Sanitation-related disease surveillance using community health promoters and mobile phone technology

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Abstract

Poor utilisation of oral rehydration and zinc therapy for diarrhoeal disease is a major impediment to early and preventative interventions of dehydration and diarrhoea in Guatemala. Improvements in culturally-sensitive public health education, patient screening and healthcare follow-up are necessary to address the growing burden of disease in children under 5 years-of-age. This paper presents a system combining mobile phone text messaging with a web-based platform to support continual education of trained health promoters, to provide real-time reporting of consultations, and to track promoter activity. The system was developed to act in coordination with a validated training framework for oral rehydration therapy and diarrhoeal disease in Guatemala in July 2013. Twenty-three local women in the village of Pixabaj in Sololá Department, Guatemala, who elected to participate in the study, were given ORT/Zn utilization and diarrhoeal diagnosis training and technical training on using the platform during a 1-week interactive education course. There have been several findings from the initial phase of this on-going study. Operator findings on the system have been positive and the resultant data collection was strong, though the framework experienced intermittent lags in service due to transiently poor mobile connectivity. It was also found that the acquired competency from the training on the promoters involved had a positive impact on the whole study cohort, including those who did not successfully complete the training course. The use of the web-based monitoring system with trained promoters has proved to be advantageous in remote tracking of activity. The identified limitations to the efficacy of text-message monitoring systems will be addressed in the next steps of this study.

1 Introduction

In Guatemala, 20% of the deaths that occur in children under 5 years old are a result of diarrhoeal disease [1]. It is well known that disseminating knowledge about oral rehydration therapy (ORT) and zinc supplementation (ZS) via community health promoters in low-income countries in conjunction with timely treatment strategies is effective in treating dehydration and preventing deaths in children under 5 years [2]. In The Lancet child survival series (2003), ORT was identified as the single intervention available with the greatest potential to save lives [3]. However, despite the introduction of ORT intervention decades ago, it is estimated that only 11-12% of children < 5 years-of-age in Guatemala are treated for diarrhoea [4]. ORT use has even been dropping in some Latin American countries. This decrease is particularly surprising given the emphasis of ORT/ZS product distribution by health organizations such as UNICEF and WHO [5]. Furthermore, poor management of diarrhoea in young children is strongly linked with incidence of malnutrition and dehydration, which increases the burden of disease among impoverished regions of the world. Improvements in water supply and environmental hygiene have achieved reductions in diarrhoeal morbidities, but there are consistent and growing gaps in providing culturally appropriate interventions and education, which have contributed to the low adoption trends seen in Latin America [1]. Existing literature offers the following reasons for this: a) lack of treatment effectiveness and/or availability, b) lacking or low public-health message penetration, and c) lack of ORT utilization by health-care providers (traditional and non-traditional) [6].

Addressing poor utilization of therapy requires investigations of a) cultural norms in the communication and b) health-seeking decision-making processes employed in ORT treatment delivery. These two factors have been established as strong predictors of the utilisation of ORT with zinc supplementation in low-income countries. Yet, in this respect, previous research in Guatemala has shown ineffective training regarding ORT, including manufacturer-led education in mixing pre-packaged oral rehydration solutions and making homemade ORT [4].
Fig. 1: MiPromotoras Message Templates. Once a template has been created (left), the message specifications and input fields can be customized (right). An example of the teaching template in English is shown.

The use of existing mobile communications networks and devices offers great promise for providing low-cost, intelligent, easily-accessible healthcare education and monitoring systems. However, a lack of sufficient national oversight and guidance has reduced the penetration of public health awareness and equally diminished the ability for primary care centres in Guatemala to screen and refer at-risk patients to hospitals and other healthcare centres. Furthermore, the large degree of complexity of care options that patients and community healthcare workers are required to navigate results in confusion and underutilisation of existing resources [7]. As a result, significant primary care needs within Guatemala’s rural population are currently unmet.

The research aim was to work with local promoters to co-create and disseminate a culturally-appropriate, accessible curriculum for homemade ORT and ZS for the indigenous Maya population of Guatemala. Promoters received continuing education and program support via a text-message reporting system, which enabled close program evaluation and monitoring.

We establish the first steps in identifying cultural, educational, and technological factors which influence the under-utilisation of ORT and ZS by parents in low-income countries for treating dehydration in children with diarrhoea. A text-message based reporting system was constructed, allowing health promoter activity to be monitored, patient data to be collected, and treatment advice to be delivered.

Using mobile communications networks, this research improves decision-making, treatment delivery, and educational processes employed in managing diarrhoeal diseases.

2 Methods

2.1 Building a web-based platform and text-message communications engine

A web-based platform shown in Fig. 1 was designed using a “Ruby on Rails” web interface, operating on standard web browsers. Frontline SMS, an open-source text-message management tool was installed on an ASUS Eee box server, which was then connected with a GLGiX GPRS modem and SIM card to send and receive text messages.

The Spanish and English-compliant system was designed with four main components:

1. Administration portal - for project admins to view, edit, and manage platform activity.
2. Text-message registration and communication framework - allowing individuals to register into the system from Guatemala.
3. Text-message template construction - allowing generation of customizable queries and questionnaires to be generated and then delivered to registered promoters.
4. Data collection and analysis - detailed logs of incoming and outgoing text messages, as well as detection algorithms were included in the back-end logic.

Examples of data collection for the teaching and consultation reports can be found in Fig. 2 below.
2.2 ORT training curriculum on rural indigenous women in Pixabaj

A one-week ORT/ZS Spanish training curriculum was developed by the study team of the larger NIH project and delivered to a group of local women in the rural highland community of Pixabaj, Guatemala. This cohort of women was recruited based on local election by the town council and individual interest in attending the course; no prior public health experience was required. The age-range was varied and cross-generational. Language competency in Spanish was required, though many women in the community were bilingual speakers of Spanish and native languages (Kaqchikel). All women were asked to bring a mobile phone to the course.

The educational outcomes were assessed through examinations to certify attendees in ORT/ZS therapy administration. This included successful passing of the following assessments:

1. Written examination - recognizing signs of dehydration, understanding the purpose of oral rehydration and zinc therapy, and the procedures for health consultations, community training, and physical examinations.

2. Medical practical - demonstrating knowledge of the correct electrolytic composition of salt and sugar for the oral rehydration fluid.

3. Technical practical - successful demonstration of sending text messages into the web-platform, and completing template delivery of consultations and trainings.

Upon passing the examination over the training curriculum, the cohort women were considered community health promoters, known locally as *promotoras*, and able to work in their community in delivering diarrhoeal consultations and ORT/ZS training.

2.3 Data-gathering on utilization of ORT/ZS therapy across rural communities and surveying the Guatemalan mobile landscape

During the training course, data on cultural and educational background, as well as pre- and post-training metrics on public health knowledge related to diarrhoeal diseases was collected through questionnaires and course surveys. Observational data was also collected across the week-long period to document consistent trends amongst course attendees.

The implementation of the server system within Chimaltenango, Guatemala allowed for data coverage/bandwidth statistics capture locally, as well as system performance in rural regions of Guatemala (namely, Pixabaj). Through the employment of a local IT manager, the server performance was recorded daily.

3 Results

Data collection from the training pilot and the beta implementation of the web-platform occurred in July 2013. Qualitative and summary results are presented here. The system is continuously monitoring promoter and patient information for further analysis. A summary of the qualitative results from the training pilot includes:

- Technical literacy amongst the cohort was poor, and correlated with age. Younger women were more proficient at completing the technical practical than older women. Less than 50% of women passed.
- There was approximately 70% pass-rate of the medical practical and written examination.
- Spanish numeracy and written proficiencies amongst women were not equivalent to oral competencies.
- Group activities encouraged positive collaboration amongst the women and were an important aspect of
A summary of the technical performance results includes:

- Lag times reported during the pilot program were between 1-5 minutes.
- During stable modem connectivity, messages received were immediately auto-responded to by system.
- System storage of incoming data was 100% during pilot phase.
- Intermittent behaviour of the modem and server box resulted in faults that delayed services to registered promotors.

4 Conclusions

We deployed a novel, comprehensive text-message based reporting and monitoring system that acted in coordination with a validated training framework for oral rehydration therapy and diarrhoeal disease in Guatemala. The installed server and remotely-connected mobile devices formed the basis for a system that can be used to further investigate barriers to care and care delivery in rural Guatemala.

Preliminary findings suggested a lack of accessible training curriculum along with technical and medical competencies as barriers to delivering and receiving healthcare in the case of diarrhoeal diseases. It achieved and encouraged collaboration and knowledge building amongst the cohort of individuals that participated in the pilot training program. It also demonstrated the need for robust implementations of systems, such as mobile/web systems, that can address the challenges of poor technical literacy in many communities in Guatemala.

This project served as a novel intersection between social behavioural studies, clinical healthcare, mobile telecommunications, information engineering, and personalised delivery of care, through which research focused on addressing a significant medical challenge. The results of this gestational project have had positive impact by improving the efficacy and sustainability of ORT education campaigns through encouraging local collaboration and ownership of program content, aided through technological infrastructure and mobile record systems.

5 Future Work

This research is working towards optimising the decision-making, treatment delivery, and educational processes employed in managing childhood diarrhoeal diseases.

In continuation with existing efforts ending in 2014, the efficacy of the educational and technical interventions will be measured to explore utilization and knowledge of ORT/ZS therapy amongst rural communities in Guatemala. Following this, objective measures of health status, streamlined monitoring of treatment through additional metrics and text-message templates, and consequently, significantly improved health outcomes can be targeted.

There is also growing scope for data-driven automated diagnostics that can be deployed against the incoming promoter and patient data. An extensive open-source, cost-free "m-Health" infrastructure (sanamobile.org) has already been developed which supports end-to-end data transmission between healthcare workers and remote experts, together with multiple expert annotations. Predictive algorithms can be developed using machine learning methods that operate on promoter data to provide a degree of initial screening, and which can then perform automated analyses to provide fundamental medical advice (i.e., diagnostic advice and patient treatment options in response to vital sign recordings). The next phase of this work will address this new landscape using existing mobile communications networks in Guatemala.

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References


