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ORIGINAL ARTICLE

Estimated injury-associated blood loss versus availability of emergency blood products at a district-level public hospital in Cape Town, South Africa

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ABSTRACT

Introduction: International guidance suggests that injury-associated haemorrhagic shock should be resuscitated using blood products. However, in low- and middle-income countries resuscitation emphasises the use of crystalloids – mainly due to poor access to blood products. This study aimed to estimate the amount of blood loss from serious injury in relation to available emergency blood products at a secondary-level, public Cape Town hospital.

Methods: This retrospective, cross-sectional study included all injured patients cared for in the resuscitation area of Khayelitsha Hospital's emergency centre over a fourteen-week period. Injuries were coded using the Abbreviated Injury Scale, which was then used to estimate blood loss for each patient using an algorithm from the Trauma Audit Research Network. Descriptive statistics were used to describe blood volume lost and blood units required to replace losses greater than 15% circulating blood volume. Four units of emergency blood are stored in a dedicated blood fridge in the emergency centre. Platelets and fresh plasma are not available.

Results: A total of 389 injury events were enrolled of which 93 were excluded due to absent clinic data. The mean age was 29 (± 10) years. We estimated a median of one unit of blood requirement per week or weekend, up to a maximum of eight or six units, respectively. Most patients (n = 275, 94%) did not have sufficient injury to warrant transfusion. Overall, one person would require a transfusion for every 15 persons with a moderate to serious injury.

Conclusion: The volume of available emergency blood appears inadequate for injury care, and doesn't consider the need for other causes of acute haemorrhage (e.g. gastric, gynaecological, etc.). Furthermore, lack of other blood components (i.e. plasma and platelets) presents a challenge in this low-resourced setting. Further research is required to determine the appropriate management of injury-associated haemorrhage from a resource and budget perspective.

African relevance

- Emergency blood products have limited availability in low-resourced, African emergency centres.
- Most injury-related transfusions in these settings are not directly dispensed from a blood bank.
- There is a high burden of injury-related blood loss in these settings.
- More effective ways of dealing with haemorrhagic shock are required in low-resourced settings.

Introduction

South Africa has one of the highest injury burdens in the world; accounting for a homicide-related mortality rate eight times, and road-traffic mortality rate twice the global rate [1,2]. In fact, South Africa has one of the highest injury-related mortality rates globally [1,2]. Local research done in Cape Town revealed an initial injury diagnosis in 26% of all presentations with most victims between the ages of 20 and 40 living within 15 km of the emergency centre (EC) they attended [3]. As observed elsewhere, the incidence of injury is higher in urban compared to rural areas; however, given such a large burden and few

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dedicated trauma centres that are often geographically removed from where injury primarily occurs, initial injury care often falls to ECs at secondary-level hospitals (hospitals with generalist specialist care, but no super-specialty care) [3,4]. This is also the case in Cape Town [3,4].

Crystalloids have been the mainstay for resuscitating injured patients for decades and have been similarly advocated by the Advanced Trauma Life Support course [5]. This has mainly to do with crystalloids being cheap, readily available and relatively good volume expanders, rather than being an evidence-based resuscitation treatment for injury-associated haemorrhagic shock [6–9]. Indeed, recent work suggests that over-aggressive crystalloid resuscitation is associated with substantial morbidity in a variety of clinical areas [6]. It also appears to be associated with prolonged ventilation time, Intensive Care Unit (ICU) and hospital stay, as well as increased complication rates, including acute lung injury, coagulopathy, abdominal compartment syndrome and surgical site infections [6]. Decreased use however, appears to have the opposite effect [7]. A 50% mortality decrease involving critically injured soldiers was observed to be associated with a 61% reduction in crystalloid use amongst a number of variables in a retrospective analysis [7]. Taking this one step further, reduced crystalloid use upfront, followed by replacing blood loss with blood products in specific ratios, by using so-called massive transfusion protocols, have led to further improved outcomes [8–10].

According to the University of South Africa Institute for Social and Health Sciences health review in 1999, it was approximated that the cost to the South African public health sector from severe road traffic accidents and gunshot injuries could amount up to R10,000 (or $2890 converted using purchasing power parity index) per day – which comes to R26,000 (or $4360) per day in today's terms – through prolonged ICU admission, hospital stay and rehabilitation [11]. Given the high level of injury seen in Cape Town's mid-level ECs, restricted access to blood products would likely encourage the use of crystalloids, possibly contributing to the associated morbidity and thereby increasing costs. So whilst the advantages of using blood products compared to crystalloids have seen crystalloid use de-emphasised in high resource settings, it is still recommended in low-resourced settings [12–16]. It is possible that a primary intervention, or investment such as appropriate, early use of emergency blood products may have a positive economic impact on downstream care as described elsewhere [16].

A key problem in Cape Town secondary-level hospital ECs is the lack of direct access to a blood bank; emergency blood products required in these ECs tend to be restricted to a fixed number of units kept in a dedicated blood refrigerator for emergencies and replenished after use from an off-site blood bank. A recent study by Morris et al. considered the indications for use of emergency blood from the blood refrigerator [17]. Emergency blood transfusions occurred mainly in the EC and this was mostly for injury-associated haemorrhage [17]. Other causes included upper gastro-intestinal haemorrhage, early pregnancy complications, anaemia and perioperative complications [17]. Yet, the study did not tell us whether there was sufficient emergency blood stock available for the intended indications, nor whether use was appropriate – only that emergency blood was used.

The number of blood products allocated to each EC are predetermined by the off-site blood bank based on past use; it includes packed red cells, but not plasma or platelets. Only Cape Town's tertiary hospitals have direct access to a 24-h blood bank. Given the high local injury burden and limited blood available in emergency blood refrigerators, it is important to quantify the requirement for emergency blood to be kept on site. To date, there has been no modelling applied to estimate the required volume of blood products needed for evidence-based injury care in secondary-level ECs across South Africa.

The aim of this study was to retrospectively estimate the amount of blood loss from serious injury in relation to the availability of emergency blood products at Khayelitsha Hospital, a secondary-level public Cape Town hospital with no on-site blood bank service.

Methods

We used a retrospective, cross-sectional design for this study. Study subjects were limited to injured patients of all ages that were triaged for care to the resuscitation area of Khayelitsha Hospital's EC. Khayelitsha Hospital, in Cape Town, South Africa has a 47-bed EC which forms part of a 230-bed secondary-level, public referral hospital. It provides a 24-h EC, as well as inpatient paediatrics, obstetrics, gynaecology, surgery, and medicine of which all but the EC, medicine and paediatrics were family medicine run at the time of the study. The EC sees around 3000 new patients per month with a reported inpatient bed occupancy level at around 131% [18]. The EC has a poverty-related burden of disease that ranges from penetrating injuries to infective diseases (including HIV and tuberculosis) [18]. The EC keeps four units of emergency blood (two units each of group O negative and positive) in a dedicated emergency blood fridge in the EC. Fresh plasma and platelets are not stored on site, although freeze dried plasma is available. In order to maintain safe stock levels, emergency blood is replenished directly after use. The nearest blood bank is at Tygerberg Hospital which is approximately 25 km away. A one-way trip would take between 35 min to an hour depending on time of day and city traffic [19]. Although no exact figure exists, the time to replenish EC emergency blood stock is estimated to be around two hours.

Patients with isolated burns or a head injury, or patients that were not managed in the resuscitation area were excluded. Subjects were first identified as injured patients that attended to the resuscitation area of the EC using the electronic Khayelitsha Hospital EC resuscitation database. This sample was then cross-checked with the hard-copy resuscitation register to ensure a complete sample. The electronic database has captured all patients managed within the resuscitation area since 1 November 2014 and has previously been described [20]. Data from eligible patients were selected from fourteen randomly selected weeks between 1 November 2014 and 30 November 2015, allowing evaluation of the ebb and flow on different days of the week whilst not over-representing busy times such as holidays, end of month, etc. We made use of the randomisation function of Office Excel (Microsoft, Redmond, US) to select the weeks included. Given an estimate of approximately 20–30% data corruption (within the database and clinical record), and approximately 21–24 injured patients with complete records seen per week in the EC's resuscitation area, fourteen weeks would result in approximately 294–336 complete data sets. We therefore set out to collect a sample of 294 injury events with complete data sets. This sample would account for just over three months' worth of moderate to severe injury data. We felt that since the study did not involve inferential statistics that rely on a predefined sample size, and the relative novelty of the study, that this convenience sample was justified.

After identification of the sample, a full list of injuries from the injury event were identified from multiple sources, including the electronic database, electronic clinical record, transfusion register and the electronic radiology record. We also included the following variables: gender, age, date and time of injury and triage priority. Injuries were then coded using the Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS) were calculated to describe injury severity. The AIS were then securely transferred to the Trauma Audit and Research Network (TARN) to derive the predefined, approximated blood volume loss using the TARN's injury-to-blood-loss tool. The TARN developed this injury-to-blood-loss tool using consensus methodology. Although the tool itself, or its methodology have not been published or externally validated it has been used in publication [21]. The tool provides the proportional circulating blood volume loss of an injury, as described by individual AISs. Using the various AISs that contribute to a patient's injuries as a guide, one can calculate the proportional circulating blood volume loss of all injuries. This data collection process and proportional circulating blood volume loss estimation is graphically described in Fig. 1.