CHAPTER 3: Can Telehealth Ontario respiratory call volume be used as a proxy for emergency department respiratory visit surveillance by public health?

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Introduction

The prompt detection of disease outbreaks is a major concern to public health as it has the potential to reduce morbidity and mortality[1]. Real-time syndromic surveillance uses existing non-traditional data for prompt analysis and feedback to those responsible for investigations and follow-up of potential outbreaks[2]. As this area of research progresses, decreasing false-alarm rates and time to detection is of great importance to increase sensitivity and specificity while keeping costs to a minimum. Improving the quality of existing signals and adding new signals are strategies that may improve the timeliness of detection[1]. Recent studies have suggested that integrating multiple data sources can significantly improve detection accuracy of syndromic surveillance systems, but more work is needed to explore the most effective means of said integration and what types of data streams give the greatest benefit[3,4]. Current data streams that have the potential for integration include: over-the-counter drug sales, emergency department (ED) visits, 911 calls, ambulatory dispatch, school/work absenteeism records, insurance/billing claims and telephone medical help lines[5]. In Ontario, Canada the earliest points of access to healthcare for the population are the Telehealth Ontario hotline, emergency departments, and primary care physicians[6]. These access points can be complementary or be dependant on their accessibility to the population.

Primary care in Ontario is at an early stage of adoption of the electronic health record (EHR) and hence is not amendable to syndromic surveillance systems at present due to the multitude of EHR vendors[7]. Telehealth Ontario services are contracted to a private company (Clinidata). Clinidata's highly skilled nurses use an electronic clinical support system that provides approved clinical guidelines, health information, care advice, and a service referral database to assess symptoms over the telephone and assist callers in making the most appropriate healthcare decision. Classification of each call, is based on 486 guidelines, which have been grouped into syndromes by the authors. All Ontario hospitals are required to provide information on patient visits to the National Ambulatory Care Reporting System (NACRS). These data are submitted on a regular basis and currently use the Canadian Enhancement to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10-CA) coding system for diagnoses[8]. The NACRS data is collected by the Canadian Institute for Health Information (CIHI) and includes "information to assist with the evaluation of the management of ambulatory care services in Canadian health care facilities"[8]. The

concern with the NACRS is one of timeliness, as data are not available in real-time, but are rather months delayed. Therefore, a provincial syndromic surveillance system incorporating all ED's, albeit ideal, is not an option at present. This issue is also compounded by the fact that some hospitals have yet to complete a migration to electronic records management, making the integration of all EDs additionally difficult. Due to limitations inherent to the delayed transmission of data collected by NACRS, it is essential to evaluate the potential benefit of using real-time Telehealth Ontario data for public health and emergency medicine purposes.

To our knowledge, no studies have evaluated the use of Telehealth Ontario data as a surveillance tool. However, other countries have both prospectively and retrospectively evaluated the use of their teletriage systems as early warning systems. Most notably, the UK have been forerunners in the field of teletriage syndromic surveillance, having used the National Health Service (NHS) Direct system for this purpose since 1999[9-17]. In the absence of available evidence on Telehealth Ontario's usefulness as a syndromic surveillance system, key decision makers may entertain doubts about telephone health hotline effectiveness which hinders further investments and integration of such data into the health mainstream[18]. It should be noted that Telehealth Ontario is a component of the Ontario Ministry of Health and Long-term Care's (MOHLTC) influenza pandemic plan to aid in surveillance during the pandemic period of influenza outbreaks with its main role to triage callers and provide health information[19]. This further indicates the importance of assessing the value of Telehealth Ontario data. Many studies have used data on ED chief-complaints, ICD-coded respiratory illnesses, and/or laboratory-confirmed influenza and respiratory viruses to retrospectively show the validity of syndromic surveillance systems[20-23], as well as showing the impact of such illnesses on the health-care system[24-29].

The objective of this study was to examine the temporal relationship between Ontario's ED visits and Telehealth calls for respiratory illnesses. It is hypothesized that calls to the Telehealth Ontario hotline will be a proxy measure for respiratory visit data from ED's in Ontario, which could warrant the inclusion of Telehealth Ontario data into a real-time syndromic surveillance system.

Methods

Study design

We conducted a retrospective study on respiratory illness data for a 22-month period between June 1st, 2004, and March 31st, 2006. Anonymized data were obtained from two sources: The MOHLTC's Telehealth Ontario program and CIHI's National Ambulatory Care Reporting System. Our data set was limited to this time frame as NACRS data was only available up to March 2006, and because we did not want to include any data during the SARS outbreak which may have introduced variability in our respiratory data.

Setting

Telehealth Ontario is a toll-free helpline provided by the MOHLTC and is available to all residents of the province. Users are encouraged to call with any general health questions with confidential advice being given regarding any health concerns. The system is available 24 hours a day, 7 days a week and 365 days a year with advice coming from trained and experienced registered nurses. Telehealth is available in English and French, with translational support available in 110 languages[30]. Outside of English and French; Mandarin, Cantonese, Farsi, Italian and Portuguese are the most requested languages[30]. Each nurse-led call lasts an average of 10 minutes with nurses directing patients to the most appropriate form of care. This is achieved using decision based software which are evidence-based, expert driven, and use dichotomous questioning[31]. NACRS was developed in 1997 by the CIHI to capture clinical, administrative and demographic information from all hospital-based and community-based ambulatory care[32]. Ontario is the only province in Canada that is mandated by the provincial MOHLTC to submit all abstracts on patient visits in a fiscal year. As of July 31st, 2006 the number of institutions submitting to NACRS in Ontario was 186[8].

Study population

This research is centered on the entire province of Ontario as its population base with all citizens being included in the catchment area. The study was part of a broader investigative project which was approved by the Queen's University Research Ethics Board.

Data collection and outcome measure

Telehealth services are provided by a private contractor that was hired by the MOHLTC which has collected data since December 2001. Each call is classified with one of 486

guidelines which have been reviewed and approved by a team of university-affiliated medical experts[31]. Upon studying various syndromic surveillance systems including: Real-time Outbreak and Disease Surveillance (RODS), the Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE) and (NHS) Direct and their respective syndrome classifications, all of the Telehealth guidelines were categorized into one of 32 syndrome names (e.g. respiratory upper, respiratory lower, asthma, trauma, gastroenteritis, and neurological-non-infectious amongst others). These 32 syndromes were created by the authors based on the formative work of the aforementioned systems, and for the purposes of this study only calls coded as an upper or lower respiratory syndrome were analyzed (Table 1).

As for the data from NACRS, once a patient's visit ends, the coding and abstracting is done at the institution. CIHI conducts edit checks on all data submitted to identify duplicate records, missing data or inconsistencies in data transmission. If errors are found, the submitting facility is asked to correct these abstracts[32]. This database has very little missing information and the reliability of the coding of data collected by CIHI ranges from 74-96%, with influenza and pneumonia reliably coded at 81%[27]. Since the fiscal year of 2002-2003, NACRS collects diagnosis and intervention related information based solely on the ICD-10-CA coding system[8]. Each ICD code was assigned by an experienced health coder from the respective health care facilities, which were then reviewed by the authors, and only those that dealt with a communicable respiratory illness were included in our data set (Table 2).

Statistical analyses

The Telehealth Ontario and NACRS data sources were compared by fitting time-series models and estimating a cross-correlogram at different lags (semi-monthly). Both data sets were transformed and detrended by differencing. Autoregressive moving average models were fitted to the differenced series to ensure the residuals were white noise. The autocorrelation and partial autocorrelation functions of the models were examined to determine autoregressive and moving average parts of the models. Residuals were checked for normality against the fitted values, and checked for white noise by the Portmanteau test. Spearman rank tests were performed and then cross-correlations were estimated for residuals (to account for seasonality and trends) at different lags with the limit of statistically significant correlation being $2/\sqrt{(N-1)}$. This method of analysis has

been previously demonstrated in National Health Service Direct research[33]. All statistical procedures were generated with SAS software, version 9.1 (SAS Institute, Cary, NC, USA).

Results

Of the 1.8 million calls to the Telehealth Ontario hotline during this study time period, 216,105 (~12%) calls were for an upper/lower respiratory complaint. In contrast, 819,832 (~5%) ICD-10-CA coded complaints of the approximately 17.5 million abstracts submitted to NACRS corresponded to infectious respiratory illnesses (Table 2). Age breakdowns from each data set are shown in Table 3 with Telehealth Ontario having more calls regarding 0-4 year-olds (49%) while ED visits are comprised of mainly 18-64 year olds (44%).

There were two corresponding peaks for respiratory calls/respiratory visits in the two data sets, both of which occurred during week 7 of 2004 and 2005. The 2004 winter peak was prolonged and produced higher proportions of calls to Telehealth Ontario and more visits to ED's for respiratory illness compared to the 2005 season (Figure 1).

The Spearman rank correlation coefficient was calculated to be 0.97. This coefficient is a non-parametric statistic that measures the strength of association between two variables. Values can range between -1 and +1 with +1 representing a strong, positively correlated result. The Portmanteau test for cross correlations of residuals found that 3 sets of residuals were white noise ($p=0.023$). White noise is a discrete time stochastic process whose terms are independent and identically distributed. This is important in time-series analysis were trends can affect statistical comparisons. Two statistically significant correlations were found between the Telehealth Ontario and NACRS data series. One was highly significant at lag (semi-monthly) 0 indicating increases in both series can occur simultaneously, while another was weakly correlated at lag 1 indicating increases in Telehealth Ontario calls can precede increases in ED visits by as much as 15 days.

Discussion

This study is the first to examine data from Ontario's Telehealth program in an effort to provide evidence of Telehealth's possible effectiveness as a surveillance tool. Our

results suggest that the integration of Telehealth Ontario data into a real-time syndromic surveillance system may be a complimentary tool for the detection of respiratory illnesses on a provincial basis. This is in line with other studies which have proposed that multiple, non-traditional data sources may be of significant use to augment current syndromic surveillance systems[4,20,34,35].

Our comparison of Telehealth Ontario to the NACRS data on respiratory illnesses show that both curves are highly correlated. The time-series cross-correlogram showed that the Telehealth Ontario data can document increases in respiratory calls simultaneously with NACRS and indicated that if threshold levels are set for the start of outbreaks, may provide warnings up to 15 days in advance of ED visits. This gives a positive indication that Telehealth Ontario can be used as a proxy measure for discharge diagnoses from ED's for respiratory illness.

The more intense and prolonged 2004-2005 winter peak was likely due to the fact that 2004-2005 was predominantly an Influenza A year (81%[36] of all cases in Canada were Influenza A, compared to 61.1%[37] in 2005-2006), with a larger number of cases relative to other years (10,006 confirmed cases in 2004-2005 versus 6,590 confirmed cases in 2005-2006). In the 2004-2005 influenza season, the Public Health Agency of Canada (PHAC) reported a peak during week nine of 2005 for Ontario, 2 weeks after the Telehealth Ontario and NACRS; in 2005-2006, the PHAC reported a peak for Ontario was during week 8 of 2006, 1 week later than the Telehealth Ontario and NACRS data[36,37]. These lag periods reiterate Telehealth Ontario's potential as a viable early warning system for respiratory illness. Evaluation of aberration detection methods on both curves is the next step to ascertain if sufficient specificity values are being obtained from the warnings to show that action by surveillance teams and doctors is warranted.

The strength of the NACRS data is that it is based on physicians' diagnoses and then converted to ICD-codes. Studies on the accuracy of ICD-9 codes for respiratory illness have shown excellent specificity and moderate sensitivity supporting their use in public health surveillance[38]. While our study used the newer classifications (ICD-10-CA), we revised our inclusion of specific codes as a result of recent work that found the most sensitive ICD-9 codes for influenza-like illness surveillance[39]. Furthermore, evidence suggests that this is a valid assumption as syndromic surveillance systems are stable

(i.e. resilient enough to change, such as a shift from coding in ICD-9 to ICD-10)[40]. While the NACRS is a concise, clinical based data set, its flaw is its timeliness. The MOHLTC mandates all Ontario hospitals to submit data, but its only requirement is that abstracts be submitted before the fiscal year-end deadline. This reporting lag makes using these data for a real-time surveillance system unfeasible, whereas the Telehealth Ontaro data are inputted in real-time as an electronic form which theoretically could be integrated into an existing provincial surveillance system.

Telehealth Ontario receives a large volume of calls for 0-4 year olds and a marked deficiency in those over the age of 65 compared to ED visits. This inadequate representation of the elderly population may be explained by their hesitation to use or lack of awareness of the Telehealth Ontario program, or their preference to see a family physician or visit the ED. The over-representation of calls associated with 0-4 year olds may in fact be essential to monitor, as children are the primary propagators of respiratory-type illnesses such as influenza, as well as having longer durations of viral shedding and generally higher titres of recovered viruses[41-43]. By early identification of respiratory illness in children, we may be able to identify circulating viruses and implement appropriate public health measures (such as public messaging, calls for vaccination and school closures) to further mitigate the spread of disease to other children, adults and the elderly. Further, if Telehealth Ontario is able to identify those patients who do not require emergency medical treatment and instead divert them to self-care or their family physician, this may help decrease the burden on ED's. However, if this is to be an effective method, further work will have to be done to ensure that patients follow the action suggested by the Telehealth Ontario nurse. Another positive aspect of the Telehealth Ontario program is its accessibility to those living in remote, geographic areas where hospitals or primary care may be difficult to access.

Limitations

Administrative data has its inherent weaknesses as there is always the possibility for coding and entry errors as well as misdiagnoses. Although experienced physicians, nurses and health coders provide this data, human error can be a factor. The retrospective aspect can also be of consequence as there is no possibility to follow-up on missing or incomplete data. Although NACRS has very good filters for this, Telehealth Ontario does not. The age and sex categories of the Telehealth Ontario data

set showed minimal missing values (data not shown). These missing values, along with possible minor misclassifications are not be expected to influence results due to the large amount of data in both series. Selection bias may also have been introduced by people that do not seek any form of medical attention. This issue is also thought to be of small consequence to our study due to the toll-free nature of Telehealth Ontario and the free access to healthcare for all Canadians. Another limitation is we only had 22-months of data to look at and therefore conclusions based on this can only reflect the seasonality and circulation of respiratory viruses for this time period.

Conclusions

The analysis of routinely collected Telehealth Ontario data provides evidence that it can be a proxy measure for ED visit data for respiratory illnesses on a provincial basis. This is potentially the only source of province-wide real-time surveillance data in Ontario. The only other method currently used is influenza-like illness surveillance which is reported by sentinel physicians (1 sentinel physician per 165,000 people)[19]. The integration of Telehealth Ontario data into existing real-time syndromic surveillance systems may improve the ability of such systems to detect outbreaks of respiratory illness and assess the impact on emergency departments quicker than current methods. This would allow public health and emergency management officials a novel means of timely surveillance which could enable prompt preparation and action towards influenza-like illness outbreaks. Further research is needed on Telehealth Ontario and other non-traditional data sources in an on-going effort to improve disease detection and to provide evidence for their effectiveness as tools for surveillance, especially during pandemic influenza periods.

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Table 3-1. Syndrome grouping of upper and lower respiratory illnesses with corresponding Telehealth Ontario guidelines

SYNDROME	*TELEHEALTH ONTARIO GUIDELINE*
Upper Respiratory	Colds (Adult After Hours)
	Colds (Pediatric After Hours)
	Congestion - Guideline Selection (Pediatric After Hours)
	Croup (Pediatric After Hours)
	Ear - Congestion (Adult After Hours)
	Ear - Congestion (Pediatric After Hours)
	Ear - Discharge (Adult After Hours)
	Ear - Discharge (Pediatric After Hours)
	Earache (Adult After Hours)
	Earache (Pediatric After Hours)
	Hoarseness (Adult After Hours)

	Hoarseness (Pediatric After Hours)
	Respiratory Multiple Symptoms - Guideline Selection (Adult After Hours)
	Respiratory Multiple Symptoms - Guideline Selection (Pediatric After Hours)
	Sinus Pain and Congestion (Adult After Hours)
	Sinus Pain Or Congestion (Pediatric After Hours)
	Sore Throat (Adult After Hours)
	Sore Throat (Pediatric After Hours)
Lower Respiratory	Cough - Acute Non-productive (Adult After Hours)
	Cough - Acute Productive (Adult After Hours)
	Cough - Chronic (Adult After Hours)
	Cough (Pediatric After Hours)
	Coughing Up Blood (Adult After Hours)
	Wheezing – Other Than Asthma (Pediatric After Hours)

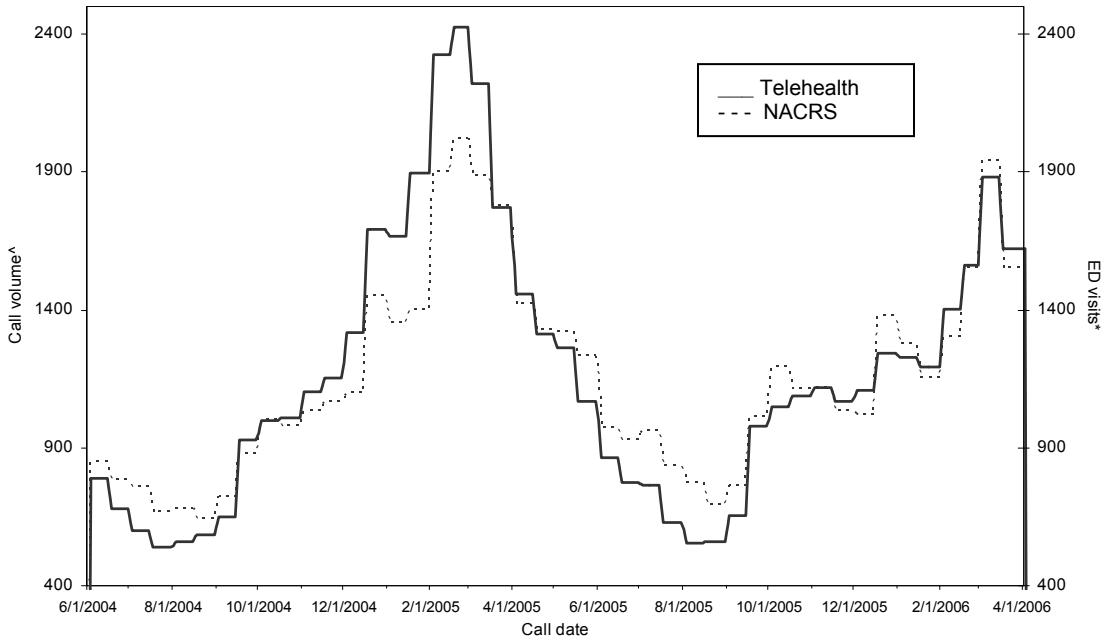
Table 3-2. Communicable respiratory syndromes coded by hospital health coder post-discharge from ICD-10-CA classifications

ICD-10-CA CODE	*CODE DESCRIPTION*
J00	Acute nasopharyngitis (common cold)
J01	Acute sinusitis
J02	Acute pharyngitis
J03	Acute tonsillitis
J04	Acute laryngitis and tracheitis
J05	Acute obstructive laryngitis (croup) and epiglottitis
J06	Acute upper respiratory infections of multiple and unspecified sites
J10	Influenza, due to identified influenza virus
J11	Influenza, virus not identified
J12	Viral pneumonia, not elsewhere classified

J16	Pneumonia due to other infectious organisms, not elsewhere classified
J17	Pneumonia in diseases classified elsewhere
J18	Pneumonia, organism unspecified
J20	Acute bronchitis
J21	Acute bronchiolitis
J22	Unspecified acute lower respiratory infection
J40	Bronchitis, not specified as acute or chronic
J41	Simple and mucopurulent chronic bronchitis
J42	Unspecified chronic bronchitis

Table 3-3. Age distribution of the National Ambulatory Care Reporting System's emergency department visits and Telehealth Ontario calls for respiratory illnesses in Ontario, Canada from June 2004 to March 2006

Age group (years)	*NACRS (n=819,832)*		*Telehealth (n=216,105)*	
	n	*%*	*n*	*%*
0-4	198,585	24.2	104,805	48.5
5-17	165,707	20.2	29,760	13.8
18-64	362,825	44.3	75,095	34.7
65+	92,715	11.3	6,445	3.0



^Call volume refers to Telehealth Ontario hotline (data series 4x original counts)

*ED visits refers to NACRS

Figure 3-1. Telehealth Ontario and the National Ambulatory Care Reporting System (NACRS) time series for respiratory illnesses, semi-monthly – Ontario, Canada, June 2004 – March 2006