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Remembering the Health Outcomes of Hurricane Katrina A Decade Later: A Report on Katrina Evacuees Discharged Post 'Emergent' Care in a Houston-based Emergency Department

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ABSTRACT

Introduction: Existing literature is missing a description of a displaced population in the aftermath of Hurricane Katrina, who were seen and discharged from emergency departments of a Houston hospital system 10 years ago.

Hypothesis/Problem: Health effects of Hurricane Katrina are an important public health topic that is not sufficiently discussed in the existing literature. Failure to provide this information is largely due to the lack of appropriate, representative data and absence of a systematic data capture process.

Methods: A retrospective Electronic Health Record review of 'Katrina evacuees', obtained from Houston Fire Department run call data, was used to identify: visit type, top three ICD-9-coded diagnoses, medical insurance, number of visits and emergency medical service utilization.

Results: The majority of patient visits were by Black, female gender and adults between 19 and 44 years. The leading diagnosis was hypertension. Circulatory system related diagnoses were nearly three times higher among Katrina evacuees than national data from 2005 and 2007. Most patients used emergency medical service services [815(60%)], had one emergency department visit [570(70%)], and reported Medicaid [577(40%)] or self-pay [425(30%)] as the insurance source.

Conclusion: Disaster planning for the aftermath of natural disasters would benefit from knowledge pertaining to known chronic and non-chronic care needs of populations in pre-specified areas. Variance in primary diagnoses suggests the need for published data reporting annual primary diagnoses in local EDs by region. Access to this information *via* the internet contributes to estimating the likelihood of ED volume of chronic and non-chronic visit demand,¹ providing foundational information for disaster preparedness plans nationwide.

KEYWORDS: Emergency medicine; Hurricane; Disaster preparedness; Natural disasters.

ABBREVIATIONS: HFD: Houston Fire Department; ED: Emergency Department; EMS: Emergency Medical Services; KE: Katrina evacuees; HER: electronic health record; FEMA: Federal Emergency Management Agency; MHH: Memorial Hermann Health System; TMC: Texas Medical Center; MRN: Medical Record Number.

INTRODUCTION

A decade ago, US history was made in the aftermath of Hurricane Katrina to the Gulf Coast region. Hurricane related disasters occurred over the previous decade.^{2,3} However, none resulted in a forced, long-term evacuation of over one million Gulf Coast residents, with ap-

proximately 200,000 New Orleans residents arriving to a neighbouring metropolitan city (Houston, Texas, USA) by planes and busloads.^{4,7} Published data on Emergency Department (ED) visits in Houston described the increase in visits by Katrina Evacuees (KE).⁶ Houston, TX is the fourth largest city in the US and local EDs are considered the public health safety net system that meets the need of merely one-third of service demands among a largely, uninsured population.⁸ Overcrowded EDs do not have the capacity to adequately provide care to a surge of thousands of patients.⁹ The forced, long-term evacuation immobilized the entire metropolitan health care system.¹⁰ Limited data substantiating the impact of Hurricane Katrina on the health care system has been published.^{6,11}

A quantified analysis detailing the increased demands on EDs due to the translocation of a population post Hurricane Katrina has not been published. Statistics of the patient population injured or whose chronic medical conditions worsened after being displaced remains unknown to the medical and public health community.¹¹ Trauma patients presenting to Mississippi hospitals were triaged and provided medical care in a relatively short time frame immediately after the storm.¹¹ Interestingly, operations were at normal levels directly before landfall of the storm as well. Following Hurricane Katrina, two waves of patients presented to the ED. The initial wave of patients were local trauma patients. The second were patients with chronic medical conditions who ran out of medication and/or access to specialty services such as dialysis, methadone, or oxygen supply.¹¹ Mobile field hospitals treated approximately 8,000 patients following the storm.^{11,12} In Houston, Texas, more than 11,000 patients were treated at Katrina Clinic, a temporary clinical establishment designed to meet the medical needs of the dislocated population,¹³ and over 10,000 received medical care at the convention center.^{6,14} Dissimilar to the Mississippi study,¹¹ this Houston based study described Katrina evacuees (KE) with a system initiated by the local fire department, and refined by the study team.

Several publications discuss mass evacuations post Hurricane Katrina, however, the focus of the discussion or study varied widely. An assessment of Chicago's public health response evaluated key systemic changes created to deliver healthcare to the displaced population.¹⁵ Surveillance done in Arkansas, Louisiana, Mississippi, Texas, and Indiana over a three-week period after Hurricane Katrina discovered primary health care services and medication refills were the top reported needs of disaster survivors.^{16,17} A needs assessment verified that most non-injury-related health care visits were for medication refills, oral health problems, or chronic conditions.^{18,19} Additionally, a survey of KE reported that 41% had a history of one chronic disease.²⁰

New Orleans residents reported significant health declines after Hurricane Katrina,²¹⁻²⁴ substantiating evidence of health declines after natural disasters.²⁴ Published findings confirm that a substantial number of people with preexisting health conditions will need medical care after a disaster.²⁵ A compara-

tive analysis, pre and post Hurricane Katrina, revealed a significant decrease in health among the adult population in New Orleans, LA a year post the storm, measured by a rising disability rate from 20.6% to 24.6%.²⁴ Demographic disparities after the storm were assessed based on age, race, and gender.²⁶⁻²⁸ Published findings support the notion that Hurricane Katrina evacuees experienced adverse health outcomes, poorer access to health care, and had disproportionately more disability after the storm.²⁴ Data captured confirm health disparities among this disaster's survivors, as chronic illness are commonly worsened by disaster conditions.¹⁹ As a result, the influx of KE patients will likely result in increased visits to the ED for chronic conditions and other health declines related to the storm.

The study described here was an in-depth analysis of a passive data collection method by a community based health care service provider's attempt to systematically describe a population displaced after a natural disaster. This is the first study to provide a description of a displaced population after Hurricane Katrina, who were evaluated and discharged from the EDs of a large health system.

MATERIAL AND METHODS

Study design and Selection of participants

The cohort of patients for this retrospective chart review was obtained from the Houston Fire Department's (HFD) KERun calls to a Memorial Hermann Hospital (MHH) System ED. HFD, the third largest fire department in the United States, is responsible for providing Emergency Medical Services (EMS) to a population of more than 2 million in an area totalling 654 square miles.²⁹ Run calls were designated as KEs by HFD if they had: (1) HFD electronic tablet records designating subject(s) as FEMA, flood evacuee, New Orleans, refugee or Katrina, (2) run calls made to temporary housing shelters housing Hurricane Katrina evacuees (i.e. Houston Reliant Center), or (3) run calls made to a zip code where FEMA maps indicated a high concentration of Hurricane Katrina evacuees. MHH is the largest not-for-profit health system in Southeast Texas and largest health system in Houston with 12 satellite hospitals, one of the nation's busiest Level 1 trauma centers and a total of 3781 beds. Thus, run calls to MHH following Hurricane Katrina serves as an indicator of resource utilization required post the translocation of a population following a natural disaster. The study was reviewed and approved by the Institutional Review Board of the University of Texas – Health Science Center at Houston and MHH (HSC-MS-07-0519).

Data Collections and Processing

The cohort utilized in this study were designated as KE if they had a: (1) Gulf coast state address, (2) Gulf coast state phone number, (3) notation on their medical record describing them as a KE or hurricane evacuee, and (4) Out-of-State insur-

ance. Patient-visits from the cohort of HFD run calls between August 2005 and August 2006 (landfall of Hurricane Katrina to one year post -storm), were cross-referenced with the MHH Electronic Health Record (EHR). Data were collected on standardized electronic abstraction forms created in Microsoft Excel® spreadsheet Version 14.0.7116.5000 (Microsoft Corporation, 2010, Redmond, Washington, USA).

Ten data abstractors received a tutorial from the PI, which included collection a mock data abstraction session. Training was supplemented with a PowerPoint tutorial (made available for review). Routine meetings took place between abstractors and investigators to ensure productive and consistent rates of data abstraction. The PI implemented quality assurance methods and reviewed the first five patient-visit-data abstractions of each abstractor. This strategy ensured achievement of performance goals. Retraining took place when errors were identified.

Abstractors included patient visits found in the MHH EHR between August 2005 and August 2006. Additional visits absent from the HFD dataset were also included. For example, if the HFD dataset shows two visits between August 2004 and August 2006 for a patient and the MHH EHR listed even visits for that same patient during that time interval, then all seven patient-visits were recorded in the study dataset. Missing, conflicting, or ambiguous data were marked as unknown by the abstractors and later reviewed by senior members of the research team for quality control/assurance purposes.

Measures: Data was collected on the following variables: name, Medical Record Number (MRN), Date of Birth (DOB), race, arrival date, discharge date, visit type, chief complaint, and top three diagnoses, along with ICD 9 codes, medical insurance, and listed address were recorded for each patient visit. Patient visit data was collected from each patient's face sheet in the EHR. Highest hospital location and EMS usage data were obtained by a review of discharge summaries or ED physician and nurse documentation.

Primary data analysis

An inter-rater reliability assessment was done on 20 patient visits from each of the 74 datasets. Patient visits were randomly selected and abstracted again by a single abstractor. Data from the abstractors were compared and the inter-rater reliability was assessed using Cohen's Kappa co-efficient with Microsoft Excel® spreadsheet Version 14.0.7116.5000 (Microsoft Corporation, 2010, Redmond, Washington, USA) (See Table 1). Abstractor agreement for each variable (number of agreements divided by the agreements plus disagreements) was illustrated. Only patient visits that concluded in the Emergency Department were utilized for data analysis, all inpatient, observation and outpatient visits to MHH were excluded.

Variables	Observer Agreement	
	Agreement, %	(95%, CI)
Gender	100	1.00(1.00-1.00)
Race	99.8	0.99(0.99-1.00)
Medical Insurance	99.1	0.99(0.98-0.99)
Visit Type	91.9	0.87(0.85-0.89)
EMS Used	88.8	0.81(0.79-0.84)
Highest Hospital Acuity	85.4	0.78(0.75-0.81)

'CI' refers to Confidence Interval

Table 1: Summary of study statistics and inter-rater reliability agreement.

RESULTS

The abstraction process flow is mapped in Figure 1. HFD cohort data contained 11,305 entries and dates of transport ranged from August 2005 to January 2007. 'Entries' are line items by HFD personnel and confirm an ambulatory phone call was made. Missing patient identification data, such as date of birth or social security number [4(.04%)] and duplicate entries [1,023(9%)] were removed. 'Patient visits' reflect patient-encounters to the ED. In some cases, a single patient had multiple patient visits. 'Patients' are the individual person present at a patient visit. 'MHH destination' refers to MHH. Frequency data reported in Figure 1 reflect the variable described as the numerator and the preceding cell as the denominator.

Abstractor agreements in Table 1 were highest in categories with well-defined, objective criteria such as gender and race (99% to 100% agreement; 0.99-1.00). However, fair abstractor agreements were noted in subjective categories such as visit type, highest hospital acuity (85% to 91% agreement; 0.78-0.91).

Descriptive Results

The study population, 815 KE, accounted for 1354 patient visits. Most patient visits were by those of Black race, female gender, and adults 19-44 years (Table 2). Approximately, one-third of ED visits did not utilize EMS services. Fifty-one percent (N=735) of the KE had Medicare/Medicaid. Eighteen percent (N=146) had private insurance. Seventy percent (N=570) had a single ED visit. Thirteen percent (N=106) had more than two visits. Only ~7 % (N=57) had greater than three visits. Merely 0.7% (N=6) utilized the ED more than ten times.

Chronic conditions, including hypertension (ranked 1st) and diabetes mellitus (ranked 3rd), were leading diagnoses among KE visits (Table 3). Non-chronic conditions, including headaches, back pain, chest pain, and abdominal pain were in the top six individual diagnoses. The percent distribution of ICD-9-CM diagnostic code categories when compared to those found in the published National Hospital Ambulatory Medical Care Surveys^{30,31} (Table 4) showed an increase in 3 categories: Musculoskeletal system & connective tissue (709.3-739.9),

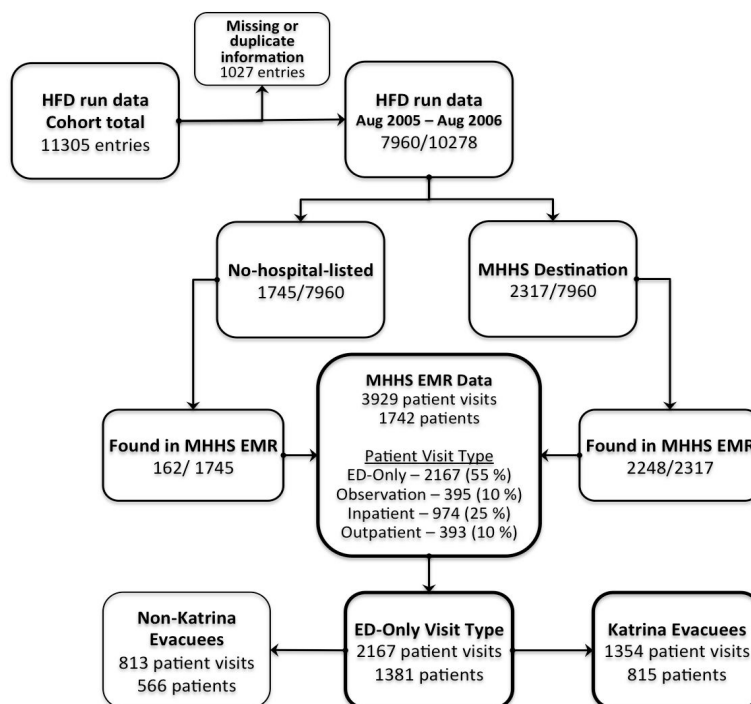


Figure 1: Data abstraction from HFD run data cohort.

Demographics	KE(N)	%
Age		
0 to 15	99	7%
15 to 24	389	29%
25 to 44	495	37%
45 to 64	268	20%
65 to 74	51	4%
75 and over	52	4%
Gender		
Male	470	35%
Female	884	65%
Ethnicity		
Black	1147	85%
White	147	11%
Asian/South Pacific	19	1%
Latino	3	0%
Other	38	3%
Healthcare Utilization	KE	%
EMS Use		
Yes	815	60%
No	519	38%
Unknown	20	1%
Insurance		
Medicare Only	69	5%
Medicaid Only	577	40%
Medicare & Medicaid	89	6%
Self-Pay	425	30%
Private	268	18%
Worker's Compensation	6	<1%

Table 2: Descriptive analysis of Katrina evacuees.

Endocrine, nutritional & metabolic, immunity (204-279.9) and Circulatory system (388.7-459.19) with a decrease in the Injury & Poisoning category (800-999.9). Compared to the leading primary diagnosis in US Emergency department in 2005 and 2007 (Table 5), spinal disorders (720-724), arthropathies and related disorders (710-719), contusions with intact skin surface (920-924) and Headache (784) were the leading ICD-9 diagnoses.

DISCUSSION

Notable public health and medical challenges resulted from Hurricane Katrina, rendering several large hospitals immobilized and KEs with chronic and non-chronic health conditions without access to usual sources of health care.¹⁹ This is one of few studies to 1) analyze summary data captured by community-

based, emergency medical services (EMS) healthcare providers and 2) assess disaster survivors' healthcare needs in comparison to a national population. Study findings provide, for the first time, the prevalence of EMS and ED utilization of a displaced population as well as the common discharge diagnoses among a displaced population seeking emergent care in a urban large health system post landfall of one of the worst natural disasters in US history, Hurricane Katrina.³² Though different, our findings add to the body of work noted from those that sought treatment in New Orleans.¹⁹ Our outcomes support findings from Chicago¹⁵ indicating health care providers need to prepare to manage chronic conditions. These conditions may worsen in the absence of healthcare access, full insurance coverage, and sufficient income.³³⁻³⁵ Attention to spinal conditions/injuries is also important, as presentation would be different from the typical

	Diagnosis	ICD-9	N	%
1	Hypertension	401.9	207	6.4
2	Headache	784	88	2.7
3	Diabetes Mellitus	250	73	2.3
4	Back pain unspecified	724.5	72	2.2
5	Chest pain	786.5	66	2.0
6	Abdominal pain	789	62	1.9
7	Convulsions	780.39	59	1.8
8	Fever	780.6	53	1.6
9	Injuring passenger in MVC other than motorcycle	E812.1	52	1.6
10	Shortness of breath	786.05	51	1.6

Table 3: Top 10 diagnoses among Katrina evacuees.

System	ICD-9-Code Range	KE	%	2005 (%)	2007 (%)
Infectious & Parasitic Diseases	1 136.9	45	1.4	3.0	2.8
Neoplasms	137 239.9	3	0.1	0.2	0.2
Endocrine, Nutritional & Metabolic, Immunity	240 279.9	148	4.6	1.5	1.8
Blood & Blood-Forming disorders	280 289.9	50	1.5	--	--
Mental Disorders	290 315.9	150	4.6	3.5	3.5
Nervous System and Sense Organs	316 388.69	51	1.6	5.1	5.2
Circulatory System	388.7 459.19	296	9.2	3.5	3.6
Respiratory System	459.2 519.9	178	5.5	11.0	9.8
Digestive System	520 578.9	75	2.3	6.0	6.1
Genitourinary System	579 628.1	139	4.3	4.6	5.4
Complications of Pregnancy, Childbirth, & the Puerperium	628.2 674.8	108	3.3	--	--
Skin & Subcutaneous Tissue	674.9 709.02	52	1.6	4.0	4.2
Musculoskeletal System & Connective Tissue	709.3 739.9	346	10.7	5.5	6.3
Congenital Anomalies	740 759.9	1	0.0	--	--
Certain Conditions Originating in the Perinatal Period	760 779.3	0	0.0	--	--
Symptoms, Signs & Ill-Defined Conditions	779.4 799.9	835	25.9	19.3	21.6
Injury & Poisoning	800 999.9	356	11.0	24.9	22.5
V Codes	V01 V86.1	109	3.4	2.6	2.7
E Codes	E800 E999.1	284	8.8	--	--

-- notes that the value was not listed.

Table 4: Katrina evacuee diagnoses by system and ICD-9 code compared to national data (reference).

	Diagnoses	ICD9-Codes	KE	%	2005 (%)	2007 (%)
1	Abdominal pain	789.0	62	1.9	4.0	4.9
2	Chest pain	786.5	66	2.0	3.8	4.1
3	Contusion with intact skin surface	920–924	93	2.9	4.2	3.7
4	Acute upper respiratory infection, excluding pharyngitis	460–461,463–466	45	1.4	3.7	3.2
5	Spinal disorders	720–724	174	5.4	2.5	3.0
6	Open wound, excluding head	874–897	42	1.3	3.5	2.7
7	Cellulitis and abscess	681–682	38	1.2	2.3	2.6
8	Fractures, excluding lower limb	800–819	22	0.7	2.0	2.1
9	Urinary tract infection, site not specified	599.0	43	1.3	1.6	1.9
10	Sprains and strains, excluding ankle and back	840–844, 845.1,848	10	0.3	2.2	1.8
11	Sprains and strains of neck and back	846,847	50	1.5	2.2	1.8
12	Otitis media and Eustachian tube disorders	381–382	13	0.4	1.9	1.8
13	Open wound of head	870–873	28	0.9	1.9	1.7
14	Rheumatism, excluding back	725–729	71	2.2	1.6	1.7
15	Diseases of the teeth and supporting structures	520-525	10	0.3	--	1.5
16	Headache	784.0	88	2.7	--	1.5
17	Arthropathies and related disorders	710-719	100	3.1	--	1.5
18	Pyrexia of unknown origin	780.6	53	1.6	--	1.4
19	Acute pharyngitis	462	16	0.5	1.4	1.4
20	Asthma	493	0	0.0	1.5	1.4
	All Other reasons		2202	68.3	--	54.2

-- notes that the value was not listed

Table 5: The 20 leading primary diagnosis in the ED: United States, 2007.

reasons patients visit the ED.

Findings suggest the majority of the displaced population had a single ED visit, half had government insurance, and two of the top three diagnoses, hypertension and diabetes, were chronic conditions left unmanaged in the wake of the storm. Comparatively, non-chronic issues, body aches/pains and headaches, were likely related to environmental and/or social stressors post disaster.

Study findings contribute to the existing body of literature by providing additional information, aiding in overall understanding of disaster-displaced populations, which is described as critical for a society to prepare and respond effectively.⁸ The data is representative of a larger displaced population that utilized EMS services prior to presentation to a health system. Primary diagnoses of KE in this study (Table 3) are vastly different from the primary diagnoses reported on a national scale (Table 5).^{30,31} Variance in primary diagnoses suggests the need for published data reporting annual primary diagnoses in local EDs by region. Access to this information *via* the internet contributes to estimating the likelihood of ED volume of chronic and non-chronic visit demand,¹ providing foundational information for disaster preparedness plans nationwide.

System level (i.e. region, county, or parish) diagnoses information should be made publicly available to facilitate prep-

aration in disaster recovery efforts. The MedCon:PreEvent tool was developed and published to assist disaster response planning and estimate displaced persons requiring special medical care during a disaster.²⁵ This tool can assist disaster planners with preparing medical needs of disaster evacuees. It provides data needed to re-evaluate the medical approach to use and enhance healthcare services provided.²⁵ Importance of a clear, comprehensive, and well communicated emergency response plan, with capabilities to be tailored to varied types, sizes, and proximities of disaster is supported.¹⁵ By having access to local primary ED diagnoses, disaster preparedness planners can prepare to provide survivors with access to preventive care needs for chronic conditions such as hypertension and diabetes. This information is pertinent to cost effective strategies because a population with preventable illness largely addressed by preventive care measures will likely avert use of the ED for non-emergent conditions. It is imperative that provisions for creation and dissemination of services and resources for survivors be prioritized by disaster preparedness groups.

LIMITATIONS

Although, this study offers insight on healthcare utilization of KE, the authors hesitate to make generalizations to healthcare use of KE overall. Study findings were subject to selection bias due to the use of HFD run call data. Study team members hypothesize that HFD run data contained some non-

translocated patients; thus, more stringent guidelines were implemented when determining study inclusion criteria. It is possible that the data may include non-translocated patients, as patients may have had out-of-state insurance or gulf coast telephone numbers and present to a MHH only after Hurricane Katrina. Data on what states the participants were from was not available. Sensitivity analysis on the inclusion criteria was not possible as the necessary criteria were not collected during the data abstraction. Study data was obtained by retrospective chart review; thus, the possibility of selection and/or transcription bias is inherent. MHH provided inpatient level care to critically ill and other vulnerable patients who were evacuated directly from hospitals in Louisiana and were not included in this study; thus, the study sample is not truly representative of KE who received care from this hospital. Information about KE that did not utilize HFD services or present to the MHH system are not included in this study. Study data was limited to patients discharged from the ED. Thus, patients that were hospitalized, likely to have higher illness burden and resource utilization were excluded from this analysis. Publicly available, comparative information is limited. Access to nationally available data precluded the option of individual level data; thus, only a frequency analysis was feasible for comparative purpose.

CONCLUSIONS

Events associated with Hurricane Katrina revealed major gaps in available disaster preparedness for at-risk medical institutions, especially tertiary and/or quaternary care academic centers.^{2,15,36-41} This study's findings contribute to future preparedness plans by defining pertinent characteristics of a translocated population post landfall of Hurricane Katrina. By eluding to the generalizability of these characteristics, at-risk metropolitan areas at large in this vulnerable region should include this information in their disaster preparedness plans, as lessons learned and suggestions for improvement are currently reported in the existing body of literature.^{2,11,15,36,42} Published reports indicate lessons have not been learned, as many recommendations have been repeated or modified;¹⁵ thus, issues thwarting recovery efforts must be confronted before the next disaster arises.⁴³ Lessons learned from Hurricane Katrina for medical providers challenge hospitals and health systems to develop a disaster based contingency plan and to become more involved in a state and local response plan.¹¹

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONSENT

The 'Developing Effective Methods for Addressing Needs of Disaster Survivors (DEMANDS)' study, HSC-MS-07-0519, was approved by the UT Health IRB as a retrospective chart review; thus, participant consent was not required.

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