Mortality for emergency laparotomy is not affected by the weekend effect: a multicentre study

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ABSTRACT

INTRODUCTION The ‘weekend effect’ describes variation in outcomes of patients treated over the weekend compared with those treated during weekdays. This study examines whether a weekend effect exists for patients who undergo emergency laparotomy.

MATERIALS AND METHODS Data entered into the National Emergency Laparotomy Audit between 2014 and 2017 at four NHS trusts in England and Wales were analysed. Patients were grouped into those admitted on weekdays and those on weekends (Friday 5pm to Monday 8am). Patient factors, markers of quality of care and patient outcomes were compared. Secondary analysis was performed according to the day of surgery.

RESULTS After exclusion of patients who underwent laparotomy more than one week after admission to hospital, a total of 1717 patients (1138 patients admitted on weekdays and 579 admitted on weekends) were analysed. Age, preoperative lactate and P-POSSUM scores were not significantly different between the two groups. Time from admission to consultant review, decision to operate, commencement of antibiotics and theatre were not significantly different. Grades of operating surgeon were also similar in both groups. Inpatient 60-day mortality was 12.5% on weekdays and 12.8% on weekends ($P = 0.878$). Median length of postoperative stay was 12 days in both groups.

When analysed according to day of surgery, only number of hours from admission to antibiotics (12.8 weekday vs 9.4 weekend, $P = 0.046$) and number of hours to theatre (26.5 weekday vs 24.1 hours weekend, $P = 0.020$) were significantly different.

DISCUSSION Quality of care and clinical outcomes for patients undergoing emergency laparotomy during the weekend are not significantly different to those carried out during weekdays.

KEYWORDS

Laparotomy – Mortality – Quality of health care – Hospitalisation

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Introduction

The ‘weekend effect’ refers to variation in clinical outcomes for patients admitted to hospital during weekends when compared with weekdays. Studies from Europe and America have identified worse outcomes for patients admitted on weekends for a variety of conditions ranging from myocardial infarction, pulmonary embolus, stroke and childbirth through to high risk colorectal surgery, repair of abdominal aortic aneurysms and revascularisation of lower limbs.^{1–8} The reasons underpinning these findings are controversial.^{2,9} Differences in staffing levels is thought to be a contributing factor with fewer doctors and less-experienced clinicians on site at the weekend.^{10–14} Reduced presence of allied health professionals (e.g. radiologists and physiotherapists) and reduced availability of resources such as imaging or pathology services have also been thought to play a role. Other studies have identified

differences in case mix or severity of illness to be determining factors.^{15,16}

In England and Wales, major reforms of NHS working hours were implemented in 2017 to counter the perceived weekend effect. These reforms were partly based on research which found that compared with patients admitted on a Wednesday, 30-day mortality was 11% higher on Saturdays and 16% higher on Sundays.¹⁵ Consequently, it was argued that several thousand ‘avoidable’ deaths per year could be saved by having the same numbers of doctors working at the weekend as during the week. The implemented changes have not gone unopposed and the reasoning behind the reforms have been questioned.¹⁷

Currently, the majority of NHS hospitals in the UK do not perform routine elective surgery during weekends (except specific ‘initiative lists’ organised to reduce exceptionally long waiting times). Outcomes for weekend surgery will therefore largely arise from emergency

procedures, of which emergency laparotomies result in the highest morbidity and mortality. Despite implementation of guidelines such as National Confidential Enquiry into Patient Outcome and Death (NCEPOD) and the Royal College of Surgeons' Higher Risk General Surgical Patient, as well as implementation of standardised laparotomy pathways, mortality following emergency laparotomy remains between 14% and 19%^{18–20} and morbidity as high as 50%.²¹

The National Emergency Laparotomy Audit (NELA) is a nationwide project commissioned by the Health Quality Improvement Partnership and run by the Health Services Research Centre on behalf of the Royal College of Anaesthetists. Under this initiative, clinicians enter data into an online database at their NHS trust. The data are related to the quality of care received by patients undergoing emergency laparotomy. The indices measured are extrapolated from standards outlined in guidelines such as NCEPOD and Higher Risk General Surgical Patient. Annual reports are then published by the NELA administrators, providing each trust with their level of achievement against key standards, thus offering a tool for quality assurance and improvement.

The objective of this study was to use data from NELA to determine whether a weekend effect exists for patients undergoing emergency laparotomy. This study compares those patients admitted during the weekend with those admitted on weekdays to determine if there are differences in patient factors, quality of care patients received, in-hospital mortality or length of stay following surgery.

Methods

Data were obtained from the NELA databases held at four NHS hospitals in England and Wales: Morriston General Hospital (Swansea), Queen Elizabeth's Hospital (Birmingham), Conquest Hospital (Hastings) and Southend University Hospital (Essex). Permission to use NELA data was obtained from each trust and from the NELA project team. Deidentified data were downloaded and analysed locally at each site prior to sharing aggregated data between authors. The study period was between December 2014 and February 2017.

Data analysis was divided into three categories: patient factors (age, American Society of Anesthesiologists (ASA) classification, preoperative P-POSSUM scores and serum lactate), markers for quality of care (time from admission to surgical review/decision to operate/antibiotics/theatre and most senior surgeon present at surgery) and patient outcomes (60-day in-hospital mortality and length of post-operative stay).

For this study, the weekend period was defined as 5pm Friday to 8am Monday. During the period of 2014 to 2017, all four hospitals were staffed by on-call doctors only during this weekend period. Patients admitted during this time were grouped into the weekend category and patients admitted during the rest of the week, into the weekday category. Patients admitted during bank holidays (from 5pm the previous day to 8am the following day) were also

included in the weekend category to reflect the same reduced staffing levels. A separate analysis was performed to compare outcomes of patients who actually had their surgery performed during the weekend (using the same time of day and bank holiday parameters) as opposed to being admitted on the weekend. This is discussed as the 'day of surgery' analyses.

In-hospital mortality, as recorded by NELA, reflects deaths during the index admission and up to 60 days of inpatient stay. NELA does not comprehensively capture postoperative complications. As the length of stay has been shown to be a significant predictor of major and minor complications,²² it was used as a proxy measure of morbidity in this study.

The scope of this study was to identify differences in quality of care received by patients who had required laparotomy at the point of admission to hospital. Therefore, only patients who had a surgical consultant review within 72 hours and underwent surgery within 168 hours of hospital admission were included. Although patients should ideally have consultant review within 24 hours, an extension to 72 hours was taken to account for those who may have been misdiagnosed initially or wrongly referred to another specialty before receiving surgical review. A time-frame up to 168 hours before surgery was allowed to include those cases where conservative management was initially trialled (e.g. diverticular abscess or adhesive small bowel obstruction) prior to a laparotomy.

Statistical analysis

Data between trusts were shared as numerical datasets. Continuous variables were not normally distributed and therefore were reported as medians and interquartile ranges (IQR) and compared between the weekday and weekend admission groups using Mann-Whitney U tests. Comparisons of ordinal variables were also performed using Mann-Whitney U tests, while Fisher's exact test was used for nominal variables.

Cases with missing data were excluded from analyses using a pairwise approach. The proportion of patients with missing data for each care quality marker were also compared between the groups, to test for selection bias. All analyses were performed using IBM SPSS version 22, with $P < 0.05$ deemed to be indicative of statistical significance throughout.

Results

Data from 2121 patients were received from the four trusts for emergency laparotomies performed between the period of December 2014 and February 2017. Of these, 183 (8.6%) patients were excluded as time to surgical review was greater than 72 hours and a further 188 (8.8%) as the decision to operate or time to theatre was greater than 168 hours. A further 33 (1.6%) patients were excluded due to lack of entry of times in the database, meaning the above parameters could not be determined.

After these exclusions, 1717 patients underwent analysis, of whom 1138 (66.3%) were admitted during weekdays

and 579 (33.7%) were admitted during weekends. The indications for laparotomy are reported in Figure 1, of which the most common were perforation (25%), peritonitis (23%) and small bowel obstruction (15%).

Patient factors

Patient demographics were similar for those admitted on weekdays and weekends (Table 1), with median ages of 68 years ($P = 0.529$) in both groups and no significant difference in the sex distribution (46.4% female vs 47.2% male, $P = 0.798$). ASA classification ($P = 0.460$), preoperative serum lactate ($P = 0.395$) and both preoperative P-POSSUM mortality ($P = 0.328$) and morbidity ($P = 0.357$) were not significantly different for weekday and weekend admissions.

Markers for quality of care

Table 2 shows the comparison of markers for quality of care between the patients admitted on weekdays and weekends. No significant differences were detected between these two groups in the median number of hours from admission to surgical review (9.4 hours vs 10.5 hours, $P = 0.226$), the decision to operate (19.0 vs. 17.7, $P = 0.767$), administration of antibiotics (12.3 vs 10.2, $P = 0.405$) or to theatre (27.2 vs 23.0, $P = 0.158$). The proportion of patients who had laparotomy performed by a consultant grade surgeon was similar for both weekday and weekend groups (82.2% vs 81.3%, $P = 0.810$; Table 3).

Missing data for markers of quality of care

Entry of time points for the parameters used to measure quality of care was only completed in 70–86% of cases. Table 4 shows the rates of missing data for the four parameters between the weekday and weekend admission groups, which were analysed to identify any potential selection bias. Recordings of times from admission to surgical review was missing more frequently for weekend admissions than those for weekday admissions (33.5% vs 28.6%, $P = 0.040$). No significant differences in data completion rates were detected for the other three markers of quality of care.

Patient outcomes

As shown in Table 3, inpatient mortality was similar for weekday and weekend admissions (12.5% vs 12.8%, $P = 0.878$) and the median postoperative length of stay was 12 days in both groups ($P = 0.738$).

Analysis by day of surgery

Of the 1138 weekday admissions, the majority (868, 76.3%) had surgery also on a weekday, while only 54.7% of weekend admissions had surgery also on a weekend day (317/579). As a result, the data were also analysed based on the date of surgery. This analysis divided the patients into 1130 (65.8%) weekday and 587 (34.2%) weekend surgeries. The results of this ‘day of surgery’ analysis (Table 5) were broadly consistent with the

Figure 1 Indications for laparotomy.

Table 1 Comparison of patient factors between weekdays and weekends.^a

Patient factor	Day of admission		P-value
	Weekdays (n = 1138)	Weekends (n = 579)	
Age (years)	68 (54–78)	68 (54–78)	0.529
Sex (% male)	528 (46.4%)	273 (47.2%)	0.798
ASA classification:			0.460 ^b
I	132 (11.6%)	76 (13.1%)	
II	462 (40.6%)	246 (42.5%)	
III	379 (33.3%)	158 (27.3%)	
IV	143 (12.6%)	85 (14.7%)	
V	22 (1.9%)	14 (2.4%)	
Preoperative lactate (mmol/l) ^c	1.6 (1.1–2.7)	1.6 (1.1–2.6)	0.395
Preoperative P-POSSUM (%):	6.5 (2.4–19.8)	6.0 (2.1–19.2)	0.328
Mortality			
Morbidity	70.9 (46.3–89.8)	68.4 (43.3–89.1)	0.357

ASA, American Society of Anesthesiologists.
^a Data are reported as N (%) with p-values from Fisher's exact tests, or as median (interquartile range) with P-values from Mann–Whitney tests, unless stated otherwise.
^b p-Value from a Mann–Whitney test, to account for the ordinal nature of the factor.
^c Based on N = 1034, after excluding patients with missing data.

Table 2 Comparison of markers for quality of care between weekdays and weekends.

Hours from admission to:	Available (M) ^a	Day of admission median (IQR)		P-value ^b
		Weekday	Weekend	
Surgical review	1197	9.4 (3.5–17.5)	10.3 (4.3–16.0)	0.226
Decision to operate	1361	19.0 (6.3–41.7)	17.7 (6.5–33.3)	0.767
Antibiotics	1265	12.3 (4.0–34.5)	10.2 (4.0–34.7)	0.403
Theatre	1479	27.2 (12.0–54.5)	23.0 (9.8–55.7)	0.158

IQR, interquartile range.
^a The number of patients for whom data were available for analysis
^b From Mann–Whitney tests.

analysis of admission day data, with no significant differences in patient demographics, inpatient mortality (12.7% vs 12.5%, $P = 0.818$) or postoperative length of stay (median number of days: 12 vs 11, $P = 0.402$). The median number of hours from admission to surgical review (9.8 hours vs 9.8 hours, $P = 0.307$) and the decision to operate (18.6 hours vs 17.9 hours, $P = 0.336$) were also not significantly different for weekday and weekend surgeries. There were, however, small but statistically significant differences in the number of hours from admission to the administration of antibiotics (12.8 hours vs 9.4 hours, $P = 0.046$) and to theatre (26.5 hours vs. 24.1 hours, $P = 0.020$), with times being shorter for weekend surgeries.

Discussion

This study collated data from four different NHS trusts participating in NELA over three years. It found that patients undergoing emergency laparotomy had similar quality of care, postoperative mortality and length of stay whether admitted or operated on a weekday or a weekend. In the analysis of outcomes according to day of surgery, there was a statistically shorter time to first antibiotics administration (12.8 hours vs 9.4 hours, $P = 0.046$) and time to theatre (26.5 hours vs 24.1 hours, $P = 0.020$) for patients who underwent surgery on weekends. This was not true, however, for time to surgical review or decision to operate. The shorter time interval for provision of antibiotics on the

Table 3 Grade of surgeon and outcomes for patients admitted on the weekdays and weekends.^a

	Day of admission		<i>P</i> -value
	Weekday	Weekend	
Grade of most senior surgeon			0.810
Consultant	936 (82.2%)	471 (81.3%)	
Specialty trainee/registrar	141 (12.4%)	78 (13.5%)	
Other	61 (5.4%)	30 (5.2%)	
Inpatient mortality ^b	142 (12.5%)	74 (12.8%)	0.878
Postoperative length of stay (days) ^c	12 (7–20)	12 (7–20)	0.738

^a Data are reported as N (%), with *P*-values from Fisher's exact tests, or as median (interquartile range), with *P*-values from Mann–Whitney tests.
^b Defined as death on same admission as surgery, and within 60 days of surgery.
^c Only recorded in 1704 cases.

Table 4 Proportions of missing data in weekday and weekend groups.

Patients with missing data for the time of:	Day of admission		<i>P</i> -value ^a
	Weekdays (<i>N</i> = 1138) <i>n</i> (%)	Weekends (<i>N</i> = 579) <i>n</i> (%)	
Surgical review	326 (28.6)	194 (33.5)	0.040 ^b
Decision to operate	230 (20.2)	126 (21.8)	0.451
Antibiotics	291 (25.6)	161 (27.8)	0.325
Theatre	151 (13.3)	87 (15.0)	0.337

^a From Fisher's exact tests.
^b Significant at *P* < 0.05.

weekend might reflect overall workload in hospitals being lower at weekends, meaning critically unwell patients receive antibiotics in a timely manner. Similarly, once the decision to operate has been made, patients may get to theatre faster on weekends when elective surgeries are not taking place to detract from theatre portering and staffing resources. However, these differences between the two groups were unable to influence our primary and secondary clinical patient outcomes of mortality or postoperative length of stay.

NELA forms the most comprehensive dataset available on the quality of perioperative care for emergency general surgery throughout England and Wales. It collects a large volume of data using evidence-based standards. However, the results of this study must be framed within its limitations. The database excludes laparotomies performed for appendicitis, cholecystitis or vascular procedures and only includes patients aged over 18 years. Therefore, the conclusions reached here can only be applied to the adult population that undergo the same casemix of emergency general surgical operations accounted for in the database. The demographics, patient factors and overall outcomes for all emergency laparotomies performed may be different to our cohort of patients. A further limitation is that

patients included in this study only account for those who underwent surgery. Details of patients who did not undergo an operation (either due to severity of comorbidities, severity of their current illness or because they refused surgery) were not entered into the database and therefore the care for these patients at the time of admission remains unaccounted for.

There was a significant quantity of missing data in the NELA database, of the order of 15–33% in various marker analyses. Comparison of the proportions of missing data in both groups found statistically significant differences only in the analyses for time from admission to surgical review, where a higher proportion of missing data was present in the weekend group (33.5% vs 28.6%, *P* = 0.040). This may highlight a less stringent use of the NELA database on the weekends when on-call staff have to prioritise clinical care over administrative activities. All other marker analyses found no significant differences in the proportions of missing data and therefore results are unlikely to have been affected.

This study analysed a large number of patients gathered from multiple centres in England and Wales. A significant number of patients were excluded to study only that cohort of patients who required laparotomy within a

Table 5 Comparisons between surgeries performed on weekdays and weekends.^a

Factor	Available (N) ^b	Day of admission median (IQR)		P-value
		Weekday	Weekend	
Patient factors:				
Age (years)	1717	68 (54–78)	68 (54–77)	0.172
Sex (% male)	1717	516 (45.7%)	285 (48.6%)	0.262
ASA classification:	1717			0.176 ^c
I		134 (11.9%)	74 (12.6%)	
II		446 (39.5%)	262 (44.6%)	
III		383 (33.9%)	154 (26.2%)	
IV		147 (13.0%)	81 (13.8%)	
V		20 (1.8%)	16 (2.7%)	
Preoperative lactate (mmol/l) ^c	1034	1.6 (1.1–2.6)	1.6 (1.2–2.9)	0.071
Preoperative P-POSSUM (%):				
Mortality	1717	6.3 (2.5–18.9)	6.3 (2.2–20.5)	0.746
Morbidity	1717	70.6 (46.3–89.5)	70.1 (43.8–90.0)	0.824
Hours from admission to:				
Surgical review	1197	9.8 (3.5–16.5)	9.8 (4.3–18.0)	0.307
Decision to operate	1361	18.6 (6.8–42.8)	17.8 (6.0–41.6)	0.336
Antibiotics	1265	12.8 (4.2–36.5)	9.4 (3.9–31.0)	0.046
Theatre	1479	26.5 (12.3–57.0)	24.1 (9.3–52.5)	0.020
Grade of most senior surgeon:	1717			0.059
Consultant		942 (83.4%)	465 (79.2%)	
Specialty trainee/registrar		137 (12.1%)	82 (14.0%)	
Other		51 (4.5%)	40 (6.8%)	
Inpatient mortality ^d	1717	144 (12.7%)	72 (12.3%)	0.818
Postoperative length of stay (days)	1704	12 (7–21)	11 (7–19)	0.402

^a Data are reported as *n* (%) with *P*-values from Fisher's exact tests, or as median (interquartile range) with *P*-values from Mann–Whitney tests, unless stated otherwise. Bold *p*-values are significant at *P* < 0.05

^b The number of patients for whom data were available for analysis.

^c *P*-value from a Mann–Whitney test, to account for the ordinal nature of the factor.

^d Defined as death on same admission as surgery and within 60 days of surgery.

week of admission to hospital. It does not identify a 'weekend effect' for these emergency laparotomies within the current UK healthcare system, either by day of admission or day of surgery. The underlying reason for this may be that it focuses only on the most unwell of general surgical admissions. The care for these patients is likely to be prioritised. Even if lower staffing levels and other factors cause a weekend effect for other pathologies, the quality of care for patients requiring emergency laparotomy may not be affected. However, given the critical illness and high level of care these patients demand, even small deficiencies in their quality of care could have significant impact on clinical outcomes. This study is therefore reassuring in not having found such a deficiency during weekends.

Previous studies, both in the UK and other countries, have suggested that patients admitted on weekends are more unwell than those admitted during the weekday.^{15,16,25} In this study, however, P-POSSUM scores and preoperative lactate levels were not significantly different between the two groups, suggesting that patients admitted on the weekend were not more unwell.

The markers for quality of care were also not significantly different when patients were compared according to day of admission, including in the time taken for surgical review, antibiotics, operative intervention or the rate of consultant presence at surgery. In the units studied, any differences in the number of doctors being present due to cover by on-call doctors only on weekends did not appear to have impacted on the quality of care that patients received.

Recent improvements in healthcare within the UK including more rigorous management of sepsis, better access to intensive care beds and protocol-driven care for patients requiring emergency laparotomy might mean that the weekend effect is now historical. Changes in the working pattern of doctors in recent years, most notably the implementation of the European Working Time Directive, might mean there is now increasingly consistent levels of emergency cover throughout the week. McCallum *et al* published data on in-hospital mortality for all general surgical admissions in hospitals in the North of England between 2000 and 2014.²⁴ While overall mortality was higher at the weekends (hazard ratio 1.15 for Saturday and 1.40 for Sunday; $P = 0.021$ and $P < 0.001$ respectively) they found that overall crude mortality had significantly decreased over this time (5.4% in 2000–2004, 4.0% in 2005–2009 and 2.9% in 2010–2014, $P < 0.001$). In the most recent group of 2010–2014, a statistically significant difference according to day of surgery no longer existed. The data in the current study are also recent (2014–2017) and the lack of difference in quality of emergency care and outcomes between weekdays and weekends adds weight to the proposition that a weekend effect may indeed no longer exist for emergency surgical admissions, at least within the English and Welsh healthcare systems. Future studies examining all emergency surgical admissions or analyses of all the NELA data collected from hospitals throughout the UK may confirm or refute this.

Conclusions

The quality of care provided for patients requiring emergency laparotomy is not significantly different on weekends compared with weekdays with postoperative in-hospital mortality and length of stay being similar. While the limitations of performing this analyses using only NELA data must be recognised, this study finds that for the most unwell of patients admitted under the general surgery emergency team the care provided on weekends is not substandard.

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