Telehealth Ontario Detection of Gastrointestinal Illness Outbreaks

Jaelyn M. Caudle, MD, Adam van Dijk, MSc, Elizabeth Rolland, MSc, Kieran M. Moore, MD

ABSTRACT

Objective: Prompt detection of infectious disease outbreaks and rapid introduction of mitigation strategies is a primary concern for public health, emergency and security management organizations. Traditional surveillance methods rely on astute clinical detection and reporting of disease or laboratory confirmation. Although effective, these methods are slow, dependent on physician compliance and delay timely, effective intervention. To address these issues, syndromic surveillance programs have been integrated into the health care system at the earliest points of access; in Ontario, these points are primary care providers, emergency departments (ED), and Telehealth Ontario. This study explores the role of Telehealth Ontario, a telephone helpline, as an early warning system for detection of gastrointestinal (GI) illness.

Methods: Retrospective time-series analysis of the National Ambulatory Care Reporting System (NACRS) ED discharges and Telehealth Ontario data for GI illness from June 1, 2004 to March 31, 2006.

Results: Telehealth Ontario recorded 184,904 calls and the NACRS registered 34,499 ED visits for GI illness. The Spearman rank correlation coefficient was calculated to be 0.90 (p<0.0001). Time-series analysis resulted in significant correlation at lag (weekly) 0 indicating that increases in Telehealth Ontario call volume correlate with increases in NACRS data for GI illness.

Conclusion: Telehealth Ontario call volume fluctuation reflects directly on ED GI visit data on a provincial basis. Telehealth Ontario GI call complaints are a timely, novel and representative data stream that shows promise for integration into a real-time syndromic surveillance system for detection of unexpected events.

Key words: Syndromic surveillance; bioterrorism; gastrointestinal illness; Telehealth

International terrorist activities have highlighted our lack of preparedness for biological attacks and have focused the attention of local and national health resources on methods to enhance detection of an event. In North America, water supply and distribution systems and the food industry represent potential targets for terrorist activity because of the essential roles these industries play in day-to-day life and the relative ease of intentional contamination. The threat to municipal water supplies, although a low probability, has severe medical, public health and economic consequences. A high index of suspicion for bioterrorism is needed because intentional outbreaks may resemble naturally occurring disease and involve endemic pathogens. Terrorism through intentional food and water tampering has already occurred in the United States. Large-scale, unintentional outbreaks of disease such as the contamination of the municipal water supply in Walkerton, Ontario further highlight the need for vigilance.

Early detection of the first symptomatic cases is an important objective in infectious disease surveillance. In Ontario, traditional health surveillance via laboratory confirmation and a reportable disease system is slow and dependent on physician compliance. Potential benefits of earlier detection include rapid post-exposure prophylaxis or treatment, allocation of health resources and implementation of public health measures (quarantine, isolation, boil water advisories) to limit spread of disease.

Syndromic surveillance is an emerging field developed in response to the threat of bioterrorism. Intended to be complementary to conventional methods, syndromic surveillance converts clinical data collected electronically at the point of care into surveillance information. A number of non-traditional data sources have been used, including emergency department (ED) visits and telephone helpline calls. Most syndromic surveillance programs are integrated into the health care system at the earliest points of care. In Ontario, access occurs via EDs, primary care providers and Telehealth Ontario (Telehealth). Integration of multiple data sources improves specificity, but studies have not yet determined the most effective data streams or method of integration.

Evaluation of the National Health Service (NHS) Direct, a system of 22 independent call centres using real-time data for health surveillance in the United Kingdom, shows promise as an early warning system for influenza and GI illness. Analogous to NHS Direct, Telehealth is suited to provincial health surveillance because of its centralized database and standardized computerized decision tree. Use of Telehealth for early detection of respiratory illness has been shown to be a timely, novel and representative data stream that shows promise for integration into a real-time syndromic surveillance system for detection of unexpected events.
illness outbreaks has recently been demonstrated using a time-series analysis similar to that presented in this paper. The objective of this study is to examine the temporal relationship of ED visits and Telehealth calls for gastrointestinal (GI) illness in Ontario.

**METHODS**

**Study design**

This is a retrospective study of GI illness data between June 1, 2004 and March 31, 2006. Anonymized data were obtained from the Telehealth and Canadian Institute for Health Information (CIHI) National Ambulatory Care Reporting System (NACRS) databases. The Queen’s University Health Sciences Research Ethics Board approved this study as part of a larger project by the Queen’s University Emergency Syndromic Surveillance Team (QUEST).

**Background on the National Ambulatory Care Reporting System**

As of July 2006, 186 institutions in Ontario submit clinical, administrative and demographic data to the NACRS using the Canadian Enhancement to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10-CA) diagnostic coding system. Hospital health records staff extract data at the conclusion of each patient visit. CIHI audits all data to identify duplicate records, missing data or inconsistencies in data transmission. If errors are found, the submitting facility is asked to correct these abstracts. Reliability of the coding data ranges from 74-96%. ICD-10-CA codes for GI illness were included in our data set (Table 1).

**Background on Telehealth Ontario**

Telehealth is a toll-free helpline provided by the Ontario Ministry of Health and Long-Term Care (MOHLTC) and is available to all Ontario residents. Registered nurses provide confidential advice for any general health question. The service is available 24 hours a day, 7 days a week and 365 days a year (24/7/365) and is offered in the Canadian official languages with translational support available in 110 languages. Each nurse-led call lasts an average of 10 minutes and concludes with a disposition to the most appropriate form of care. The decision-based software is evidence-based, expert-driven, and uses dichotomous questioning.

Data are collected in the form of 486 guidelines which have been reviewed and approved by a team of medical experts. Telehealth guidelines were categorized by QUEST a priori into 1 of 32 syndromes (e.g., respiratory upper, GI) after review of classifications used by existing syndromic surveillance systems including the Rapid Outbreak Detection System, Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE) and NHS Direct. For this study, only GI coded calls were analyzed (Table 2).

**Statistics**

The Telehealth and NACRS data sources were compared by fitting time-series models and estimating a cross-correlogram at different lags (weekly). Data sets were transformed and detrended by differencing and autoregressive moving average models were fitted to the differenced series to ensure the residuals were normally distributed and independent. Autocorrelation and partial autocorre-

<table>
<thead>
<tr>
<th>Table 1.</th>
<th>Communicable Gastrointestinal Syndromes Coded by Hospital Health Coder Post-emergency Department Discharge Using ICD-10-CA Classifications</th>
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</thead>
<tbody>
<tr>
<td>ICD-10-CA Code</td>
<td>Code Description</td>
</tr>
<tr>
<td>A00</td>
<td>Cholera</td>
</tr>
<tr>
<td>A01</td>
<td>Typhoid and Paratyphoid Fevers</td>
</tr>
<tr>
<td>A02</td>
<td>Other Salmonella Infections</td>
</tr>
<tr>
<td>A03</td>
<td>Shigellosis</td>
</tr>
<tr>
<td>A04*</td>
<td>Other Bacterial Intestinal Infections</td>
</tr>
<tr>
<td>A05f</td>
<td>Other Bacterial Foodborne Intoxications</td>
</tr>
<tr>
<td>A06</td>
<td>Amoebiasis</td>
</tr>
<tr>
<td>A07s</td>
<td>Other Protozoal Intestinal Diseases</td>
</tr>
<tr>
<td>A08</td>
<td>Viral and Other Specified Intestinal Infections</td>
</tr>
<tr>
<td>A09</td>
<td>Diarrhea and Gastroenteritis of Presumed Infectious Origin</td>
</tr>
<tr>
<td>A22</td>
<td>Anthrax</td>
</tr>
</tbody>
</table>

* Includes subcodes for enteritis due to Enteropathogenic Escherichia coli, Campylobacter species, Yersinia enterocolitica and Clostridium difficile 
† Includes subcodes for foodborne staphylococcal or Clostridium perfringens intoxication and botulism 
‡ Includes subcodes for infections due to Giardia, Cryptosporidium, Isospora, Trichomonas and unspecified protozoal intestinal disease

<table>
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<tr>
<th>Table 2.</th>
<th>Syndrome Grouping of Gastrointestinal Illness with Corresponding Telehealth Ontario Guideline</th>
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<tr>
<td>Syndrome</td>
<td>Telehealth Ontario Guideline</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Diarrhea (Adult)</td>
</tr>
<tr>
<td></td>
<td>Diarrhea (Pediatric)</td>
</tr>
<tr>
<td></td>
<td>Stools – Blood In (Pediatric)</td>
</tr>
<tr>
<td></td>
<td>Stools – Unusual Colour (Adult)</td>
</tr>
<tr>
<td></td>
<td>Stools – Unusual Colour (Pediatric)</td>
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<tr>
<td></td>
<td>Vomiting (Adult)</td>
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<td></td>
<td>Vomiting (Pediatric)</td>
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</tbody>
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<tr>
<th>Table 3.</th>
<th>Age Distribution of the National Ambulatory Care Reporting System (NACRS) Emergency Department Visits and Telehealth Ontario Calls for Gastrointestinal Illness in Ontario, Canada from June 2004 to March 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Group (yrs)</td>
<td>NACRS ( n=34,499 )</td>
</tr>
<tr>
<td>0-4</td>
<td>15,067</td>
</tr>
<tr>
<td>5-17</td>
<td>6825</td>
</tr>
<tr>
<td>18-64</td>
<td>10,061</td>
</tr>
<tr>
<td>65+</td>
<td>2546</td>
</tr>
</tbody>
</table>

RESULTS

During the study, Telehealth received 1.8 million calls of which 184,904 (10%) were for selected GI guidelines. The NACRS database registered 17.5 million abstracts; 34,499 (0.2%) were for the GI diagnostic codes. ED visits occurred more frequently among patients aged 0-4 years (44%) whereas patients aged 18-64 years more often contacted Telehealth (42%) for their symptoms. There was minimal representation of patients over age 65 years for Telehealth (6.4%) and ED (7.4%) contact (Table 3).
Telehealth vomiting and diarrhea algorithms were used most often to address caller concerns. Adults aged 18-64 years reported an equal incidence (35% and 37%, respectively) whereas vomiting (59%) was more common than diarrhea (31%) in the 0-4 year group. Rectal bleeding was rarely reported in the pediatric population but accounted for 21% of all adult Telehealth contacts. ICD-10-CA code A08 (viral enteritis) accounted for 75% of ED GI discharges (Figure 1). An additional 15% of ED visits were coded as A09 (diarrhea and gastroenteritis of presumed infectious origin). Specific food-borne illness was rarely diagnosed (3.5%).

Two peaks for GI Telehealth calls and ED discharges occurred in January and March 2005 (Figure 2). The Spearman correlation coefficient was calculated at 0.90 (p<0.0001). One statistically significant correlation was found between the Telehealth and the NACRS GI data at lag (weekly) 0, indicating increases in both series can occur simultaneously. The absence of a positive lag indicates changes in Telehealth GI call volume do not precede corresponding ED discharges.

**DISCUSSION**

Prompt detection of infectious disease outbreaks is a primary concern for public health, emergency and security management organizations. To address the issues of delayed recognition and intervention inherent in traditional health surveillance, syndromic surveillance programs have been integrated into the health care system at the earliest points of access. These programs use real-time, existing data streams for prompt analysis and identification of infectious disease outbreaks. Although Telehealth was not intended for surveillance, results from this study suggest integration of Telehealth data into a real-time surveillance system may be a complementary tool for the detection of GI illness in Ontario.

The time-series cross-corrlelogram demonstrated that Telehealth data can document increases in GI calls simultaneously with, but not preceding, ED visits. NACRS data are based on physicians’ discharge diagnostic codes. Although not equivalent to ICD-10-CA codes, Telehealth calls are potentially proxy measures for ED discharge diagnosis of communicable GI illness.

The success of a surveillance system depends on its simplicity, flexibility, data quality, acceptability, sensitivity, representativeness and timeliness. Utility of the NACRS as a provincial surveillance tool is limited by the timeliness of data submission and analysis which may be delayed by months. In contrast, Telehealth is high volume, universally accessible, available 24/7/365 and allows real-time electronic data collection using a centralized database for all of Ontario. These characteristics permit earlier reporting of communicable GI illness despite the absence of a positive lag on statistical analysis. As a single database, Telehealth would provide effective disease surveillance without the need to assimilate ED data from disconnected sources.

GI Illness resulting from intentional contamination of food or water is likely to affect a wide demographic. Integrating Telehealth data into ED surveillance systems will allow a larger percentage of health care users to be monitored, including patients not subject to traditional surveillance methods. Patients who do not seek medical care by a physician or receive laboratory confirmation of their illness and those directed by Telehealth to remain at home will be included in an integrated surveillance system. Formal infectious disease surveillance will also be extended to Northern Ontario, an area of widely dispersed populations that is traditionally underserved by health care resources.

In keeping with the nonspecific symptom profile of GI pathogens, most ED visits were assigned to the A08 (viral enteritis) and A09 (diarrhea and gastroenteritis of presumed infectious origin) codes. Even though a constellation of symptoms may suggest a communicable disease, a specific pathogen is unlikely to be diagnosed during the initial ED visit. Further, most physicians do not perform laboratory evaluation in uncomplicated cases of GI illness.

Real-time detection of an outbreak allows rapid introduction of strategies to mitigate the associated mortality and morbidity. Because GI pathogens have short incubation periods (3-5 days), traditional surveillance methods are too slow to facilitate an effective response. Early detection by Telehealth surveillance can limit spread of disease through rapid introduction of post-exposure prophylaxis or treatment, allocation of health resources and implementation of public health measures. Patterns of infectivity will depend on the agent and the source; widespread infection is expect-
ed for water-borne sources versus a more limited distribution of illness from a food delivery source. Once an outbreak is recognized, further spatial analysis and real-time geographic mapping of Telehealth data to corresponding public health units or water distribution systems can facilitate targeted epidemiologic investigation and effective resource allocation. Conversely, during periods of increased security concerns, Telehealth surveillance can provide reassurance that an infectious disease outbreak is not occurring, thereby allowing modification of aberration detection tools to lower thresholds for investigation of statistical alerts. These lower thresholds will detect even smaller aberrations in the expected background rate of disease. Telehealth data for respiratory, fever/influenza and gastrointestinal syndromes are actively monitored by the Public Health Division of Ontario MOHLTC.

**Limitations**

This study relies on retrospective administrative data which may have errors in coding or diagnosis. The NACRS has effective filters for this, however Telehealth does not. Selection bias introduced by people who do not seek any form of medical attention is unlikely to affect results because of the universal access to health care for all Canadians. Information on repeat Telehealth or ED contact by individuals for the same illness is not available. Lack of telephone access would bias results in favour of NACRS data, however this issue is likely to affect a negligible portion of the population. An analysis of the Telehealth and ED data in relation to the overall population has not been done and remains an opportunity for future research. Conclusions of the study reflect only the 22 months of data and may not be representative of longer trends for GI illness.

**CONCLUSIONS**

Telehealth data can serve as proxy measures for ED discharge diagnosis data for GI illness in Ontario. This represents a novel use of Telehealth as a health surveillance tool.

**REFERENCES**


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RÉSUMÉ

Objectifs : La détection précoce d’épidémies de maladies infectieuses et l’introduction rapide de stratégies d’atténuation représentent une préoccupation de premier plan pour les organismes de santé publique, de secours et de gestion de la sécurité. Les méthodes de surveillance traditionnelles s’appuient sur la détection clinique et le signalement astucieux de maladies ou sur leur confirmation en laboratoire. Même si ces méthodes sont efficaces, elles sont lentes, dépendent du bon vouloir du médecin et retardent l’intervention efficace et opportune. Pour aborder ces questions, les programmes de surveillance syndromique ont été intégrés aux systèmes de soins de santé dans les premiers points d’accès. En Ontario, ces points sont les fournisseurs de soins primaires, le service des urgences et Télésanté Ontario. Dans cette étude, nous explorons le rôle de Télésanté Ontario, une ligne d’aide téléphonique, comme système d’avertissement précoce pour la détection des maladies gastro-intestinales (GI).


Résultats : Télésanté Ontario a enregistré 184 904 appels et le SNISA a reçu 34 499 visites aux urgences concernant les maladies GI. Nous avons calculé le coefficient de corrélation de rang à 0,90 (p<0,0001). L’analyse de séries chronologiques a donné lieu à une corrélation importante au point 0 (hebdomadaire), indiquant que les augmentations du volume d’appels à Télésanté Ontario sont en corrélation avec celles des données du SNISA concernant les maladies GI.

Conclusion : Les fluctuations du volume d’appels à Télésanté Ontario reflètent directement les données sur les visites aux urgences à l’échelon provincial concernant les maladies GI. Les appels concernant les maladies GI effectués auprès de Télésanté Ontario représentent un filon de données représentatif, nouveau et opportun qui laisse entrevoir l’avenir d’un bon œil en ce qui concerne leur intégration dans un système de surveillance syndromique en temps réel pour la détection d’événements inattendus.

Mots clés : surveillance syndromique, bioterrorisme, maladies gastro-intestinales, Télésanté Ontario

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