Building Continents of Knowledge in Oceans of Data: The Future of Co-Created eHealth
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A Qualitative Evaluation of a Decision Support System for District-Level Disease Surveillance in Sierra Leone

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Abstract. A decision support system for district-level disease surveillance was piloted with the Port Loko District Health Management Team in Sierra Leone. Through a qualitative evaluation, the study explores the impact of the system on disease surveillance workflows. Results indicate that the system aided decision making for operational tasks, and reduced the time taken to analyze and report surveillance data. In addition, the study discusses the challenges of deploying a pilot system during the Ebola recovery in Sierra Leone, and proposes a high-level architecture for a modular, interoperable decision support system for disease surveillance for public health decision makers in low-resource health systems.

Keywords. Disease surveillance, public health, global health, Ebola

1. Introduction

1.1. Background

The 2014-16 West African Ebola Virus Disease (EVD) epidemic highlighted the pressing need for strengthening health information systems in Sierra Leone, Liberia and Guinea. Many local and international partners, who were supporting the Ebola response, developed their own data collection and management tools. As a result, the process of data collection and sharing was highly fragmented, leading to delays in data availability and variation in data quality [1]. Technology could have been better utilized to address a) the lack of standards for data entry, security and sharing b) the timeliness and quality of data for making decisions, and c) the skills gaps in the health management workforce preventing the effective use of the data collected. These challenges are equally applicable to other infectious disease outbreaks in countries with weak public health systems, and some of the lessons learnt from the use of technology during the EVD response informed the design of interventions in the 2015-16 Zika epidemic [2].

In 2015, the government of Sierra Leone released the National Ebola Recovery Strategy for Sierra Leone 2015-17 [3]. As part of the plan, the Ministry of Health and Sanitation – Sierra Leone (MoHS-SL) committed to developing a robust national health

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information system, which was cemented through the Bintumani Declaration in August 2016 [4]. Sierra Leone, like many other low- and middle-income countries, has focused on implementing the WHO Integrated Disease Surveillance and Response (IDSR) framework, which utilizes structured data from health providers. In the past five years several countries have implemented eIDSR [5][6], an electronic version of the framework, in which the data collected can be stored in an instance of the District Health Information System (DHIS2) [7].

Between November 2015 and September 2016 IBM Research Africa in partnership with Port Loko District Health Management Team (DHMT) and GOAL Global designed and built a web-based decision support tool for district-level disease surveillance as part of the Ebola recovery effort. The deployed system aimed to enable easier and faster sharing and analyses of health data to strengthen the epidemic preparedness of DHMTs. In this paper, we provide a qualitative evaluation of the system piloted in Port Loko, along with a discussion of the implementation challenges and future opportunities.

2. Methods

The decision support system was designed to integrate and analyze Integrated Disease Surveillance and Response (IDSR), Infection Prevention and Control (IPC) and Alerts (data from the emergency hotline used for reporting suspected Ebola cases and deaths in communities). A web application allowed users to explore and compare datasets, and prioritize at-risk facilities using an epidemic preparedness score created from the three datasets. Table 1 outlines the functionalities available to users through the system. For further details on the design, architecture, security, analytics and screenshots of the system the reader is referred to [8]. The system was piloted with the Port Loko District Health Management Team in Sierra Leone between October 2016 and January 2017. The system was made available for use to all members of the IDSR, IPC and Alerts teams, as well as the District Surveillance, Monitoring and Evaluation, and Medical Officers.

Table 1. A summary of web pages in the deployed decision support system. The comparisons page was added following the formative evaluation .

Home Page	Overview of aggregated reporting rate and risk level for IDSR and IPC datasets by week.
Health Units	List of peripheral health units (PHUs) prioritized by risk level, with a description of the risk(s).
Reports	Three subpages for each of the datasets (IDSR, IPC and Alerts) providing a map visualization of risk levels, and interactive graphs of trends over time.
Comparisons	Comparison of IDSR trends across facilities and Alerts trends across chiefdoms.
Data Store	Provided a space to upload, map and search non-routine, tabulated datasets containing GIS information, such as ad hoc surveys.

A qualitative evaluation of the system was conducted using semi-structured interviews with key users (a monitoring and evaluation officer, two surveillance officers, a surveillance data manager and an epidemiologist) and focus groups with target user groups (IDSR, IPC and Alerts team members) at the DHMT office before deployment of the system in September 2016, and after the deployment of the system at pilot scale in January 2017. Interviews and focus group discussions were documented through extensive notes. An inductive thematic analysis [9] (a method commonly used in

psychology for corpora of qualitative data gathered under non-experimental conditions) was used to code notes using open codes, from which themes were generated.

3. Results

3.1. Key themes from the pre-deployment evaluation

Theme 1: All users talked about the ***collection, cleaning and analysis of routine datasets*** when discussing their daily work routines. In addition to the formal health information datasets (IDSR, IPC and Alerts), DHMT members also said they used less formal data sources such as media reports, personal calls and pharmacy records. Users reported that data were cleaned, analyzed and visualized manually using a number of software tools including Excel, SPSS, QGIS and ArcGIS. PowerBI was also used to create charts for routine data reporting.

Theme 2: Participants spoke about the ***two types of decisions that they made based on routine health information***: short-term, operational decisions (e.g. determining whether a rapid response team should be dispatched for an IDSR report) and longer term, strategic decisions (e.g. planning the health workforce needs for the district).

Theme 3: Participants also discussed ***barriers to effectively and efficiently using data***. Connectivity of power, cellular and data networks were identified as key barriers in the effective use of routine health information. In addition, lack of training on data analysis tools, and lack of transportation were also identified as barriers to the effective use of Health Information Systems (HIS) in Port Loko.

3.2. Key themes from the post-deployment evaluation

Theme 1: Participants mentioned ***extensive changes in the Sierra Leonean HIS***, namely that the mode of data collection was about to change from paper forms to smartphone apps, and the data model had changed since the pre-deployment evaluation. Use of the national District Health Information System 2 (DHIS2) [7] had been strengthened, and all routine datasets were to be integrated into DHIS2 in the near future. In addition, the dashboards in DHIS2 had been implemented for some datasets.

Theme 2: Participants described how they used the system during the pilot for data manipulation to ***identify high-risk areas***. Users reported that the visualization of disease trends and a snapshot view of the district on a given date was useful and that in the event of an outbreak, they would use these datasets together to provide a more holistic view of the situation. The subscription for PowerBI had been cancelled due to a lack of funding.

Theme 3: Users said they could ***integrate the piloted system into their routine workflow***. Users reported that it was quicker to complete tasks using the system (5 to 10 minutes to analyze data using the tool, compared to 30 minutes to 8 hours using their previous workflows) as data cleaning and visualization were automated, and suggested that the system could be used in the fortnightly surveillance meeting. Users requested several new features, including integrated workflow tracking capabilities. Finally, users raised concerns that funding and connectivity (power and internet) may limit the sustainability of the system, based on their prior experiences of pilot projects.

4. Discussion

4.1. Principal findings

Iterative design in a rapidly evolving health informatics ecosystem: Some of the user needs identified at the beginning of the project [8], could be addressed through DHIS2, which was rolled out during the development of this system, making some features in deployed system redundant. However, DHIS2 does not provide analytics that combine data from multiple datasets and the mapping functionality of DHIS2 was limited and not easily used by the DHMT.

Data processing vs. data manipulation: Between the pre- and post-deployment evaluations there was the change in language used from wording around 'processing', 'cleaning' and 'creating reports 'to wording around 'searching', 'finding' and 'interpreting' data. Since the system automated the cleaning, analysis and visualization of data, it appeared users had more time to focus on exploring the data and identifying facilities or chiefdoms at high risk of an infectious disease outbreak.

Impact on decision making: Many of the 'low-level' decisions discussed in the pre-deployment interviews and focus groups (e.g. identifying under-reporting facilities) were aided by using the system. However, the system did not directly impact longer term, strategic decision making and further work is needed to determine the user requirements for decision support for strategic planning.

'Pilot fatigue': The DHMT members indicated their hesitation in investing time to learn and integrate new tools into their workflows, given their prior experience of pilot technologies being withdrawn once the project funding finished. As a result, we did not request them to use the system in place of their routine workflow, but in addition to it.

4.2. Evaluation approach

The use of a qualitative, inductive approach allowed us to capture feedback on a broad range of issues without making any prior assumptions about the users or their adoption of the technology. However, the findings presented are limited to the Port Loko DHMT, and further user studies are needed to identify if the needs and feedback gathered in Port Loko are representative of other DHMTs in Sierra Leone. Given the number of systemic changes that occurred over the period of the pilot, we were unable to quantitatively measure the impact of the system on health outcomes in Port Loko since it would have been difficult to disaggregate any impact from the system from that of the wider health system reforms.

4.3. Lessons learnt

As increasing volumes of routine surveillance and other healthcare data are collected and stored in DHIS2 in Sierra Leone and in other countries that use DHIS2, there is a need to provide tools to ensure that the data can be effectively used for day-to-day management and longer term strategic planning of the health system. Such tools should include modules for both emergency and routine operations for response and prevention of infectious disease outbreaks. A proposed high-level architecture is shown in Figure 1 in which such a decision support tool pulls data from DHIS2 and other sources through APIs.

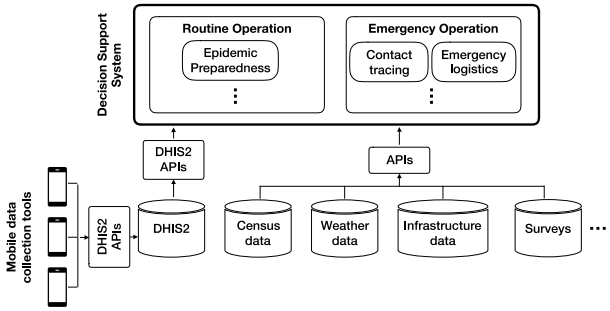

Figure 1: A proposed high-level architecture for a modular, interoperable decision support system for disease surveillance for public health decision makers in low-resource health systems.

5. Conclusion

A qualitative evaluation of the deployment of a district-level disease surveillance system in Port Loko, Sierra Leone revealed that the system a) reduced the time required to clean and analyze data and allowed users to focus on viewing and interpreting the data and b) provided support for operational decisions, but was not used for longer term, strategic planning. The rapid development of the HIS ecosystem in Sierra Leone between 2015 to 2017 required continual refinement of the product development roadmap and users were experiencing pilot fatigue due to the number of pilots conducted. Finally, we propose an interoperable architecture that is interoperable with DHIS2 to allow for the development of a modular decision support system that can be easily scaled to other low-resource health systems that utilize DHIS2.

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