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ORIGINAL RESEARCH ARTICLE

Time to analgesia delivery in musculoskeletal trauma care: An observational study

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Abstract

Introduction: Timely administration of analgesia is fundamental to emergency musculoskeletal trauma care. Delays contribute to suboptimal outcomes, patient dissatisfaction, and the potential progression to chronic pain.
Objective: This study aims to assess door-to-analgesia time (DTAT) in the emergency department (ED) and to identify factors contributing to delays.
Methods: A prospective observational study was conducted over 5 months, enrolling 90 adult patients with musculoskeletal trauma at an urban tertiary ED. Pain intensity was recorded using a numerical rating scale at triage, pre- and post-analgesia, and discharge. Patients were stratified into Group A (DTAT ≤30 min) and Group B (DTAT >30 min). Statistical analyses were performed to identify predictors of delayed analgesia and to evaluate pain relief efficacy.
Results: The mean DTAT was 40.6 min, with 45% of patients receiving analgesia within 30 min. Older age (>45 years) was a significant predictor of prolonged DTAT (>45 min; $p<0.05$). No significant differences in DTAT were observed across triage categories (T2: 34.4 min vs. T3: 43.6 min; $p>0.05$). Analgesia administration led to a 50% reduction in mean pain score; however, DTAT was not significantly associated with patient satisfaction.
Conclusion: Delayed analgesia remains a challenge, particularly among older patients. Strategies such as nurse-initiated analgesia, enhanced triage protocols, and optimized resource allocation may improve DTAT and patient outcomes. Multicenter studies are warranted to validate and refine pain management protocols in ED settings.

Keywords: Musculoskeletal trauma; Pain; Analgesia time; Quality improvement

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1. Introduction

Pain is one of the most frequent complaints for which patients come to the hospital and, particularly, to the emergency department (ED). The International Association for the

Study of Pain defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.[1] Pain affects billions of people worldwide, contributing to high levels of disability and mortality.[2] Given its wide-ranging burden, effective pain management remains one of the key priorities in health care.[3] Among the many conditions associated with pain that present in the ED, musculoskeletal trauma is particularly distressing; therefore, significant attention has been directed toward addressing it by clinicians and researchers.[4]

Relieving pain is an essential component of emergency care management, and analgesia is among the most frequently requested treatments by patients in the ED.[5] Prompt and effective pain management improves not only patient comfort but also diminishes systemic opioid side effects, stress responses, and the risk of developing chronic pain.[5] Considering these imperatives, clinical guidelines, such as those issued by the British Association of Accident and Emergency Medicine, recommend that patients with severe pain (pain score 7–10) receive analgesia within 20 min of arrival at the ED.[6]

Despite the well-established benefits of early analgesia, studies indicate a persistent gap between physicians' perceptions of patients' pain and the actual pain experienced.[7] Alarming data indicate that up to 70% of patients with acute painful conditions do not receive timely analgesia in the ED, where pain management is often deprioritized in acute care settings.[8] This phenomenon, known as "oligoanalgesia," represents a widespread challenge in emergency medicine. Contributing factors include inadequate knowledge of analgesic dosing, underestimation of pain severity, and insufficient patient reassessment for pain relief.[9,10] The consequences of oligoanalgesia extend beyond immediate discomfort, leading to increased psychological distress, heightened physiological stress responses, and a greater risk of chronic pain development.[9-11]

Moreover, early administration of analgesia is crucial for improving patient outcomes and satisfaction. In this study, we investigate delays in analgesia administration with a focus on the door-to-analgesia time (DTAT) model, which measures the interval between patient arrival and the provision of analgesia. Conducted at an urban Malaysian academic tertiary care hospital managing approximately 90,000 ED visits annually, this study aims to quantify the proportion of patients experiencing delayed analgesia due to musculoskeletal injuries, defined as DTAT >20, >30, or >45 min. We also examine major predictive factors for this delay, including triage processes, pain scores, physician level, and analgesia prescription and administration practices.

In summary, although no universally accepted DTAT standard exists, several guidelines and prior studies have established reference thresholds. For instance, the Royal College of Emergency Medicine (RCEM) recommends analgesia within 15 min for moderate-to-severe pain,[6] while the British Association of Accident and Emergency Medicine proposes administration within 20 min.[6] Observational studies have also used 30- and 45-min thresholds as pragmatic benchmarks to evaluate the timeliness of analgesia delivery in high-volume emergency settings.[12,13] We therefore selected 20-, 30-, and 45-min thresholds to allow comparison with both guidelines-recommended and real-world performance targets. Thus, it is imperative to investigate modifiable factors that can optimize pain management. By identifying determinants of delayed analgesia, this study seeks to inform strategies for enhancing ED pain protocols, ultimately improving patient care and clinical efficiency in musculoskeletal trauma cases.

2. Materials and methods

2.1. Study design and setting

This prospective observational study was conducted at the ED of the University of Malaya Medical Centre, a tertiary academic hospital with an annual patient volume of approximately 90,068 cases, of which 10% (8,254 cases) presented with musculoskeletal trauma-related pain.

2.2. Participant selection

Patients were eligible if they were ≥18 years old and presented with pain due to musculoskeletal injuries, and were either discharged home or admitted to the ward. In addition, participants needed to be alert and able to communicate effectively with the research medical officer.

Patients were excluded if they had:
(i) Pain attributed to acute coronary syndromes, acute abdomen, or head injuries
(ii) Glasgow coma scale <15 or altered mental status at triage
(iii) Evidence of alcohol intoxication
(iv) Self-administration of analgesia within 4 h before ED arrival
(v) Polytrauma requiring active or partial resuscitation
(vi) Hemodynamic instability (systolic blood pressure <90 mmHg or heart rate >120 beats/min)
(vii) Non-traumatic pain or cases where analgesia was deemed unnecessary.

2.3. Sample size calculation

For an absolute risk difference of 10% between the hypothesized (analgesia given within 30 min) and actual population proportion achieving timely analgesia, with $\alpha = 0.05$ and power = 0.80, and accounting for a 20% non-response rate, the required sample size was estimated at 90 participants.

2.4. Data collection and measurement

At triage, patient data were systematically recorded, including:

(i) Demographics (e.g., age, gender, ethnicity, and education level)
(ii) Clinical variables (e.g., triage level and time of arrival)
(iii) Injury characteristics (e.g., type, site, number, mechanism, and duration)
(iv) Pain scores were assessed using an 11-point numerical rating scale (NRS) at triage (arrival), at analgesia administration (DTAT), 1 h post-analgesia, and at discharge or ward referral
(v) Analgesic administration details (e.g., drug type, route, dose, and administration time)
(vi) Physician seniority (senior: emergency physician/trainee; junior: medical officers/interns)
(vii) Patient satisfaction (Likert scale)
(viii) Total ED length of stay.

All data collectors underwent standardized training on pain assessment using the NRS to ensure inter-rater reliability. Inter-rater agreement was evaluated in a pilot cohort of 10 patients, achieving a κ-coefficient of 0.87.

The primary outcome was DTAT, defined as the time (minutes) from ED arrival to administration of the first analgesic dose. Patients were categorized based on DTAT ≤20, ≤30, and ≤45 min, in alignment with published guidelines and benchmarks.[6,12,13] Comparative analyses between these groups were conducted to identify demographic and clinical factors associated with delayed analgesia.

2.5. Statistical analysis

Descriptive statistics were used to summarize participant characteristics and clinical outcomes. Categorical variables were expressed as frequencies and percentages, whereas continuous variables were assessed for normality using the Shapiro–Wilk test and other distributional criteria. Normally distributed data were presented as mean ± standard deviation, and non-normally distributed data were reported as median (interquartile range). Between-group comparisons were performed using Pearson's Chi-square (χ^2) test or Fisher's exact test for categorical variables, independent samples *t*-test or one-way analysis of variance for normally distributed continuous variables, and Mann-Whitney U test or Kruskal–Wallis test for non-normally distributed continuous variables.

The primary outcome, DTAT, was analyzed using Cox proportional hazards regression to identify predictors of analgesic delay, with variables showing $p<0.10$ in univariate analysis included in the multivariate model. All regression analyses were evaluated for proportional hazards assumptions, linearity, and multicollinearity. Statistical significance was set at $p<0.05$ (two-tailed), and all analyses were conducted using Statistical Package for the Social Sciences version 25.0 (IBM Corporation, United States) and R Statistical Software version 4.3.1 (R Foundation for Statistical Computing, Austria).

2.6. Ethical considerations

The study received ethical approval from the University of Malaya Research Ethics Committee (approval number: 2013–161203/EM/R/MHA), and written informed consent was obtained from all participants or their next-of-kin before enrollment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

3. Results

3.1. Demographic

In this study, 90 out of 100 patients completed the assessments (Table 1). The mean age was 39.43 years. Among them, 68 (75.6%) were male, and the majority were Malay (*n* = 38; 42.2%), followed by Indian (*n* = 25; 27.8%),

Table 1. Demographic characteristics of patients (*n*=90)

Variables	Number of patients, *n* (%)
Gender	
Male	68 (75.6)
Female	22 (24.4)
Mean age±SD (years)	39.43±15.5
Ethnic group	
Malay	38 (42.2)
Chinese	12 (13.3)
Indian	25 (27.8)
Others[a]	15 (16.7)
Education level	
Illiterate	14 (15.6)
Primary education	23 (25.6)
Secondary education	28 (31.1)
Tertiary education	25 (27.8)
Triage zone	
Level 2, yellow (T2)	23 (26)
Level 3, green (T3)	67 (74)

Note: [a]Indonesians, Filipinos, and Bangladeshis.
Abbreviation: SD: Standard deviation.

Chinese ($n = 12$; 13.3%), and others, including Indonesians, Filipinos, and Bangladeshis ($n = 15$; 16.7%). Most participants had secondary education ($n = 28$; 31.1%), whereas 14 (15.6%) were illiterate. Approximately one-quarter had primary education ($n = 23$; 25.6%) and tertiary education ($n = 25$; 27.8%), respectively. Triage zone levels T2 (yellow) and T3 (green) comprised 23 (26%) and 67 (74%) patients, respectively. There was no significant association between the triage zone level and patient characteristics, including education level ($\chi^2 = 3.498$; degrees of freedom [df] = 3; p=0.32), gender ($\chi^2 = 3.381$; df = 3; p=0.401), and ethnicity ($\chi^2 = 2.391$; df = 3; p=0.495).

3.2. Types of musculoskeletal injuries

Abrasion was the most frequent injury ($n = 22$), followed by laceration ($n = 15$). Less common injuries included hematoma ($n = 6$), bruising ($n = 4$), and incision ($n = 1$). Some patients presented with multiple injury types, such as abrasion–laceration ($n = 7$), abrasion-bruising ($n = 2$), abrasion-hematoma ($n = 1$), and bruising-hematoma ($n = 2$). These findings indicate that abrasions were the most common injury, with lacerations also relatively frequent, while incisions were rare. A minority of patients presented with both abrasions and lacerations.

Fractures were also the most common injury ($n = 29$). In contrast, muscle cuts ($n = 9$), dislocations ($n = 6$), and concurrent fractures with dislocations ($n = 9$) were less frequent. These findings demonstrate that fractures accounted for over half of the injuries (55%), with muscle cuts and dislocations less common. A subset of patients (17%) had both fractures and dislocations.

3.3. Mechanism of injuries

Motor vehicle accidents (MVAs) were the most common mechanism of injury ($n = 42$). Falls were also frequent ($n = 25$). Less common mechanisms included industrial accidents ($n = 13$), assault ($n = 6$), and sports injuries ($n = 4$). Notably, MVAs accounted for more than half of the cases. Falls were the second most frequent cause, while industrial, assault, and sports-related injuries were less prevalent. There were no significant differences in time to analgesia administration between mechanisms of injury (p>0.05) (Table 2). These findings indicate that, regardless of whether the trauma was caused by an MVA, fall, industrial accident, assault, or sports injury, the time to analgesia delivery did not differ significantly across groups. This suggests that the mechanism of injury did not influence the timeliness of analgesia provision.

Table 2. Differences in door-to-analgesia time by mechanism of injury

MOI	Number of cases	DTAT (Mean±SD)
MVA	42	40.19±27.62
Sport injury	4	44.50±43.44
Fall	25	38.40±32.32
Assault	6	46.50±37.55
Industrial accident	13	46.92±30.66
Item	**MOI**	**Residual**
df	4	85
Sum Sq	876	80358
Mean Sq	219.0	945.4
F-value	0.232	
Pr(>*F*)	0.920	

Abbreviations: df: Degrees of freedom; DTAT: Door-to-analgesia time; MeanSq: Mean square; MOI: Mechanism of injury; MVA: Motor vehicle accident; SD: Standard deviation; SumSq: Sum of squares.

3.4. DTAT

The mean DTAT was 40.6 min, with 45% of patients receiving analgesia within the internationally recommended 30-min window; however, this remained above the RCEM standard, which recommends analgesic administration within 15 min for moderate to severe pain. Patients triaged to T2 had a shorter mean DTAT compared to those in T3 (34.4 vs. 43.6 min) (Table 3). Statistical analysis using the Welch two-sample t-test revealed no significant difference between the two triage categories ($t = -1.2243$; df = 36.219; p=0.2287), with a 95% confidence interval (CI) of −24.42 to 6.03 min.

In multivariate regression, age >45 years was a significant predictor of delay beyond 45 min (Figure 1). Among patients ≤45 years, analgesia time showed no association with age, whereas in those >45 years, it decreased significantly with increasing age. No other demographic (e.g., education, ethnicity, and gender) or clinical (e.g., time of arrival, pain duration at presentation, pain score at presentation) variables demonstrated an association. Subgroup analysis showed that patients presenting during peak hours (12 p.m.–6 p.m.) experienced longer DTAT (mean: 46 min) compared to off-peak hours (mean: 35 min), although this did not reach statistical significance (p=0.08).

3.5. Pain score

The mean presenting NRS score at triage was 6.43, which decreased by 50% to 3.22 following analgesia, admission, or discharge (Table 4). There was no significant difference in DTAT between T2 and T3 patients ($t = -1.224$, p=0.228). Approximately 39 patients (43.3%) had a DTAT of <15 min, while 29 (32.2%) received analgesia between 15 and 30 min after arrival (Table 4). At triage,

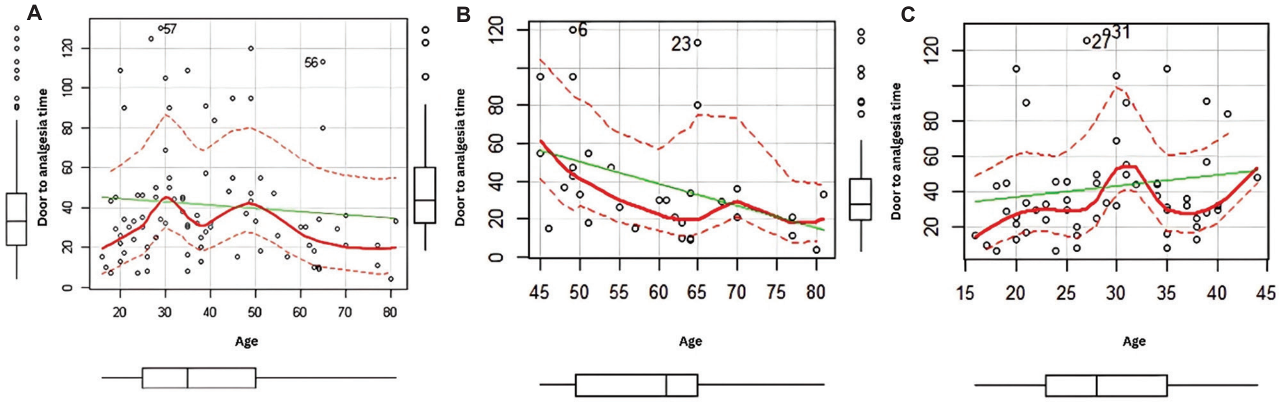

Figure 1. Scatter plot with trend line and confidence interval illustrating the association between door-to-analgesia time and patient age: (A) all patients, (B) patients aged >45 years (y = 0.606 [age] + 24.99; $p>0.05$), and (C) patients aged ≤45 years (y = −1.155 [age] +108.11; $p<0.05$).

Table 3. Treatment delay by triage zones T2 and T3

Treatment delay	Triage zone						χ^2 (df)	*p*-value
	T2		T3		Total			
	Count	Percentage within treatment delay (%)	Count	Percentage within treatment delay (%)	Count	Percentage within treatment delay (%)		
≤20 min	9	40.9	13	59.1	22	100	3.02 (1)	0.082
>20 min	15	22.1	53	77.3	68	100		
Total	24	26.7	66	73.3	90	100		
≤30 min	14	35.0	26	65.0	40	100	2.56 (1)	0.110
>30 min	10	20.0	40	80.0	50	100		
Total	24	26.7	66	73.3	90	100		
≤45 min	18	28.6	45	71.4	63	100	0.39 (1)	0.531
>45 min	6	22.2	21	77.8	27	100		
Total	24	26.7	66	73.3	90	100		

Note: Statistical significance was set at $p<0.05$ (two-tailed).

Table 4. Comparison of pain scores at triage, consultation, and admission/discharge

Statistics	Pain score at triage	Pain score at consultation	Pain score at admission/discharge
Mean	6.43	6.63	3.22
Median	6.50	7.00	3.00
Standard deviation	2.229	2.133	1.959
Minimum	2	2	0
Maximum	10	10	8

45 patients presented with severe pain (NRS score: 7–10; mean: 8.3), 36 with moderate pain (NRS score: 4–6; mean: 5), and nine with mild pain (NRS score: 1–3; mean: 2.66). Among patients with fracture–dislocation injuries, the mean pain scores decreased by 60% post-analgesia, suggesting higher responsiveness to analgesic intervention.

3.6. Patient satisfaction

Overall, 10 patients reported being highly satisfied, 65 were satisfied, and 15 were not satisfied, findings that were unrelated to DTAT delays (Figure 2). Satisfaction remained mostly stable, with a slight increase over time. Some variation in satisfaction levels was observed, as indicated by the scatter of points and CI. The majority of data points were concentrated within a lower range of ED stay duration, as shown in the boxplot in Figure 2A.

Based on the normal probability-probability (P–P) plot of regression standardized residuals for DTAT and patient satisfaction (Figure 2B), the model indicated that when patient satisfaction was zero, the predicted DTAT was approximately 34.162 min. The patient satisfaction coefficient (β = 0.948) indicated that for each unit increase in patient satisfaction, DTAT increased by 0.948 min. However, the *p*-value (p=0.853; $p>0.05$) was not significant,

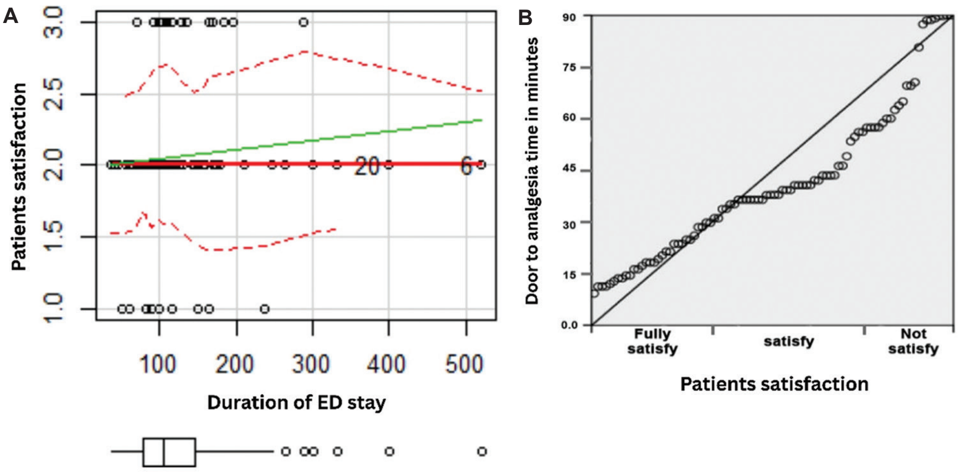

Figure 2. Relationship between patient satisfaction and ED stay duration. (A) Scatter plot with trend line and confidence interval illustrating the relationship between patient satisfaction and duration of ED stay. The green line indicates a slight positive trend, suggesting that longer ED stays may be associated with a modest increase in patient satisfaction. The red line represents the linear trend, with a minimal slope, indicating overall stable satisfaction over time. Dashed red lines depict the confidence interval. The boxplot below the scatter plot summarizes the distribution of ED stay durations, showing the median and data spread. (B) Normal probability plot of regression standardized residuals for door-to-analgesia time and patient satisfaction.
Abbreviation: ED: Emergency department.

indicating that the relationship between patient satisfaction and DTAT was not statistically significant.

4. Discussion

This observational study evaluated DTAT outcomes among musculoskeletal trauma patients based on triage categorization and identified factors influencing DTAT. Effective pain management is a cornerstone of emergency care, aiming to reduce or eliminate pain and restore patient functionality. Previous research has indicated that a significant proportion of trauma patients experience prolonged waits for analgesia, with many waiting over an hour before receiving pain relief.[14] Similarly, our findings revealed a mean DTAT of 40.6 min, with 45% of patients receiving analgesia within 30 min. Notably, T2 patients had a shorter mean DTAT than T3 patients (34.4 vs. 43.6 min), demonstrating the influence of triage prioritization. However, our study's DTAT was lower than that reported in British and American studies,[12,13,15] indicating potential institutional efficiencies in our setting.

Our investigation into DTAT predictors identified age over 45 years as a significant factor associated with delays exceeding 45 min for analgesia administration in the multivariate regression analysis. These findings align with a retrospective cohort study of 857 patients, which also reported that older patients experienced longer delays in opioid administration due to complex medical conditions and prioritization of younger trauma patients.[16] In addition, factors such as triage category, diagnosis, physician seniority, and ED disposition have been reported to influence analgesic delays.[16,17] Our study corroborates these findings, highlighting an average 15-min delay between T2 and T3 patients, thereby demonstrating the impact of triage priority on pain management. Interestingly, pain severity at presentation and duration of symptoms were not significantly associated with DTAT, a pattern consistent with other investigations in the field.

Another important determinant of DTAT is the role of healthcare providers in analgesic administration. In an Australian tertiary care hospital, 80% of registered nurses administered analgesics, including intravenous opioids.[18] A meta-analysis and systematic review further demonstrated that nurse-led analgesic administration reduced DTAT by an average of 30 min (Mean difference [MD]: 30.61 min; 95% CI: −50.58 to −10.64 min; p=0.003), leading to improved patient satisfaction and clinically significant pain reduction.[19] Given these findings, nurse-initiated analgesia protocols may be a viable strategy to enhance pain management efficiency in our setting.

Apart from provider roles, environmental factors in the ED also significantly influence DTAT. An Australian study highlighted that ED capacity and patient placement affected the timeliness of analgesic administration, with patients awaiting care in overcrowded areas experiencing longer DTAT.[20] Similarly, differences in staff availability across ED zones contribute to delays, with waiting areas often being understaffed compared to resuscitation units, leading to prolonged DTAT in the former.[21] Future studies should explore how patient placement in different ED zones affects DTAT to optimize resource allocation and patient flow management.

While gender and ethnicity have been previously associated with DTAT disparities,[22,23] no significant association between these variables and DTAT was observed in this study. However, previous research from the United States involving over 6,000 ED patients demonstrated that racial disparities exist in pain management, with non-Hispanic white patients more likely to receive timely analgesia compared to non-Hispanic Black, Hispanic, and other ethnic groups.[22,23] These findings suggest that healthcare disparities in pain management may vary across regions and should be further investigated in multicenter studies.

Interestingly, no association between injury type and DTAT was observed in this study, contrary to findings from a prior study examining analgesic prescribing patterns. The study reported shorter DTAT for injuries involving distal extremities, likely due to faster clinical assessments and management.[24] This discrepancy highlights the need for further research into the influence of injury location on DTAT variability.

A crucial outcome of our study is the 50% reduction in pain scores post-analgesia, indicating effective pain relief. Optimizing pain management strategies in the ED is essential for preventing chronic pain development and reducing healthcare costs. Interestingly, despite delayed analgesia in a proportion of patients, no significant association between DTAT and patient satisfaction was observed. Although faster pain relief would be expected to correlate directly with higher satisfaction, prior research demonstrates that patients often prioritize effective communication, perceived empathy, and overall care experience over analgesia timeliness.[19,21] In addition, the substantial reduction in pain intensity observed after treatment may have mitigated dissatisfaction related to delays. Therefore, this finding, while initially counterintuitive, is consistent with existing literature suggesting that patient satisfaction in the emergency setting is influenced by multiple factors beyond DTAT. It is noteworthy that despite achieving a 50% reduction in pain scores, the overall DTAT performance remained below the RCEM target of 15 min. Comparable studies in the United Kingdom have reported median DTATs exceeding 60 min in certain urban hospitals.[25] This underscores the universal challenge of oligoanalgesia, irrespective of healthcare system maturity.

Moreover, implementing validated pain scales, such as incorporating facial expression indicators alongside the NRS, could improve pain assessment accuracy.[26] In addition, employing a multimodal pain management approach, including non-opioid analgesics, opioids, and non-pharmacological methods (e.g., ice application, patient positioning), may enhance overall pain control and patient comfort.[27]

Several strategies have been shown to reduce DTAT and improve pain management efficiency. A previous study demonstrated that nurse-led triage interventions, enhanced nursing documentation standards, and department-wide education on early analgesic administration resulted in a 31% reduction in DTAT.[28] These findings highlight the importance of quality improvement initiatives, including nurse-led pain protocols and triage system enhancements, in reducing DTAT across various healthcare settings.

Although our multivariate model primarily identified age over 45 years as a significant predictor of delayed analgesia, other factors such as physician seniority, time of patient arrival, and the specific type or route of analgesia administered could also influence DTAT. For instance, prior studies suggest that senior clinicians may expedite pain management decisions,[18,19] and certain analgesics (e.g., intravenous opioids) may require longer preparation and monitoring times.[24] Due to sample size constraints, these variables were not fully explored in the regression model, highlighting an area for future research.

4.1. Limitations and future directions

This study, conducted in a single-center tertiary academic hospital, provides valuable institutional benchmarks for the 30-min DTAT target. However, its external validity requires further investigation through multicenter studies. While our sample size exceeded the minimum required for statistical adequacy, it may have missed weaker associations with DTAT. In addition, subgroup analyses examining clinician-level performance may provide further insights but would require larger sample sizes to maintain statistical power while ensuring participant anonymity. Moreover, we did not include physician seniority, time of arrival (daytime vs. nighttime shifts), and analgesic type in our multivariate regression due to limited statistical power. These factors should be considered in studies with larger sample sizes to delineate their independent contributions to DTAT delays. The Hawthorne effect, whereby staff may alter their behavior due to awareness of being observed, could have contributed to shorter DTAT than under routine practice conditions. However, the persistence of delays despite study oversight highlights systemic barriers. Future research should explore modifications to ED workflows, such as age-specific triage prioritization, alternative analgesic administration strategies, and patient placement optimizations, to enhance the timeliness and effectiveness of pain management. From a policy perspective, integrating nurse-initiated analgesia protocols and real-time DTAT dashboards could facilitate continuous quality improvement.

5. Conclusion

This study identified age over 45 years as a significant predictor of delayed DTAT, with triage categorization influencing the timeliness of analgesia. Despite achieving a 50% reduction in pain scores following analgesia, further improvements, such as nurse-led analgesic administration, the optimization of ED resource allocation, and the implementation of enhanced triage protocols, are warranted. Future multicenter studies across diverse healthcare settings are essential to validate these findings and to assess the feasibility of establishing universal DTAT benchmarks. Tailoring pain management protocols to accommodate local resources, cultural expectations, and patient demographics will be critical to improving emergency care outcomes.

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Conflict of interest

The authors declare they have no competing interests

Author contributions

Conceptualization: May Ohn, Zaw Myo Hein
Formal analysis: May Ohn, Zaw Myo Hein, Swe Swe Latt
Investigation: May Ohn, Khin Ohn
Methodology: May Ohn, Zaw Myo Hein
Writing–original draft: May Ohn
Writing–review & editing: All authors

Ethics approval and consent to participate

The study received ethical approval from the University of Malaya Research Ethics Committee (approval number: 2013-161203/EM/R/MHA), and written informed consent was obtained from all participants or their next-of-kin before enrollment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Consent for publication

Written informed consent for publication was obtained from all participants or their next-of-kin before enrollment.

Availability of data

Data are available from the corresponding author upon reasonable request.

References

1. Raja SN, Carr DB, Cohen M, *et al*. The revised international association for the study of pain definition of pain: Concepts, challenges, and compromises. *Pain*. 2020;161(9):1976-1982.

   doi: 10.1097/j.pain.0000000000001939

2. Blyth FM, Huckel Schneider C. Global burden of pain and global pain policy-creating a purposeful body of evidence. *Pain*. 2018;159(Suppl 1):S43-S48.

   doi: 10.1097/j.pain.0000000000001311

3. Andrews JS, Cenzer IS, Yelin E, Covinsky KE. Pain as a risk factor for disability or death. *J Am Geriatr Soc*. 2013;61(4):583-589.

   doi: 10.1111/jgs.12172

4. Todd KH. A review of current and emerging approaches to pain management in the emergency department. *Pain Ther*. 2017;6(2):193-202.

   doi: 10.1007/s40122-017-0090-5

5. Hodkinson M. Where is the paramedic profession going with pain management? *J Paramed Pract*. 2016;8(3):118-120.

   doi: 10.12968/jpar.2016.8.3.118

6. Grant PS. Analgesia delivery in the ED. *Am J Emerg Med*. 2006;24(7):806-809.

   doi: 10.1016/j.ajem.2006.05.004

7. Cakir U, Cete Y, Yigit O, Bozdemir MN. Improvement in physician pain perception with using pain scales. *Eur J Trauma Emerg Surg*. 2018;44(6):909-915.

   doi: 10.1007/s00068-017-0882-7

8. Calil AM, Pimenta CA, Birolini D. The "oligoanalgesia problem" in the emergency care. *Clinics (Sao Paulo)*. 2007;62(5):591-598.

   doi: 10.1590/s1807-59322007000500010

9. Fabbri A, Voza A, Riccardi A, Study and Research Center of the Italian Society of Emergency Medicine. The pain management of trauma patients in the emergency department. *J Clin Med*. 2023;12(9):3289.

   doi: 10.3390/jcm12093289

10. Sinatra R. Causes and consequences of inadequate management of acute pain. *Pain Med*. 2010;11(12):1859-1871.

    doi: 10.1111/j.1526-4637.2010.00983.x

11. Green SM. There is oligo-evidence for oligoanalgesia. *Ann Emerg Med*. 2012;60(2):212-214.

    doi: 10.1016/j.annemergmed.2012.06.006

12. Awolola AM, Campbell L, Ross A. Pain management in patients with long-bone fractures in a district hospital in KwaZulu-Natal, South Africa. *Afr J Prim Health Care Fam Med*. 2015;7(1):818.

doi: 10.4102/phcfm.v7i1.818

13. Hatherley C, Jennings N, Cross R. Time to analgesia and pain score documentation best practice standards for the emergency department - a literature review. *Australas Emerg Nurs J*. 2016;19(1):26-36.

doi: 10.1016/j.aenj.2015.11.001

14. Ducharme J, Tanabe P, Homel P, *et al*. The influence of triage systems and triage scores on timeliness of ED analgesic administration. *Am J Emerg Med*. 2008;26(8):867-873.

doi: 10.1016/j.ajem.2007.11.020

15. Todd KH, Ducharme J, Choiniere M, *et al*. Pain in the emergency department: Results of the pain and emergency medicine initiative (PEMI) multicenter study. *J Pain*. 2007;8(6):460-466.

doi: 10.1016/j.jpain.2006.12.005

16. Arendts G, Fry M. Factors associated with delay to opiate analgesia in emergency departments. *J Pain*. 2006;7(9):682-686.

doi: 10.1016/j.jpain.2006.03.003

17. Hughes JA, Cabilan CJ, Staib A. Effect of the 4-h target on time-to-analgesia in an Australian emergency department: A pilot retrospective observational study. *Aust Health Rev*. 2017;41(2):185-191.

doi: 10.1071/AH16025

18. Cabilan CJ, Eley R, Hughes JA, Sinnott M. Medication knowledge and willingness to nurse-initiate medications in an emergency department: A mixed-methods study. *J Adv Nurs*. 2016;72(2):396-408.

doi: 10.1111/jan.12840

19. Cabilan CJ, Boyde M. A systematic review of the impact of nurse-initiated medications in the emergency department. *Australas Emerg Nurs J*. 2017;20(2):53-62.

doi: 10.1016/j.aenj.2017.04.001

20. Carter EJ, Pouch SM, Larson EL. The relationship between emergency department crowding and patient outcomes: A systematic review. *J Nurs Scholarsh*. 2014;46(2):106-115.

doi: 10.1111/jnu.12055

21. Hughes JA, Alexander KE, Spencer L, Yates P. Factors associated with time to first analgesic medication in the emergency department. *J Clin Nurs*. 2021;30(13-14):1973-1989.

doi: 10.1111/jocn.15750

22. Shah AA, Zogg CK, Zafar SN, *et al*. Analgesic access for acute abdominal pain in the emergency department among racial/ethnic minority patients: A nationwide examination. *Med Care*. 2015;53(12):1000-1009.

doi: 10.1097/MLR.0000000000000444

23. Chen EH, Shofer FS, Dean AJ, *et al*. Gender disparity in analgesic treatment of emergency department patients with acute abdominal pain. *Acad Emerg Med*. 2008;15(5):414-418.

doi: 10.1111/j.1553-2712.2008.00100.x

24. Scholz SM, Thalmann NF, Müller D, Trippolini MA, Wertli MM. Factors influencing pain medication and opioid use in patients with musculoskeletal injuries: A retrospective insurance claims database study. *Sci Rep.* 2024;14(1):1978.

doi: 10.1038/s41598-024-52477-7

25. Keating L, Smith S. Acute pain in the emergency department: The challenges. *Rev Pain*. 2011;5(3):13-17.

doi: 10.1177/204946371100500304

26. Samcam I, Papa L. *Acute Pain Management in the Emergency Department*. London: InTechOpen; 2016.

doi: 10.5772/62861

27. Nagpal AK, Gadkari C, Singh A, Pundkar A. Optimizing pain management in emergency departments: A comprehensive review of current analgesic practices. *Cureus*. 2024;16(9):e69789.

doi: 10.7759/cureus.69789

28. Heilman JA, Tanski M, Burns B, Lin A, Ma J. Decreasing time to pain relief for emergency department patients with extremity fractures. *BMJ Qual Improv Rep.* 2016;5(1):u209522.w7251.

doi: 10.1136/bmjquality.u209522.w7251