# Chapter 8 Outcome Measures

In This Section



## EXECUTIVE SUMMARY – OUTCOME MEASURES

- Gunshot victims had the highest mortality approaching 18% followed by pedestrians and falls greater than 5 meters.
- There has been a steady improvement in mortality outcomes and survival at Liverpool Hospital even allowing for compound factors such as injury severity score, fractured neck of femurs, patients receiving CPR who were included in the Registry. Based upon data from 1999, there is a statistically significant improved outcome compared to MTOS (this is to be expected), however as this data is now dated to the mid 1980's (the Registry has the advantage of showing the trend analysis within their own hospital). The W scores identified that in 1999, 2.29 patients per 100 would survive that may have died compared to MTOS values and norms.
- Great care must be used when undertaking such analysis. Results can be secured by:
- Performing subset analysis for all the patients not just selecting those with greater ISS.

## DEATHS FOLLOWING TRAUMA - SWSAHS

### Outcome for Each Mechanism of Injury for All SWSAHS

| Mechanism | Patients (Major) | *% of Total* | Deaths n | *Deaths %* | Survivors ISS | Deaths ISS |
|---|---|---|---|---|---|---|
| Driver | 937 | *14.1* | 40 | *4.3* | 10.8∀8.1 (1-66) | 40.3∀18 (10-75) |
| Front passenger | 357 | *5.4* | 14 | *3.9* | 11.5∀8.3 (1-43) | 39.9∀16.2 (13-66) |
| Back passenger | 165 | *2.5* | 10 | *6.1* | 11.0∀9.4 (1-75) | 5 ∀15.2 (29-75) |
| Motor cyclist | 425 | *6.4* | 10 | *2.4* | 10.9∀8.2 (1-75) | 46.9∀13.9 (30-75) |
| Pillion | 16 | *0.2* | 0 | *0.0* | 10.3∀7.6 (4-35) | * |
| Pedestrian | 476 | *7.2* | 40 | *8.4* | 12.7∀10.1 (1-75) | 45.4∀18.4 (5-75) |
| Pedal Cyclist | 221 | *3.3* | 2 | *0.9* | 8.8∀7.5 (1-75) | 48.5∀14.8 (38-59) |
| Blunt Assault | 547 | *8.2* | 12 | *2.2* | 9.9+6.9 (1-41) | 34.3∀20.6 (9-75) |
| Stabbing | 279 | *4.2* | 9 | *3.2* | 8.7∀7.2 (1-35) | 40.7∀26.0 (17-75) |
| Gunshot | 74 | *1.1* | 13 | *17.6* | 9.9∀11.1 (1-75) | 38.5∀21.9 (16-75) |
| Industrial | 213 | *3.2* | 4 | *1.9* | 9 ∀6.6 (1-34) | 63.5∀23 (29-75) |
| Fall <1m | 1936 | *29.1* | 132 | *6.8* | 7.8∀5.3 (1-35) | 13.8∀11 (1-75) |
| Fall ≥1m <5m | 95 | *1.4* | 1 | *1.1* | 10 ∀7.4 (1-34) | 9 ∀ 0 (9-9) |
| Fall ≥5m | 131 | *2.0* | 10 | *7.6* | 12.2∀8.4 (1-41) | 37.8∀13.9 (25-66) |
| Recreation | 384 | *5.8* | 2 | *0.5* | 7.4∀5.1 (1-36) | 26∀1.4 (25-27) |
| Burn | 99 | *1.5* | 1 | *1.0* | 12.2∀9.9 (1-75) | 9 ∀ 0 (9-9) |
| Other | 287 | *4.3* | 4 | *1.4* | 6.8∀5.0 (1-34) | 25 ∀ 0.0 (25-25) |
| No documented | 12 | *0.2* | 0 | *0.0* | 11.6∀9.9 (1-26) | * |
| Total | 6654 | *100* | 304 | *4.6* | 9.5∀7.4 (1-75) | 29.6∀21.2 (1-75) |

### ISS AND OUTCOME FOR ALL MAJOR CATEGORY ADMISSIONS TO SWSAHS HOSPITALS

| SWSAHS | 1995 | 1996 | 1997 | 1998 | 1999 | Total |
|---|---|---|---|---|---|---|
| Survived ISS | 9.5∀7.6 (1-75) | 9.6∀7.8 (1-75) | 9.2∀7.4 (1-59) | 9.4∀6.8 (1-75) | 9.7∀7.5 (1-75) | 9.5∀7.5 (1-75) |
| Died ISS | 27.0∀21.9 (4-75) | 34.1∀19.7 (9-75) | 35.9∀22.7 (1-75) | 27.6∀20.2 (4-75) | 24.1∀20.0 (4-75) | 29.6∀21.2 (1-75) |
| All Patients ISS | 10.4∀8.8 (1-75) | 10.4∀9.8 (1-75) | 11.0∀10.6 (1-75) | 11.2∀9.9 (1-75) | 10.2∀8.7 (1-75) | 10.4∀9.5 (1-75) |

## DEATHS FOLLOWING TRAUMA – LIVERPOOL HOSPITAL

### Outcome for Each Mechanism of Injury for Liverpool Hospital

| Mechanism | Patients (Major) | *% of Total* | Deaths n | *Deaths %* | Survivors ISS | Deaths ISS |
|---|---|---|---|---|---|---|
| Driver | 731 | *18.2* | 40 | *5.5* | 11.4∀8.5 (1-66) | 40.3∀18.0 (10-75) |
| Front passenger | 280 | *7.0* | 14 | *5.0* | 12.4∀8.9 (1-43) | 39.9∀16.2 (13-66) |
| Back passenger | 131 | *3.2* | 10 | *7.6* | 11.3∀9.8 (1-75) | 53.0∀15.2 (29-75) |
| Motor cyclist | 259 | *6.6* | 10 | *3.9* | 12.3∀9.1 (1-75) | 46.9∀13.9 (30-75) |
| Pillion | 13 | *0.3* | | *0.0* | 10.5∀8.3 (4-35) | * |
| Pedestrian | 368 | *8.8* | 34 | *9.2* | 13.5∀10.9 (1-75) | 46.4∀17.5 (17-75) |
| Pedal Cyclist | 105 | *2.7* | 2 | *1.9* | 10.2∀9.4 (1-75) | 48.5∀14.8 (38-59) |
| Blunt Assault | 348 | *9.0* | 8 | *2.3* | 10.8∀7.4 (1-41) | 32.1∀17.4 (25-75) |
| Stabbing | 216 | *5.5* | 8 | *3.7* | 9.3∀7.5 (1-35) | 435.∀26.3 (17-75) |
| Gunshot | 60 | *1.3* | 12 | *20.0* | 9.7∀7.0 (1-29) | 39.7∀22.5 (16-75) |
| Industrial | 162 | *4.2* | 3 | *1.9* | 9.9∀7.0 (1-34) | 59.7∀26.6 (29-75) |
| Fall <1m | 639 | *15.0* | 70 | *11.0* | 9.3∀6.6 (1-35) | 16.8∀13.5 (4-75) |
| Fall ≥1m <5m | 70 | *1.8* | 0 | *0.0* | 10.2∀7.7 (1-34) | * |
| Fall ≥5m | 116 | *2.8* | 10 | *8.6* | 12.1∀8.1 (1-41) | 37.8∀13.9 (25-66) |
| Recreation | 159 | *4.1* | 2 | *1.3* | 8.3∀6.3 (1-36) | 26.0∀1.4 (25-27) |
| Burn | 62 | *1.6* | 1 | *1.6* | 14.4∀11.5 (1-75) | 9 ∀0 (9-9) |
| Other | 70 | *1.8* | 3 | *4.3* | 8.4∀6.1 (1-33) | 25.0∀0.0 (25-25) |
| Not Documented | 5 | *0.1* | 0 | *0.0* | 19.6∀9.3 (4-26) | * |
| Total | 3794 | *94.0* | 227 | *6.0* | 11.0∀8.4 (1-75) | 34.3∀20.7 (4-75) |

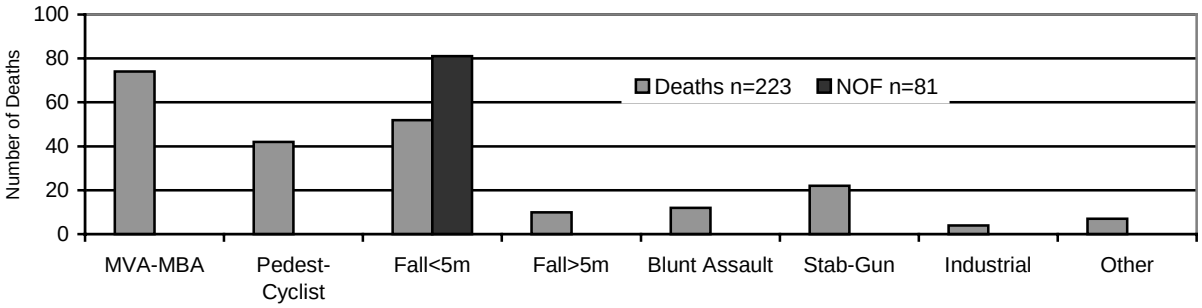
### ISS AND OUTCOME FOR ALL MAJOR CATEGORY ADMISSIONS TO LIVERPOOL HOSPITAL

| Liverpool | 1995 | 1996 | 1997 | 1998 | 1999 | Total |
|---|---|---|---|---|---|---|
| Survived ISS | 10.4 ∀8.7 (1-75) | 10.6∀8.4 (1-75) | 11.4∀8.6 (1-59) | 10.8∀7.9 (1-75) | 11.6∀8.7 (1-75) | 11.0∀8.4 (1-75) |
| Died ISS | 31.2∀22.2 (4-75) | 36.1∀18.4 (9-75) | 40.0∀21.7 (9-75) | 32.8∀19.6 (4-75) | 31.1∀21.4 (4-75) | 34.3∀20.7 (4-75) |
| All Patients ISS | 11.8∀11.2 (1-75) | 12.5∀11.5 (1-75) | 13.0∀11.9 (1-75) | 12.0∀10.3 (1-75) | 12.6∀10.7 (1-75) | 12.4∀11.1 (1-75) |

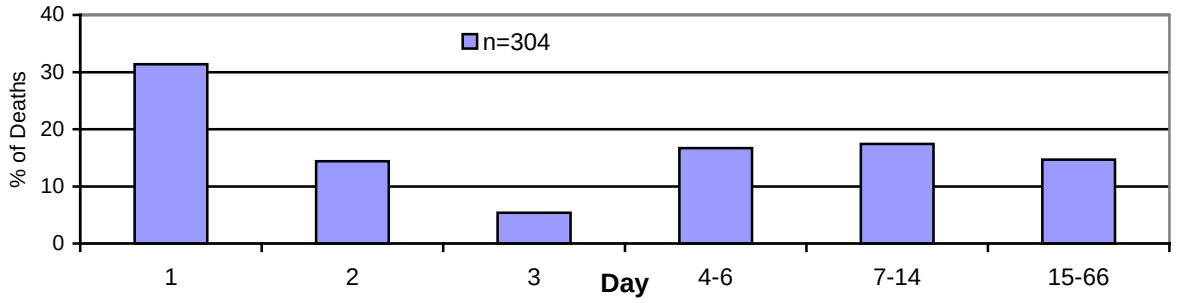
## DEATHS FOLLOWING TRAUMA

There were 304 deaths for patients with Major category injuries for all of SWSAHS. While generally the patient with an isolated fractured neck of femur is categorised as minor category injury, all deaths following trauma are entered into the major injury category. This allows a more detailed analysis. Therefore the 81elderly patients with isolated fractured neck of femur who died have been reclassified are counted as Major category injuries.

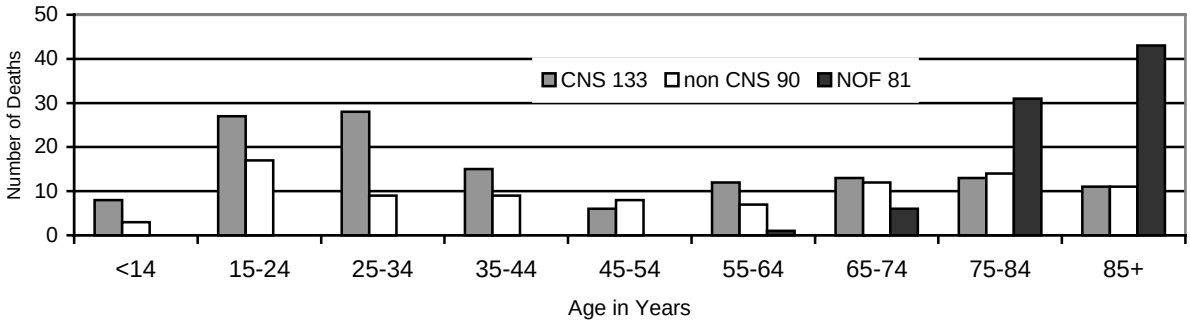
**Mechanism of Injury - Deaths in SWSAHS**




**Number of Days Elapsed From Arrival to Patients Death**

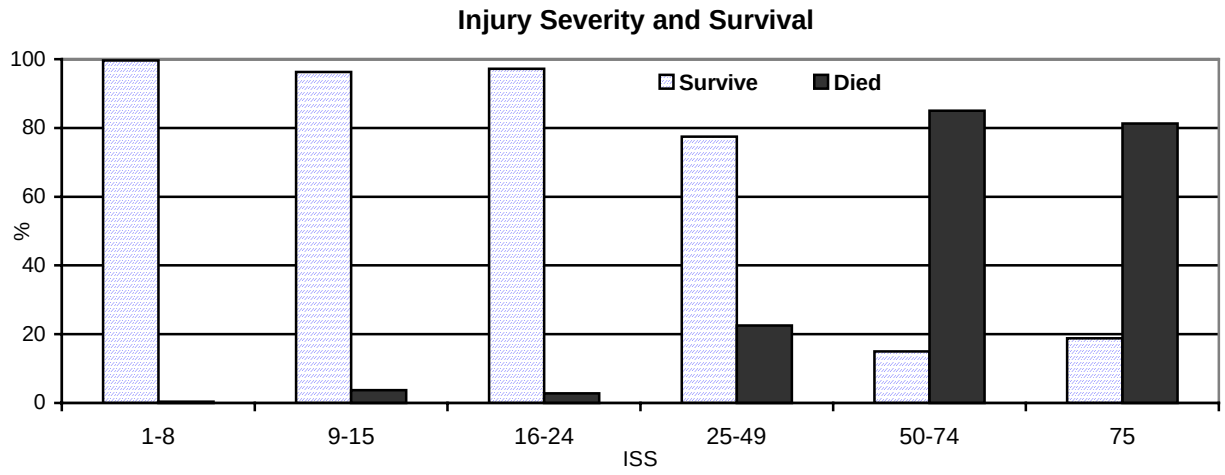



**Age Distribution and Category of Death**



## OUTCOME FOR INJURY SEVERITY

| ISS | Survived | | Died | | Total |
|---|---|---|---|---|---|
| | n | % | n | % | |
| 1 – 8 | 2905 | *99.6* | 13 | *0.4* | 2918 |
| 9 – 15 | 2422 | *96.3* | 93 | *3.7* | 2515 |
| 16 – 24 | 595 | *97.2* | 17 | *2.8* | 612 |
| 25- 49 | 416 | *77.5* | 121 | *22.5* | 537 |
| 50- 74 | 6 | *15.0* | 34 | *85.0* | 40 |
| 75 | 6 | *18.8* | 26 | *81.3* | 32 |
| Total | 6350 | *95.4* | 304 | *4.6* | 6654 |



## STATISTICAL MODELS FOR EVALUATING INJURY SEVERITY

### TRISS

Several scales have been formulated to quantify injury severity and mix.

**The Trauma Score (TS)** is a modification of the mathematically derived Triage Index. TS is based on the Glasgow Coma Scale, as well as on assessments of cardiovascular status (capillary return and systolic blood pressure) and respiratory status (rate and effort). Weighted values assigned to the variable are added to obtain the TS. The Trauma Score while widely used, depended on capillary refill and respiratory expansion which were difficult to assess in the field at night. Later the Revised Trauma Score (RTS) was developed.

**Revised Trauma Score (RTS)** is based on Glasgow Coma Scale, systolic blood pressure and respiratory rate. Variables are assigned coded values from 4 (normal) to 0. A lower than normal coded value for any variable suggests the need for care in a trauma centre. For evaluation of in-hospital outcome, coded values of GCS, SBP, and RR are weighted and summed to yield the RTS which takes values from 0 to 7.84. Higher values are associated with better prognoses. RTS provides more accurate predictions for patients with serious head injury and supplies more reliable outcome predictions than TS.

**REVISED TRAUMA SCORE**

| GCS | SBP | RR | Coded Value |
|---|---|---|---|
| 13-15 | >89 | 10-29 | 4 |
| 9-12 | 76-89 | >29 | 3 |
| 6-8 | 50-75 | 6-9 | 2 |
| 4-5 | 1-49 | 1-5 | 1 |
| 3 | 0 | 0 | 0 |

RTS = 0.9368 GCSc + 0.7326 SBPc + 0.2908 RRc
where the small c refers to the coded value.

**Abbreviated Injury Scale**

Early work characterizing the severity of individual injuries was conducted by De Haven at Cornell in the 1950s. Work on the Abbreviated Injury Scale (AIS) began in 1969. AIS lists several hundred injuries each of which is assigned a score of 1 (minor injuries) to 6 (nearly always fatal). AIS has been revised several times. The most recent revision is AIS-90. The 1985 version for the first time provided severity scores for penetrating injuries. In addition to the severity score, the AIS also associates a five-digit code with each unique description of injury, similar in function to ICD-9-CM codes.

**Injury Severity Score (ISS)** is a summary score for multiple traumatic injuries. ISS takes values from 1 to 75. Any patient with an AIS of 6 is assigned and ISS of 75. Otherwise ISS is calculated by summing the squares of the three highest AIS scores for injuries to different body regions. ISS correlates with mortality but has documented limitations. It only considers the highest AIS score from any body region, and it considers injuries with equal AIS scores to be of equal severity, regardless of body region. Nonetheless, ISS remains the most frequently used summary measure of severity of anatomic injuries.

## STATISTICAL MODELS FOR EVALUATING INJURY SEVERITY

**Major Trauma Outcome Study (MTOS)**

Much of our recent knowledge on trauma indices has come from the Major Trauma Outcome Study which began in 1982 to refine methods for injury severity scoring, to establish national normative outcomes for trauma, and to provide trauma care institutions with objective evaluations of quality assurance and outcome.

**RTS** assessed at patient admission and other times, provides physiologic information that can be used for pre-hospital and inter hospital triage. When combined with ISS, patient age, and type of injury, the resulting indices can be used for quality assurance and comparisons of outcome between or among hospitals of groups of patients.

**TRISS** is based on RTS, ISS, Age and Type of Injury in a regression formula. Values for these factors are weighted and summed to yield TRISS, which will be a value between 0 and 1.
TRISS methodology calculates the probability of Survival (Ps) of patients injured from a retrospective database using a logistic model

Ps = 1/(1+e-b)
Where **Ps** = probability of survival
e = 2.7183 (base of Naperian logarithms)
and b = b0 + b1 (RTS) + b2 (ISS) + b3 (AGE)
and b0,b1, b3 are weights derived by applying the Walker-Duncan regression algorithm to study data.

**TRISS REGRESSION WEIGHTS**

| | b0 | b1(RTS) | b2(ISS) | b3 (AGE) |
|---|---|---|---|---|
| Blunt | -1.3054 | 0.9756 | -0.0807 | -1.9829 |
| Penetrating | -1.8973 | 1.0069 | -0.0885 | -1.1422 |

where RTS = Revised Trauma Score (on ED admission)
ISS - Injury Severity Score
A = 1 if age > 54 years A = 0 if age <=54 years

Reference:
Champion HR, Copes WS and Sacco WJ. Chapter 5 Trauma Scoring. In: Feliciano DV, Moore EE, Mattox KL (eds) *Trauma*.Third Edition. Stamford: Appleton & Lange; 1996; 53-67.

# STATISTICAL MODELS FOR EVALUATING TRAUMA CARE

## TRISS

The TRISS[1] is a score based on Revised Trauma Score (RTS), ISS, Age and type of injury in a regression formula. Values for these factors are weighted and summed to yield TRISS which will be a value between 0 and 1. The TRISS methodology is used to calculate the probability of survival. Using available TRISS we can calculate the number of patients who would be expected to die following trauma in a group of patients. Not all patients admitted have a TRISS score. This is because all factors must be present to be calculated.

## STANDARDISED MORTALITY RATIO

Standardised Mortality Ratio [2] = Observed / Expected deaths

## Z STATISTIC

TRISS methodology is used to calculate the Z statistic[1, 3], which gives a comparison of outcome compared to a baseline population data established by the Major Trauma Outcome Study (MTOS). A Z statistic value outside –1.96 and +1.96 indicates that the difference between the test population and the base line population in the number of survivors or deaths is significant at $P<0.05$ level. As it is a mortality analysis a negative value is desired. The formula for the Z statistic when considering mortality is:

Z = Actual deaths - Predicted Deaths / sq root (Pred Deaths x Pred Survivors)

## W STATISTIC

Because clinically unimportant deviations from the norm can still result in a Z statistic that appears significant, the W statistic was developed to quantify the clinical significance of statistically significant Z scores. W is the difference between the predicted number of survivors (given by summing the predicted survival probabilities for each patient) and the actual number of survivors, divided by the total number of patients divided by 100. This is the number of excess survivors per 100 patients, compared with the predictions.

$$W = \frac{\text{no. of actual survivors - no. of predicted survivors}}{\text{number of patients /100}}$$

## References

[1] Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: The TRISS method. *J Trauma*. 1987; **27**:370-378.

[2] MacKenzie EJ, Steinwachs DM, Bone LR, Floccare DJ, Ramzy AI. The Preventable Death Study Group. Inter-rater reliability of preventable death judgements. *J Trauma*. 1992; **33**:292-303.

[3] Flora JD. A method for comparing survival of burn patients to a standardized survival curve. *J Trauma*. 1978; **18**:701-705.

## Comment and Suggestions for Further Reading

Many attempts have been made to evaluate injury severity and best practice for trauma care and a great deal of literature is available. It is recognised that reservations and limitations have been raised regarding TRISS. The Z score and SMR are based on TRISS methodology, which has limitations in many sub-groups of patients – especially in penetrating injuries and major blunt trauma.

Some references that would make a useful starting point include:

Champion HR, Copes WS and Sacco WJ. Chapter 5 Trauma Scoring. In: Feliciano DV, Moore EE, Mattox KL (eds) *Trauma*.Third Edition. Stamford: Appleton & Lange; 1996; 53-67.

Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the Trauma Score. *J Trauma*. 1989; **29**:623-629.

Baker SP, O'Neill B, Haddon W Jr, Long WB. The Injury Severity Score: A method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*. 1974; **14**:187-196.

Dykes EH, Spence LJ, Young J, Bohn D, Filler RM and Wesson DE "Preventable Pediatric Trauma Deaths in a Metropoloitan Region" J of Pediatric Surgery, Vol 24, No 1 (Jan), 1989:pp107-111

Sugrue M, Seger M, Sloane D, Compton J, Hillman K, Deane S. Trauma outcomes: A death analysis study. *Ir J Med Sci*. 1996; **165**:99-104.

Champion HR, Copes WS, Sacco WJ, et al. The Major Trauma Outcome Study: Establishing national norms for trauma care. *J Trauma*. 1990; **30**:1356-1365.

Sampalis JS, Boukas S, Lavoie A, et al. Preventable death evaluation of the appropriateness of the on-site trauma care provided by Urgences-Santé physicians. *J Trauma*. 1995; **39**:1029-1035.

Demitriades D, Chan LS, Velmahos G, et al. TRISS methodology in trauma: the need for alternatives. *Br J Surg*. 1998; **85**:379-384.

Jurkovich GJ, Mock, C. Systematic review of trauma system effectiveness based on registry comparisons. *J Trauma*. 1999; **47**:S46-S55.

Pollock DA. Summary of the discussion: trauma registry data and TRISS evidence. *J Trauma*. 1999; **47**:S56-S58.

## STATISTICAL MODELS FOR EVALUATING TRAUMA CARE

## MORTALITY OUTCOME ANALYSIS

There were a total of 304 deaths following trauma for the patients admitted to hospitals in South Western Sydney Area Health Service in the five year period. These include 81 deaths of elderly patients with a fractured neck of femur as their only injury. International studies do not include isolated fracture of neck of femur in their trauma mortality outcome analysis. We do not normally include this group of patients in the Major Trauma category except when they die during their hospitalisation for this injury. The following tables represent mortality outcome analysis using TRISS methodology. The number of patients with TRISS available, the deaths, predicted deaths (using TRISS), the Z scores, Standardised Mortality Rate and W scores are shown separately for SWSAHS and Liverpool Hospital. A negative Z score is desirable as it reflects less patients died than predicted by TRISS. A positive W score score is desirable as it reflects more patients survived than predicted by TRISS.

**Liverpool Hospital: All Patients with TRISS**

| Year | N with TRISS | Death | PDeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 641 | 36 | 35.59 | 0.10 | 1.01 | - |
| 1996 | 726 | 53 | 51.22 | 0.37 | 1.03 | - |
| 1997 | 724 | 41 | 50.82 | -2.18 | 0.81 | 1.36 |
| 1998 | 797 | 38 | 48.08 | -2.26 | 0.79 | 1.26 |
| 1999 | 799 | 30 | 48.30 | -4.15 | 0.62 | 2.29 |
| Total | 3687 | 198 | 234.01 | -3.64 | 0.85 | 0.98 |

**Liverpool Hospital: Excluding Elderly Fractured Neck of Femur Deaths**

| Year | N with TRISS | Death | Pdeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 637 | 32 | 35.49 | -0.88 | 0.90 | - |
| 1996 | 722 | 49 | 51.11 | -0.44 | 0.96 | - |
| 1997 | 720 | 37 | 50.72 | -3.05 | 0.73 | 1.91 |
| 1998 | 797 | 38 | 48.08 | -2.26 | 0.79 | 1.26 |
| 1999 | 797 | 28 | 48.25 | -4.60 | 0.58 | 2.54 |
| Total | 2673 | 184 | 233.65 | -5.02 | 0.79 | 1.35 |

**SWSAHS All Hospitals: All Patients with TRISS**

| Year | N with TRISS | Death | Pdeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 939 | 46 | 43.84 | 0.47 | 1.05 | - |
| 1996 | 1016 | 62 | 60.79 | 0.23 | 1.02 | - |
| 1997 | 1216 | 47 | 63.17 | -2.97 | 0.74 | 1.33 |
| 1998 | 1358 | 56 | 60.18 | -0.76 | 0.93 | - |
| 1999 | 1353 | 55 | 62.07 | -1.34 | 0.89 | 0.52 |
| Total | 5882 | 266 | 290.1 | -2.06 | 0.92 | 0.41 |

**SWSAHS All Hospitals: Excluding Elderly Fractured Neck of Femur Deaths**

| Year | N with TRISS | Death | Pdeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 929 | 36 | 43.59 | -1.65 | 0.83 | - |
| 1996 | 1007 | 53 | 60.55 | -1.44 | 0.88 | - |
| 1997 | 1212 | 43 | 63.07 | -3.69 | 0.68 | 1.66 |
| 1998 | 1348 | 46 | 59.92 | -2.56 | 0.77 | 1.03 |
| 1999 | 1336 | 38 | 61.63 | -4.5 | 0.62 | 1.77 |
| Total | 5832 | 216 | 288.75 | -6.25 | 0.75 | 1.25 |

## STATISTICAL MODELS FOR EVALUATING TRAUMA CARE
## MORTALITY OUTCOME ANALYSIS

**SWSAHS Urban and Rural Hospitals**

| Year | N with TRISS | Death | Pdeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 298 | 10 | 8.25 | 0.72 | 1.21 | - |
| 1996 | 290 | 9 | 9.57 | -0.26 | 0.94 | - |
| 1997 | 492 | 6 | 12.35 | -2.08 | 0.49 | 1.29 |
| 1998 | 561 | 18 | 12.10 | 1.86 | 1.49 | - |
| 1999 | 554 | 25 | 13.77 | 3.82 | 1.82 | -2.03 |
| Total | 2195 | 68 | 56.05 | 1.92 | 1.21 | - |

**Urban and Rural: Excluding Elderly Fractured Neck of Femur Deaths**

| Year | N with TRISS | Death | Pdeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 292 | 4 | 8.10 | -1.72 | 0.49 | - |
| 1996 | 285 | 4 | 9.43 | -2.49 | 0.42 | 1.91 |
| 1997 | 492 | 6 | 12.35 | -2.08 | 0.49 | 1.29 |
| 1998 | 551 | 8 | 11.84 | -1.23 | 0.68 | - |
| 1999 | 539 | 10 | 13.38 | -1.17 | 0.75 | - |
| Total | 2159 | 32 | 55.1 | -3.76 | 0.58 | 1.07 |

In 1999 10 patients died following trauma at an urban or rural hospital in SWSAHS. A closer examination reveals that of these 10 patients, four were ambulance triage category 7 (dying) and three of these died in the emergency department. Of the remaining six (all were aged between 73 – 102 years) five had relatively minor injuries but had coexisting morbidities or developed complications.

| Age | Description | ISS | TRISS |
|---|---|---|---|
| 1 | Pedestrian hit by car – Severe head injury Category 7 (Dying) Died in ED | 25 | 0.035 |
| 2 | Pedestrian hit by car –Severe spinal, head and chest injuries Category 7 (Dying) Died in ED | 35 | 0.397 |
| 25 | Hanging - Category 7 (Dying) Died in ED | 25 | 0.0348 |
| 36 | Stabbing –Transect Femoral vessels; massive blood loss Direct to operating theatre - coagulopathy Category 7 (Dying) | 18 | 0.03 |
| 73 | Fall – Fractured pelvis – Myocardial infarct and cardiac arrest | 5 | 0.981 |
| 83 | Fall – Intracranial bleed and sub dural haematoma | 26 | 0.906 |
| 88 | Fall 5 days prior - # Clavicle – Developed pneumonia, Renal failure | 13 | 0.965 |
| 102 | Fall – fractured pelvis – developed CCF, aspiration pneumonia, Rnal failure | 4 | 0.983 |
| 87 | Fall 4 days prior – Subdural haematoma (also Ca. Widespread metastases) | 16 | 0.956 |
| 81 | Fall – Fractured ribs – developed smalll bowel obstruction | 4 | 0.983 |

## STATISTICAL MODELS FOR EVALUATING TRAUMA CARE

## MORTALITY OUTCOME ANALYSIS – MTOS CRITERIA

Patients admitted to Liverpool Hospital meeting Major Trauma Outcome Study (MTOS) inclusion criteria. Inclusion criteria any of the following:

- All trauma deaths including dead on arrival
- All patients admitted for 72 hours or more due to injury
- All inter-hospital transfers for treatment of acute injury
- All injured patients treated in intensive care (patient: nurse ratio 2:1 or greater)

**MTOS: All Patients with TRISS Meeting MTOS Criteria**

| Year | N with TRISS | Death | PDeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 577 | 36 | 32.7 | 0.87 | 1.1 | - |
| 1996 | 656 | 53 | 47.5 | 1.21 | 1.12 | - |
| 1997 | 639 | 41 | 48.5 | -1.73 | 0.85 | - |
| 1998 | 716 | 38 | 47 | -2.07 | 0.81 | 1.25 |
| 1999 | 731 | 30 | 47.2 | -3.97 | 0.64 | 2.35 |
| Total | 3319 | 198 | 223 | -2.61 | 0.89 | 0.75 |

**MTOS: Excluding Elderly Fractured Neck of Femur Deaths**

| Year | N with TRISS | Death | PDeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 573 | 32 | 32.6 | -0.17 | 0.98 | - |
| 1996 | 652 | 49 | 47.4 | 0.35 | 1.03 | - |
| 1997 | 635 | 37 | 48.4 | -2.64 | 0.77 | 1.79 |
| 1998 | 716 | 38 | 47 | -2.07 | 0.81 | 1.25 |
| 1999 | 729 | 28 | 47.1 | -4.43 | 0.59 | 2.63 |
| Total | 3305 | 184 | 222 | -4.05 | 0.83 | 1.16 |

### ANOTHER MORTALITY OUTCOME ANALYSIS MTOS and ISS ≥ 12

Another analysis is provided here for patients admitted to Liverpool Hospital meeting Major Trauma Outcome Study (MTOS) inclusion criteria and not meeting MTOS criteria but with an ISS ≥12. This demonstrates the power of the statistical analysis with slightly different subsets.

**MTOS or ISS≥12: All Patients with TRISS Meeting MTOS Criteria or ISS ≥12**

| Year | N with TRISS | Death | PDeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 596 | 36 | 35.08 | 0.24 | 1.03 | - |
| 1996 | 678 | 53 | 50.61 | 0.51 | 1.05 | - |
| 1997 | 653 | 41 | 50.13 | -2.06 | 0.82 | 1.4 |
| 1998 | 731 | 38 | 47.55 | -2.17 | 0.80 | 1.31 |
| 1999 | 743 | 30 | 48.02 | -4.12 | 0.62 | 2.43 |
| Total | 3401 | 198 | 231.38 | -3.42 | 0.86 | 0.98 |

**MTOS or ISS≥12: Excluding Elderly Fractured Neck of Femur Deaths**

| Year | N with TRISS | Death | PDeath | Z | SMR | W |
|---|---|---|---|---|---|---|
| 1995 | 592 | 32 | 34.97 | -0.77 | 0.92 | - |
| 1996 | 674 | 49 | 50.50 | -0.32 | 0.97 | - |
| 1997 | 649 | 37 | 50.03 | -2.95 | 0.74 | 2.01 |
| 1998 | 731 | 38 | 47.55 | -2.17 | 0.80 | 1.31 |
| 1999 | 741 | 28 | 47.97 | -4.57 | 0.58 | 2.7 |
| Total | 3387 | 184 | 231.03 | -4.82 | 0.80 | 1.39 |

## Outcome Measure Stratified for Age and Injury Severity
### Liverpool Hospital 1995 – 1999

### Blunt Injuries

| Age 0 – 64 years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 2111 | 4 | 20 | -3.65 | 0.2 | 9.8∀12 (1-213) | 7.5∀3.3 (1-14) | 30∀15.4 (0-64) |
| 16-24 | 353 | 4 | 13.6 | -2.98 | 0.29 | 14∀16 (1-129) | 18.5∀2.4 (16-24) | 31.4∀14.5 (1-64) |
| 25-49 | 268 | 45 | 48.3 | -0.70 | 0.93 | 16.8∀23.7 (1-213) | 30.2∀5.7 (25-45) | 30.2∀15.4 (0-64) |
| 50-74 | 24 | 18 | 18 | -0.01 | 1 | 7.5∀13.8 (1-64) | 58.2∀6.5 (50-66) | 27.5∀13.1 (1-56) |
| 75 | 10 | 6 | 10 | | 0.6 | 10.1+19.6 (1-60) | 75 | 32.6∀16.7 (8-59) |
| All | 2766 | 77 | 109.9 | -4.48 | 0.7 | 11∀14.4 (1-213) | 11.8∀9.9 (1-75) | 30∀15 (0-64) |
| **Age 65 years and older** | | | | | | | | |
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 345 | 23 | 9.8 | 4.40 | 2.35 | 15.2∀15.5 | 7.1∀3.3 | 76∀7.6 |
| 16-24 | 68 | 7 | 5.5 | 0.77 | 1.28 | 22.4∀20.1 (1-106) | 18∀2.5 (16-24) | 74.3∀6.8 (65-92) |
| 25-49 | 65 | 24 | 16.7 | 2.47 | 1.43 | 19.9+21.4 (1-104) | 29.2∀6 (25-48) | 76.9∀6.8 (66-91) |
| 50-74 | 5 | 5 | 4.6 | 0.69 | 1.08 | 1 | 55.8∀6.8 (50-66) | 76.8∀6.8 (66-91) |
| 75 | 1 | 1 | 0 | * | * | 1 | 75 | 67 |
| All | 477 | 60 | 37.6 | 4.76 | 1.59 | 16.6∀17.2 | 12.2∀10.2 | |

### Penetrating Injuries

| Age 0 – 64 years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 260 | 0 | 3.128 | -1.85 | 0 | 6.8∀6.6 (1-66) | 3.7∀3.8 (1-14) | 29.5∀10.8 (12-64) |
| 16-24 | 24 | 2 | 2.26 | -0.42 | 0.9 | 15.9∀17.5 (1-77) | 17.4∀1.5 (16-21) | 31.2∀11.6 (17-52) |
| 25-49 | 30 | 5 | 4.726 | 0.18 | 1.06 | 13.3∀12.9 (1-60) | 27.5∀3.1 (25-35) | 30.7∀12.2 (15-62) |
| 50-74 | 0 | 0 | * | | | | | |
| 75 | 4 | 4 | 4 | | 1 | 1 | 75 | 32.3∀15.9 (16-53) |
| All | 318 | 11 | 14 | -1.22 | 0.78 | | | |
| **Age 65 years and older** | | | | | | | | |
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 7 | 0 | 0.141 | -0.38 | 0 | 8.3∀6.4 (1-20) | 806∀3.5 (4-14) | |
| 16-24 | 2 | 0 | 0.068 | -0.26 | 0 | | | |
| 25-49 | 1 | 1 | 0.136 | 2.52 | 7.337 | | | |
| 50-74 | 0 | | | | | | | |
| 75 | 0 | | | | | | | |
| All | 10 | 1 | 0.35 | 1.15 | 2.89 | 10.5∀11.2 (1.38) | 12.8∀8.7 (4-34) | 72.1∀5.8 (65-79) |

## Outcome Measure Stratified for Age and Injury Severity
### Liverpool Hospital 1995 – 1999
### Road Trauma

| Age 0 – 64 years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 1115 | 2 | 10.52 | -2.69 | 0.19 | 10.5∀12.9 (1-132) | 7.8∀3.4 (1-14) | 29.2∀14.8 (0-64) |
| 16-24 | 199 | 3 | 8.11 | -2.08 | 0.37 | 17.2∀19.4 (1-129) | 19∀2.4 (16-24) | 28.9∀13.3 (2-63) |
| 25-49 | 156 | 29 | 30.7 | -0.46 | 0.94 | 21∀27 (1-213) | 31.7∀5.9 (25-45) | 29∀14 (1-63) |
| 50-74 | 21 | 15 | 15.2 | -0.12 | 0.99 | 8.4∀14.7 (1-64) | 58∀6.7 (50-66) | 24.7∀11.1 (1-53) |
| 75 | 7 | 4 | 7 | * | 0.57 | 14∀22.7 (1-60) | 75 | 33∀18.7 (8-59) |
| All | 1498 | 53 | 71.5 | -3.27 | 0.74 | 12.4∀16.4 (1-213) | 12.8∀11 (1-75) | 29.1∀14.5 (0-64) |
| **Age 65 years and older** | | | | | | | | |
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 113 | 2 | 3 | -0.63 | 0.65 | 16.3∀15.2 (2-116) | 7.9∀ (1-14) | 73.7∀6.3 (65-98) |
| 16-24 | 28 | 3 | 1.9 | 0.75 | 1.51 | 32.3∀24.1 (5-106) | 19.1∀2.6 (16-24) | 72.2∀5.6 65-82) |
| 25-49 | 26 | 10 | 7.8 | 1.13 | 1.29 | 25.7∀24.8 (1-104) | 33∀6.6 (25-48) | 75∀4.6 (65-82) |
| 50-74 | 5 | 5 | 4.6 | 0.69 | 1.08 | 1∀0 | 55.8∀6.8 (50-66) | 72∀3 (65-77) |
| 75 | 1 | 1 | 1 | | 1 | 1 | 75 | 67 |
| All | 175 | 21 | 14.8 | 1.61 | 1.42 | 19.9∀19.6 (1-116) | 15.4∀13.2 (1-75) | 73.6∀5.9 (65-98) |

### Falls Trauma

| Age 0 – 64 years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 242 | 1 | 2.61 | -1.0 | 0.38 | 10.6∀11.8 (1-83) | 6.7∀3.1 (1-14) | 64∀19 (0-64) |
| 16-24 | 48 | 1 | 2.59 | -1.14 | 0.39 | 9.2∀9.4 (1-48) | 17.5∀2.4 (16-24) | 41.6∀19 (3-64) |
| 25-49 | 21 | 3 | 4.05 | -0.75 | 0.74 | 9.9∀8.8 (1-31) | 27.3∀3.9 (25-38) | 43.2∀19 (0-61) |
| 50-75 | 0 | | | | | | | |
| All | 311 | 5 | 9.26 | -1.67 | 0.54 | 10.3∀11.3 (1-83) | 9.7∀6.8 (1-38) | 38.5∀ 19 (0-64) |
| **Age 65 years and older** | | | | | | | | |
| **ISS** | **n** | **Deaths** | **Pd** | **Z** | **SMR** | **LOS** | **ISS** | **Age** |
| 1-15 | 199 | 20 | 5.39 | 6.53 | 3.7 | 14.1∀15.3 (1-116) | 6.7∀3 (1-14) | 78.4∀7.8 (65-99) |
| 16-24 | 24 | 4 | 2.92 | 0.81 | 1.36 | 13.4∀9 (1-36) | 17.5∀2 (16-24) | 78.2∀6.7 (69-92) |
| 25-49 | 29 | 12 | 6.79 | 2.86 | 1.76 | 17.2∀19.6 (1-90) | 26∀2.4 (25-34) | 80∀7.6 (66-91) |
| 50-75 | 0 | | | | | | | |
| All | 252 | 36 | 15.12 | 6.58 | 2.38 | 14.4∀15.4 1-116 | 10∀7.2 1-34 | 78.6∀7.7 (65-99) |

## Deaths at Urban and Rural Hospitals

Of the 304 deaths in SWSAHS over the five-year period, 77 occurred in urban and rural hospitals.

**Urban Hospitals**
These include Bankstown, Campbelltown, Fairfield and Camden Hospitals

- 11 were taken to the nearest urban hospital because they were dying and would not have survived the journey to Liverpool Hospital.
- 15 patients were taken to an urban hospital with transport decision code of minor injury. Of these, 13 were elderly patients who sustained injuries following falls.
- 4 presented to the hospital by private transport.
- 39 of these were in elderly patients following Fractured Neck of Femur.

**Rural Hospital (Bowral)**
- 8 were admitted to Bowral Hospital, which is not subject to ambulance bypass criteria.

**Mode of Transport and Transport Decision Code for Deaths at Urban and Rural Hospitals**

| Transport Decision | Fairfield | Campbelltown | Bankstown | Bowral | Total |
|---|---|---|---|---|---|
| Code 1-Minor | 1 | 2 | 12 | - | 15 |
| Code 7-Dying | 4 | 3 | 4 | - | 11 |
| Elderly NOF | 9 | 8 | 22 | 3 | 42 |
| Rural | - | - | - | 5 | 2 |
| Private transport | 3 | - | 1 | - | 4 |
| Total | 17 | 13 | 39 | 8 | 77 |