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Authors

Pressler, Susan J
Jung, Miyeon
Lee, Christopher S
et al.

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Predictors of emergency medical services use by adults with heart failure; 2009–2017

Susan J. Pressler, PhD, RN[a,*], Miyeon Jung, PhD, RN[a], Christopher S. Lee, PhD, RN[b], Thomas P. Arkins, BS[c], Daniel O'Donnell, MD[d], Ryan Cook, MPH[e], Giorgos Bakoyannis, PhD[f], Robin Newhouse, PhD, RN[a], Irmina Gradus-Pizlo, MD[g], Peter S. Pang, MD, MS[h]

[a] Indiana University School of Nursing, 600 Barnhill Dr., Indianapolis, IN 46202, United States
[b] Boston College William F. Connell School of Nursing, 140 Commonwealth Avenue, Chestnut Hill, MA 02467,United States
[c] Indianapolis Emergency Medical Services, 3930 Georgetown Road, Indianapolis, IN 46254, United States
[d] Department of Emergency Medicine, Indiana University School of Medicine, 3930 Georgetown Road, Indianapolis, IN 46254, United States
[e] Department of Biostatistics, Indiana University School of Medicine, 410W. 10th St., Suite 3000, Indianapolis, IN 46202, United States
[f] Department of Biostatistics, Indiana University Fairbanks School of Public Health and School of Medicine, 410W. 10th St., Suite 3000, Indianapolis, IN 46202, United States
[g] Department of Medicine, University of California Irvine School of Medicine, 101 City Drive South. City Tower, Suite 400, Orange, CA 92868,United States
[h] Department of Emergency Medicine, Indiana University School of Medicine, 720 Eskenazi Avenue, Indianapolis, IN 46202, United States

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ABSTRACT

Background: Heart failure (HF) necessitates frequent transport by emergency medical services (EMS), but few studies have been conducted to evaluate predictors of EMS use and of multiple EMS transports that are amenable to intervention.
Objectives: To characterize prehospital clinical status of community-dwelling adults with reported HF who used EMS across 8 years and to evaluate predictors of EMS use and multiple EMS transports.
Methods: Data were from a database in a large Midwestern county. Descriptive statistics, logistic and negative binomial regression were used for analysis.
Results: EMS transports were evaluated for 6582 adults with 16,905 transports. The most common chief complaints were respiratory problems, feeling sick, and chest pain. Shortness of breath, chest pain, level of consciousness, age, gender, race, and hospital site predicted multiple transports.
Conclusions: Clinicians need to educate patients with HF about ways to manage shortness of breath and chest pain and when to activate EMS.

Heart failure (HF) is a serious chronic condition associated with high mortality rates, frequent hospitalizations, and poor quality of life. In the United States (U.S), the prevalence of HF is approximately 6.5 million and the annual incidence is approximately 1,000,000.[1] The 12-month mortality rate is 29.6% and the 5-year mortality rate is 52.6% for adults with HF.[1] It is a leading cause of hospitalization among adults age 65 years and older,[1] necessitating the need for prehospital transport by emergency medical services (EMS). Healthcare resource use is high among these adults. In the U.S. in 2015, the cost of care for adults with HF was $11 billion.[2] The total number of EMS transports for HF is unclear but likely high. There were 958,167 visits, on average, to emergency departments for acute decompensated heart failure from 2006 to 2010 in the U.S. and these visits accounted for 0.77% of all emergency department visits.[3] In a study of patients from Canada enrolled in the Acute Studies of Nesiritide in Decompensated Heart Failure (ASCEND-HF), 27% of patients in the clinical trial and 52% of patients in the registry arrived at hospitals by ambulance.[4]

National evidence-based clinical practice guidelines are available to guide medical therapeutics for adults with HF.[5,6] Evidence-based scientific statements and best practices are available to coordinate care for adults with HF as they transition from hospital to home and to improve self-care for adults living in the community.[7–9] However, adults with HF continue to require frequent hospitalizations for acute decompensated HF. In a past study, adults with HF reported delays in seeking treatment for decompensation because of difficulties in interpreting symptoms as emergent, urgent, or non-urgent.[10] Ultimately, this delay in seeking treatment may lead to increased mortality and morbidity given the progressive decrement in left ventricular function due to myocardial necrosis with each acute cardiac decompensating event.[11]

The prehospital phase of care, from activation of EMS to arrival at the emergency department, is a critical window of time to implement

* Corresponding author.
E-mail addresses: sjpress@iu.edu (S.J. Pressler), miyjung@iu.edu (M. Jung), leeddo@bc.edu (C.S. Lee), Thomas.Arkins@IndianapolisEMS.org (T.P. Arkins), dapodonn@iu.edu (D. O'Donnell), gbakogia@iu.edu (G. Bakoyannis), newhouse@iu.edu (R. Newhouse), igpizlo@uic.edu (I. Gradus-Pizlo), ppang@iu.edu (P. Pang).

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life-saving treatments.[12–14] Accurate assessment of the emergent situation is essential to directing initial care. The critical window of time concept of 'door-to-balloon' is well characterized for adults with acute coronary syndromes in which prehospital assessment and treatment have led to rapid assessment and activation of the cardiac catheterization team with improvements in diagnosis and outcomes.[13,14] Less data are available for adults with HF to determine if there is a critical window of time in the prehospital phase for implementation of treatments that would improve diagnosis and survival and reduce morbidity. In a consensus document on prehospital and emergency care for acute HF, Mebazaa and colleagues[12] recommended treatments that should be implemented during the prehospital phase but noted that the recommendations are primarily based on clinical judgment. Lack of empirical evidence regarding prehospital clinical status including presenting symptoms makes development of a treatment algorithm difficult.

Although empirical evidence is lacking for prehospital clinical status variables as predictors of mortality and morbidity, studies have been conducted to evaluate predictors of inpatient and outpatient mortality and re-hospitalization among patients with HF treated in the emergency department. In past studies, predictors evaluated included demographics, vital signs, laboratory values, and comorbidities. Among samples of patients with HF, systolic blood pressure was a predictor of mortality[15–19] and combined mortality and rehospitalization.[17] Diastolic blood pressure was a predictor of mortality.[19,20] Heart rate was a predictor of in-hospital mortality among patients with HF.[15,18,19] Compared with patients with HF who self-presented to the emergency department, patients transported by EMS had lower oxygen saturation levels.[21] In other studies among patients with HF, poorer cognitive function[22,23] and breathlessness[24] were predictors of mortality. In univariate analyses among patients with HF, presence of angina was significantly associated with mortality.[24]

Using real-time data collected at the point of care, the current study was conducted to describe prehospital clinical status and treatments administered to a large population of community-dwelling adults with reported HF who were transported by EMS and to evaluate predictors of EMS use and multiple EMS transports. Aim one was to characterize the prehospital clinical status of and treatments and medications administered to adults with HF who were transported by EMS from home to one of three acute-care hospitals in a large Midwestern county from July 1, 2009 through June 30, 2017. Aim two was to evaluate predictors of EMS use and multiple EMS transports using clinical status variables associated with mortality and hospitalization among adults with HF in past studies. The study was designed to be hypothesis generating for future studies.

Methods

Design and data source

This observational study was approved by the university institutional review board. The data were obtained from the electronic health records of a single, large urban Midwestern county (Marion County, Indiana, 2017 population 950,082)[25] EMS program. In 2017, this EMS agency employed 230 full-time emergency medical technicians (EMTs) and paramedics. During peak on-duty times, there are 31 advanced life support-equipped ambulances in service to cover 261 square miles. In 2017, the EMTs and paramedics responded to 112,180 calls and delivered patients to 26 hospitals, four of which had level 1 trauma centers. Medical direction is provided by faculty physicians at Indiana University School of Medicine.

The EMS electronic health record had over 775,000 visits to people needing transport from July 1, 2009 to June 30, 2017. The data in the record are collected by the EMS personnel using the electronic health record system based upon the National EMS Information System (NEMSIS) standard. The electronic health record has structured categorizations that are completed by EMS personnel. EMS personnel receive four hours of training prior to beginning employment. The database is maintained by continuous analysis of system metrics. The EMS medical directors designed the protocols for treatments.

Sample

The inclusion criteria were: (1) diagnosis of HF in the EMS electronic health record; (2) age 21 years and older; (3) EMS activated by adult needing transport, family member, or bystander; and (4) transported by EMS to one of the three acute-care hospitals in the city between July 1, 2009 and June 30, 2017. Records of all adults who met the inclusion criteria were included in the study. There were no exclusion criteria because the purpose of the study was to characterize all EMS transports of patients with HF.

Procedures

All transports of patients who met the inclusion criteria were identified by the EMS Chief of Information Technology and Informatics (co-author TPA) using the EMS electronic health records. As the intent was a 'real-world' analysis, input from EMS providers was taken at face value, similar to input from physicians, nurses, and other clinicians into the hospital electronic health records. No study specific abstraction was performed to compare accuracy. The data retrieved from the electronic health records were downloaded by the EMS Chief into a Microsoft Excel® data file. The data manager from the university biostatistics division (co-author RC) converted the Excel® file to statistical databases. The EMS Chief and data manager verified the statistical databases for completeness and accuracy prior to analysis by cross-checking Excel® and SPSS data in the files. Missing data were coded as missing and not included in analyses. The statistical databases were deidentified prior to analysis.

Measures

Demographic and clinical status variables were originally obtained from the adults or family members by EMS paramedics and EMTs during transport using structured categorizations: weight; chief complaint; number of medications currently taking; presence or absence of atrial fibrillation, cardiac pacemaker, implantable cardiac defibrillator; and history of hypertension, coronary artery disease, coronary artery bypass graft, HF, myocardial infarction, and sudden cardiac arrest. In addition, clinical status variables obtained by the paramedics and EMTs included the following: symptoms of shortness of breath, chest pain, and other pain; vital signs of systolic and diastolic blood pressure, heart rate, heart rhythm, respiratory rate, and temperature; oxygen saturation; end-tidal carbon dioxide; and Glasgow Coma Scale.[26] The Glasgow Coma Score was developed to assess changes in level of consciousness.[26] Possible scores range from 3 to 15, with lower scores indicating lower levels of consciousness. Scores of 13–15 suggest mild brain injury, 9–12 suggest moderate brain injury, and 3–8 suggest severe brain injury. Validity and reliability have been documented and the overall score is correlated with mortality.

Treatments and medications administered were delivered and documented by paramedics and EMTs. Types of treatments administered were: airway maintenance; bleeding and burn care; cardiopulmonary resuscitation; immobilization; medication management (type, dosage, and route); oxygen therapy; and safety management.

Number of transports was obtained from the EMS database. The EMS and study data managers identified the number of transports for each patient in the database using the variables first name, last name, age, and gender. The number of transports for each patient was added as a variable in the statistical database before deidentifying it. The first transport was considered the index transport for adults with multiple transports.

The six pre-specified independent predictor variables assessed at the index EMS transport were: (1) blood pressure; (2) heart rate; (3) oxygen saturation; (4) decreased level of consciousness; (5) shortness of breath; and (6) chest pain. These variables predicted mortality and hospitalization among patients with HF in past studies.[15–24]

Statistical analysis

All variable scores were examined for statistical outliers. Descriptive statistics were computed for demographic and study variables. To accomplish aim one, descriptive statistics were computed to characterize the clinical status, chief complaints which included clinical status variables such as respiratory problems and symptoms such as chest pain, and treatments and medications administered for all adults at the index transport and for all transports. To accomplish aim two and evaluate predictors of multiple EMS transports, univariate analyses (*t*-test and Chi-squared) were conducted to examine differences between adults with one transport and with multiple transports. Significant variables were entered into the logistic regression analyses as independent variables to evaluate predictors of multiple transports (i.e., one versus more than one).[27,28] Models were adjusted for age, gender, race, and receiving hospital. The odds ratios, significance levels, and the confidence intervals were examined for the six individual predictor variables. Negative binomial regression was used to identify predictors of multiple transports following the full distribution of the number of transports corrected for exact overdispersion. Negative binomial regression was used in the analysis of the number of transports to account for overdispersion of these data. Results from negative binomial regression are presented as incident rate ratios and interpreted as the relative percent (%) increase in number of transports. Data were analyzed using SAS® and Stata®. The significance level was $P < .05$.

Results

The sample was 6582 adults with reported HF who had at least one EMS transport from July 1, 2009 through June 30, 2017. Descriptive and clinical characteristics are presented in Table 1. A majority of adults (mean age 63.7 years) were women (57.6%) and reported race as Black (57.7%). At the index transport, nearly two-thirds (65%) of the adults had chest pain and nearly half (44.1%) had shortness of breath (Table 1). Mean Glasgow Coma Scale score was 14.5, mean systolic and diastolic blood pressures were 146.6 mmHg and 82.6 mmHg, respectively, and mean heart rate was 91.3 beats per minute. Mean respiratory rate was 20.1 breaths per minute and mean oxygen saturation was 94.7%.

The 6582 adults had a total of 16,905 transports. There was a range between 1 and 80 transports per person. The median number of transports was 2 (inter-quartile range = 1–6; mean = 2.6 ± 4.4 transports). A majority of adults (60.6%) had one transport and the other adults had two (15.9%), three (7.2%), four (4.2%), and five or more (12.1%) transports.

In terms of prehospital clinical status, adults had 28 different chief complaints ranging from possibly mild complaints (e.g., headache) to cardiac arrest. The three most frequent chief complaints at the index transport were respiratory problems (28.8%), feeling sick (20.8%), and chest pain (15.2%). All other chief complaints at index transport were reported by fewer than 10% of the adults. Although less frequent, there were numerous chief complaints for pain other than chest pain (headache, abdominal, generalized), injuries (trauma/injury, burns, poisoning/overdose), diabetic emergency, stroke, cardiac arrest, and seizures. The most frequent chief complaints across all transports were respiratory problems (26.6%), feeling sick (23%), and chest pain (17%) (Fig. 1). The frequency was similar for chief complaints at index transport and subsequent transports, with respiratory problems, feeling sick, and chest pain accounting for approximately 80% of transports up to adults' tenth transport (Fig. 1).

Table 1
Descriptive statistics for demographic and clinical status variables for adults at index transport ($N = 6582$)[a].

Variable	*n* (%) or Mean ± SD
Gender, ($N = 6580$)	
Women	3792 (57.6%)
Men	2788 (42.4%)
Age in years	63.7 + 14.5
Race, ($N = 6506$)	
Alaskan Native or American Indian	3 (0.0%)
Asian	6 (0.1%)
Black	3755 (57.7%)
Pacific Islander	1 (0.0%)
White	2695 (41.4%)
Other	46 (0.7%)
Ethnicity, ($N = 6435$)	
Hispanic/Latino	60 (0.9%)
Not Hispanic/Latino	6375 (99.1%)
Weight in kg ($N = 4918$)	95.6 ± 33.7
Number medications taking	6.4 ± 5.3
Atrial fibrillation and/or atrial flutter	687 (10.4%)
Cardiac pacemaker	446 (6.8%)
Implantable cardioverter defibrillator	261 (4.0%)
Comorbid conditions	
Hypertension	4967 (75.5%)
Coronary artery disease	750 (11.4%)
Coronary artery bypass graft	327 (5.0%)
Myocardial infarction	1161 (17.6%)
Sudden cardiac arrest	52 (0.8%)
Shortness of breath, ($N = 5901$)	2602 (44.1%)
Chest pain, ($N = 5901$)	3837 (65.0%)
Other pain, ($N = 5901$)	136 (2.3%)
Glasgow Coma Scale score ($N = 6035$)	14.5 ± 2.0
End-title carbon dioxide, mm/Hg ($N = 60$)	34.6 ± 22.5
Blood pressure, systolic, mm/Hg ($N = 6513$)	146.6 ± 40.1
Blood pressure, diastolic, mm/Hg ($N = 5512$)	82.6 ± 22.6
Heart rate ($N = 6486$)	91.3 ± 25.3
Respiratory rate ($N = 6472$)	20.1 ± 6.9
SpO2 level,% ($N = 5438$)	94.7 ± 8.4
Temperature, degrees Fahrenheit ($N = 253$)	98.3 ± 1.7
Number of EMS transports per patient	
1	3986 (60.6%)
2	1049 (15.9%)
3	475 (7.2%)
4	277 (4.2%)
5 – 80	795 (12.1%)

Abbreviations: EMS, Emergency Medical Services; SD, standard deviation.
[a] Actual sample size is indicated when number of total patients does not sum to 6582 due to missing data.

Descriptive statistics are presented for treatments and medications administered during the index transport and all transports in Tables 2 and 3. During the index transports, 23 different types of treatments were administered and a total of 12,885 treatments were administered. The most frequent treatments were establishing intravenous/intraosseous access (26.8%) and administering oxygen therapy (23.7%), medication (23.1%), and intravenous fluid (14.8%). During all transports, a total of 38,079 treatments were administered. The most frequent treatments were administering medications (37.1%), establishing intravenous/intraosseous access (23.2%), administering oxygen therapy (20.8%), and delivering intravenous fluid (11.4%). During the index transports, 29 different medications were administered and the most frequent medications were nitroglycerin (25.4%), albuterol (23.6%), aspirin (14.1%), ipratropium bromide (15.7%), ondansetron (5.5%), and fentanyl (5.2%). Medications were delivered by multiple routes, including oral, sublingual, nasal, endotracheal tube, inhalation, intravenous, and intraosseous. During all transports, the most frequent medications were nitroglycerin (26.9%), albuterol (23.0%), aspirin (16.5%), ipratropium bromide (15.9%), ondansetron (5.8%), and fentanyl (4.8%) and these medications were delivered by the same routes as at the index transports.

Predictors of multiple transports are shown in Table 4. Among the *a priori* selected predictors, chief complaints of shortness of breath

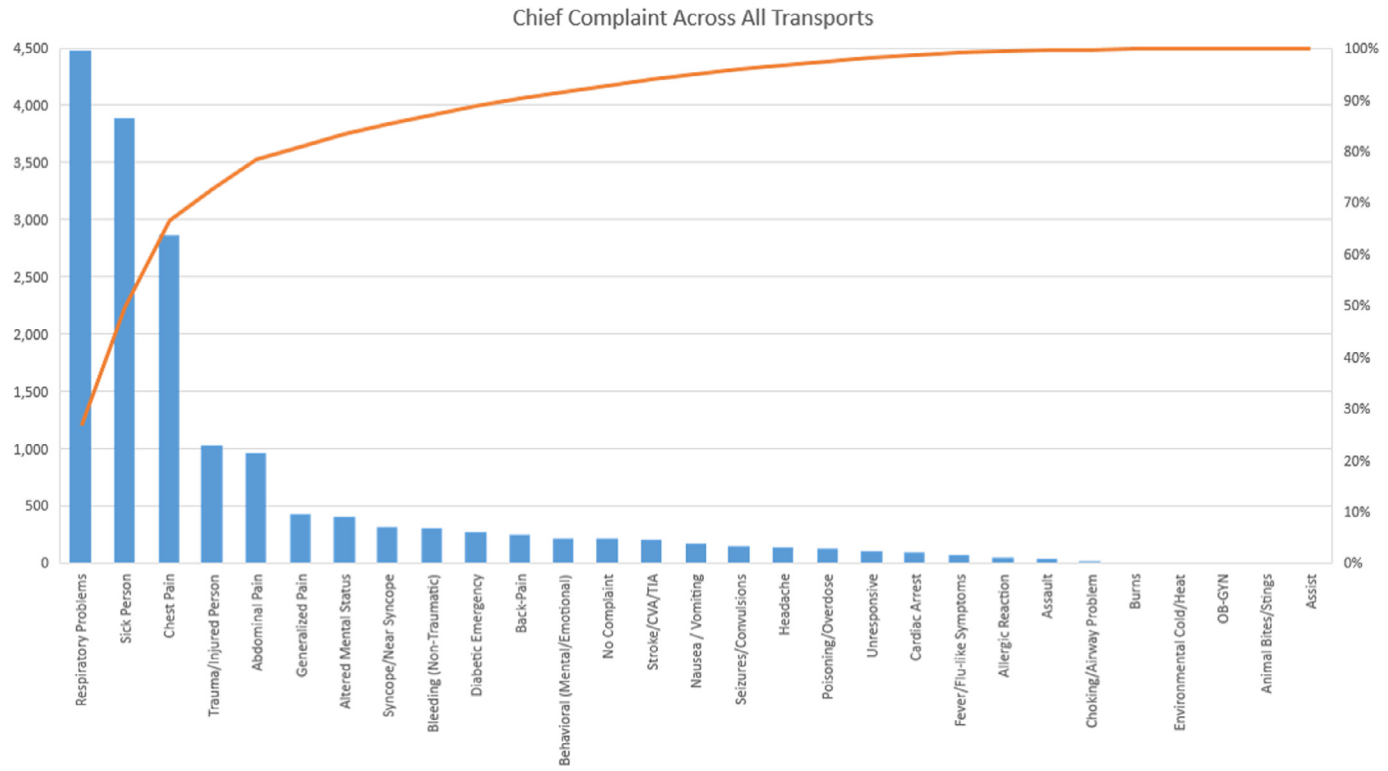

Fig. 1. Chief complaint across all transports.

and chest pain and lower level of consciousness (i.e., lower Glasgow Coma Scale scores) were significantly associated with greater odds of having multiple transports. Significant covariates associated with greater odds of having multiple EMS transports were age, gender, race, and hospital site. Adults of younger age, female gender, and Black race were more likely to have multiple transports.

Predictors of greater number of EMS transports are presented in Table 4. Index chief complaints of shortness of breath, chest pain, and higher oxygen saturation were associated with having significantly more transports. For example, adults who had shortness of breath during the index transport had 13.1% more transports compared with adults who were otherwise similar. Significant covariates associated with more EMS transports were age, gender, and hospital site.

Discussion

Results of this study are important because the prehospital clinical status, chief complaints, and treatments and medications administered were characterized for a large sample of community-dwelling adults with reported HF transported from home to hospital by EMS over 8 years and predictors of multiple transports were evaluated. The chief complaint of respiratory problems was the most frequent complaint at the index transport and across all transports, documented for more than one-fourth (26.6%) of all transports. The next most frequent chief complaints were feeling sick (23%) and chest pain (17%). Unexpectedly, chest pain was the most frequently reported clinical status variable at the index transport and was documented for nearly two-thirds (65%) of the adults. Shortness of breath was the second most frequently reported clinical status variable at the index EMS transport, documented for 44.1% of the adults. The finding was expected that respiratory problems would be the most frequent chief complaint because dyspnea is a hallmark symptom of HF decompensation. Collectively, these findings provide new insight into the reasons why community-dwelling adults with reported HF are transported by EMS. There is a need to improve our understanding of these presenting chief complaints to develop and test prehospital interventions.

Table 2
Treatments administered at index transport and at all transports.

Treatment	Index transport (*N* %)	All transports (*N* %)
Intravenous/intraosseous access	3448 (26.8%)	8830 (23.2%)
Intravenous fluid	1905 (14.8%)	4337 (11.4%)
Medical control	724 (5.6%)	1389 (3.6%)
Medication given	2970 (23.1%)	14,122 (37.1%)
Oxygen therapy	3051 (23.7%)	7939 (20.8%)
Ventilation	161 (1.2%)	299 (0.8%)
Equal to or less than 1% at index and total transports[a]	626 (4.9%)	1163 (3.1%)
Total treatments	12,885	38,079

[a] Basic life support airway care, Bleeding or burn care, Chest decompression, Clear airway, Electrical therapy, Extrication, Extubation, Intubation, Patient positioning, Restraints, Spinal immobilization, Splint, Start cardiopulmonary resuscitation, Stop cardiopulmonary resuscitation, Suctioning, Surgical cricothyrotomy, Vagal maneuver.

Table 3
Medications administered at index transport and at all transports.

Medication	Index transport (*N* %)	All transports (*N* %)
Albuterol	1254 (23.6)	3237 (23.0)
Aspirin	747 (14.1)	2321 (16.5)
Atropine	59 (1.1)	81 (0.6)
Epinephrine 1:10,000	120 (2.3)	126 (0.9)
Fentanyl	274 (5.2)	673 (4.8)
Ipratropium bromide	833 (15.7)	2236 (15.9)
Nitroglycerin	1350 (25.4)	3787 (26.9)
Ondansetron	290 (5.5)	814 (5.8)
Equal to or less than 1% at index and total transports[a]	380 (7.2)	796 (5.7)
Total medications administered	5307	14,071

[a] Acetaminophen, Adenosine, Amiodarone, Calcium chloride, Dextrose 10%, Dextrose 50%, Diphenhydramine, Dopamine, Epinephrine 1:1000, Glucagon, Ketorolac, Lidocaine, Magnesium sulfate, Methylprednisolone, Metoclopramide, Midazolam, Morphine, Naloxone, Oral glucose, Prednisone, Sodium bicarbonate.

Table 4
Predictive models of more than one transport and multiple transports.

	Odds of More than One Transport			Multiple Transports (in Percentage)		
	OR	95% CI	*p*-value	IRR	95%CI	*p*-value
Age (in years)	0.992	(0.988–0.997)	0.003	0.988	(0.985–0.990)	<0.001
Male Gender	0.836	(0.729–0.959)	0.011	0.929	(0.868–0.994)	0.032
Race*						
Alaskan Native/Native American	2.048	(0.127–32.944)	0.613	0.808	(0.166–3.941)	0.792
Asian	–	–	–	1.108	(0.252–4.863	0.892
Black	1.284	(1.119–1.473)	<0.001	1.070	(0.999–1.145)	0.050
Other	0.355	(0.111–1.134)	0.081	0.772	(0.459–1.297)	0.328
Not Hispanic/Latino	0.547	(0.211–1.413)	0.213	0.967	(0.620–1.507)	0.881
Receiving Facility†						
Hospital 1	1.269	(1.055–1.527)	0.012	1.311	(1.194–1.440)	<0.001
Hospital 2	1.489	(1.215–1.825)	<0.001	1.449	(1.308–1.606)	<0.001
Systolic Blood Pressure (mm/Hg)	1.001	(0.998–1.003)	0.599	1.000	(0.999–1.002)	0.702
Diastolic Blood Pressure (mm/Hg)	0.999	(0.995–1.004)	0.765	1.000	(0.998–1.002)	0.954
Heart rate (bpm)	0.999	(0.998–1.003)	0.831	0.999	(0.998–1.001)	0.278
$Sp0_2$ (%)	1.009	(0.999–1.018)	0.079	1.008	(1.003–1.013)	0.002
Glasgow Coma Scale	1.067	(1.018–1.119)	0.007	1.019	(0.997–1.042)	0.098
Shortness of Breath (index transport)	1.177	(1.022–1.357)	0.024	1.131	(1.056–1.213)	0.001
Chest Pain (index transport)	1.160	(1.001–1.344)	0.048	1.150	(1.069–1.238)	<0.001

OR, odds ratio; CI, confidence interval; IRR, incidence rate ratio.
* relative to White race.
† relative to Hospital 3.

It is noteworthy that chest pain was the most frequently reported clinical status variable and the third most frequent chief complaint. As such, the presenting chief complaints of these adults might confound assessment and initial approach to emergency care. In past studies of treatment seeking delay among adults with HF, chest pain was not often mentioned as a frequent symptom associated with delay and EMS transport.[4,29–32] Harjola reported that only 9% of the patients who used EMS had chest pain.[21] Sporer reported that nitroglycerin was administered to 93% of 319 patients with HF transported by EMS, but it was unclear if the medication was administered for actual chest pain or prophylaxis.[32] In the current study, nitroglycerin was the most frequently administered medication at 25.3% during the index transports. Ekman and colleagues reported that self-reported angina was significantly associated with all-cause hospitalization and mortality among 3029 patients with HF.[24] The etiology of chest pain in HF may be the result of acute coronary syndrome or high filling pressures of the left ventricle and demand ischemia. Therefore, the increased mortality might be expected in these conditions. Investigators examining health outcomes among adults with HF need to conduct more comprehensive and frequent assessments of chest pain and recognize its important prognostic implications and need for therapy. Clinicians caring for patients with HF need to educate patients and family members about efficacious ways to assess and manage chest pain on a routine and ongoing basis, including when to seek urgent and emergency treatment.

In this study, the adults had 28 different chief complaints, reflecting the complexity of the HF syndrome. These disparate complaints represent a diagnostic challenge for determining adults' primary problem and identifying therapeutic targets for interventions. The finding of multiple chief complaints of pain in different locations (chest, headache, abdominal, back) is consistent with research conducted by Goodlin and colleagues[33] who investigated pain among 347 outpatients with advanced HF from clinics and hospices. The prevalence of pain was 84.4% at any body site and interfered with activity for 70% of these patients. Pain was reported as severe or very severe for 28.6% of patients with chest pain and for 38.9% of patients with pain at other sites and only opioid medications were reported as providing relief. Degenerative joint disease, other types of arthritis, shortness of breath, and angina pectoris were the strongest predictors of pain. In a literature review conducted to evaluate the prevalence of pain in 65 studies among patients with HF, the prevalence of pain ranged from 23 to 85%.[34]

Injuries were another group of chief complaints in this study that triggered EMS activation. Injuries have received limited attention among adults with HF. For example, adults with HF are at increased risk of falls[35,36] and associated fractures. Cerebellar damage has been reported among adults with HF, which may be an etiology for falls.[37] Research is needed to design and test safety interventions such as fall prevention programs to prevent injury among adults with HF.

At the index and across all EMS transports, 23 different treatments and 29 different medications were administered. The most frequent treatments were establishing medication access routes, providing oxygen therapy, and administering medications and intravenous fluids. The most frequently administered medications were for chest pain and shortness of breath. The most frequently administered medication was nitroglycerin at index transport. These findings support the need for future studies that more comprehensively assess and manage pain among adults with HF in the community.

Index chief complaints of shortness of breath and chest pain and poorer level of consciousness were predictors of multiple transports. Index chief complaints of shortness of breath and chest pain and higher oxygen saturation were predictors of number of transports. Younger age, female gender, Black race, and hospital to which adults were taken were significant covariates. Continued focus on management of shortness of breath and chest pain has potential to reduce EMS transports.

Strengths of this novel study were use of data obtained at the point-of-care from a large, diverse population of community-dwelling adults with a report of HF who used EMS services across 8 years. In contrast to many studies among HF populations, this population was comprised of more women than men and more Black patients than White patients. The findings provide new knowledge about the prehospital status of these adults who activated EMS that can be used to design and test multi-level interventions to improve care and outcomes among adults with HF.

Limitations of this study were lack of echocardiographic validation of the HF diagnosis and lack of data about non-cardiac comorbid conditions. The lack of HF diagnosis validation is a common limitation in prehospital studies for medical conditions such as HF that do not have easily obtainable and reliable diagnostic tests for use in the emergency field setting. The lack of data about non-cardiac comorbid conditions prevented analysis of these conditions as predictors of outcomes. A future study is needed to validate the reported HF diagnosis using emergency department or cardiologist diagnoses and echocardiograms and to evaluate non-cardiac comorbid conditions as

predictor variables. Another limitation was that was that adults may have had more transports than analyzed in this study but data were not obtained prior to 2009 and only three hospitals were included in the analyses. Although using real-time data collected by multiple clinicians limited availability of data to validate diagnoses, the large amount of data obtained at the point of care offered a unique opportunity to investigate the actual prehospital status of adults and the treatments and medications received. These data are hypothesis-generating and can be used to guide design of prospective studies for validation of findings and testing multi-level interventions.

In conclusion, chest pain and respiratory problems were the most frequent complaints among a large population of adults with reported HF. Shortness of breath, chest pain, lower level of consciousness, younger age, female gender, Black race, and hospital site predicted multiple transports across the 8 years of the study. Studies are needed to determine the relationships between prehospital symptoms and treatments and short- and long-term outcomes after transport. Assessments and interventions are needed to improve management of chest pain among adults with HF. It needs to be determined if the low flow state of decompensated HF triggers myocardial ischemia among these adults. Interventions to relieve chest pain may be particularly needed among younger adults, women, adults of Black race, and adults with lower level of consciousness during transport. Clinicians can use these findings to improve assessment of adults and implement interventions to improve symptom management, cardiovascular status, and health outcomes.

Disclosures

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