

Text messaging app improves disease surveillance in rural South Sudan

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Background: In South Sudan, remote health facilities face challenges in submitting weekly surveillance reports for epidemic-prone diseases due to long distances and difficult terrain health workers must cover to hand-deliver paper reports. Not only are patients unable to access care while health workers are away, identification of and timely response to an infectious disease outbreak is hampered.

Methods: Data journey mapping with stakeholders was conducted in three counties in Eastern Equatoria State to inform an appropriate mHealth solution. A short message service (SMS) application was selected because it did not require internet connection and only needed minimal equipment investments. The SMS app was designed using open source Android software due to low set-up and maintenance costs. Health facility staffs use personal phones to send an SMS in a predetermined format to the County Health Department (CHD) Android phone base. CHD staff review data; once verified, CHD exports the data to existing health information system software for onward submission to the State Ministry of Health (SMOH). To engender perceived value and incentive use, health workers must use personal airtime to send the SMS; they receive a bonus if they submit reports on time. For long-term sustainability of the system, CHDs have incorporated system maintenance costs into their monthly budgets.

Results: Eighty-nine health workers and 21 CHD staff were trained to use the SMS app. They found the innovation interesting and easy to use. All three counties increased on-time submissions upon introduction of the app. The predefined SMS template is important for data accuracy. Availability of a dedicated CHD staff and mobile network coverage in the most remote areas present ongoing challenges to timely report submissions in some counties. CHDs declare the SMS app has revolutionized weekly disease surveillance reporting in their counties. Eastern Equatoria SMOH has requested scale up of this app to all counties of the state. National Ministry of Health (MOH) has expressed strong interest in scaling up the initiative for monthly data reporting.

Conclusions: The SMS app has improved timeliness and efficiency of weekly disease surveillance reporting. It overcomes transportation challenges of health reporting in remote areas and improves access to patient care since health workers do not need to leave post to deliver the report. Minimal start-up and operation costs make this an appropriate solution in resource-poor contexts with a high likelihood of long-term sustainability.

Keywords: Disease notification; epidemiological monitoring; health information systems; rural health services; text messaging

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Introduction

Timely and accurate data are necessary for quality health management (1). Immediate reporting allows for timely action to be taken to prevent the emergence or rapid transmission of epidemic prone diseases (2). However, this cannot be achieved adequately with a paper-based reporting system (1). The Government of South Sudan Ministry of Health (MOH) conducts integrated disease surveillance and response (IDSR) reporting for diseases with epidemic potential, those targeted for eradication elimination, and those of major public health significance (3). Each health facility throughout the country is responsible for submitting IDSR data using a paper form on a weekly basis to the County Health Department (CHD). The CHD aggregates this data and submits it to the State Ministry of Health (SMOH), who subsequently aggregates all county data and submits it to the national MOH. On Wednesday or Thursday of each week, the national MOH releases a weekly surveillance bulletin with compiled and analyzed data it received for the previous week, regardless if all health facilities/counties/states have reported. In order for this bulletin to be prepared in time, health facilities must submit their data to CHDs by Monday of each week.

Many counties struggle to submit their data in a timely manner for inclusion in the weekly surveillance bulletin. Most often, health facility staffs physically deliver paper forms, traveling from their post to the CHD. Delivering this report requires them to be away from their post for half a day or more. Since many health posts have only one staff, this means patients are left waiting or return home without being seen. Distances between the health facilities and the CHD are often long and the road conditions poor or impassable at times. Furthermore, health facility staff must use their own money to pay for transport.

In addition to neglecting patients, the lack of timely reporting also means the SMOH and national MOH are hindered in their efforts to identify and swiftly respond to disease outbreaks, resulting in higher morbidity and mortality.

With increasing mobile phone coverage throughout the country, the use of mobile phones for data collection has great potential to increase program efficiency and reach (4). The use of mobile phones for rapid data collection and reporting is increasing around the world (5). Using mobile phones for data reporting also saves time that the health worker would have spent travelling, and allows the health worker more time to focus on of health service provision (6).

Based on other international success stories, an electronic solution to data reporting was envisioned as a solution to increase timeliness and accuracy of IDSR, as well as improve patient care by decreasing the amount of time health workers must be away from their posts. Though internet access is still challenging in many areas of the South Sudan, mobile coverage is widely available (though not universal). Thus, a short message service (SMS) platform was determined to be the best way forward.

The American Refugee Committee (ARC) has been operating in what is now South Sudan since 1994. It implements programs in Central and Eastern Equatoria, Northern Bahr El Ghazal, and Warrap States in health systems strengthening; gender-based violence prevention; and water, sanitation, and hygiene (WASH). ARC developed and rolled out the mobile health (mHealth) IDSR initiative in Kapoeta South, Kapoeta East, and Magwi counties in Eastern Equatoria State, where it receives funding from the Health Pooled Fund for health systems strengthening.

Methods

Participatory planning and implementation

ARC consulted with members of the national MOH mHealth Technical Working Group for tools and guidance to develop this initiative. ARC then presented its plans at an official meeting of the working group for feedback before piloting the initiative. Finally, ARC presented the results of the pilot to the group and continues to participate in the group to share experiences and plan scale-up efforts.

To ensure ownership, ARC involved the CHDs from each of the three counties from the beginning planning stages through all aspects of implementation and ongoing management. This was built on the solid relationship already established between ARC and the CHDs over the past 4 years of jointly implementing health systems strengthening projects.

Data journey mapping with stakeholders

Using UNICEF tools from the co-chair of the mHealth Technical Working Group, ARC first conducted data journey mapping exercises in Kapoeta South and Kapoeta East to understand the full range of actors at every level of data collection, aggregation, and report submission, including communities, health facilities, CHD, SMOH, and

Table 1 Comparison of system platform possibilities

Parameter	RapidPro	TextIt	Other open source software
Internet access	Required	Required	Not required*
Remote server	Required	Required	Not required*
Monthly charges	Required: buy credits	Required: buy credits	Not required*
Access to data at State/MoH	Real time	Real time	Sent by email*
One phone for each county	No**	No**	Yes*

*, if internet component is not incorporated; **, one phone could serve more than one county.

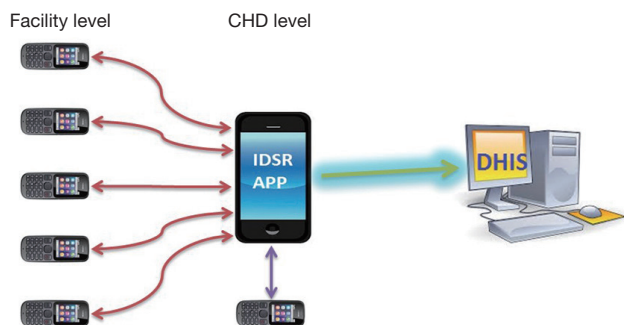


Figure 1 Data flow through SMS IDSR system. SMS, short message service; IDSR, integrated disease surveillance and response.

national MOH (7). Constraints in timely IDSR submission were also identified and fully explored.

Mobile platform development

A consultant with requisite experience in medicine, information technology, and South Sudan’s public health care system was hired to develop the SMS technology platform and train end users. Three possibilities for the mobile platform were compared considering the parameters in *Table 1*.

Other open source software (Android) was selected due to low set-up and maintenance costs, and because it could work without any need for internet. At the health facility level, existing technology was used (health facility staff’s personal mobile phones), as opposed to procuring new phones, so as to minimize costs and prevent misuse. At the CHD level, an Android phone was procured to act as the number/server to which the SMS data is submitted.

Figure 1 presents a schematic of the data flow through the SMS IDSR system. Health facility staffs use their personal phones to send a series of SMS messages in predefined

format. The text messages are sent to the Android phone at the CHD office. A time stamp is generated on the phone each time a facility submits a report.

To transmit data from the CHD to the national MOH data health information system (DHIS), an interface was developed. This interface imports data from the CHD Android phone server and converts it into a format that can be exported to the DHIS. It also generates weekly IDSR reports in print preview to enable the CHD to monitor which facilities have submitted their reports and to view and verify the data prior to submission to the DHIS. In addition, the interface can generate a summary of report submission timeliness by health facility according to the time stamps.

Pre-existing paper IDSR forms are maintained at health facilities for periodic data validation upon supportive supervision visits to specific health facilities.

Training

Two groups of users were trained in each county: CHD staff and health facility staff. For CHD staff, the county health commissioner, monitoring and evaluation officer, and surveillance officer were trained. Their training focused on how to support the facility staff in sending IDSR reports, how to transfer SMS data from the Android phone to the interface, how to generate SMS data reports, and how to export data from the interface to the DHIS. At the facility level, one to two people were trained (facility in-charge and clinical officer) depending on the size of the facility. The facility staff training focused on how to send the weekly report by SMS and troubleshooting common issues in report submission.

During the training, it was discovered that it was often necessary to begin by showing staff how to compose, edit/forward, and send an SMS, particularly among aged staff. To make the system easier to use, an SMS template was

Table 2 Numbers and types of trainees

County	CHD staff	ARC staff	Health workers	Total
Kapoeta South	9	6	13	28
Kapoeta East	3	7	14	24
Magwi	9	5	62	76
Total	21	18	89	128

CHD, County Health Department; ARC, American Refugee Committee.

developed for users. With this template, the user simply has to enter the number of cases or deaths for each data point inside the predefined format. Facility staff made fewer errors when entering data into the predefined format.

Pre-testing

The SMS IDSR system was pre-tested for 3 weeks in Kapoeta South County. Technology glitches were corrected, and the training curriculum was fine-tuned before rolling out to the other counties.

Sustainability

A bonus system was designed to motivate and sustain system use. An airtime bonus of two South Sudanese Pounds (SSP) is sent to the phone sending reports if their reports are submitted by Monday, as validated by the time stamp. Health facilities that report on Tuesday morning before 10:00 am receive 1 SSP bonus airtime. Health facilities that send in their reports after 10:00 am on Tuesday do not receive any bonus airtime. The bonus is intended to reimburse the airtime the facility staff use to send in the report, plus some additional as incentive to submit the report on time. The IDSR mobile phone app automatically sends the bonus airtime to the health facility immediately upon receipt of a complete report.

The weekly cost to run this program is 30 SSP (approximately US\$ 10 at the time) for every 10 health facilities. This covers the phone airtime credit for bonuses, as well as for sending report feedback to health facility staff. To ensure sustainability, the CHDs have already or are in the process of including this cost in their monthly budget.

Results

The SMS IDSR system was rolled out in January 2015 in Kapoeta South County, February 2015 in Kapoeta East County, and March 2015 in Magwi County. CHD staff and

health workers found the innovation interesting and easy to use. CHDs declare the SMS app has revolutionized IDSR reporting in their counties.

Table 2 summarizes the total number of persons trained. In over 98% of health facility staff phones, the basic SMS functions were existent and were working as expected. However, staff who could not read or write the English language had significant challenges in learning how to use the SMS application. In addition, staff with visual impairments, especially among those of advanced age, had challenges seeing the characters on the phone screen. Since the accuracy of the numbers is of paramount importance, staffs in the same facility without visual problems were preferred users.

The bonus system was well received. Health facility staff was excited to receive the 2 SSP bonus upon submission of a complete report. They had no apprehension about using their personal airtime to send the IDSR report, because they the bonus they receive is more than the amount they use to send the report.

The graphs below (*Figures 2-4*) show the improvements in timeliness of data reporting as a result of the intervention, comparing the periods before and after rollout. The yellow arrow in each graph indicates the week in which the SMS IDSR app was introduced.

After rollout of the intervention, for the first time, all nine facilities in Kapoeta South County submitted their IDSR reports by 10:00 am on Monday.

Timeliness of data reporting in Kapoeta East County also significantly improved after introducing the SMS app. However, the county continues to struggle to reach 100% because eight of the 18 health facilities in the county do not have mobile network coverage. These facilities use high frequency radio to transmit their weekly surveillance data, but equipment maintenance makes it an unreliable mode of communication.

On March 1, 2015, the Magwi County surveillance officer vacated his post to attend school. With no one at

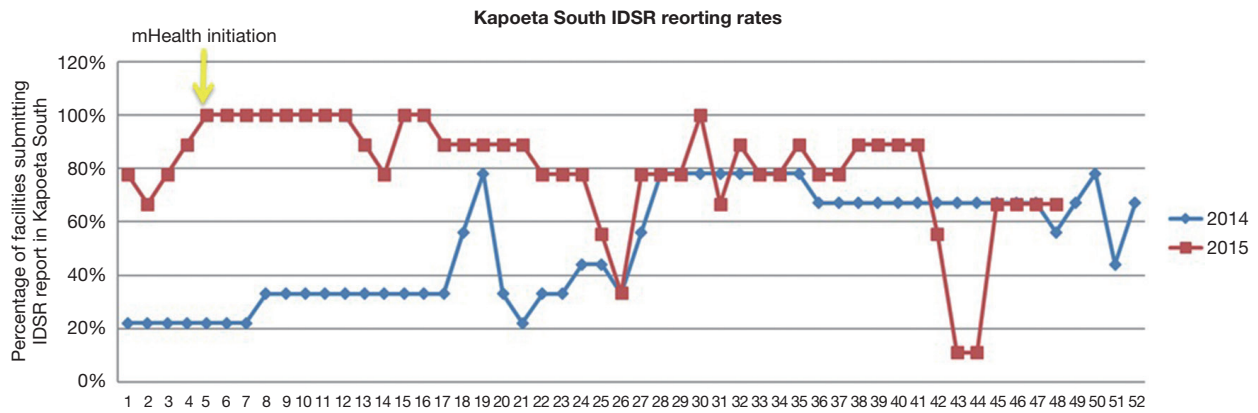


Figure 2 Percent of health facilities reporting on time, Kapoeta South.

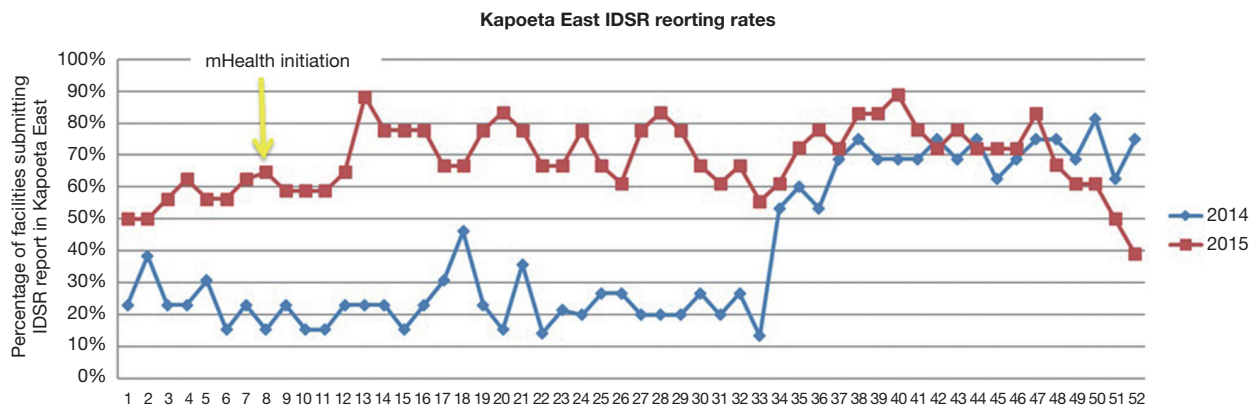


Figure 3 Percent of health facilities reporting on time, Kapoeta East.

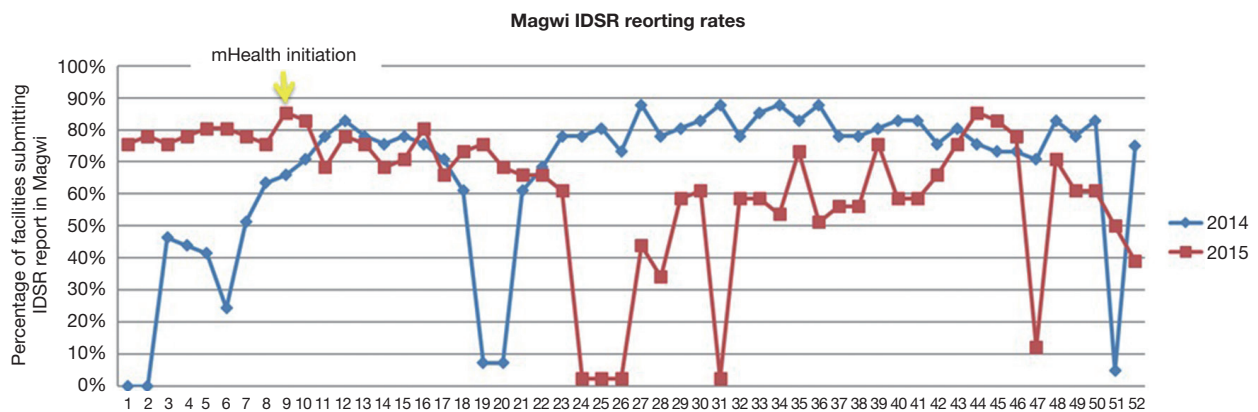


Figure 4 Percent of health facilities reporting on time, Magwi.

the CHD to validate and follow up data reports, reporting timeliness declined. Magwi County also has 41 health facilities—many more than Kapoeta South and Kapoeta East counties—making it more difficult to achieve a high percentage of on-time reporting.

Implementation challenges

Some of the challenges encountered included: CHD staff forgetting to charge the Android phone, insufficient airtime on the phone, losing the Android phone, and lack of CHD staff dedicated to manage the reporting (as described in Magwi County). These resulted in reduced reporting levels during the specific weeks in which the challenges occurred.

The SMS IDSR system is now fully managed by the CHDs, while ARC provides ongoing technical support whenever the CHDs encounter any challenges.

Discussion

Two conditions are necessary for successful implementation of the SMS IDSR app: (I) mobile phone network coverage at the health facilities; and (II) dedicated CHD staff. Kapoeta South County had dedicated CHD staff and mobile phone network coverage available in all the health facilities; this enabled the county to realize the greatest success. Kapoeta East County had dedicated CHD staff, but mobile phone network coverage was only available in 10 out of 18 health facilities. This resulted in slightly lower levels of reporting timeliness. In Magwi County, mobile coverage is widely available, but there was no dedicated CHD staff.

As a testament to the overall success of this initiative, the Eastern Equatoria SMOH requested scale-up of the SMS IDSR app to the other five counties in the state. The National MOH has also requested expanding the initiative for monthly DHIS reporting. These are currently under discussion and pending funding.

To ensure the success of scale-up and potential replicability in similar contexts, we recommend the following recommended:

- (I) Ensure basic functionality of the equipment. The Android phone based must be powered on and have adequate airtime. Health facility staff must have functioning SMS capability on their phones and also maintain adequate airtime for sending reports.
- (II) Use a predefined SMS template. This makes it easier for those unfamiliar with sending SMS and increases overall data accuracy.

- (III) Monitor the rollout phase closely to troubleshoot specific technology or user issues and support/reinforce positive user behavior.
- (IV) Conduct periodic data quality audits to ensure the SMS-reported data correspond with the paper reports at the health facilities.
- (V) Review time stamp reports with health workers on a regular basis (at least quarterly) to motivate performance.
- (VI) Identify a backup staff (at CHD level or equivalent) responsible for monitoring the system, following up with health facilities, and facilitating data transfer in the event the surveillance officer leaves post.
- (VII) Design system sustainability from the beginning. Integrating system operation costs in MOH budgets ensures long-term sustainability beyond donor funding. The bonus system incentivizes health workers to use the SMS reporting system and contributes to the success and sustainability of the initiative.

Conclusions

The SMS IDSR platform is an effective system that improves timeliness and quality of reporting of epidemic-prone illnesses, especially in remote areas. It requires minimal start-up and operation costs, optimizing its long-term sustainability in resource-poor areas. In a country with severe shortages of health care workers, this system improves access to patient care since health workers do not need to leave post to deliver the report. Scale-up of this initiative would greatly enhance national data timeliness and accuracy. This would improve South Sudan's ability to identify and facilitate rapid responses to infectious disease outbreaks, as well as improve overall health data monitoring and analysis. Similar improvements would be expected in comparable contexts.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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