Assessing Capacity and Disease Burden in a Virtual Network of New York City Primary Care Providers Following Hurricane Sandy

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ABSTRACT *Urban contexts introduce unique challenges that must be addressed to ensure that areas of high population density can function when disasters occur. The ability to generate useful data to guide decision-making is critical in this context. Widespread adoption of electronic health record (EHR) systems in recent years has created electronic data sources and networks that may play an important role in public health surveillance efforts, including in post-disaster situations. The Primary Care Information Project (PCIP) at the New York City Department of Health and Mental Hygiene has partnered with local clinicians to establish an electronic data system, and this network provides infrastructure to support primary care surveillance activities in New York City. After Hurricane Sandy, PCIP generated several sets of data to contribute to the city's efforts to assess the impact of the storm, including daily connectivity data to establish practice operations, data to examine patterns of primary care utilization in severely affected and less affected areas, and data on the frequency of respiratory infection diagnosis in the primary care setting. Daily patient visit data from three heavily affected neighborhoods showed the health department where primary care capacity was most affected in the weeks following Sandy. Overall transmission data showed that practices in less affected areas were quicker to return to normal reporting patterns, while those in more affected areas did not resume normal data transmissions for a few months. Rates of bronchitis increased after Sandy compared to the two prior years; while this was most likely attributable to a more severe flu season, it demonstrates the capacity of primary care networks to pick up on these types of post-emergency trends. Hurricane Sandy was the first disaster situation where PCIP was asked to assess public health impact, generating information that could contribute to aid and recovery efforts. This experience allowed us to explore the strengths and weaknesses of ambulatory EHR data in post-disaster settings. Data from ambulatory EHR networks can augment existing surveillance streams by providing sentinel population snapshots on clinically available indicators in near real time.*

KEYWORDS *Disaster preparedness, Surveillance, Primary care, Health information technology, Electronic health records*

INTRODUCTION

In 2012, an estimated 106 million people were impacted by natural disasters.¹ Over the past several years, such events have increased in frequency and magnitude, and

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climate change models indicate this trend is expected to continue.² This phenomenon has heightened urgency to strengthen emergency response strategies and limit public health impact.^{3,4} Urban contexts introduce unique challenges that must be addressed to ensure areas of high population density can function as well as possible when disasters occur.⁵ The ability to generate timely and useful data to guide decision-making is critical when disasters occur in the urban context.⁶

Substantial federal investment has spurred widespread adoption of electronic health record (EHR) systems in recent years,⁷ creating electronic data sources and networks that may play an important role in public health surveillance efforts, including in post-disaster situations. Data from large outpatient networks, hospitals, and other settings have played a role in routine and emergency surveillance, with success.^{8,9} Although primary care practices do not typically provide urgent care, emerging research suggests that this setting can also contribute in important ways to disaster response,¹⁰ and that the ability to track post-disaster trends in ambulatory care may contribute significantly to the overall picture of post-disaster health.¹¹ Timely feedback of data to clinicians who might otherwise be isolated from such information can increase situational awareness and contribute to connecting a fragmented health system.¹² In disaster situations, such feedback loops serve a vital role. However, the added value and potential of centralized data from primary care EHRs in post-disaster surveillance remains largely unexplored.

Small practice settings staffed by one or two providers are of special interest because they provide primary care to the majority of Americans,¹³ but, by virtue of their independent structure, they have historically lacked the capacity for efficient information exchange and data aggregation. Although it is generally acknowledged that primary care has an important role to play in surge capacity post-disaster,¹⁴ a 2012 brief by the Center for Studying Health System Change notes that primary care physicians—particularly in independent practices—rarely collaborate on emergency preparedness and state they lack time and financial resources to make a meaningful impact in post-disaster care coalitions or activities. To assess primary care capacity and utilization quickly in disasters, systems need to centralize data collection and dissemination.

The Primary Care Information Project (PCIP), a bureau of the New York City Department of Health and Mental Hygiene (NYCDOHMH), was formed in 2005 to improve population health by helping medical providers serving vulnerable patients to improve their quality of care through health information technology (HIT).¹⁵ PCIP also serves as New York City's regional extension center, and in that role, assists providers in the adoption and implementation of EHR systems.¹⁶ PCIP currently provides quality improvement and EHR implementation support to nearly 9,000 providers at over 1,000 small practices, 63 Community Health Centers, and 54 hospitals and outpatient clinics, accounting for approximately one third of the city's total outpatient provider population. PCIP connects to more than 600 of these practices via a structured data querying system, the Hub Population Health System (the Hub), which enables data to be exchanged in real time without impacting practice workflows.^{17,18} PCIP's virtual connection to, and partnership with, local clinicians forms an innovative and effective virtual network of urban independent primary care practices and provides infrastructure to support primary care surveillance activities in New York City. This report summarizes the role PCIP played in post-Sandy surveillance activities after the storm hit the New York metropolitan area on October 29, 2012 and explores the potential for a data network of this type to contribute to post-disaster public health surveillance.

In Post-Disaster Scenarios, What Do We Want to Know, and What Can We Know, from Electronic Primary Care Data?

The information needs in a post-disaster situation will vary, but as a general rule, electronic primary care data could be useful in quickly assessing shifts in healthcare utilization patterns as well as the capacity of the local ambulatory care network to serve those impacted by the disaster. Post-disaster primary care data may also aid in the monitoring of diseases and health conditions directly or indirectly related to the disaster. In the urban setting in particular, reliable electronic data could facilitate quick retrieval of information related to these questions from a large number of providers without further straining aid and recovery resources.

In the case of Hurricane Sandy, PCIP developed several sets of data, collected at different times via the Hub data system, to contribute to NYCDOHMH's efforts to assess the impact of the storm. First, PCIP automatically collects data daily to assess connectivity of the network, indicating which practices are transmitting data and which are not. We examined this daily data for the 10-day period pre-Sandy and 2-month period post-Sandy to understand whether we could get post-disaster data from practices. Second, 2 weeks after Sandy, the NYC mayor's office asked PCIP to provide retrospective data for the time period 1 week prior to Sandy through the 2-week period post-Sandy, to enable NYCDOHMH to determine the extent to which primary care practices sited in severely affected areas were still seeing patients. PCIP also extracted retrospective summary data pulled prior to Sandy to clarify where patients from the Rockaways, a highly affected coastal area in Queens, typically sought care. Finally, in order to explore one example of how our system might contribute to tracking relevant disease incidence in the primary care setting, we retrospectively extracted data related to respiratory infection diagnosis (RID) for analogous 2-week time periods (starting October 1 and ending January 6) across three continuous years (2010–11, 2011–12, and 2012–13). We selected this diagnosis for data exploration in response to concerns about infections related to household mold following flooding. Practice-level demographics were obtained from account information collected by our staff.

Sample Indicators/Outcomes of Interest that EHRs Can Provide We were able to generate information on the following outcomes of interest post-Sandy: percent of practices in both highly affected and less affected areas transmitting data on a daily basis pre- and post-Sandy, percent of practices in highly affected areas transmitting any data, and, within those, the percent of practices actually seeing patients; proportion of patients in a highly affected neighborhood that typically sought primary care in that neighborhood; and overall patient volume pre- and post-Sandy. For the diagnosis portion of this exploratory exercise, we restricted the definition of RID to new diagnosis of bronchitis or pneumonia within the defined time periods as detected in encounter-level ICD-9 diagnosis codes. Practice EHRs returned aggregated, de-identified patient counts of RID and total patients with a visit. We used patient visits as the denominator when calculating rates of RID.

What NYCDOH Learned from Collecting Post-Sandy Data from New York City EHRs

A major concern following Sandy was whether primary care practices were still operational, particularly in areas most affected by the storm. In our data, we observed that the majority of practices in both affected and unaffected areas were

not transmitting data in the immediate days after the storm. Of the 27 practices in the three most heavily affected neighborhoods (Rockaways, Coney Island, Staten Island) that were transmitting data before the storm, 24 had resumed transmission as of 2 weeks after the storm (Table 1). Of those that had resumed transmissions, 18 were already seeing patients. Only two of the four practices in the Rockaways were transmitting, and of those, neither appeared to be seeing patients based on their data, while all 12 of the practices in Staten Island were both transmitting and seeing patients. This suggested some neighborhoods were continuing to suffer a primary care shortage 2 weeks after the storm.

Compared to practices from more affected areas (defined here as practices in zip codes that experienced flooding over 50 % or more of their land; $N=40$), practices in less affected areas ($N=549$) experienced less interruption in data transmission (Fig. 1). Although most practices did not generally transmit data on the night after Sandy (October 30), by November 7, the group of practices in less affected areas had returned to pre-storm transmission levels (5 % not transmitting). Practices from the more affected areas did not return to this transmission rate until early January 2013. Through monitoring these data, we realized we needed to be cautious in interpreting any practice-level trends from more affected areas, where sample size was already limited and was further diminished for some time after the storm.

An analysis of the Rockaways, one of the most affected neighborhoods, found that half of patients from the Rockaways sought care in their own neighborhood in 2011, where, according to our transmission data following Sandy, PCIP practices remained inoperative even 2 weeks after the storm in 2012 (data not shown). Additionally, we found that approximately a third (29 %) of the patients at practices in the Rockaways had home zip codes outside of the Rockaways, particularly in nearby Southeast Queens. Although these patients may have been able to receive care elsewhere, it is useful in emergency situations to know where patients typically seek care and what neighborhoods outside those with obvious primary care shortages may also be affected. A sub-analysis of office visit volume in all boroughs showed that there was only slight decline across the city following Sandy (data not shown). By the fourth week following the storm, overall patient volume was comparable to the same 2-week time period the previous year. This suggests that our ability to track primary care trends on a population level may be curtailed immediately after a disaster, although in the case of Sandy, that ability very quickly returned to normal (with the exception of the small number of non-transmitting practices in more affected areas mentioned above).

In the disease-related data we extracted, we found that average occurrence of RID among our practices ranged from 3.6 to 6.8 per 1,000 during the 2010–11 and 2011–12 October through December time period, with an upward trend observed each year (Fig. 2). While pneumonia rates were similar across all years, rates of bronchitis were approximately 1.5 times higher in 2012–13 compared to the previous 2 years. However, it is important to note that similar increases were

TABLE 1 Status of PCIP practices in severely affected areas 2 weeks post-Hurricane Sandy

	Total	Transmitting	Transmissions showed practice was seeing patients
Rockaways	4	2	0
Coney Island	11	10	6
Staten Island	12	12	12
Total	27	24	18

FIG. 1 Proportion of Hub practices not transmitting data.

observed in the 2012–13 flu season around the same time period, suggesting that spikes in respiratory infections in that year were related to a severe flu season, not the storm.¹⁹ Similar RID rates were observed between patients from affected and unaffected areas (data not shown).

DISCUSSION

Although PCIP has conducted some initial exploration of the capacity for its data to serve a surveillance role,²⁰ Hurricane Sandy was the first disaster situation where

FIG. 2 Average practice rates of respiratory infection diagnosis (RID) 402 New York City primary care practices.

PCIP was asked to play a significant role in trying to assess public health impact and generate information that could contribute to aid and recovery efforts. Based on our experience post-Sandy, there is an interest in understanding post-disaster care utilization patterns in the primary care as well as emergency care context, as electronic primary care data becomes more accessible. This event served to advance our thinking about ways that electronically derived data from our provider network may aid in future disaster efforts. The report on this exploratory work may add value to other health departments who wish to begin to explore the potential for EHR data to serve a supportive role in surveillance efforts.

In the weeks following Hurricane Sandy, PCIP and other bureaus at NYCDOHMH were concerned primarily with serving the immediate needs of the city. In retrospect, PCIP realized we had yet to adequately explore the role of their data in post-disaster surveillance and the extent to which it might serve a supportive surveillance role. Thus, for this analysis, care capacity data were not retrieved until some weeks post-Sandy, and diagnosis data were not extracted until several months later. The diagnosis data we explored were intended to shed some light on what we can potentially glean from EHR data in this type of situation and were not exhaustive. Should a similar disaster occur in New York City in the future, the lessons learned from Sandy have better prepared PCIP to execute tailored queries in response to a range of scenarios and do so in real time.

This report illustrates several key strengths of ambulatory EHR data in post-disaster settings. This kind of EHR data network queries primary care interactions, capturing indicators of morbidity in a segment of the affected population that may not appear in hospital or emergency department data. This model can be very quickly mobilized to provide data in near real time. Automated electronic query systems require no action on the part of a provider or administrator to generate data, and data transmit overnight, allowing for minimal disruption at the practice. Further, since the health department sees only aggregate data, this model facilitates public health benefit without jeopardizing patient privacy or threatening institutional trust. These aggregated data can also be shared with stakeholders. The query system used by this model is flexible, allowing public health officials to tailor the subject matter to the disaster context. For instance, we explored RID in this case but could have submitted queries to extract data about a range of other disease concerns that might be appropriate to a given context. Finally, ambulatory EHR surveillance can be shared back to the rendering providers to improve disaster response and coordination and heighten awareness of public health issues.

As with most surveillance systems, EHR data networks also carry limitations. First, EHR-derived estimates may be affected by both selection and surveillance bias, and these may be stronger in a post-disaster context, when healthcare-seeking patterns may differ and providers may be more likely to monitor patients for particular conditions like RIs.²¹ Caution should be used when interpreting trends in post-disaster data, which may be influenced by factors unrelated to the event, such as the uptick in flu we observed in our data that happened to coincide with the aftermath of Sandy. EHR data also contain measurement error generated by variation in documentation patterns. Practices may have continued to serve patients without transmitting or without using their EHR, in which case these figures overestimate the loss of service. Generalizability may be limited to care-seeking populations and will be highly affected by the practices contributing data. If care delivery has not yet been reestablished, data may not be available from the most affected areas until after the immediate crisis. Understanding that raw data from

ambulatory practices likely provide sentinel snapshots rather than true population prevalence, EHR data networks can supplement existing data streams in data-rich environments. When other data streams may be scarce, ambulatory EHR networks may offer a working information baseline to inform resource allocation and public health planning.

New York City's recently unveiled \$20-billion disaster preparedness infrastructure plan reflects a growing consensus that municipalities need to carefully think through how they will deal with city-wide emergency situations when they occur.²² It is essential to have a surveillance infrastructure in place, as well, to quickly quantify impact and nimbly direct city action. This analysis suggests that ambulatory EHR data networks like PCIP's Hub may become a valuable part of that infrastructure. Further work is needed to determine the usefulness of post-disaster EHR-based primary care surveillance compared to other surveillance sources, using different case definitions, and in the context of different jurisdictions.

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