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**ORIGINAL RESEARCH**

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# Does emergency department workload adversely influence timely analgesia?

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## Abstract

**Objective:** The impact of ED overcrowding on delay to analgesia has not been well studied. Our objective was to determine if ED workload influenced time to analgesia (TTA).

**Methods:** An observational, retrospective study (May 2006 to March 2007) was conducted. Adult patients with diagnoses of acute biliary pain, renal colic, wrist and femoral neck fractures were identified and assigned to an ED workload group based on total patient care time – a validated measure of ED workload. The groups were defined by low, middle and high quartiles of total patient care time. The high quartile was defined as overcrowded – equating to average ED occupancy/24 h of 85–140%. Data collected included demographics, pain score and analgesia data. The primary outcome was comparison of TTA between workload groups. Data were analysed using Cox regression and multivariate analyses. Sample size required was 50 per group.

**Results:** A total of 254 patients were studied (52% male; median age 57 years). Demographics were similar between groups. Ninety-three per cent received analgesia with median TTA of 53 min (interquartile range 30.5–114.5). No significant association was found between workload and TTA (hazard ratio [HR] 1.02, 95% CI 0.99–1.02). On multivariate analysis, factors associated with delay to analgesia included advanced age (HR 0.35, $P = 0.006$), language other than English (HR 0.55, $P = 0.010$), lower triage acuity (HR 0.20, $P = 0.000$) and delay to pain assessment (HR 0.16, $P = 0.000$). Those with higher pain scores received analgesia more quickly (HR 1.12, $P = 0.003$).

**Conclusion:** No relationship between workload and TTA was observed; however, there were delays to analgesia associated with age, non-English-speaking background and delay to pain assessment.

**Key words:** *analgesia, overcrowding, workload.*

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## Introduction

Relief of pain is a high priority for patients and clinicians alike. Despite guidelines for pain management,[1,2] delivery of analgesia for patients in the ED has been shown to be suboptimal both in Australia[3,4] and overseas.[5–9]

Quality pain management includes timely provision of analgesia, appropriate choice of agent and sufficient dosage. Recent studies have determined that identifiable factors are associated with a delay to analgesia, including age, triage code and fears of addiction.[3,5,9–12]

It has been shown that overcrowding causes system dysfunction in the ED – manifested by longer waiting times,[13] an increase in the number of patients leaving without being seen,[14–16] delays to hospital admission,[17] increased frequency of ambulance diversion[18,19] and extended length of stay.[20,21] With respect to clinical outcomes, two Australian studies report a link between patient mortality and ED crowding,[22,23] and a Canadian study describes a relationship with delays to thrombolysis for patients with acute myocardial infarction.[24]

At the time of the present study, there had been little analysis of the association between delivery of effective analgesia and ED workload. One small study has suggested that higher ED census levels are associated with poor pain management for older patients with hip fracture.[25] To our knowledge, no Australian research has considered this relationship. The objective of the present study was to determine if ED overcrowding negatively impacts on the timeliness of pain management – an indicator of ED quality of care.

## Methods

### Study design

This was an observational study conducted using explicit retrospective medical record review method. It was approved by the auspicing hospital under the National Health and Medical Research Council Quality Assurance Guidelines.

### Setting

The study was conducted in the ED of Western Hospital Footscray (WHF), Melbourne, Victoria, Australia, a metropolitan teaching hospital with approximately 300 inpatient beds. The ED has an annual census of approximately 32 000 adult patients. It has 3 resuscitation bays, 24 treatment spaces and 4 fast-track spaces. There is an adjacent eight-bed short-stay unit.

### Participants

Patients were eligible for inclusion if they presented to WHF between 1 May 2006 and 31 March 2007 with a final ED diagnosis of fractured neck of femur, fractured wrist, renal colic or biliary colic/cholecystitis. These diagnoses were chosen as examples of acutely painful conditions that could be identified reliably from the ED data management system. Patients were excluded if they were under 18 years of age, were cognitively impaired or reported mild/no pain at presentation. Patients were defined as 'in pain' if they had a recorded pain score >3 (on a 10-point verbal rating scale), or there was a qualitative description of moderate to severe pain, at or within 30 min of the first nursing observation. Patients were identified from a search of the ED management database (HASS) for the defined diagnoses.

The ED workload was measured using total patient care time (TPCT), the sum of ED arrival to ED discharge time for all patients in a 24 h (midnight to midnight) period. Its unit measurement is days. TPCT has proven efficacy as a marker of ED occupancy and overcrowding.[26,27] TPCT was calculated for each day in the study period and a value was matched to each patient according to the date at triage. Patients were assigned to groups of ED occupancy defined by TPCT quartiles. Three groups (quartiles) were used to facilitate investigation of a 'dose–response' relationship:

- Low (LQ): <25th centile
- Middle (MQ): quartile around the median
- High (HQ): >75th centile

Random sampling was undertaken within workload groups with the objective of 400 patients spread evenly across diagnoses and workload groups (see sample size below).

### Data collected

Study data were collected by abstracting information from patient medical records onto an explicit data form. It was then transferred to an electronic database program (Microsoft Access).

We collected demographic data, prehospital data (including mode of arrival, prehospital analgesia and ambulance pain scores), date and time of arrival and observations, triage category, pain scores at triage and in the ED, vital signs, ED pain management, final diagnosis and disposition. Analgesia was defined as

oral paracetamol or NSAID, oral opioid, parenteral opioid, inhaled methoxyflurane or nitrous oxide, nerve block or mechanical analgesia, such as splint, sling or plaster cast. If data were not available on the patient medical record, it was assumed to be absent. The data abstractor (RM) was not blinded to the study hypothesis.

### Outcomes of interest

The primary outcome of interest was comparison of time to analgesia (TTA) between ED workload groups (TPCT quartiles). TTA was defined as time of ED arrival to administration of analgesia. Secondary outcomes of interest included the relationship between TTA and demographic and clinical variables (including age, sex, triage category, initial pain score and prehospital analgesia).

### Data analysis

Data were analysed using STATA (version 8, StataCorp, College Station, TX, USA). Primary analysis was descriptive. Survival analysis using Cox regression was used for the relationship between TPCT and TTA. TTA was also analysed categorically using 60 min as a cut-off for the receipt of analgesia. Although arbitrary, 60 min was chosen as it reflects a published clinical indicator from the Australian Council on Healthcare Standards,[28] and has been used in another local study.[3]

To investigate the relationship between clinical and demographic factors and TTA, multivariate analysis was used. Predictors found to have $P < 0.1$ on univariate analysis were included in a multivariate model with previously identified risk factors, including age, sex, prehospital analgesia, time of presentation, triage category and pain score. Results were expressed as hazard ratios with 95% CI and a $P$ value.

### Sample size

It was determined that a minimum sample of 50 patients per occupancy group would give adequate power ($P < 0.05$), assuming that 10 min constituted a clinically significant difference in TTA between the LQ and HQ groups. We decided to study approximately 400 patients, divided as equally as possible between the four diagnostic categories, aware that missing data, cognitive impairment, miscoding, lack of pain and lost records would reduce the eligible sample.

### Interrater agreement

Interrater agreement testing (kappa analysis) was conducted for 10% of the final eligible sample (25/254).

### Ethics approval

Monash University Standing Committee on Ethics in Research Involving Humans granted ethics approval for the present study.

## Results

### Sample

During the study period, 742 patients presented to the ED with the selected conditions. After allocation to TPCT group and random selection, 436 were selected for medical record review, of whom 254 were eligible for inclusion (Fig. 1). Discrepancies in category size result from lower numbers of fractured wrist presentations, and skewed arrival of biliary colic patients (who were more likely to present in periods of high workload).

The median TPCT during the study period was 21.6 days (range 10.2–43.0). The LQ was 10.2–17.2 days, MQ 19.2–23.4 days and HQ 25.4–43 days. Interrater agreement of data collected was excellent: age ($\kappa = 1.0$), time to pain assessment ($\kappa = 1.0$), TTA ($\kappa = 1.0$), receipt of prehospital analgesia ($\kappa = 1.0$), administration of parenteral analgesia ($\kappa = 1.0$) and primary spoken language ($\kappa = 0.78$).

### Patient characteristics

Men comprised 52% of the sample; median age was 57 years. The majority (79.5%) designated English as first language. There were no significant differences between workload groups for age distribution, transport mode, weekday presentation and arrival time. Forty-two per cent of patients arrived at hospital by ambulance. Triage distribution was Australian Triage Scale category (ATS) 2 5%, ATS 3 54% and ATS 4 41%. The final diagnosis was renal colic in 34%, biliary pain in 28%, fractured neck of femur (NOF) in 21% and fractured wrist in 17%. Forty per cent of patients were admitted to hospital.

### ED analgesia and relationship between TTA and TPCT

Overall, 232 patients (91%) received analgesia in the ED; the proportion was similar across all groups

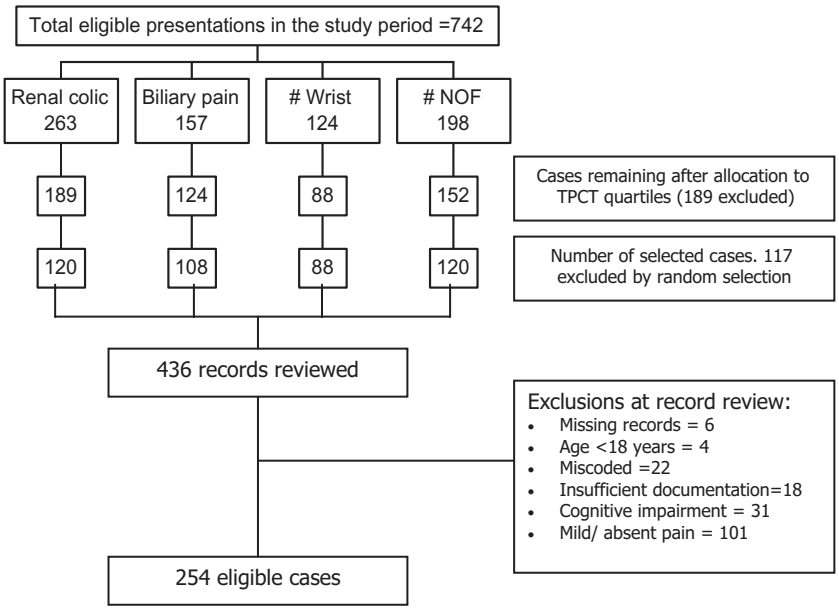


**Figure 1.** Sample derivation. NOF, neck of femur; TPCT, total patient care time.

**Table 1.** TTA by workload group

| TTA | Total ($n$ = 232) | LQ ($n$ = 79) | MQ ($n$ = 76) | HQ ($n$ = 77) |
|---|---|---|---|---|
| Median | 53 | 51 | 60 | 42 |
| Interquartile range | 30.5–114.5 | 29–124 | 38.5–129.5 | 30–91 |

*HQ, high quartile; MQ, middle quartile; LQ, low quartile; TTA, time to analgesia.*

(LQ 91%, MQ 88%, HQ 95%). In 74% of these cases, parenteral analgesia was used.

The median TTA was 53 min (range 0–699, interquartile range 30.5–114.5). Median TTA was 67 min for fractured NOF, 53 min for fractured wrist, 35 min for renal colic and 78 min for biliary colic/cholecystitis. TTA data for the three workload groups are described in Table 1. The box-whisker plot showed no association between TPCT group and TTA (Fig. 2) and this was confirmed by Cox regression analysis (hazard ratio 1.02, 95% CI 0.99–1.03, $P$ = 0.599). Fifty-six per cent of patients in the LQ group, 50% in the MQ group and 58% in the HQ group received analgesia within 1 h of presentation; these differences were not statistically significant.

### Factors predicting TTA

On multivariate analysis, several factors were found to be independently associated with delay to analgesia (Table 2). Multivariate analysis confirmed that occupancy (TPCT) was not an independent predictor of TTA.

## Discussion

The present study found no significant association between workload and TTA. The key finding that workload did not impact on TTA contrasts with previous findings. Hwang *et al.*[25] reported that overcrowded shifts (defined as >120% occupancy) were associated with deterioration in pain-associated process measures (performance of documented pain assessment and time to pain assessment), but not TTA in a cohort of patients with femoral neck fractures. In that study, mean time to treatment was 141 min, much longer than our study. Recently, Pines and Hollander,[29] in a study of 13 758 patients presenting with severe pain, found that delays to treatment were associated with waiting room number

**Table 2.** TTA by variable, multivariate analysis

| Predictors | | HR | 95% CI | *P* |
|---|---|---|---|---|
| Age | | 0.99 | 0.98–0.99 | 0.027 |
| First language | English | 1.77 | 1.12–2.77 | 0.013 |
| | Other than English | 1.0 | † | |
| Triage category | 2 | 1.00 | † | |
| | 3 | 0.37 | 0.18–0.79 | 0.011 |
| | 4 | 0.19 | 0.08–0.41 | 0.000 |
| TT pain assessment | 0–10 | 1.00 | † | |
| | 11–18 | 0.42 | 0.26–0.69 | 0.001 |
| | 19–31 | 0.38 | 0.22–0.63 | 0.000 |
| | 32–299 | 0.17 | 0.10–0.29 | 0.000 |
| First pain score | Regression | 1.13 | 1.06–1.21 | 0.000 |
| Diagnosis | Renal colic | 1.00 | † | |
| | Biliary colic | 0.59 | 0.41–0.85 | 0.005 |
| | Wrist | 0.49 | 0.41–0.85 | 0.005 |
| | NOF | 0.56 | 0.29–1.10 | 0.094 |
| Occupancy (TPCT) | LQ | 1.00 | † | |
| | MQ | 1.44 | 0.95–2.19 | 0.085 |
| | HQ | 1.32 | 0.91–1.93 | 0.149 |

*†Reference group. Lower HR indicates longer TTA. HQ, high quartile; HR, hazard ratio; MQ, middle quartile; LQ, low quartile; NOF, neck of femur; TT, time to; TTA, time to analgesia; TPCT, total patient care time.*

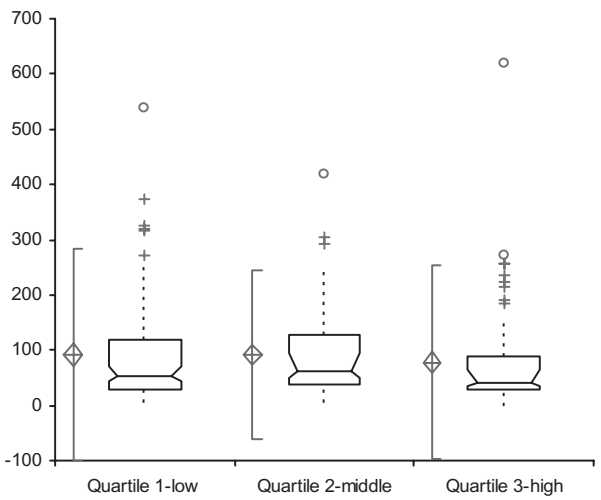


**Figure 2.** Box-whisker plot of TTA for TPCT groups. TPCT, total patient care time; TTA, time to analgesia.

(OR 1.03 for each additional patient waiting) and occupancy rate (OR 1.01 for each 10% increase in occupancy). The median TTA in that study was 74 min.

The variation between findings might be explained by regional differences in pain management processes. The ED studied here has a well-established commitment to pain management. It has departmental pain policies, which include reporting of pain score as part of routine nursing observations, titrated i.v. opioids as the preferred method of administration for narcotic analgesia and nurse-initiated analgesia procedures.[30] The latter initiative alone has been shown to reduce TTA by between 21 and 34 min.[30] Comparing the performance of the study ED with other Australian ED supports this explanation. A recently completed audit by the National Institute of Clinical Studies reported analgesia performance across 36 Australian hospitals.[31] They found median TTA for fractured NOF of 92 min, for abdominal pain of 70 min and for migraine of 62 min. In contrast, our study found an overall median TTA of 53 min.

There is, however, an alternate explanation for the findings of the present study. Increasingly, flow-management modelling is used to map capacity, delay and workload in the ED.[32,33] Queuing theory provides a theoretical basis for this work. In a landmark paper, Bagust *et al.*[34] used queuing principles to develop models for the relationship between inpatient bed capacity, demand and adverse events demonstrating the inverse reciprocal relationship between hospital occupancy and performance. It is possible that position on this curve impacts TTA. Workload might impact proportionately on TTA until workload reaches a critical point beyond which the system is saturated and further increases in occupancy have negligible impact on performance. Our study was not designed to test this theory, however.

The present study identified independent predictors of TTA. Patients were more likely to experience delays to analgesia if they were elderly, did not nominate English as their preferred language, failed to receive prompt assessment of their pain or were triaged to ATS category 3 or 4. Patients reporting a higher initial pain score received analgesia faster (for every increase of one on a verbal 10-point rating scale, analgesia was administered 12% faster). Older age,[3,12] triage category[3] and diagnosis[3] have previously been identified as a risk factors for delay to analgesia. The finding that lower acuity (triage category) is associated with delay to analgesia was expected as pain is one of several factors evaluated in the triage process. Our finding that sex is not a barrier to pain management sits among an ambivalent body of evidence.[5,11,35] We found preferred language other than English was associated with significant delays to analgesia. Several other studies have investigated language and ethnicity as barriers to pain management, and the findings are conflicting.[5,10,11,36–38]

### Limitations

The present study has limitations that must be considered when interpreting the results. It was a retrospective review conducted in one metropolitan ED. The findings might not be generalizable to other settings. There are inherent, well-described limitations in medical record review method. Despite validation,[26,27] there are some limitations to using TPCT as a measure of overcrowding. It represents the total time dedicated to patient care in a 24 h period, and so does not take into account microfluctuations in crowding. In the present study, this was countered to some extent by using shift of arrival as an independent predictor in the multivariate model. There is some risk of bias as the principle data collector was not blinded to the study hypothesis.

## Conclusion

No relationship between workload and TTA was observed; however, there were delays to analgesia associated with age, non-English-speaking background and delay to pain assessment.

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### Competing interests

None declared.

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