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METHODS

Enabling semantic interoperability of regional trends of disease surveillance data for Namibia through a health-standards-based approach

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The Ministry of Health and Social Services in Namibia under the division of epidemiology uses a manual paper-based approach to capture disease surveillance data through 5 levels of reporting, the levels being community level, health facility level, district level, regional level, and national level. As a result, this method of communicating and exchanging disease surveillance information is cost and time consuming, which prevents disease surveillance information from reaching the head office on time. The current method used to exchange and communicate disease surveillance data is a manual process and very time consuming due to the fact that surveillance officers have to organize and store the files and hunt down the information when it is needed. Therefore, the study developed a prototype that aggregates disease surveillance data from 14 regions in Namibia and can thus enable the disease service office to capture disease surveillance data through the use of mobile devices. The functionality of the prototype would allow a disease surveillance officer in one regional office to access the data of other regional office in real time. The method used to communicate disease surveillance data is through the excel spreadsheet (IDSR), which is called the integrated disease surveillance and response. Furthermore, the excel file will be sent to the relevant authority through email. However, we still do not have a web-based system to report cases of diseases. Instead, this is a process starting from the intermediate hospital disease surveillance data, which is captured then sent to the regional office and from the regional office to the district office and then to the national office and from the national office the information is further sent to the WHO and other development partners as well as to the top management or to the highest authority. So it does not end at the national level but goes to management such as the Permanent Secretary, and the data is used to inform the development partners, and the national surveillance office prepares official letters to the management as a form of reporting disease surveillance data. The symphonic surveillance office helps to detect a particular disease. The doctors send an investigation case form to the laboratory for testing the disease that has been identified.

Keywords: interoperability, HL7, semantic interoperability

1. Introduction

The of Health and Social Services in Namibia under the division of epidemiology currently faces challenges in using a manual paper-based process of capturing disease surveillance data from the regional level, national level and eventually to the World Health Organization (1). This is the department in the Ministry of Health and Social Services that deals with disease surveillance data, involving different levels. Communicable diseases are the most common cause of illness, disability, and death in Namibia. While these diseases pose a large threat to the wellbeing of the Namibian communities, there are well-known interventions that are available for controlling and preventing them. Namibia has a relatively efficient surveillance and emergency preparedness and response (EPR) system in place (2). The Ministry of Health and Social Services has three levels of exchanging disease surveillance information such as the regional level,

which does not have a mandate to declare the outbreak of a disease in the region through monthly meetings and the CDC manager, facilities meetings and sharing information with other colleagues, collecting malaria statistics, and collecting data through other staff members that attend regional meetings. However, in these instances they don't get real data as data is collected through a manual process through an investigation case form for malaria. The second one is a national surveillance office, which deals with 5 levels of reporting, namely community level, health facility level, district level, regional level, and national level which includes different offices such as one administrative office (IDSR) (integrated disease surveillance and response), which is responsible for reporting disease surveillance data as received every Monday and then submitting the data to the World Health Organization and other development partners every Tuesday of the week (2). All the 35 district hospitals have a surveillance office that is responsible for facilitating the process of ensuring that disease surveillance data passes all the 5 levels of reporting disease surveillance data as well all the 14 regions which have a surveillance office that is responsible for reporting disease surveillance data to the right channel and the management health information office. If the community health worker detects an incident of an epidemic, he/she completes an investigation case form and sends it to the health facility for further identification. Diseases are classified into a different category called case definition depending on the symptoms and then doctors determine if it is a known disease or an unknown disease. The community health worker in the field can gather disease surveillance data and send it to the intermediate hospitals such as Rundu hospital, Oshakati hospital, Katutura hospital, and Windhoek Central hospital, and at each intermediate hospital there is one surveillance officer who is responsible for completing an investigation case form and then sends it to the next level. In each health facility there is a disease surveillance office that is responsible for receiving and sending disease surveillance data to the district office through completing an investigation case form. At the district level there is a disease surveillance office that is responsible for receiving disease surveillance data from the health facility and they send such information to the head office through completing an investigation case form. The national level receives disease surveillance data through the district level and the national level sends this information to the laboratory for testing purposes to identify what type of disease is affecting a particular region and then the disease surveillance office has to go and physically collect the investigation case form from the laboratory and eventually sends the results to top management to declare that particular epidemic officially on media such as television and newspapers. So the process does not end at national level but it further proceeds to the administrative office that is responsible for managing the integrated disease surveillance and response system, which is in excel format, and they report all the disease surveillance data weekly, monthly, quarterly, and yearly. Moreover, every Monday the disease surveillance data is received from all the four levels of reporting disease surveillance data and submitted to the World Health Organization and development partners every Tuesday on a weekly basis. The national surveillance office is responsible for preparing official letters to report disease surveillance data.

1.1. Problem statement

In the Namibian health sector, different public health institutions face challenges of lack of interoperability of health information systems (2). The Namibian health sector has many heterogeneous health systems which are not integrated in order to share and communicate with each other for the purpose of exchanging disease surveillance data from the 14 regional health directorates under the Ministry of Health and Social Services. This has been a major concern for the MoHSS because a health professional in one health institution cannot access information from another health institution. The current method used by health institutions is a manual process that causes delays and this is time consuming when a health professional is capturing disease surveillance data from the regional level to the national level (3).

The current system being used by the Ministry of Health and Social Services to communicate and exchange health-related information is through emails, telephone, WhatsApp groups or taking a picture of something and sending it to whoever needs it and also through monthly meetings. The other method that is used to share disease surveillance data is through filling what is called an investigation case form. When sharing disease surveillance data, there is a form to be completed manually, which is completed in one facility and then sent to the district office and from the district office, finally the form will be sent to the head office under the division of epidemiology where disease surveillance is done by the surveillance focal person. Currently, the Ministry of Health and Social Services does not have an integrated health system for disease surveillance data. With the DHIS2, you cannot view data that is entered from the regions and the regional people will view data that is entered by another region. In other words, there is no platform to exchange and communicate disease surveillance data in real time. The department of epidemiology in the Ministry of Health and Social Services usually receives disease surveillance data from the district offices and regional offices before the 5th of every month and all activities are done over a month and all disease surveillance data is reported weekly and monthly, and at the same time the reports that are presented monthly and weekly are different and not the same reports. It takes time to capture data from the health facilities manually, and there is no access to other silo systems, and as such all systems do not communicate with each other. There are duplicate systems.

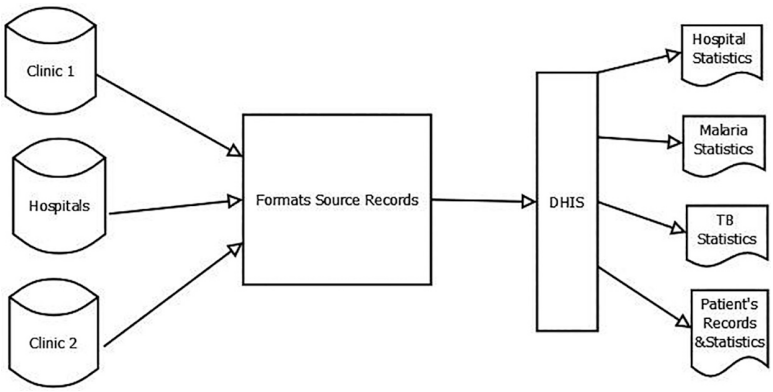

FIGURE 1 | Aggregated disease surveillance information.

2. Literature review

2.1. Interoperability

Interoperability is defined as a way of exchanging and use of information in a heterogeneous network made up of many local area networks (4).

In other words, interoperability deals with information exchange whereby interoperable systems are characterized by their ability to exchange information. The definition stresses the fact that information exchange must be direct in conformity to the illustration depicted in figure one below (4). The IEEE defines interoperability as the inherent ability of a system to exchange information. Interoperability is defined as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" [(5), p. 122–134]. Asuncion and van Sinderen (6) discuss "pragmatic interoperability" as the interoperability dealing with mutual understanding in the use of data between collaborating systems. Recently, comprehensive frameworks have been proposed to capture the many facets of interoperability (7, 8).

2.2. HL7

HL7 International is one of several American National Standards Institutes (ANSI) accredited Standards Developing Organizations (SDOs) operating in the healthcare arena (9). Most of these SDOs produce standards (sometimes called specifications or protocols) for a particular healthcare domain such as pharmacy, medical devices, imaging or insurance (claims processing) transactions. According to Working et al. (9), HL7 international is a not-for-profit standards Development Organizations (SDO). A "message" is considered the minimal unit of data transferred between systems using HL7. For example, an admission transaction would be sent as an HL7 "ADT" message. Messages are comprised of two or more "segments "that act as building blocks for each message (10).

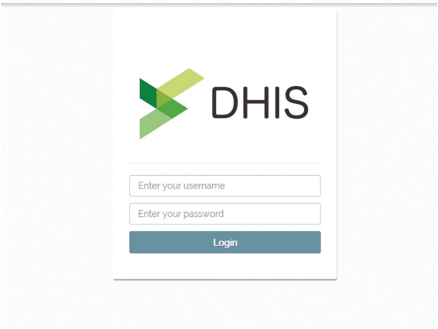

FIGURE 2 | Login interface.

2.3. Semantic interoperability

Semantic interoperability pertains to the possibility that information distributed over the net can be processed by programmes that understand the meaning of the bits and bytes in which the information items are encoded without the need for constant human interpretation (and translation) (11). Semantic interoperability plays a pivotal role in healthcare organizations through enabling ubiquitous forms of knowledge representations (12). By integrating heterogeneous information, it strives to answer complex queries and pursues information sharing in healthcare. In healthcare, data exchange schema and standards allow data sharing across clinicians, labs, hospitals, pharmacies, and patients regardless of the application or application vendor. However, the absence of interoperability within and across organizational boundaries impedes the ability to exchange information in a complex network of computerized systems developed by different manufacturers.

3. Methodology

Two hospitals in the Khomas region of Namibia, the MoHSS, the CDC and members of the Khomas community participated in this study. The first phase of the study was qualitative, applying an interpretive approach and a

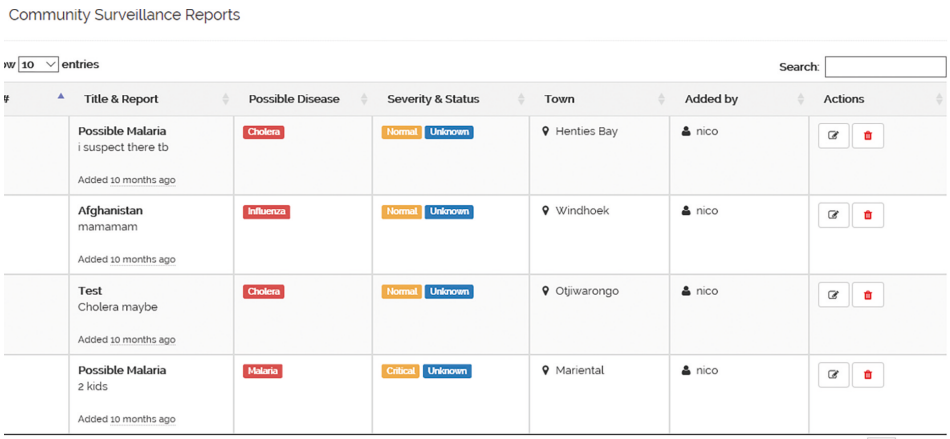

FIGURE 3 | Community surveillance report.

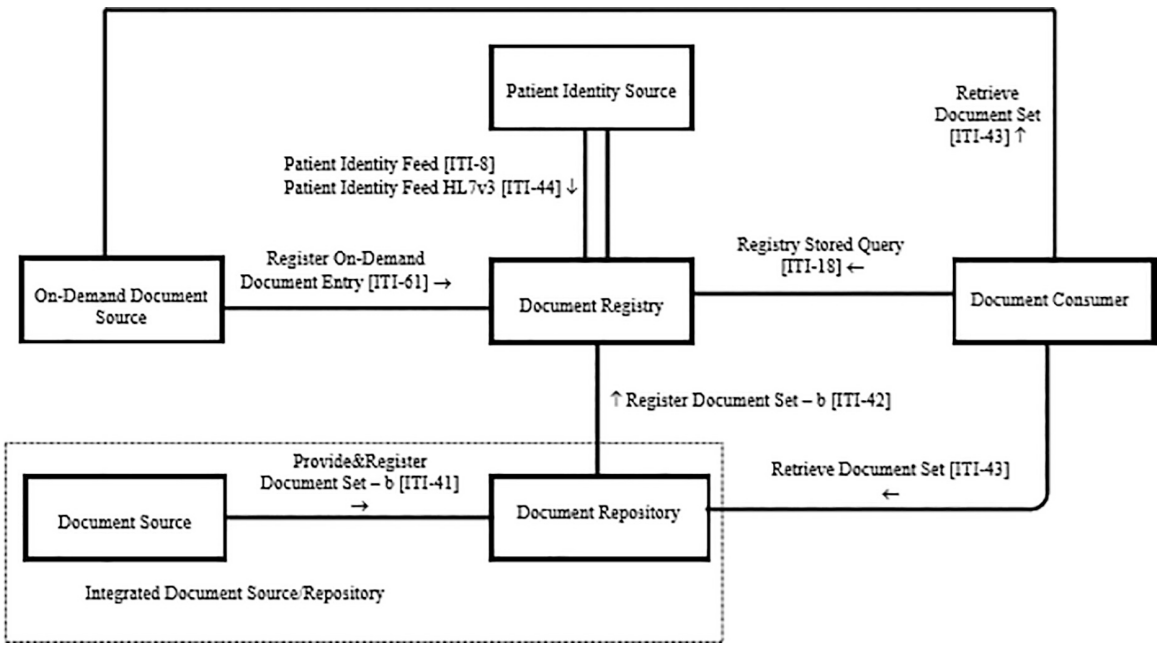

FIGURE 4 | Cross-enterprise document sharing-b (XDS.b) diagram.

qualitative multi-case study research design. Face-to-face interviews, focus group interviews, questionnaires, and document sampling were used as data collection methods to identify the requirements for a semantic interoperability prototype that enables the integration of disease surveillance information in real time across the entire health sector in Namibia. Through laboratory experimentation, the second phase of the study led to the development of a prototype. Design science research was used to guide the development of the prototype.

4. Architecture of the system

Different health facilities can access disease surveillance data from heterogeneous health information and as a result, hospital statistics from different health facilities can produce, malaria statistics, TB statistics, and patient statistics as long as the data is in JSON format.

Figure 1 represents the architecture of the prototype and its functionality, which means surveillance data from different data sources can be aggregated, and the system produces a real-time report to different health facilities in Namibia, which enables fast and informed decision-making in the health sector in Namibia.

5. Technology demonstrator

This is a login interface that can allow only registered users to login.

This shows the disease surveillance data captured in different towns in Namibia, indicating title and reports of a specific disease, possible disease name, severity,, and status,

whether a disease is normal or unknown, and the name of the town where the disease occurred.

Figure 3 represents reports from different towns in Namibia with possible disease cases such as Cholera in Henties Bay and Afghanistan in Windhoek. This means real-time surveillance data can be accessed at the same time from different towns in Namibia, which enables health professionals to make timely and informed decisions.

6. The profile

Cross-Enterprise Document Sharing (XDS) is an integrated health profile that enables several healthcare service delivery organizations that belong to an XDS Affinity Domain to cooperate in the care of a patient by sharing clinical records from heterogeneous systems.

7. Discussion

In the Namibian healthcare sector, the process of capturing disease surveillance is a manual process and time consuming. Disease surveillance is captured manually following the 5 levels of reporting: community level, health facility level, district level, regional level, and national level. At each level, the process of capturing disease surveillance data is manual, which causes delays when a health professional wants to access such information in real time using data from all the levels. Therefore, the study developed a prototype that aggregates disease surveillance data from the 14 regions in Namibia that can enable disease service offices to capture disease surveillance data through the use of mobile devices.

7.1. The system users

The system will be used by health professionals in the ministry of health and social services in Namibia such as nurses, doctors, and COVID-19 management committees. The Cross-Enterprise Document Sharing diagram below represents the mechanism of how surveillance data can be exchanged and communicated among different health stakeholders in the Namibian health domain.

This is a type of integrated profile that does not define specific policies and business rules; however, it has been designed to accommodate a wide range of such policies to facilitate the deployment of standards-based infrastructures for sharing patient clinical documents. In addition, this integrated profile is managed through federated document repositories and a document registry to create a longitudinal record of information about a patient within a given XDS Affinity Domain.

8. Conclusion

The Ministry of Health and Social Services uses a manual process of capturing disease surveillance data, which undergoes five levels of reporting, viz. community level, health facility level, district level regional level, and national level. The Ministry of Health and Social Services does not have a platform that interlinks the hospitals' silo systems with ministry systems. There is no system that tracks contagious disease and as it stands, the ministry or hospitals rely on the person in the hospital or the ministry. Therefore, this study developed a prototype that aggregates disease surveillance data from the 14 regions in Namibia that can enable the disease service office to capture disease surveillance data through the use of mobile devices.

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