

Emergency Department and Inpatient Health Care Services Utilization by the Elderly Population: Hurricane Sandy in The State of New Jersey

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ABSTRACT

Objective: In this investigation, we reported the increase in emergency department and inpatient admission cases during the month of November 2012 post Hurricane Sandy as compared with baseline (November 2010, 2011, and 2013) for elderly patients aged 65 and up.

Methods: Medical claims data for patients aged 65 and over treated at emergency department and inpatient health care facilities in New Jersey were analyzed to examine the surge in frequencies of diagnoses treated immediately following Hurricane Sandy. The differences were quantified using gap analysis for 2 years before and 1 year after the event.

Results: There was an average increase of 1700 cases for the month of November 2012 relative to baseline for the top 15 most frequently diagnosed emergency department medical conditions. On a daily basis, a volume increase by an average 57 cases could be expected, including significant numbers of limb fractures and other trauma cases for these most frequently encountered medical conditions.

Conclusions: Understanding the surge level in medical services needed in emergency departments and inpatient facilities during a natural disaster aftermath is critical for effective emergency preparation and response for the elderly population. (*Disaster Med Public Health Preparedness*. 2018;12:730-738)

Key Words: elderly care during disaster, disaster surge response, disaster preparation, health services utilization

Older adults have increased vulnerability to injuries in disasters because of their reduced physical flexibility, decreased sensory responsiveness, medical conditions, and potential socioeconomic challenges that may impede preparation and response capabilities during disasters.¹⁻⁴ The elderly population aged 65 and older is estimated to surpass 70 million by 2030.^{4,5} Disaster emergency planning and response for the elderly population deserve careful observations from evidenced-based recommendations and prudent consideration. External attributable risks to prevent injuries in older adults during disasters and public health emergencies may be the absence of proper disaster planning for elderly care services and lack of coordination among health care providers and community emergency personnel. Additional external factors include lack of knowledge and training in care services surge capacity and disaster response preparation by health care staff can render older adults without treatments and urgent care for their injuries.² In this study, we are using data collected from New Jersey following Hurricane Sandy to understand the clinical caseload of health care

services utilized by those aged 65 and older during and after the storm at emergency departments (ED) and hospitals across New Jersey. This study's purpose is to augment knowledge for geriatric patient care during and after a disaster and to provide insights on clinical caseload for pre-disaster planning.

Hurricane Sandy was the most destructive and deadly storm of the 2012 hurricane season and the second costliest hurricane in US history.⁶⁻⁸ The storm's impacts in New Jersey led to a virtual statewide shutdown of transportation. All public transportation was suspended, pending limited restoration of scheduled service as assessments were taken.⁶ New Jersey sustained the brunt of Sandy's force as devastating damage occurred in almost every section of the state.⁷ As the storm traveled up the northeast coast of the United States, it became the largest Atlantic hurricane on record (as measured by diameter, with severe winds spanning 1100 miles).⁶⁻⁸ Current estimates of the US damage wrought by the storm total about \$72 billion.⁷ The New Jersey state government estimated construction costs of \$29.5 billion to repair

and replace the damage caused by the storm.⁶⁻⁸ Mildenhall et al reported the storm created damage >346,000 housing units, of which 22,000 were entirely destroyed.⁸

The vulnerability of older adults during disasters was revealed in the aftereffects of Hurricane Katrina in 2005. People aged 60 and older accounted for 15% of the population before Hurricane Katrina in New Orleans.¹ However, >70% deaths attributable to the hurricane were 60 and older, according to Grantmakers in Aging, which has been active in the hurricane relief effort.¹ Approximately 47% of all deaths in Louisiana attributed to Hurricane Katrina were people 75 years old or older, with 103 deaths occurring in nursing facilities.² It is also likely that behavioral health conditions such as post-traumatic stress disorder, major depressive disorder,⁹ and substance use disorder were affected.¹⁰ Stress and chaos in disasters-related conditions are particularly challenging for seniors with mental health conditions such as dementia and those who experienced traumatic life events such as a war and the Holocaust.¹¹ A recent study suggests that the need for mental health services was unevenly distributed geographically among Medicaid beneficiaries in the days and weeks following the hurricane.¹²

Hurricane Sandy's impact on the local health care delivery infrastructure was significant, causing changes in both the supply and demand for health care services.^{6,7} The immediate surge in demand in emergency and inpatient health care services due to trauma casualties, power outage, and suspended public transportation to outpatient facilities caused a spike in cases that challenged EDs across the state. To gain better insights into medical resources planning and staffing needed to adequately address volume and case mix of health care services presented in the emergency and inpatient settings to the elderly population during the primary surge period of the hurricane, we analyzed comprehensive health care utilization data to show patterns and duration of clinical services provided to patients aged 65 years and older immediately following the hurricane in the State of New Jersey. Complex interactions among the pre-, intra-, and post-disaster health of a given population may also affect the caseload and volume of health services delivered. Davis et al¹² demonstrated a distinct difference between the primary and secondary surge in health service needs. Primary surge is defined as the need for health care during and immediately after an incident generated by trauma, injury, and illness caused by the incident, or by pre-existing chronic conditions not properly treated during the incident.^{12,13} Followers of the news during Hurricane Sandy may recall that many health authorities also feared the emergence of other threats such as water-borne illnesses enabled by large bodies of standing water and disrupted public infrastructure. After all, the storm's passage over Haiti produced more than 9000 cholera cases, as reported by the Center for Economic and Policy Research.¹⁴

This study's approach was to capture and present the primary surge caseload of health care services utilized by elderly adults aged 65 and older in the urgent settings such as EDs and hospitals. It provided a time series of monthly caseload for the top categories of clinical diagnosis in the EDs across New Jersey prior and post the hurricane over a 12-month period. The study also estimated the cost impact of the storm on the hospitals and EDs caring for the elderly population aged 65 and older for the top categories of clinical caseload. Because of the public transportation suspensions, power outages, roadblocks, and driving challenges, the elderly population would likely resort to temporary medical tents, EDs, and medical centers to seek care.^{6,7} Due to the severity of infrastructure damage and public transportation suspensions, we hypothesized that the hurricane would produce significant demand increases during the primary surge for medical treatments related to acute trauma-related conditions in the elderly population aged 65 and older in urgent medical settings such as the EDs and hospitals. Common chronic conditions for the elderly population including heart disease, hypertension, diabetes, and arthritis would be among the top medical conditions that needed urgent care and treatment in the emergency and hospital settings.¹ To quantify the clinical caseload during the primary surge period and verify the prevalence of chronic conditions presented to EDs and hospitals from the elderly population post hurricane, we conducted analysis on multiple data sets from the Agency for Healthcare Research and Quality (AHRQ), a division of the U.S. Department of Health and Human Services. AHRQ publishes annual updates to the "Healthcare Cost and Utilization Project" (HCUP). The data offered a wide-ranging and comprehensive emergency and inpatient care response picture for the elderly population during the primary surge period of Hurricane Sandy.¹⁵ This study also made available a time series graph illustrating clinical ED caseload over time. It did not delve into the quantification of additional resources needed in the ED and hospital settings to care for elderly patients for the secondary surge and recovery process.

METHODS

Data Source

Data was obtained from the AHRQ HCUP, which consists of health care databases collected through a federal-state-industry partnership with sponsorship by AHRQ.¹⁵ HCUP databases are gathered via efforts from state data organizations, hospital associations, private data organizations, and the federal government to generate a national information supply of encounter-level health care data. HCUP contains the largest collection of hospital care data in the United States, with all-payer, encounter-level information starting from 1988.¹⁵ These databases allow researchers to conduct studies in wide range of health policy issues, including health care services utilization, cost and quality of care, accessibility to health care services, and treatment outcomes at the national, state, and local market levels. The HCUP State

Inpatient Database (SID) and State Emergency Department Database (SEDD) are databases that capture discharge information at the encounter level to be used for research purposes. The SEDD includes discharge information on all ED visits for a state that do not result in an admission. The SID encompasses all New Jersey community hospital discharges.¹⁵ We obtained both the SID and the SEDD for the state of New Jersey for each year from 2010 to 2013.

Study Population

This study examined encounters for patients aged 65 and older who presented to a New Jersey ED or were admitted to a New Jersey hospital between January 1, 2010, and December 31, 2013. All general acute-care hospitals in New Jersey were included in the data set. In 2012 there were 1,043,274 inpatient stays and 3,124,655 ED visits for all ages. There were 380,989 inpatient stays and 365,962 ED visits for patients aged 65 and above accounting for 36.5% of all inpatient stays and 11.7% of all ED visits in 2012. A similar volume of patients was seen in the other years studied. Treatment patterns were analyzed based on principal diagnosis codes to identify changes in utilization and in the types of health conditions being treated in the elderly population of New Jersey in ED and inpatient facilities in the aftermath of Hurricane Sandy.

Data Analysis

We compared all International Classification of Diseases Version 9 primary diagnosis codes listed for ED and inpatient encounters for elderly patients during November 2012, the month following Hurricane Sandy, to those during November for the 2 years before the hurricane (2011 and 2010) as well as 1 year after the storm (2013).¹⁶ This comparison was done to look for changes in volume and case mix of the elderly population age 65 and above seeking ED and hospital care immediately following Hurricane Sandy, relative to what is typical in November, based on prior and subsequent years. The comparison was based on the proportion of each diagnosis volume that occurred in November to the diagnosis volume of a 12-month period. The volume increase was controlled by calculating the proportion of a diagnosis for the primary surge month of November over the total number of the diagnosis seen in a 12-month period. This method adjusted for confounding factors such as capacity increase, seasonal-related outbreaks, and potential local epidemics that may account the volume increase in the EDs and inpatient settings outside of the hurricane effect.

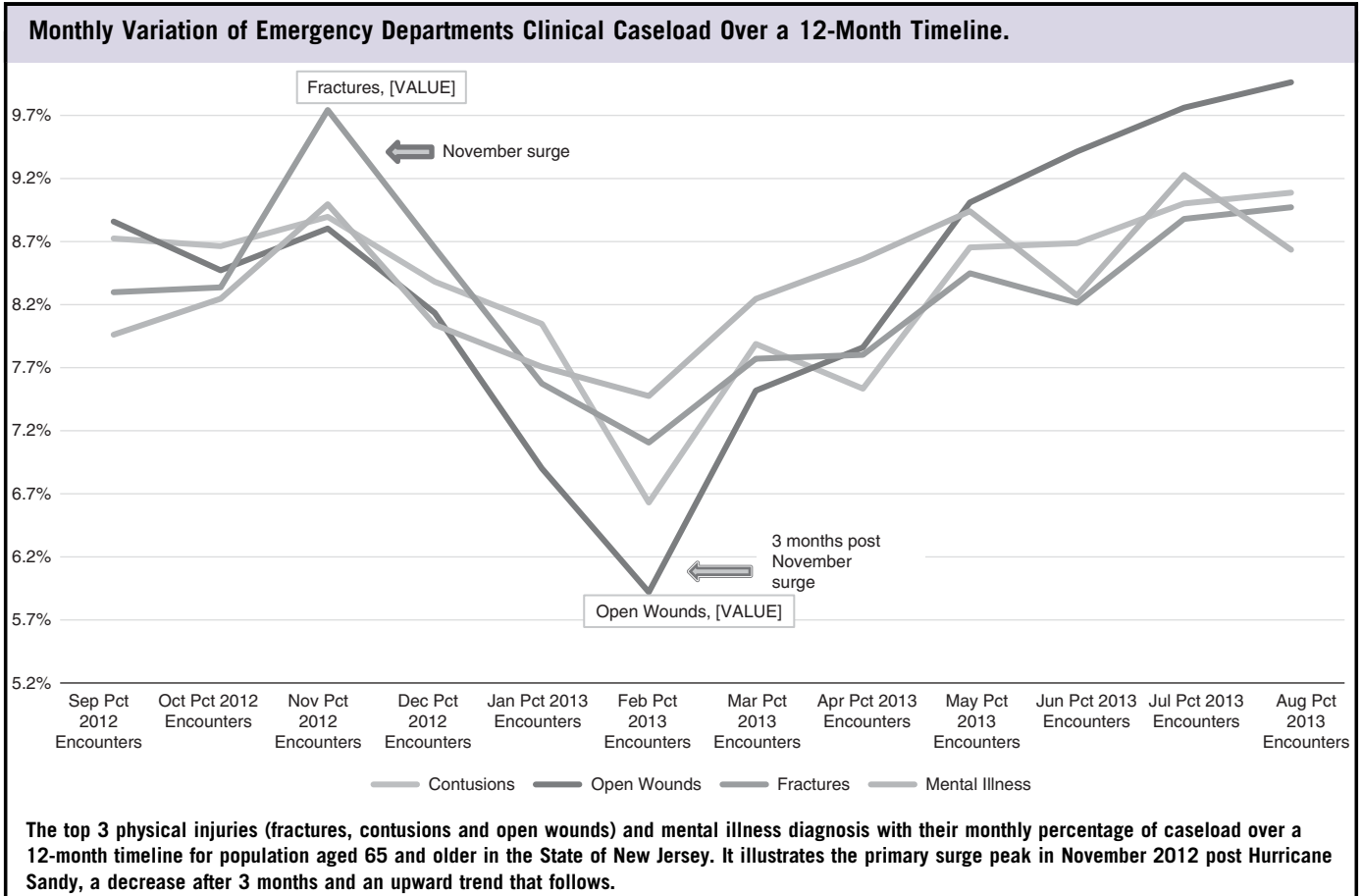
ED and inpatient data were analyzed separately to explore differences in diagnoses presented at each type of health care facility independently. Diagnosis codes were examined at the 3-digit level because we observed changes in coding practices beyond the third digit across years. In presenting the top categories of health services contributing to the highest volume and caseload increase post hurricane, we set a

threshold of ~ 10% increase in the November share for each diagnosis code in 2012 when compared with the November share for 2010, 2011, and 2013 for this study. The diagnosis codes that were above this threshold were identified as the minimum benchmark standard in this study for conditions with a significant increase in utilization in the month following the hurricane. By setting the benchmark to a minimum of a 10% increase from baseline, it allows this study to locate and focus on the health services that significantly contribute to the primary surge in health services demand of the elderly population post hurricane. The Wilcoxon rank-sum test was used to determine if there is a significant difference in volume for November 2012 compared with other months in the study period. The rank-sum test is a non-parametric test of the null hypothesis that it is equally likely that a randomly selected value from November 2012 will be less than or greater than a randomly selected from all other months in the study period. The Tukey test was performed to identify clinical caseload outliers in November 2012 in comparison with other months from September 2012 to December 2013. Outliers are values below $Q1 - 1.5(Q3 - Q1)$ or above $Q3 + 1.5(Q3 - Q1)$. The first quartile, denoted $Q1$, is the value in the data set that holds 25% of the values below it. The third quartile, denoted $Q3$, is the value in the data set that holds 25% of the values above it. The interquartile range is defined as follows: $Q3 - Q1$. When there are outliers in a sample, the median and interquartile range are used to summarize a typical value and the variability in the sample, respectively.¹⁷

RESULTS

In this investigation, we produced a timeline of elevated clinical caseload for the elderly population aged 65 and older post Hurricane Sandy in the State of New Jersey. We presented clinical caseloads with the highest increase from the baseline during the month of November post Hurricane Sandy to establish the primary surge effect. The Wilcoxon rank-sum test demonstrated a significant difference in the volume of cases by diagnosis code in November 2012 compared with other months for both inpatient and ED patients (P -values: inpatient < 0.0001 ; ED < 0.0001). The baseline was defined as the average of the month of November in 2010, 2011, and 2013 (2 years before and the year after the hurricane) for elderly patients aged 65 and older. Figure 1 displays the monthly ED clinical caseload for the 3 most frequent physical injuries and mental disorder diagnosed and treated in the ED over a 12-month period. Physical injuries such as fractures, open wounds and fractures, and mental illness were the most frequently treated conditions for the month of November 2012 immediately after the hurricane. Figure 1 also illustrates the immediate surge of different types of clinical caseload and captures any notable variations in clinical caseload following the hurricane. We conducted an analysis to quantify clinical caseload variations over a period of 12 months following the hurricane. The data showed the

FIGURE 1



variations in clinical caseload diminished beyond 9 months post Sandy. Therefore, Figure 1 displays a 9-month post hurricane caseload data to demonstrate any notable variations. The caseload decreased rapidly from the peak in the next 3 months after November to reach a temporary trough. The trough then took an upward turn and increased after February 2013. Six clinical category high outliers for the month of November 2012 were identified by the Tukey outlier test. The 6 clinical high outliers were fractures, injury other and unspecified, encounter for other and unspecified procedures and aftercare, observation and evaluation for suspected conditions not found, visual disturbances, and repeat prescription refills.

The primary surge of physical injuries and mental disorder ED caseload is illustrated in Figure 2. Trauma-related injuries such as open wounds, fractures, contusions, sprains and strains, and other unspecified injuries had the highest increase by caseload of 880 cases seen and treated in the ED for the month of November 2012 relative to the baseline. The surge of ED clinical treatment demand caused an extra \$7.3 million of health care costs for the top 15 clinical caseload categories in the month of November 2012. On a daily basis, there was a volume increase of an average of 57 cases for the most frequently encountered medical conditions in EDs for the

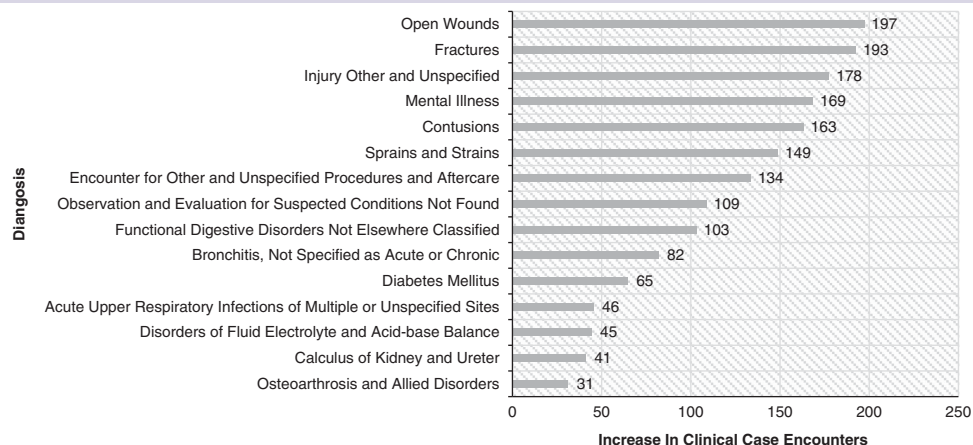
month of November 2012 across New Jersey for the elderly population aged 65 and older. Mental illness caseload was the second most frequent after the injuries related diagnostic category of services needed care and treatment in the ED. Table 1 reports health care charges and presents the caseload volume of the top ED surge clinical diagnostic categories.

Chronic conditions were frequently observed in the elderly population in the ED and inpatient settings. Essential hypertension was the most frequently encountered chronic condition in both ED and inpatient during the aftermath of Hurricane Sandy. An average of 16,000 cases of essential hypertension were seen in these 2 settings. Essential hypertension represented over 10 times as many as the average number of 1400 cases in injury-related diagnoses seen in the ED. Disorder of lipid metabolism was the second highest chronic condition treated in both ED and inpatient settings. However, chronic condition caseload did not change significantly compared with the baseline. Table 2 illustrates the relative comparisons of different chronic conditions with acute conditions in the ED and inpatient settings.

Most ED trauma presentations did not result in inpatient hospitalization. The biggest increase in caseload for November 2012 relative to baseline was for respiratory system

FIGURE 2

Hurricane Sandy Primary Surge in Emergency Departments (ED) Cases From Baseline in New Jersey.



The primary surge of physical injuries and mental illness cases in New Jersey ED clinical cases for November 2012 following Hurricane Sandy relative to baseline (averages of November 2010, 2011, and 2013) for the elderly population aged 65 and older.

TABLE 1

Number of Emergency Department (ED) Primary Surge Cases in November 2012 and Associated Total Charges

Diagnosis	Number of Cases Above Baseline	Average Charge (\$)	Total Charge (\$)
Open wounds	197	3845	758,747
Fractures	193	5290	1,019,207
Injury other and unspecified	178	5656	1,004,883
Mental illness	169	4608	777,216
Contusions	163	4195	685,183
Sprains and strains	149	3261	485,889
Encounter for other and unspecified procedures and aftercare	134	1057	141,286
Observation and evaluation for suspected conditions not found	109	2635	287,215
Functional digestive disorders not elsewhere classified	103	4092	422,840
Bronchitis, not specified as acute or chronic	82	3663	301,587
Diabetes mellitus	65	5641	366,665
Acute upper respiratory infections of multiple or unspecified sites	46	2986	136,361
Disorders of fluid electrolyte and acid-base balance	45	9191	410,531
Calculus of kidney and ureter	41	7867	325,169
Osteoarthritis and allied disorders	31	5115	160,270

The highest increase of ED clinical caseload categories and their charges during primary surge period of Hurricane Sandy in the State of New Jersey for population aged 65 and older.

and chest symptoms. These symptoms accounted for an increase of 543 admissions for respiratory-related problems. The second highest increase in admissions was for disorders of fluid electrolyte and acid-base imbalance balance resulting from dehydration. The highest increase by percentage of admissions relative to the baseline was intracerebral hemorrhage with an increase of 3% as illustrated in Figure 3. The caseload was 146 associated with intracerebral hemorrhage. It was presented as the highest by percentage because the denominator of admissions for the diagnosis was smaller.

Similarly, Table 3 presents the proportional increases from the baseline for the top ED cases in November 2012.

For the month of November following the hurricane, there was a total increase of 35% in ED encounters for the top 10 diagnoses for adults aged 65 and older who visited EDs throughout the state of New Jersey. The highest percentage increase in ED presentations was for repeat prescription refills, which increased by 10.7% in comparison with the baseline. It is important to note that this percentage increase represents a very modest number of actual prescriptions. The baseline prescriptions and refills cases amounted to just 134 counts, as compared to the much larger numbers of trauma presentations. This large increase is again due to the relatively small denominator used for calculation.

TABLE 2

Top Chronic Conditions in Emergency Department (ED) and Inpatient Settings (Patients Age 65 and above), November 2012 New Jersey

5 Most Frequent Chronic Conditions ^a , ED, New Jersey, November 2012		5 Most Frequent Chronic Conditions ^a , Inpatient (IP), New Jersey, November 2012		5 Most Frequent ED Cases ^b	
Secondary ED Diagnosis	No. of Cases	Secondary IP Diagnosis	No. of Cases	Principal ED Diagnosis	No. of Cases
Essential hypertension	14,520	Essential hypertension	17,537	Contusions	1607
Disorders of lipid metabolism	7106	Disorders of lipid metabolism	15,218	Open wounds	1592
Diabetes mellitus	5763	Other forms of chronic ischemic heart disease	12,828	Fractures	1524
Cardiac dysrhythmias	3211	Disorders of fluid electrolyte and acid-base balance	12,762	Sprains and strains	1190
Other forms of chronic ischemic heart disease	2899	Cardiac dysrhythmias	11,921	Injury other and unspecified	1084

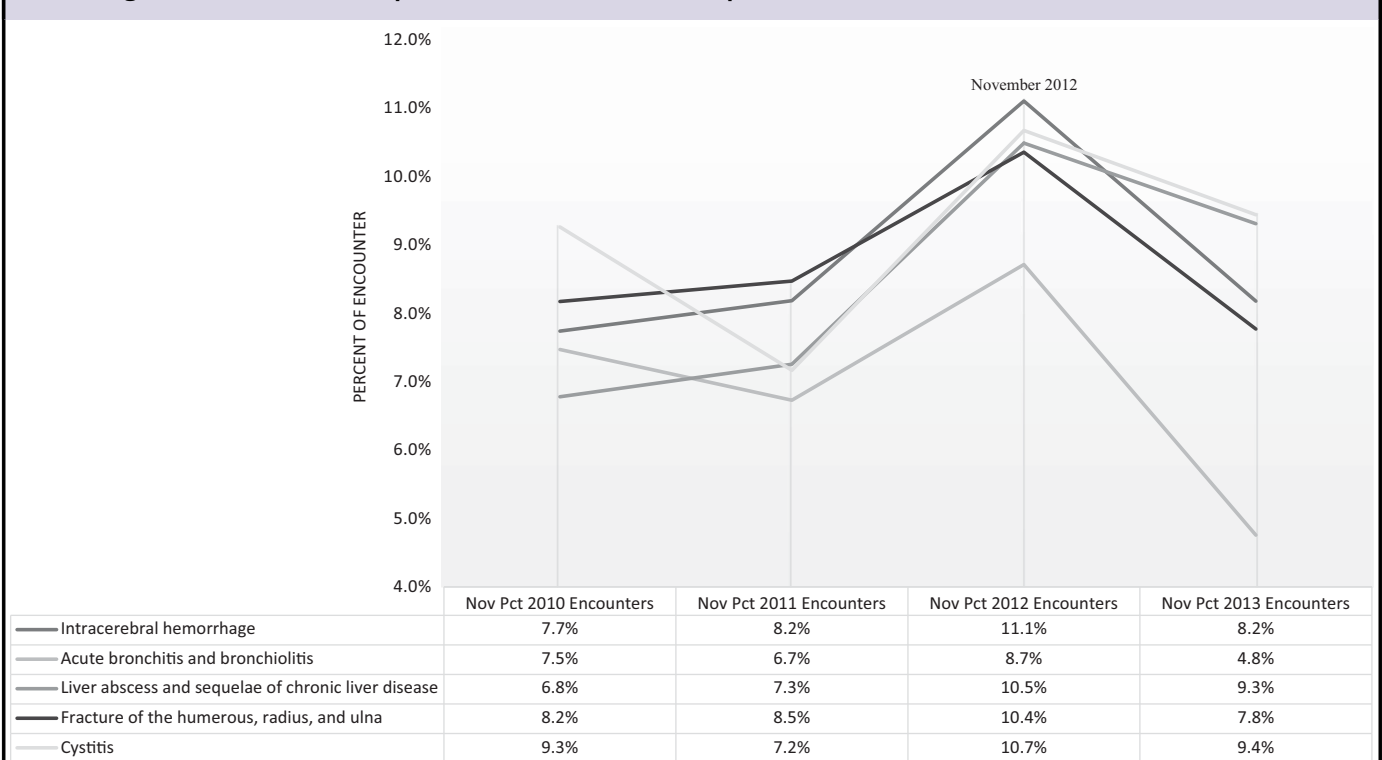
The most frequent chronic conditions treated in ED and inpatient settings during November 2012 in New Jersey for elderly patients aged 65 and older.

^aChronic conditions counted by looking at secondary diagnosis codes for ED and inpatient settings.

^bAmong ED diagnoses with a large increase over baseline in November 2012.

FIGURE 3

Percentage of November 2012 Inpatient Clinical Caseload Comparison With Baseline.



The comparison of the November 2012 primary surge for inpatient caseload to baseline percentage of clinical caseload in November 2010, 2011, and 2013 in New Jersey for patient population age 65 and above seen following Hurricane Sandy.

DISCUSSIONS

Elderly adults with multiple chronic conditions typically require regular medication refills and office visits for management of their conditions. Chronic conditions are prevalent among elderly adults aged 65 and older. Close to

80% of older adults have at minimum, 1 chronic condition such as heart disease, cancer, diabetes, or stroke, and 50% have 2 or more.¹ The CDC's National Center for Health Statistics reported that hypertension occur in nearly 50% of older adults aged 65 and over. Other frequent chronic

TABLE 3

Increase in Emergency Department (ED) Cases in November 2012 From Baseline by Diagnosis

ED Diagnosis	November Share of Encounters 2010 (%)	November Share of Encounters 2011 (%)	November Share of Encounters 2012 (%)	November Share of Encounters 2013 (%)	Difference Between 2012 and 2010 (%)	Difference Between 2012 and 2011 (%)	Difference Between 2012 and 2013 (%)	Average Difference (%)
Encounters for administrative purposes (repeat prescription ^a)	6.95	7.85	17.80 (▲)	6.49	10.85	9.95	11.30	10.70
Observation and evaluation for suspected conditions not found	8.80	7.51	12.48 (▲)	7.31	3.68	4.97	5.17	4.61
Fitting and adjustment of other device	6.05	10.11	11.10	9.73	5.05	0.98	1.37	2.47
Encounter for other and unspecified procedures and aftercare	7.77	8.06	10.82	7.62	3.05	2.76	3.20	3.00
Visual disturbances	8.18	9.00	10.81	7.66	2.63	1.80	3.14	2.52
Symptoms involving nervous and musculoskeletal systems	6.88	7.93	10.46	8.28	3.58	2.53	2.18	2.76
Superficial injury of face, neck, and scalp except for eye	8.63	8.79	10.41	7.95	1.77	1.62	2.46	1.95
Occlusion of cerebral arteries	8.22	8.94	10.35	8.65	2.13	1.41	1.70	1.74
Follow-up examination	8.61	7.92	10.28	7.76	1.67	2.36	2.51	2.18
Bronchitis, not specified as acute or chronic	7.58	6.79	10.27	6.71	2.69	3.48	3.55	3.24

The percent share of November 2012 encounters per diagnosis in EDs and the increase from baseline for the state of New Jersey in the years 2010–2013 for population aged 65 and older. ^aRepeat prescription refills was observed to have the highest increase from the baseline.

conditions include arthritis, heart disease, cancer, and diabetes.¹ Medical and public health challenges are to be expected after disasters such as Hurricane Sandy. It is important to first identify and treat storm-related casualties requiring immediate attention.¹⁸ This study confirmed that trauma-related cases were the leading primary cause of the surge for ED presentations involving elderly citizens. The primary surge of ED clinical treatment demand caused an extra \$7.3 million of health care costs for the top 15 clinical caseload categories in the month of November 2012. The presentations for chronic conditions such as essential hypertension cases were encountered 10 times as frequently as the trauma cases. Essential hypertension-related health services and medication demand presented much more frequently than trauma-related health services and supplies. Furthermore, repeat prescription refills had the biggest increase in percentage relative to baseline. Elderly adults aged 65 and older who lost their medications during the hurricane or who lacked outpatient access due to transportation challenges presented at EDs for their repeat prescription refills. Lack of access to clean drinking water sources could be particularly challenging to frail elderly adults or adults with multiple chronic conditions, thus resulting in the large increase in dehydration and fluid imbalance cases. Dehydration resulting in fluids and electrolytes disturbances caused the second highest admission for elderly adults aged 65 and older after the hurricane. The same finding was reported by Swerdel et al; they found that hospitalizations with dehydration increased significantly immediately after Hurricane Sandy in New Jersey. They also found that those over 65 years of age accounted for the vast majority of the increase.¹⁹

A natural disaster is a stressful and traumatic event and often can trigger an acute exacerbation of existing chronic conditions, including any elderly adults' underlying mental health conditions. The Centers for Disease Control and Prevention reported that about 40% of shelter evacuees might have suffered from post-traumatic stress disorder after Hurricane Katrina.¹ In our study, episodic mood disorders were among the top inpatient admission diagnoses observed. Mental illness can be observed as the second highest in clinical caseload treated in the EDs after trauma-related injuries. These findings may represent an important area for the public health community to continue to work on to reduce morbidity and the associated burden on our health care systems.

LIMITATIONS AND GAP ANALYSIS

This study focused on the month of November post Hurricane Sandy as the immediate impact health services utilization assessment. It did not address any ripple effect or sustainment effort required to address the effort beyond the initial peak of cases. The data source did not identify the specific day of month. Thus, this study focused on the month of November as a whole. Immediately following the storm, there were other agencies that responded to treat and care for

all casualties. The U.S. Department of Health and Human Services sent over 500 personnel, including 9 Disaster Medical Assistance Teams from 8 states, to deliver care at medical shelters. The American Red Cross opened 171 shelters across 13 states, with thousands of volunteers working alongside paid personnel throughout the area.⁷ FEMA set up 68 Disaster Recovery Centers in Connecticut, New York, and New Jersey where people could apply for assistance and seek information on alternative housing. Within 24 hours, FEMA supplied more than a million liters of water and more than a million plate-ready meals to the New York National Guard and to volunteers to distribute to those in need.⁷ This study's focus was in emergency and hospital care and thus it did not capture additional urgent clinical caseload provided by disaster relief agencies such as the ones mentioned above, or any outpatient services that were provided by free-standing physician clinics and practices.

CONCLUSION

In the aftermath of Hurricane Sandy, EDs and hospitals experienced an increase in case volume and health care expenditure related to trauma, other acute medical conditions, and underlying chronic conditions for the elderly population aged 65 and older in the State of New Jersey. Many elderly adults sought care in the EDs and hospitals during the aftermath of Hurricane Sandy due to transportation disruptions. The highest workload increase can be observed in injuries related to trauma such as open wounds, fractures, contusions, sprains and strains, and other unspecified injuries, which collectively accounted for the highest increase in volume seen in the ED for the month of November 2012. New Jersey EDs handled on average 1700 more cases for the month of November 2012 (post Hurricane Sandy) relative to the baseline for the top 15 most frequently diagnosed and treated ED medical conditions for the elderly population aged 65 and older. The primary surge in these ED care services required extra medical resources that generated an ~\$7.3 million increase in health care costs for the month of November 2012. The elevated clinical caseload of trauma-related injuries sustained for 3 months. This study confirmed that trauma-related cases were the leading cause of the surge in elderly population aged 65 and older visiting the EDs for care and treatments during the primary surge of the hurricane. The surge in trauma-related care services generated ~\$4.0 million of the \$7.3 million total health care costs for November 2012. Most ED trauma presentations did not result in inpatient hospitalization.

Chronic conditions such as essential hypertension cases were encountered 10 times as frequently as the trauma cases. However, the utilization and demand for chronic conditions-related health services and medication did not increase much more significantly than the baseline during and after the hurricane. Study findings showed inpatient trauma-related workload did not increase as much as outpatient workload, as most presentations were treated and discharged without admission. Fracture injuries, specifically fractures of the humerus, radius,

and ulna were reported as the fourth-highest admission diagnosis for the month of November 2012. Tomio et al summarized that a considerable number of recommendations for the disaster preparedness of chronically ill patients were developed by the lessons learned from recent disasters. Some of the recommendations were based on prior disasters' epidemiological findings; however, an abundance of recommendations came from anecdotal evidence or expert opinions. In addition, most of these recommendations had not been scientifically studied and validated.²⁰ Findings of this study provided a quantitative effort to understand the immediate surge workload as ED and hospital staffs responded to injured and medically ill adults aged 65 and older during and after Hurricane Sandy in New Jersey. We hope these findings contribute to literature that offers evidence-based results and insights for the elder medical care services and disaster preparedness.

FUTURE DIRECTION

In future studies, we plan to identify hospitals within geographical areas most impacted by the storm, study their surge levels, and compare them to hospitals within less-impacted geographical areas to further understand medical services utilization in the aftermath of Hurricane Sandy in New Jersey. We also plan to further quantify and focus on the number of mental health cases observed post Hurricane Sandy and monitor the associated medical services utilization and length of related medical treatments as a result of the impact of a natural disaster to understand any secondary surge effect of the hurricane. In the number of articles published on elderly disaster victims, not very many contain the focus on frail elders. In addition, the majority of researchers do not differentiate between frail and strong elderly adults in their studies.¹⁸ Our future work will aim to use both age and level of physical impairment as indicators of which populations aid workers should target first at disaster relief sites.

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