the health workers had requested that a free text entry field termed as 'notes' be provided to record any additional information such as the resident address of an overseas visitor. The application is built such that it would typically take less than 10 seconds for a single record to be entered. Several of the fields consist of pre-populated look up values to simply select the data, instead of typing them. Most health

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workers prefer digitizing the data at the end of the day but not during the peak patient visitation hours.

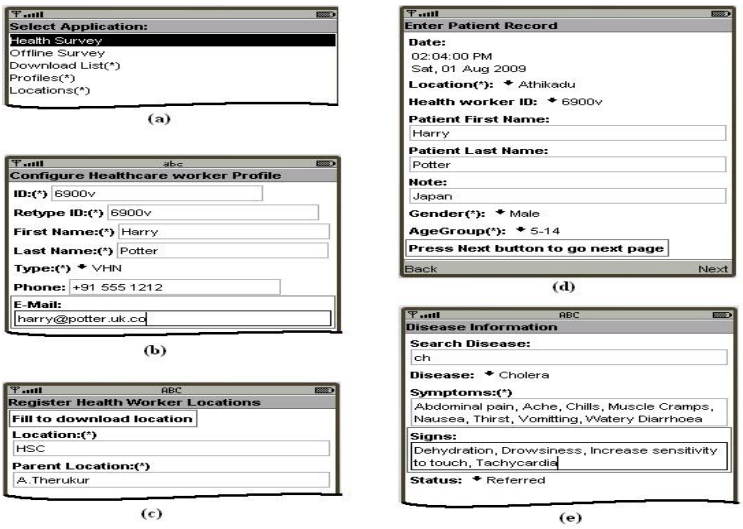

Figure 1. Screen shots of the mHealthSuvey mobile phone application

Other health subcentre nurses submit their data less frequently, in some cases every three days. Two of the PHCs were introduced data-entry assistants to help them with the digitization process because the Sector Health Nurses at the PHCs did not have the capacity to engage in this extra project introduced activity. If the equivalent paper work is relaxed and data is entered only through the mobile that should buy them more time to engage in other activities.

Submitted data, transported through the internet gateway, is stored in a central-database in a server. An Indian Rupee 199.00 rental package per health worker with two Gigabytes of data transmission capacity, limited number of free SMS, and free voice calls within the closed user group was ample to cover a single month's work. The data collected using mHealthSurvey by mobile phone was stored in backend database for analysis through the T-Cube Web Interface (TCWI) (Waidyanatha et al. 2010) and disseminated the outbreak information through Sahana Messaging Broker (Gow & Waidyanatha 2010) (Figure 2).

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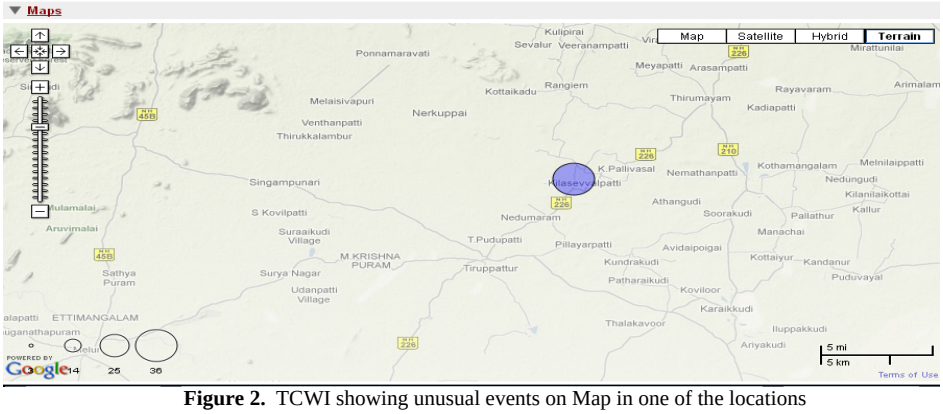

Figure 2. TCWI showing unusual events on Map in one of the locations

Prior to the data capture, the health workers were given two day intensive technology training in May 2009 which consisted of mobile phone technology orientation; especially the use of mobilie phone features beyond voice. mHealthSurvey application training was on how to use mobile phone internet to connect to a server, download the mHealthSurvey application on to the mobile phone from the server, install the software on the mobile phone, set up a profile defining the working locations, and submit health survey records. A series of standard operating procedures were introduced in the upkeep of the mobile phone, troubleshooting software issue and attending to other technical problems when they are in the field.

3. Results

On an average 217 health records were submitted each day through mobile phone, with 74 per cent of the data coming from the PHCs. Over a period of fourteen months 91,066 records were collected during this pilot study (Figures 3 & 4). The collected data were analyzed by the researcher to identify the latencies and the quality of the submitted data. Periodic checks were conducted by the systems administrators to rectify the erroneous data, which otherwise would effect the TCWI detection analysis.

Based on our experience with the health workers in the technology training workshop, they were required to submit patient record on mobile phone while interacting with the patients. When we analyzed the submitted data, we found that majority of them were submitting records after completing their routine works at the end of the day or when they had free time. We found that although there was patients' inflow in to health facility on Sundays and Government declared holidays; the data submission had not totally occurred during this period, which was the only instance of data not being entered. The detection of unusual event or disease outbreak were detected through T-Cube Interface and disseminated in the form of SMS, Email and Web through Sahana Alerting software (Figure 5).

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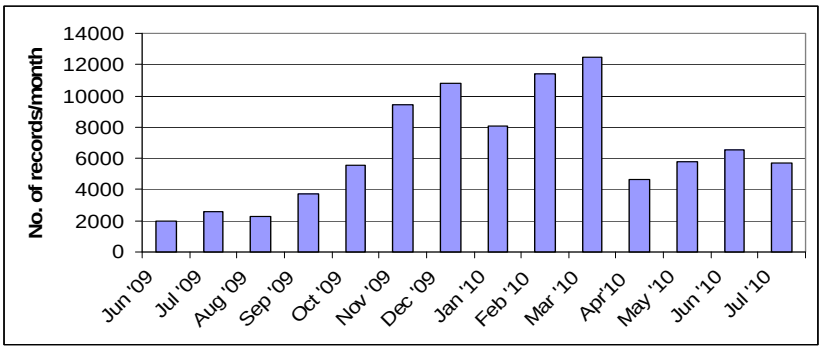

Figure 3. Month wise number of records submitted by health workers

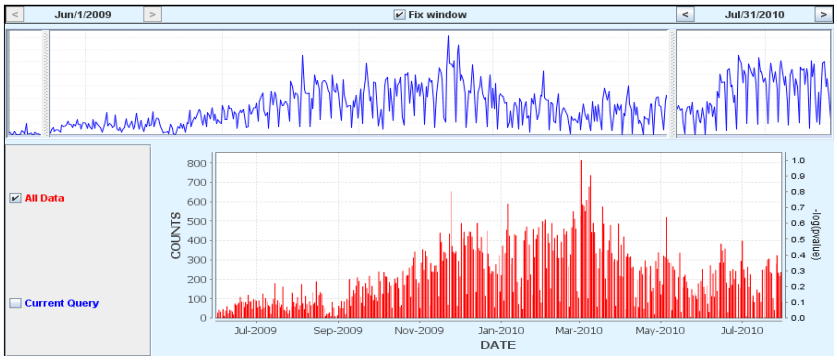

Figure 4. Month wise data distribution in Time series analysis of TCWI

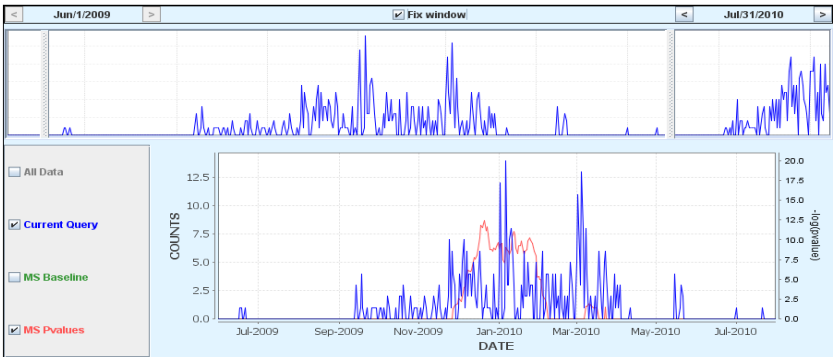

Figure 5. The detection of unusual events or disease outbreak information through TCWI

With regard to cost benefit analysis (Figure 6), we worked out the cost required for per district per month. It clearly showed that there is a drastically cost reduction observed in all the three components involved in collect, detect and alert when compared to the existing paper based system. It was also worked out the cost required per 100 records in mHealthSurvey data collection. As per the hardware requirement for submission of data, we went for minimum standard mobile phone (NOKIA), which

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was price at Rs. 4000 (US$ 88) at the time of project inception. The mobile phone bill was charged on monthly basis at the rate of Rs. 199 (US$ 4.41) and an average they could do the survey records maximum of 4000 with the capacity of 2GB space in the mobile phone. In this data collection, the cost per 100 completed records was Rs. 4.00(US$ 0.09).

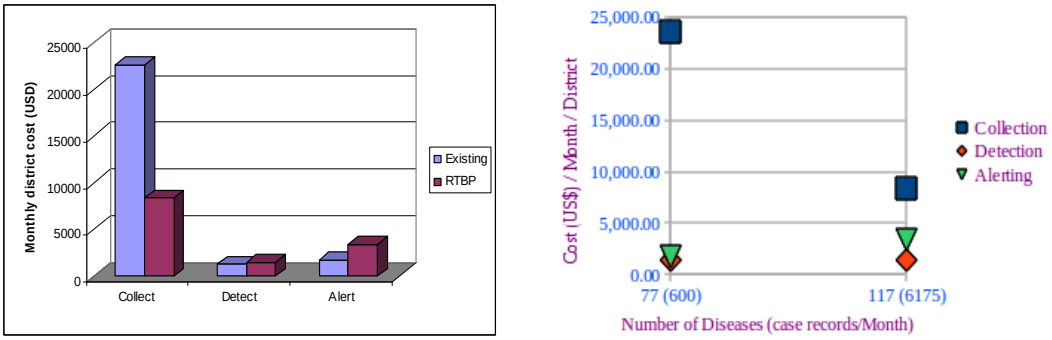

Figure 6. Cost Benefit analysis in collection, detection and alerting components

4. Discussion

The health workers were not actually familiar with the data submission on mobile phone and they were also limited in handling mobile even for voice interaction prior to the technology training workshop. Using previous untrained village health nurses as data collector, we were able to make use of mobile phones to enter and submit data at the point of health care. During the course of evaluation phase of the RTBP, no accountable hardware or software problems, in relation to the mHealthSurvey data collection element, were encountered. Three health workers had lost or accidently damaged the phones but had purchased an equivalent phone with their own money. They were not hesitant to make the investment because they used the phone for their personal use and were a personal necessity. In situations the mHealthSurvey ceased to function due to some minor technical fault or accidently deleting the application, the health workers were able to reinstate it even while they were in the field. The TCWI helps in monitoring the survey data and carry out quality checks in real time. There was no data loss in mobile phone data entry as it was directly uploaded from the mobile phone to the server. This has significantly reduced data loss because it was earlier reported that technical problems occurred during data uploads and downloads using PDA based data collection (Antonio Bernabe Ortiz 2008).

We were able to implement this patient data submission with low costs of materials. The mobile phone submission costs of around Rs. 4.00 (US$ 0.09) per 100 records compares favorably. If you see the current paper based system, this figure would include paper costs, printing costs, paper transportation costs, human resources for data entry and data consolidation. Based on our findings, we would conclude that mobile phone based patient data collection is feasible on large scale. With regards to potential disadvantages, one of the drawbacks of using mobile phone system was that

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the health care workers could not incorporate any disease name in the list of diseases in the event that the new disease name was identified.

Based on our findings, the limitation was that the project employed the health workers who were already engaged in their routine works which affected the data submission in real time basis. Thus, it was recommended that there should be persons to be appointed for mobile phone data entry so that they can capture all the patients' data in the respective health care centers. Our experiences in the pilot project study suggests that the health workers were able to submit patient health data using mobile phone and mobile phone makes it a friendly, efficient and cost effective tool of data collection.

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