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Pain and heart failure during transport by emergency medical services and its associated outcomes: Hospitalization, mortality, and length of stay

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Abstract

Background: Over 22% of patients with heart failure (HF) are transported by emergency medical services (EMS) for a primary complaint of pain. The relationship between a primary complaint of pain on hospitalization status, mortality, or length of stay following transport by EMS is understudied.

Objectives: To determine if a primary complaint of pain during EMS transport predicted hospitalization status, mortality, or inpatient length of stay.

Methods: In this retrospective longitudinal cohort study, data were analyzed from electronic health records of 3,539 patients with HF. Descriptive statistics and multivariate logistic and linear regression analyses were used to achieve study objectives.

Results: Demographics were mean age 64.83 years (SD = 14.58); gender 57.3% women, 42.7% men; self-reported race 56.2% Black, 43.2% White, 0.7% Other. Of 3,539 patients, 2,346 (66.3%) were hospitalized, 149 (4.2%) died, and the mean length of stay was 6.02 (SD = 7.55) days. A primary complaint of pain did not predict increased odds of in-hospital mortality but did predict 39% lower odds of hospitalization ($p < .001$), and 26.7% shorter length of stay ($p < .001$). Chest pain predicted 49% lower odds of hospitalization ($p < .001$), and 34.1% ($p < .001$) shorter length of stay, while generalized pain predicted 45% lower odds of hospitalization ($p = .044$) following post-hoc analysis.

Conclusions: A primary complaint of chest pain predicted lower odds of hospitalization and shorter length of stay, possibly due to established treatment regimens. Additional research is needed to examine chronic pain rather than a primary complaint of pain.

Introduction

Approximately 6 million patients have heart failure (HF) in the United States, and almost 1 million are hospitalized yearly.[1–3] Patients with HF often experience multiple disabling symptoms such as dyspnea, activity intolerance, cognitive dysfunction, depression, and

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sleep-disordered breathing.[2,4,5] Pain is among the most common symptoms experienced by patients with HF. A systematic review conducted in 2017, alongside studies published afterwards, have reported that pain prevalence in HF ranges from 23–85%.[6,7] A study by Conley and colleagues of 173 patients found that pain was more frequently reported (57%) than fatigue (54.3%) and depression (45.7%).[8] In another study conducted by Haedtke and colleagues of 347 patients, pain was more common than over 20 other symptoms including shortness of breath, low energy, drowsiness, and sleep disturbances.[7] In addition to high prevalence rates, locations of pain can vary considerably. For example, chest pain is one common location and has been reported by 13–46.8% of outpatients with chronic HF.[9–11] In other studies, pain in locations other than chest (e.g., back, extremities) were more frequently reported.[9,12,13] Back, extremity, and joint pain were reported by 55.3–71.3% of 96 patients with HF who were recruited from outpatient clinics compared to 35.1% who reported chest pain.[13] Severity of pain can vary by location. In a separate study of patients with HF receiving care in cardiology clinics, non-chest pain was rated as “severe” or “very severe” more often (38.9%) compared to chest pain (28.6%).[12]

Pain etiologies are complex and likely heterogenous among patients with HF, which may explain the noted variability in pain locations and severity.[6] Given the complexity of pain, the current study was informed by the National Institutes of Health Symptom Science Model,[14,15] which was developed to construct a deeper understanding of complex symptoms. For example, chest pain may not be ischemic in nature and may instead arise from other cardiac conditions including myocarditis, or from non-cardiac causes including pulmonary embolism, respiratory infection, and aortic disorders.[16] The multiple locations of pain reported in previous studies suggest that patients with HF experience several subtypes of pain including nociceptive pain (e.g., ischemic chest pain), neuropathic pain (e.g., diabetic neuropathy) and mixed pain.[17] Unfortunately, locations of pain are frequently the only data available from health systems and other point-of -care settings. Use of this data remains a valuable method of linking pre-hospital pain data with hospital outcomes, such as mortality and length of stay, despite the challenges of operationalization and missing data.[18]

Although pain in community and outpatient samples is well documented, pain in pre-hospital settings remains understudied. In our previously conducted study among 4,663 patients with HF, 1,034 (22%) activated EMS with a primary complaint of pain, including chest (68.1%), abdominal (17.7%), generalized (9.2%), and back (5%).[19] Pre-hospital pain can manifest during complications frequently reported during transport, such as acute coronary syndrome, which predicts short-term and long-term mortality and hospital readmission.[20–22] Among 25,323 patients with acute coronary syndrome, including MI and unstable angina, 14.5% of patients with comorbid HF died in the hospital compared to 3% of patients without HF, and patients with both conditions had significantly longer length of stay.[22] Other factors that influence frequent hospitalization and higher in-hospital mortality rates include more severe HF,[23] more comorbidity,[22] older age,[24] female gender,[24] Black race,[25–27] symptom burden,[28,29] and shortness of breath at presentation to the emergency department (ED).[30] However, few published studies have reported hospital outcomes among patients who presented with non-chest pain.

Given that comorbid symptom burden in HF increases hospitalization and mortality rates,[28,29] a primary complaint of pain – which indicates severe or urgent pain – may play an important role, but this relationship is understudied. Pain in HF has been associated with a higher rate of 30-day ED use compared to patients with other primary complaints, but locations of pain were not collected,[31] nor has pre-hospital pain been previously connected with length of stay or mortality, which leaves gaps in the current literature. Previous investigators have reported that patients with HF and ongoing cardiac ischemic pain are at a higher risk of hospitalization,[11] but other locations of pain were poorly characterized.[7] It is crucial to address pain among hospitalized patients with HF to reduce suffering and improve quality of life.[32] Improving length of stay and mortality are of increased interest because of the high cost of HF care, the majority of which stems from hospitalizations.[33]

In the current study, point-of-care data were obtained from patients during transport by EMS with either a pain or non-pain primary complaint. These EMS data were combined with hospital outcomes data following their arrival at the ED. The three aims of this study were to evaluate if a primary complaint of pain predicted 1) increased hospitalization; 2) increased in-hospital all-cause mortality; and 3) longer length of stay compared with a non-pain primary complaint. The hypotheses were that a primary complaint of pain would predict increased 1) hospitalization, 2) in-hospital all-cause mortality, and 3) longer length of stay compared with a non-pain primary complaint. An exploratory aim was to evaluate if a location of pain (i.e., abdominal, back, chest, generalized) was associated with increased hospitalization, hospital all-cause mortality, and longer length of stay.

Methods

Design and data sources

This study was a retrospective longitudinal cohort design. The data were initially collected as part of a parent study in which predictors of EMS use and multiple EMS transports were analyzed among 6,582 patients with HF transported to the ED by EMS from June 2009 to June 2017.[34] Both the parent study and current study were approved by the Indiana University Human Research Protection Program (approval no. for the current study 12247). Full details are provided in the parent study about the eligibility and data collection procedures for this dataset.[34] Briefly, data were identified and retrieved from EMS medical records from patients within a large urban Midwestern county who met eligibility criteria by the EMS Chief of Information Technology and Informatics.[34] The medical record from EMS met standards from the National EMS Information System.[34] The inclusion criteria for the parent study were a self-report diagnosis of HF in the EMS record, age 21 years or older, activated EMS, and was transported by EMS to the hospital. There were no exclusion criteria in the parent study.[34]

In this current study, data were matched from each patient in this previous EMS dataset (pre-hospital) with their corresponding hospital electronic medical record data from the Indiana Network for Patient Care (INPC) research database.[35] Matching of the EMS and INPC datasets were completed by a data manager at Regenstrief Institute. Regenstrief Institute is an internationally renowned organization specializing in electronic medical records and health care data integration. Patients were matched using last name, first

name, middle initial, date of birth, and gender using each patient's unique encounter ID number. The merged databases were verified for completeness and accuracy, and all data were deidentified at Regenstrief Institute before analysis. Additional exclusion criteria for the current study were applied following merging of the EMS and INPC databases. The exclusion criterion was patients with incomplete data about outcomes required for the regression analyses. A total of 3,539 patients were retained in the final dataset. A schematic of the entire data selection and merging procedure is presented in Figure 1.

Measures

Variables included in this study from the EMS dataset were self-reported by patients or family members and recorded by EMS personnel in pre-designated fields within the EMS medical record. Variables included in this study from the INPC database were obtained from hospital electronic medical records. A complete depiction is provided in Figure 1 of the two data sources used (EMS vs. INPC) for each variable that was analyzed in the current study.

The independent variable for all hypotheses was whether patients presented with a pain or non-pain primary complaint. Patients with a primary complaint of pain were further separated into four possible locations (abdominal pain, back pain, chest pain, or generalized pain) which was used for the exploratory aim. Patients with a non-pain primary complaint served as the reference category for the independent variable in all analyses. All primary complaints were obtained from the EMS medical record documented during transport. Patients could only have one primary complaint recorded.

The dependent variable for hypothesis 1 was hospitalization status following arrival at the ED by EMS as retrieved from the INPC database. Patients admitted to inpatient units in the hospital were categorized as hospitalized. Patients not admitted to an inpatient unit but instead received care in the ED or on an observation unit were categorized as not hospitalized. The dependent variable for hypothesis 2 was all-cause mortality among patients transported by EMS and admitted to an ED, observation, or inpatient unit (alive, died in hospital) which was retrieved from the INPC database as part of discharge information. The dependent variable for hypothesis 3 was inpatient length of stay in days which was calculated among patients who were hospitalized on an inpatient unit and did not die in the hospital (n = 2,220). Only the patients who were hospitalized on an inpatient unit were analyzed because ED and observation stays were on average less than 24 hours in duration.

Statistical analyses

Demographic and clinical characteristics of the sample were summarized using descriptive statistics. The number and percentage of hospitalizations and deaths in the hospital were plotted across all primary complaints to describe the sample. Univariate analyses were conducted to assess for significant differences in sociodemographic and clinical variables between patients with and without a primary complaint of pain. Additional univariate analyses were conducted to compare demographic and clinical variables by hospitalization and mortality. All analyses were conducted using Stata 17 with a significance level of alpha < 0.05.

For hypothesis 1, multiple logistic regression was conducted to evaluate a primary complaint of pain during EMS transport as a predictor of hospitalization.[36] For hypothesis 2, multiple logistic regression was conducted to evaluate a primary complaint of pain as a predictor of in-hospital mortality. For hypothesis 3, multiple linear regression was used to evaluate a primary complaint of pain as a predictor of hospital length of stay. Correlations among each of the covariates were evaluated prior to linear regression. The length of stay data were log transformed before regression analysis because they were not normally distributed. The data were approximately normal after being log transformed. Coefficients from the linear regression of the log-transformed length of stay data were converted to a percentage change (i.e., percentage increase or decrease in days) for interpretation.[37] Heteroscedasticity of the dependent variable and multicollinearity/tolerance of the independent variables and covariates were assessed following completion of the multiple linear regression.[36,38] If pain was associated with hospitalization, mortality, or length of stay at a threshold p-value of < .100, pain was expanded to stratify by locations for the exploratory aim. The models used for the exploratory aim retained all other covariates from the models used for the primary aims. Variables were entered simultaneously in all regression analyses.

Covariates were demographic and clinical variables and were included in the final models if a previous study had provided evidence supporting a relationship with pain and/or hospital outcomes among patients with HF and they were available in the dataset.[7,9,12,39–42] Demographic variables included as covariates were age, self-reported gender, self-reported race, and self-reported ethnicity. Patients whose race was not Black or White (n = 24) were collapsed into one category “other” during analysis because of sample size limitations. This “other” category already existed under the race variable in the dataset (n=17). Additional races that were collapsed into this category were Alaska Native/American Indian (n=1), Asian (n=5), and Pacific Islander (n=1). Clinical variables included as covariates were shortness of breath at admission, number of medications, number of comorbid conditions (consisting of arthritis, coronary artery disease, chronic obstructive pulmonary disease [COPD], diabetes, hyperlipidemia, essential hypertension, myocardial infarction, stroke), cardiac devices (consisting of pacemaker, implantable cardioverter defibrillator), peak B-type natriuretic peptide (BNP; normal range 0–100 pg/mL), and peak troponin I (normal range 0.0–0.4 ng/mL). All comorbid conditions were obtained using ICD-9 and 10 codes in the INPC database.

Results

Demographics are presented in Table 1 for the entire sample (N = 3,539). The mean age of the sample was 64.83 (SD 14.58) years (range 20.61–103.44). The sample was 57.3% women and 42.7% men. Self-reported race of the sample was 56.2% Black, 43.2% White, and 0.7% Other. The mean peak troponin I (n = 2,596) was 1.82 (SD 37.95) ng/mL, and the mean peak BNP (n = 1,709) was 820.10 (SD 1,134.65) pg/mL.

Of the 3,539 patients transported by EMS, 801 (22.6%) presented with a primary complaint of pain and 2,738 (77.4%) presented with a primary complaint that was not pain. The most common primary pain complaint was chest pain (n = 548, 68.4%), followed by abdominal pain (n = 144, 18%), generalized pain (n = 64, 8%), and back pain (n = 45, 5.6%). Patients

without a primary complaint of pain were older, less frequently self-reported Hispanic/Latino ethnicity, and more frequently presented with shortness of breath, a higher number of comorbid conditions, COPD, diabetes, and stroke. In contrast, patients with a primary complaint of pain more frequently presented with a pacemaker or implantable cardioverter defibrillator.

Hospitalization

Of the 3,539 patients with HF transported by EMS, 2,346 (66.3%) were hospitalized and 1,193 (33.7%) were not hospitalized. The percentage of hospitalizations are reported by each primary complaint in Figure 2. The primary complaint with the highest percentage of hospitalizations (total n > 10) was altered mental status (n = 106/122, 86.9%). The primary pain complaint with the highest percentage of hospitalizations was abdominal pain (n = 91/144, 63.2%). The results for hypothesis 1 are reported in Table 2 examining the effect of transport by EMS with a primary complaint of pain. The hypothesis was not supported for aim 1. In logistic regression analyses, odds of hospitalization were significantly decreased among patients with a primary complaint of pain, which was the opposite of our hypothesized relationship (OR = 0.61, 95% CI = 0.50–0.74). Odds of hospitalization increased for every one-year increase in age (OR = 1.02, 95% CI = 1.01–1.03), increased among patients who presented with shortness of breath on admission (OR = 2.12, 95% CI = 1.79–2.52), and among patients who presented with a higher number of comorbid conditions (OR = 2.39, 95% CI = 2.22–2.58). Conversely, odds of hospitalization decreased among women compared to men (OR = 0.76, 95% CI = 0.64–0.91). Based on a post-hoc regression model using the four pain locations, odds of hospitalization decreased among patients who presented with chest pain (OR = 0.51, 95% CI = 0.40–0.64), and patients who presented with generalized pain (OR = 0.55, 95% CI = 0.31–0.98).

In-hospital mortality

A total of 149 (4.2%) out of 3,539 patients died in the hospital (either in the ED, observation, or inpatient units) following transport by EMS. The mortality percentages are reported by each primary complaint in Figure 3. The primary complaint with the highest percentage of patients that died (total n > 10) was cardiac arrest (n = 27/40, 67.5%). The primary pain complaint with the highest percentage of patients who died was abdominal pain (n = 8/144, 5.6%). The results for hypothesis 2 are reported in Table 3 examining the effect of transport by EMS with a primary complaint of pain on in-hospital mortality. The hypothesis was not supported for aim 2. In logistic regression analyses, odds of in-hospital mortality were not statistically significant among patients with a primary complaint of pain (OR = 0.69, 95% CI = 0.43–1.11). Odds of in-hospital mortality increased for every one-year increase in age (OR = 1.04, 95% CI = 1.03–1.05). In addition, odds of in-hospital mortality decreased among women compared to men (OR = 0.52, 95% CI = 0.37–0.73).

Length of stay

Of the subsample of 2,220 patients with HF who were admitted to an inpatient unit and did not die in the hospital, the mean length of stay was 6.02 (SD 7.55) days. The median length of stay was 4.08 days with an interquartile range of 2.31–7.14 days. The results for hypothesis 3 are reported in Table 4 examining the effect of transport by EMS with

a primary complaint pain on inpatient length of stay. The overall regression model was statistically significant ($R^2 = 0.0459$, adjusted $R^2 = 0.0415$, $F(10, 2209) = 10.62$, $p < .001$). However, the hypothesis was not supported for aim 3. In linear regression analyses, presenting with a primary complaint of pain predicted a decrease in length of stay, which was the opposite of our hypothesized relationship ($\beta = -0.119$, $p < .001$). Other variables that predicted a longer length of stay included older age ($\beta = 0.099$, $p < .001$), being a woman ($\beta = 0.047$, $p < .001$), and presenting with and a higher number of comorbid conditions ($\beta = 0.101$, $p < .001$). Based on a post-hoc regression model using the four pain locations, patients with chest pain predicted a shorter length of stay ($\beta = -0.137$, $p < .001$), but other locations were not significant.

Discussion

A primary complaint of pain did not significantly predict in-hospital mortality among patients with HF who were transported to the ED by EMS. A primary complaint of chest pain did significantly predict a shorter length of hospital stay while chest and generalized pain predicted lower odds of hospitalization. This study extends previous work by examining outcomes in the hospital among a sample of patients with HF experiencing severe cardiac and non-cardiac chest pain as well as pain in other locations. Previous studies either did not capture locations of pain,[31] or only measured chest pain.[11,43] This is an important contribution to the literature, as non-cardiac pain is frequently reported, making up as high as 65% among patients with HF.[9,12,44] Lastly, this study adds to the current literature regarding which pre-hospital clinical status variables are associated with mortality and other outcomes in the hospital.[34]

Hospitalization among patients with HF is common.[45] In a large national study of over 7.5 million ED visits among patients with HF between 2002–2010, 74.2% were hospitalized on an inpatient unit.[46] This is higher than the percentage observed in the current study (66.3%), which may be partially due to overall increasing rates of observation admission in the United States.[47] Chest pain was associated with lower odds of hospitalization, which was unexpected. Diagnostic strategies are generally effective at identifying the etiology of chest pain,[49] and treatment regimens for ischemic chest pain and acute coronary syndrome have been well established, such as nitrates or angioplasty,[50] which may explain the results. Authors of previous studies have reported that persistent chest pain was associated with a 35–42% higher risk of hospitalization among patients with HF, though both studies were of patients with heart failure with reduced ejection fraction.[11,43] In another study, pain was associated with higher 30-day acute care utilization among patients with HF, but it is unclear how many patients with pain were hospitalized vs. visited the ED only or how many patients presented with comorbid vs. a primary complaint of pain.[31] Another interesting result was that men were more likely to be hospitalized, which is congruent with findings in other studies, though women remain a larger proportion of the HF population overall.[48]

An estimated 2.9–4.9% of patients with HF die in the hospital according to several large national studies.[24,51] These rates are comparable with the in-hospital mortality rates observed in this study (4.2%), and may reflect overall decreasing in-hospital mortality trends among patients with HF over the past decade.[24] A primary complaint of pain was

not associated with mortality, which was somewhat unexpected given previous research examining clinical outcomes among patients with HF and acute coronary syndrome, although patients in our sample were experiencing both cardiac and non-cardiac chest pain. Interestingly, men were more likely to die in the hospital compared to women, which has been reported in other studies.[24] Only 21 patients with a primary complaint of pain died in the hospital, which limits the ability to fully examine risk of mortality, particularly by pain location. The cause of death remains unclear for patients in this study, which may have better explained the mortality results. Additional research could examine mortality rates following discharge in addition to in-hospital mortality rates and with a larger sample size.

According to a national study, trends in mean length of stay have decreased from 8.6 to 6.5 days among patients with HF, the latter of which is comparable to the findings observed in this study (6.02 days).[51] The length of stay findings observed in this study are important to note, as longer length of stay (> 4 days) has been associated with higher hospital readmission and mortality rates.[52] The only location that significantly predicted a decreased length of stay was chest pain, which was unexpected. Given that patients with chest pain had a lower odds of hospitalization, this might explain the length of stay findings. The R^2 for the length of stay regression model indicates that additional variables need to be evaluated. Many factors can influence length of stay that were not available in this dataset, including peripheral edema, cardiothoracic ratio, medications received at admission (e.g., diuretics), living status, and precipitating events (e.g., infection) among others.[23,53] Inclusion of these additional factors in future studies may increase the explanatory capabilities of the model.

It is possible that chronic pain in combination with other symptoms and comorbid conditions plays a larger role in hospital outcomes than pain alone. One symptom that requires additional research is shortness of breath. Approximately 45% of patients in this study had shortness of breath on admission to the ED, which was associated with a higher risk of hospitalization. In addition, more than 30% of the sample had a history of COPD, which has been associated with higher mortality in other studies of patients with HF.[54] Authors of previous studies have reported a high occurrence of shortness of breath among patients with HF, frequently coinciding with pain.[7,12,55] It is therefore possible that pain may play a shared role with other symptoms experienced by patients with HF as evidenced by the high percentage of shortness of breath and serious respiratory issues on admission to the ED.

Interestingly, neither of the primary complaints with the highest percentage of hospitalizations and mortality were pain. This may be because 40.9% of patients presented with urgent medical conditions, including diabetic emergency, cardiac arrest, respiratory/airway problems, stroke, or trauma.[34] Patients with these other primary complaints may have been triaged and prioritized more frequently than patients with pain. This may explain the largely lower associations of presenting with a primary complaint of chest or generalized pain with study outcomes. This observation is somewhat supported by previous research in which authors reported that hospital admissions among patients with HF often stem from cardiovascular issues or comorbid non-cardiovascular conditions, rather than HF symptoms.[56]

This sample is unique because it consists of patients who activated EMS for primary complaint of pain, which constitutes pain that was considered serious enough by the patient to seek additional care. Although a primary complaint of pain did not predict increased hospitalization, chronic pain in concert with other chronic comorbid conditions may still play a significant role in hospitalizations.[11,31,43] A primary complaint of pain in this dataset may comprise of new acute pain and/or an exacerbation of chronic pain. This study only targeted patients presenting to EMS with urgent pain, so patients in our non-pain subsample still could have presented with some form of pain that was not recorded as a primary complaint. Pain is a frequently reported symptom among many acute conditions including trauma, burns, and falls. In addition, pain is common among general community dwelling patients with HF outside of those who are seeking emergency care.[39] Follow up research is subsequently needed to compare the effect of chronic pain vs. acute/urgent pain on hospital outcomes. In addition, research is needed that moves beyond pain locations to examine the deeper mechanistic underpinnings of pain, including pain subtypes.

Limitations

There are some limitations of the study. The point-of-care pain measure used in the study did not allow for differentiation between acute and chronic pain. Additional research is needed to examine hospital outcomes among patients with confirmed chronic pain, which may differ when compared to those presenting with acute pain. Relatedly, the data did not allow for deeper characterization of pain (e.g., nociceptive, neuropathic pain) and future research could build from this work by targeting or stratifying by pain subtypes in addition to locations of pain. It is unknown if patients were treated successfully for their pain, which may have informed why patients with pain were largely more frequently discharged from the ED rather than hospitalized and had lower mean length of stay.

The data were obtained from a large Midwest metropolitan area, and so may not be representative of other regions in the United States, particularly rural regions, which have varying rates of HF mortality risk during hospitalization.[57] This sample, which consisted of patients activating EMS, may differ from a general community dwelling sample which may consist of a higher percentage of stable HF. The sample does not include patients who utilized personal transportation from home, a doctor’s office, or clinic (i.e., not via EMS), and may not represent all patients who present to the ED or are hospitalized. This study collected data regarding self-reported race and ethnicity, which may not adequately capture sociocultural elements or social determinants. Given the limitations of the dataset, future studies of pain in HF should include a more detailed representation of race, health disparities, and inequities.[58] Validation of HF by echocardiography was not possible because the required data (e.g., left ventricular ejection fraction) were not available. This reduced the ability to fully delineate factors by severity of HF or decompensation status, which can affect what factors are associated with clinical outcomes.[23] The INPC dataset had BNP data available for only 1,709 of 3,539 patients (48.3%), and no NTPro-BNP data. Given the large percentage of missing data, BNP was not utilized in the regression models though future work should incorporate BNP into studies regarding pain and hospital outcomes, as BNP and NTPro-BNP play an important factor in hospitalizations and mortality.[59] Lastly, there

were additional factors that were not available in this study, such as prior HF hospitalization history, medications received during transport, or renal function.[23,53,60]

Conclusion

A primary complaint of chest pain was associated with lower length of stay, and chest and generalized pain were associated with lower odds of hospitalization, but pain was not associated with in-hospital mortality. This study provides a unique contribution by examining patients with HF and several locations of pain during transport to the hospital and the subsequent association with hospital outcomes. Additional research is needed to examine hospital outcomes among patients with HF who present with pain in other locations, acute and chronic pain, and multi-site pain. Deep phenotyping and mechanistic work that moves beyond pain locations is needed to improve understanding of this complex symptom in this population.

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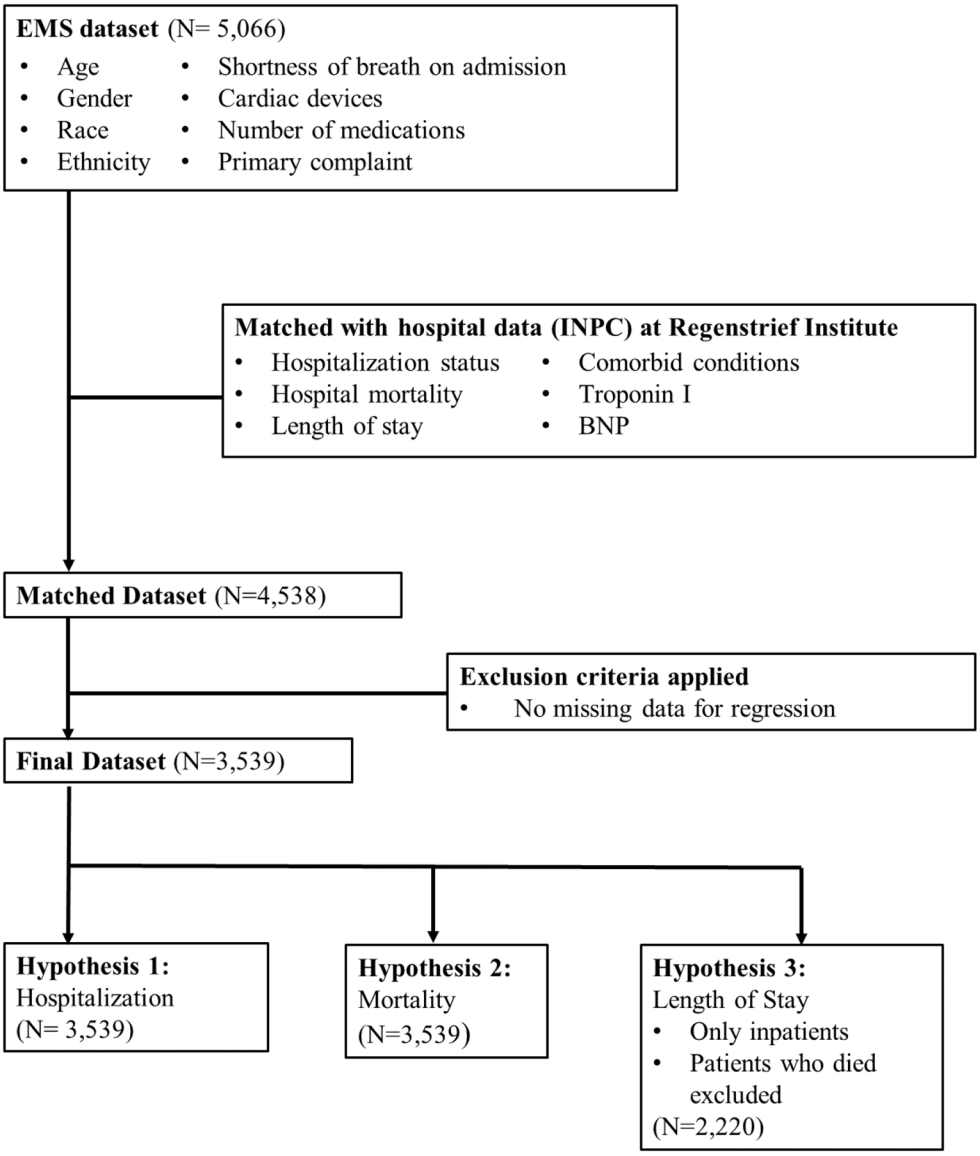

Figure 1 –.

Flow diagram of the merging process of emergency medical services and hospital datasets and final sample sizes by aim

BNP: B-type natriuretic peptide; EMS: Emergency Medical Services; INPC – Indiana Network for Patient Care

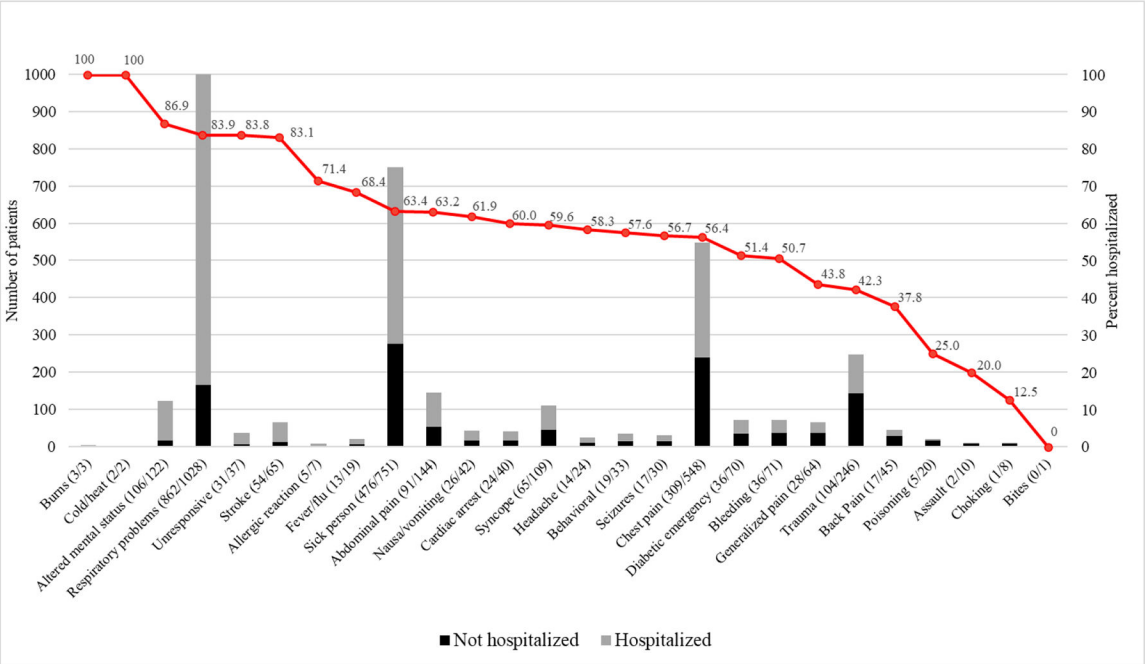

Figure 2 –.

Percentages of patients with heart failure hospitalized across all primary complaints following transport by emergency medical services, in descending order (N = 3,539, 2,346 hospitalized)

Note. Percentages are aligned with bar chart representing the sample size for each primary complaint.

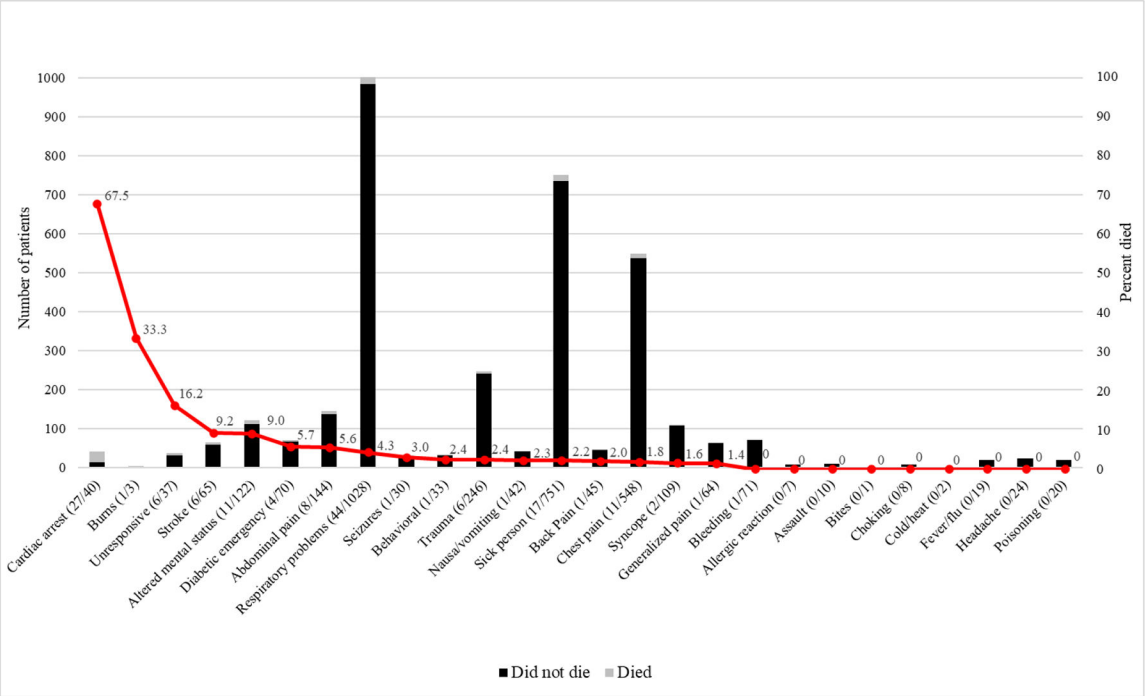

Figure 3 –.

Percentages of patients with heart failure who died across all primary complaints following transport by emergency medical services, in descending order (N = 3,539, 149 died)

Note. Percentages are aligned with bar chart representing the sample size for each primary complaint.

Table 1 –

Demographic and clinical characteristics of patients with heart failure and by patients with a non-pain or pain primary complaint during transport by emergency medical services (N = 3,539)

Variable	Total sample (N = 3539)	Non-pain primary complaint (n = 2738)	Pain primary complaint (n = 801)	P-value
	Mean ± SD or n (%)	Mean ± SD or n (%)	Mean ± SD or n (%)	
Age in years	64.83 ± 14.58	66.23 ± 14.27	60.03 ± 14.61	<.001[a]
Gender				.167[b]
Women	2028 (57.30)	1586 (57.93)	442 (55.18)	
Men	1511 (42.70)	1152 (42.07)	359 (44.82)	
Race				.203[c]
Black	1988 (56.17)	1558 (56.90)	430 (53.68)	
White	1527 (43.15)	1163 (42.48)	364 (45.44)	
Other	24 (0.68)	17 (0.62)	7 (0.87)	
Ethnicity (n = 3,464)				.034[c]
Not Hispanic/Latino	3443 (99.39)	2675 (99.55)	768 (98.84)	
Hispanic/Latino	21 (0.61)	12 (0.45)	9 (1.16)	
Shortness of breath at admission	1590 (44.93)	1263 (46.13)	327 (40.82)	.008[b]
Number of medications	6.53 ± 5.36	6.51 ± 5.35	6.60 ± 5.40	.669[a]
Number of comorbid conditions	1.68 ± 1.51	1.71 ± 1.49	1.59 ± 1.46	.050[a]
Comorbid conditions				
Arthritis	141 (3.98)	115 (4.20)	26 (3.25)	.225[b]
Coronary artery disease	1217 (34.39)	921 (33.64)	296 (36.95)	.082[b]
COPD	1083 (30.60)	898 (32.80)	185 (23.10)	<.001[b]
Diabetes	638 (18.03)	527 (19.25)	111 (13.86)	<.001[b]
Hyperlipidemia	1119 (31.62)	872 (31.85)	247 (30.84)	.588[b]
Hypertension	1155 (32.64)	883 (32.25)	272 (33.96)	.365[b]
Myocardial infarction	511 (14.44)	382 (13.95)	129 (16.10)	.127[b]
Stroke	90 (2.54)	84 (3.07)	6 (0.75)	<.001[b]
Devices				
Pacemaker	271 (7.66)	189 (6.90)	82 (10.24)	.002[b]
ICD	156 (4.41)	97 (3.54)	59 (7.37)	<.001[b]
Laboratory values				
Peak troponin I in ng/mL (n = 2,596)	1.82 ± 37.95	0.85 ± 17.60	4.84 ± 70.49	.160[a]
Peak BNP in pg/mL (n = 1,709)	820.10 ± 1134.65	841.49 ± 1159.68	733.30 ± 1023.89	.091[a]
Hospitalization status	2,346 (66.29)	1,901 (69.43)	445 (55.56)	<.001[b]
In-hospital mortality	149 (4.21)	128 (4.67)	21 (2.62)	.011[b]
Length of stay (n= 2,220)	6.02 ± 7.55	6.23 ± 6.99	5.15 ± 9.53	.028[a]

BNP; B-type natriuretic peptide: COPD; chronic obstructive pulmonary disease: ICD; Implantable cardioverter-defibrillator

a: independent samples t-test

b: chi2

c: Fisher's Exact

Table 2 –

Multiple logistic regression of a primary complaint of pain on hospitalization following transport by emergency medical services (N = 3,539, 2,346 hospitalized)

Variable	Odds Ratio (95% CI)	Std. Error	P-value
Primary complaint of pain	0.61 (0.50 – 0.74)	0.060	<.001
Age	1.02 (1.01 – 1.03)	0.003	<.001
Gender (reference level = Men)			
Women	0.76 (0.64 – 0.91)	0.066	.002
Race (reference level = White)			
Black	1.15 (0.97 – 1.36)	0.099	.114
Other	1.38 (0.52 – 3.63)	0.682	.520
Shortness of breath at admission	2.12 (1.79 – 2.52)	0.184	<.001
Number of medications	0.99 (0.97 – 1.00)	0.008	.081
Number of conditions	2.39 (2.22 – 2.58)	0.090	<.001
Devices			
Pacemaker	0.72 (0.50 – 1.02)	0.130	.068
ICD	0.68 (0.43 – 1.08)	0.159	.103

CI; confidence interval: ICD; Implantable cardioverter-defibrillator

Table 3 –

Multiple logistic regression of a primary complaint of pain on mortality in the hospital following transport by emergency medical services (N = 3,539, 149 died)

Variable	Odds (95% CI)	Std. Error	P-value
Primary complaint of pain	0.69 (0.43 – 1.11)	0.167	.124
Age	1.04 (1.03 – 1.05)	0.007	<.001
Gender (reference level = Men)			
Women	0.52 (0.37 – 0.73)	0.090	<.001
Race (reference level = White)			
Black	0.91 (0.65 – 1.27)	0.157	.583
Other	1.13 (0.15 – 8.74)	1.181	.905
Shortness of breath at admission	0.84 (0.60 – 1.19)	0.148	.332
Number of medications	0.97 (0.94 – 1.00)	0.016	.086
Number of conditions	1.09 (0.98 – 1.22)	0.061	.118
Devices			
Pacemaker	0.46 (0.19 – 1.11)	0.207	.084
ICD	0.68 (0.20 – 2.34)	0.428	.540

CI; confidence interval: ICD; Implantable cardioverter-defibrillator

Table 4 -

Linear multiple regression of a primary complaint of pain on log transformed length of stay data among patients who were hospitalized on an inpatient unit (N = 2,220)

Variable	Beta ± Std. Error	% Change	t	p-value
Pain location (reference level = no pain)	−0.119 ± 0.056	−26.66	−5.61	<.001
Age	0.099 ± 0.002	0.80	4.61	<.001
Gender (reference level = Men)				
Women	0.047 ± 0.045	10.56	2.23	.026
Race (reference level = White)				
Black	−0.018 ± 0.044	−3.63	−0.84	.403
Other	0.002 ± 0.266	2.74	0.10	.919
Shortness of breath at admission	0.007 ± 0.044	1.61	0.35	.723
Number of medications	0.025 ± 0.004	0.50	1.20	.230
Number of conditions	0.101 ± 0.015	7.57	4.76	<.001
Devices				
Pacemaker	−0.020 ± 0.092	−7.60	−0.86	.388
ICD	0.022 ± 0.127	13.09	0.97	.333

CI; confidence interval: ICD; Implantable cardioverter-defibrillator

R^2: 0.0459

Adjusted R^2: 0.0415