PREVENTABLE TRAUMA DEATH IN SINGAPORE

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SYNOPSIS

We reviewed 431 trauma deaths in Singapore for 1985 in order to evaluate the need for a trauma system. Of the 431 cases, 197 died from CNS-related causes. The remaining 234 were victims of non-CNS related trauma. Of the 234 cases, 164 cases (70.1%) died at the scene of accident or were brought into hospital dead. Seventy patients reached hospital alive. Of these 70 patients, 27 (38.6%) deaths were identified to be preventable. The remaining 43 deaths were deemed non-preventable. The mean age of the preventable death group was 30.9 years (range 8—72 years). There were 25 males and 2 females. Motor vehicular accidents were responsible for 77.8% of these deaths. The mean injury severity score (ISS) for the preventable death group of patients was 32.3. After comparison with the results of other studies, we conclude that there is a need for an organized trauma care system in Singapore.

INTRODUCTION

Accidental death has been described as the neglected disease of modern society (1). It is the leading cause of death between the ages of 1 to 40 years in Singapore and is the fourth leading cause overall (2).

Many studies (3,4,5,6) show that there is a high proportion of unacceptable care and outcome in the absence of an organized approach to trauma care. A significant proportion of trauma deaths could have been prevented by such a system. The assence of the system includes optimal resuscitation an triage at the

scene of the accident, rapid transportation to an appropriate hospital capable of vigorous resuscitation and aggressive surgical management, followed by intensive care post-operatively and subsequent rehabilitation. Such a hospital should have in-house emergency physicians, general surgeons, anaesthetists and full time availability of fully staffed operating theatre, blood bank facilities, plus back up in neurosurgery, orthopaedic surgery and other specialities (7). Several states and regions in the United States have implemented a systems approach to trauma care. This has resulted in improved survival of trauma patients (8,9,10,11).

In the past three decades, the concept of preventable trauma death has emerged. This concept has been defined with increasing precision for determining the quality of trauma care (12). Using this methodology, studies have evaluated delivery of trauma care in different communities and have influenced trauma care systems development.

This report utilizes the preventable trauma death concept to evaluate the adequacy of trauma care in Singapore and to determine the need for an organized trauma care system.

METHODS

We reviewed the 431 trauma deaths that occurred in Singapore in 1985 using post-mortem records from the Coroner's office. These records consisted of autopsy findings, police records and hpspital clinical summaries. We excluded cases of suicide, burns, drowning, electrocution and poisoning. There was a 100% autopsy rate for the cases reviewed.

Trauma deaths were divided into two groups, those dying primarily from central nervous system (CNS) related causes and those dying from non-CNS related causes. Victims of non-CNS trauma were further subdivided into those who were brought in dead to hospital and those who reached hospital alive. The latter category formed the study population of this report.

Preventable trauma deaths were identified by a panel of surgeons from the Singapore General Hospital. In order to decide whether a death was preventable or not, three standard questions had to be answered. Firstly, were the injuries sustained by the patient associated with good survival. Secondly, was the injured potentially salvageable with optimal care, such as would be available in an organized trauma care system. Thirdly, were there any errors available in the records which may have caused or contributed to the patient's death.

In all cases of non-CNS trauma deaths an injury severity score (ISS) was calculated as described by Baker et al (13). In this method, scores of 1 to 5 are assigned according to degree of severity to each of the six body systems. The ISS is obtained by summing the squares of the scores of the three most severely injured body systems. Data obtained are reported as mean ± standard deviation.

RESULTS

Of the 431 trauma deaths that occurred in Singapore in 1985 which were evaluated in this study, 197 (45.7%) were due primarily to CNS causes, the remaining 234 cases were due to non-CNS related causes. 164 (70.1%) died at the scene of accident or were brought in dead to hospital. Seventy (29.9%) cases of non-CNS trauma deaths reached hospital alive.

Of these 70 cases of non-CNS trauma deaths, there were 59 males (84.3%) and 11 females (15.7%). The mean age was 44.6 years (range 8 to 83 years). Motor vehicular accidents were responsible for 56 deaths (80.0%). The other mechanisms of injury included industrial falls, gunshots, stabs and blunt trauma due to assaults or being hit by objects (TABLE 1). The mean injury severity score (ISS) was 34.6 ± 11.4.

TABLE 1
MECHANISM OF INJURY 70 PATIENTS

Motor Vehicle Accidents	56
Industrial Falls	6
Blunt Trauma — Assault	4
Hit by objects	2
Gunshots	1
Stabs	12

Twenty-seven (38.6%) preventable deaths were identified out of the 70 non-CNS trauma deaths who reached hospital for treatment. Fourteen (20.0%) were judged to be definitely preventable and 13 (18.6%) were judged to be potentially preventable. Of the 27 preventable non-CNS trauma deaths, there were 25 (92.6%) males and 2 (7.4%) females. The mean age of this group of patients were 30.9 years (range 8 — 72). The majority (88.9%) of deaths were in those less than 50 years of age. The mean ISS was 32.3 ± 7.0. Motor vehicle accidents were responsible for 77.8% of these deaths (TABLE 2).

TABLE 2
MECHANISM OF INJURY — PREVENTABLE DEATHS

Motor Vehicle Accidents	21
Industrial Falls	3
Blunt trauma — Assault	2
Hit by objects	1

For the 43 non-preventable non-CNS trauma deaths, the mean age was 52.6 years (range 19-83 years). The mean ISS was 36.0 ± 13.4.

The survival time of non-CNS trauma patients who reached hospital alive ranged from 50 minutes to more than 3 months. Fifty one (81.4%) of the 70 cases who reached hospital alive died within 24 hours. The early causes of death (less than 24 hours) included 1) shock and haemorrhage and 2) respiratory insufficiency. The late causes of death (more than 24 hours) included 1) bronchopneumonia 2) septicaemia 3) multiple organ failure and 4) disseminated intravascular coagulation.

Of the twenty-seven preventable non-CNS trauma deaths, the most commonly injured organs included: rib fractures, lung injuries, long limb fractures and liver injuries (Table 3). All patients had injuries to more than one body system. More than half the patients also had associated CNS injuries which were not the primary cause of death. Only 5 of the 27 patients (18.5%) had operative procedures performed for them. These included laparotomies, wound deuridement, fracture fixation and an amputation.

A summary of 14 cases which were identified as definitely preventable is tabulated below (Table 4). Nine of these deaths were secondary to haemorrhage. In four of these cases, the source of bleeding was

TABLE 3
ORGANS INJURED (27 PATIENTS)

Chest (22 patients)		Head, Neck & Spine (17 patients)	
Rib fractures	16	Brain	11
Lung	14	Fracture Skull	3
Diaphragm	1	Spine	2
		Spine Maxillo-facial/ mandible	3
Abdomen/pelvic contents (14 patients)		Larynx	1
Liver	9		
Kidney	7		
Colon	3	Extremities & Bony Pelvis (14 patients)	
Spleen	2		
Urethra	2		
Stomach	1	Long Limb Fractures	10
Duodenum	1	Pelvis Fractures	4
Small intestine	1		
Bladder	1		

TABLE 4
SUMMARY OF DEFINITELY PREVENTABLE NON-CNS TRAUMA DEATHS

Patient/Sex/Age	Trauma	Cause of Death	Comments
1/M/37	Ruptured Liver	Haemorrhage	Delayed Diagnosis Survived 8 hrs 49 mins
1/M/28	Open fracture mandible Fracture ala of Larynx	Aspiration of blood	Patient survived 3 hrs 30 mins
3/M/19	Maxillo-facial fracture Mandible Fracture Dislocated left hip	Bronchopneumonia	Patient survived 20 hrs
4/M/34	Bilateral rib fracture	Bilateral haemothorax	Undiagnosed (L) Haemothorax containing 1200 cc
5/M/27	Ruptured liver Fracture humerus Fracture tibia/fibula	Haemorrhage	Patient survived 65 mins
6/F/34	Bilateral Femoral shaft fracture Superficial ruptures of the liver	Haemorrhage	Delayed extraction from vehicle
7/M/18	Multiple rib fracture	Bilateral Haemothorax	Patient survived 95 mins
8/M/21	Multiple rib fracture Lacerated lung	Bilateral Haemothorax	Patient survived 5 hrs 10 mins
9/M/31	Multiple rib fracture Ruptured right lower lobe of lung Ruptured urethra	Haemothorax Haemomedastinium	Had laparotomy for ruptured urethra
10/M/41	Ruptured lung	Haemothorax	Observed for 8 hrs 25 mins Presumed diagnosis of dissecting aortic aneurysm
11/M/41	Multiple limb fracture intrapulmonary haematoma	Haemorrhage	Survived 50 mins
12/M/36	Ruptured Duodenum	Sepsis	Delayed laparotomy
13/M/36	Pelvic fracture, dislocated left hip, fracture radius/ulna	Sepsis	Developed Bronchopneumonia post-operatively
14/M/41	Multiple rib fractures	Flail chest	

either misdiagnosed or undiagnosed. Two deaths followed aspiration from maxillo-facial and mandibular injuries. Another two patients died from septicaemia — one from bronchopneumonia which developed after an operation for fixation of his fractures and the other from peritonitis following a delayed laporatomy for a ruptured duodenum. The last death was due to a flail chest which could have been salvaged by ventilatory support. Ten out of the 13 potentially preventable non-CNS deaths were secondary to haemorrhage. Two patients died from sepsis — one from an infected amputation stump and the other from bronchopneumonia. The remaining patient died from acute renal shutdown.

The sources of management are summarized in Table 5. Critical errors in treatment were more frequent than diagnostic errors and consisted primarily of inadequate treatment of shock by inappropriate blood and fluid replacement; and inadequate respiratory support with little or no airway control, ventilatory assistance or pulmonary toilet. Diagnostic errors included failure to diagnose intrathoracic haemorrhage or injury and ruptured intraabdominal viscera.

TABLE 5
SOURCES OF MANAGEMENT ERROR (27 PATIENTS)

TREATMENT	
Shock/Haemorrhage	12
Respiratory Support	
Airway Control	2
Ventilatory Assistance	3
Pulmonary Toilet	2
Wound Management	1
Renal Failure	1
DIAGNOSIS	
Chest Injuries	4
Abdominal injuries	2

DISCUSSION

A review of the literature on the quality of trauma care provided in communities served by an organized trauma system reveals certain features: 1) there is a low rate of preventable deaths, 2) deaths are more frequent in the older age groups, 3) the mean ISS for all trauma deaths is higher and 4) there is vigorous resuscitation and aggressive surgical intervention as evidenced by a high rate of resuscitative surgery.

In our present study, there was a rate of preventable non-CNS deaths of 38.6%. In different communities in the United States were patients have been treated in trauma hospitals, preventable trauma death rates of 2% to 15% have been reported (11,14,15). Central to improving quality is recognition that seriously injured patients require systems for tertiary care. Trauma hospitals appear to be essential for optimal care (12).

Baker et al (13) have shown that for a given ISS, mortality is higher in the 50 to 59 year old age group and increases greatly for patients more than 70 years old. In a comparative study of two counties in the United States, West et al (6) showed that the majority of deaths in San Francisco County which was served by an organized trauma system occurred in patients more than 50 years old. In Orange County, where there was no trauma system at the time of the report, the majority of the deaths occurred in the 10 to 40 year old age group. In our study, the majority of the preventable non-CNS trauma deaths (92.6%) were in those less than 50 years of age. This represents a sad socio-economic loss for Singapore.

The overall mean ISS for cases of non-CNS deaths brought to hospital alive in our study was 34.6. Frey (16) reports that in some trauma centres in the United States, few deaths occur with an ISS Below 45. It has been shown that there is a lower rate of preventable deaths among patients with more severe injuries in a region served by a trauma system than one that is not (6).

Only 18.5% of patients in the preventable non-CNS trauma death groups had operations performed in our study. It has been suggested that in a trauma centre setting, trauma victims requiring a life-saving procedure would be operated on (7). West et al (6) in his comparative study of two counties demonstrated that there was a more aggressive approach to patients as shown by a higher rate of life-saving operative procedures performed in the county served by a trauma centre.

There was a high rate (70.1%) of non-CNS trauma deaths who were brought in dead. This suggests that improvements in pre-hospital care can be made. Frey et al (17) in his analysis of 159 motor vehicular fatalities suggested that improved survival might result if skilled resuscitation was available to protect the airway and support circulation at the accident scene and during transport. Other studies (8,9) also show that implementation of organized emergency care systems which include pre-hopsital care can substantially reduce preventable deaths.

The pattern of injury and sources of management errors revealed in this study has implications for the concept and operation of a hospital which manages trauma victims. Such a centre should be able to deal with multiply-injured patients. The coexistence of injuries to different body systems — head, chest, abdominal and orthopaedic — in all the patients whose deaths may be preventable suggests that there should be in-house radiologists, tertiary surgical specialists and intensive care specialists. A multidisciplinary approach is required.

The major sources of error in management of patients in this study were inadequate treatment of shock, failure to arrest haemorrhage and failure to provide respiratory support (Table 5). Reference has been made to the 'golden period' of some 60 minutes, the time following injury when resuscitation and stabilization are most critical in the successful management of the injured (18). It is not only the time taken to transport the injured patient to hospital which is critical but also the time delay within the hospital prior to appropriate surgery which can influence morbidity and mortality. Direct transfer of a patient from the reception area to the operating room has been shown to improve care of trauma patients (19). Movement of the critically ill or injured from one floor to another or to another facility for tests or study has been described by Cowley et al as 'life threatening' (20). Treatment should be immediate and operations should be able to be performed at an instant notice.

This study demonstrates the need for an organized system of trauma care in Singapore. The development of a trauma hospital integrated with injury prevention, prehospital care, rehabilitation, quality assurance and public education provide the basis on which we will see a reduction of unnecessary loss of lives from trauma. Future improvement in trauma care may then be measured against the present data.

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