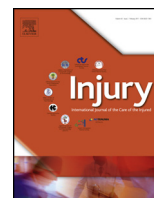




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## Major trauma: Does weekend attendance increase 30-day mortality?

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### ABSTRACT

**Background:** Differing mortality rates according to day of hospital admission is an area of debate, where a supposed increased rate of mortality with weekend admissions has been termed "the weekend effect". We sought to identify the 30-day mortality rates in major trauma patients attending our Major Trauma Centre (MTC) and the underlying reasons for these.

**Methods:** A retrospective review of data retrieved from the Trauma Audit and Research Network (TARN) database was undertaken for all patients attending between January 2013 and July 2015 with an Injury Severity Score of 9 or higher. 30-day mortality rates were calculated according to day of attendance.

**Results:** 1424 patients met the inclusion criteria. There was no significant difference in 30-day mortality between weekend attendances (7.8%) compared to those on a weekday (7.7%). 30-day mortality was highest in patients attending on Fridays (10.8%) and lowest in those attending on Sundays (5.5%). A significantly higher 30-day mortality rate was seen in patients attending on a Friday or Saturday (10.4%) compared to those attending Sunday to Thursday (6.6%) (RR 1.548). Patients with a head injury as their most serious injury on a Friday or Saturday were more likely to have GCS < 9 (34.7% vs 24.4%) and more likely to die (22.7% vs 12%) than those attending Sunday to Thursday.

**Conclusion:** There is no significant difference in 30-day mortality when directly comparing weekday to weekend attendances. There is a significantly higher mortality on Friday and Saturday compared to remainder of the week which appears to be explained by a greater severity of head trauma.

**Implications:** This study provides no evidence of a "weekend effect" in this MTC but the increased severity of and mortality from head injury identified on Friday and Saturday is a public health concern which warrants further investigation.

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### Introduction

In the UK, differing levels of mortality on different days of the week has been recently highlighted as a public health and political issue, particularly between weekdays and the weekend where a supposed increased rate of mortality in patients admitted at the weekend has been termed "the weekend effect" [1–4].

To date, there has been no irrefutable evidence of increased mortality in patients admitted at the weekend, once confounding factors have been appropriately accounted for. Some studies carried out in the UK have found different mortality rates in patients admitted on different days of the week, but unclear definitions of when "the weekend" is have clouded the validity of the studies and the reasons for these differing mortality rates have not been fully elucidated [5,6].

Some studies have attributed these to variations in staffing levels and infrastructure [5]. Others have found no significant difference in mortality outcome when comparing weekend admissions to weekday admissions [7,8].

To our knowledge, no true "weekend effect" has been demonstrated in the literature for major trauma patients, indeed two recent UK studies have clearly demonstrated that there is no increase in mortality in patients attending at weekends compared to those attending during the week [9,10].

In this study, we set out to identify whether there was any difference in the 30-day mortality rates of patients attending a level one trauma centre with moderate and severe trauma injuries on different days of the week, and by doing so investigate whether or not a true "weekend effect" exists for this cohort. In this centre, emergency trauma team staffing levels and provisions for imaging and intervention do not vary according to the day of the week: the same numbers of consultants, registrars and junior doctors are on call for neurosurgery, cardiothoracic surgery, orthopaedic surgery, vascular surgery, general surgery, plastic surgery, paediatric surgery and radiology at the weekend as during the week.

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Emergency department consultants are present in the department 24 h a day, 7 days a week, and act as trauma team leaders for the majority of trauma calls. Access to emergency CT and MRI scanning, interventional radiology, blood bank services and emergency general, trauma, vascular, neurosurgical and cardiac theatres is also the same at the weekend as during the week.

## Methods

Data were retrieved from the Trauma Audit and Research Network (TARN) database relating to patients attending St George's Hospital, London between 5 January 2013 and 1<sup>st</sup> July 2015 with moderate or severe trauma, as defined by an ISS of greater than 8 [11]. The data available from TARN and collated included age, gender, Injury Severity Score (ISS), Glasgow Coma Score (GCS), mechanism of injury, mortality, and total hospital length of stay.

The day of the week on which patients attended the emergency department was determined and patients were then categorised into 2 groups, according to whether they had attended on a weekday (Monday 00:00 to Friday 23:59) or weekend day (Saturday 00:00 - Sunday 23:59).

The mean ISS and GCS as well as 30 day mortality rates were calculated for each day of the week, and for both groups.

Further analysis saw patients grouped into Friday 00:00 to Saturday 23:59 attendances and Sunday 00:00 to Thursday 23:59 attendances to ascertain whether there was any significant differences between these two groups. This was done as although their attendance at the hospital was not strictly "weekend" their first 48 h of care fell into this category.

## Statistics

Statistical analysis was performed using the IBM SPSS 23 programme. The Mann-Whitney *U* test was used to determine whether there were any significant differences in the age, ISS and GCS in each group.

An outcome crosstabulation was produced indicating the number of patients attending on weekdays and weekend days along with the respective mortality outcome such that an odds ratio analysis and relative risk could be calculated. The same crosstabulation technique was used to compare the Friday-Saturday and Sunday-Thursday groups.

A *p*-value of less than 0.05 was considered significant.

## Results

1427 patients met the inclusion criteria. Of these, 3 were excluded as their attendance time had not been recorded, leaving a total of 1424 patients in the study.

### Demographics

449 patients (31.5%) attended at the weekend and 975 (68.5%) attended on a weekday.

There was no significant difference in age, gender and ISS scores between the two groups (Table 1).

**Table 1**  
Demographics and Injury Severity Score in the weekday and weekend groups.

	Weekday	Weekend	Overall
Gender	Male 625–64.1% Female 350–35.9%	Male 295– 65.7% Female 154– 34.3%	Male 920–64.4% Female 504– 35.4%
Age (years)	53.0	52.1	52.4
Mean ISS	19 (9–75)	19 (9–59)	19

### Injury Severity Score (ISS) by day of attendance

There was no significant difference in the ISS when comparing different days of the week: the mean ISS in the weekend group was 19 (range 9–59), and in the weekday group also 19 (range 9–75) (Fig. 1).

### Glasgow Coma Score (GCS) by day of attendance

There was no significant difference in GCS when comparing different days of the week. Friday and Saturday had the lowest mean GCS scores of any day (Fig. 2) but these were not significantly different from any other day.

### 30-Day mortality: weekend vs weekday attendance

Patients attending on a Friday had the highest 30-day mortality rate at 10.8%, those on a Saturday had the second highest at 10.0% and those attending on a Sunday had the lowest (5.5%) (Fig. 3).

Odds ratio analysis of the 30-day mortality in the weekend group compared to the weekday group did not demonstrate a statistically significant difference (1.01; CI 0.67–1.54) and the relative risk of death within 30 days for weekday compared with weekend attendances was 0.987 (CI 0.671–1.451), demonstrating a trend towards lower mortality during the week but this did not reach statistical significance (Table 2).

### 30-Day mortality: Friday and Saturday attendances compared to the rest of the week

The 30-day mortality rate for those attending on Friday or Saturday was 10.4%. In patients who attended between Sunday to Thursday the 30-day mortality rate was 6.6% (Table 3).

The relative risk of death within 30 days of attendance on a Friday or Saturday was 1.584 (95% CI 1.102–2.278), indicating a 58.4% relatively increased risk of death compared to attendance between Sunday to Thursday, which did reach statistical significance (Table 4).

There was no statistical difference in ISS ( $p=0.20$ ) or age ( $p=0.25$ ) between the Friday and Saturday, and Sunday to Thursday groups.

Further analysis of the Friday and Saturday group compared to the Sunday to Thursday group revealed a trend towards a lower average GCS in the Friday and Saturday group, though this did not reach statistical significance ( $p=0.11$ , Fig. 4).

We looked at the injuries of those patients who attended on Fridays and Saturday to look for any identifiable explanation for the increased 30 day mortality. Of the 418 patients, 33.7% ( $n=141$ ) had a head injury as the most severe injury, 15.7% had a GCS of less than 9, and of those 141 patients 11.2% had a GCS of 3. 22.7% of patients with head injury as the most severe injury category died within 30 days.

In comparison, in the cohort of patients attending from Thursday to Sunday there were 934 patients of which 290 had a head injury as the most severe injury (31%). 7% had a GCS of 3 and 11.2% had a GCS of less than 9. Of this cohort of head injured patients who attended on Sunday to Thursday 12% died within 30 days. This suggests that patients who attend on a Friday or Saturday have a tendency to have more significant head injuries, as indicated by a lower average GCS, and were more likely to die from these.

When other factors were considered to explain any differences in mortality the age and ISS at presentation were investigated. The mean age of attendees who died within 30 days was significantly greater than those who survived when compared using a Mann-Whitney *U* test (70.8 vs 50.9 years,  $p<0.0001$ , Fig. 5).

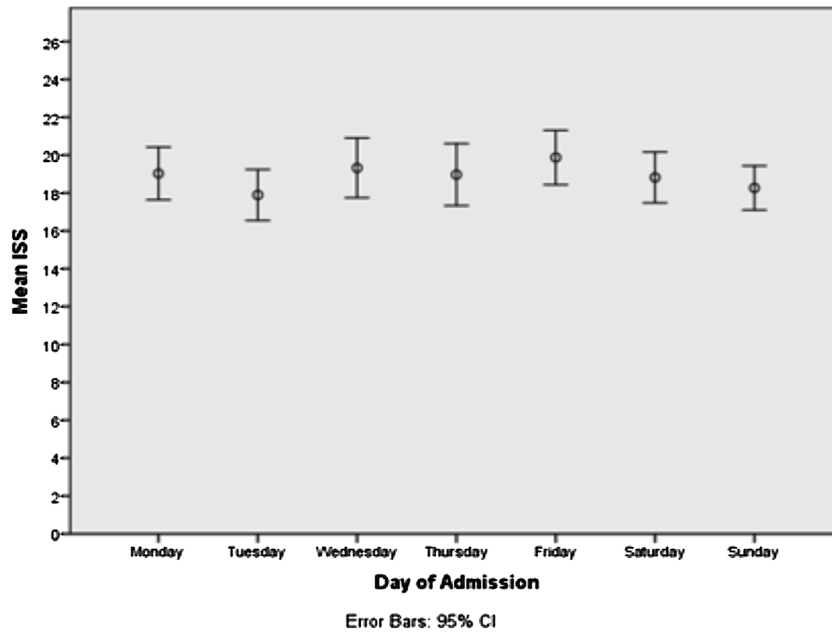


Fig. 1. Error bar chart showing the mean ISS score of patients attending on each day of the week.

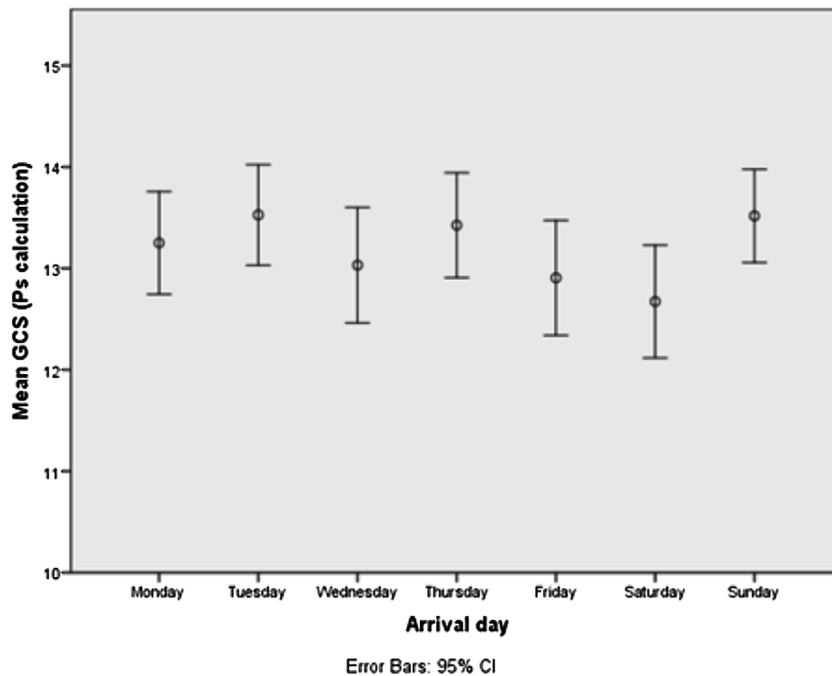


Fig. 2. Error bar chart showing mean GCS score across all days of the week.

As would be expected, the mean ISS score for those who died within 30 days of attendance was significantly higher than in those who survived when compared using a Mann Whitney U test (29 vs 18,  $p < 0.0001$ , Fig. 6).

The mean GCS of those who died within 30 days was lower than in those who survived (8 vs 14,  $p < 0.0001$ , Fig. 7) when compared using a Mann Whitney U test.

### Discussion

In the studied cohort there was no true “weekend effect”, that is there was no significant difference in the 30-day mortality rates

between patients attending on a weekday compared to those attending on a Saturday or Sunday who had an ISS greater than eight.

It is interesting to see that the mortality pattern we observed was similar to that of a previous study looking into the mortality pattern in an elective surgery setting [12].

In our study, the mortality rates were highest in those attending on a Friday and Saturday and when grouping these days together there was a significantly higher 30-day mortality rate compared to the rest of the week. The reasons for this are not clear but we do not believe it is due to emergency staffing levels or resources in our unit, as these are consistent throughout the week. Patients

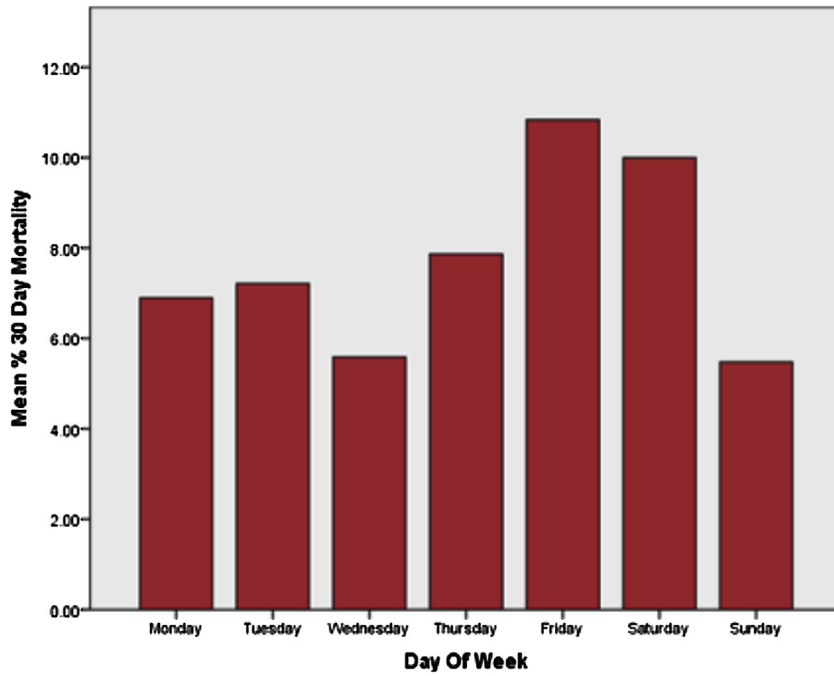


Fig. 3. Bar chart showing the mean 30-day mortality according to the day of the week of attendance.

Table 2

Odds ratio of 30-day mortality in the weekend group compared to the weekday group.

	Value	95% confidence interval	
		Lower	Upper
Odds ratio for arrival day (weekday/weekend)	1.014	0.668	1.541
For cohort outcome = alive	1.001	0.969	1.034
For cohort outcome = dead	0.987	0.671	1.451
N of valid cases	1424		

Table 3

Crosstabulation of trauma patients attending on Friday and Saturday compared to Sunday to Thursday.

Arrival day			Outcome		Total
			Alive	Dead	
Fri-Sat	Count		388	45	433
		% within arrival day	89.6%	10.4%	100%
	Sun-Thurs	Count	926	65	991
		% within arrival day	93.4%	6.6%	100%
Total	Count	1314	110	1424	
	% within arrival day	92.3%	7.7%	100%	

Table 4

Odds ratio and relative risk of 30-day mortality of trauma patients attending on Friday and Saturday compared to those attending Sunday to Thursday.

	Value	95% confidence interval	
		Lower	Upper
Odds ratio for arrival day (Fri-Sat/Sun-Thurs)	0.605	0.406	0.901
For cohort outcome = alive	0.959	0.925	0.994
For cohort outcome = dead	1.584	1.102	2.278
N of valid cases	1424		

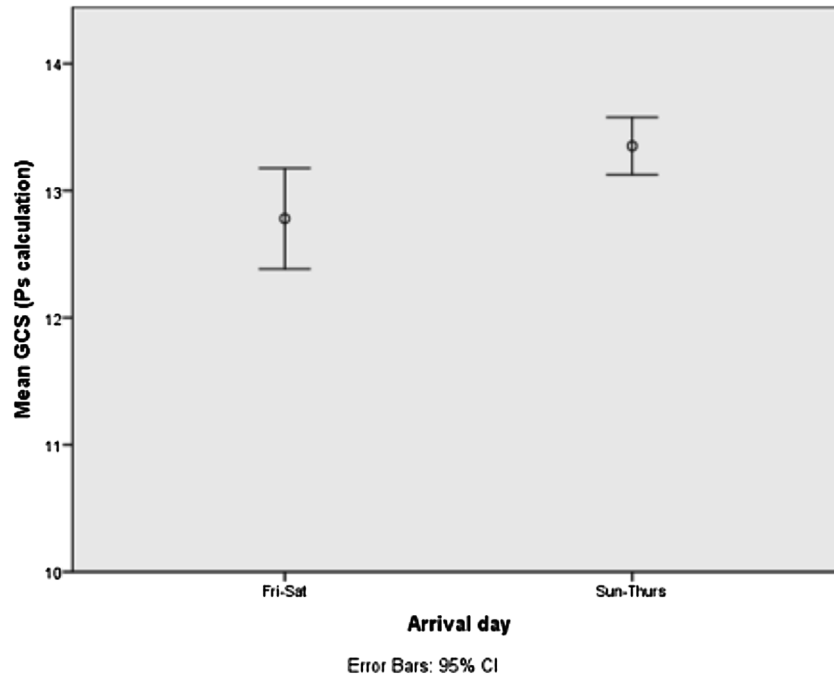


Fig. 4. A simple error chart showing the mean GCS score for all patients attending on Friday and Saturday compared to those attending between Sunday and Thursday.

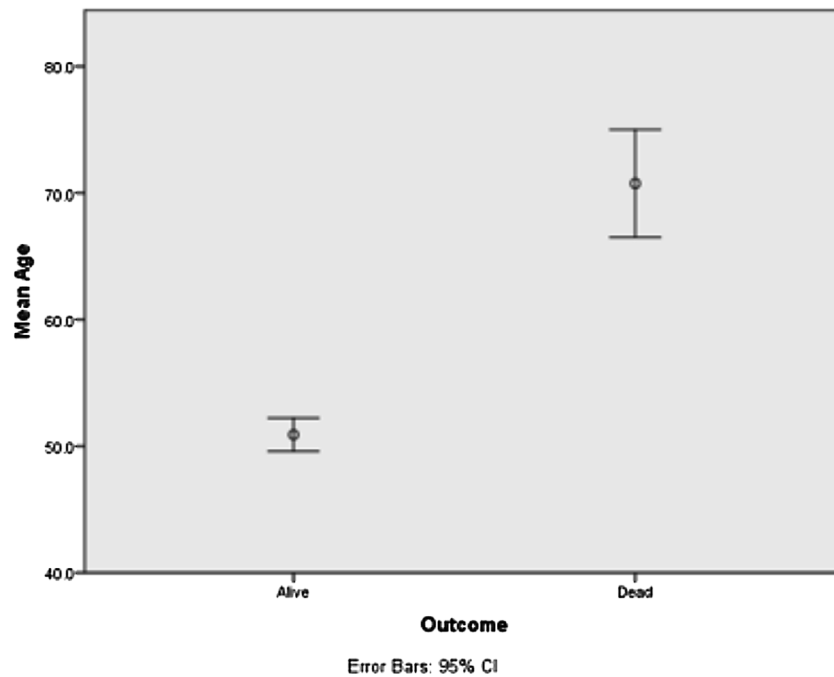


Fig. 5. An error bar showing mean age of those that died within 30 days compared with those who remained alive.

attending on Friday and Saturday have a trend towards lower GCS on arrival and are more likely to die from significant head injuries - and we have demonstrated that mean GCS is significantly lower in the patients who did not survive to 30 days.

Severe head injuries are known to be seen more frequently in Accident and Emergency departments at weekends and nights [13]. Around 70% of weekend admissions are alcohol related, with

the majority of these presenting as traumatic injuries [14]. “The Weekend Warrior” effect may also be in play here, whereby an increased level of participation in recreational activities and sporting activities leads to increased attendance with head trauma [15].

Saturday and Sunday are the days that we associate with the weekend, and are at the core of the debate over the

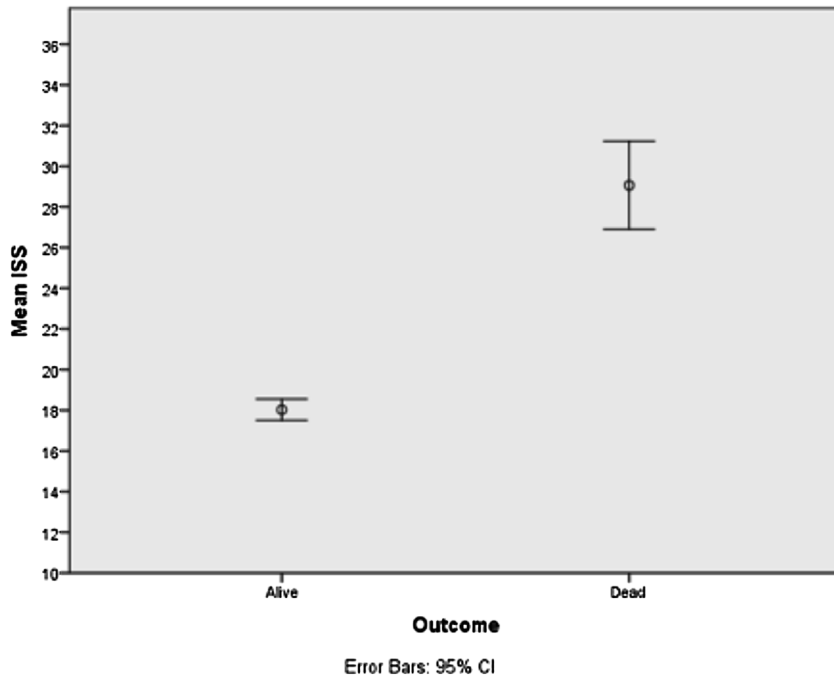


Fig. 6. Simple error graph showing mean ISS for those who died within 30 days compared with those who remained alive.

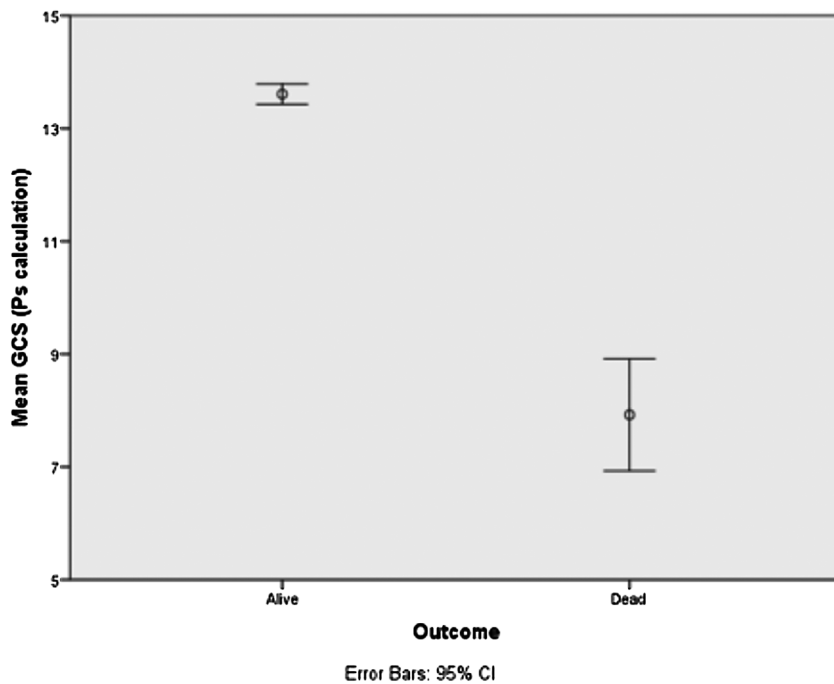


Fig. 7. Error graph showing mean GCS for those who died within 30 days compared with those who survived.

implementation of a "seven day" NHS. Based on our results there is a case to say that if policies are forged on "the weekend effect" without delving into the detail of this, they could be missing the point, given that Friday and Saturday attendances are associated with the highest mortality rates in the studied cohort.

There are limitations to this study in that it is retrospective, limited to one centre and the numbers studied are relatively small compared to those that would be available during a multi-centre study.

### Conclusion

These data do not provide any evidence of a true "weekend effect" in moderate and severe trauma patients presenting to a level 1 trauma centre. However, there is a significant increase in 30-day mortality for moderate and severe trauma patients who attended on Fridays and Saturdays when compared with attendances during the rest of the week. With consistent trauma team

staffing levels as well as access to emergency imaging and intervention on every day of the week, this difference in mortality is not explained by variable staffing and resources and may be related to the type of injury - which cannot be fully determined from the available data.

Further work is required to identify the cause of the increased mortality we have shown on Friday and Saturdays, and to determine whether these deaths are preventable.

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