Informing the Front Line about Common Respiratory Viral Epidemics

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Abstract

The nature of clinical medicine is to focus on individuals rather than the populations from which they originate. This orientation can be problematic in the context of acute healthcare delivery during routine winter outbreaks of viral respiratory disease where an individual’s likelihood of viral infection depends on knowledge of local disease incidence. The level of interest in and perceived utility of community and regional infection data for front line clinicians providing acute care is unclear. Based on input from clinicians, we developed an automated analysis and reporting system that delivers pathogen-specific epidemic curves derived from a viral panel that tests for influenza, RSV, adenovirus, parainfluenza and human metapneumovirus. Surveillance summaries were actively e-mailed to clinicians practicing in emergency, urgent and primary care settings and posted on a web site for passive consumption. We demonstrated the feasibility and sustainability of a system that provides both timely and clinically useful surveillance information.

INTRODUCTION

Every winter, overlapping outbreaks of respiratory viruses sicken hundreds of thousands of adults and children. The resulting upper and lower respiratory viral infections are responsible for most of the outpatient, urgent care and emergency care visits in the winter season and contribute significantly to hospitalizations and deaths in the US.1-2 Therefore, front line healthcare providers (hereafter referred to as clinicians) practicing in emergency, urgent, and primary care settings, play a critical role in the clinical management of seasonal respiratory outbreaks. They perform diagnostic testing and apply therapeutic interventions including: patient education, vaccination and prescription of antibiotic and antiviral medication. Excess diagnostic testing and over prescribing of antibiotics may result from the inability to correctly recognize respiratory viral illnesses.

For infectious diseases with person-to-person spread, such as influenza, the individual’s likelihood of infection and the performance of rapid tests designed to detect them depends on the local incidence of disease.3 A clinician’s understanding of local disease incidence and unusual cases is dependent on observed trends or recent clinical experiences.3 Thus the timely dissemination of information about the incidence of circulating seasonal viruses to clinicians has the potential to improve their “situational awareness” about ongoing outbreaks. Improved awareness may then improve diagnostic precision and ultimately patient management.

Physicians practicing in the emergency departments of academic medical centers often have access to viral diagnostic testing as well as formal and informal communication about current outbreaks. In contrast, clinicians in other settings may have limited access to such information. Thus, they are an ideal target for interventions designed to improve the communication between public health and the front line.

In order to increase the awareness of clinicians about the epidemiology of circulating respiratory viruses in a timely and clinically useful manner, we developed an automated analysis and reporting system for pediatric respiratory infections diagnosed at a large integrated healthcare delivery organization where viral diagnostic testing is routinely performed on children with fever and or respiratory symptoms. These reports, which displayed pathogen-specific data, were posted on a web site and periodically distributed to physicians practicing in a specialty children’s hospital, and a network of urgent care clinics and primary care offices. In this paper we describe the evolution of the system from a manual reporting process to a fully automated one and present a formative evaluation of the systems performance and perceived utility.

BACKGROUND

Due to the threat of a bioterrorist attack the use of biosurveillance technologies and real-time public health surveillance systems has increased dramatically over the last decade.5 In many parts of the US, it is now possible to track, in real time, the
number of visits to emergency departments and ambulatory clinics for various symptom complaints and diagnoses, and this capability is being increasingly applied to more common public health threats like influenza and other respiratory viruses. The ability to track laboratory-confirmed disease in such a timely fashion is far less prevalent, but this functionality is likely to be more clinically useful for understanding what pathogens are driving the seasonal increases in visits for nonspecific syndromes (e.g. respiratory complaint with fever or influenza-like illness/ILI) observed by syndrome surveillance systems.

Very little research has been done to address the feasibility and utility of providing surveillance data to clinicians and even less has been done to evaluate the effect this information may have on clinical practice and over all public health. The effectiveness of existing and emerging mechanisms for providing surveillance information to clinicians depends on the availability, specificity and timeliness of the data being used as well as the method of dissemination. Which data types (e.g., ILI vs. lab-confirmed cases of influenza) and which information dissemination mechanisms will be most useful to clinicians are understudied questions.

Historically, the information sources available to clinicians have included 1) news media, 2) listservs from the state and local health department, 3) websites such as the Centers for Disease Control and Prevention and the State health department and 4) informal communications amongst colleagues. In Utah, we have been able to take advantage of a unique resource - Intermountain Healthcare – where an exceptional degree of ongoing viral testing has provided the opportunity to add information about the activity level of several common viral pathogens to the armamentarium of information sources.

Setting

Intermountain Healthcare (IH) is a large vertically integrated health care delivery organization located in the Intermountain west. IH operates 20 hospitals and over 100 ambulatory care facilities including 28 urgent care clinics. Primary Children’s Medical Center (PCMC) is IH’s 233-bed tertiary care specialty children’s hospital with a 5-state referral base and houses the laboratory where the majority of viral pathogen testing occurs.

Viral Testing

Testing for 7 common respiratory pathogens including adenovirus (AV), Influenza A and B (Flu A, Flu B), Parainfluenza (PV), 1, 2, and 3, and respiratory syncytial virus (RSV) by Direct fluorescent assay of nasal wash specimens began in December 2000. Testing for human metapneumovirus (hMPV) using similar methodology began in December 2006. Testing has a turn around time of 4 hours and favorable sensitivity and specificity compared to viral culture. Testing for all viruses costs ~$25 (US). Testing is available 7 days a week, with 5 run times during the winter season. In 2006, ~6,000 tests were performed. Testing is most often performed on patients with respiratory symptoms with fever.

METHODS

Since the inception of viral testing, disseminating summary results has been a priority. The method of dissemination has evolved from a manual system to the automated system described below. Initially, reports were manually created and posted in web pages (that were not well advertised) and e-mailed to ~20 medical directors and division heads at PCMC. As the process was automated, we also: 1) expanded the listservs and created geographically regional reports as testing came on line throughout the state, 2) posted printouts in various hospital locations, 3) developed a dedicated web site – Germ Watch – to serve as a consistent source for the information. The design objectives of Germ Watch were to automatically generate weekly summary surveillance reports of viral testing and disseminate these reports with minimal intervention to the intended users (70+ clinicians practicing within the 28 urgent care clinics of IH).

In November 2004, we convened 3 focus group meetings, with a total of 14 physicians in urgent care or general practice, to assess interest in population data about viral pathogens and discuss the design of the system for distributing reports. All of the participants desired access to information about circulating viral pathogens. The majority of participants were not aware of other resources for this type of information. Desired frequency of updates was variable, ranging from quarterly when activity was low to weekly and possibly more frequently during times of peak or unusual activity (e.g. winter). All agreed the information would be helpful but the reasons varied and included validating viral diagnoses and treatment decisions; report sharing leading to increased parent/patient satisfaction with their diagnosis; broader impact on ordering diagnostic testing (e.g., chest x-rays, labs); initiating preventive treatments (e.g., vaccination, antiviral prophylaxis or treatment) on at-risk patients; and antibiotic or steroid prescribing. Time series graphs were the preferred format for providing a quick overview, but most felt that a brief textual summary
describing the “big picture” could be helpful. Ease of access was emphasized and the preferred method of communication was electronic format combining an ‘active notification’ including a brief textual summary message with a link to a ‘passive display.’

Viral testing results are stored in the laboratory information system (LIS) with a set of standardized test codes and result codes developed by central laboratory personnel. A load script, run each night between the hours of 10 pm and 6 am populates general laboratory tables in the enterprise data warehouse (EDW) Oracle 9i® database with data from the LIS. This means that the laboratory testing results are available with a 24-hour lag time. A materialized view, containing the specific microbiology results of interest, is used to improve the efficiency of reporting tools running against this data and to remove duplicate test results, quality assurance testing and results entered on test patients.

Time-series graphs displaying the weekly counts of positive test for the various viruses are automatically generated every Monday morning using IHs’ enterprise reporting tool, Crystal Reports®. The reports, in portable document format (PDF) are directly posted to the web site and e-mailed to analysts and 1st line reviewers (authors ATP and PHG) for integrity checking and generation of a brief synopsis. If an error is detected, reports can be quickly suppressed on the web site until corrected. Once the synopsis is written, usually a few sentences describing overall trends, the reports are forwarded to an email list of intended users and the ‘Weekly Bulletin’ on the Germ Watch home page is updated.

RESULTS

Virologic testing

Figure 1 depicts the number of samples submitted for DFA testing cumulated across all IH microbiologic laboratories. The pattern of testing was highly seasonal. DFA assays were 2.5 times more frequent during the 6-month period November-April than during May-October. Thus, on the basis of testing behaviors, November and April represented the boundaries of the winter virus respiratory season. The volume of DFA testing rose significantly during the 2002-2003 winter season compared to the previous two years. From 2003 to 2006, the total number of assays submitted per year was stable. The overall percentage of samples positive for at least one virus on the panel was 35%. During winter season the cumulative positive rate was 41% compared to 18% in the off season. During the peak epidemic periods in 2004 and 2006, the cumulative positive rate was 46%.

Automatic distribution of graph reports

Figure 2 shows one component of the report. The also includes two other graphic panels depicting other viruses (AV, PIV, Flu B, and hMPV) and PIV serotypes. These graphs were actively distributed to clinicians during four consecutive winter seasons, typically starting in late October or early November and ended in late March or early April. An average of 70 clinicians (~100% of the adult and pediatric urgent care providers and ~18% of IH’s ~400 Physician Division clinicians) received the weekly graphs.

A number of pediatricians informally reported that one of their uses of the graphs was to support parent communication. For selected parents of children with acute infectious syndromes, graphs were incorporated into a discussion of the patient’s diagnosis and treatment. The perceived benefits of the graphs included improved understanding of the spread of infectious diseases; enhanced understanding of the distinction between viruses and bacteria; validating viral diagnosis without having to test patient; and validating decision to not prescribe antimicrobial drugs.
Passive Distribution - Web-posted reports

Table 1 contains summary data from analysis of the Germ Watch web log for the 18-week period spanning the most recent viral season: Nov 5, 2006-Mar 10, 2007. The Germ Watch home page was visited a total of 884 times with an average of 49 times a week. The Respiratory Viruses sub-page, was visited a total of 541 times with an average of 30 times a week. The Respiratory Surveillance graphs on this page were downloaded a total of 408 times (weekly average of 23, daily average of 8). The capability for tracking unique individual user access was not available at the time of this study.


<table>
<thead>
<tr>
<th>Web Site Activity</th>
<th>Weekly Range (Avg.)</th>
<th>Daily Range (Avg.)</th>
<th>Total</th>
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<td>1–41 (8)</td>
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<td>1–133 (5)</td>
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<td>Respiratory Page Visits</td>
<td>13–51 (30)</td>
<td>1–26 (25)</td>
<td>541</td>
</tr>
<tr>
<td>Respiratory Page Views</td>
<td>17–96 (48)</td>
<td>1–36 (8)</td>
<td>860</td>
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<tr>
<td>Respiratory Graph Downloads</td>
<td>9–49 (23)</td>
<td>0–22 (3)</td>
<td>408</td>
</tr>
</tbody>
</table>

Comparison with syndromic surveillance

The frequency of positive viral tests depicted in figure 3 mirrored the occurrence of visits to urgent care clinics for respiratory chief complaints. Pathogen-specific data revealed patterns that were not evident from analysis of non-specific markers of respiratory infection. Thus, the respiratory syndrome epidemic curve was composed of the multiple epidemic curves of individual pathogens with varying shapes and forms. Not all respiratory pathogens routinely increased during the winter months. Pathogens that were predictably seasonal included RSV, PIV, Flu A, Flu B, and hMPV. The epidemic behavior of individual pathogens was clearly demonstrated by the Germ Watch graphs. RSV, which was detected primarily in infants, demonstrated a biannual pattern of large outbreaks alternating with smaller outbreaks. During two of the winter seasons, the peaks of RSV and influenza were asynchronous. One year, distinct epidemics of different serotypes of PIV were observed. Thus, the conditional probabilities of positive tests for specific pathogens, given diagnostic testing, changed dramatically during the course of the winter season. This type of information was considered relevant and useful by clinicians.

DISCUSSION

Germ Watch is a system that generates, posts, and delivers epidemic curves to front-line clinicians at IH. The curves display counts of patients with specific types of respiratory pathogens per unit of time. The system began as a clinical service developed by members of the pediatric infectious disease division and microbiology laboratory at PCMC. The participation of personnel in the medical informatics department then led to automation of the data processing and report distribution.

In this paper, we present a descriptive analysis and formative evaluation of the system. The ongoing use of the web site and the positive feedback from recipients of the emailed graphs demonstrate the feasibility and value of implementing an automated reporting system. As part of a newly funded study, this system is now being transitioned into a program to support timely exchange of information between clinicians and public health personnel. The pathogen-specific reports depicted here are complementary to other sources of data for public health surveillance. Germ Watch has the potential to fill a gap between reportable disease surveillance and syndromic disease surveillance.
The generation of meaningful population data about respiratory pathogens depends on having an adequate volume of patients from whom diagnostic samples are obtained. The practice of obtaining nasopharyngeal aspirates from acutely symptomatic children has been widely adopted in Utah, because of its perceived benefits for clinical decision-making. The Germ Watch system has successfully capitalized on this experience. It has aimed to enhance timely awareness of dissemination of infection at the population level, with a focus on respiratory viral pathogens and pertussis.

An important question is whether tracking respiratory pathogens may be similarly feasible in adult populations. Arguments to do so, may be bolstered by recent evidence suggesting that RSV cannot be readily distinguished from influenza A on clinical grounds in elderly hospitalized. Pediatricians may be more “population-oriented” than their adult counterparts because of the relative dominance of acute infections as the basis for urgent care visits. Identification of specific organisms runs counter to an opposing trend in clinical medicine, which is to decrease use of sputum culture to make a bacteriologic diagnosis in patients with community-acquired respiratory infection. Results from a pilot project suggest that expanded use of viral diagnostic testing may have a salutary impact on inappropriate antimicrobial prescribing. The effect of Germ Watch on clinical and public health practice will be addressed in more detail in our newly initiated study.

Acknowledgement

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REFERENCES