Enhancing event-based disease surveillance and response efforts in Kenya through SMS reporting and web portal dashboards

mSOS

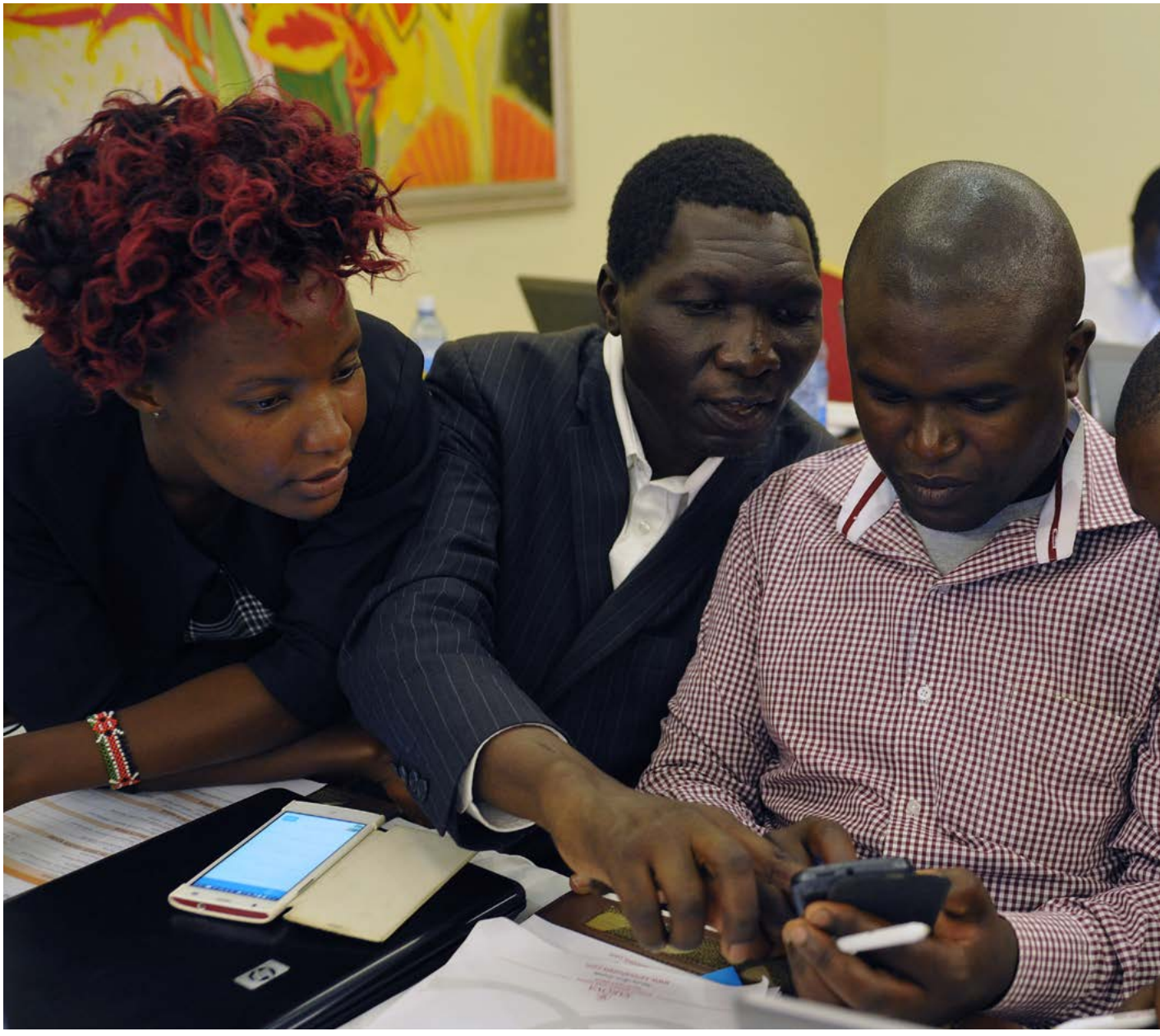


Photo by Takeshi Kuno

Mobile SMS-based disease outbreak alert system (mSOS) enhanced timely notification—and the technology can be used to enhance disease surveillance in resource-limited settings.

Disease outbreaks pose serious public health risks worldwide as seen in the recent SARS, Ebola, and Zika epidemics. Resource-limited settings lack strong disease surveillance mechanisms to quickly detect, diagnose, and contain outbreaks.[1] This hinders a nation's ability to fully comply with the World Health Organization (WHO)'s International Health Regulations (IHR 2005) and the Integrated Disease Surveillance and Response (IDSR) strategies.[2-4]

In Kenya, as in other African countries, paper-based reports or ad hoc information from the health facilities reach the authorities at the national and sub-national levels late, which in turn limits abilities to respond in a timely manner to control the outbreaks.[4] To overcome these challenges, the Ministry of Health (MOH) and the Japan International Cooperation Agency, Japan Agency for Medical Research and Development, Science and Technology Research Partnership for Sustainable Development (JICA-AMED SATREPS) project piloted the mSOS (mobile SMS-based disease outbreak alert system) in 2012–2014.[5-7]

A randomized controlled trial was implemented, which showed that mSOS enhanced timely notification and that the technology can be used to enhance disease surveillance in resource-limited settings.[8,9] Based on recommendations from the stakeholders, a technical working group was formed at MOH, and the system is currently undertaking a series of modifications before a nation-wide rollout.[10-13]

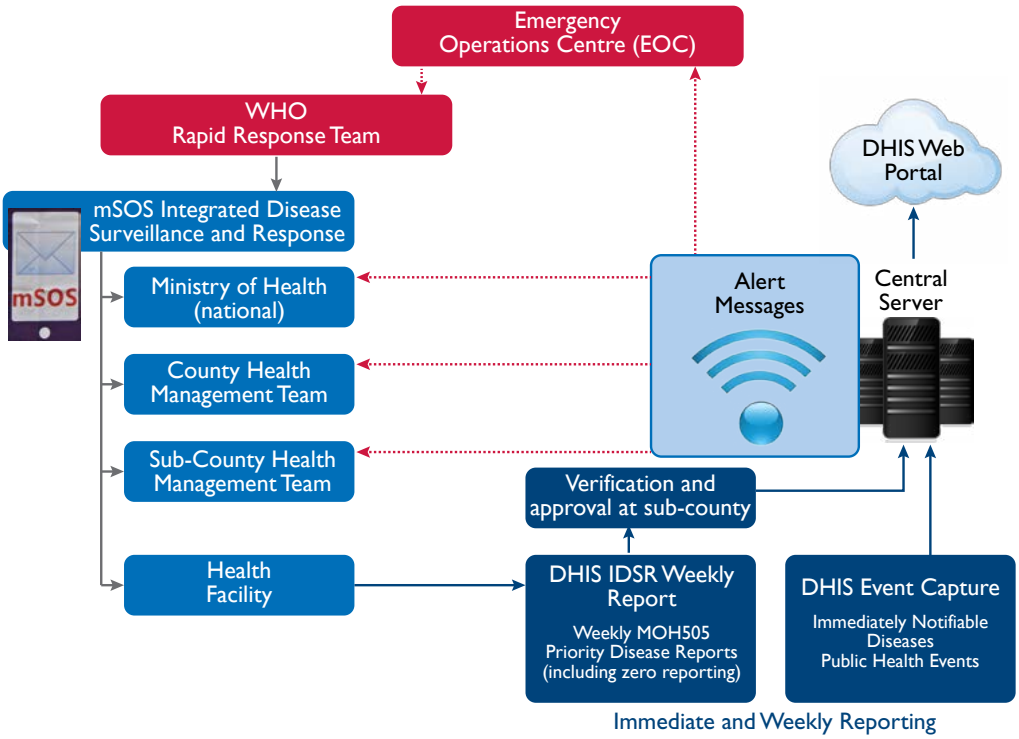
About mSOS

Mobile SMS-based disease outbreak alert system (mSOS) is a formatted text-message system that allows real-time communication between health facility workers and disease surveillance coordinators at the sub-county, county, and national levels in line with the IDSR guidelines.[5-7]

At the time of the pilot, the IDSR guidelines recommended health facility workers completing and submitting paper-based forms to the sub-county-level disease surveillance coordinators, and sub-county-level disease surveillance coordinators electronically transmitting information to higher-level managers at the county and national-levels. Sub-county disease surveillance coordinators are the first-level responders to the reporting facilities. mSOS tried to eliminate redundancies of data entry at multiple levels, and to make information-sharing instant at all levels.[4] The system consists of two components: text messaging function, and web portal (see Figure 1, next page).

1. mSOS (text messaging): The text messaging function allows health facility workers to input formatted text messaging with patient-level information of suspected disease outbreaks. A text message is immediately sent to relevant health authorities at the national and sub-national levels with information on the place, time, and details of a patient with suspected disease that needs to be reported within 24 hours.
2. mSOS web portal (dashboard): mSOS web portal displays a dashboard with patient-level information, bar graphs with cumulative incidents, and hot spot maps indicating the health facilities that reported the cases. The relevant authorities at the national and sub-national levels can also enter the time and details of actions taken on the notifications sent.

Figure 1.
Structure of the mSOS Integrated Disease Surveillance and Response Mobile System



Twelve diseases and conditions were picked for the pilot from the immediately notifiable diseases list in IDSR. The list included adverse events following immunization (AEFI), anthrax, cholera, dengue fever, Guinea worm, measles, neonatal tetanus, plague, Rift Valley fever, viral hemorrhagic fever, yellow fever, and any public health event of concern (e.g, infectious, zoonotic, foodborne, chemical, radio nuclear, or caused by an unknown condition). The pilot was implemented in two counties: Busia and Kajiado. Busia County borders Uganda by the Victoria Lake basin with 7 sub-counties, and Kajiado County borders Tanzania with 5 sub-counties.[8-14]

Program Design Process

The design process took 1 year: 6 months in conceptualization, 3 months in programming, and 3 months in beta testing. The implementation period was 6 months.

1. Conceptualization: mSOS was conceptualized in mid- to late-2012. The JICA expert conducted informal interviews with MOH employees and workers in health facilities to objectively understand the practice and implementation of IDSR guidelines and bottlenecks of disease surveillance activities on the ground.
2. Technical working group: A technical working group was formed at the MOH Disease Surveillance and Response Unit (DSRU), and mSOS was developed in early 2013. The technical working group consisted of the head of DSRU, managers in charge of national disease surveillance and data management, the JICA expert, and experts from the WHO and Kenya Medical Research Institute (KEMRI). Minutes were written and circulated to all members.
3. Contracting: Strathmore University Faculty of information technology (IT) was identified as the institution to perform programming for mSOS because of past experience working with the MOH. One of the servers at the MOH was identified to host mSOS. Due to strict regulations by the Kenyan telecommunication authorities, a contract for a toll-free number was signed with a premium rate service provider (PRSP) and not directly with a telecommunication company.
4. Programming: Several students at Strathmore University Faculty of IT undertook mSOS programming as part of their internship. Students and their supervisor regularly attended the technical working group meetings to understand user requirements, and presented progress in the technical working group meetings.

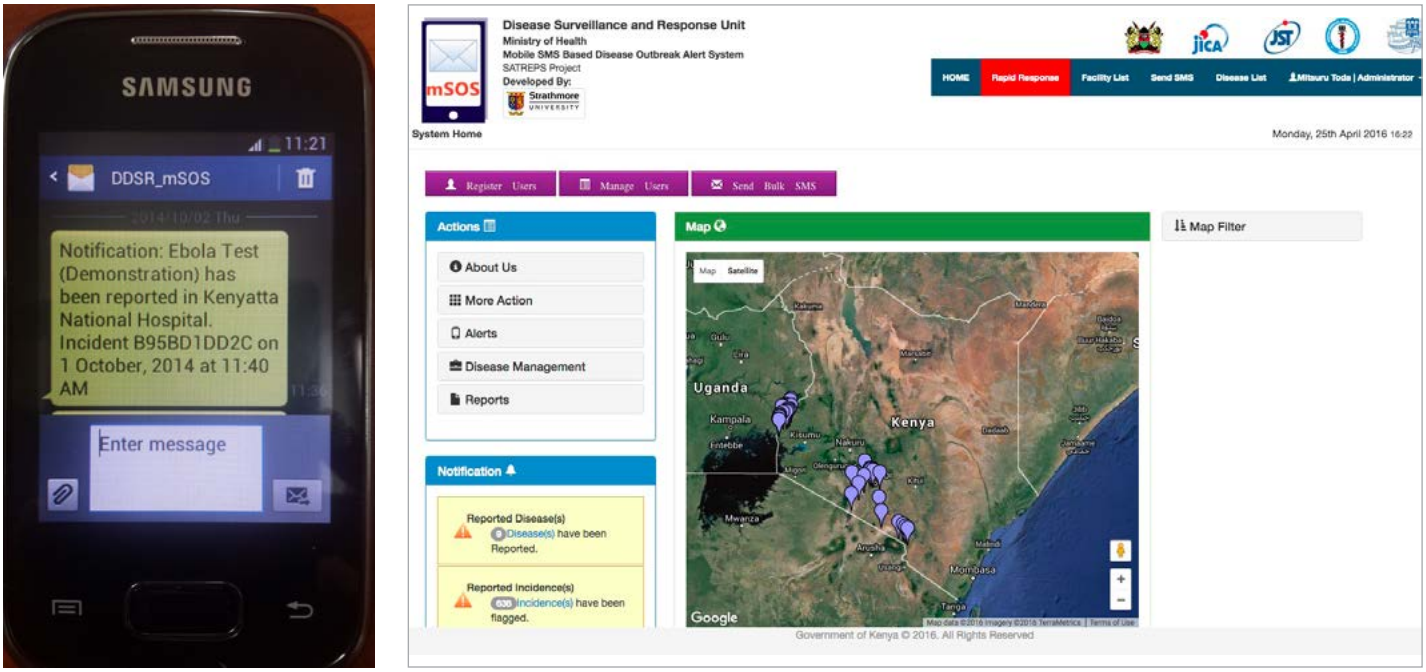
5. **Stabilizing the system:** After repeated prototyping of the system, mSOS was pretested in a few health facilities in Nairobi in early 2013, and several bugs and issues with power outages were identified. A tracking system was programmed in order to monitor downtime, and redundant backup was created.

6. **Pilot implementation:** mSOS pilot was implemented for 6 months, October 2013–April 2014. A 1-day training or refresher course for IDSR guidelines and a 1-day training on mSOS was conducted in September and October 2013 for 67 health facility in-charges in Busia and Kajiado counties. All 12 sub-county disease surveillance coordinators were also trained on how to troubleshoot and use the mSOS web portal.

Growth in Scale

After the implementation of the pilot, and before the results were analyzed, DSRU recommended mSOS to be modified as mSOS Ebola.[15-17]

1. **mSOS Ebola (text messaging):** When a patient suspected of having Ebola was identified by the Ebola Rapid Response Team, patient-level information was sent through formatted text-messaging using mSOS Ebola. The messages with the detailed information on the time, place, and nature of the suspected patient case were delivered to senior management at DSRU and a few policy decision-makers at the MOH. An alert message was also sent to the designated KEMRI laboratory workers.
2. **mSOS Ebola (web portal):** Patient-level information on the suspected cases, response action conducted, and laboratory confirmation were displayed on the password-protected web portal dashboard.
3. **mSOS Ebola (KEMRI Laboratory module):** Results on the laboratory confirmation of the patient serum samples were updated using the mSOS Ebola web portal, and text messages were automatically delivered to senior management at DSRU and a few policy decision-makers at the MOH.
   After mSOS Ebola was implemented, the mSOS stakeholders' meeting was held to disseminate the preliminary results of the pilot.
4. **mSOS pilot dissemination:** At the stakeholders' meeting, mSOS was very well received. Health workers appreciated the ease of use of the system and rapid feedback from their managers through mSOS.[11-12] Health managers especially appreciated the real-time information sharing. The system was unanimously recommended for integration into the national health information and management system, specifically to the open-source District Health Information Software 2 (DHIS2) platform.[18]



Sample mSOS alert messaging (left) and web portal dashboard (right)

5. **Buy-in from the MOH:** Due to the overwhelming recommendations at the stakeholders' meeting on the ability of mSOS to quickly adapt to the needs on the ground (as seen by mSOS Ebola), the scale-up of mSOS was included in the Cabinet Secretary's Performance Contract 2015/16, a contract between the MOH Cabinet Secretary and the President of Kenya.[19]
6. **Technical working group for scale-up efforts:** A technical working group coordinated by DSRU includes multiple units within the MOH, such as the Health Information System; Information, Communication, Technology; eHealth; Zoonotic Disease; and Disaster Response units. It also includes multiple international partners, such as the WHO [SIKIWIS], Centers for Disease Control and Prevention (CDC) [mHealth Kenya, I-TECH], JICA [JICA-AMED SATREPS project], and United States Agency for International Development (USAID) [AfyaInfo project].[13]
7. **Establishment of mSOS/IDSR Weekly Mobile Reporting System:** A new enhanced version of the mSOS pilot, mSOS/IDSR Weekly Mobile Reporting System was developed through the technical working group in late 2015. This new system combines event-based and indicator-based disease surveillance information. Once a suspected disease outbreak or public health event is detected at the health facility level, information is sent through the system to a central server at the MOH. The central server then sends alert messages to multiple officers responsible for outbreak and disaster response. The list of diseases and conditions is expanded to not only suspected disease outbreaks of immediate concern, such as cholera and measles, but also public health events (event-based) and routine disease information (indicator-based), including diseases such as malaria.[20]

Evaluation and Results

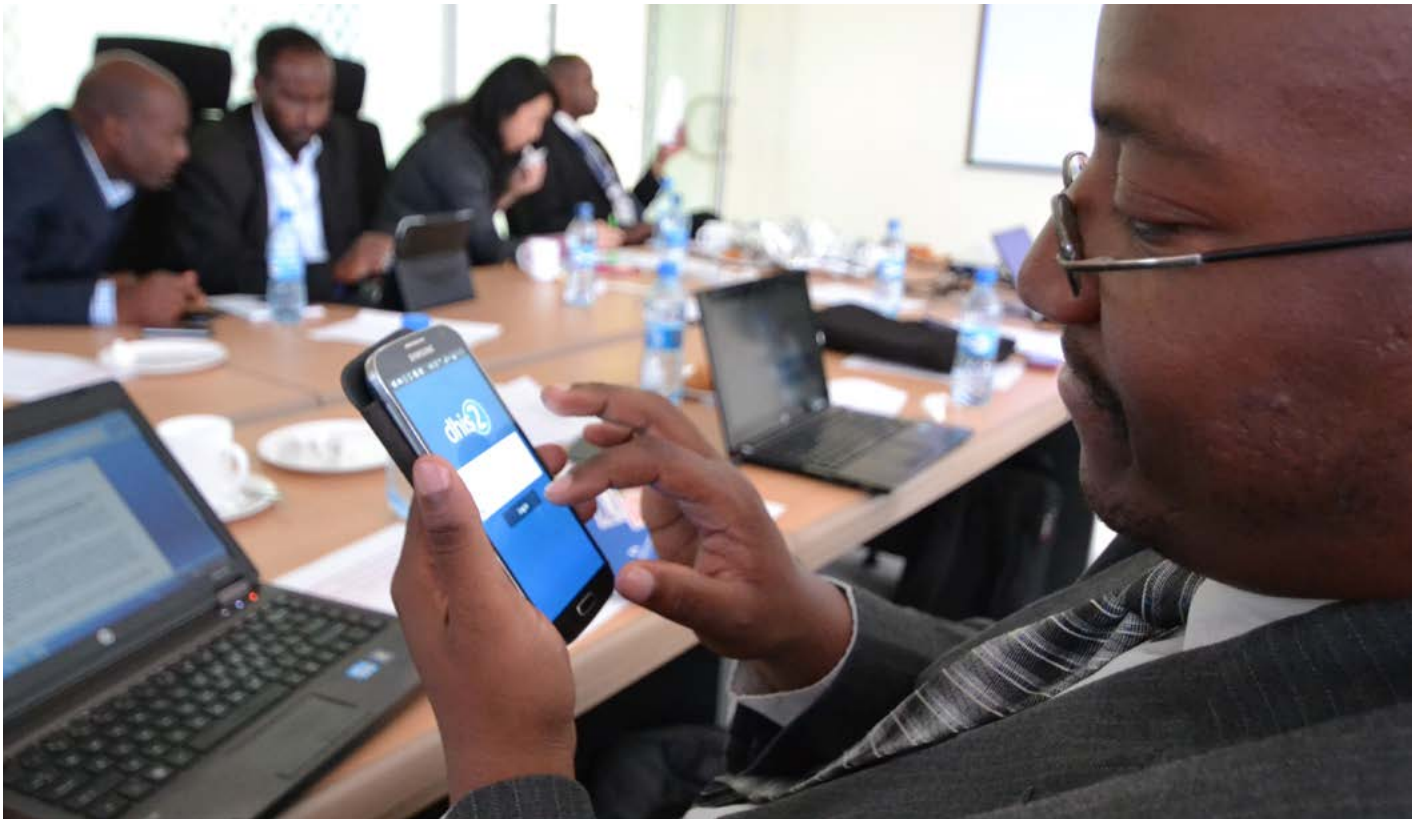
As part of the cluster randomized controlled trial to test the effectiveness of the system, the research study included quantitative and qualitative assessments of the current IDSR guidelines implementation, and the impact of mSOS implementation.[21]

A baseline assessment was conducted in June 2013, including retrospective data for the six-months before the intervention (December 2012–May 2013), reviewing all information from outpatient, inpatient, and maternal and child health registers for the 12 diseases and conditions selected for the study. In addition, in-depth interviews with health facility in-charges and sub-county disease surveillance coordinators were completed. A post-intervention survey, including documents review, and in-depth interviews with health facility in-charges and sub-county disease surveillance coordinators were completed in May 2014. In addition, a focus group discussion was conducted at the national level.

A total of 153 health facilities were assessed for eligibility, and 142 completed the baseline survey in the selected 12 sub-counties in Busia and Kajiado counties. Health facilities included public, private, faith-based, and non-governmental organization-owned facilities at all levels of care. A total of 135 health facilities attended the IDSR training and the randomization was conducted during the IDSR training by stratifying health facilities by sub-counties and randomly selecting intervention facilities from each stratum by a 1:1 ratio. Sixty-eight facilities were in the control group and 67 were in the intervention group. A total of 65 health facilities in the control group and 66 health facilities in the intervention group were assessed during the follow-up survey.

The quantitative analysis included examining the reporting rates comparing paper-based and mSOS reports. A retrospective review at the baseline survey showed that 36 cases (17 cases in the control group and 19 cases in the intervention group) required immediate notification. Only one paper-based report in the control group was completed. During the post-intervention survey, we found that 130 cases in the intervention group and 39 cases in the control group required immediate notification. One paper-based report in the control group was completed, and 25 cases were reported through mSOS in the intervention group. The results showed that the health facilities that used mSOS achieved more timely notifications than those that did not (+16.7%). The results of the evaluation were published in Emerging Infectious Diseases in April 2016.[8]

Analyses are currently ongoing for qualitative data collected during field interviews and focus group discussions.



Lessons Learned in Program Implementation and Scaling

Lessons learned from mSOS pilot implementation were that timing, leadership, and feedback are important components of the implementation success.

1. Timing: mSOS was conceptualized, piloted, and disseminated during a time when the MOH was exploring ways to move from paper-based reporting to electronic reporting. It was also a time when various outbreaks occurred within Kenya and around the world, most notably Ebola in West Africa. At the same time, mobile phone penetration skyrocketed within the country, even in hard-to-reach areas. Compliance with IHR 2005 was also a task that the MOH needed to address. Overall, there was an increased awareness and willingness of the ministry to look at a mobile phone solution that could enhance disease surveillance and compliance with IHR 2005. The scale-up was also suggested at a time when the MOH is addressing a number of related efforts including: trying to integrate all information systems within DHIS2, preparing an electronic nationwide master facility list, conducting a review of event-based surveillance, proposing mobile phone-based indicator surveillance, holding various taskforce meetings for national outbreaks, and construction of an Emergency Operation Centre at the MOH. mSOS was able to leverage these timings to not only pilot the system, but also to tie into current disease surveillance efforts within Kenya's MOH.
2. Leadership: Strong leadership by the DSRU, which promoted buy-in from the national government, county governments, and international partners, lead to mSOS being recommended for scale-up and integration into the national health information and management system. DSRU included mSOS in its work plans, and staff members from the unit helped support the system. DSRU also worked with the Health Information Systems (HIS), ICT, and eHealth units and their partners to assure that the maintenance could be conducted within the ministry through DHIS2. This in turn would help mSOS be a sustainable system.
3. Feedback: Inclusion of the opinions from all aspects, such as the end-user, programmers, and health managers were an important component of the development and implementation of mSOS pilot. Repeated pretesting and informal feedback from users helped mitigate system abruption and solve bugs in a timely manner. In addition, engagements with various stakeholders through the technical working group helped mSOS be programmed and evolve as a flexible tool to offer local solutions to local problems. The large stakeholder meeting and users' feedback helped move mSOS into the next stage.

Future Plans

The MOH envisions that real-time reporting and response through the mSOS/IDSR Weekly Mobile Reporting System will reduce lag time for notification and response to outbreaks and disasters, and minimize morbidity and mortality in Kenya. The system will continue to improve as the MOH rolls it out to all levels, including all 47 counties, all sub-counties, and the 7,500 health facilities across the nation.

1. **Stakeholders meeting:** A stakeholders meeting was held in December 2015 and pretesting was completed with the relevant MOH units and international partners.
2. **Training:** In early 2016, national-level officers in the MOH attended a training of trainers (TOT) workshop. Since February 2016, a series of TOT workshops including county and sub-county disease surveillance coordinators (DSCs) and health records information officers (HRIOs) have been ongoing by the MOH with funding support from international partners. The training materials, including manuals and slides, were drafted and printed. As of April 2016, approximately 350 national, county, and sub-county DSCs and HRIOs were trained in half of the regions in Kenya.[13] A launch ceremony is scheduled in 2016 after TOT is completed at the national, county, and sub-county levels.
3. **Expansion of modes:** The system would be modified to smartphone- and feature phone-based applications so that health workers could use their personal phones to report.
4. **Emergency Operation Centre:** The system will be linked to the national Emergency Operation Centre for 24/7 analysis of information and prompt response action to notifications that need further investigation. The system will serve as an early warning mechanism, whereby analysis on trends could inform potential outbreaks and mitigate morbidity and mortality in the nation.
5. **Expansion of users:** In the future, the system will be expanded to the community level and to the public where suspected cases can be reported and filtered automatically by the system.
6. **Paperless reporting:** Once the system is rolled out to the whole nation, it may also replace the current paper-based reporting guidelines in the future. ■

Snapshot: mSOS	
Geographic Coverage	Kenya Pilot: 67 health facilities Scale-up: 7,500 health facilities
Implementation Dates	2013 to present
Implementation Partners	Ministry of Health (multiple units), Kenya SATREPS Project Japan International Cooperation Agency (JICA) Japan Agency for Medical Research and Development (AMED) Strathmore University Faculty of Information Technology
Donor(s)	World Health Organization Centers for Disease Control USAID JICA AMED
Contact Information	Dr. Daniel Langat, Disease Surveillance and Response Unit, Ministry of Health, Kenya, langat4@yahoo.com

References & Additional Resources

1. Gates, B., The next epidemic—lessons from Ebola. *N Engl J Med,* 2015. 372(15): p. 1381-4.
2. World Health Organization, *International Health Regulations* (2005), 2008.
3. Kasolo, F., et al., IDSR as a platform for implementing IHR in African countries. *Biosecur Bioterror,* 2013. 11(3): p. 163-9.
4. Ministry of Public Health and Sanitation. *Integrated Disease Surveillance and Response in Kenya: Technical Guidelines 2012,* 2012.
5. Ministry of Health Disease Surveillance and Response Unit. *Mobile SMS Based Disease Outbreak Alert System.* 2015 [cited 2015 December 15]; Available from: http://ddsr.or.ke/mSOS/about.
6. Mendoza, G., et al., mSOS: Using mHealth to strengthen real-time disease surveillance and response in Kenya, in *mHealth Compendium 2014,* African Strategies for Health (ASH), Management Sciences for Health (MSH); USAID: Arlington, VA.
7. Osamu, S., Feature Story: Using Mobile Phones to Prevent an Epidemic of Infectious Diseases, 2016, *Japan Journal.*
8. Toda, M., et al., Effectiveness of a Mobile Short-Message-Service-Based Disease Outbreak Alert System in Kenya. *Emerg Infect Dis,* 2016. 22(4): p. 711-5.
9. Njeru, I., et al., *mSOS (mobile SMS-based disease outbreak alert system) Preliminary Report,* 2015, Disease Surveillance and Response Unit (DSRU) at the Ministry of Health: Nairobi, Kenya.
10. Njeru, I., et al., Meeting Highlights: mSOS Stakeholders' Meeting: Dissemination of findings, 2015, JICA-AMED SATREPS project.
11. Japan International Cooperation Agency. mSOS Stakeholders' Meeting (05 June 2015). 2015 [cited 2015 June 5]; Available from: http://www.jica.go.jp/project/english/kenya/006/news/general/150605.html
12. Japan International Cooperation Agency. *mSOS: A Versatile Tool for Disease Outbreak Alert.* 2015 June 5, 2015 [cited 2015 June 5]; Available from: http://www.jica.go.jp/kenya/english/office/topics/150605.html
13. Japan International Cooperation Agency. *Activities towards nationwide scale-up of mSOS.* 2016 [cited 2016 April 4]; Available from: http://www.jica.go.jp/project/english/kenya/006/news/general/160404.html
14. Toda, M., et al., *mSOS User Manual,* 2013, Disease Surveillance and Response (DDSR), Ministry of Health (MOH); Japan International Cooperation Agency (JICA): Nairobi, Kenya.
15. Japan International Cooperation Agency. One year after the declaration of an Ebola state of emergency. 2015 [cited 2015 July 31]; Available from: http://www.jica.go.jp/english/news/focus_on/ebolaphotos.html
16. Japan International Cooperation Agency. mSOS Ebola handover ceremony was held at the Ministry of Health in December 9, 2014. 2014 [cited 2014 December 9]; Available from: http://www.jica.go.jp/project/english/kenya/006/news/general/141209.html
17. Japan Science and Techology Agency. *Using Mobile Phones to Contain Infectious Diseases.* 2015 April 27, 2015 [cited 2015 March]; Available from: http://www.jst.go.jp/report/2014/150313-2_e.html
18. Ministry of Medical Services. Ministries of Health Launch District Health information System. 21 Feb 2012 5 July 2012 [cited 2012 5 July]; Available from: http://www.medical.go.ke/index.php?option=com_content&view=article&id=136:ministry-of-health-launch-dhis-software&catid=34:news-and-events&Itemid=62
19. Japan International Cooperation Agency. Meeting with Mr. James Macharia, Cabinet Secretary, Ministry of Health. 2015 [cited 2015 December]; Available from: http://www.jica.go.jp/project/english/kenya/006/news/general/150708.html
20. Wanjiru, R., et al., *mSOS/IDSR Weekly Mobile Reporting: Training Manual, 2016,* Ministry of Health Kenya; World Health Organization (WHO); Centers for Disease Control and Prevention (CDC); Japan International Cooperation Agency (JICA); United States Agency for International Development (USAID): Nairobi, Kenya.
21. ISRCTN Registry. ISRCTN79529838: Evaluating the response to suspected disease outbreaks using a short message service (SMS) model. Available from: http://www.isrctn.com/ISRCTN79529838, http://apps.who.int/trialsearch/Trial2.aspx?TrialID=ISRCTN79529838