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Is adequate pain relief and time to analgesia associated with emergency department length of stay? A retrospective study

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ABSTRACT

Objectives: Evaluate the association of adequate analgesia and time to analgesia with emergency department (ED) length of stay (LOS).

Setting and Design: Post hoc analysis of real-time archived data.

Participants: We included all consecutive ED patients ≥18 years with pain intensity >6 (verbal numerical scale from 0 to 10), assigned to an ED bed, and whose pain was re-evaluated less than 1 h after receiving analgesic treatment.

Outcome measures: The main outcome was ED-LOS in patients who had adequate pain relief (AR=↓50% pain intensity) compared with those who did not have such relief (NR).

Results: A total of 2033 patients (mean age 49.5 years; 51% men) met our inclusion criteria; 58.3% were discharged, and 41.7% were admitted. Among patients discharged or admitted, there was no significant difference in ED-LOS between those with AR (median (25th–75th centile): 9.6 h (6.3–14.8) and 18.2 h (11.6–25.7), respectively) and NR (median (25th–75th centile): 9.6 h (6.6–16.0) and 17.4 h (11.3–26.5), respectively). After controlling for confounding factors, rapid time to analgesia (not AR) was associated with shorter ED-LOS of discharged and admitted patients (p<0.001 and <0.05, respectively). When adjusting for confounding variables, ED-LOS is shortened by 2 h (95% CI 1.1 to 2.8) when delay to receive analgesic is <90 min compared with >90 min for discharged and by 2.3 h (95% CI 0.17 to 4.4) for admitted patients.

Conclusions: In our study, AR was not linked with short ED-LOS. However, rapid administration of analgesia was associated with short ED-LOS.

Strengths and limitations of this study

- This is a rare study that examines the association between pain relief and length of stay in a large cohort of emergency department patients.
- This study also controlled for multiples confounding variables.
- The main limitation of our study is its post hoc design and preformed database from a single-centre study in an academic hospital.

INTRODUCTION

Emergency department (ED) overcrowding has been a concern for many years, and Canada is no exception, with nearly 60% of EDs reporting that problem in 2007.[1] The phenomenon of 'boarding' is one of the principal factors identified as its cause.[2 3] 'Boarding' (or 'access block') refers to situations where bedridden emergency patients wait for the allocation of a bed in the ward for an unreasonably long time period (prolonged ED length of stay (LOS) with consequent patient overflow in EDs. However, a recent retrospective study revealed that among patients waiting more than 6 h in the ED, 50% were finally admitted while the other 50% were discharged,[4] indicating that non-boarding patients' LOS also contributes to overcrowding. It has been shown to be a strong predictor of low satisfaction among patients[5] and healthcare workers.[1] It is also associated with long hospital LOS,[6 7] and high short-term and medium-term mortality rates.[8–10] Furthermore, overcrowding is linked with reduced timelines and quality of interventions and treatments,[11–13] including delayed analgesic administration,[14 15] particularly when pain is severe,[16] all of which contributes to the snowball effect of cumulating waits.

Pain represents more than 40% of consultations in EDs.[17] In large studies of patients with moderate-to-severe pain, only 21–68%[18–27] received analgesics, and 50–74% still had moderate-to-severe pain at discharge.[17] Severe, persistent pain may also lead to unwanted physiological responses, namely, increased adrenergic tone, augmented oxygen consumption, predisposition to hypercoagulability, decreased immune function and heightened risk of delirium.[28 29] Moreover, adequate and

timely treatment of acute pain could reduce the risk of chronic pain.[17] The relationship between pain management and LOS has not been studied as a primary outcome. However, a study of intermittent injection versus patient-controlled analgesia (PCA) for sickle cell crisis pain in the ED, established that PCA was associated with a significant reduction in the ED-LOS, although there was no difference in initial or final pain intensity score.[30]

Recent studies have attempted to identify the factors contributing to prolonged ED-LOS. Many of them have already been recognised, namely, number of laboratory examinations required, having to undergo X-ray or scan, the need for more than three medications, and number of consultants.[10 31] To the best of our knowledge, the adequacy and effectiveness of pain management have never been investigated in this regard. We sought to evaluate which component of initial pain management was associated with ED-LOS reduction. We hypothesised that ED-LOS would be lessened in patients with significant pain relief.

MATERIALS AND METHODS

Study design

We conducted a post hoc analysis of real-time archived data on all consecutive patients presenting with severe pain at our ED between March 2008 and February 2011. The aim of our study was to assess if pain relief was associated with ED-LOS reduction. As a secondary objective, we evaluated if time to receiving analgesic treatment was linked with lessened ED-LOS.

Setting

Hôpital du Sacré-Cœur de Montreal is an urban, adult, level I trauma centre with 540 inpatient beds and 60 000 ED visits/year. It sustains 22 000 hospitalisations annually, of which 51% are admitted through the ED. The study was approved by the institutional review board.

Selection of participants

Patients 18 years or older were included if they were assigned to an ED treatment bed, had severe pain at triage (defined as >6 on an 11-point verbal numerical scale from 0 to 10),[32–34] received an analgesic, and had their pain intensity re-evaluated in less than 1 h after such medication.

Patients were excluded if they died during their ED stay, were pregnant or had been transferred from another hospital. We also excluded patients with altered mental status, intoxicated subjects and anyone with chest pain necessitating emergent percutaneous coronary intervention, because their LOS would be determined by treatments other than pain management.

Data collection

Data were extracted from computerised information and nursing records in our ED (MedUrge, MediaMed Technologies, Mont-Saint-Hilaire, Québec, Canada). This system is an integrated and mandatory working tool for all physicians, nursing staff, and any employee involved in the ED healthcare process. It contains all demographic data, triage information (including vital signs, purpose of consultation, and pain level when relevant) as well as any pertinent data collected in real time by nurses during their re-evaluation rounds, including medication administration, and pain intensity.

Data processing

The cut-off of >6 on 10 was chosen because it was felt that lower pain intensity is less likely to warrant observation in itself. ED-LOS was measured in hours from the time of arrival at the ED to discharge or admission to a ward. We defined adequate pain relief (AR) as reduction of 50% or more of the initial pain level scored on the numerical scale within 1 h after receiving the first analgesic. The 50% reduction and the 1 h threshold are based on previous literature suggesting that they represent a meaningful decline[35 36] and acceptable delay in managing severe pain.[34 37 38] Initial pain was the one reported on the triage form. Time between arrival and analgesic administration was dichotomised into ≤90 vs >90 min and also analysed by three categories (<1; between 1 and 2; and >2 h). We selected a 90 min threshold because it is the median time to analgesia reported in many EDs with a pain scale integrated in their triage assessment.[19 39 40]

Our primary outcome was ED-LOS of patients with AR and without adequate pain relief (NR). Our secondary outcome was ED-LOS of patients who received their medication in ≤90 min compared with those who received it after a longer time period.

Data analysis

Median LOS (25th–75th centile) between groups of patients was compared by the Mann-Whitney U test and relationship among LOS and continuous predictors by Spearman rank-order correlations. Median differences and their 95% CI are also reported. All LOS are presented in hours and separately for patients with intravenous versus patients with other than intravenous route of analgesia administration. To examine the relative influence of AR and time to analgesia on LOS, generalised linear model regressions with γ-distribution and a log link function were undertaken for patients discharged from the ED and those admitted to a ward, controlling for age, gender, route of analgesia administration (intravenous vs other), number of doses of analgesia, type of arrival at ED (ambulance or walk-in), triage priority (high vs low), crowding defined as number of patients in ED beds at the time of arrival, time of day of arrival with high or low LOS (calculated from a database of 162 000 patients of 18 years or older assigned to a bed between March 2008 and February 2011 from the same ED and selecting hours of arrival with high LOS and hours of arrival with low LOS), time between arrival and physician's first assessment, number of examinations,

number of specialty consultations, baseline pain intensity score, trauma versus non-trauma, abdominal pain versus other, need for oxygen and for isolation. Generalised linear model was chosen because LOS is largely skewed and tends to produce less prediction errors than traditional linear regression.[41] Mean LOS difference and Wald 95% CI adjusted at mean covariates were produced from estimated marginal means. The Canadian healthcare system being public and free, the presence or absence of insurance was not analysed. α-Level was set at 0.05 for all statistical tests. All data were analysed with SPSS V.20 (IBM, Somers, New York, USA).

RESULTS

A total of 2033 patients met our inclusion and exclusion criteria. Of these patients, about half (51%) were male, more than two-third arrived at ED alone, 1186 (58.3%) were finally discharged and 847 were admitted (table 1).

Among patients who were discharged from the ED, 45.7% had AR compared with 40.3% of admitted patients. There was no significant difference in ED-LOS between patients with AR compared with those NR (p=0.41 for discharged patients and p=0.87 for admitted patients; table 2).

Among patients who were discharged from the ED, 533 (45%) received analgesia in ≤90 min, with unadjusted ED-LOS reduction of 2.2 h (95% CI 1.4 to 3.0; p<0.001) compared with those with >90min. The same analysis was applied to patients being admitted: only 265 (31%) received their medication in that interval, and their median unadjusted ED-LOS reduction was 3.9 h (95% CI 2.0 to 5.7; p<0.001; table 2). Median ED-LOS for three different times to receive analgesia is displayed in table 3.

Tables 4 and 5 show the bivariate relations between LOS and all confounding variables controlled for route of analgesia administration for discharged and admitted patients, respectively. For discharged patients with intravenous route of analgesia administration—only type of arrival, crowding and baseline pain intensity score were not related to LOS; while for other than intravenous route of analgesia administration—type of arrival, triage priority, oxygen support, time of day LOS, crowding and baseline pain intensity score were not associated with LOS. For admitted patients with intravenous route of analgesia administration—triage priority, type of arrival, blood testing, time of day LOS, crowding, number of doses and baseline pain intensity score were not related to LOS; while for other than intravenous route of analgesia administration—gender, triage priority, type of arrival, trauma injury, abdominal pain, time of day LOS and time to patient care by physician were not associated with LOS.

Multivariate analysis showed that when controlling for confounding variables, a brief time period (≤90 min) before analgesic administration (not AR) is associated with shortened ED-LOS for discharged and admitted patients (β=0.16; 95% CI 0.10 to 0.22; p<0.001 and β=0.09; 95% CI 0.006 to 0.18; p<0.05, respectively). When adjusting for confounding variables, ED-LOS is shortened by 2 h (95% CI 1.1 to 2.8; p<0.001) when time to receive analgesic is <90 compared with >90 min for discharged and by 2.3 h (95% CI 0.17 to 4.4; p<0.05) for admitted patients.

Table 1 Patient characteristics of the whole sample

Characteristics	Total (N=2033)
Mean age (±SD)	49.5 (17)
Male (%)	51
Triage priority (%)	
High (1–2)	45.3
Low (3–5)	54.7
Arrival (%)	
Ambulance	29.2
Walk-in	70.8
Admitted (%)	41.7
Discharged	58.3
Treated with opiates only (%)	66.7
Treated with non-opiates only	11.1
Treated with combination	22.2
Route of analgesia administration (%)	
Intravenous	62
Other	38
With trauma injury (%)	7.6
With abdominal pain (%)	39.5
With blood test (%)	6.4
With heart-rate monitoring (%)	11.7
With oxygen support (%)	9.5
In isolation (%)	4.5
Mean (±SD) baseline pain intensity score	8.8 (1.1)
Mean (±SD) final pain intensity score	5.1 (3)
Median LOS in hours (25th–75th centile)	12.3 (7.8–20.3)
Median time between arrival at ED and analgesic treatment in hours (25th–75th centile)	1.8 (1.1–3.2)
Median time to patient care by physician in hours (25th–75th centile)	0.72 (0.42–1.4)

ED, emergency department; LOS, length of stay.

LIMITATIONS

The main limitation of our study is its post hoc design and preformed database. Potential confounding variables, such as ethnicity and linguistic barrier, which are not recorded in demographic charts of our computerised system, could not be taken into consideration. Time from pain onset, component of chronic pain and pharmacological or non-pharmacological analgesia prior to arrival at the ED were also unknown. Case complexity assessment was difficult, although we controlled for number of examinations, number of consultants, need for oxygen and for isolation, which are markers of complexity. Likewise, we do not know if some patients did

Table 2 Median unadjusted LOS differences (25th–75th centiles) for pain relief groups and time to analgesia groups

	LOS in hour median (25th–75th centile)	LOS in hour median (25th–75th centile)	Median difference (±95% CI)
Disposition after ED	**Adequate relief**	**No adequate relief**	
Discharged patients	9.6 (6.3–14.8)	9.6 (6.6–16.0)	0.02 (−0.81 to 0.86)
Admitted patients	18.2 (11.6–25.7)	17.4 (11.3–26.5)	−0.8 (−2.8 to 1.1)
Total	11.9 (7.8–19.6)	12.6 (7.8–20.6)	−0.7 (−1.6 to 0.3)
Disposition after ED	**≤1.5 h delay**	**>1.5 h delay**	
Discharged patients	8.5 (5.8–12.5)	10.8 (7.3–17.7)	2.2* (1.4 to 3.0)
Admitted patients	15.2 (10.4–22.6)	19.1 (11.8–27.6)	3.9* (2.0 to 5.7)
Total	10.1 (6.6–16.3)	14.1 (9.0–22.7)	4.0* (2.3 to 5.6)

*p<0.001.
ED, emergency department; LOS, length of stay.

not receive an analgesic nor had suboptimal pain management because of refusal. However, it is doubtful that any of these confounding variables would cause significant differential bias. Finally, our single-centre study in an academic hospital might limit the generalisation of our results.

DISCUSSION

As far as we know, this is the first investigation to evaluate the impact of pain relief on ED-LOS, and our results demonstrated that rapid administration of analgesia (not AR), is associated with shorter ED-LOS. It has been reported that patients expect to receive pain medication 25–30 min after their arrival,[42] which coincides with the guidelines of our triage system (Canadian Emergency Department Triage and Acuity Scale).[43] Unfortunately, this goal is far from being achieved in many EDs, not only in Canada, but also around the world.[19 27 42] This is a persistent problem that dates back to the late 1980s when Wilson and Pendleton[44] first defined the term 'oligoanalgesia'.

Recently, the Pain and Emergency Medicine Initiative study demonstrated that patient satisfaction was associated more with the way ED physicians responded to their symptoms of pain than to the actual result of pain treatment.[19] Which components of this response to pain were significant was not specified, but a possible part of it was the promptness with which pain was addressed. Patients with severe pain probably associate receiving pain medication quickly with quality of care and are more inclined to accept a medical treatment plan, even if they do not get relief. This might explain why we observed improved ED-LOS with prompt analgesic administration in patients being discharged or admitted.

In our study, the adjusted ED-LOS was 2 h shorter in discharged patients who received their medication in ≤90 min than in those treated in >90 min. The rapid administration of analgesia, associated with shorter ED-LOS, could have a significant impact on ED overcrowding. For example, our centre received an average of 5000 patients/year with severe pain on an ED bed. If we extrapolate the proportion of patients who received analgesia in >90 min after arrival and the time saved if received in less than 90 min from our study of this population, a bed could be available during 16 h every day. Such economy of beds would contribute to better throughput of patients and render our EDs more efficient, as espoused by Asplin *et al*[2] with their conceptual model of overcrowding in 2003.

A recent consensus of the Canadian Association of Emergency Physicians has ranked 'ED-LOS' and 'time to

Table 3 Median LOS (25th–75th centiles) for three different times to receive analgesia controlled for route of analgesia administration for discharged and admitted patients

Disposition after ED	IV LOS in hour median (25th–75th centile)	Other than IV LOS in hour median (25th–75th centile)
Discharged patients	(N=698)	(N=481)
Time to receive analgesia		
<1 h	8.6 (6.0–11.8)	6.6 (4.4–9.5)
From 1 to 2 h	10.5 (6.9–15.9)	8.2 (5.4–12.2)
>2 h	12.9 (8.9–18.0)	10.1 (6.3–19.2)
Admitted patients	(N=556)	(N=289)
Time to receive analgesia		
<1 h	16.4 (10.8–23.8)	17.2 (10.7–24.8)
From 1 to 2 h	14.9 (10.4–22.6)	18.1 (10.0–26.4)
>2 h	18.7 (11.6–27.4)	19.6 (12.9–28.7)

ED, emergency department; IV, intravenous route of analgesia administration; LOS, length of stay.

Table 4 Relationship between LOS and all confounding variables for discharged patients

Confounding variables	IV LOS in hour (N=702)	Other than IV LOS in hour (N=484)
Categorical confounders	Median (25th–75th centile)	Median (25th–75th centile)
Gender		
Male	9.5 (6.7–15.0)**	8.0 (5.5–12.3)**
Female	11.1 (7.9–16.9)	9.8 (6.1–18.4)
Triage priority		
High (1–2)	9.7 (6.7–15.3)**	8.8 (5.8–13.1)
Low (3–5)	10.8 (7.9–17.0)	8.8 (5.8–15.0)
Arrival		
Ambulance	10.8 (7.3–16.3)	8.8 (5.7–15.5)
Walk-in	10.0 (7.2–15.7)	8.7 (5.8–13.5)
Trauma injury		
Yes	7.1 (4.1–13.0)**	6.4 (4.6–12.7)**
No	10.4 (7.3–15.9)	9.0 (5.9–14.8)
Abdominal pain		
Yes	11.3 (7.8–17.5)**	10.5 (5.7–13.4)**
No	9.6 (6.9–14.6)	8.3 (6.9–14.6)
Blood test		
Yes	16.4 (10.2–23.6)**	18.5 (11.6–25.0)**
No	10.0 (7.1–15.5)	8.6 (5.8–13.8)
Heart-rate monitoring		
Yes	14.6 (10.6–24.4)**	12.7 (9.2–27.8)**
No	9.8 (6.9–15.2)	8.2 (5.7–13.4)
Oxygen support		
Yes	13.5 (8.7–23.0)**	10.4 (8.7–23.0)
No	10.0 (7.1–15.4)	8.6 (5.7–14.0)
Isolation		
Yes	22.7 (11.3–36.7)**	22.6 (11.7–44.3)**
No	10.0 (7.1–15.7)	8.6 (5.8–13.5)
Time of day of arrival with		
Low LOS	9.0 (7.1–10.7)**	8.6 (6.1–10.4)
High LOS	11.1 (7.2–16.9)	8.8 (5.7–15.2)
Continuous confounders	Spearman rank-order correlation	Spearman rank-order correlation
Age	0.18**	0.09*
Crowding	0.06	−0.06
Time to patient care by physician	0.21**	0.19**
Number of examinations (range 0–15)	0.33**	0.29**
Number of specialist consultations (range 0–8)	0.41**	0.44**
Number of doses (range 1–7)	−0.13**	−0.10*
Baseline pain intensity score	−0.06	−0.01

IV, intravenous route of analgesia administration; LOS, length of stay.
*p<0.05; **p<0.01.

first dose of analgesic' in the top 12 priority indicators of quality care.[45] In the USA, the Joint Commission on Accreditation of Healthcare Organizations mentions 'early intervention' as the first goal in the treatment of acute pain.[37] Similarly, the Australian National Institute of Clinical Studies ranked 'reduced time to analgesia' as the top priority and is currently working on improving their numbers.[42]

New solutions are being proposed to improve the initial approach to pain management. For example, the simple act of making pain scoring mandatory at triage has been shown to reduce time to analgesia by 45 min.[40] Extension of this practice could also integrate pain treatment as early as triage to limit further delays. Such measures have been introduced in Australia where nurse-initiated pain protocols are currently being evaluated. A paediatric ED study has shown 50% reduction of time to analgesia with such a protocol.[39] Early administration of analgesics has been investigated in prehospital settings, and appears to be safe and effective, particularly with the use of intranasal fentanyl.[46 47] Even if no study has yet shown a benefit of this practice in LOS, it certainly has promising advantages, and further investigations should be considered.

In summary, we found that shorter time to analgesia administration is associated with ED-LOS reduction. This observation supports recent interest in analgesia implementation as early as triage or in prehospital settings to improve the throughput component of the overcrowding phenomenon seen in EDs around the world.

Table 5 Relationship between LOS and all confounding variables for admitted patients

Confounding variables	IV LOS in hour (N=558)	Other than IV LOS in hour (N=289)
Categorical confounders	Median (25th–75th centile)	Median (25th–75th centile)
Gender		
Male	15.4 (10.5–23.6)*	18.9 (11.4–27.5)
Female	18.0 (11.7–25.4)	19.5 (12.7–27.9)
Triage priority		
High (1–2)	16.4 (10.4–24.5)	18.4 (11.1–25.8)
Low (3–5)	17.2 (11.7–25.0)	19.5 (12.9–27.6)
Arrival		
Ambulance	17.0 (10.7–25.3)	20.7 (13.5–28.4)
Walk-in	16.6 (11.4–24.5)	18.4 (12.0–26.9)
Trauma injury		
Yes	12.5 (8.7–21.1)*	15.7 (8.2–27.6)
No	17.0 (11.4–24.8)	19.4 (12.6–27.6)
Abdominal pain		
Yes	16.0 (10.9–23.3)*	19.4 (12.9–26.7)
No	18.0 (11.5–27.6)	19.3 (11.6–28.2)
Blood test		
Yes	19.8 (11.8–28.5)	27.9 (16.4–35.8)**
No	16.4 (10.9–24.5)	18.8 (11.6–26.8)
Heart-rate monitoring		
Yes	23.1 (16.2–38.6)**	30.0 (25.3–45.2)**
No	15.6 (10.7–23.1)	17.8 (11.3–25.7)
Oxygen support		
Yes	20.9 (12.3–34.4)**	26.8 (15.1–45.0)**
No	15.9 (10.8–24.1)	18.7 (11.7–26.7)
Isolation		
Yes	30.1 (21.8–54.3)**	35.5 (22.6–57.8)**
No	15.9 (10.8–23.8)	18.5 (11.6–26.7)
Time of day of arrival with		
Low LOS	15.7 (9.7–29.1)	16.2 (10.6–24.2)
High LOS	17.0 (11.4–24.5)	19.8 (12.7–27.8)
Continuous confounders	Spearman rank-order correlation	Spearman rank-order correlation
Age	0.15**	0.22**
Crowding	0.03	0.17**
Time to patient care by physician	0.16**	0.06
Number of examinations (range 0–15)	0.34**	0.36**
Number of specialist consultations (range 0–8)	0.31**	0.37**
Number of doses (range 1–7)	−0.03	−0.15**
Baseline pain intensity score	0.003	−0.12*

IV, intravenous route of analgesia administration; LOS, length of stay.
*p<0.05; **p<0.01.

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