
Journal of Urban Health: Bulletin of the New York Academy of Medicine Vol. 80, No. 2, Supplement 1 2003

Clinical Evaluation of the Emergency Medical Services (EMS) Ambulance Dispatch-Based Syndromic Surveillance System, New York City

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ABSTRACT *Since 1998, the New York City Department of Health has used New York City Emergency Medical Services (EMS) ambulance dispatch data to monitor for a communitywide rise in influenzalike illness (ILI) as an early detection system for bioterrorism. A clinical validation study was conducted during peak influenza season at six New York City emergency departments (EDs) to compare patients with ILI brought in by ambulance with other patients to examine potential biases associated with ambulance dispatch-based surveillance. We also examined the utility of 4 EMS call types (selected from 52) for case detection of ILI. Clinical ILI was defined as fever (temperature higher than 100°F) on history or exam, along with either cough or sore throat. Of the 2,294 ED visits reviewed, 522 patients (23%) met the case definition for ILI, 64 (12%) of whom arrived by ambulance. Patients with ILI brought in by ambulance were older, complained of more severe symptoms, and were more likely to undergo diagnostic testing, be diagnosed with pneumonia, and be admitted to the hospital than patients who arrived by other means. The median duration of symptoms prior to presenting to the ED, however, was the same for both groups (48 hours). The selected call types had a sensitivity of 58% for clinical ILI, and a predictive value positive of 22%. Individuals with symptoms consistent with the prodrome of inhalational anthrax were likely to utilize the EMS system and usually did so early in the course of illness. While EMS-based surveillance is more sensitive for severe illness and for illness affecting older individuals, there is not necessarily a loss of timeliness associated with EMS-based (versus ED-based) surveillance.*

INTRODUCTION

In the event of a large-scale bioterrorist attack, early detection is essential for notification and mobilization of public health resources, rapid epidemiological and criminal investigations, and mass treatment and prophylaxis to limit casualties.[1,2] Infection with many of the Category A agents of bioterrorism, as defined by the Centers for Disease Control and Prevention, presents with nonspecific prodromal symptoms similar to those of influenzalike illness (ILI), including fever, cough, malaise, and myalgia.[3–6] The emerging field of syndromic surveillance relies on monitoring nonspecific symptoms, and ILI in particular, as an early warning system for infectious disease outbreaks and those outbreaks caused by bioterrorism.[7,8] Many syndromic surveillance systems are based on monitoring data from existing sources, such as

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emergency department (ED) chief complaints or discharge diagnoses with selected *International Classification of Disease, 9th Revision* (ICD-9) codes.[9–17]

Since 1998, the New York City Department of Health (DOH) has monitored the volume of Emergency Medical Services (EMS) 911 ambulance dispatches to detect communitywide increases in respiratory febrile illness. Each EMS call is triaged by a call-receiving operator into 1 of 52 call types and 1 of 9 priorities. Calls are immediately computerized and dispatched to ambulances across the five boroughs of New York City. For the purposes of syndromic surveillance, we selected 4 of 52 call types thought to be most indicative of respiratory or viral illness: SICK (sick adult), SICPED (sick pediatric), DIFFBR (difficulty breathing), and RESPIR (respiratory distress). Fluctuations in the volume of this ILI syndrome group correlate with seasonal influenza activity as measured by traditional surveillance methods.[18]

EMS ambulance dispatch systems may serve as a potentially useful source of syndromic surveillance data in other jurisdictions. A concern with ambulance dispatch-based surveillance systems, however, is that they might not include data on individuals with mild illness or patients in the early stages of illness. To examine this potential bias involved in EMS ambulance dispatch versus ED-based surveillance for ILI and to determine the case sensitivity and predictive value positive (PVP) of the selected EMS call types for ILI, a large chart review study was conducted.

METHODS

Data Collection

A retrospective review was conducted on all ED visits at six large, high-volume hospitals on January 19, 1999, during peak influenza season (Figure). ED staff set aside duplicate copies of ED medical charts (face sheets) for this 24-hour period. Information on ambulance utilization and EMS call type, as well as presence of fever, chills, cough, sore throat, or "flu," was collected from all charts. If these signs or symptoms were noted in the chief complaint, history, physical exam, or clinical impression, a full chart review was conducted. A standardized abstraction form was used to collect such information as patient demographics, symptoms and clinical presentation, diagnostic testing ordered, treatment modalities, and patient disposition. Clinical ILI was defined as fever (temperature higher than 100°F) on history or exam, along with either cough or sore throat.[19]

EMS call type was ascertained if available from copies of the ambulance call report found in the patient's chart. In the case of missing EMS data, call type was determined by matching ED visits to EMS call data for the same 24-hour period by address and run time.

Data Analysis

Data were entered into EpiInfo 6.0 and analyzed using SAS 8.02. Bivariate comparisons were tested using the chi-square statistic. The Fisher exact test was used if expected cell size was fewer than five. Sensitivity and PVP for ILI were calculated for the selected call types.

RESULTS

The 2,294 ED visits reviewed represented a mean completeness of chart review of 92% of all visits to the six participating EDs and constituted approximately 25% of all ED visits in New York City on January 19, 1999.

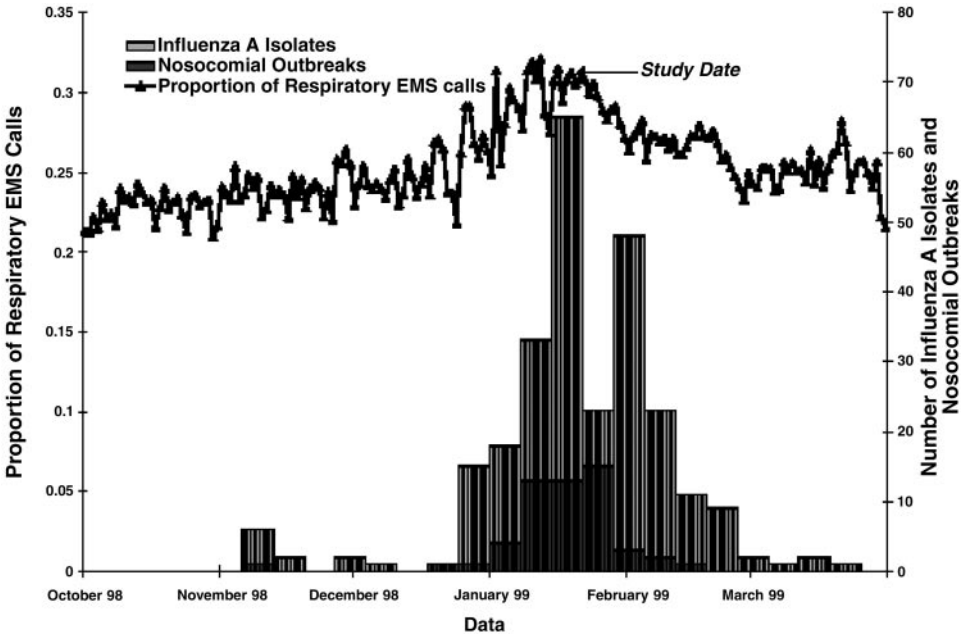

FIGURE. Emergency department chart review study conducted during peak of 1998–1999 influenza season in New York City, as defined by number of influenza A isolates, nosocomial outbreaks, and EMS respiratory calls.

Influenzalike Illness

Of the 522 patients (23%) who met the case definition for ILI, 94% had cough, and 22% had sore throat. Other commonly reported symptoms included vomiting (25%), headache (12%), shortness of breath (11%), myalgia (10%), and diarrhea (10%) (Table 1). The majority of patients had normal vital signs, although 8% had tachycardia (heart rate higher than 100 beats per minute), 1% had tachypnea (respiratory rate higher than 30 per minute), and only 1 patient was hypotensive (systolic blood pressure lower than 90 mmHg) at time of triage.

For most patients, fever was noted on history, but only 13% had measured temperatures in excess of 100°F. Clinical examination revealed that 22% of the patients had abnormal lung sounds, of which 39% presented with wheezing and 39% presented with "congestion," suggestive of lower respiratory infection. At the time of triage, 75% appeared to be in "no apparent distress."

Only 12% of patients had some type of diagnostic testing performed. Tests included chest x-rays (22%), routine blood work (12%), blood cultures (11%), arterial blood gases (2%), and viral culture (1%). Influenza typing and rapid antigen testing was ordered for only 1 individual. Approximately half (51%) of all patients with ILI received some form of medical treatment in the ED, with antibiotic treatment being the most prevalent (37% given oral antibiotics and 9% given intravenous antibiotics; categories not mutually exclusive).

The most common discharge diagnoses were upper respiratory infection (URI) (38%), nonspecific viral illness (24%), otitis media (18%), pneumonia (12%), and asthma (10%). Only 2 patients were given a specific discharge diagnosis of influenza, neither of whom had influenza testing ordered. The majority (83%) of pa-

TABLE 1. Clinical emergency department presentation of patients with influenzalike illness (ILI) (n = 522), January 19, 1999, New York City

Symptom	N (%)
Fever*	522 (100)
Cough*	493 (94)
Sore throat*	116 (22)
Vomiting	130 (25)
Headache	62 (12)
Shortness of breath	57 (11)
Myalgia	51 (10)
Diarrhea	51 (10)
Chest pain	49 (9)
Chills	43 (8)
Abdominal pain	41 (8)
Fatigue	33 (6)
Malaise	27 (5)
Rash	24 (5)
Nausea	20 (4)

*Denoted symptoms used in case definition for ILI, for which ILI case has fever and cough or sore throat.

tients who met the case definition for ILI were treated and released, 10% were admitted, and 1% (n = 3) died during the ED visit.

Ambulance Versus Non-ambulance Patients

Of the 522 patients who met the case definition for ILI, 64 (12%) arrived by ambulance. The age and symptom profiles of individuals with ILI arriving by ambulance were significantly different from patients with ILI who arrived by other means (non-ambulance) (Table 2). Of those who arrived by ambulance, most (57%) were 18 years of age or older; 19% were 65 years or older versus 2% of patients with ILI ($P < .01$). Compared with non-ambulance patients, patients who arrived by ambulance presented with symptoms of greater severity, such as chest pain (22%) and shortness of breath (30%), and were more likely to be noted as ill appearing (20%) by triage staff. Among ambulance patients, the incidence of abnormal lung sounds, of diagnostic testing such as chest x-ray (48%) and blood culture (31%), and of antibiotic treatment (59%) was also significantly higher ($P < .05$ for all comparisons) than for non-ambulance patients. The time since onset of symptoms, however, was no different for the two groups (median = 48 hours).

Case Sensitivity and Predictive Value Positive

Of the 64 patients brought in by ambulance who met the case definition for ILI, call type was ascertained for 57 (89%) patients. The selected ILI call types had a combined sensitivity of 33/57 (58%) and included SICK (n = 17), DIFFBR (n = 8), SICPED (n = 5), and RESPIR (n = 3). Among the 24 false negatives (those patients with ILI brought in by ambulance who did not have a selected call type), the call types included ASTHMA (asthma attack, n = 13), CARDIAC (cardiac/chest pain,

TABLE 2. Selected characteristics of patients presenting to emergency departments with influenzalike illness (ILI), ambulance versus non-ambulance, January 19, 1999, New York City

Characteristic	All patients with ILI, N = 522 (%)	Ambulance, N = 64 (%)	Non-ambulance, N = 458 (%)
Age,* years			
0–18	374 (73)	28 (43)	346 (70)
18–64	117 (23)	24 (38)	93 (18)
65+	22 (4)	12 (19)	10 (2)
Median duration of symptoms	48 hours	48 hours	48 hours
Chest pain*	49 (10)	14 (22)	35 (8)
Shortness of breath*	57 (11)	19 (30)	38 (8)
Ill appearing†	42 (10)	9 (20)	33 (9)
Abnormal lung sounds*	115 (23)	25 (41)	90 (20)
Had chest x-ray*	113 (22)	30 (48)	83 (19)
Had blood culture†	59 (11)	19 (31)	40 (9)
Given antibiotics*	231 (44)	38 (59)	193 (42)
Diagnosed with pneumonia†	61 (12)	13 (22)	48 (11)
Admitted*	49 (10)	20 (33)	29 (7)
Expired in emergency department†	3 (0.6)	2 (4)	1 (0.2)

Note: Only selected/significant characteristics are displayed. Percentages were calculated using denominators with non-missing data.

*$P < .01$.

†$P < .05$.

n = 4), ABDPN (abdominal pain, n = 3), and 1 each of UNC (unconscious patient), OBLAB (obstetric emergency/labor), SEIZR (seizure), and STATEP (status epilepticus/prolonged seizures).

Of the 431 patients who arrived at the ED by ambulance, call type was ascertained for 386 (90%). Of the 153 patients who had one of the selected call types, 33 met the case definition for ILI, for a PVP of 22%. Among the 120 false positives (those patients brought in by ambulance with a selected call type who did not meet the case definition for ILI), the following percentages of call types were assigned: 51% SICK, 32% DIFFBR, 15% RESPIR, and 2% SICPED. Of the 120 false positives, 9 had fever, 14 had cough, and 1 had sore throat without meeting the case definition for ILI.

DISCUSSION

In this clinical validation study, approximately 25% of all ED visits in New York City were reviewed for 1 day during peak influenza season. We found that use of ambulance dispatch data for ILI surveillance introduces some biases compared with surveillance of all ED visits. Patients with ILI who used the EMS system were older and were more likely to complain of chest pain and shortness of breath, have abnormal lung sounds, receive a chest x-ray, be diagnosed with pneumonia, and be admitted to the hospital. However, the median duration of symptoms prior to presentation (48 hours) was no different from that of other ED patients. Individuals

with symptoms that might occur during the prodromal phase of inhalational anthrax, such as chest pain or shortness of breath,[20] were more likely to use the EMS system and usually did so early in the course of illness. While EMS-based surveillance is more sensitive for severe illness and for illness affecting older individuals, there is not necessarily a loss of timeliness associated with EMS-based (versus ED-based) surveillance.

The findings of this study also underscore some of the limitations of traditional medical surveillance for bioterrorism or pandemic influenza. Diagnostic viral testing occurred in less than 1% of patients with ILI, and bacterial cultures were ordered for only 10% of cases. Although 44% of patients with ILI were given antibiotics, the etiology of nearly all ILI cases seen in the ED remains unknown. The low rate of routine diagnostic testing highlights the need for alternative surveillance methods for early detection of biologic terrorism. Whether syndromic surveillance in general and EMS surveillance in particular will be able to meet this challenge requires further evaluation.

Limitations to this chart review study include missing charts and incomplete or illegible data. Also, all symptoms may not be elicited or noted on a brief ED medical history. The study was conducted on only 1 day, and the six large EDs chosen may not be typical in terms of their mix of patients and ambulance use.

This study also examined the case sensitivity and PVP for the ILI syndrome when assigned through a subset of ambulance dispatch call types. Few studies have performed a similar evaluation of syndromic surveillance categories. One ED surveillance study based on chief complaint and discharge diagnosis found a sensitivity of approximately 43% and a PVP of approximately 44% for acute respiratory illness.[17] Our study found a slightly higher sensitivity (58%) but lower PVP (22%) for a related, but separate, construct of clinical ILI.

The recent development and implementation of such syndromic surveillance systems and the diversity of available data sources have created an urgent need for validation and evaluation of system attributes, such as presented here. Our findings dramatically illustrate that a syndromic surveillance system that has been shown to have high sensitivity and specificity for outbreak detection elsewhere[18] can be based on data with relatively low case sensitivity and PVP. Evaluation of syndromic surveillance systems should consider the sensitivity and PVP for both case and outbreak detection.[21]

ACKNOWLEDGEMENT

We would like to thank Erlinda Amoroso, Sergey Blyumberg, Youssouf Camara, Dan Cimini, Larry Colbert, Awilda Colon-Serrant, Solomon Dada, Dorothy Edwards, Mohammad Haroon, Muhammad Iftekharuddin, Anne Labowitz, Barbara Neal, Nelson Parian, Jose Poy, Viony Skeete, James Swanzy-Parker, and Andrea Young of the New York City Department of Health; Dario Gonzalez, Mike Byrne, and John Adams of the New York City Fire Department Bureau of EMS; and all the emergency department directors and staff at the participating hospitals for their assistance in ensuring the success of this project.

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