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Comparison of trauma management between two major trauma services in Riyadh, Kingdom of Saudi Arabia and Melbourne, Australia

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ABSTRACT

Introduction The burden of injury in the Kingdom of Saudi Arabia (KSA) has increased in recent years, but the country has lacked a consistent methodology for collecting injury data. A trauma registry has been established at a large public hospital in Riyadh from which these data are now available.

Objectives We aimed to provide an overview of trauma epidemiology by reviewing the first calendar year of data collection for the registry. Risk-adjusted analyses were performed to benchmark outcomes with a large Australian major trauma service in Melbourne. The findings are the first to report the trauma profile from a centre in the KSA and compare outcomes with an international level I trauma centre.

Methods This was an observational study using records with injury dates in 2018 from the registries at both hospitals. Demographics, processes and outcomes were extracted, as were baseline characteristics. Risk-adjusted endpoints were inpatient mortality and length of stay. Binary logistic regression was used to measure the association between site and inpatient mortality.

Results A total of 2436 and 4069 records were registered on the Riyadh and Melbourne databases, respectively. There were proportionally more men in the Saudi cohort than the Australian cohort (86% to 69%). The Saudi cohort was younger, the median age being 36 years compared with 50 years, with 51% of injuries caused by road traffic incidents. The risk-adjusted length of stay was 4.4 days less at the Melbourne hospital (95% CI 3.95 days to 4.86 days, p<0.001). The odds of in-hospital death were also less (OR 0.25; 95% CI 0.15 to 0.43, p<0.001).

Conclusions This is the first hospital-based study of trauma in the kingdom that benchmarks with an individual international centre. There are limitations to interpreting the comparisons, however the findings have established a baseline for measuring continuous improvement in outcomes for KSA trauma services.

Strengths and limitations of this study

- ► All records with dates of injury from 1 January 2018 to 31 December 2018 inclusive were extracted from both the Riyadh and Melbourne databases.
- ► Extensive cleaning was undertaken to optimise the quality of the analyses.
- ► Two system indicators and five process indicators were analysed from the Riyadh data.
- ► Baseline characteristics and risk-adjusted endpoints of inpatient mortality and length of stay using binary logistic regression were determined from those records from each site that were identified as being complete and accurate enough to provide robust risk adjustment.
- ► The dataset was limited by incomplete records, as was interpretation of the benchmarking model due to the differences between the Riyadh and Melbourne systems.

INTRODUCTION

The burden of traumatic injuries in the Kingdom of Saudi Arabia (KSA) has increased significantly in recent years, with road trauma being reported in 2017 as being the leading cause of premature death.[1] However, to obtain a complete epidemiological picture, it is important to understand that traumatic injuries also occur from other causes. Falls are reported as being the next most frequent cause of injury in the KSA.[2 3]

Injury prevention strategies proposed in epidemiological studies previously focused on road safety initiatives,[4 5] on which the kingdom has been working since the early 2000s.[6] Public health strategies to address other causes of injury seem to be limited. Strategies for burns and falls injuries had been suggested as priority areas to target prevention of paediatric trauma.[7]

Dijkink *et al*[8] noted as recently as 2016 that, although classified as a high-income country, Saudi Arabia had only a level II trauma system, as measured by the WHO Maturity Index.[9] This meant that there was no organised method of using available injury data to inform clinical knowledge or quality improvement. A trauma registry would be the most efficient method for collating injury data and the benefits have long been recognised elsewhere.[10–12]

The need to collect national trauma data in Saudi Arabia was acknowledged by the Ministry of Health (MOH) in 2014 with the planned national implementation of an electronic injury surveillance system.[13] Ongoing innovations in Saudi healthcare were detailed in Vision 2030.[14] Improvements in the national trauma systems have now been initiated and have enabled the collection of trauma data that are available for use by the trauma community.

The aim of this study was to review the first full calendar year of data collected by a trauma registry to provide an overview of trauma epidemiology at a large Saudi Arabian public hospital; apply established performance indicators to establish a baseline from which to measure continuous improvement; and perform preliminary risk-adjusted analyses to benchmark outcomes with the largest Australian major trauma service situated in the state of Victoria. The findings are the first to report the major trauma profile from a single centre in the KSA and compare trauma outcomes with an individual international level I trauma centre.

METHODS

Setting

In 2016, the largest MOH hospital in the kingdom, the King Saud Medical City (KSMC), situated in Riyadh, began a collaboration with the Alfred Hospital in Melbourne to improve the care of injured people. A key component of this project was the successful implementation of the Saudi TraumA Registry (STAR). Data collection commenced in August 2017.[15] This registry was developed as a potential prototype of the kingdom's first national trauma registry.

The STAR collected data from all patients who presented to the KSMC who met predetermined inclusion and exclusion criteria, which were strictly observed to ensure the cohort was within the population of interest. Inclusion criteria were patients who had presented to hospital as a result of acute physical injury(ies); had either died in the emergency department (ED) as a result of injury(ies); been admitted for greater than 2 calendar days; been admitted to the intensive care unit (ICU) or had died from injury(ies) following inpatient admission. The 83 variables in the dataset included 11 demographic fields, 12 relevant to the injury event, 58 reflecting the care provided at the KSMC including procedures performed, and 2 that described the injuries ((online supplemental file 1: Saudi TraumA Registry (STAR) Minimum Dataset V 4.0).

The overall Injury Severity Score (ISS) of each case was derived from the Abbreviated Injury Scale (AIS) codes allocated by trained coders to each diagnosed injury.[16] The severity of each injury is assigned as one to six, that is: minor, moderate, serious, severe, critical and maximal. Any patient with an ISS of greater than 12, or who died as a consequence of their injuries, was coded on the database as major trauma,[17] which was standardised in Australian/New Zealand trauma registries following an AIS version update, to allow for historical cohort comparisons.

Methodology

All records with dates of injury from 1 January 2018 to 31 December 2018 inclusive were extracted from the STAR database. The records were extensively cleaned to optimise the quality of the analyses. The majority of errors that required correction were chronological; anomalous in that the information did not match other values within the record; and AIS coding errors where the description of the injury did not match the body region and/or the severity of the code. A series of error reports were submitted to the STAR team who amended the errors and resubmitted the record for inclusion in the analyses. Edits built into the STAR database did not allow fields to remain empty. However, data collectors entered default or erroneous values in some cases, which were rectified where possible. Cases were excluded where there was insufficient information. The STAR trauma profile was analysed from all the records where injury event data had been entered. Patients aged less than 15 years were included to report overall patient demographics at the KSMC.

Two system indicators and five process indicators were analysed. These were presentation to at least one other hospital prior to admission to the KSMC or admission to the KSMC directly from the scene; direct admissions to the KSMC that were attended at the scene by a Saudi Red Crescent Authority (SRCA) ambulance; the length of time spent in the ED; length of stay (LOS) in the ICU; non-risk-adjusted LOS in hospital: median time to surgery, including the casemix of surgical procedures; and non-risk-adjusted outcomes.

To enable benchmarking, we extracted data from the Alfred Hospital Trauma Registry (AHTR), which is a trauma epidemiology and performance monitoring programme that has collected trauma data at that site since July 2001. The Alfred Hospital, which is the source of the data, receives the highest number of adult major trauma patients in Australasia.[18] In 2019 the AHTR contributed to over 40% of the Victorian State Trauma Registry (VSTR) dataset, which collects data from every hospital and healthcare facility in the state. The AHTR is the model for the STAR and deploys the same inclusion criteria.

All records with dates of injury between 1 January 2018 and 31 December 2018 inclusive were extracted from the AHTR database. Baseline characteristics were determined from those records from each site that were identified as being complete and accurate enough to provide robust risk-adjustment analysis. The Alfred Hospital does not admit paediatric patients, therefore, for benchmarking purposes, all patients in the STAR database who were aged less than 15 years at the time of injury were excluded from those analyses.

The primary endpoints were inpatient mortality and LOS. Binary logistic regression was used to associate between site and inpatient mortality. Potential confounding variables assessed were gender, age group, injury cause, Glasgow Coma Score (GCS) arrival motor score, individual body components AIS scores and ISS group. Starting from the most significant factor identified in the univariable analysis, we used the likelihood ratio test to evaluate whether inclusion of the next most significant variable helped improve the model fit. This was sequentially undertaken until all variables were evaluated. For LOS, we used quantile (median) regression to analyse the data since LOS was significantly positively skewed. We used a similar model selection process for inpatient mortality to build a multivariable model. Data analysis was undertaken in Stata V.16 (Stata Corp, College Station, Texas, USA). Level of significance was set at 5%.

Patient and public involvement

Patient consent was not obtained due to the low risk analyses of de-identified, aggregate data and waived accordingly by the ethics committees. The study design precluded the involvement of patients or the public in the reporting of our findings.

RESULTS

In 2018, 2436 records of eligible patients were registered on the STAR database. The definitive care dataset was completed for 2219 records. The injury event dataset only was completed in 217 cases. A further 136 records were otherwise incomplete, with either AIS coding not done or default values entered. These records, and patients who were aged less than 15 years at the time of injury (n=295) or records with age unknown,[2] were included in the trauma profile but were excluded from the risk-adjustment analysis. The risk-adjusted sample size was 1786 records (figure 1).

The AHTR included 4069 patients on its database in 2018. Of these, 3980 were included in the risk-adjustment analysis. Eighty-six records with no injuries identified and three records that were incomplete were excluded (figure 1).

STAR trauma profile

The whole STAR cohort of 2436 records were analysed to obtain the trauma profile (table 1). The median age was 29 years with an IQR of between 20 and 44 years, including paediatric patients aged <15 years. Nationality was reported as Saudi for 60% of records. Overall, 85% of patients were men.

Most injury events (92%) were of the ‘blunt’ type, 4% were penetrating trauma and 3% of cases were burns. One per cent of cases were classified as ‘other’, which included electrical injury suffocation and asphyxia. Seven records had an unknown cause of injury. Overall, 51% of all injuries were due to road traffic incidents.

Of the 2219 records where the definitive care dataset was complete, seven patients did not have injury coding performed, due to either having died or having been discharged before any diagnoses were made. Of the remaining 2212 records, the majority (78%) had an ISS of less than or equal to 12.

Five hundred and seven records (23%) were classified as major trauma, where the ISS was >12 or where the patient had died. These included records where no or minimal coding had been performed, but the patient was known to have died.

Process and system indicators

A sample size of 1697 records had sufficient known values with which to analyse prespecified process and system indicators. Records with unknown values in the relevant variables were excluded (522).

Almost one-quarter of patients (414, 24.4%) attended at least one other hospital prior to presentation to the KSMC. Of the 1283 patients (75.6%) who were admitted directly to the KSMC, 605 (47.2%) were known to have been attended at the scene by an SRCA ambulance.

The median time spent in the ED was 7 hours and 16 min (IQR 4 hours 17 min–10 hours 54 min). The median LOS in the ICU for the 358 patients admitted therein was 9 days (IQR 4–17 days). The median non-risk-adjusted LOS in hospital was 8 days (IQR 4–14 days).

There were 2035 surgical procedures performed in the operating theatre on 1432 patients. Median time to surgery was 115 hours (IQR 32–243). Of these, 1362 (67%) were orthopaedic procedures including spinal fixations. Ninety-eight (5%) neurosurgical procedures were performed. The median time to theatre for initial craniotomies/craniectomies was 10 hours (IQR 7–21). Seventy-five (4%) laparotomies were performed. Thirteen thoracotomies and eight tracheostomies were performed, comprising only 1% of surgical procedures. There were 479 (24%) ‘other’ operations performed, including vascular surgery, skin grafts and soft tissue repairs.

The discharge destination was known for 2216 records, and unknown for 3 records. The vast majority of patients were discharged home (88.5%). Other discharge destinations were to other hospitals for acute or convalescent care (2.7%); or patients who absconded or discharged against medical advice (5.2%). Seventy-seven patients died in hospital as a result of injury, which is a case fatality rate of 3.5% (95% CI: 2.7% to 4.3%) overall. The case fatality rate for major trauma was 15.2%.

Trauma profile comparison with the AHTR

The proportion of men (table 2) was higher at KSMC relative to the Alfred (86.3% compared with 68.6%). The mean age of STAR records at the time of injury was found to be 36 years compared with 50 years at the Alfred.

Length of stay

The risk-adjusted LOS (table 3) at the Alfred was 4.4 days less (95% CI 3.95 days to 4.86 days, p<0.001) than at the

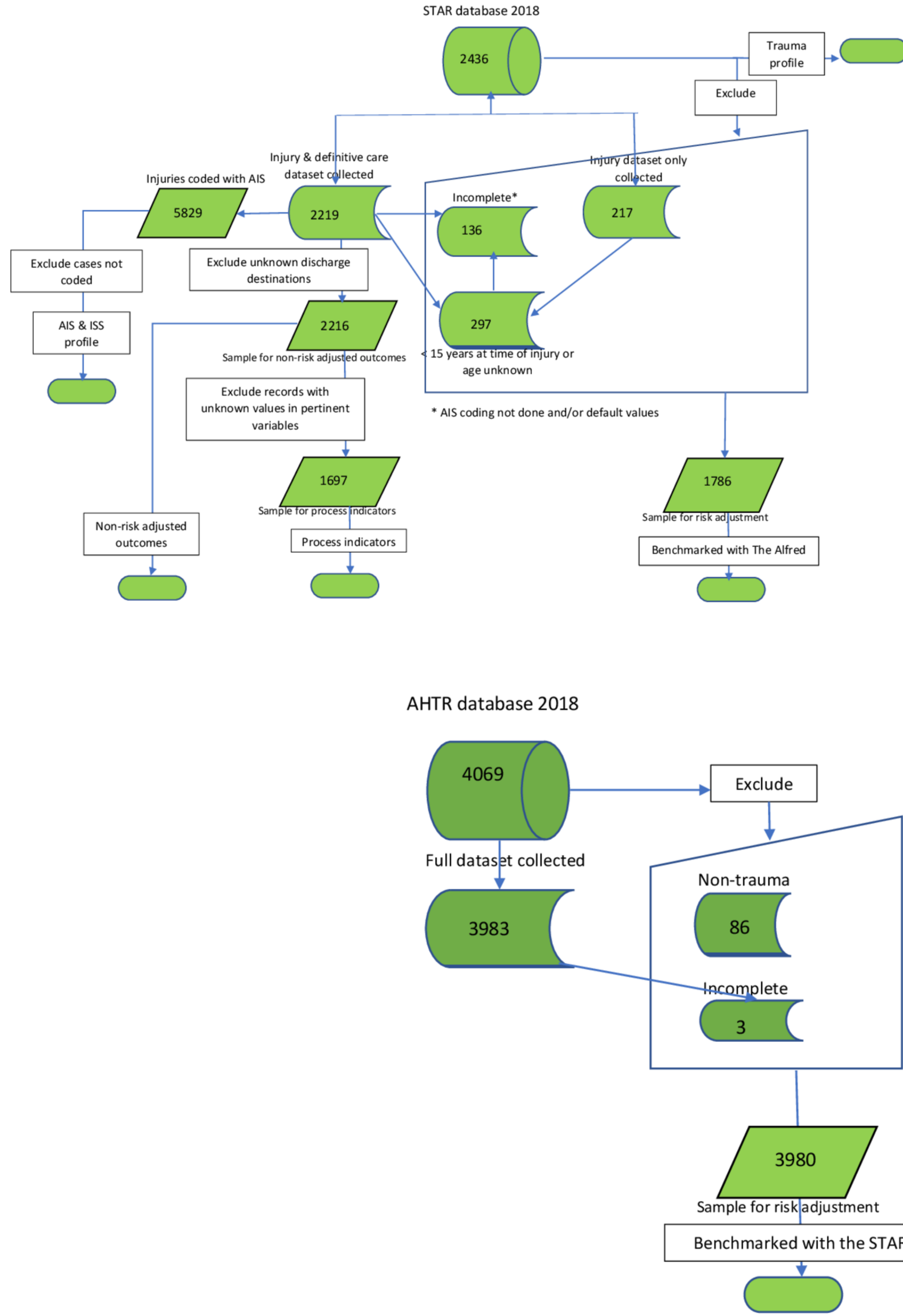

Figure 1 Flow chart of inclusions and exclusions of STAR and AHTR data. AHTR, Alfred Hospital Trauma Registry; AIS, Abbreviated Injury Scale; ISS, Injury Severity Score; STAR, Saudi TraumA Registry.

Characteristic	n	%
Total records	2436	
Saudi nationality	1463	60.1
Gender		
Male	2074	85.1
Female	362	14.9
Age in years at event; median (IQR)	29 (20–44)	
0–14 and unknown	297	12.2
15–24	596	24.5
25–40	896	36.8
41–60	414	17.0
61–70	89	3.7
71–80	82	3.4
81+	62	2.5
Type of injury		
Blunt	2230	91.5
Penetrating	97	4.0
Burns	81	3.3
Other	21	0.9
Unknown	7	0.3
Cause of injury		
Burns—all types	81	3.3
Cause with systemic effect (drowning, suffocation, asphyxia and electrical injury)	11	0.5
Falls—both high and low	865	35.5
Motor vehicle occupants	852	35.0
Motorcyclists	112	4.6
Other specified external cause	48	2.0
Pedal cyclist—rider or passenger	7	0.3
Pedestrian	237	9.7
Penetrating wounds including gunshots and stabbing	97	4.0
Struck by object or person	119	4.9
Unspecified external cause	7	0.3
Injury Severity Score range		
Total records	2219	
Unknown	7	0.3
≤12	1734	78.1
13–25	401	18.1
26–40	64	2.9
>40	13	0.6
Severity of individual injuries		
Total injuries coded	5829	
Minor or severity unknown	565	9.7
Moderate	3748	64.3
Serious	1284	22.0
Severe	152	2.6
Critical	75	1.3
Maximal	5	0.1
Trauma status		
Major	507	22.8
Non-major	1712	77.2

Table 1 STAR trauma and injury profile

STAR, Saudi TraumA Registry.

KSMC, adjusting for GCS on arrival, age and the severity of injuries.

Mortality

Adjustment for GCS on arrival, age, severity of injury and cause of injury (table 4) showed that the odds of in-hospital death from traumatic injuries at the Alfred were less than at the KSMC (OR 0.25; 95% CI: 0.15 to 0.43, p<0.001).

DISCUSSION

This study describes the trauma profile at a large tertiary referral hospital in KSA, which will contribute to the knowledge required to improve the trauma system. We have established a prototype for the national trauma registry that is essential for the kingdom to understand how and why injuries occur.

The over-representation of men at 85% and the young mean age of 33 years at the time of injury have implications for the community. The post-discharge levels of disability were not included in this study, however Gabbe *et al*[19] noted compelling evidence of ongoing problems following serious injury that are likely to be lifelong.

The study found that 51% of all trauma in the STAR cohort, including paediatric patients, was due to road traffic incidents. These included motor vehicle events where the victims were drivers or passengers, pedestrians, motorcycle riders, motorcycle passengers and pedal cyclists. This was consistent with the known problem of road trauma in the kingdom and confirmed the need for public safety initiatives and regulation. Mansuri *et al*[20] noted that some measures are already in place, including seat belt legislation.

An integrated trauma system requires a multidisciplinary response to treating injuries, which begins with the care delivered at the scene of injury. In the KSA, the SRCA is the primary first responder.[21] Optimising initial care is essential to improved outcomes. The STAR dataset includes a number of relevant prehospital variables, the values for which can only be sourced from the SRCA Patient Care Record. In this study, 47.2% of patients

Table 2 Characteristics of STAR and AHTR cohort

Characteristic	STAR	AHTR
Total records	1786	3980
Gender		
Female	244 (13.7%)	1250 (31.4%)
Male	1542 (86.3%)	2730 (68.6%)
Age in years at event; mean (SD)	36.2 (17.4)	49.8 (21.9)
Cause of injury		
Burns—all types	49 (2.7%)	172 (4.3%)
Cause with systemic effect (drowning, suffocation, asphyxia and electrical injury)	9 (0.5%)	28 (0.7%)
Falls—both high and low	595 (33.3%)	1409 (35.4%)
Motor vehicle occupants	664 (37.2%)	841 (21.1%)
Motorcyclists	85 (4.8%)	360 (9.0%)
Other specified external cause	35 (2.0%)	202 (5.1%)
Pedal cyclist—rider or passenger	5 (0.3%)	276 (6.9%)
Pedestrian	177 (9.9%)	215 (5.4%)
Penetrating wounds including gunshots and stabbing	81 (4.5%)	161 (4.0%)
Struck by object or person	86 (4.8%)	306 (7.7%)
Unspecified external cause	0 (0.0%)	10 (0.3%)
Injury Severity Score range		
<12	1365 (76.4%)	2609 (65.6%)
12–25	369 (20.7%)	1098 (27.6%)
26–40	45 (2.5%)	202 (5.1%)
>40	7 (0.4%)	71 (1.8%)

There was a statistically significant p value of <0.001 in all categories.
AHTR, Alfred Hospital Trauma Registry; STAR, Saudi TraumA Registry.

Table 3 Risk-adjusted length of stay

N=5302	Coefficient (95% CI)	P value
KSMC	1.0	Reference
Alfred	−4.40 (3.95 to 4.86)	<0.001
Glasgow Coma Score motor on arrival to the KSMC		
Obeys command	1.0	Reference
No movement	2.07 (1.01 to 3.03)	<0.001
Extension to pain	2.68 (−0.19 to 5.54)	0.068
Flexion to pain	15.79 (13.28 to 18.29)	<0.001
Withdraws to pain	1.43 (−0.77 to 3.63)	0.202
Localises to pain	1.55 (0.26 to 2.83)	0.018
ISS categories		
<12	1.0	Reference
12–25	0.13 (−0.48 to 0.73)	0.681
26–40	2.06 (0.68 to 3.43)	0.003
>40	3.43 (0.84 to 6.03)	0.009
Age at injury event (years)		
15–24	1.0	Reference
25–40	0.06 (−0.45 to 0.56)	0.824
41–60	0.37 (−0.16 to 0.89)	0.170
61–70	1.04 (0.35 to 1.73)	0.003
71–80	1.74 (1.04 to 2.43)	<0.001
81+	2.10 (1.40 to 2.80)	<0.001
Chest injury severity		
No chest injury	1.0	Reference
Minor	−0.12 (−1.00 to 0.76)	0.796
Moderate	0.91 (0.22 to 1.61)	0.010
Serious	1.69 (1.06 to 2.32)	<0.001
Severe	4.35 (3.10 to 5.60)	<0.001
Critical	3.35 (0.92 to 5.79)	0.007
Abdominal injury severity		
No abdominal injury	1.0	Reference
Minor	0.43 (−0.41 to 1.28)	0.313
Moderate	1.83 (0.89 to 2.77)	<0.001
Serious	2.40 (0.96 to 3.85)	0.001
Severe	5.37 (3.86 to 6.88)	<0.001
Critical	4.68 (1.22 to 8.14)	0.008
Spinal injury severity		
No spinal injury	1.0	Reference
Minor	1.40 (−0.38 to 3.18)	0.123
Moderate	1.69 (1.24 to 2.13)	<0.001
Serious	2.84 (2.14 to 3.54)	<0.001
Severe	8.80 (6.61 to 10.99)	<0.001
Critical	9.97 (7.63 to 12.32)	<0.001
Maximal	−5.53 (−18.12 to 7.06)	0.389
Upper limb injury severity		
No upper limb injury	1.0	Reference

Continued

who presented to the KSMC from scene were attended by the SRCA. The relationship between the SRCA and the STAR will develop as the 'feedback loop' of performance monitoring becomes a routine part of the prehospital sector's quality assurance activities. The study also revealed that almost one-quarter of all presentations to the KSMC had attended at least one other hospital prior to admission. Ongoing data collection will reveal whether more patients are transported directly from scene with improved prehospital triage.

There is little consensus on the best process indicators to monitor the quality of in-hospital care.[22] The STAR is an integral component of the KSMC Trauma Unit quality assurance programme and can provide regular reports of

Table 3 Continued		
N=5302	Coefficient (95% CI)	P value
Minor	–0.05 (–0.64 to 0.54)	0.871
Moderate	1.14 (0.68 to 1.59)	<0.001
Serious	4.26 (2.39 to 6.12)	<0.001
Severe	2.23 (–6.53 to 10.99)	0.617
Lower limb injury severity		
No lower limb injury	1.0	Reference
Minor	–0.07 (–0.65 to 0.51)	0.814
Moderate	2.45 (1.93 to 2.97)	<0.001
Serious	5.30 (4.72 to 5.89)	<0.001
Severe	7.88 (6.25 to 9.50)	<0.001
Critical	6.28 (3.57 to 8.98)	<0.001
Other injury or burns severity		
No other or burns injury	1.0	Reference
Minor	–0.15 (–1.42 to 1.12)	0.821
Moderate	3.62 (0.05 to 7.20)	0.047
Serious	3.53 (0.19 to 6.87)	0.038
Severe	14.87 (7.69 to 22.05)	<0.001
Critical	0.41 (–2.98 to 3.80)	0.814
Maximal	–5.50 (–18.11 to 7.12)	0.393
Head injury severity		
No head injury	1.0	Reference
Minor	0.05 (–0.58 to 0.68)	0.879
Moderate	0.31 (–0.35 to 0.96)	0.361
Serious	1.63 (0.93 to 2.34)	<0.001
Severe	4.35 (3.27 to 5.43)	<0.001
Critical	7.09 (5.53 to 8.65)	<0.001

ISS, Injury Severity Score; KSMC, King Saud Medical City.

Table 4 Risk-adjusted mortality		
N=5287	OR (95% CI)	P value
KSMC	1.0	Reference
Alfred	0.25 (0.15 to 0.43)	<0.001
Glasgow Coma Score motor on arrival to the KSMC		
Obeys command	1.0	Reference
No movement	34.23 (18.97 to 61.76)	<0.001
Extension to pain	24.04 (7.32 to 78.99)	<0.001
Flexion to pain	10.95 (3.32 to 36.10)	<0.001
Withdraws to pain	9.71 (2.86 to 32.90)	<0.001
Localises to pain	4.92 (2.18 to 11.10)	<0.001
ISS categories		
<12	1.0	Reference
12–25	3.98 (2.49 to 6.38)	<0.001
26–40	5.12 (2.63 to 9.96)	<0.001
>40	15.79 (6.84 to 36.43)	<0.001
Age at injury event (years)		
15–24	1.0	Reference
25–40	0.85 (0.43 to 1.68)	0.635
41–60	1.49 (0.74 to 3.00)	0.260
61–70	4.03 (1.70 to 9.53)	0.002
71–80	6.89 (3.19 to 14.90)	<0.001
81+	16.58 (7.57 to 36.30)	<0.001
Cause of injury		
Falls both high and low	1.0	Reference
Cause with systemic effect	10.71 (3.66 to 31.33)	<0.001
Motor vehicle occupants	0.70 (0.41 to 1.19)	0.193
Motorcyclists	0.13 (0.03 to 0.59)	0.008
Other specified external cause	0.23 (0.03 to 1.77)	0.159
Pedal cyclist—rider or passenger	0.26 (0.05 to 1.39)	0.116
Pedestrian	1.36 (0.71 to 2.63)	0.357
Struck by object or person	0.25 (0.05 to 1.25)	0.092

ISS, Injury Severity Score; KSMC, King Saud Medical City.

selected indicators. Our study revealed that the median length of time that KSMC patients spent in the ED in 2018 was 7 hours. Australian data show that the median length of time spent in the ED for injured patients in the financial year 2016–2017 was 4.26 hours.[23] We did not attempt to determine optimal time frames, however monitoring processes allows more accurate identification of delays and barriers to optimising performance.[24]

Post-discharge from ED, the clinical pathway diverged for trauma patients at the KSMC. A majority (64.5%) underwent procedures in the operating theatre. We found that the time to initial procedure in the operating theatre varied considerably, most likely for clinical and logistic reasons. Time-critical procedures such as craniotomy were prolonged, with a median time to craniotomy/craniectomy of 10 hours. Although there is no consensus on the timing of craniotomy/craniectomy,[25–27] it is a further useful measure to monitor the KSMC's clinical practice.

The STAR data showed that the LOS at the KSMC was between 1 and 207 days, excluding five people who died in the ED. The median LOS overall was 8 days. The Australian Trauma Registry[11] reported a median hospital stay of 7 days for major trauma, which is very similar to 6.5 days reported by the VSTR. Our study did not differentiate between major and non-major trauma for LOS, however the availability of state and national Australian data, and this initial use of Alfred Hospital data, allows for other more focused studies.

To explore the differences between the process indicators that the STAR data have described at the KSMC, the comparison given in Australian and/or Victorian data was beyond the scope of this study. We showed that the length of time spent in ED; the time to theatre, specifically craniotomy; and the LOS are longer at the KSMC. There are some likely reasons for this—for example, the time from injury to admission to rehabilitation for patients with traumatic injuries is reported as being significantly longer in Saudi Arabia than elsewhere.[28 29] This may cause a shortage of acute beds, and therefore patients delay in ED until a bed can be found. Similarly, anecdotally, there are difficulties with access to specialty surgeons, which impedes the flow of patients from ED to theatre and to the wards. The STAR dataset is not designed to evaluate these issues, however it can provide answers to some questions, such as the efficacy of the trauma team activation system, which is in place at the KSMC and functions well (not reported here). Findings from the STAR data can now be applied at the KSMC to quantify and measure improvements.

This is the first step in developing a robust model of risk-adjusted comparisons for processes and outcomes that will be further improved as more data become available. Cameron[30] asserted that accurate benchmarking is a work in progress and that the standardisation of variables and comparing 'like with like' is yet to occur. Nevertheless, for the first time in the kingdom, there is a method available of benchmarking outcomes internationally.

LIMITATIONS

There were several limitations to the study. Patients for whom information was not available for the entire episode of care limited the dataset. Data collection commenced at the time of admission to the KSMC but the record may not have been completed at the time of discharge. The lack of complete data caused the sample size of complete cases to vary between analyses.

Likewise, the completeness of the data differed between variables, with some variables reporting a high proportion of 'unknown' values. The reduced sample size of known values limited the interpretation of the findings.

The benchmarking model was limited due to the differences between the two systems. Cultural differences in approach to 'end-of-life' decisions, such as early extubation in severe head injuries and discharge for palliative care, are examples of benchmarking challenges. The possibility of unmeasured confounders is high. In particular, a longer follow-up time for the STAR cohort, with patients remaining in hospital, provided higher exposure for the primary outcome of in-hospital death. Furthermore, the collection of data at one centre only is not necessarily generalisable to the whole of the KSA. A population-based measurement of trauma care would develop with the contribution of multiple sites to the registry.

CONCLUSION

This is the first hospital-based study of major trauma in the KSA that benchmarks with an individual international centre. There were demonstrated differences in the demographics, processes and outcomes that require further exploration. The application of accepted performance indicators has established a baseline to measure continuous improvement. An increased understanding of the causes and effects of injury events will assist the kingdom to meet the challenges of caring for people who sustain serious injuries and suffer the consequences of ongoing disability.

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