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Development of an Electronic Notification System for Influenza-Like Illness Sentinel Surveillance

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Abstract. An electronic Influenza like Illness surveillance system developed to support general practices to electronically notify the cases of influenza like illness (ILI) for national sentinel surveillance in New Zealand. Content analysis was performed to capture the information necessary for ILI surveillance. An online form was implemented within the patient management system to record the details of ILI cases. A middleware framework was developed to manage the information flow between GPs and national influenza surveillance coordinators. The framework used an HL7 version 2.4 messaging standard to receive the notification data and Rhapsody integration engines to parse the message and store the information in national ILI data base. This paper presents the system design and implementation details of electronic ILI notification system. It presents data model designed to capture information for ILI case along with the HL7 messages structure implemented in the system.

Keywords. Influenza, Surveillance, HL7

Introduction

New Zealand's general practitioners (GPs) based Influenza like Illness (ILI) sentinel surveillance system was established in 1991 as part of the World Health Organisation's (WHO) Global Influenza Surveillance and Response System [1]. It is operated nationally by the Institute for Environmental Science and Research (ESR) and locally by influenza surveillance coordinators in the public health services. ILI Sentinel surveillance usually operates in the winter, from April to September every year [2]. Local surveillance coordinators recruit GPs within their region to participate on a voluntary basis. GPs manually record the age group for each suspected ILI patient consulted in their practice on a standardised form [3, 4]. Currently, every week during the Influenza season, GPs or practicing nurses in the 60 participating general practices, consolidate results, fill out forms manually and fax them through the ILI coordinators in their respective public health services. These forms are manually collated in each public health unit and the information on the number of ILI consultations and specimen taken from each general practice is faxed to national ILI coordinator at ESR. This method of manual data collection is time consuming, putting additional pressure on the practice and public health staff during the winter season and only generates a limited amount of data i.e. ILI counts for each practice and their age groups.

In New Zealand, most general practices use one of the propriety practice management systems (PMSs). These PMSs are being used to maintain patient's

electronic health record (EHR), obtaining electronic laboratory results and referring patients to secondary care electronically [5, 6]. This wide use of PMSs offers the opportunity to automate the process of GP based ILI sentinel surveillance, which potentially could be quick, well-documented and reliable as compared to fax. In addition, it offers the opportunity to improve data quality of ILI case content by controlling structure content as optional and mandatory fields and automatic population from PMS system. With an aim to modernise New Zealand's traditional ILI sentinel surveillance system, we developed an electronic ILI (eILI) notification system by replacing the process of manual collection with an automated system. This system allows GPs to fill in an electronic form at the time of patient consultation in their PMS and submit it in real time to ESR using an HL7 message. This paper presents the data model and the technical aspects of the eILI system implemented for electronic notification of ILI cases from primary care to a public health surveillance system. The objective of this paper is to present technical solutions developed in New Zealand which could be applicable in surveillance systems of other countries or international networks.

1. System Design and Implementation

1.1. Content Analysis

A content analysis was performed to capture the necessary information required to perform the sentinel ILI surveillance. This analyses was performed in collaboration with Public Health Physicians and the national ILI coordinator in ESR. Four categories of information were identified to be included in the form. The categories and the specific data elements are described in Table 1.

Table 1. eILI Form Data Elements

Reporting Information	Health Practitioner Information	Patient Information	Clinical Information
Date and time of notification	Full Name	National Health Index Number (NHI)	Date of Encounter
Reporting system	Practitioner identifier	Date of Birth	Patient meets the criteria for ILI (yes/no)
Reporting facility name	Facility Name	Gender	Patient meets the criteria for specimen collection (yes/no)
	Facility Address	Ethnicity	Patient consent given (yes/no)
		District Health Board	Symptoms start date
		Patient Occupation	Specimen collection (yes/no)
			Specimen collection date
			Source of specimen
			Patient has antiviral medication (yes/no)
			Current medications
			Influenza vaccination done (yes/no)
			Vaccination date

In these data elements, date and time of notification created, reporting system, reporting facility name, provider full name, identifier, facility name, patient NHI, date of birth, gender, ethnicity, district health board, date of encounter, patient meets the criteria of ILI, patient meets the criteria of specimen collection deemed necessary to be recorded in the ILI form. All other data elements are non-mandatory to be recorded and is on the discretion of form user to provide this information on case to case basis.

1.2. Form Workflow

Figure 1 outlines the workflow of eILI form. In this workflow, when a patient attends a general practice with a respiratory illness and meets the case definition of ILI, as per Figure 2, the GP can open the ILI form. The form is opened with provider details, patient details and date of encounter pre-populated using the information in PMS. The GP ticks the check box for 'Patient meets the criteria for Influenza like Illness' to confirm that the current patient is having ILI illness. The GP discusses the ILI sentinel surveillance with patient and sought the verbal consent from the patient to take a swab, if needed. If 'No' consent was given by the patient, the GP fill out the symptoms section, close the form and proceed as per normal consultation. Where a consent is given, the GP complete the ILI form, take the swab if needed and submit the form and continue consultation as per normal. A copy of the form will be stored in the patient record in the PMS. Where a swab is taken, GP can print the completed ILI form containing the patient details to be sent to laboratory with specimen. After being submitted, the ILI form will be automatically transmitted to ESR. Upon receiving the form, the ESR system will send an acknowledgment back to the sending system and process the data received for surveillance purposes.

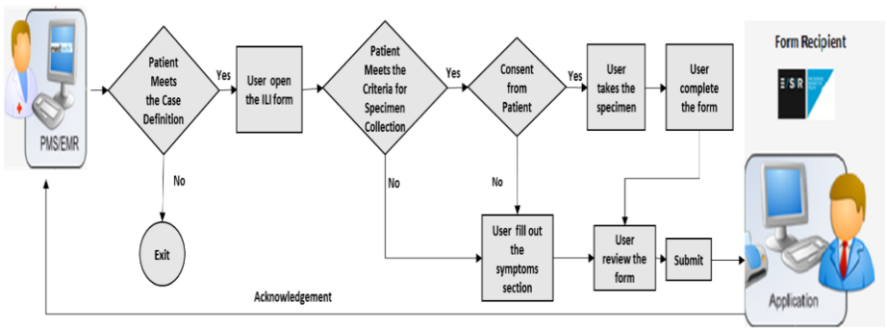

Figure 1. eILI Form Workflow

An acute respiratory illness with onset during the last 10 days with:

- *a history of fever or measured fever of ≥38°C, AND*
- *cough requiring*
- *a general practice consultation*

Figure 2. Case Definition for Community Influenza-like-Illness

1.3. System Architecture

Figure 3 provides a high level overview of the eILI system architecture which is designed to implement the end to end ILI notification process. An electronic form has been developed to capture the data elements defined in section 1.1. This is implemented using the HealthLink Online Form Solution that uses a Health Information Standards Organisation (HISO) Online Forms Standards to deliver electronic messaging and communications across the health sector [7]. The HISO Online Forms standards allows information capturing by using automatic population from PMS data base and field validations. In this architecture, the submitted form is sent to ESR via a HealthLink's Messaging Service, in HL7 format, which is collected by message parsing and integration service at the receiving end. This messaging and parsing service uses the Rhapsody Integration Engine [8], ensuring that the message received, meets the minimum data set standard, stores the raw message in a message store and parses the required information from the HL7 message and stores it in the ILI database. An acknowledgement will be sent to sending facility after the completion of this process.

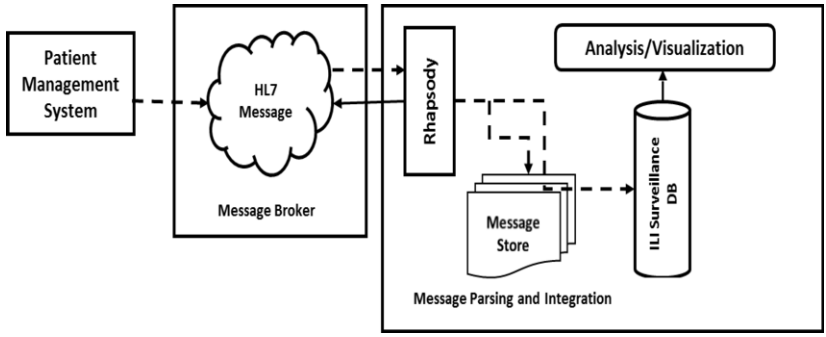

Figure 3. eILI System Architecture

1.4. HL7 Message Specifications

An HL7 message is designed and implemented using the HL7 version 2.4 REFI 12 format. The message is compliant with New Zealand Referrals, Status and Discharges Messaging Standard - HISO 10011.3 [9, 10]. Message specifications have been developed based on information requirements for ILI notification as per section 1.1. Two types of messages are included. One is ORU message, which is used for receiving ILI notification information from PMS and other is ACK response message, which is used to send the acknowledgement or rejection to message sender. Table 2 shows the segments of ILI notification message and ILI response message. In this message structure; MSH is the message header, RF1 is used to convey notification number, date and time of notification created and details of reporting system. PRD segment is used to include the practitioner's information which includes provider role (nurse or GP), full name, organisation name, identifier and facility address. PID segment is used to include patient details which includes NHI, full name, date of birth, gender, ethnicity, district health board and occupation. The ORC is common order segment (s) consisting of multiple

OBR and OBX segments which is used to include clinical information about the ILI case. The NTE segment is used to record any comment in free text format. The receiver process MSH, RF1, PRD, PID, ORC, OBR, OBX and NTE segments and discards other segments, if any. In ACK response message structure as shown in table 2, MSH is the message header, MSA is the acknowledgement section and ERR is the error code in case of any error occurred.

Table 2. HL7 message types and their segments in eLI system

ILI Notification Message		**Acknowledgement Response Message**	
Segment Name	*Description*	*Segment Name*	*Description*
MSH	Message Header	MSH	Message Header
RF1	Notification Number	MSA	Message Acknowledgement
PRD	Practitioner Details	ERR	Error
PID	Patient Details		
ORC	Common Order Segment		
NTE	Notes and comments on results information		

2. Discussion and Conclusion

Nationwide use of PMSs in general practice provides an opportunity to improve and automate ILI case reporting for sentinel surveillance replacing the current paper-based process, which is not real time, inefficient, time consuming and is collecting limited information for surveillance purpose. This project addressed the gap in standardised guidance for the electronic transmission of ILI case reports from primary care to the national collections. Through stakeholder input and assessment, we identified the requirements for electronic ILI case reporting, designing an online ILI form and corresponding message structure using HL7 version 2.4. We specified the content for an ILI case report form that meets public health needs and feasible to extract from an EHR. The data requirements address: (1) the initial data needed by public health for the purpose of sentinel surveillance and reporting; and (2) the addition of unique identifiers for the patients and case specific data to support ILI surveillance. These findings go beyond the information typically requested in traditional method of data collection. We implemented the eILI online form, which integrates seamlessly with the EHR in the PMS using the HISO Online Forms Standards (HISO 10014.3). This standard allowed the pre-population of the form with patient, clinical and provider information already available in the EHR/PMS, field validation and consistency checks. This capability has the potential to greatly reduce the time and effort to complete the form and enhance data quality and consistency in ILI reporting. We implemented a messaging framework which allowed the PMS user to send the ILI forms electronically to public health entities.

The form design and the HL7 version 2.4 message format developed and implemented has several strengths. First, it supports electronic information exchange and the automatic population of the surveillance database without the need for manual data

entry, ensuring timely reporting and more standardised content. Second, HL7 version 2 interfaces are widely used in healthcare and public health agencies. Therefore, there are existing technical and human resources available to implement a version 2.4 message guide. The form design and the HL7 version 2.4 message implementation we adopted have limitations. First, the content analysis we performed involved one public health service and the national ILI surveillance coordinator. However, the content was aligned with the current hospital based flu surveillance in New Zealand [11]. Consultation is underway, before the national roll out of the system to further validate the form content. Second, the HL7 messaging standard is not simple to implement and maintain. However, it is the most widely used medical messaging standard in New Zealand and several other countries. Third, the HL7 message structure we developed does not use the most current version. However, standards continually evolve and it is always necessary to select a reasonable version; at the beginning of the project. Version 2.4 is implemented for other types of electronic reporting from PMS (eg. eReferral)[6]. Fourth, the HL7 v2.4 messaging standard is based on a "vertical bar" or pipe-delimited format which does not integrate well with XML tools and the internet. However, we are planning to test the implementation of Fast Healthcare Interoperability Resources (FHIR) in future which will allow to use data models and XML for information capturing and transmission [12].

The eILI system is designed to allow GPs and public health unit to adopt digital methods of information management for ILI sentinel surveillance, rather than the informal and fax based methods used previously. This system provides a technical background that would be useful in rolling out the system at national level for sentinel ILI surveillance in future. The improvements will add new capability to the surveillance systems by increasing the amount of data received from practices in real time and making it more useful and efficient in a pandemic setting, hence improving the national surveillance capabilities. The current study is focused on the technical component of the system. However, a further evaluation of the system performance and feedback from end users would be useful to measure its impact on public health.

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