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Research Article

Association between Pain Scores and Illness Severity in United States Emergency Departments

John-Ryan McAnnally[1], Clint Christensen[1], Laura Williams[2], Randolph Devereaux[3], Jessica Whittle[1] and David Seaberg[3]*

[1]Department of Emergency Medicine, University of Tennessee College of Medicine Chattanooga, Chattanooga, TN, USA

[2]Department of Community Health, Mercer University School of Medicine, Macon, GA, USA

[3]Department of Emergency Medicine, Summa Health, Akron, OH, USA

***Corresponding Author:** David Seaberg, Department of Emergency Medicine, Summa Health, Akron, OH, USA.

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Abstract

Background: Pain score measurement is nationally mandated for all Emergency Department visits in the United States (US). While the importance of recognizing and treating acute pain is well established, little is known about the association between pain scores and clinical outcomes. We sought to characterize pain-related visits to US Emergency Departments and to determine whether pain scores were associated with illness severity.

Methods: We analyzed 20,070 records from the National Hospital Ambulatory Medical Care Survey, Emergency Department Sample (NHAMCS-ED), years 2009-10. NHAMCS-ED is a nationally representative, four-stage probability sample of ED visits in the US, containing detailed information for each patient visit including pain score measured with 0-10 Likert scale. We analyzed pain related ED visits for each organ system using Reason for Visit code. We identified emergent diagnosis by ICD-9 codes adapted from the CDC. We used survey weights to calculate national estimates for all pain-related ED visits. We performed logistic regression for emergent diagnosis, hospital floor admission, and operating room or ICU admission, adjusting for age, sex, race, payer type, and vital signs. Results are presented as Odds Ratios with 95% confidence intervals.

Results: There were 38,748,303 annual pain-related ED visits in the population. Pain scores did not vary by age, race, payer status, or vital signs. A greater proportion of women reported severe pain. Higher pain scores were associated with increased Computed Tomography (CT) imaging, longer wait times, and longer lengths of visit. Higher pain scores for headache (OR 0.89; 95% CI 0.82 - 0.98), EENT (0.91; 0.86 - 0.98), and lower extremity (0.93; 0.88 - 0.99) were inversely associated with emergent diagnosis. Higher pain scores for abdominal pain (1.11; 1.05 - 1.06) and flank pain (1.17; 1.07 - 1.27) had increased odds of emergent diagnosis. Complaint of generalized pain had increased odds of admission to the Intensive Care Unit or Operating Room (1.6; 1.16 - 2.20).

Discussion: Pain scores may predict illness severity for complaints of abdominal, flank, and generalized pain. For other organ systems, pain scores appear to have limited predictive value.

Keywords: *Pain Scores; Illness Severity; Emergency Departments*

Introduction

Pain score measurement is nationally mandated for all Emergency Department visits in the United States. In 2001 an expert panel consisting of primary pain physicians, nurses, and pharmacists concluded that pain was both under-recognized and under-treated. As a result, documenting and treating pain were incorporated into guidelines for hospital accreditation as part of the "Pain as the Fifth Vital Sign" campaign [1].

Inadequacy in recognizing and treating acute pain, as well as racial/ethnic disparities in administration of appropriate analgesia, has been reported in US Emergency Departments [2-4]. Observational and prospective studies have identified ED provider bias, ethnic differences in pain reporting, and cultural differences in expression of pain as barriers to appropriate pain treatment [4-7].

Despite adequate studies describing suboptimal pain management in the ED, little is known about the association of pain scores and clinical outcomes. A prospective Emergency Department study in 2005 found that changes in pain scale number after administration of nitroglycerin did not help to differentiate cardiac from non-cardiac chest pain [8]. A retrospective chart review of trauma site surveys in 2007 reported that 32 of 2,282 patients died secondary to overmedication of pain and recommended that the current emphasis of pain recognition be balanced by dangers of oversedation [9]. Pain scale severity has shown no association with headache and subarachnoid hemorrhage nor abdominal pain and appendicitis [10-13]. In addition, a retrospective chart review of an internal medicine practice found no improvement in quality of pain management after an initiative to ensure routine pain intensity documentation [14].

With the recording of pain scores along with vital signs during each Emergency Department visit it is essential to know whether pain intensity portends worse prognosis or emergent condition. We sought to characterize pain-related visits to US Emergency Departments and determine whether pain severity was associated with illness severity.

Methods

Description of the Data

We analyzed data from the National Hospital Ambulatory Medical Care Survey Emergency Department (NHAMCS-ED) sample, years 2009 - 2010. NHAMCS-ED, administered and maintained by the National Center for Health Statistics and Centers for Disease Control and Prevention, is a nationally representative, four-stage probability sample of Emergency Department visits in the US. Samples are taken from primary sampling units (PSUs) which consist of counties, metropolitan statistical areas, cities, towns, and other geopolitical units. Sampling is stratified by hospitals within PSUs, emergency service areas within hospitals, and individual patient data from visits to emergency service areas [15]. Raw data can be weighted to generate national estimates which account for geographic region, population size, and non-response. The study was approved as an exempt study by the University of Tennessee College of Medicine Chattanooga Institutional Review Board.

Detailed information exists for each ED record including verbatim reason for visit, demographics, initial vital signs, medications and tests ordered, *International Classification of Disease, ninth revision* (ICD-9) coded diagnosis, and ED disposition. Prior to 2009, pain was categorized as none, mild, moderate, or severe. In 2009 the survey methodology was changed to include more detailed pain scale information, reporting a level of 0-10.

Verbatim reason for visit is abstracted by NHAMCS maintainers and then categorized and assigned a reason for visit code (RVC). Three fields are provided for a primary, secondary, or tertiary complaint. We identified RVC for headache, eye, ear, nose, and throat pain, neck and back pain, chest pain, abdominal pain, arm and leg pain, and generalized pain. The category of generalized pain includes 'ache all over', generalized cramps, spasms, and pain otherwise unspecified.

Study Sample

We analyzed all visits for patients aged 18-85 years, excluding records if the patient left without being seen, left against medical advice, was dead on arrival, or died in the Emergency Department. We calculated national estimates of visit characteristics across 4 categories of pain (1 - 3, 4 - 6, 7 - 9 and 10). We analyzed pain related ED visits for each organ system using RVC. We considered emergent diagnosis, admission to hospital floor, admission to ICU, and transfer to operating room to be surrogate endpoints for illness severity.

Primary Predictor: Pain Score

Pain scores are recorded in NHAMCS on a Likert scale with values 0 to 10. We analyzed integer pain severity rating for all pain-related ED visits.

Covariates

We adjusted the logistic regression models for patient age, race/ethnicity, insurance status, and vital signs including heart rate, respiratory rate, and blood pressure.

Outcome: Emergent Diagnosis

We identified emergent diagnosis by ICD-9 codes adapted from the CDC and previous investigation [3,16]. We included both immediately life-threatening and urgent diagnoses. For complaint of headache we included intracranial hemorrhage (subarachnoid, subdural, epidural, and otherwise unspecified), meningitis, encephalitis, temporal arteritis, stroke, mass, abscess, and skull fracture. Eye, Ear, Nose, and Throat emergencies identified included neck abscess, spinal fracture, epiglottitis, cellulitis, mass, fractures, open wounds, and pharyngeal edema. Abdominal emergencies identified included acute appendicitis, cholecystitis, bowel obstruction, bowel perforation, GI hemorrhage, pancreatitis, pyelonephritis, renal stone, mesenteric ischemia, abdominal aortic dissections and ectopic pregnancy. Chest emergencies identified included acute coronary syndrome, aortic dissection, pericarditis, endocarditis, pneumonia (nonspecific or attributable to specific organism), cardiac tamponade, pulmonary embolus, pneumothorax and hemothorax, esophageal perforation, and rib fractures. For upper and lower extremity emergency we identified fractures, dislocations, cellulitis, arterial and deep venous thrombosis.

Outcome: Hospital Admission

Because patients may remain undifferentiated in the Emergency Department with respect to diagnosis, we included admission to the hospital as another surrogate of illness severity. NHAMCS contains detailed information about disposition from the Emergency Department including admission or observation in hospital, admission to critical care unit, stepdown unit, or operating room.

Using survey weights we calculated national estimates of visit characteristics for all pain-related ED visits. We performed logistic regression analysis for odds of emergent diagnosis and admission to floor, ICU, or operating room, adjusting for demographics and vital signs and reported 95% confidence intervals. We used unpaired Student t-tests to denote trend with an alpha set at 0.05.

Results

We analyzed 20,070 patient visit encounters for years 2009 - 10. Using survey weights, we estimate this represents 38 million visits per year, which is similar to previous estimates for annual US ED pain-related visits [3]. Figure 1 denotes the distribution of pain scores from 0 to 10. Pain severity was similarly reported across age, payer status, race, and vital signs (Table 1). Lower pain severity (score 1 - 3) was similar for men and women, but a higher proportion of women reported severe pain (score 10) 62% (95% CI 60% - 64%) vs 51% (95% CI 48% - 54%) (p = 0.021 for trend). There was a higher proportion of visits with CT imaging for severe pain 23% (95% CI, 22% - 25%) vs 17% (95% CI 15% - 19%) (p < 0.001 for trend). Length of visit (220 vs 179 minutes, p < 0.001 for trend) and wait time (61 vs 51 minutes, p < 0.001 for trend) were longer when higher pain scores were reported.

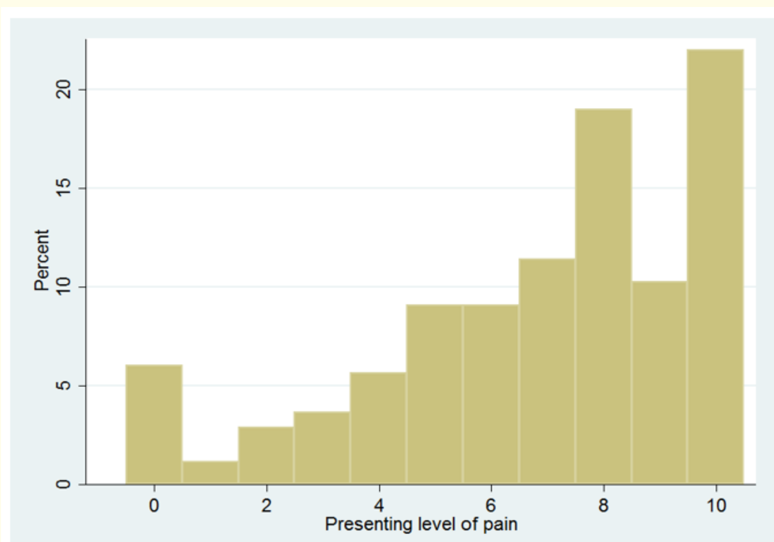

Figure 1: *Distribution of pain scores.*

Characteristics		Pain 1 - 3 (n = 1,636) N or % (95% CI)		Pain 4 - 6 (n = 5,225) N or % (95% CI)		Pain 7 - 9 (n = 8,552) N or % (95% CI)		Pain 10 (n = 4,661) N or % (95% CI)	
Age (years)		46	(44 - 47)	43	(42 - 44)	40	(40 - 41)	42	(41 - 42)
Sex									
	Female	51	(48 - 54)	59	(57 - 61)	63	(61 - 64)	62	(60 - 64)
	Male	49	(46 - 52)	41	(39 - 43)	37	(36 - 39)	38	(36 - 40)
Race									
	White	9	(9 - 10)	25	(24 - 27)	43	(42 - 45)	22	(21 - 23)
	Black	6	(5 - 7)	23	(21 - 24)	44	(42 - 47)	27	(25 - 29)
	Hispanic	7	(5 - 8)	29	(26 - 32)	41	(38 - 44)	23	(21 - 26)
	Other	9	(7 - 12)	31	(27 - 36)	40	(36 - 45)	20	(16 - 25)
Payer Status									
	Private	11	(10 - 12)	29	(27 - 31)	41	(39 - 43)	19	(18 - 21)
	Medicare	10	(9 - 12)	27	(25 - 29)	39	(37 - 41)	24	(22 - 27)
	Medicaid	5	(4 - 5)	20	(18 - 22)	47	(45 - 49)	28	(26 - 30)
	Self - pay	6	(5 - 8)	23	(21 - 25)	46	(43 - 48)	25	(23 - 27)
	Other	7	(6 - 9)	26	(24 - 29)	43	(40 - 46)	23	(21 - 25)
Vital Signs									
	Pulse	90	(89 - 92)	89	(88 - 90)	88	(87 - 88)	90	(89 - 90)
	Systolic Blood Pressure	132	(131 - 133)	133	(132 - 134)	133	(133 - 134)	135	(134 - 136)
	Respiratory Rate	20	(19 - 20)	19	(19 - 19)	19	(18 - 19)	19	(19 - 19)
Transport									
	Arrived by EMS	18	(15 - 21)	14	(12 - 16)	12	(10 - 13)	15	(14 - 17)
	Private vehicle	82	(79 - 85)	86	(84 - 88)	88	(87 - 90)	85	(83 - 86)
Triage Level									
	Immediate	8	(5 - 14)	27	(18 - 37)	45	(35 - 55)	20	(12 - 31)
	Emergent	11	(9 - 13)	29	(26 - 32)	38	(35 - 41)	22	(20 - 24)
	Urgent	8	(7 - 9)	25	(24 - 27)	43	(41 - 44)	24	(22 - 25)
	Semi - urgent	7	(6 - 8)	24	(23 - 26)	45	(43 - 47)	23	(22 - 25)
	Nonurgent	9	(7 - 11)	21	(18 - 24)	45	(42 - 49)	25	(22 - 28)
CT imaging									
	No CT	83	(81 - 85)	80	(78 - 82)	80	(78 - 81)	77	(75 - 78)
	Had CT	17	(15 - 19)	20	(18 - 22)	20	(19 - 22)	23	(22 - 25)
Any Imaging									
	No Imaging	39	(36 - 42)	40	(38 - 42)	45	(43 - 47)	44	(42 - 47)
	Had Imaging	61	(58 - 64)	60	(58 - 62)	55	(53 - 57)	56	(53 - 58)
Length of visit (minutes)		179	(170 - 188)	193	(185 - 201)	205	(195 - 216)	220	(209 - 232)
Wait time (minutes)		51	(47 - 54)	54	(50 - 59)	58	(54 - 62)	61	(56 - 67)
72 hr return									
	Yes	4	(3 - 6)	3	(3 - 4)	4	(4 - 5)	6	(6 - 8)
	No	96	(94 - 97)	97	(96 - 97)	96	(95 - 96)	94	(92 - 94)
7 day return									
	Yes	3	(2 - 5)	2	(2 - 3)	4	(3 - 5)	6	(5 - 8)
	No	97	(95 - 98)	98	(97 - 98)	96	(95 - 97)	94	(92 - 95)

***Table 1**: Characteristics of study population by self - reported pain level.*
(n = 20,070. 38,748,303 annualized visits).

Across organ systems, higher pain intensity was associated with increased odds of emergent diagnosis for abdominal pain (OR 1.11 (95% CI 1.05 - 1.16)) and flank pain (OR 1.17 (95% CI (1.07 - 1.27)). Higher pain intensity was associated with increased odds of disposition to ICU or operating room for generalized pain (OR 1.6 (95% CI 1.16 - 2.20)).

There was no association between pain severity and illness severity for chest pain, neck and back pain, nor upper extremity pain (Table 2). Higher pain intensity for headache (OR 0.89; (95% CI 0.82 - 0.98)), ENT pain (OR 0.91; (95% CI 0.86 - 0.98)), and upper extremity pain (OR 0.93; (95% CI 0.88 - 0.99)) had decreased odds of emergent diagnosis.

	Hospital Admission OR (95% CI)		Admission to ICU or Operating Room OR (95% CI)		Emergent Diagnosis OR (95% CI)	
Location of Pain						
Any Pain						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	1.08	(0.84 - 1.39)	0.83	(0.61 - 1.11)	1.01	(0.81 - 1.25)
Pain 7 - 9	0.91	(0.72 - 1.16)	0.69	(0.51 - 0.95)	0.92	(0.76 - 1.13)
Pain 10	1.08	(0.86 - 1.37)	0.69	(0.49 - 0.99)	1.14	(0.92 - 1.42)
Headache						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	5.44	(1.91 - 15.45)	16.19	(1.92 - 136.22)	1.02	(0.43 - 2.41)
Pain 7 - 9	3.01	(1.05 - 8.64)	8.05	(0.96 - 67.39)	0.53	(0.21 - 1.30)
Pain 10	3.37	(1.33 - 8.59)	12.64	(1.37 - 116.85)	0.54	(0.20 - 1.47)
EENT						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	3.24	(0.78 - 13.44)	8.96	(0.69 - 116.23)	1.31	(0.68 - 2.52)
Pain 7 - 9	1.17	(0.34 - 4.11)	10.08	(1.07 - 95.16)	0.54	(0.31 - 0.94)
Pain 10	2.92	(0.79 - 10.84)	19.06	(1.53 - 236.76)	0.7	(0.36 - 1.36)
Chest						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	0.9	(0.61 - 1.35)	0.79	(0.52 - 1.22)	0.69	(0.45 - 1.06)
Pain 7 - 9	0.9	(0.61 - 1.33)	0.72	(0.47 - 1.12)	0.97	(0.65 - 1.43)
Pain 10	0.88	(0.56 - 1.37)	0.74	(0.46 - 1.21)	1.25	(0.78 - 2.00)
Abdominal						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	1.48	(0.87 - 2.54)	0.95	(0.42 - 2.17)	0.92	(0.58 - 1.47)
Pain 7 - 9	1.88	(1.13 - 3.14)	1.34	(0.59 - 3.07)	1.37	(0.90 - 2.09)
Pain 10	2.6	(1.57 - 4.30)	1.47	(0.70 - 3.10)	1.72	(1.10 - 2.67)
Flank						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	0.51	(0.12 - 2.23)	0.02	(0.00 - 0.31)	0.87	(0.32 - 2.35)
Pain 7 - 9	0.5	(0.13 - 1.97)	0.07	(0.01 - 0.51)	1	(0.45 - 2.21)
Pain 10	1.04	(0.27 - 3.91)	0.18	(0.03 - 0.99)	2.18	(0.94 - 5.03)
Neck and Back						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	2.52	(1.03 - 6.15)	2.37	(0.45 - 12.35)	1.04	(0.65 - 1.66)
Pain 7 - 9	1.52	(0.57 - 4.09)	0.93	(0.16 - 5.61)	0.76	(0.47 - 1.21)
Pain 10	2.37	(0.88 - 6.41)	1.87	(0.31 - 11.45)	0.73	(0.45 - 1.18)
Lower extremity						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	1.01	(0.47 - 2.18)	0.48	(0.13 - 1.80)	1.07	(0.40 - 2.88)
Pain 7 - 9	0.67	(0.35 - 1.28)	0.42	(0.16 - 1.14)	1.07	(0.39 - 2.94)
Pain 10	1.39	(0.70 - 2.74)	0.9	(0.30 - 2.71)	1.04	(0.33 - 3.27)
Upper extremity						
Pain 1 - 3	ref	---	ref	---	ref	---
Pain 4 - 6	0.38	(0.18 - 0.84)	0.29	(0.10 - 0.82)	1.17	(0.71 - 1.94)
Pain 7 - 9	0.39	(0.17 - 0.87)	0.28	(0.11 - 0.71)	1	(0.62 - 1.61)
Pain 10	0.26	(0.12 - 0.59)	0.09	(0.03 - 0.24)	1.28	(0.75 - 2.20)

Table 2: *Odds Ratios for Hospital Admission, Admission to ICU, and Emergent Diagnosis by location of pain and pain score.*

Discussion

In this analysis pain severity was associated with illness severity for complaints of abdominal pain, flank pain, and generalized pain. While national initiatives have increased the general awareness of pain treatment, it remains vital to clinicians to know whether a higher pain score portends emergent diagnosis or severe illness [1,3,17]. Though a disparity in treatment of pain exists across race, emergent diagnosis and severe illness occur without respect to race/ethnicity.

In this study patients had increased odds of CT imaging with high pain severity ratings. These results suggest that CT imaging is, in part, influenced by severity of self-reported pain. Given the increased odds of emergent diagnosis and hospital admission, this practice pattern may be justified for complaints of abdominal pain and flank pain. There are insufficient data in the NHAMCS-ED dataset to determine which specific CT imaging test was performed.

Longer wait times and longer lengths of visit were observed for patients with higher pain scores; however, further studies are needed to elucidate the underpinnings of these findings. Longer length of visit may be influenced by increased use of CT, diagnostic tests, or physician uncertainty (insert reference). Longer wait times may be influenced by the time for formal examination room to open or for availability for attending physician to evaluate, though these data show no difference in evaluation by physician vs mid-level provider.

Nonspecific, generalized pain had increased odds of admission to the ICU. This complaint may be linked to severe underlying illness. Generalized pain is more common in the elderly which may be a reason for the increased likelihood of admission [18].

Additionally, a study by Nemec [19] found that patients with non-specific complaints are more likely to have serious conditions requiring admission.

Headache, ENT pain, and upper extremity pain were inversely associated with emergent diagnosis. Functionally, a patient with higher rating for headache, ENT pain, or upper extremity pain had lower odds of an emergent illness.

The lack of association between chest pain and illness severity complements previous results which report the difficulty in using pain score to differentiate chest pain etiology [8]. For neck, back, and upper extremity pain there is no association with pain score and severity of illness.

Women were more likely than men to report severe pain. While previous studies have highlighted ethnic and gender difference in pain severity reporting [6,7], this analysis showed no difference in emergent diagnosis nor critical disposition between women and men. While improvements in pain management have been made over the past decade, further efforts are needed to ensure adequate analgesia in the Emergency Department. This study identifies key conditions in which pain scores are associated with severity of illness, although the strength of these correlations were weak.

Limitations

NHAMCS-ED is, by design, a retrospective cross sectional database of emergency department visits in the United States. As such, it is not possible to determine causality (e.g. whether increased pain scores result in increased CT imaging). Not all emergent diagnoses may have been detected or measured in our data set thus skewing our results. However, we accounted for this by using hospital admission as a surrogate for serious illness.

Conclusion

Pain scores may predict illness severity for complaints of abdominal, flank, and generalized pain, although the correlations were not strong. For other organ systems, pain scores appear to have limited predictive value. Our study suggests that pain scores may have limited utility to predict admission severity than previously thought. Further research focusing on the influence of pain scores in ED utilization and throughput metrics is warranted.

Meetings

This study was presented at the Society for Academic Emergency Medicine annual meeting, San Diego, CA. May 14, 2015.

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There was no direct financial support for this study.

Conflicts of Interest

No conflicts of interest for any author.

Author Contributions

JM, CC, LW, RD, and DS conceived the study design and research methodology. JM, RD, DS, and JW analyzed the data. JM, CC, RD, DS, and JW prepared the manuscript. JM drafted the manuscript and all authors contributed substantially to multiple revisions. JM takes responsibility for the manuscript as a whole.

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