Use of technology for public health surveillance reporting: opportunities, challenges and lessons learnt from Kenya

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Abstract

Background Infectious diseases remain one of the greatest threats to public health globally. Effective public health surveillance systems are therefore needed to provide timely and accurate information for early detection and response. In 2016, Kenya transitioned its surveillance system from a standalone web-based surveillance system to the more sustainable and integrated District Health Information System 2(DHIS2). As part of Global Health Security Agenda(GHSA) initiatives in Kenya, training on use of the new system was conducted among surveillance officers. We evaluated the surveillance indicators during the transition period in order to assess the impact of this training on surveillance metrics and identify challenges affecting reporting rates.

Methods From February to May 2017, we analysed surveillance data for 13 intervention and 13 control counties. An intervention county was defined as one that had received a refresher training on DHIS2 while a control county was one that had not received training. We evaluated the impact of the training by analysing completeness and timeliness of reporting 15 weeks before and 12 weeks after the training. A chi-square test was used to compare the reporting rates between the two groups. A structured questionnaire was administered to the training participants to assess the challenges affecting surveillance reporting. A Likert scale was used to grade the challenges.

Results The completeness of reporting increased after the training by 17 percentage points (from 45% to 62%) for the intervention group compared to 3 percentage points (49% to 52%) for the control group. Timeliness of reporting increased by 21 percentage points (from 30% to 51%) for the intervention group compared to 7 percentage points (from 31% to 38%) for the control group. Major challenges identified for the low reporting rates included lack of budget support from government, lack of airtime for reporting, health workers strike, health facilities not sending surveillance data, use of wrong denominator to calculate reporting rates and surveillance officers being given other competing tasks.

Conclusions Training plays an important role in improving public health surveillance reporting. However, to improve surveillance reporting rates to the desired national targets, other challenges affecting reporting must be identified and addressed accordingly.

Background

Infectious diseases remain an important public health problem causing up to 63% of all childhood deaths and 48% of all premature deaths globally (1). Infectious disease outbreaks, if not detected and reported early, can rapidly spread and result in high morbidity and mortality (2). Effective public health surveillance systems can provide timely and accurate information leading to early detection of potential outbreaks and containing them in the local areas (3). Unfortunately, public health surveillance systems are poorly developed in many low and middle income countries (LMIC) as demonstrated by the recent Ebola outbreak in West Africa which led to devastating consequences in the health and economy of several countries (4,5).

A systematic approach is required to strengthen public health surveillance systems that can quickly detect and respond to the initial cases of disease outbreaks and other public health emergencies. Therefore, the World Health Organization (WHO) and other organizations such as the U.S. Centers for
Disease Control and Prevention (CDC), International Organization for Animal Health (OIE), and the United Nations’ Food and Agriculture Organization (FAO) work with member countries to devise and invest in several strategies and frameworks to strengthen disease detection and response capacities.

The key strategy for implementing public health surveillance in the African countries is the Integrated Disease Surveillance and Response (IDSR) strategy which was launched by WHO Afro in 1998 (6). IDSR is used as one of the tools that help in the implementation of International Health Regulations (IHR) which are legally binding to member countries (7). IDSR also supports the implementation of the Global Health Security Agenda (GHSA) (8) and the One Health Initiative (OHI) (9, 10) which are used in many countries to strengthen countries’ capacity to prevent, detect, and rapidly respond to infectious diseases and other public health emergencies. To ensure a systematic approach, IDSR comprises several core functions (case detection, case confirmation, case registration, case reporting, data analysis and interpretation, preparedness, investigations and response) as well as several support functions (communication, training, supervision and resource mobilization) (11).

Although many countries have made significant progress in the implementation of IDSR, many challenges still hinder these countries from achieving optimal implementation. Though varied, many challenges are similar across the countries that have evaluated and published their IDSR performance. These challenges include: inadequate financial resources, poor coordination, weak laboratory capacity, poor communication systems, poor supervision, erratic feedback, inadequate training of health workers, lack of IDSR technical guidelines and reporting tools (12-16).

One of the main goals of IDSR implementation is to monitor disease and public health event trends in order to ensure that any unusual disease patterns such as outbreaks are detected quickly, investigated and responded to within the shortest time possible. For this reason, IDSR performance is often evaluated on completeness of reporting (proportion of health facilities and districts reporting) and timeliness of reporting (proportion of reports sent on time) (17, 18). To ensure early detection, IDSR emphasizes immediate reporting (within 24 hours) for epidemic-prone diseases as well as weekly summary reporting. Timely reporting and data analysis enable the responders at various levels (e.g. sub-county, county, regional and national) to identify any unusual events early and therefore respond in time.

The IDSR strategy recognizes that for data to be quickly reported to the next level, investments must be made on the reporting platforms and hence the emphasis on communication as one of the support functions for IDSR (6). While many countries have migrated from paper-based to electronic IDSR reporting, not much is published about the electronic platforms that different countries are using for IDSR and the challenges that affect use of these platforms. In Kenya, the IDSR technical guidelines were first launched in 2002 and later revised in 2010 to incorporate elements of IHR and OHI which emphasizes inclusion of priority emerging and re-emerging communicable and non-communicable conditions as well as zoonotic diseases. The surveillance reporting system remained mainly manual until 2007 when efforts were made to migrate to an Epi Info-based system. Districts (now referred to as sub-counties) would compile their reports and send them to the national level via email, fax, couriers or hand delivery. The
national team then entered the data into the digital desktop platform (Epi Info) for analysis. A weekly epidemiological bulletin was produced and shared back to the districts via email.

In 2011, the Ministry of Health (MOH) shifted reporting from the Epi Info system to a standalone (not integrated with other program systems) web-based system (e-IDSR) due to challenges such as untimely and incomplete reporting especially from hard to reach areas. In this system, data from health facilities were captured electronically using computers at the at sub-county level rather than at national level, while higher levels (national and county) were given rights to view and use the data. In August 2016, the country migrated eIDSR from the standalone system to the District Health Information System (DHIS2). The DHIS2 platform is an integrated web-based platform with capacity to report data from all other programs. System maintenance costs are therefore shared across programs making the system more sustainable.

Before the switch to DHIS2 in August 2016, all 47 county surveillance officers, 304 sub county surveillance officers, and 304 sub-county health records and information officers were trained on selected modules on IDSR surveillance strategy as well as the practical use of the DHIS2 platform. The training was conducted between January and June 2016 and also included facility surveillance focal persons from each of the Level 4 (sub-county), Level 5 (county) and Level 6 (national) health facilities.

After the switch to DHIS2, the surveillance focal persons based in health facilities continued to send surveillance reports (events-based or weekly disease workload) via a short message service (SMS) to the sub county surveillance officers who would then enter the data into DHIS2. In certain cases where a health facility focal person had been trained and had credentials for accessing DHIS2, the data would be reported directly into the web-based system at the facility level. The county and national staff would then access and monitor the data by accessing the DHIS2.

During the transition from eIDSR to DHIS2 in late 2016, the reporting rates (completeness and timeliness) plummeted in the initial months. The low reporting rates were attributed to inadequate training of surveillance officers on the new system. The MOH hypothesized that re-training surveillance officers would improve reporting rates and requested support to conduct a re-training of the county and sub county surveillance officers from counties where reporting rates were most affected (data entry is mainly done by sub county surveillance officers). Training was conducted between February and March 2017 by MOH with technical support from I-TECH Kenya. In this paper, we share the impact of training on timeliness and completeness of IDSR reporting rates in the new reporting platform. We also report on the challenges affecting the surveillance reporting rates at the various levels.

**Methods**

**Study setting and design**

Kenya is divided into 47 counties and 300 sub counties. In February and March 2017, the Ministry of Health re-trained 78 surveillance officers from 13 prioritized counties whose surveillance reporting rates
(proportion of health facilities sending weekly reports) were the lowest. Training of other counties was to be done once more funding was available.

From December 2016 to May 2017, we conducted an assessment of the surveillance training and its associated impact in the 13 selected counties (intervention counties). In addition, we also included in the assessment another 13 control counties (Figure 1). An intervention county was defined as one who's county and sub-county surveillance officers had received refresher training on DHIS2 in February or March 2017. These thirteen intervention counties were also the poorest performing counties at an average weekly reporting rate of 45% over a 15 week reporting period from Epi Week 48 of 2016 to Epi Week 10 of 2017 (Table 1). A control county was defined as a one that belonged to the next 13 poorest reporting counties and that had not received the refresher training with an average reporting rate of 49% over the same 15 week reporting period.

The 13 non-intervention counties were selected for control because they had the next poorest reporting rates and would therefore be a good comparison to the intervention counties as they would likely have similar challenges. The total number of health facilities were 2229 and 1876 in the intervention and control counties, respectively.

Training of participants (the intervention)

The intervention was a 2-day refresher training that was conducted in February and March 2017. The refresher training used the same curriculum that had been used during the initial training before the switch to DHIS2. However, the theory sessions were excluded, and the training focused solely on the practical elements of managing data in DHIS2. Specifically, the participants (county and sub-county disease surveillance focal persons) were trained on how to access the DHIS2 system through the web and mobile app, how to sign up and log in, how to enter surveillance data (indicator and event based) and how to analyze the data.

Operational definitions

For both the intervention and control counties, completeness of reporting was defined as the proportion of health facilities that had weekly surveillance reports uploaded in DHIS2. One report was expected per facility per week. For each study group, timeliness of reporting was defined as the proportion of health facilities that uploaded weekly surveillance reports on time in DHIS2. A weekly surveillance report was defined as on time if it was submitted by subsequent Wednesday of the reporting week.

Comparison of completeness and timeliness was made over a 27 weeks period i.e. 15 weeks before the intervention and 12 weeks after the intervention for both the intervention and control counties. Our target was to compare 15 weeks before and after the intervention but we had to limit the post intervention period to 12 weeks to guarantee that the control counties had not conducted any refresher training.

Data management and analysis
Pre and post training test data

A training pre and post-test was administered to the 78 participants via Google forms to assess their level of knowledge of using DHIS2 surveillance platform before and after the training. The mean percentage score of the pre and post training tests was calculated and paired sample t-test was used to test for significant change in knowledge before and after the training.

Survey on challenges affecting surveillance

A structured questionnaire was administered to the 78 training participants via Google forms to assess the challenges they faced during surveillance reporting. The challenges were graded by respondents using a Likert scale ranging from 0 to 5 (0 being no challenge and 5 being a major challenge). The Likert scores for all the 78 responses were averaged for each question across all participants and then ranked to determine the most significant challenges.

Completeness and Timeliness of Reporting

Surveillance data before and after the training for both the intervention and control groups was downloaded from DHIS2. The data downloaded from DHIS2 was aggregated and did not include any individual patient data or identifiers.

For completeness and timeliness, we calculated and compared the percentage reporting rates cumulatively at the county level across all the weeks before and after the intervention for both intervention and control counties. We then used the Chi square test to determine whether the difference in percentage reporting before and after the intervention for both the intervention and control counties was significant.

We analyzed the data on completeness and timeliness of reporting looking at the trends over a 27-week period between Epi week 48 of 2016 and Epi week 22 of 2017 i.e. 15 weeks before the training and 12 weeks after the training (Figure 2).

Results

Pre and Post Test

A total of 78 county and sub county surveillance officers from 13 counties and 62 sub counties were trained, of which 43 completed the pre-test and 75 completed the post-test. Training was done in 3 clusters and one cluster did not do the pre-test due to logistical challenges. For the 42 who did both tests, the average score for the pre-test was 58% (range 32-89%) and this increased to 75% (range 58-100%) in the post-test. The difference in mean between the 2 groups for those who did both tests was 17 with a t-score of 7.81 and p-value <.00005 (two tailed paired t-test at 0.05 significance level).
Completeness of reporting

After the training, the completeness of reporting for the intervention counties gradually improved from 55% in Epi week 9 of 2017 to 69% in Epi week 21 of 2017 and surpassed the control group whose reporting rates were 56% and 59% at Epi week 9 and 21, respectively (Figure 2). Additionally, the completeness of reporting trends for the intervention group neared the national completeness of reporting after 7 weeks. There was a decline of reporting rates in week 19 of 2017 for all the groups due to an unexpected system downtime but this improved again in the subsequent week (Figure 2). However, the reporting rates for the intervention group remained higher than the control group in all the weeks of observations. Overall, after the training the average completeness of reporting for the intervention counties increased significantly, from 45% to 62%, that is by 17 percentage points (95% CI 16.14 - 17.86; P value <0.0001). The average across control groups increased from 49% to 52%. Despite this improvement of the intervention group after training, the reporting rates for all groups remained lower than the expected national target of 80% (Table 1).

Timeliness of Reporting

We observed an almost similar trend for the timeliness as for completeness. The average timeliness of reporting was 41.2% at Epi week 9 of 2017 for the intervention group and 40.6% for the control group. However, after the training the timeliness for the intervention group increased to 59.8% at Epi week 21 compared to 48.6% for the control group. The timeliness of reporting for the intervention group also matched the national average reporting rate after about 7 weeks after the training. The timeliness of reporting was noted to have improved more than completeness. (Figure 3).

Overall, the average timeliness of reporting increased significantly after the training from 30% to 51% i.e. by 21 percentage points (95% CI 20.16 - 21.84; P value <0.0001) for the intervention group as compared to an increase from 31% to 38% for the control group i.e.by 7 percentage points (95% CI 6.27-7.73; P value <0.0001) (Table 2). Despite this improvement, the reporting rates for all groups remained lower than the national target of 80% (Figure 3).

Challenges affecting reporting rates
The challenges directly related to the use of the DHIS2 system, e.g. technical challenges using DHIS2 (score 1.4 out of 5), lack of access rights to DHIS2 (score 0.9), lack of support from DHIS2 help desk (score 1.4), were scored lower as compared to other challenges, e.g. lack of funding for operations (score 4.8), lack of airtime for reporting (score 4.7), surveillance officers having other competing tasks (score 3), and high turnover of surveillance staff (score 2) as shown in Figure 4.

Discussion

In this study, we demonstrated that the refresher training significantly improved knowledge on use of DHIS2 surveillance platform as demonstrated by the 17 percentage points increase in post training score. More importantly, the training was successful as the surveillance reporting rates improved significantly in the intervention group following the training. During the 12 weeks after training the completeness of reporting increased by 17 percentage points in the intervention group compared to only 3 percentage points in the control group. The timeliness of reporting also improved by 21 percentage points in the intervention group compared to 7 percentage points for the control group. The difference of 14 percentage points between the intervention and control groups for both completeness and timeliness can therefore be attributed to our intervention. As other studies done elsewhere have shown, training has a role in improving reporting rates (19-21).

Another observation made in this study was that reporting rates in the intervention counties improved almost immediately after the training. It took only 7 weeks for the reporting rates in the intervention group to match the national average reporting rates (which were higher) after which the rates seemed to stagnate at between 60 and 70% for completeness and below 60% for timeliness. This therefore indicates that despite the training impact, there are likely other factors other than the training affecting the reporting rates.

There are many challenges that affect surveillance reporting rates and training is often wrongly seen as a quick fix to the poor reporting rates. From the findings in this study, it was clear that training was only a partial solution but that other challenges affecting surveillance must be addressed by the government and other stakeholders if reporting rates are to improve further towards the desired target of 80%.

As noted in our study, the training on use of DHIS2 reporting platform addressed some challenges such as inadequate technical capacity in using DHIS2. However, challenges related to use of DHIS2 were not perceived by users as being the biggest hindrance to system use and complete and timely reporting. The major challenges and biggest deterrents to system use and better reporting rates were lack of budgetary support and lack of airtime which could not be resolved through the training we conducted.

Many countries in the world are now using electronic systems for public health surveillance reporting as these have been shown to improve reporting rates (22-26). The District Health Information System (DHIS2) is one of the most popular electronic systems for reporting health related data and is currently used in over 40 countries (27). DHIS2 provides an opportunity to embrace a sustainable open source technology to improve public health surveillance reporting. However, like any other health information
system, resources such as computers, internet and training opportunities are often cited as challenges, as found in this study and must be provided to promote its optimal implementation (28).

Kenya migrated IDSR reporting from a standalone web-based surveillance system to the robust DHIS2 system in 2016 and this provided an opportunity to observe and learn from the transition. When countries embrace use of electronic systems for reporting, it is common for health personnel to blame inadequate capacity building for poor performance of indicators. Our study demonstrated that capacity building can help to improve surveillance reporting indicators but only to a certain extent. We also identified the specific challenges that affect surveillance reporting which can be targeted by program managers for improvement.

In the AFRO region, other countries have evaluated their surveillance systems in the past in a bid to identify the challenges affecting surveillance reporting and some of them were similar to what we found. For example, in Zambia some of the challenges found were inadequate trained staff, coordination challenges and poor infrastructure (13). Ghana and Malawi found some of the challenges to include lack of technical guidelines, lack of standard case definitions, inadequate supervision/feedback and low prioritization of surveillance activities by health workers (12, 14).

In a study conducted earlier in Kenya, having reporting tools, job aids (posters) and a designated surveillance officer were considered as great determinants of adequate and regular reporting (15). Uganda found inadequate number of trained staff, inadequate funding, irregular supervision and high turnover of staff as some of the key challenges (20). In others studies done in Democratic Republic of Congo and Kenya, low knowledge on surveillance case definitions also affected surveillance reporting (29, 30).

This study's limitations included use of reporting rates data for the pre intervention period (period before training) that was collected during a nationwide doctors’ strike. Though the strike only affected doctors and no other cadres like surveillance officers, it is likely that this may have had a negative impact on the reporting rates. However, as this was a nationwide strike, we believe that any effects on the reporting rates would have affected equally the intervention and control groups. Secondly, the study observation period was limited to a short time (27 weeks) as this is the period that no similar training intervention occurred in any of the control counties. Thirdly, the control counties were selected as they were the closest to the intervention counties in terms of poor performance and hence the best for comparison. However, their reporting rates were slightly better than the intervention counties and hence the opportunity to improve may not have been the same as in the intervention counties.

Conclusions

Public health surveillance reporting is crucial for timely detection and response to disease outbreaks. With support from governments and other strategic partnerships such as the Global Health Security Agenda and World Health Organization, many countries have made good progress in improving public health surveillance systems. Surveillance reporting indicators therefore continue to improve especially
through adoption of electronic systems. In this paper, we have demonstrated that training on the use of surveillance reporting platforms has some role to play in improving the reporting indicators. However, there are other additional and equally important challenges that affect surveillance reporting systems and a systematic evaluation of the surveillance system must be conducted regularly in order to identify and address them. Only then will the surveillance reporting targets be met.

**Abbreviations**

CDC: Centres for Disease Control and Prevention  
DHIS2: District Health Information System 2  
e-IDSR: electronic Integrated Disease Surveillance and Response  
FAO: United Nations’ Food and Agriculture Organization  
GHSA: Global Health Security Agenda  
IDSR: Integrated Disease Surveillance and Response  
IHR: International Health Regulations  
I-TECH Kenya: International Training and Education Centre for Health Kenya  
LMIC: Low and Middle Income Countries  
MOH: Ministry of Health  
OIE: International Organization for Animal Health  
OHI: One Health Initiative  
SMS: Short Message Service  
WHO: World Health Organization

**Declarations**

**Ethics approval and consent to participate**

This study was considered as evaluation of a public health program by the Ministry of Health and CDC Kenya. Our evaluation did not collect any personal level data and it was therefore classified as non-human research and exempted from Institutional Review Board (IRB) by the CDC Centre for Global Health under approval number 2018-293. All participants gave their consent to participate in the evaluation.
Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

IN and NK participated in the design, data collection, data analysis and drafting of the first manuscript. DK, DL and NL participated in the design and data collection for the study. SD, NL, PR, GO, DM, CE and MAW participated in the design of the study and review of the draft manuscript. All authors read and approved the final manuscript.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the organizations they come from i.e. Centers for Disease Control and Prevention, Kenya Ministry of Health and I-TECH Kenya

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**Tables**

Table 1: *Completeness of surveillance reporting pre and post training*
|                                          | Intervention counties |                                             | Control counties |                                             |
|----------------------------------------|-----------------------|------------------------------------------------|------------------|------------------------------------------------|
|                                        | Number of weekly reports received (a) | Number of expected weekly reports (b) | % Reporting rate (a/b x100) | Number of weekly reports received (c) | Number of expected weekly reports (d) | % reporting rates (c/dx100) |
| before training (15 weeks period)      | 12716                 | 28352                                        | 45%              | 18023                                        | 36769                                        | 49%                      |
| after training (12 weeks period)       | 14011                 | 22579                                        | 62%              | 15332                                        | 29290                                        | 52%                      |
| Difference before and after training   | 17%                   | (95% CI 16.14-17.86)                         |                  | 3%                                           | (95% CI 2.23-3.77)                         |                          |
| Chi square                             | 1491                  |                                              |                  | 72                                            |                                              |                          |
| P value                                | <0.0001               |                                              |                  | <0.0001                                      |                                              |                          |

The difference between the change of 17% in the intervention group and 3% in the control group is 14% and this is what can be attributed to the intervention.

Table 2: Timeliness of surveillance reporting pre and post training
|                                    | Intervention counties | Control counties |
|------------------------------------|-----------------------|------------------|
|                                    | Number of weekly      | Number of expected|
|                                    | reports received (a)  | weekly reports   |
|                                    |                       | received (b)      |
| % Timeliness (a/b x100)            |                       |                  |
|                                    | Number of weekly      | Number of expected|
|                                    | reports received (c)  | weekly reports   |
|                                    |                       | received (d)      |
| % Timeliness (c/d x100)            |                       |                  |
| **before training** (15 weeks      | 8572                  | 11435            |
| period)                            | 28352                 | 36769            |
|                                    | 30%                   | 31%              |
| **after training** (12 weeks       | 11490                 | 11164            |
| period)                            | 22579                 | 29290            |
|                                    | 51%                   | 38%              |
| Difference before and after        | **21%** (95% CI 20.16 - 20.16) |
| training                           |                       |                  |
|                                    | **7%** (95% CI 6.27-7.73) |
| Chi square                         | 2247                  | 357              |
| P value                            | <0.0001               | <0.0001          |

The difference between the change of 21% in the intervention group and 7% in the control group is 14% and this is what can be attributed to the intervention.

**Figures**
Figure 1

Map of Kenya showing 13 intervention and 13 control counties: Intervention counties: Mombasa, Kilifi, Kwale, Lamu, Tana River, Garissa, Wajir, Isiolo, Marsabit, Muranga, Nyeri, Kirinyaga, Nairobi. Control counties: Mandera, Vihiga, Kiambu, Tharaka Nithi, Elgeyo Marakwet, Meru, Turkana, Bungoma, Samburu, Migori, Nandi, Embu, Trans Nzoia.
Figure 2

Trends in completeness of reporting pre and post training
Figure 3

Timeliness of surveillance reporting pre and post training

![Bar chart showing timeliness of surveillance reporting pre and post training]

Figure 4

Challenges affecting surveillance reporting rates (n=78 responders)