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Clinical Investigation

CLINICAL INVESTIGATION

Association between day and time of admission to critical care and acute hospital outcome for unplanned admissions to adult general critical care units: cohort study exploring the 'weekend effect'

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Abstract

Background. We aimed to identify any association between day and time of admission to critical care and acute hospital outcome.

Methods. We conducted a cohort study using prospectively collected data from the national clinical audit of adult critical care. We included 195 428 unplanned admissions from 212 adult general critical care units in England, Wales and Northern Ireland, between April 1, 2013 and March 31, 2015 in the analysis.

Results. Hourly admission rates for unplanned admissions varied more than three-fold during the 24 h cycle. Overall acute hospital mortality was 26.8%. Before adjustment, acute hospital mortality was similar between weekends and weekdays but was significantly lower for admissions at night compared with the daytime (−3.4%, −3.8 to −3.0%; $P<0.001$). After adjustment for casemix, there remained no difference between weekends and weekdays (−0.0%, −0.4 to +0.3%; $P=0.87$) or between nighttime and daytime (−0.2%, −0.5 to +0.1%; $P=0.21$). Delays in admission were reported for 4.3% of admissions and were slightly more common during weekdays than weekends and in the daytime than at night. Delayed admission was associated with a small increase in acute hospital mortality, but adjusting for this did not affect the estimates of the effect of day and time of admission.

Conclusions. The day of week and time of admission have no influence on patient mortality for unplanned admissions to adult general critical care units within the UK. Ways to improve critical care and hospital systems to minimize delays in admission and potentially improve outcomes need to be ascertained in future research.

Key words: critical care; delivery of health care; mortality

Critically ill patients are a vulnerable group who benefit from timely admission to a critical care unit. Critically ill patients may present at any time of day, thus critical care unit staffing levels and resources should be adequate throughout a 24 h period, weekends,

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Editor's key points

- Patients admitted to hospital outside normal working hours typically have acute illnesses that increase risk.
- Poor outcomes can occur because of underlying acute illness (casemix), reduced quality of care, or both.
- Statistical adjustment is required to account for casemix when exploring the potential impact of quality of care.
- This study could not identify a 'weekend effect' of critical care in the UK.

and holidays. A number of organizational factors are associated with patient outcome; these include improved outcomes with 'closed' models of critical care,[1] presence of dedicated intensivists (consultants with dedicated sessions in intensive care as opposed to non-specialist or generalist physicians),[2–4] high-intensity intensivist staffing,[56] and adequate nursing numbers.[7] Nonetheless, the number of doctors present on the critical care unit, availability of accredited intensivists, and accessibility of diagnostic and surgical services may vary at different times of day and at weekends compared with weekdays.[8] It is imperative to ascertain whether out-of-hours services are adequate to cover emergency care without any adverse impact on outcome for patients. As such, the effect of day and time of admission to the hospital or critical care unit on mortality has been the subject of recent scrutiny and controversy. Organizational factors that may contribute to variations in care throughout the working week should be identified.

A systematic review of 10 studies (eight examining nighttime admissions to critical care and six examining weekend admissions) concluded that nighttime admission was not associated with an increase in mortality, although patients admitted throughout the weekend had an increased risk of death compared with patients admitted during the week.[9] The authors acknowledged significant heterogeneity in studies, which was an inevitable consequence of pooled data from eight different countries. Differences in healthcare delivery between countries limit the application to influence health-care policy within a specific country. Within the UK, the effect of day and time of admission on outcome has been examined in 56 250 critical care unit admissions from 1995 to 2000. After adjustment for casemix, neither time of day nor day of week was associated with any differences in mortality.[10]

We report an up-to-date analysis of the association between day and time of admission to critical care and hospital outcome for unplanned (emergency) admissions to adult general critical care units in the UK. The objective was to identify any current association between day and time of admission to critical care and acute hospital outcome.

Methods

The study was performed on an anonymized extract from an existing national clinical audit database and thus did not require specific National Health Service (NHS) research ethics review under current UK guidance. The study was approved by the Intensive Care National Audit and Research Centre (ICNARC) Data Access Advisory Group (approval no. DAAG 161148). The ICNARC Case Mix Programme (CMP) has approval under Section 251 of the NHS Act 2006 to process patient identifiable data without consent (approval no. PIAG 2-10(f)/2005). We registered the study on ClinicalTrials.gov (NCT02751164) and uploaded the analysis plan on April 19, 2016 before any data extraction or analysis.

Data

Data were extracted from the ICNARC CMP database. We included data from NHS adult general critical care units in England, Wales and Northern Ireland. Data from specialist units, such as neurosciences and cardiothoracic units, and standalone high-dependency units (independent high-dependency care units without the ability to provide facilities for invasive mechanical ventilation) were excluded. We included admissions throughout a 2 yr period from April 1, 2013 to March 31, 2015. This time period was selected to reflect current clinical practice and address the study question with a high level of precision, and thus no power calculation was undertaken.

We included all patients aged 16 yr or older with unplanned admission to the critical care unit (i.e. excluding admissions from an operating theatre after elective or scheduled surgery, planned local medical admissions, planned transfers, and repatriations). Exclusion criteria were readmission of the same patient to the critical care unit during the same acute hospital stay, transfer from another critical care unit, transfer from another acute hospital, admission for organ donation, and if there were missing data on time of admission, acute hospital outcome, or on key confounders (age, location before admission, primary reason for admission, all physiological variables). For patients who were admitted to the critical care unit more than once during the same acute hospital stay, only the first admission was included to ensure that outcomes were independent.

The primary exposure variable was the day and time of admission to the critical care unit, dividing the week into 14 time periods. It was not possible to correct for any possible confounders relating to variation in organizational factors; a pragmatic approach of dividing the day into routine working hours (08.00–17.59 h) and out of hours (18.00–07.59 h the next day) for both weekdays (Monday–Friday) and weekends (Saturday–Sunday) was adopted. The selected time frames were identified to represent approximate working schedules of medical staff on shift work patterns in UK critical care units. The primary outcome was acute hospital mortality, defined as death before ultimate discharge from acute hospital.

The key potential confounders, identified *a priori* and adjusted for in the analysis, included age, severe conditions in the past medical history (APACHE II illness severity score definitions), prior functional dependency (categorized as none, some, or total assistance with activities of daily living), number of days from hospital admission to critical care unit admission, location before admission, cardiopulmonary resuscitation (CPR) within 24 h before admission to critical care, primary reason for admission to critical care (by body system), and acute severity of illness (ICNARC Physiology Score).[11] Continuous data were entered as linear terms. Both age and physiology score have previously been shown to have approximately linear effects in the development of the ICNARC model. Details on confounding factors are found in the statistical analysis plan (Appendix 1). Long-term outcome data were not available.

Delayed admission to the critical care unit was also explored as a potential mediator of the effect of day and time of admission on outcome. Delayed admission to the critical care unit was defined as the patient for admission remaining outside the critical care unit for at least 1 h despite a decision to admit being made and documented in the patient notes after formal referral and agreement by appropriate staff with authority to admit to the unit. The duration of the delay was defined as the interval between the time of the documented