

OUTCOMES AFTER SEVERE TRAUMA AT A NORTHERN CANADIAN REGIONAL TRAUMA CENTRE

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OBJECTIVE: To evaluate outcomes of trauma patients at a northern community trauma referral centre that does not meet several of the guidelines for a trauma centre.

DESIGN: A retrospective study.

SETTING: Sudbury General Hospital in northern Ontario.

PARTICIPANTS: All trauma patients admitted between 1991 and 1994 who had an Injury Severity Score (ISS) greater than 12.

OUTCOME MEASURES: Actual survival to discharge was compared to survival predicted by TRISS analysis. Z, W and M scores were calculated by standard TRISS techniques.

RESULTS: Of 526 patients with an ISS greater than 12, 416 (79%) were suitable for TRISS analysis. Of these 416 patients, 310 (74%) were men. The mean age was 39 years. Two hundred and sixty-one (63%) patients were admitted directly to the Sudbury General Hospital, whereas 155 (37%) were transferred from other hospitals. The leading causes of injury were motor vehicle-traffic accidents in 48%, motor vehicle-nontraffic in 21% and falls in 8%. Overall, there were more unexpected survivors than patients who died. The Z score for survivors was 4.95, and the W score was 5.66.

CONCLUSIONS: In the setting of a geographically isolated, medium-volume trauma centre where blunt injuries predominate, excellent trauma survival can be achieved without meeting all trauma centre guidelines for staffing and facilities. Relaxing stringent requirements for the availability of physicians may facilitate surgical recruitment and retention.

OBJECTIF : Évaluer les résultats des soins dispensés aux accidentés à un centre communautaire traumatologique de référence du Nord qui ne satisfait pas à toutes les lignes directrices d'un centre de traumatologie.

CONCEPTION : Étude rétrospective.

CONTEXTE : Hôpital général de Sudbury dans le nord de l'Ontario.

PARTICIPANTS : Tous les accidentés admis entre 1991 et 1994 et dont l'indice de gravité du traumatisme (IGT) était supérieur à 12.

MESURES DE RÉSULTATS : On a comparé le nombre réel de patients qui ont survécu à un traumatisme au nombre de survivants prédit par l'analyse TRISS. On a calculé des ratios Z, W et M à l'aide des techniques ordinaires du TRISS.

RÉSULTATS : Des 526 patients affichant un IGT supérieur à 12, 416 (79 %) se prêtaient à une analyse du TRISS. De ces 416 patients, 310 (74 %) étaient des hommes. L'âge moyen était de 39 ans. Deux cent soixante-trois (63 %) patients ont été admis directement à l'hôpital général de Sudbury, tandis que 155 (37 %) provenaient d'autres hôpitaux. Les accidents d'automobile liés à la circulation ont figuré pour 48 % des traumatismes, les accidents de véhicule motorisé non liés à la circulation ont été à l'origine de 21 % des traumatismes, et enfin les chutes ont compté pour 8 % des causes de blessures. Dans l'ensemble, le nombre de survivants non prévus a été plus élevé que le nombre de patients qui sont décédés. Le ratio Z chez les survivants s'est établi à 4,95 et le ratio W à 5,66.

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CONCLUSIONS : Dans un centre de traumatologie à volume moyen qui est isolé géographiquement et où dominent les traumatismes contondants, il est possible d'obtenir un excellent taux de survie sans pour cela satisfaire à toutes les lignes directrices des centres de traumatologie en ce qui concerne la dotation et les installations. L'assouplissement des exigences rigoureuses sur la disponibilité des médecins pourrait favoriser le recrutement et la rétention de chirurgiens.

The development and implementation of practice guidelines and standards of care are becoming increasingly important in all areas of health care.^{1,2} The Committee on Trauma of the American College of Surgeons has established criteria necessary for an American institution to be designated as a trauma centre.³ These guidelines were developed and are regularly updated to ensure that most major trauma care is done in centres of excellence that have demonstrated a commitment to the care of the seriously injured patient.

The Trauma Association of Canada approved guidelines for Canadian centres in 1993 (unpublished data). These guidelines differ somewhat from the American guidelines, reflecting the heavy predominance of blunt trauma in Canadian centres: Canadian guidelines allow nonsurgeons to assume the role of trauma team leaders. Canadian surgeons do not have to be in-house continuously but must have a maximum response time of 20 minutes.

Previous studies have reported varying results from centres that do not meet guidelines pertaining to in-house surgical coverage⁴⁻⁶ and 24-hour in-house operating-room support.^{6,7} Guidelines pertaining to audit filters⁸ and trauma team activation⁹ have recently come under scrutiny, and outcomes from Canadian academic trauma institutions where trauma team leaders may come from nonsurgical backgrounds have been reported.¹⁰⁻¹²

In this study we had 3 objectives:

- to evaluate survival in trauma patients treated at a medium-volume northern Canadian community hospital that acts as a regional trauma cen-

tre but does not meet Trauma Association of Canada guidelines,

- to compare these outcomes with those from the Major Trauma Outcome Study (MTOS),¹³

- to determine if this “nonadherence” to recommended guidelines has a detrimental effect on patient survival.

METHODS

Study design

We used a retrospective case-series approach to review the care and outcome of all trauma patients who had an Injury Severity Score (ISS) greater than 12 between 1991 and 1994.

Setting and study population

During the study years, the Sudbury General Hospital was a 250-bed community hospital, serving a population of 800 000 spread over 290 000 km². Since 1991, the hospital has been 1 of 10 designated “lead hospitals for trauma” in Ontario, acting as the referral centre for all major multisystem trauma and in particular all neurosurgical trauma in northeastern Ontario. Isolated vascular trauma was usually handled at another local hospital.

There were 12 rotating trauma team leaders all of whom were full-time emergency physicians. One leader was always on duty in the emergency department. These physicians initiated and oversaw care until the patient was transferred to the operating room or a suitable inpatient bed. The surgeon on call was not required to be in the building but could usually respond within 20 minutes. There was no formal

trauma team, and consultants were called in as needed. Family and residents in emergency medicine rotated through the emergency department but were never primarily in charge of trauma resuscitation. There were no surgical residents. Patients with single-system trauma were admitted to the appropriate surgical specialty: patients with multisystem trauma were usually initially admitted under the care of an intensive care physician. There was a single operating-room team in the hospital between the hours of 1730 and 2330. A team was on call from home between 2330 and 0730. Between the hours of midnight and 0800 there was often only 1 physician on site (in the emergency department).

There were no formal patient management protocols, although there were suggested practice care guidelines that had been developed within the institution. Guidelines were established after critical appraisal of the literature by a trauma multidisciplinary committee.

Measurements

A comprehensive data set was collected on all trauma patients with an ISS greater 12. Information was obtained from the ambulance call report, detailed chart review and autopsy report. Data collected by the trauma data analyst were reviewed for completeness and accuracy by the trauma nurse coordinator. Controversial cases were reviewed by a medical director before assigning final ISS scores. Information was entered into the Ontario Trauma Registry using Collector software (Trianalytics Inc., Bel Air, Md).

Whenever possible, TRISS analysis was performed. Z, W and M scores were calculated using standard TRISS techniques.¹⁴ (TRISS coefficients were supplied by Trianalytics Inc., 1994.) The Revised Trauma Score (RTS)¹⁵ and the Abbreviated Injury Scale (AIS-90)¹⁶ scoring systems were used. A probability of survival was calculated for each patient if the RTS and ISS were available on arrival. The Z and W scores were calculated automatically by the Collector software. The M statistic was calculated manually. The Z score was calculated for survivals rather than deaths (i.e., a positive score reflects better than average survival). The W score reflects the number of extra survivals (or deaths) per hundred compared with that predicted for the population group by the MTOS. The M statistic assesses the degree of injury-severity match between the population group being studied and the MTOS population.

RESULTS

Inclusion and exclusion criteria

Of the 526 patients with an ISS greater than 12, 416 (79%) were suitable for TRISS analysis. Patients were excluded if the RTS or ISS was not available. This happened almost exclusively in patients who had been intubated before their arrival at the Sudbury General Hospital, in which case it was impossible to calculate a Glasgow Coma Scale (GCS) score on arrival. Patients with non-AIS codeable injuries (e.g., drowning and hanging) were also excluded. Separate mortality statistics were calculated manually for patients who were excluded from TRISS analysis.

Demographic/clinical characteristics

Of the 416 patients eligible for

TRISS analysis, 310 (74%) were men. The mean age was 38.9 years. The mean ISS was 23.8 (ranging from 13 to 75). Two hundred and sixty-one (62%) patients were admitted directly, 155 (37%) were transfers from other hospitals. The total prehospital time (time of injury to time of ambulance arrival at hospital) for direct admissions averaged 121 minutes (ranging from 6 to 3510 minutes, median 58 minutes). For patients who were transferred from other facilities, prehospital time averaged 124 minutes (ranging from 4 to 1543 minutes, median 51 minutes).

Blunt trauma occurred in 396 (95%) cases, penetrating trauma in 17 (4%) cases and burns in 3 (1%) cases. The most common causes of injury were motor-vehicle traffic accidents (201 [48%]), motor vehicle nontraffic accidents (90 [21%]), falls (35 [8%]), homicide and assault (26 [6%]) and self-inflicted injuries (7 [2%]). The demographic and clinical characteristics are outlined in Tables I and II.

The head was the most commonly injured region. Sixty-two percent of patients had a head AIS score of 2 or greater. One-third of the patients had significant thoracic injuries, and a similar number had significant facial injuries. Only 54 (13%) patients had abdominal injuries of AIS grade 2 or more. Fifty-four craniotomies, 40 la-

parotomies and 3 thoracotomies were performed urgently (within 6 hours of hospital arrival). No urgent revascularizations were done.

The 416 patients suitable for TRISS analysis yielded a Z score for survivors of 4.95 and a W score of 5.66 (Table III). Twenty-four (5.7%) of the patients subjected to TRISS analysis died.

Overall there were more unexpected survivors than patients who died during the study period (7 versus 5). Six of the unexpected survivors were over 60 years of age, as were 2 who died unexpectedly. One patient with a probability of survival greater than 0.95 died. The M statistic was calculated to be 0.757 (Table IV).

One hundred and ten patients were excluded from TRISS analysis. Within this group, 31 (28%) patients died. Of these patients, 25 had head AIS scores

Table I
Demographic Characteristics of 416 Patients Eligible for TRISS Analysis

Characteristic	No. (and %) of patients
Sex	
Male	310 (74)
Female	106 (25)
Age, yr	
0-14	36 (9)
15-54	279 (67)
> 55	101 (24)

Table II
Descriptive Features of Traumatic Events in 416 Patients Eligible for TRISS Analysis

Feature	No. (and %) of patients
Type of admission	
Transfer	155 (37)
Direct	261 (63)
Outcome	
Discharged alive	392 (94)
Died	24 (6)
Type of injury	
Blunt	396 (95)
Penetrating	17 (4)
Burn	3 (1)
Cause of injury	
Motor vehicle, traffic	201 (48)
Motor vehicle, nontraffic	90 (22)
Falls	35 (8)
Homicide and assault	26 (6)
Other	64 (15)

Mean ISS was 23.8.

of 5 or 6; the other 6 died on the way to the hospital or from non-AIS codeable injuries.

Overall, of 55 patients who died, 40 had head injuries with an AIS severity of 5 or 6.

DISCUSSION

In general, survival has been shown to improve when patients with major injuries are treated at trauma centres.^{17,18} Guidelines have been developed that outline the criteria which must be met to achieve trauma centre designation (Trauma Association of Canada: unpublished data, 1993).³ These criteria have been revised over the years but continue to be controversial.^{19,20} The need for 24-hour in-house operating-room teams⁷ and an in-house trauma surgeon⁴ have been questioned, especially for hospitals with a low incidence of penetrating trauma. Clearly there are a small number of “crash protocol” patients who are well served by having the full range

of specialists and services immediately available. However, there is evidence that in some settings excellent care can be provided using more limited resources, especially in centres dealing with predominantly blunt trauma.^{4,6,7,21,22}

Only 12% of the patients in this study had abdominal injuries of AIS grade 2 or more. There was no case in 3 years in which an adverse outcome could be attributed to a delay in surgical evaluation or lack of in-house operating-room staff, when reviewed by a trauma program director or trauma multidisciplinary committee.

Trauma Association of Canada guidelines requiring the presence at all times of 2 physicians capable of intubating may not be achievable outside teaching centres. This study showed that, at least in this patient population, care did not appear to be compromised by the failure to meet this requirement.

Trauma care is time-consuming and often poorly remunerated. It tends to occur during off-hours and is

not favourably regarded by many surgeons.^{23,24} Moreover, in northern Ontario, recruitment and retention of surgical specialists is a major problem, and strategies to improve job satisfaction of surgical consultants are warranted. The greater use of interested nonsurgeons in the provision of trauma care may be one such retention strategy. Using this strategy, the Sudbury General Hospital has been able to provide trauma care that consistently exceeds MTOS expectations for survival.

There are several limitations to this study. First, there may be patients who appear as survivors in our trauma registry but who were subsequently sent to another centre for complicated orthopedic care or pediatric injuries (11%) and who subsequently died. However, follow-up of transferred patients indicates that this occurred less than once per year.

Second, because of the large catchment area, long prehospital response times may have selected those expected to have good outcomes in that most of them had already survived the “golden hour” of trauma care. Ninety percent of blunt trauma deaths in northeastern Ontario occur before arrival at hospital. This may have been particularly relevant in the referred group which constituted 37% of the patient population. Referred patients were originally excluded during the development of TRISS coefficients but are included in the Ontario Trauma Registry TRISS statistics.

Third, the M statistic was 0.757, indicating a poor match with the data from the MTOS population. However, patients in our study were more severely injured, on average, than in the MTOS group. This is because only patients with ISS scores greater than 12 are entered into our trauma registry compared with all trauma patients in the MTOS group.

Table III

TRISS Scores

Group	score	W score	Sample size, no.
Adult, blunt trauma	4.82	5.94	365
Adult, penetrating trauma	-0.11	—	15
Pediatric, < 15 yr	1.5	—	36
Total subset	4.95	5.66	416

Table IV

Severity of Trauma (Percent of Patients in Each Probability of Survival Cohort)

Probability of survival	Sudbury study	Major Trauma Outcome Study
0.00–0.25	3.9	3.6
0.26–0.50	3.7	1.7
0.51–0.75	5.5	2.9
0.76–0.90	12.1	4.4
0.91–0.95	16.2	4.5
0.96–1.00	58.6	82.5

M statistic = 0.757

Fourth, further bias may have occurred because our injury data were obtained by careful chart review by a dedicated data analyst rather than from chart discharge diagnoses. Therefore, fewer diagnoses may be missed when calculating ISS scores, with resultant higher ISS scores than for similarly injured patients from the MTOS study. This factor may apply to all other lead hospitals in the Ontario Trauma Registry; indeed, the Z score for the registry as a whole is 2.09 (Dr. Peter L. Lane, Medical Director, Trauma Services, London Health Sciences Centre, London, Ont.: personal communication, 1994).

TRISS analysis cannot be performed on patients who arrive intubated. One centre recently reported¹² that they were able to collect the necessary data for TRISS scoring on 298 of 300 patients seen by their trauma service in a year, but this is an unusual capture rate which most centres are unable to duplicate. We could only calculate TRISS scores for 79% of those in our registry. It is well known that patients who are excluded from TRISS scoring have a higher death rate.²⁵ The death rate was 28% in the TRISS exclusion group versus 6% in the TRISS inclusion patients. Review of the patients excluded from TRISS analysis at this hospital revealed that most had major head injury with coma and had been intubated before arrival at our hospital. The others died en route to hospital or had injuries not well defined by the AIS system (e.g., hanging, drowning). Offner and colleagues²⁵ proposed a methodology for dealing with this group of patients, avoiding the respiratory component of the RTS and using only the best motor response for the neurologic component. They then calculated new coefficients to come up with a TRISS-like probability of survival. Stewart, Lane and Stefanits²⁶ used this

method to examine the Ontario Trauma Registry. Using the Offner coefficients, they calculated a Z score for our institution of 6.68, with a W score of 9.13, when intubated patients were included. This suggests that our centre's high Z score for survivors was not due to the exclusion of sicker patients in the TRISS calculations.

CONCLUSIONS

Notwithstanding these concerns, in this relatively isolated medium volume centre with a heavy preponderance of blunt injury, trauma survival rates were obtained that were above those expected from the MTOS study of North American trauma centres. The use of nonsurgeons in a major role did not appear to jeopardize patient outcome. Operating-room coverage deviated from Trauma Association of Canada guidelines, but no deaths were attributable to this deviation. Similarly, the lack of 2 physicians at all times capable of advanced airway control did not preclude excellent outcomes.

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SESAP Critique / Critique SESAP

ITEMS 299-302

At least 5000 cases of caustic ingestion occur in the United States each year. Most of the accidental ingestions occur in children, while caustic ingestion in adults is more frequently intentional. The nature and degree of the resulting injury depends on the type of substance ingested and its physical form. Injuries to children are most frequently a result of ingesting liquid alkali, ie, liquid drain cleaner, which produces liquefaction necrosis in the gastrointestinal tract. Cellular necrosis occurs within 2 to 3 days and sloughing of the mucosa 4 to 7 days after the injury. Stricture formation occurs later. Because liquid alkali preparations are often present in the home and are colourless and odourless, they are easily swallowed and are more likely to result in damage both to the esophagus and stomach. Crystalline or solid alkaline materials (ie, solid drain cleaners) adhere to the mucous membranes and are more difficult to swallow, resulting primarily in injury to the oropharynx or upper esophagus. Ingestion of acid results in coagulation necrosis. Acid ingestion is usually painful and therefore results in rapid expulsion of the chemical unless it is being deliberately swallowed.

Patients with caustic ingestion should not have gastric lavage or induced emesis because it would expose the mucous membrane to additional injury. Plain chest x-ray and abdominal films to look for evidence of perforation should be followed by early endoscopy to assess the nature and severity of the injury. Although corticosteroids have frequently been used, no evidence in controlled trials justifies their use. Evidence for use of antibiotics is similarly lacking. Although placement of a nasogastric tube will not prevent subsequent stricturing, placement of a string into the stomach for late dilatation may be useful. In the absence of perforation, oral feeding may begin as soon as the patient is able to swallow saliva. After 1 to 2 weeks the degree of injury should be assessed by esophagogram using water-soluble contrast material. Dilatation of strictures should be delayed until this time, though esophageal replacement may be necessary if serial dilatation fails.

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