Original Articles

Transfusion requirements in 970 patients with gunshot wounds[[1]](#footnote-1)

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Abstract

During 1990-1991, data on a consecutive series of gunshot wound (GSW) patients admitted to the Los Angeles County - University of Southern California Medical Center were collected. The information was recorded by Trauma Nurse Coordinators and analysed with the SPSS Version 6.1 advanced statistical package. The volume of transfused packed cells and plasma was enumerated for each patient. Patients were also classified by injury-severity, body region and outcome. Single or multiple GSW of head, trunk and extremities occurred in 192, 645 and 133 victims. Mortality was 12.6 percent. Transfusions were given to 42, 135 and 17 of those with head, trunk and extremity injuries. The most common volume was 600 ml or 2 units. The total was 722 litres or 2 406 units. Thirty-five patients received more than 5 litres. Coagulopathy and hypothermia were the main complications. This experience could be related to warfare by adjusting the regions injured to those in warfare. In any event, 776 patients who survived were not transfused and would presumably be successfully triaged. Transfusion requirements would, irrespective of body region, be ultimately determined by the timing and control of bleeding.

Introduction

Society worldwide has acknowledged the benevolence of voluntary blood donors. Blood transfusion is an essential support for modern medicine and surgery. Blood transfusion is the vital component of resuscitation of patients who are in haemorrhagic shock from any cause or wound. The hazards and side-effects of blood transfusion are well-known and hardly impinge upon its safety.1

Data about blood transfusion volume in civilians with gunshot wounds could enable comparisons with sparse data available from literature from combat experiences, to estimate blood transfusion requirements for future battlefield trauma management. 2,3,4

Methods

A study reported previously comprised an analysis of data recorded prospectively in the Trauma Emergency Medical Information System (TEMIS) for a consecutive series of patients with gunshot wounds (GSW) admitted to the Los Angeles County - University of Southern California Medical Center between 1 September 1989 and 31 August 1990.5 Body regions were reported as head when there was any wound of the head and neck, as trunk when there were wounds of the trunk with or without wounds of the extremities, and of extremities when there were only upper or lower extremity wounds.Patients with thoracic and lumbar spinal cord injury who were paraplegic would be included in trunk unless specified as paraplegic.

The injury severity score (ISS), the volume (ml) of blood which was supplied as packed cells in 300 ml units, and the volume of fresh frozen plasma which was supplied in 2 ml units was also available. The data were recorded by Trauma Nurse reviewers and transcribed for this study to a 486 Personal Computer (ACER) containing the SPSS Version 6.1 advanced package.

Outliers would be classified as patients who received more than 5 000 ml blood transfusion.

In wartime, injuries have a different regional distribution generally recognised to be about 12, 27 and 60 per cent for head, trunk and extremity respectively.6 Wartime estimates would be calculated by adjusting regional transfusion volumes.

Results

Single or multiple GSW of head, trunk and extremities occurred in 192, 645 and 133 patients respectively. The mortality of the patients in each region (in the same order) was 31, 10 and 0 percent. The numbers of patients in each region are further described by injury severity in Table 1. The number of patients transfused in Table 1 is given in Table 2.

**Table 1.** Gunshot wounds by region of injury and Injury Severity Score

|  |  |  |
| --- | --- | --- |
| **Region** | **ISS 0 - 15** | **ISS > 15** |
| **Head** | 90 | 102\* |
| **Paraplegic** | 9 | 27 |
| **Trunk** | 422 \*\* | 187 \*\*\* |
| **Extremity** | 127 | 6 |

\* 60 Dead

\*\* 8 Dead

\*\*\* 56 Dead

**Table 2.** Patients transfused by region of injury and Injury Severity Score

|  |  |  |
| --- | --- | --- |
| **Region** | **ISS 0 - 15** | **ISS > 15** |
| **Head** | 7 | 34 \* |
| **Paraplegic** | 2 | 6 |
| **Trunk** | 32 \*\* | 95 \*\*\* |
| **Extremity** | 14 | 3 |

\* Transfusions in 23 deceased

\*\* Transfusions in 3 deceased

\*\*\* Transfusions in 46 deceased

The median volume of packed cells transfused according to injury severity and outcome is given in Table 3.

**Table 3.** Median volumes (ml) transfused

|  |  |  |  |
| --- | --- | --- | --- |
| **Region** | **ISS 0 - 15** | **ISS > 15** | **Dead** |
| **Head** | 900 | 1 200 | 1 200 |
| **Trunk** | 1 200 | 1 800 | 4 350 |
| **Extremity** | 1 050 | 900 | 0 |

The range of blood volume for each region in each category is shown in Table 4.

**Table 4.** Range of blood volume (ml) transfused

|  |  |  |  |
| --- | --- | --- | --- |
| **Region** | **ISS 0 - 15** | **ISS > 15** | **Dead** |
| **Head** | 600-  3 004 | 300-  4 804 | 300-60 000 |
| **Trunk** | 300-14 770 | 300-30 202 | 300-57 454 |
| **Extremity** | 600-  7 204 | 300-  6 060 | 0 |

Numbers with fractions of 100 ml include fresh frozen plasma, but this has not been analysed separately.

Total volume of blood transfused in each category of Table 3 is given in Table 5.

**Table 5.** Total volumes (ml) transfused by region of injury, outcome and Injury Severity Score\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Region** | **Alive**  **ISS 0 - 15** | **Alive**  **ISS > 15** | **Dead** |
| **Head** | 9 006 | 20 724 | 116 546 |
| **Trunk** | 48 013 | 177 769 | 321 112 |
| **Extremity** | 21 309 | 7 260 | 0 |

\* Total 721 739 ml or 2,406 units

The statistics are displayed graphically in Figure 1 which gives the volume (ml) transfused by the numbers of patients in each region, the total number of patients receiving transfusions being 194, which represents 42, 135 and 17 patients with head, trunk and extremity GSW respectively. The frequency distribution curves show considerable skewness in each region. The mode, however, was 600 ml for each region.

Among outlier survivors there were none with head injury. There were one and eight with trunk wounds whose injury severity score was less or greater than 15 respectively. There were two outlier survivors with wounds of the extremities in each injury severity category. Among deceased outliers there were 4 and 21 patients with head and trunk GSW. The total blood transfusion requirement of the 36 outliers was 452 litres or 1 509 units.

Recalculation of total regional volumes in wartime proportions would realise 86 litres, 217 litres and 124 litres for head, trunk and extremities or a total of 428 litres representing 1 427 units. If outliers were excluded from each region estimates would be revised downwards to 36, 79 and 15 litres for head, trunk and extremities respectively. The revised total requirements would become 131 litres or 435 units.

Discussion

It is quite obvious that in addition to considerable mortality, morbidity and cost, therapy for gunshot wounds is accompanied by a considerable consumption of blood and blood products.5 It should also be stressed, however, that the vast majority of patients (776) in this study were not transfused at all.

Patient outcome could be clearly related to injury severity. Injury severity and mortality could also be seen to influence the volume of blood transfusion. There were expected regional differences in transfusion volume. Severely head-injured patients were not transfused as frequently as those with trunk and extremity wounds, presumably because their problem was increased intracranial pressure rather than intracranial bleeding. On the other hand, paraplegic patients were transfused with equal frequency in each severity group because of hypovolaemia caused by spinal shock. Patients with severe trunk injuries bled more because of injuries to the cardiovascular system and no accompanying tamponade. Massive bleeding occurred in all regions. Patients with extremity wounds who lose their total blood volume are as much at risk of coagulopathy as any patient in similar circumstances. The reason that blood transfusion was not universal in deceased patients was usually that they were moribund on arrival, not responding to any volume expansion, rendering transfusion futile.



***Figure 1.*** *Frequency distribution of blood transfusion volume by region of injury*

The reason 5 litres was selected for outlier classification was that in each region the major distribution curve in Figure 1 would intersect the abscissa at that volume. Outlier volumes were required because of coagulopathy and hypothermia; both occurred in the majority of fatal cases. The magnitude of both problems has been reduced with the use of the Level 1 infuser.7 In wartime, however, many of these patients would die in the field. Field conditions and the location and magnitude of medical materiel and support could be factored into supply estimates if a flexible supply model was developed.

It is quite apparent from study of the shape of the regional volume curves in Figure 1 that the rapid control of haemorrhage is accompanied by a good prognosis. This is supported by the outcome data which show a low mortality in patients not transfused (or not bleeding). Timelines and injury severity and region, therefore, are the major outcome factors, whereas timing and control of bleeding ultimately determine the final transfusion requirements.

There was a congruence between regions in the most common volume of blood transfused, being 600 ml or 2 units of packed cells. It was likely that this reflected a responsible attitude on the behalf of staff: to the community in the use of a scarce resource; and to the patients in minimising side-effects related to the therapy. It also supports the contention that in each region bleeding has the same biological behaviour and the same potential for control.

Because of the common mode and the striking similarity in the shape of the regional volume/frequency distribution, we feel that this data can be translated to any similar situation involving GSW trauma. This justifies calculation of volume estimates relevant to civilian or military situations, in spite of the obvious difference in wounding and the use of helmets and body armour.

In a report which included 279 laparotomies from the Second Surgical Hospital (Mobile Army), Lai Khe in Vietnam, Byerly and Pendse state: “The hepatectomies were generally large debridements, using every available technique to control the bleeding. Only the availability of large amounts of blood made these operations anywhere near feasible”.8 Major operations, therefore, can be performed during warfare providing that the triage and blood supply are favourable. Military blood volume estimates would, however, be lower than civilian requirements.

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