There is no ‘weekend effect’ in elective orthopaedic surgery

Mohammad Al-Ashqar, Adeel Aqil, Hannah Phillips, Hassaan Sheikh, Simon Harrison, Sameh Sidhom, Gautam Chakrabarty, Ravinder Dimri

Calderdale and Huddersfield NHS Foundation Trust, Huddersfield, UK

ABSTRACT

INTRODUCTION The ‘weekend effect’ is said to occur when patient outcomes are adversely affected by the day of the week on which they present to hospital or have surgery. However, it is uncertain whether such a phenomenon exists for elective orthopaedic surgery. We investigated whether there is a ‘weekend effect’ in elective orthopaedic patients.

METHODS Retrospectively collected data were obtained from our institution’s electronic patient records. We collected demographic and International Statistical Classification of Diseases and Related Health Problems tenth revision coding data for all included patients. Multivariate analyses identified covariate-adjusted risk factors, associated with prolonged stays. Thirty-day mortality data were assessed according to the day on which surgery occurred.

RESULTS We analysed data for 892 patients over a one-year period. During the year, 457 patients had a total hip and 435 had a total knee replacement; 814 patients (91.3%) underwent surgery during the week, while 78 (8.7%) had surgery on a Saturday. There was no difference in average length of stay between the groups (5.0, 2.6 vs 5.0, 3.4, $P = 0.95$). Variables associated with prolonged hospitalisation included increasing age (covariate adjusted relative risk 1.02, 95% confidence interval 1.01–1.03, $P < 0.001$) and an American Society of Anesthesiologists score of 2, (relative risk 1.6, 95% confidence interval 1.15–2.20, $P = 0.005$). There was one death in a patient who underwent surgery on a Monday.

CONCLUSION There is no ‘weekend effect’ for elective orthopaedic surgery.

KEYWORDS

Weekend effect – Mortality – Length of stay – Arthroplasty

Accepted 18 March 2018

CORRESPONDENCE TO

Adeel Aqil, E: a.aqil@ic.ac.uk

Introduction

Several large studies have alluded to the possibility that patients may have a greater risk of mortality and longer hospital stays if admitted through emergency departments over the weekend rather than during the week.^{1–3} Differences in outcomes over the weekend, coined the ‘weekend effect’, may be the result of differences in service provision or population characteristics.⁴ While causality is difficult to establish with retrospective studies, pragmatically speaking it would still seem appropriate to focus resources on these at-risk patients. This has led some to call for normal weekday services to continue throughout the weekend.^{5,5} However, non-specific alterations to services may not be a cost-effective method of addressing the weekend effect issue and even those who call for change agree that at-risk services need to be identified before initiating change.³ The weekend effect seems to be condition specific and patients presenting with acute pneumonias or urinary tract infections have not been shown to have greater mortality rates.⁶ However, patients with medical emergencies such as acute cardiac, cerebrovascular emergencies or those requiring intensive care admissions have demonstrated a weekend effect.^{6–9}

To date, no study has assessed whether outcomes of routine major elective orthopaedic surgery are influenced by the day of the week on which they are performed. To reduce patient waiting times and address theatre capacity issues, our institution has been performing elective hip and knee arthroplasty on Saturdays for a number of years. We were therefore in a good position to assess whether a weekend effect existed in elective orthopaedics. We set out to investigate whether a weekend effect influenced mortality and length of hospital stay while controlling for all recorded patient related factors. In addition, we aimed to determine which other variables were risk factors to these adverse outcomes. All investigations were conducted in conformity with ethical principles of research. Informed consent was not required as this study did not involve human subjects.

Materials and methods

A retrospective review of all patients who underwent primary hip and knee arthroplasty between 1 September 2014 and 31 August 2015 was performed in a district general hospital. Patients who underwent revision arthroplasty and unicompartmental knee surgery were excluded. In our

institution, weekend operating was performed in a bid to lower waiting list times. In other words, fitter patients were not selected for weekend surgery, but rather they were selected by clerical staff and from a pool of patients who had been waiting the longest for their procedures.

There was a total of 892 patients for whom demographic data, American Society of Anesthesiologists (ASA) grade at the time of surgery, surgery type (hip or knee arthroplasty), age and sex were collected. Patient comorbidity profiles using the International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes were also collected. These data were used to calculate Charlson comorbidity indices for each patient. ASA grade has been found to be a useful predictor of length of hospital stay in elective orthopaedic surgery.¹⁰ Our group has also found that, on univariate analysis, ASA grade has been demonstrated to be a potential predictor of variables to mortality in hip fracture patients.¹¹ Thus, in a bid to ensure transparency, the authors have included both variables as we have done in other published studies.^{11,12}

As elective surgery in our unit is performed six days a week, we noted whether surgery was performed on a weekday or on a Saturday. Finally, operating surgeon details were also noted and used for subsequent analyses. Our primary outcome of interest was mortality at 30 days. Inpatient electronic records were scrutinised and presence and cause of mortality were recorded if present. Our secondary outcome of interest was a hospital length of stay greater than the national average of four days.¹⁵

Statistical analysis was performed in two stages. We initially divided data into two groups: Group 1 had stays of four days or less and Group 2 had hospital stays longer than four days. All collected variables were compared between these two groups with univariate analysis using a chi-square or Fisher's exact test for categorical data or an independent t or Mann-Whitney test for continuous variables. A subsequent

backward stepwise Cox regression model was undertaken to identify the most significant determinants of length of stay longer than four days. Our criteria for inclusion of variables into the model included a *P*-value of 0.15 or less on univariate analysis, in accordance with published statistical methods.^{14,15} Results were displayed as relative risks rather than odds ratios, to aid clinical interpretation.¹⁶

Results

A total of 892 patients underwent elective hip or knee arthroplasty surgery during our study period of one year. Of these, 457 had a total hip replacement and 435 patients had a total knee replacement; 814 patients had surgery during the normal working week (91.3%), while 78 patients had surgery on a Saturday (8.7%). Thirteen different specialists were recorded as operating surgeon.

Our primary outcome measure was death at 30 days; however, in this series there was only one death (0.1%), which occurred in a patient who was ASA III and underwent surgery on a Monday.

Our secondary outcome measure was length of hospital stay. Specifically, we wished to determine which variables were associated with a length of stay beyond the national average of four days. Two-thirds of patients had hospital stays greater than or equal to the national average. Median length of stay for Group 1 (four days or less) was three days (range one to three days) and that of Group 2 (longer than four days) was five days (range 4–24 days). Demographic data were not similar between the two groups. Univariate analysis revealed that prolonged stays were more likely in female, older patients who had undergone total knee rather than hip replacement surgery (Table 1).

There was no statistical difference in mean length of stay when surgery was performed during the week or on the weekend (5.0, 2.6 versus 5.0, 3.4, *P* = 0.95). Similarly,

Table 1 Comparison of demographic data between patients whose length of hospital stay was at or shorter than and longer than the national average of four days.

Variable	Length of stay		<i>P</i> -value
	≤ 4 days	> 4 days	
Patients <i>n</i> (%)	281 (31.5)	611 (68.5)	
Age, years (range)	67 (27–91)	73 (40–95)	< 0.001 ^a
Sex:			< 0.001 ^a
Male <i>n</i> (%)	133 (37.8)	219 (62.2%)	
Female <i>n</i> (%)	148 (27.4)	392 (72.6%)	
Operation type:			< 0.001 ^a
Total hip replacement <i>n</i> (%)	168 (36.8)	289 (63.2%)	
Total knee replacement <i>n</i> (%)	113 (26.0)	322 (74.0%)	

^a Included in the multivariate analysis.
Results are displayed as median (range) for continuous data, and as *n* (%) of population) for discrete data.
Continuous data were analysed using an independent t-test, categorical data using chi-squared/ Fisher's test and ordinal data using the Mann-Whitney-Wilcoxon test.

weekend surgery was not associated with a stay longer than four days on univariate analysis and so was not included in the further multivariate assessment. There was no association between operating surgeon and prolonged stays with univariate assessment.

The distribution of the different comorbidities is summarised in Table 2. Higher proportions of length of stay longer than four days were seen with a number of comorbidities (Table 2). Univariate analysis showed nine variables that met the criteria for inclusion into the Cox regression model. These were age, sex, operation type, history of myocardial infarction, connective tissue disease, diabetes mellitus, chronic kidney disease, higher ASA and Charlson scores. The model thereafter inferred that only two variables are significant risk factors for prolonged hospital stay longer than four days. These included increasing age with a covariate adjusted relative risk (RR) of 1.02 (95% confidence

Table 2 Comparison of clinical data between patients whose length of hospital stay was at or shorter than and longer than the national average of four days.

Variable	Length of stay ^a		P-value
	≤ 4 days	> 4 days	
Comorbidities (n)	281	611	
Myocardial Infarction	7 (2.5)	34 (5.6)	0.057 ^b
Congestive heart failure	1 (0.4)	7 (1.1)	0.447
Peripheral vascular disease	3 (1.1)	9 (1.5)	0.762
Other cardiovascular conditions	0 (0)	2 (0.3)	1.0
Dementia	1 (0.4)	5 (0.8)	0.671
COPD	13 (4.6)	36 (5.9)	0.528
Connective tissue disease	6 (2.1)	28 (4.6)	0.09 ^b
Peptic ulcer	1 (0.4)	0 (0)	0.315
Diabetes mellitus:			
Complicated	0 (0)	1 (0.2)	1.0
Uncomplicated	25 (8.9)	87 (14.2)	0.029 ^b
Chronic kidney disease	5 (1.8)	32 (5.2)	0.018 ^b
Hemiplegia	0 (0)	2 (0.3)	1.0
Lymphoma	1 (0.4)	2 (0.3)	1.0
Malignancy	1 (0.4)	4 (0.7)	0.732
Liver disease	0 (0)	1 (0.2)	0.631
Weekend surgery	23 (8.2)	55 (9)	0.799
ASA grade:			< 0.001 ^b
1	54 (19.2)	50 (8.2)	
2	205 (73.0)	394 (64.5)	
3	22 (7.8)	165 (27)	
4	0 (0)	2 (0.3)	
5	0 (0)	1 (0.2)	
Charlson score (median, range)	2 (0–8)	3 (0–9)	< 0.001 ^b

Variable	Length of stay ^a		P-value
	≤ 4 days	> 4 days	
Consultants (n):	281	611	0.192
1	11 (3.9)	39 (6.4)	
2	5 (1.8)	23 (3.8)	
3	31 (11.0)	58 (9.5)	
4	20 (7.1)	62 (10.1)	
5	41 (14.6)	48 (7.9)	
6	24 (8.5)	63 (10.3)	
7	21 (7.5)	71 (11.6)	
8	46 (16.4)	59 (9.7)	
9	10 (3.6)	51 (8.3)	
10	12 (4.3)	35 (5.7)	
11	15 (5.3)	44 (7.2)	
12	19 (6.8)	21 (3.4)	
13	26 (9.3)	37 (6.1)	

ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease.

^a Results are displayed as median (range) for continuous data and as *n* (%) of population for discrete data. Continuous data were analysed using an independent t-test, categorical data using chi-square/Fisher's test and ordinal data using the Mann-Whitney-Wilcoxon test.

^b Included in multivariate analysis.

interval, CI, 1.01–1.03, $P < 0.001$) and ASA scores of 2, (RR 1.6, 95% CI 1.15–2.20, $P = 0.005$). More patients (51%) had an ASA grade of 2, with smaller percentages being grade 1 (9%), grade 3 (16%) and grade 4 (0.2%).

Discussion

This is the first study to specifically investigate for the presence of a weekend effect on both length of stay and mortality rates in an elective orthopaedic patient population. We purposely selected large-joint arthroplasty as our study group, as they nationally represent the most common major elective orthopaedic surgical procedures.¹⁵ Our study demonstrated no apparent difference in length of stay for patients having weekend or weekday surgery. In fact, there was no significant difference in average length of stay for patients having surgery on any day, suggesting that patients undergoing surgery on Thursdays and Fridays were not disadvantaged by having their first postoperative days on the weekends. There was also no significant difference in length of stay in relation to the operating surgeon, despite the variety of specialisation and operative techniques used. All 15 consultants performed both total hip and knee arthroscopies with varying frequency. Some surgeons were revision hip specialists, others were soft-tissue and revision knee specialists and others performed only primary joint arthroplasties. We did not measure specific technical criteria such as approach, length of incision or usage of drains but, overall,

operating surgeon did not relate to length of stay. Variables of significance included increasing age, female sex, ASA grades greater than 1, a history of myocardial infarction and diabetes mellitus. Interestingly, patients who remained inpatients longer than four days were on average six years older than patients who went home within four days (73 years vs 67 years; Table 1). The majority of our sample (599 patients) had an ASA grade of 2; 394 (65.8%) stayed for longer than four days; 187 patients were recorded as having ASA grade 3 and 165 (88.2%) of this group stayed for longer than four days. Of note, the reasons for this length of stay were all non-modifiable patient-related factors, rather than surgical or service related factors. These risk factors to prolonged hospitalisation were also identified in a recent but smaller American study and other smaller studies, which found no association between day of elective surgery and length of inpatient stay.^{17–19}

In our series of 892 patients, we had only one death, at 30 days (0.1%). This occurred in a patient who was ASA grade 3 and who underwent surgery on a Monday. In a review of all the evidence pertaining to the weekend effect across all surgical specialties in Canada, investigators also found that mortality rates of elective patients remained low (0.6%). They also concluded that, nationally, there was insufficient evidence to ascribe any connection between elective services and a potential weekend effect.²⁰ A multicentre study examining the weekend effect on mortality on English elective surgical patients has also been performed.²¹ In this study, authors classified hip and knee arthroplasty as low risk to 30-day mortality and grouped them with patients undergoing other low-risk procedures, including those undergoing tonsillectomy, varicose vein stripping and abdominal, femoral or elective inguinal hernia repairs. Clearly, these procedures are very different; however, a lower 30-day mortality was still evident for those having weekend surgery (Saturday and Sunday) than for any day during the week.²¹ In this same study, 4634 procedures were deemed as high risk because of their predictable requirement for a postoperative intensive care bed and were found to be associated with a higher mortality at the weekend. However, none of these was an orthopaedic procedure.²¹

The majority of orthopaedic studies that have investigated the possibility of a weekend effect have done so on the higher-risk fracture of the neck of the femur (FNOF) and patients with major trauma. However, only a single-centre, UK-based study of 2989 patients with FNOF has found an association between weekend admission and higher mortality rates.²² This finding has not been echoed by other studies.^{1,23} A larger multicentre study of 59,670 FNOF patients actually found a lower mortality rate in weekend patients (6%) compared with those presenting during the week (7%).¹ Another large study examining over one million hospital admissions found only three diagnoses to be associated with a weekend effect. These included cancer of the ovary or uterus, duodenal ulcers and cardiovascular symptoms. In their analysis of 22,001 hip fractures, again no weekend effect was evident.² The largest multicentre study was actually from the UK and examined over four million acute

admissions and 53,153 patients with hip fractures. While the study found overall evidence for a weekend effect across all acute admissions, there was again a lower mortality rate for patients with hip fracture at weekends (12.9%) than during the week (13.4%).⁶ Patients with major trauma also seem to be untouched by a 'weekend effect'.^{20,24}

If the weekend effect is more than simply an observation of coincidence, then it appears from the literature to be disease specific.^{1,6,20,25} Given the lack of any evidence to support the presence of a weekend effect in elective, general or trauma services, it is difficult to see how a change in staffing working patterns will have any effect on outcomes in orthopaedics as a surgical subspecialty. Indeed, a consultant-driven trauma service is already provided during weekends in the majority of units in the UK. 'Staffing levels' as a causal reason for a weekend effect has never been proven. In fact, some suggest that more than 48 hours of decreased staffing levels below that which we currently deem acceptable would be required to manifest in an increase in mortality.²⁵ Similarly, other studies investigating a relative lack of senior doctors working on weekends have found that this factor does not explain a weekend effect and that other organisational factors might be more important.^{26–29}

In England, patients presenting through accident and emergency departments with acute renal, cardiovascular or cerebrovascular emergencies are most implicated with higher weekend mortality rates.⁶ Only 4634 high-risk elective procedures are being performed each year in England where a greater mortality has been observed. None of these is an orthopaedic procedure and almost all predictably require a postoperative stay in intensive care.²¹ A concentration of resources and increase in support for intensive care units looking after these 'at-risk patients' may be a reasonable strategy to improve survival rates.

This study is limited by the fact that it was retrospective in nature and done without a prior power calculation. However, it is unique in its objectives of searching for a potential weekend effect specifically in UK elective orthopaedics services and, as such, data to perform a meaningful power calculation were lacking. Instead, we decided that if a clinically significant difference was evident, it would be manifest when looking at data for an entire year. The main limitation is that this study presents data from a single centre, with fewer numbers of subjects than previous multicentre non-specialty specific studies. However, the need for specialty and procedure-specific studies is important as these studies highlight the real group of patients who have a higher risk of mortality. Thus, policy makers may be empowered with data, which allows them to direct resources to the patients who are most at risk of death.

Conclusion

In summary, we found that performing elective orthopaedic surgery on a weekend did not adversely affect mortality or length of stays. Given this finding, it would be difficult to see how specific changes, such as in staffing working patterns, could affect these outcomes. Instead, the non-modifiable

patient related risk factors were most associated with an increased length of stay beyond the national average of four days. Policies aiming to improve outcomes for patients presenting at the weekend could focus resources on the small number of high-risk and non-orthopaedic procedures, which routinely require postoperative intensive care.

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