Emergency Department Visits for Homelessness or Inadequate Housing in New York City before and after Hurricane Sandy

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ABSTRACT Hurricane Sandy struck New York City on October 29, 2012, causing not only a large amount of physical damage, but also straining people's health and disrupting health care services throughout the city. In prior research, we determined that emergency department (ED) visits from the most vulnerable hurricane evacuation flood zones in New York City increased after Hurricane Sandy for several medical diagnoses, but also for the diagnosis of homelessness. In the current study, we aimed to further explore this increase in ED visits for homelessness after Hurricane Sandy's landfall. We performed an observational before-and-after study using an all-payer claims database of ED visits in New York City to compare the demographic characteristics, insurance status, geographic distribution, and health conditions of ED patients with a primary or secondary ICD-9 diagnosis of homelessness or inadequate housing in the first week after Hurricane Sandy's landfall versus the baseline weekly average in 2012 prior to Hurricane Sandy. We found statistically significant increases in ED visits for diagnosis codes of homelessness or inadequate housing in the week after Hurricane Sandy's landfall. Those accessing the ED for homelessness or inadequate housing were more often elderly and insured by Medicare after versus before the hurricane. Secondary diagnoses among those with a primary ED diagnosis of homelessness or inadequate housing also differed after versus before Hurricane Sandy. These observed differences in the demographic, insurance, and co-existing diagnosis profiles of those with an ED diagnosis of homelessness or inadequate housing before and after Hurricane Sandy suggest that a new population cohort—potentially including those who had lost their homes as a result of storm damage—was accessing the ED for homelessness or other housing issues after the hurricane. Emergency departments may serve important public health and disaster response roles after a hurricane, particularly for people who are homeless or lack adequate housing. Further, tracking ED visits for homelessness may represent a novel surveillance mechanism to assess post-disaster infrastructure impact and to prepare for future disasters.

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INTRODUCTION

In October 2012, Hurricane Sandy wreaked havoc along the eastern seaboard of the USA. The second costliest hurricane in US history (after Hurricane Katrina), Hurricane Sandy caused \$71.4 billion in damages.¹ The effects of Hurricane Sandy on health were profound, and included 159 attributed fatalities in the US alone.² Hurricane Sandy struck New York City (NYC) on October 29, 2012, causing not only flooding, power outages, transportation disruptions, and physical damage, but also the closure of health care facilities including several large hospitals.

In prior research, we examined the effect of Hurricane Sandy on emergency department (ED) use in NYC and found that, while overall ED use decreased post-Sandy, ED use increased for patients from the most vulnerable evacuation flood zone.³ We found a number of primary medical diagnoses driving this increased ED use, such as renal conditions including dialysis dependence, respiratory conditions including chronic obstructive pulmonary disease and ventilator dependence, and diabetes.³ More surprisingly, however, we also found a statistically significant post-hurricane increase in ED visits with a primary or secondary diagnosis code of homelessness.³ Indeed, homelessness emerged above most medical conditions as having one of the strongest and most persistent increases in ED diagnoses comparing the weeks pre- and post-Sandy's landfall.³

It is well known that natural disasters can cause people to lose their homes, leading to increases in homelessness. Thousands of people became newly homeless after Hurricane Sandy, and advocacy groups estimated that 22,000 households remained displaced 1 year later.⁴ Further, people who are already homeless are particularly vulnerable during disasters such as hurricanes and may face direct weather-related environmental stressors, or exacerbations of or difficulty managing chronic behavioral and physical health conditions.⁵ We were unable to find any prior research examining ED use for homelessness (i.e., ED visits for any presenting reason by patients who are either already or newly homeless) subsequent to a natural disaster. Therefore, in the current study, we sought to examine characteristics of people using EDs before and after Hurricane Sandy's landfall who received an ED diagnosis code of homelessness or inadequate housing, including their demographic characteristics, insurance status, geographic location, and co-existing diagnoses.

METHODS

Study Design

We used an all-payer claims database of ED visits in NYC to evaluate post-hurricane increases in ED use for homelessness or inadequate housing in NYC, comparing ED use after Hurricane Sandy made landfall on October 29th, 2012 to the prior 43 weeks before the storm. This approach matches the design of our original study which identified homelessness as a potential risk factor for requiring emergency care after a disaster. We also compared the demographic characteristics, insurance status, geographic distribution, and health conditions of ED patients with a primary or

secondary diagnosis of homelessness or inadequate housing before and after Hurricane Sandy. Though the increase in ED use for homelessness and inadequate housing continued to be significant on certain days in the second week after Hurricane Sandy, we limited these analyses to the first week after the hurricane's landfall because a second significant storm system in the form of a "Nor'easter" impacted the region in week 2 after Hurricane Sandy, and thus after week 1 it would not have been possible to attribute changes in ED use for homelessness or inadequate housing to Hurricane Sandy versus subsequent weather systems. Therefore, unless otherwise specified, data for the first week after Hurricane Sandy made landfall (also referred to more simply as "after" Hurricane Sandy) were compared to baseline average weekly ED use in the prior 43 weeks before the storm ("before" Hurricane Sandy).

Data Source

The New York State Department of Health collects claims data from hospitals on ED visits and inpatient hospitalizations and compiles it in its Statewide Planning and Research Cooperative System (SPARCS). SPARCS is the most comprehensive data resource for ED use in New York State and includes visits by all payers (i.e., privately insured, Medicare, Medicaid, and uninsured patients). It includes patient demographic data, insurance status, diagnosis codes, and patient addresses that can be used to identify the exact location of a patient's residence.

Study Population

We included all patients aged 18 years and older who visited a NYC ED in 2012, had a documented ZIP code located in NYC, and had either a primary or secondary diagnosis code of homelessness or inadequate housing. In our analyses of NYC ED visits, we found that the majority of patients documented as homeless in address fields still had a NYC ZIP code listed. Because we aimed to study non-institutionalized NYC adults who visited a 911-receiving ED at a general acute care hospital in NYC, we excluded patients from correctional facilities and nursing homes, as well as patients who visited an ED associated with a specialty hospital (i.e., surgical subspecialty, oncological, or Veterans Administration facilities). In addition, SPARCS redacts data for patients with a diagnosis of HIV/AIDS; these records were not included.

ICD-9 Diagnosis Codes

We used the ICD-9 codes V60.0 (lack of housing) and V60.1 (inadequate housing) to identify ED patients with a primary or secondary ED diagnosis of "homelessness or inadequate housing." In a prior study, we demonstrated the utility of using administrative ICD-9 codes for identification of statistically significant changes in ED use and also for population-based surveillance.⁶ Though ICD-9 codes undoubtedly capture only a small proportion of all ED patients who are homeless, our goal in this study was not to quantify all ED use among people who were homeless but rather to further investigate the increase in ED visits for homelessness observed in our prior study by examining in detail visits for which the primary or secondary diagnosis for that ED visit was coded as lack of or inadequate housing before and after Hurricane Sandy.

We also evaluated the frequency of co-occurring ICD-9 codes based on the first three digits and/or letter prefix. For patients who had an ED visit with a primary diagnosis of homelessness or inadequate housing, we examined the secondary

diagnosis codes to evaluate other conditions and comorbidities that may have accounted for increases in ED use after the storm. For patients who had a secondary diagnosis of homelessness or inadequate housing, we examined the primary diagnosis code associated with the ED visit to evaluate the presenting cause of ED visits among patients who received a secondary diagnosis of homelessness or inadequate housing, but may have come to the ED primarily for other conditions.

Flood Areas

In our prior study of ED use patterns, we found that ED visits for diagnoses of homelessness significantly increased after Hurricane Sandy among people from the most vulnerable evacuation flood zone in NYC.³ To further identify the geographic changes in the distribution of ED patients with homelessness or inadequate housing diagnoses, we compared the increases in ED utilization with a primary or secondary diagnosis code of homelessness or inadequate housing to a geographic shapefile of post-Hurricane Sandy flood areas mapped by FEMA. These areas were available from the Hurricane Sandy Impact Analysis performed by the FEMA Modeling Task Force.⁷

Data Elements and Data Analysis

We examined demographic characteristics and insurance status of ED patients given a primary or secondary diagnosis of homelessness or inadequate housing. Specific variables of interest included the proportion of elderly (aged 65 and older), female, non-Hispanic black, and Hispanic patients. We also examined the proportion of privately insured, Medicare, Medicaid, and uninsured patients. These variables were examined for the 1 week following Hurricane Sandy's landfall and compared to results for the average of the 43 weeks in 2012 before the storm to examine for differences post-hurricane compared to baseline. Comparisons were made using Fisher's exact testing.

We next evaluated the geographic distribution of NYC ED patients who presented with a primary or secondary diagnosis of homelessness or inadequate housing, again comparing the number of ED visits for the 1 week after the Hurricane Sandy's landfall compared to weekly average baseline ED use in 2012 prior to Hurricane Sandy's landfall. We analyzed this geographic distribution by patients' postal ZIP code to identify areas of significant changes in ED use. We calculated a Z-score for the number of ED visits for the week after the storm's landfall using an average and standard deviation from the prior 43 weeks of 2012. Then, we identified areas with significant changes in ED use by mapping ZIP codes with an absolute value of the Z-score of 1.96 and 2.545, which we correspond to a 95 and 99 % confidence of an increase or decrease in post-disaster ED use.

Finally, we determined the most common primary diagnoses among ED patients with a secondary diagnosis of homelessness or inadequate housing and the most common secondary diagnoses among ED patients with a primary diagnosis of homelessness or inadequate housing. We compared the top 10 of these primary and secondary diagnoses before and after the hurricane, and also evaluated which of these diagnoses had the highest proportional increases in number of ED visits in the week after Hurricane Sandy's landfall compared to the weekly average prior to the storm. To be considered, the increase in ED visits for a given primary or secondary diagnosis had to be statistically significant, meaning that the Z-score for the number of ED visits for the week after the disaster had to be 1.96, correlating to a *p* value of at least 0.05.

Statistical analyses were performed using Stata 12.1 (StataCorp: College Station, TX, 2011). Geographic analysis was performed using ArcGIS Desktop 10.2 (ESRI: Redlands, CA, 2013). The study was approved by the NYU School of Medicine Institutional Review Board and the SPARCS Data Protection Review Board at the New York State Department of Health.

RESULTS

As shown in Fig. 1, there was a significant increase in ED visits in NYC for a primary or secondary diagnosis of homelessness or inadequate housing beginning on the day of Hurricane Sandy’s landfall, which persisted for the first week after Hurricane Sandy compared to before the storm. There was an additional spike in ED visits for homelessness or inadequate housing that occurred on days 9 and 10 in the second week after Hurricane Sandy; as noted in the Methods section, this spike corresponded with a subsequent Nor’easter and thus we limited our further analyses to the first week after Hurricane Sandy because after this point it was not possible to attribute changes in ED use to Hurricane Sandy versus subsequent weather systems. Although Fig. 1 shows only 4 weeks prior to Hurricane Sandy for clarity, the prior 39 weeks in 2012 had similar ED use patterns and thus in subsequent analyses and the reported results we compared the baseline weekly average of the 43 weeks prior to Hurricane Sandy in 2012 to the single week subsequent to Hurricane Sandy’s landfall.

Patient Characteristics

Patients who visited the ED for a primary or secondary diagnosis of homelessness or inadequate housing differed in several key characteristics in the 1 week after versus the average weekly baseline before Hurricane Sandy (Table 1). Those receiving a primary diagnosis of homelessness or inadequate housing were significantly more

FIG. 1 Changes in emergency department visits for diagnoses of lack of or inadequate housing after versus before Hurricane Sandy’s landfall. Changes in emergency department visits for a primary or secondary diagnosis of V60.0 or V60.1 in NYC. The vertical line represents the day of Hurricane Sandy’s landfall (October 29th, 2012).

TABLE 1 Characteristics of emergency department users with primary or secondary diagnoses of homelessness or inadequate housing at baseline and 1 week after Hurricane Sandy's landfall in New York City

Patient characteristics	Before Hurricane Sandy		After Hurricane Sandy		<i>p</i> value for difference
	Weekly average ^a	Proportion of patients (%)	1 week post-storm	Proportion of patients (%)	
Primary diagnosis of lack of or inadequate housing					
Total (V60.0 + V60.1) ^b	2.8	100	27	100	
V60.0	2.6	94	15	56	<0.01 ^c
V60.1	0.2	6	12	44	<0.01 ^c
Demographics					
Elderly (≥65 years)	0.4	13	12	44	<0.01 ^c
Female	0.6	22	7	26	0.62
Black (non-Hispanic)	1.3	48	9	33	0.21
Hispanic	0.7	24	4	15	0.44
Insurance					
Private	0.0	1	0	0	<0.01 ^c
Medicare	0.5	18	16	59	
Medicaid	1.4	51	4	15	
Self-pay	0.9	31	7	26	
Secondary diagnosis of lack of or inadequate housing					
Total (V60.0 + V60.1)	263.2	100	372	100	
V60.0	261.1	99	289	78	<0.01 ^c
V60.1	2.1	1	83	22	<0.01 ^c
Demographics					
Elderly (≥65 years)	14.4	5	97	26	<0.01 ^c
Female	53.0	20	103	28	<0.01 ^c
Black (non-Hispanic)	106.5	40	108	29	<0.01 ^c
Hispanic	59.2	23	62	17	0.01 ^c
Insurance					
Private	12.5	5	16	4	<0.01 ^c
Medicare	39.0	15	124	33	
Medicaid	178.7	68	192	52	
Self-pay	33.0	13	40	11	

^aBaseline weekly average in the prior 43 weeks in 2012 before Hurricane Sandy's landfall^bICD-9 codes for "lack of housing" (V60.0) and "inadequate housing" (V60.1)^cStatistically significant differences in population characteristics based on Fisher's exact tests

likely to be elderly in the 1 week after versus the weekly average before the hurricane (44 vs. 32 %). Concurrently, they were more likely to be insured by Medicare (59 vs. 18 %) and less likely to be insured by Medicaid (15 vs. 51 %) after the hurricane. Patients with a secondary ED diagnosis of homelessness or inadequate housing were also more often elderly (26 vs. 5 %) and insured by Medicare (33 vs. 15 %) after the hurricane. In addition, patients with secondary ED diagnoses of homelessness or inadequate housing were somewhat more likely to be female and less likely to be black or Hispanic in the week after versus the weekly average before Hurricane Sandy's landfall. Finally, the proportional distribution of ICD-9 codes of V60.0 ("lack of housing") versus V60.1 ("inadequate housing") differed for both primary and secondary diagnoses after Hurricane Sandy's landfall, with a much larger proportion

being accounted for by the V60.1 (“inadequate housing”) code after versus before the hurricane.

Geographic Distribution

We identified ZIP codes with a statistically significant change in the number of ED visits with primary or secondary diagnoses of homelessness or inadequate housing comparing the week after Hurricane Sandy’s landfall to the average weekly baseline prior to the disaster in 2012 (Fig. 2). In general, we found the largest increases in ED use for homelessness or inadequate housing among patients coming from flood areas after Hurricane Sandy. For primary diagnoses, 13 of 15 (86.7 %) of the ZIP code “hot spots” with statistically significant increased ED use for homelessness or inadequate housing after Hurricane Sandy’s landfall included FEMA flood areas. For secondary diagnoses of homelessness or inadequate housing, 27 of 30 (90 %) of the observed ZIP code “hot spots” included FEMA flood areas.

Primary Diagnoses

For patients who received a secondary ED diagnosis of homelessness or inadequate housing, we examined their coded primary diagnoses to determine what might have been the key reason or other reasons for their ED visits and compared these primary diagnoses before and after Hurricane Sandy (Table 2). The most common primary diagnoses for those with a secondary diagnosis of homelessness or inadequate housing were related to mental illness and substance use both before and after Hurricane Sandy. Primary diagnoses among those with a secondary diagnosis of homelessness or inadequate housing that represented the largest increases after

FIG. 2 Geographic areas with increased emergency department use after Hurricane Sandy by patients with diagnoses of homelessness or inadequate housing. Statistically significant changes in emergency department use among patients with a primary versus secondary diagnosis code of V60.0 or V60.1. Figure compares the week after Hurricane Sandy’s landfall to baseline weekly average from the 43 weeks in 2012 prior to Hurricane Sandy by NYC ZIP codes.

TABLE 2 Most common primary diagnoses among patients presenting to emergency departments for a secondary diagnosis of homelessness or inadequate housing

Weekly baseline before Hurricane Sandy	1 week after Hurricane Sandy	Highest absolute increases after versus before Hurricane Sandy
Schizophrenia (15 %)	Schizophrenia (11 %)	Chronic bronchitis (+3 %)
Alcohol dependence (13 %)	Alcohol dependence (7 %)	Administrative encounters (+2 %)
Episodic mood disorders (10 %)	Episodic mood disorders (6 %)	Chronic airway obstruction (+2 %)
Drug dependence (8 %)	Drug dependence (5 %)	Hypothermia (+2 %)
Alcohol-induced mental disorders (7 %)	Alcohol-induced mental disorders (5 %)	General symptoms (+1 %)
Drug-induced mental disorders (4 %)	Drug-induced mental disorders (4 %)	Electrolyte abnormalities (+1 %)
Other non-organic psychoses (3 %)	Chronic bronchitis (3 %)	Other lung diseases (+1 %)
Cellulitis or abscess (3 %)	General symptoms (3 %)	Heart failure (+1 %)
Non-dependent Drug Abuse (2 %)	Administrative encounters (2 %)	Other consultation (+1 %)
Respiratory symptoms (2 %)	Cellulitis or abscess (2 %)	General medical exam (+1 %)

All differences presented in column 3 are statistically significant with a *p* value <0.001

Hurricane Sandy included respiratory conditions (chronic airway obstruction and chronic bronchitis) and hypothermia. In addition, there was an increase in primary diagnoses of “administrative encounters,” all but one of which was for prescription refills.

Secondary Diagnoses

For patients who received a primary ED diagnosis of homelessness or inadequate housing, we examined their secondary diagnoses and compared these secondary diagnoses before and after Hurricane Sandy (Table 3). The most commonly coded secondary diagnoses among those with a primary ED diagnosis of homelessness or inadequate housing differed significantly before and after Hurricane Sandy. There were large increases in secondary diagnoses of hypertension and diabetes after Hurricane Sandy. Other large increases in secondary diagnoses among those with primary diagnoses of homelessness or inadequate housing after Hurricane Sandy occurred for ischemic heart disease, chronic bronchitis, chronic skin ulcers, post-procedural state, and kidney disease.

DISCUSSION

We discovered significant increases in ED visits for diagnoses of homelessness or inadequate housing in the time period following Hurricane Sandy’s landfall and examined differences in sociodemographic factors and co-occurring diagnoses for those presenting to the ED for homelessness or inadequate housing before and after the hurricane. There are several plausible hypotheses for why there might have been increases in ED visits for homelessness or inadequate housing diagnoses after Hurricane Sandy. First, people who had become newly homeless or otherwise

TABLE 3 Most common secondary diagnoses among patients presenting to emergency departments for a primary diagnosis of homelessness or inadequate housing

Weekly baseline before Hurricane Sandy	1 week after Hurricane Sandy	Highest absolute increases after versus before Hurricane Sandy
Screening for bacterial disease (9 %)	Hypertension (30 %)	Hypertension (+24.3 %)
General medical exam (8 %)	Diabetes (26 %)	Diabetes (+23.8 %)
Hypertension (6 %)	Ischemic heart disease (7 %)	Ischemic heart disease (+7.4 %)
General symptoms (5 %)	Chronic bronchitis (7 %)	Chronic bronchitis (+7.4 %)
Non-dependent drug abuse (3 %)	Chronic skin ulcer (7 %)	Chronic skin ulcer (+7.4 %)
Other soft tissue disorders (3 %)	Post-procedural state (7 %)	Post-procedural state (+6.6 %)
Asthma (3 %)	General symptoms (4 %)	Chronic kidney disease (+2.9 %)
Diabetes (2 %)	Non-dependent drug abuse (4 %)	Hypertensive CKD (+2.9 %)
Anxiety disorders (2 %)	Asthma (4 %)	Anxiety disorders (+2.0 %)
Other joint disorders (2 %)	Anxiety disorders (4 %)	Asthma (+1.2 %)

All differences presented in column 3 are statistically significant with a *p* value <0.001

inadequately housed as a result of damage from Hurricane Sandy might have sought assistance in an ED. Conversely, it is possible that people who were already homeless prior to Hurricane Sandy experienced exacerbations of their chronic illnesses or new illnesses or environmental exposure effects driving their use of the ED after the hurricane, or they may have lost their regular place of shelter after the hurricane and sought care in the ED for social reasons. Most likely, the observed increase in ED visits for homelessness and inadequate housing after Hurricane Sandy was driven by some combination of these hypotheses.

Our study suggests that some of those who had an ED diagnosis of homelessness or inadequate housing in the days following Hurricane Sandy may have been individuals who had newly become homeless after the disaster. First, after Hurricane Sandy, the distribution of specific ICD-9 homelessness-related diagnoses shifted dramatically, with proportionately more diagnoses of “inadequate housing” (V60.1) versus “lack of housing” (V60.0) after versus before the hurricane. Also, the demographic profile of those with an ED diagnosis of homelessness or inadequate housing differed significantly after Hurricane Sandy compared to baseline, with a larger proportion of patients being elderly, on Medicare, and female, and a somewhat smaller proportion being non-Hispanic black or Hispanic after Hurricane Sandy. These demographic differences suggest that a new cohort of people was using the ED for diagnoses of homelessness or inadequate housing after the hurricane. The large changes in most common secondary diagnoses among those presenting for primary ED diagnoses of homelessness or inadequate housing also could suggest that a new cohort of homeless patients was accessing the ED after Hurricane Sandy. Further, we observed particularly large increases in ED use for diagnoses of homelessness or inadequate housing among people coming from geographic areas that were later validated by FEMA as flooded areas, where people were more likely to have lost their homes or have flooding making their homes at least temporarily inhabitable.

People who lost their homes during the hurricane were perhaps experiencing their first episode of homelessness and did not know where to turn for shelter or other

assistance other than the ED. NYC opened 73 emergency shelters with the capacity to accommodate 71,000 people from the most vulnerable flood zone (who had been instructed to evacuate their homes) 1 day prior to Hurricane Sandy's landfall, but only 6800 evacuees actually used these shelters.⁸ Further, many people in flood zones chose not to evacuate their homes and thus might not have been safely sheltered-in-place when the hurricane struck.⁸ The evacuation shelters included eight Special Medical Needs Shelters, which served 2236 evacuees.⁸ ED visits for homelessness diagnoses after Hurricane Sandy may represent areas for improvement in the City's evacuation shelter system, potentially including efforts to increase awareness and use of the evacuation shelters among those living in flood zones. It is also unclear whether transportation challenges might have played a role in driving ED use, as people may have been more easily able to call 911 for transport to an ED rather than find transportation to an evacuation shelter or other source of help. Nonetheless, without the availability of shelters for evacuees, the number of ED visits for homelessness after Hurricane Sandy might have been even higher than observed.

Prior research in non-disaster settings has found that people reported that they commonly used the ED as a "first stop" site soon after becoming homeless.⁹ This study and others speak to the role of the ED not just as a medical safety net in the USA, but also as a social safety net.^{10, 11} Indeed, some authors have described the ED as a "social welfare institution."¹² EDs are uniquely accessible because they are open 24 h per day, 7 days per week and have a federal mandate (under the Emergency Medical Treatment and Active Labor Act) to provide care to all who walk through their doors, unlike most other social service sites.¹³ Because these characteristics of EDs make them uniquely accessible, EDs may be reasonable sites for an initial contact by someone newly experiencing homelessness. These factors underscore the need for EDs to screen for homelessness so that it can be recognized and to offer robust social services—either available onsite or via a referral—so that patients identified as homeless can receive assistance. Likewise, EDs may be sites for people to access social services in addition to medical services, both in the wake of a disaster and otherwise.

A second hypothesis for the observed increase in ED visits for homelessness diagnoses after Hurricane Sandy is that ED use by those who were already homeless may have increased after the hurricane. This increase might have occurred for social reasons. For example, people who previously lived on the streets might have needed a safe place to go or people who previously lived in shelters might not have been able to access their shelters, despite the extensive outreach and placement efforts by NYC's Department of Homeless Services to those living on the streets or in shelters that were evacuated before the hurricane.

Simultaneously, people who were already homeless before Hurricane Sandy might have experienced new medical problems or exacerbations of existing medical problems that drove their use of the ED after the hurricane. In general, research has found that people who are homeless tend to be disproportionately represented among ED patients, and particularly among the most frequent users of EDs,^{14–17} in large part due to their high burden of chronic medical and behavioral health problems. Mental health and substance use diagnoses remained consistent in their prevalence as primary ED diagnoses among those with a secondary diagnosis of homelessness or inadequate housing before and after Hurricane Sandy. Other primary diagnoses among those with a secondary diagnosis of homelessness or inadequate housing that represented the largest increases after Hurricane Sandy

included respiratory conditions (chronic airway obstruction and chronic bronchitis) and hypothermia, both of which could plausibly have been exacerbated by environmental conditions faced by homeless persons after the hurricane.

The largest increases in secondary ED diagnoses among patients with a primary diagnosis of homelessness or inadequate housing after Hurricane Sandy compared to baseline were for chronic diseases such as hypertension and diabetes. It is possible that providers may have coded hypertension or diabetes as diagnoses simply because these are very common chronic medical conditions, even if patients were not experiencing any acute exacerbations of these conditions requiring ED care; providers may have felt compelled to code a medical diagnosis for billing reasons. On the other hand, people who were homeless or who became homeless as a result of Hurricane Sandy may have had difficulty accessing their medications or engaging in other self-care after the hurricane, leading to exacerbations of these chronic conditions requiring an ED visit. Consistent with this hypothesis, we found an increase in ED visits for primary diagnoses of prescription refills after Hurricane Sandy among those receiving a secondary diagnosis of homelessness or inadequate housing. Overall, our findings could indicate that people who are homeless—whether newly so or not—may be particularly vulnerable to experiencing medical problems requiring ED care after a disaster or being unable to access their regular sources of medical care and related supports, and thus may require special post-disaster outreach to address their physical and behavioral health needs. These considerations should be incorporated into future city or regional disaster plans.

In this study, we also found that the geographic distribution of increases in ED visits for diagnoses of homelessness or inadequate housing correlated with FEMA-classified flood-affected areas. If these diagnosis codes point to regions with significant housing damage, then ED data may be useful in the early identification of areas suffering disproportionate impact from disasters such as Hurricane Sandy. By mapping areas with increases in ED visits for diagnoses of homelessness or inadequate housing, disaster response could be directed to those areas with significant damage, in a manner comparable to early warning systems. Our findings suggest that monitoring ED visits after a disaster may be a useful way to quickly determine the geography of new onset homelessness or housing damage and may be helpful in predicting disaster impact and shaping disaster response for not just medical issues but also social ones such as loss of housing.

Future studies should analyze how these patterns in ED visits correlate to FEMA and HUD data to determine whether these findings have more significant predictive implications beyond identifying patients at risk for post-disaster medical and social needs related to homelessness or inadequate housing. These early warning indicators of disaster impact can be important data to shape disaster response, especially as detailed damage reports can take many weeks or months to be developed and the ability to guide response effectively relies on reliable and objective early data.

Limitations

As with any study that uses administrative claims data, our study was subject to coding errors that can occur in the collection of the data. Further, we used FEMA maps of flooded areas, which may not precisely match the true underlying impact of the hurricane, particularly for electrical failures. Also, our study is limited to NYC and to Hurricane Sandy. Our findings may not be generalizable to other regions of the country or other types of disasters in which different changes in ED use may occur.

Finally, there are limitations in using the ICD-9 codes for homelessness and inadequate housing. It is unclear how often or how consistently ED providers document these ICD-9 codes, particularly given concerns some providers might have about whether ED visits will be reimbursed for these codes rather than more traditional “illness” codes. The ICD-9 codes likely capture only a very small proportion of all ED patients who are homeless or experiencing housing problems, but our goal was not to quantify ED use among people who were homeless but rather to examine visits for which the primary or secondary diagnosis for that ED visit was coded as homelessness or inadequate housing before and after Hurricane Sandy. With the recent transition to ICD-10 codes, future studies will need to assess the impact of the new diagnosis code categories using our methodology. Even though our findings do not represent all homeless individuals, we observed statistically significant differences before and after Hurricane Sandy that may be a signal that is important for predicting patterns and for disaster response. Because there is no reason to believe that providers would use the ICD-9 codes differently after versus before Hurricane Sandy for any reason other than differences in patients’ reasons for ED visits, using the ICD-9 codes is felt to be a valid way to examine temporal trends in ED use for homelessness or inadequate housing despite their limitations. One next step for future research would be to link administrative health care data with homeless shelter system data, to better distinguish those who were already homeless at the time of the hurricane versus those who had newly become homeless. Also in the future, if hospital EDs were to more routinely utilize the ICD-9 or ICD-10 codes for homelessness or inadequate housing, these codes might become even more potent avenues for homelessness-related disaster surveillance, in addition to opening doors to new research and service provision opportunities to better understand and serve the significant number of ED patients who are homeless.

CONCLUSIONS

In conclusion, we found increases in NYC ED use for primary and secondary diagnoses of homelessness or inadequate housing immediately after Hurricane Sandy’s landfall. This study speaks to the important role played by emergency departments after natural disasters not just in providing essential medical care, but potentially also in addressing pressing patient social needs such as homelessness that may occur or be exacerbated after a disaster. Future studies are needed to determine how to best use this data to prevent the negative effects of disasters like Hurricane Sandy on individuals who are homeless prior to the disaster, as well as those who may become newly homeless as a result of the disaster.

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