Open Forum Infectious Diseases

BRIEF REPORT

Real-time Communication With Health Care Providers Through an Online Respiratory Pathogen Laboratory Report

Paul A. Christensen,[1] Randall J. Olsen,[1] Katherine K. Perez,[1,2] Patricia L. Cernoch,[1] and S. Wesley Long[1]

Departments of [1]Pathology and Genomic Medicine and [2]Pharmacy, Houston Methodist Hospital, Houston, Texas

We implemented a real-time report to distribute respiratory pathogen data for our 8-hospital system to anyone with an Internet connection and a web browser. Real-time access to accurate regional laboratory observation data during an epidemic influenza season can guide diagnostic and therapeutic strategies.

Keywords. analytics; epidemic; epidemiology; influenza; laboratory.

The US Centers for Disease Control and Prevention (CDC) provides data regarding influenza activity, aggregated from state data sources that generally lag 1 or more weeks behind the date of release [1]. However, real-time data summarizing regional hospital system observations are more relevant for local clinical decision-making. Clinicians frequently request updates from the microbiology laboratory on influenza test positivity, in addition to other common respiratory pathogens, during the respiratory virus season to help inform their daily practice. In addition, clinical laboratories should routinely monitor local influenza data to determine if epidemics are occurring, if continued testing is necessary, or if patients can be treated based on positive symptoms alone [2, 3]. To address these local needs in a major US metropolitan area, our clinical microbiology laboratory implemented an online dashboard to distribute respiratory pathogen data for our 8-hospital system to clinicians, epidemiologists, infection control practitioners, system leadership, and the public. The report provides easy access from any workstation or mobile device with an Internet connection. Development of this report began in the Fall 2017, before the respiratory virus season, during which influenza reached an epidemic status across the United States that resulted in supply shortages, testing difficulties, and a widespread public health crisis [4, 5].

METHODS

Sophia influenza A+B fluorescent immunoassay and Biofire Respiratory Pathogen Panel test result data were extracted from our laboratory information system (SCC Soft Computer). The extracts included de-identified laboratory result data, including specimen collection date, facility, and result for all influenza and respiratory pathogen tests. The data were further analyzed and aggregated to produce 4 interactive charts published to a public-facing web server. The accuracy of the report was validated by comparison with data generated natively by our laboratory information system, as well as a manual review of all test results from 1 day. We gathered visitor statistics from the server log files. Internet protocol addresses were mapped to Internet service provider, country, city, and organization using ipinfo.io [6].

RESULTS

Data Analysis

Four distinct data summary analyses were performed. First, for our most commonly detected pathogens (influenza A, influenza B, respiratory syncytial virus, and rhinovirus/enterovirus), we calculated the number of positive tests for each day and week. Second, we calculated the number of positive tests at each facility. Third, we calculated the daily and weekly positivity rates of our respiratory pathogen molecular test. Fourth, we calculated the frequency with which each pathogen was identified by our molecular test. These counts reflected anonymized and aggregated data devoid of Protected Health Information.

Data Visualization

To present users with interactive and dynamic data, we elected to use Hypertext Markup Language (HTML) [7] and Javascript [8] as our visualization modality. We used Chart.js [9] as the framework for producing our interactive charts. The data analyses generated Javascript arrays that were stored in Chart.js data structures to produce 4 charts (Figure 1). Chart 1, titled *Influenza, Respiratory Syncytial Virus, & Rhinovirus/Enterovirus Positivity (Molecular & Antigen)*, displayed the number of positive tests for each organism over the queried time interval. Chart 2, titled *Influenza, Respiratory Syncytial Virus, & Rhinovirus/Enterovirus Positivity (Molecular & Antigen, By Location)*, displayed the number of these pathogens detected by molecular

Received 4 October 2018; editorial decision 26 November 2018; accepted 27 November 2018; published online November 30, 2018.

Correspondence: S. Wesley Long, MD, PhD, Department of Pathology and Genomic Medicine, Houston Methodist Hospital, 6565 Fannin St, R6-116, Houston, TX 77030 (swlong@houstonmethodist.org).

Open Forum Infectious Diseases®

DOI: 10.1093/ofid/ofy322

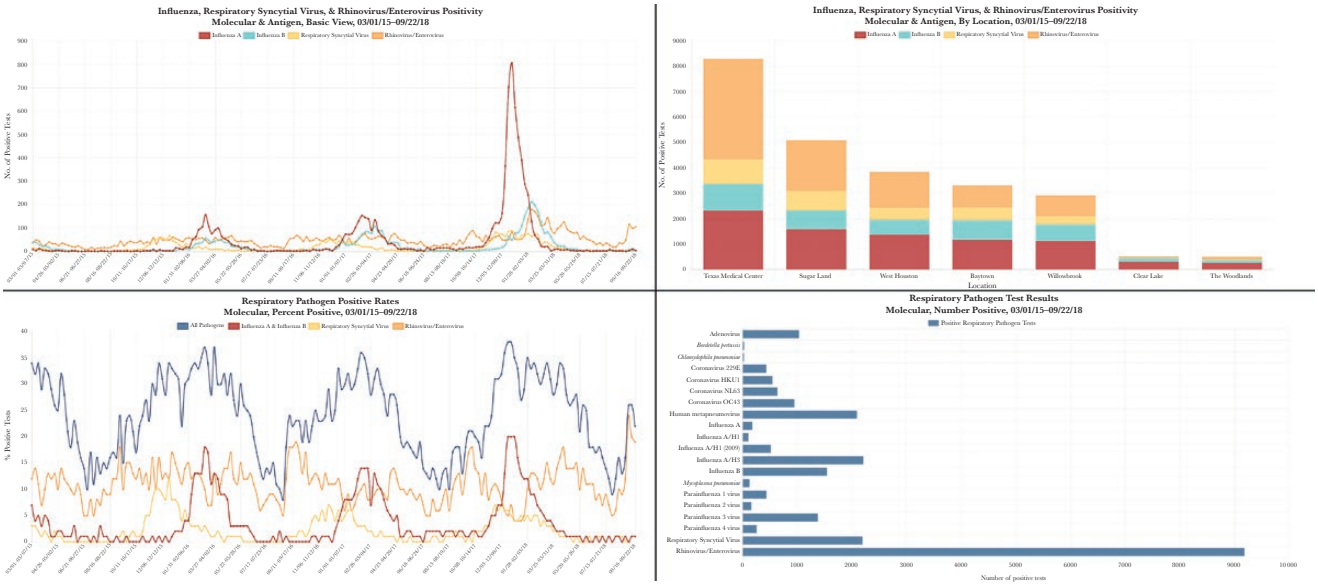

Figure 1. The 4 charts presented to the users of this report using the 2015–present time interval (March 1, 2015–September 22, 2018).

or antigen testing at each facility. Tests performed at emergency departments and outpatient clinics were counted with the associated hospital. Chart 3, titled *Respiratory Pathogen Positive Rates (Percent Positive)*, showed the molecular test positivity rate for all pathogens and for the subsets influenza A, influenza B, respiratory syncytial virus, and rhinovirus/enterovirus. Chart 4, titled *Respiratory Pathogen Test Results*, showed the numbers of pathogens identified by our molecular test over the queried time interval.

For both Chart 1 and Chart 3, we created radio buttons that allowed the user to toggle between a weekly or daily summary. For Chart 1, we built a radio button to switch between Basic View and Detailed View. In Basic View, the influenza A molecular and antigen results are grouped together; in Detailed View, the subtypes of influenza A detected by our molecular platform are graphed separately. Three distinct time intervals were supported, including the most recent 8 weeks, the past year, and 2015–present.

User Feedback and Website Monitoring

The 4 charts were packaged into an HTML report and uploaded to a public-facing web server. We unveiled the report and requested informal feedback at the system infection control meeting, the system antimicrobial stewardship meeting, and the hospital infection prevention and control committee meeting. We included a link to the report in an e-mail distributed to all employees from the Executive Vice President of the hospital system.

We updated the graphs daily. Over the subsequent 9 weeks, the report was accessed 1594 times, and over the next 27 weeks, the report was accessed 839 times. Approximately 66% of the originating IP addresses were from within our hospital system, and 6% were from locations outside the United States. Views on mobile devices accounted for 16% of the traffic, and 20% of views were referred from the Department of Pathology and Genomic Medicine website. Views peaked at 241 per hour right after the link was distributed by our Executive Vice President. During the first week, 64% of all hour intervals saw at least 1 page view, with an average of 8 views per hour. Daily view counts decreased as the influenza season ended and stabilized at 32 views per week on average.

Test Result Data and Clinical Response

At the height of the influenza epidemic at our hospital system, 32% (88/273 on December 22, 2017) of all influenza antigen tests and 24% (47/197 on December 27, 2017) of respiratory pathogen molecular tests were positive for influenza A or influenza B. Forty-six percent (55/120 on December 25, 2017) of these molecular tests were positive for any respiratory pathogen. Vendor supply stocks were limited nationwide [5], and in January 2018, our supply of universal transport media diminished, requiring the creation of 1:3 aliquots to preserve material for sample collection. Based on these data and following CDC/World Health Organization (WHO) guidelines for epidemics [2, 3], our primary care group stopped testing for influenza and treated symptomatic patients as if they were influenza positive. Our interactive website provided near real-time data, which allowed this decision to be made a week earlier than otherwise would have been possible using federal and state data. Furthermore, our inpatient pharmacy was able to anticipate oseltamivir utilization and stock accordingly while remaining prepared for potential drug shortages.

DISCUSSION

We developed a near real-time report that presents statistics regarding respiratory pathogen testing from our microbiology laboratory. The population tested includes all inpatient and outpatient individuals across our 8-hospital system (2264 operating beds) and all patients in the associated free-standing emergency and primary care clinics. The report is available to any device with an Internet connection and is updated daily to provide critical data to clinicians, epidemiologists, infection prevention and control committees, hospital leadership, and the public. We developed the site with mobile devices in mind, which allows the graphs and fonts to be readable on any platform. The user can switch between daily and weekly data aggregations using radio buttons. The time interval of interest can be modified using preconfigured buttons. Data can be filtered by clicking the data labels in the chart legends. These features are possible because of our decision to develop a web-based report, as opposed to a PDF, spreadsheet, or word processing document. Anecdotal feedback collected at the time of rollout was universally positive. Interest in the report quickly peaked after the initial announcement but continued to be viewed daily. As the influenza season ended, infectious diseases clinicians asked that we add a rhinovirus/enterovirus trend to the website so they could track the summer respiratory virus season as well. At least 1 clinician changed ordering practice in early September 2018 after identifying a spike in rhinovirus/enterovirus positivity frequency. In November 2018, the Chief Physician Executive and Specialty Physician Group CEO sent an e-mail to physician leaders across the system regarding a significant uptick in respiratory syncytial virus isolates and rising influenza A pathogens detected by laboratory testing, which was identified through our website report.

Based on the data provided by our laboratory in this report and CDC/WHO guidelines for epidemics, our primary care group stopped laboratory testing for influenza and treated symptomatic patients as if they were influenza positive. Access to accurate real-time data during an epidemic influenza season can guide diagnostic and therapeutic strategies. During the epidemic, there was a nationwide shortage of testing reagents [5]. Earlier identification of high positivity rates by monitoring real-time data allows for an institution to implement "treat don't test" guidelines earlier, preserving test reagents for critical situations where they are most needed.

In summary, our microbiology laboratory implemented a near real-time Internet report to distribute respiratory pathogen data for our 8-hospital system to clinicians, hospital epidemiologists, infection control committees, system leadership, and the public. Facile access to accurate real-time data during an epidemic influenza season can guide diagnostic and therapeutic strategies. The report is available at https://flu.houstonmethodist.org/.

Acknowledgments

Financial support. This work was supported by the Department of Pathology and Genomic Medicine at Houston Methodist Hospital. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Potential conflicts of interest. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Centers for Disease Control and Prevention. FluView: a weekly influenza surveillance report prepared by the Influenza Division. https://www.cdc.gov/flu/weekly/. Accessed January 2018.
2. Centers for Disease Control and Prevention. Guide for considering influenza testing when influenza viruses are circulating in the community. https://www.cdc.gov/flu/professionals/diagnosis/consider-influenza-testing.htm. Accessed January 2018.
3. World Health Organization. WHO recommendations on the use of rapid testing for influenza diagnosis. http://www.who.int/influenza/resources/documents/rapid_testing/en/. Accessed January 2018.
4. Centers for Disease Control and Prevention. Summary of the 2017–2018 influenza season. https://www.cdc.gov/flu/about/season/flu-season-2017–2018.htm. Accessed September 12, 2018.
5. Aquino AC. Labs take stock of surprising flu season. CAP Today. **2018**. Published on March 2018.
6. IPinfo. IP address API and data solutions - geolocation, company, carrier info, type and more. ipinfo.io. Accessed September 2018.
7. World Wide Web Consortium. W3C HTML. https://www.w3.org/html/. Accessed January 2018.
8. ECMA International. ECMAScript language specification. https://tc39.github.io/ecma262/. Accessed January 2018.
9. Timberg E, Linsley T, Brunel S, et al. Chart.js. 2.0 ed. https://www.chartjs.org/. Accessed January 2018.