Preliminary Data from a *De Novo* Trauma Registry

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Abstract

Background: Trauma remains a significant cause of morbidity and mortality globally. Trauma registries are a key component of trauma systems in developed countries which have promoted improvement of patient care and outcomes. The experience with trauma registries in low income countries is limited. The current study shares preliminary data from the Kenyatta National Hospital Trauma Registry whilst documenting the process of design to implementation. **Methods**: A *de novo* registry dataset was designed based on previous studies and programmed as a custom application for deployment to the site. Scope of data collected was demographic, details of injury, pre-hospital events, hospital care and outcomes. Data were summarized as percentages and means for analysis. **Results:** The development of the registry from concept to operational software took 12 months. Preliminary data revealed an average completion rate of 88.6%. Majority of patients were young males who were referred to the hospital. Accidental injury at home or on the roads was the most common cause of admission with majority of patients not receiving any pre-hospital care. Sixteen percent of patients died while admitted. **Conclusion**: The data obtained from this *de novo* registry largely aligns to previous institutional reports while revealing data points for increased focus during training for registry abstraction. This experience may form the platform for trauma quality improvement initiatives at the institution as well as scaling to other institutions to allow for collation of regional trauma data.

Keywords: Trauma; Registry; LMIC; Kenya

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Background

The rising burden of trauma in low- and middle-income countries has been identified (1). There are several programs that have been targeted at reducing the impact of trauma globally, all of which include strengthening of trauma systems in one way or other (2). Trauma registries, as part of larger trauma systems, have been critical to driving quality improvement and demonstrating system benefits, including mortality reduction (1, 3). Accounts of active trauma registries however are restricted mostly to the developed countries with few reports from Asia or Sub-Saharan Africa (4).

Despite enumerated benefits, trauma registry data have been shown to almost always be incomplete (5,6). Missing data presents a challenge when benchmarking of registries is required and should be anticipated and delimited (5).

The objective of this study is to share preliminary data derived from a trauma registry in a Kenyan referral hospital whilst describing its structure, process of development and implementation. We share the lessons learnt during its implementation.

Methods

Setting

The registry was implemented at the Kenyatta National Hospital (KNH), a 1,880-bed capacity institution that serves as the main tertiary care centre for Kenya. It has 8 surgical wards, a burns unit and an intensive care unit. In collaboration with the University of Nairobi, it serves as the teaching facility for various post-graduate programs including General Surgery, Orthopedic Surgery, Neurosurgery and Anaesthesia.

Development of the trauma registry

Development of the registry began in November 2012 with a consensus building process to arrive at

the dataset. Data points were derived from previous studies based at the facility (7,8). Outcome was a 2-page form designed in Microsoft Excel (Microsoft Inc., 2007) with 46 data points. This paper Case Report Form (pCRF) was adapted for electronic data capture in Microsoft Access (Microsoft Inc., 2007). Data elements collected included patient demographic details (study number, name, sex, age, education, occupation), time and date of injury and hospital presentation. Other data elements included injury events, pre-hospital care, vital signs on admission, injury classification by anatomical region and organ, injury classification by Injury Severity Score, operative access, treatments, procedures, disposition and medical costs.

Database design was in third-normal form with application-level security enhanced using programmatic login. Visual Basic for Applications was used for the back-end of the registry. Final compiled database had a file size of 2.62 MB. The application was able to export data in a comma-delimited file to allow for import to statistical software of choice. Injury Severity Score (ISS) was auto-calculated by the application from user-entered Abbreviated Injury Scale (AIS) values. The resultant application was deployed as stand-alone on desktop and laptop Personal Computers though the choice of Microsoft Access was to allow easy interoperability with the main hospital database system on registry maturity.

Data Management

Data were abstracted from existing patient medical records by research assistants (RAs) with a clinical background. Each RA was trained on the abstraction process from the medical records onto the pCRF, on the coding of injuries by AIS and use of the electronic trauma registry (eTR).

The registry pilot implementation began on January 2013 and covered a 3-month period. This paper audits entries made for 6 months after this pilot period (April to September 2013). Case definition was based on in-patients of ICD-10-CM codes S00 - T88. A daily list of inpatients was generated from the Accident and Emergency (A&E) register, pre-hospital and initial hospital management documented with subsequent record completion within the inpatient units. Data were extracted electronically and imported into the Statistical Package for Social Sciences (SPSS, version 16.0) for analysis. Categorical data were summarized in frequencies and percentages while means were used for continuous variables. Data were visualized with tables

Results

TR development and pilot testing

The development of the TR from concept to operational software took 12 months. We developed the software at an estimated cost of USD 1,400**.** This included the cost of software development and its implementation. Pilot testing involved deployment of the software on notebook laptops with research assistants abstracting data from records in the Accident and Emergency department and the wards where patients were admitted. Stakeholder buy-in was obtained through facilitating system demonstrations and regular communication with administrative and clinical personnel during the pilot phase. The initial 3-month period allowed for establishment of data abstraction protocols, understanding the temporal cycles from patient presentation, investigation, admission, intervention and discharge. No alterations were required to downsize the dataset once deployed and access to the platform was found to be secured well with application-level login. Datasets were transmitted electronically as flat files on secure email with manual importing to SPSS for analysis.

Item completion

The number of cases within the registry definition was 891. Three hundred and thirty eight had final discharge data and are analyzed. Table 1 shows item completion rates.

Table 1: Item completion table (n=338)

Item	Completion frequency	(%)
Age of patient	330	97.6
Gender	332	98.2
Primary or secondary admission	304	89.9
Education level	334	98.8
Occupation	335	99.1
Intent of injury	325	96.2
Cause of injury	331	97.2
Scene of injury	322	95.3
Time of injury	251	74.3
Pre-hospital care given	324	96.4
Mode of arrival to hospital	301	89.1
Time to hospital	307	90.8
Systolic blood pressure	212	62.7
ISS calculation done	309	91.4
Length of stay	249	73.6
Cost of care	230	68.0

The average completion rate was 88.6%. Lower rates of completion were recorded for time of injury (74.3%), systolic blood pressure (62.7%), length of stay (73.6%) and cost of treatment (68%) compared to other parameters.

Patient characteristics

Mean age of the victims was 25.64 years (range: 1–84 years). The sex was male in 81.0%, female in 19.0% and missing in 1.8% of admissions. The proportion with primary, high school and tertiary education was 36.8%, 23.7% and 10.7% respectively while individuals in informal and formal employment formed 30.5% and 10.2% respectively. Where the information was available, majority of patients (63.8%) were secondarily admitted.

Causes, place and time of injury

The intent of the injuries was 'accidental', intentional, self-harm, other and unknown/missing - in 60.7%, 23.4%, 2.1%, 0.3% and 13.6% respectively. The most common causes of injury were transport related crashes (27.2%), assault (26.0%), burn (25.4%) and fall (10.9%). Eighty one percent of injuries occurred at home, street or highway and a third (32.3%) between 6.00pm and midnight.

Distribution of Injuries by anatomical regions

Many patients presented with injuries located in more than one anatomical region; therefore 694 injuries were recorded from 338 cases. The extremities and head/neck regions were most involved (Table 2).

Table 2: Regional distribution of injuries

Region	Frequency (%)
Head/neck	183 (26.4)
Extremity	257 (37.06)
Chest	90 (13.0)
Spine	11 (1.6)
Abdomen	69 (10.0)
Other	83 (12.0)

Severity of Injuries

The most common AIS was 4. The proportion of injuries with AIS of 4 was 40.9%, 40.8%, 34.8%, 30.5% and 25% for external, extremity, chest, neck and head. Mean ISS was 18.8 (median 16.0). Majority of the patients (64.7%) in the registry were assigned ISS of > 15. The proportion of patients with ISS of ≤ 9 and 9-15 was 12.3% and 23.0% respectively. Injury severity score was significantly higher for patients admitted secondarily (20.8 versus 13.8, $p < 0.001$) but similar for the gender groups (male 18.3, female 20.7) and intent groups (intentional injury 19.1, 'accidental injury' 17.3, $p = 0.18$).

Pre-hospital care

The proportion of patients who received any type of pre-hospital care was 8.3%. The overall rate of ambulance utilization was 30.8%. The ambulances used belonged to referring hospitals, the Kenya Red Cross, St. Johns and other organizations in 81.8%, 3%, 1% and 14.1% of cases respectively. One fifth of patients reached the hospital within an hour of the injury event (table 3).

Table 3: Pre-hospital features for KNH Trauma Registry

Feature	Category	Number (%)
Pre-hospital care	Given	27 (8.3)
	Not given	178 (54.6)
	Unknown	121 (37.1)
Time from event to hospital	0-30 minutes	32 (10.4)
	31mins – 1 hr	66 (21.5)
	1 hr – 2 hrs	43 (14.0)
	2 hrs – 6 hrs	26 (8.5)
	6hrs – 24 hrs	13 (4.2)
	>24 hrs	20 (6.5)
	Unknown	107 (34.9)
Arrival mode	Walk-in	14 (4.7)
	Ambulance	104 (34.6)
	Private car	40 (13.3)
	Taxi	41 (13.6)
	Other pubic means	55 (18.3)
	Other	47 (15.6)

In-hospital mortality

Two hundred and seventy eight patients (82.2%) were discharged home, four left against medical advice and two were transferred to other facilities. Fifty four (16%) patients died. The average ISS was 16.1 for patients who were discharged and 32.5 for those who died ($p = 0.001$). The proportion of with ISS 1-8, 9-15 and > 15 was 4%, 6% and 90% for non-survivors and 14.2%, 25.6% and 60.2% for survivors respectively (table 4). The mortality rates were similar (16% versus 15.9%) for males and females. No statistical difference was noted for mortality by type of admission (17.5% versus 10.0%, $p = 0.076$), intent of injury (20.9% versus 13.7%, $p = 0.12$) or substance use (18.5% versus 11.5%, $p = 0.037$). Death was not

associated with age, admission BP and admission GCS on univariate analysis ($p > 0.05$). As expected, survivors had longer lengths of hospital stays (21 days versus 5 days, $p < 0.001$).

Table 4: Proportion of injury severity groups among survivors and non-survivors

	Discharge home	Died in hospital	Other
ISS 1-8	36 (94.7%)	2 (5.3%)	0
ISS 9-15	65 (91.5%)	3 (4.2%)	3 (4.2%)
ISS > 15	153 (76.5%)	45 (22.5%)	2 9 (1.0%)

Discussion

Registries are an epidemiology tool that offers a means of collecting continuous, standardized injury data that offers advantages over discrete means of injury surveillance, such as retrospective or prospective data collection. The current experience adds to the body of knowledge with active registries in developing countries (9). The registry design and software development by local expertise removed the large initial cost barrier associated with such a process. Commercially available software may cost up to USD $10,000 for application and additional for yearly licensing. The Karachi registry was established with a budget of USD 9,600 (10). We recommend customizing off-the-shelf software thus reducing software development time as a means to confer cost-savings in resource-limited settings.

The steps that involved data resizing, training, stakeholder involvement, leadership and pilot implementation were necessary as many accounts have documented the challenges of developing and implementing trauma registries (10,11). Like others, we considered that optimizing the amount of information captured, excellence in patient records, committed data personnel, availability of funding and buy-in from hospital management as key drivers in the process (12). Funds were made available to engage specific data abstractors for the registry project. We propose a sustainability strategy based on provider-based data entry, incorporation of the standardized trauma data collection tool as part of the hospital medical records and trauma data coordination by a hospital-employed champion who will continuously flag areas for retraining and emphasis to minimize data loss. KNH is transitioning from a paper-based medical records system to an electronic platform. Whether the abstraction of registry data points from the platform rather than a stand-alone system will be more efficient could be the subject of subsequent studies.

Even as hospitals seek to set up registries, incomplete entry of key parameters should be anticipated and attempts made to mitigate this. The current study demonstrates a fair rate of completion of data. Of note however is the less than impressive documentation of parameters such as systolic blood pressure on admission (62.7%), time of Injury (74.3%) and length of stay (73.6%). O'Reilly and others (4) reported values for GCS, respiratory rate and systolic blood pressure as having the greatest proportion of missing values in their study; with a higher likelihood of 'missingness' when the parameter was abnormal. They further determined that patients with poorer outcomes were more likely to have missing data. We posit that the documentation of physiological parameters by Emergency Department clinicians when presented with critical patients is overtaken by the need to offer acute care. However, the fact that more than one third did not have information on systolic blood pressure may frustrate the determination of scoring systems like the Revised Trauma Score (RTS) and Trauma and Injury Severity Score (TRISS), important for benchmarking. Strategies have been put in place to improve completion rates include stationing a research assistant at the Accident and Emergency department to flag missing parameters early and facilitate active case follow-up.

Our preliminary analysis underscores the significant contribution of road traffic accidents to trauma burden in the country (13). The analysis has also shown the deficiency in the trauma care landscape but hopefully process and outcome metrics can be usefully incorporated into the registry. The proportion of patients who received any type of pre-hospital care was less than 10% while ambulance utilization was recorded for only a third of patients. The pre-hospital times were variable with a significant proportion of primary admissions arriving after two hours. The results reinforce similar previous accounts from Kenya and are consistent with other registries from the developing world (7,14). The pre-hospital care scenario in Kenya is worse outside the capital, Nairobi. In a recent study of 1094 injured patients presenting at the Machakos General Hospital, none of the injured was evacuated from the scene of injury by an ambulance (15). Most other countries in the developing world have recorded similar experiences where commercial drivers, volunteers, and bystanders provide the bulk of pre-hospital transport and first aid (16).

The current results however suggest that the system has over-exaggerated the levels of injury severity. The most common Abbreviated Injury Scale (AIS) score was 4, mean ISS was 18.8, and majority of the

injuries were categorized as severe on the ISS scale. This depiction of injury severity is inconsistent with the previous studies from KNH which show that the majority of injuries are mild to moderate on the ISS (14). As shown even in this audit, the injuries are mostly fracture/dislocations, burns, lacerations and concussions in limbs and head/neck regions with low acuity injuries. To improve the data quality in the registry, a system of entry validation to identify incorrect AIS coding and other missing data against the patient records is advised.

Useful quality indicators determined by the KNH Trauma Registry included mortality and hospital length of stay. The median length of stay of 14 days is consistent with other data from the hospital occasioned by conservative treatment and late operative fixation of skeletal fractures (8). This may be a good entry point for system enhancement and motivation to approach 5.12 average duration of stay (DOS) for patients similar to the Pietermaritzburg trauma service described by Laing and others (17).

Fifty four (16%) patients died. This compares unfavorably with 7.9% in the Pietermaritzburg registry in South Africa (17). Although the much higher injury severity profiles from the KNH series may explain the higher mortality rates, we are not aware that the cohort characteristics have suddenly changed from the cohorts of the earlier estimations. Even with higher mean ISS of 12 and a larger proportion (24.8%) with ISS > 15, the mortality rate in the Pietermaritzburg trauma service is half that estimated by our registry data. There is need for continuous verification of our trauma data to allow availability of valid quality indicators that can motivate for enhanced overall quality of trauma care. Though the current study has looked at some patient factors that may inform the understanding of the trauma patient, we believe that the harnessing of geo-data collected at admission would map out geographical characteristics of the patients seen and contribute to a further understanding of the patterns of trauma. Mapping of major highways or neighborhoods may open the door for analyses as to contributing factors (18). Having shared our experience with setting up a hospital-based trauma registry in a low-resource country, we anticipate that the registry will scale to several other institutions and allow for collation of regional trauma data.

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