The Effect of Emergency Department Crowding on the Management of Pain in Older Adults with Hip Fracture

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OBJECTIVES: To evaluate the effect of emergency department (ED) crowding on assessment and treatment of pain in older adults.

DESIGN: Retrospective review of ED records from a prospective cohort study.

SETTING: Urban, academically affiliated, tertiary medical center.

PARTICIPANTS: One hundred fifty-eight patients, aged 50 and older, evaluated and hospitalized from the ED with hip fracture.

MEASUREMENTS: Patient-related risk factors: age, sex, nursing home residence, ED triage status, dementia, Acute Physiology in Age and Chronic Health Evaluation II physiological score, and RAND comorbidity score. ED crowding risk factors: ED census and mean length of stay. Outcomes: documentation of pain assessment, time to pain assessment, time to pain treatment, patients reporting pain receiving analgesia, and meperidine use.

RESULTS: Mean age was 83 (range 52–101), 81.0% of patients complained of pain, mean time to pain assessment was 40 minutes (range 0–600), time to treatment was 141 minutes (range 10–525), and mean delay to treatment was 122 minutes (range 0–526). Of those with pain, 35.9% received no analgesia, 7.0% received nonopioids, and 57.0% received opioids. Of those receiving opioids, 32.8% received meperidine. ED crowding at census levels greater than 120% bed capacity was significantly associated with a lower likelihood of documentation of pain assessment ($P = .05$) and longer times to pain assessment ($P = .01$).

CONCLUSION: Older adults with hip fracture are at risk for underassessment of pain, considerable delays in analgesic administration after pain is identified, and treatment with inappropriate analgesics (e.g., meperidine) in the ED. Higher levels of ED census are significantly associated with poorer pain management. **J Am Geriatr Soc 54:270–275, 2006.**

Key words: pain; aging; quality of care; emergency department crowding

The emergency department (ED) is a unique environment in which highly specialized care is delivered to the acutely ill and injured and safety net care is provided to vulnerable and disenfranchised populations. The phenomenon of ED crowding increasingly threatens both of these missions. Atypical presentations, cognitive impairment, comorbidities, and polypharmacy serve to make the older patient particularly vulnerable to the adverse effects of a crowded ED. Given the rapidly increasing volume of ED visits by persons aged 65 and older,[1] it is imperative to understand the patient-related risk factors and the effect of ED crowding on the care of the older adult.

ED crowding is a problem that is assumed to have negative effects on patient care, although there is no direct evidence of this. Prior studies have indirectly assessed these issues by examining use of emergency systems in different countries and community-wide outcomes. A Spanish study[2] showed an association between mortality rates and weekly number of visits. More recently, Canadian investigators[3,4] showed an increase in emergency medical services system and ambulance response times for patients with chest pain between 1997 and 1999 and thrombolytic delays for acute myocardial infarction during periods of high network ambulance diversion. Although much progress has been made in the evaluation of multifactorial ED crowding measures validated against medical staff perception of crowding, it has not been established how these crowding factors affect the quality of patient care.

Pain management has been identified as an issue for quality-of-care improvement in older adults[5] and serves as a useful model to explore ED care in the geriatric population. Disparities in pain management have been well documented in multiple populations and settings.[6–9] Specifically, a recent review of ED pain management indicates that it is often inconsistent and inadequate (oligoanalgesia),[10] and almost

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50% of emergency physicians report discomfort in their level of training in giving analgesia to older people.[11] These findings suggest that older adults in the ED may be at high risk for oligoanalgesia.

The objective of this study was to evaluate the effect of ED crowding on the assessment and treatment of pain in older adults with hip fracture. Hip fracture was used as a model, because it is common in the geriatric population and is associated with significant pain and loss of function.[12]

METHODS

A retrospective cohort review was conducted. Institutional review board approval and exemption from full review was obtained at the medical center where data were collected and reviewed. Patients for this study originated from a previously conducted prospective cohort study[13] of hip fracture patients seen at an urban, academically affiliated medical center from August 1997 to July 1998. The medical center is a 1,171-bed, tertiary-care teaching facility with approximately 70,000 annual ED visits, of which approximately 36,000 were adult visits. During the study period, the ED was staffed with an average of four attending physicians, nine resident physicians, and seven nurses daily. The purpose of the original study was to evaluate functional and other outcomes for patients with hip fractures. Exclusion criteria from the original study were patient age younger than 50, fractures that occurred as an inpatient, transfers from another hospital, multiple trauma, pathological fractures, distal and femoral shaft fractures, bilateral hip fractures, and previous fracture or surgery at the currently fractured site.

For this study, supplemental data were gathered from patient ED medical record review and from the medical center admission, discharge, transfer (ADT) administrative database. Patients from the original prospective cohort study[13] were included for this study if they were evaluated and admitted from the medical center ED. Patients were excluded if they were directly admitted to the medical center and not initially evaluated in the ED for hip fracture.

Risk factor data obtained from the original study included age, sex, presence of dementia (defined as patient self-report of Alzheimer's disease or other dementia or physician chart note of dementia (Alzheimer's disease, organic brain syndrome, other dementia)), site of residence (home vs nursing home (includes skilled nursing facility patients)), modified RAND comorbidity score,[13,14] and Acute Physiology in Age and Chronic Health Evaluation II critical care score, without Glasgow Coma Scale. Methods for collection of these variables have been described previously.[13] Additional risk factor data collected from the ED medical record review included triage status (1 = nonurgent, 2 = urgent, 3 = emergent) (use of the Emergency Severity Index[15] was not incorporated into routine use at this ED during the study period) and time of arrival to ED.

ADT data were used to collect the ED crowding risk factors: ED census and mean ED length of stay (LOS) during the hour the index hip fracture patient arrived. All patients in the ADT database have ED registration and discharge times. Using this information, it was possible to determine the total number of patients present in the ED (ED census) at the hour the index hip fracture patient was triaged. Using the ADT data, it was also possible to calculate the ED LOS, which was defined as the time from ED registration to when the patient left the ED (discharge or transfer to the floor). Mean ED LOS was the average LOS for all of these patients. (E.g., three patients present in the ED during the hour the index hip patient arrived. The ED LOS for Patient 1 is 60 minutes, for Patient 2 is 60 minutes, for Patient 3 is 120 minutes. Thus, the mean ED LOS is 80 minutes.) These two factors were chosen as measures of ED crowding based on their previous use as proposed measures in the medical literature,[16–19] their construct and face validity as factors of ED crowding, and the widespread availability of these data in most hospital and medical center databases. To the authors' knowledge, this is the first study to evaluate the association between potential ED crowding factors and the quality of pain management.

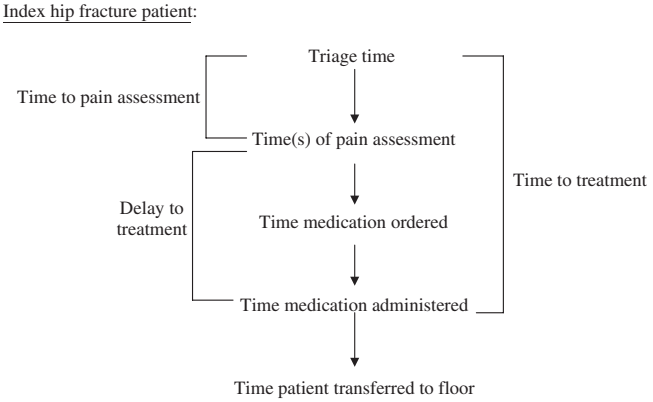

Figure 1. Schematic of emergency department patient time data.

Outcome data were gathered from the ED medical record review and included four quality of pain management measures: documentation of pain assessment, time to pain assessment (by a physician), documentation of administration of pain medication and, if administered, type of analgesic (opioid vs nonopioid (nonsteroidal antiinflammatory drug, acetaminophen)), and time to pain treatment. Documentation of pain assessment was defined as the physician's recording of pain evaluation or the reporting of pain in the patient history or during physical examination (e.g., "tenderness at right hip," "pain on palpation"). For a schematic diagram of ED patient time data, see Figure 1. Given the increased association between meperidine and adverse effects in patients with impaired renal clearance (older adults), the prevalence of meperidine as a choice of pain treatment was specifically examined.[20] All data collected from the medical record abstraction were completed without knowledge of the ADT data results.

Two of the investigators (UH, TS) manually abstracted data from ED records; the data were subsequently entered into a Microsoft Access database (Microsoft, Corp., Redmond, WA). One of the authors (UH) reviewed all charts and also reviewed a 10% random sample of the abstraction data with 100% concordance with the primary abstractor. Missing documentation data (pain assessment and administration of pain medication) were treated as no documentation performed. Missing time data (pain assessment and pain treatment) were replaced with the earliest time written in the medical record notes adjacent to the assessment or

Table 1. Characteristics of Emergency Department (ED) Patients with Hip Fractures (N = 158)

Characteristic	Value
Age, mean (range)	83 (52–101)
Female, n (%)	126 (79.7)
Nursing home, n (%)	34 (21.5)
Triage status, n (%)	
Nonurgent	4 (2.5)
Urgent	106 (67.1)
Emergent	13 (8.2)
Missing	35 (22.2)
RAND comorbidity score, mean ± SD (range 0–12)	2.7 ± 2.2
Acute Physiology, Age, and Chronic Health Evaluation score without Glasgow Coma Scale, mean ± SD (range 0–12)	4.0 ± 2.7
Dementia, n (%)	54 (34.2)
ED census, mean ± SD*	37 ± 14
ED length of stay, mean ± SD†	639 ± 279
Patients missing ED documentation, n (%)	5 (3.2)
Patients reporting complaint of pain, n (%)	128 (81.0)
Patients with documented assessment of pain, n (% of patients reporting pain)	115 (89.8)
Minutes to first documented pain assessment, mean (range)	40 (0–600)
Minutes to first documented pain treatment, mean (range)	141 (10–525)
Delay in treatment, minutes, mean (range)	122 (0–526)
Received analgesia for pain, n (%)	82 (64.1)
Received nonopioid medication for pain, n (%)	9 (7.0)
Received opioid medication for pain, n (%)	73 (57.0)
Received meperidine, n (% of patients for whom opioid prescribed)	24 (32.8)
Patients with documented assessment of pain, n (%)	115 (72.8)

* Number of patients during entire period of study.
† Minutes during entire period of study.
SD = standard deviation.

administration note. For nonnormally distributed data (time), log transformations were completed. Bivariate Pearson correlation, *t* test, and chi-square tests were conducted initially. Variables that were significant or of borderline significance in the bivariate analyses ($P < .15$) or had construct validity were used to build logistic and linear regression models for multivariate analyses.

Finally, because standards for distinguishing between ED crowding and noncrowding have not been established, sensitivity analyses were completed using alternate cutoff values for dichotomous definitions of crowded versus noncrowded periods for ED census (80–130% bed capacity) and mean ED LOS (80–130% annual mean ED LOS).

All analyses were performed using SAS 9.0 (SAS Institute, Inc., Cary, NC).

RESULTS

The original hip fracture study enrolled 179 patients from this study site. Of these, 158 were admitted from the ED and were included in this study. Mean patient age was 83 (range 52–101), 79.7% (n = 126) were female, 81.0% (n = 128) reported a complaint of pain, and 72.8% (n = 115) had documentation of pain assessment (Table 1). The mean time to first documented pain assessment was 40 minutes (range 0–600 minutes); mean time to first documented pain treatment was 141 minutes (range 10–525 minutes); mean time between first documented pain assessment and pain treatment was 122 minutes (range 0–526 minutes). Log transformation of time data revealed normal distribution. Of those reporting complaints of pain (n = 128), 35.9% received no analgesic, 7.0% received nonopioid medication (e.g., acetaminophen), and 57.0% received an opioid. Of the patients who received opioids (n = 73), 32.8% received meperidine (Table 1).

The ED crowding variables, ED census, and mean ED LOS were not significantly correlated (Pearson correlation coefficient = 0.09, $P = .27$). Sensitivity analyses were conducted of the ED crowding factors, ED census, and mean ED LOS, using alternate dichotomous cutoffs for crowded and noncrowded periods. A sample of these analyses for ED census is shown in Table 2. ED census levels greater than 120% bed capacity were associated with a statistically significantly lower probability of documented pain assessment than census levels of 120% bed capacity or less (odds ratio (OR) = 0.47 (95% confidence interval (CI) = 0.22–0.97; $P = .04$). Remaining sensitivity analyses of ED census and mean LOS did not reveal additional trends or associations.

Using the results of the sensitivity analyses to establish parameters for dichotomous variables, it was found that greater ED census (>120% bed capacity) was significantly

Table 2. Comparison of Pain Management Outcomes with Alternate Cutoffs for Emergency Department Census (N = 158)

		Documentation of Pain Assessment		Received Analgesia	
Percentage of Bed Capacity (Census)	Hip Fracture Patients n (%)	Odds Ratio (95% Confidence Interval)	*P*-value	Odds Ratio (95% Confidence Interval)	*P*-value
140 (>51)	34 (21.5)	0.52 (0.23–1.15)	.10	2.14 (0.92–4.97)	.07
130 (>47)	40 (25.3)	0.45 (0.21–0.96)	.04	2.08 (0.95–4.55)	.06
120 (>44)	50 (31.6)	0.47 (0.22–0.97)	.04	1.64 (0.81–3.32)	.17
110 (>40)	69 (43.7)	0.51 (0.25–1.03)	.06	1.31 (0.69–2.50)	.41
100 (>36)	83 (52.5)	0.56 (0.27–1.15)	.11	1.12 (0.59–2.12)	.72
90 (>33)	92 (58.2)	0.77 (0.38–1.58)	.48	1.08 (0.57–2.00)	.82
80 (>29)	110 (69.6)	0.99 (0.46–2.12)	.98	0.98 (0.49–1.97)	.96

Table 3. Multivariate Logistic and Linear Analyses of Risk Factors with Outcomes

Variable	Documentation of Pain Assessment		Received Analgesia		Ln (Time to Pain Assessment)		Ln (Time to Pain Treatment)	
	Odds Ratio (95% CI)	*P*-value	Odds Ratio (95% CI)	*P*-value	Parameter Estimate (95% CI)	*P*-value	Parameter Estimate (95% CI)	*P*-value
Age	0.99 (0.96–1.04)	.86	0.99 (0.96–1.03)	.77	− 0.003 (− 0.027–0.022)	.81	− 0.01 (− 0.03–0.02)	.58
Male*	0.83 (0.33–2.10)	.70	0.343 (0.14–0.77)	.01	0.44 (− 0.09–0.98)	.10	0.24 (− 0.58–1.06)	.56
RAND score ≤2	1.33 (0.63–2.82)	.45	1.02 (0.52–2.01)	.96	− 0.23 (− 0.65–0.19)	.28	0.02 (− 0.41–0.44)	.95
Dementia	1.43 (0.65–3.11)	.37	0.76 (0.37–1.54)	.45	− 0.45 (− 0.89–0.01)	.04	− 0.05 (− 0.51–0.40)	.81
Census >120%*	0.46 (0.21–0.98)	.05	2.02 (0.89–4.62)	.10	0.79 (0.25–1.32)	.01	0.19 (− 0.29–0.67)	.44
Mean emergency department length of stay >100% annual	0.85 (0.39–1.88)	.70	1.17 (0.55–2.45)	.69	− 0.14 (− 0.58–0.30)	.54	0.22 (− 0.25–0.69)	.36

* $P < .15$ in the bivariate analyses.
CI = confidence interval.

associated with a lower likelihood of having pain documentation on first assessment (OR = 0.46, 95% CI = 0.21 − 0.98; $P = .05$) and a longer time to pain assessment (parameter estimate = 0.79 (log transformation of 6.13 minutes), $P = .01$) in multivariate analyses (Table 3). ED census was not associated with other outcome variables or opioid prescribing. ED LOS was not significantly associated with any of the outcome variables.

DISCUSSION

The Joint Commission on Accreditation of Healthcare Organizations[21] and the Institute of Medicine[22] recognized the management of pain as an entity requiring performance standards with timeliness and adequacy. Previous studies have provided limited information about the quality of pain management for older adults in the ED setting. With greater ED crowding and the growing population of older adults with unique patient-related risk factors in the healthcare system, there is the potential for delivery of poorer quality care. This study found that older adults with hip fracture were at risk for undertreatment of pain (oligoanalgesia), considerable delays in analgesic administration once pain was identified, and treatment with inappropriate analgesics (i.e., meperidine) in the ED. Factors significantly associated with pain management for this group included ED crowding as measured according to census threshold levels beyond bed capacity, the presence of dementia, and sex.

The significant association between ED crowding, as measured according to ED census levels greater than 120% bed capacity, and poorer-quality pain management is an important finding, because it provides evidence that ED crowding is associated with and may affect patient care. (For this study, census levels greater than 120% vs 120% or less bed capacity occurred with 50 vs 108 of the hip fracture patients.) Specifically, during periods of greater patient volume, hip fracture patients had less documentation of pain on first assessment and longer times to pain assessment. During periods of heavy volume, it is likely that busy staff are less attentive and responsive to complaints of painful conditions, especially in vulnerable patients, such as older people who, because of cognitive (delirium, dementia) or sensory impairments (e.g., hearing), may not be able to advocate for their own care.

ED census as a measure of crowding only affected the quality of pain management when certain threshold levels were exceeded. For this particular ED, census significantly affected pain management at census levels greater than 120% bed capacity (Table 3). It is possible that individual EDs have unique threshold levels at which ED "bed crises" occur and that affect how care is delivered. This finding is consistent with stochastic modeling of inpatient hospital bed utilization demonstrating that, above 85% bed occupancy, risks to patients and the efficient delivery of emergency care become discernible and, above 90% occupancy, "bed crises" occur regularly.[23] Preliminary data using hourly ED occupancy rates as a measure of ED overcrowding have been shown to be associated with worse ED performance at distinct occupancy thresholds.[24]

Although ED crowding measures continue to be proposed and studied, there is not a criterion standard measure or established definition. The finding of ED census as a significant factor in the evaluation of ED crowding provides insight into what is likely a multifactorial phenomenon. It was speculated that, although ED census may be a simplistic measure, it could be used as an index of a much more complex condition. This may also account for the disparity seen in the correlation between ED census and mean ED LOS (Pearson correlation coefficient = 0.09, $P = .27$). Each factor may represent different facets of ED crowding. For example, an efficient ED, with a short mean ED LOS, may have a high ED census because of the greater patient turnover during a given period, or it is possible that an inefficient ED, with a long mean ED LOS, may have a high ED census, because patients back up and are slow to be discharged or transferred to the floor.

Disparities in ED pain management have been documented with respect to race, ethnicity, and age.[7–9] What is not known is the association with other patient-related risk factors often found with a geriatric patient population. It was hypothesized that older patients with greater polypharmacy and age-related changes in drug pharmacokinetics and pharmacodynamics might make physicians wary of prescribing sedating pain mediations. It was decided to

evaluate the association between sex, greater age ($\geq$85), comorbidity status, and the presence of dementia and the quality of pain management. Of these patient-related factors, sex and dementia appeared to affect time to pain assessment and receiving analgesia.

This study found that men received analgesia less frequently and showed a trend toward taking longer times to having their pain assessed and that patients with a history of dementia had quicker times to documented assessment of pain, although no significant differences existed in the other pain management outcomes. These findings are contrary to the hypotheses. Although a growing body of literature indicates that women and minorities often face undertreatment of pain, especially for metastatic cancer pain,[6,25] the predominance of women in this study (79.7%) may have biased the results. Additionally, previous work at this study institution on pain management in patients with dementia may have influenced the more-prompt assessment of pain in the ED for patients with dementia.[12]

Because this was a retrospective cohort study conducted at a single institution, the results may not be generalizable to all ED settings. The retrospective nature of medical record review limits the ability to ascertain the reliability of pain assessment and treatment documentation by the medical staff. As with all observational studies based on patient medical record review, it is possible that there was not complete documentation of pain assessment for patients in pain who received treatment for their pain, although given that adjustment to analgesic dosing and state-of-the-art pain control requires ongoing documentation of pain scores (akin to titrating dopamine for blood pressure or insulin for glucose), absence of pain documentation in the medical record is clinically similar to no documentation, because it cannot guide the analgesic care of the patient. It is also possible that practice patterns have changed since the late 1990s. Specifically, national data[26] suggest that overall use of meperidine is decreasing, and these data may overrepresent the use of this medication. In addition, the retrospective design of this study limits the ability to determine whether the estimates of ED crowding measures, ED census, and mean ED LOS were accurate and precise.

In conclusion, the findings of this study were significant for oligoanalgesia (only 64.1% of patients complaining of pain received medication), considerable delays in analgesic administration once pain was identified ($>$2 hours), and treatment with inappropriate analgesics (meperidine) in the ED for older patients with hip fractures. Factors significantly associated with pain assessment and treatment included ED crowding as measured according to census levels greater than 120% bed capacity, dementia, and sex. The finding that ED crowding, as measured according to census levels, negatively affects pain management provides direct evidence that this phenomenon adversely affects quality of care. Although this was a study conducted in a single medical center in the late 1990s, it is likely that this is an indication of the need for a better understanding of current and future ED pain-management guidelines. By studying patient-related factors that are unique to the older ED adult patient and factors intrinsic to the ED environment that may be associated with ED crowding, it may be possible to develop models for future prospective studies and target areas of quality improvement.

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