Helsinki Trauma Outcome Study 2005: Audit on Outcome in Trauma Management in Adult Patients in Southern Part of Finland

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Abstract
The outcome performance of the adult patients trauma care in Helsinki University Hospital was compared with a sample of English hospitals. This was a first time such an audit on trauma care was conducted in Finland. Helsinki University Hospital submitted the Trauma Audit and Research Network (TARN, UK) data of adult trauma patients during 1 year period (from 1 September 2004 to 31 August 2005). Patients younger than 16 years were excluded. The outcome performance was assessed by TARN prediction model using the TARN database as reference. There were total of 1,717 patients in Helsinki and 16,774 patients in English hospitals fulfilling the study inclusion criteria, and 1,635 (95.2% of total) eligible patients in Helsinki and 15,269 (91.0% of total) in England were used for analysis. The patients were older and the mean ISS was higher in Helsinki (mean ISS in Helsinki 14 vs. 11 in England). The standardized W statistic (a measure of survival variation from the expected mean, per 100 patients) was + 3.0 (confidence intervals + 2.3 to + 3.8) for Helsinki University Hospital and + 0.2 (confidence intervals –0.1 to 0.4) for English hospitals. These results suggest that the organization of trauma care in Helsinki University Hospital area is more effective in preventing death after trauma in adults than that covering the present sample of English hospitals.

Key Words
Trauma system · Outcome · Finland · TARN

Eur J Trauma Emerg Surg 2008
DOI 10.1007/s00068-007-7129-y

Introduction
Trauma is the leading cause of death in the population under 40 years of age [1]. Finland is a relative small country with 5.3 million inhabitants. There were 4,125 trauma related deaths in Finland 2003, and trauma was the third commonest cause of death in the whole population [2]. The public health care system is hierarchical and based on large number of community hospitals and other local hospitals, and about 21 central hospitals of which 5 are university hospitals with the largest responsibilities.

There are no strict national guidelines for intra-hospital trauma care in Finland, and with the lack of a formal trauma system or trauma registries in Finnish hospitals, the results cannot be appropriately evaluated. Even the incidence of severely injured patients in Finland is not exactly known, but in the western part of Norway it (injury severity score, ISS more than 15) was found to be 30/100,000 [3]. In view of the similarities of economical and social infrastructure, the Scandinavian countries may well be compared to each other. In regard to that, the incidence in Norway is slightly higher...
than the annual estimate of 20–25/100,000 found in Finland in 2004 [4].

Although injury prevention has been successful in reducing the incidence of trauma in many areas and countries, the management of trauma patients is still a considerable challenge to the medical services. Several reports have documented a reduction in overall mortality, preventable death and morbidity after the installation of a regionalized and well-organized trauma system [5–8]. Thus, the effect between injury prevention and clinical injury services to overall death rates has to be distinguished. To achieve this, there has to be adequate measures for clinical trauma care in pre-hospital and hospital settings. Establishment of audit methodology for trauma care has demonstrated improvements in outcome after trauma in many countries [7, 9, 10]. Analysis from the trauma audit research network (TARN) [11], which receives data from over 50% of trauma-receiving hospitals in England and Wales, has shown a gradual decline in the severity adjusted risk of death after trauma since 1989 [9]. The audit of a trauma receiving hospitals ability to meet standards and adequate outcomes of care is mandatory in improving the quality, in further development of those standards and in evaluating the effects of changes made in services for the injured patients. The performance data of a hospital should be systematically analyzed and compared with that of other hospitals or a recognized standard. However, until now there have been no studies on assessing or auditing the outcome of trauma patients in Finland.

Since there is no nation-wide Finnish or European trauma registry, the reference database for the present study is from the TARN. The TARN is an independent professional group with expertise in quality assurance and analysis, and it was established in 1989 to provide comparative anonymous data on the process of trauma care in England, Wales and Northern Ireland. About 50% of trauma-receiving hospitals in England and Wales submit data to the network [11]. The present study was conducted as a first step to assess the current situation in the area of the largest trauma center, Helsinki University Hospital, in Finland.

Materials and Methods
Study Populations
Helsinki is the capital of Finland with about 600,000 people. Helsinki University Hospital provides acute trauma care for Helsinki and its surroundings, resulting in a catchments area of about 1.5 million people (25% of the Finnish population). Helsinki University Hos-


dental has three individual emergency care providing units. Two of them, Töölö Hospital and Meilahti Hospital, provide the acute care for all major traumas excluding patients younger than 16 years not having a possible brain injury. That would obviously result in low and biased number of adolescent patients in Töölö and Meilahti, thus patients less than 16 years were excluded from this study.

There is ambulance doctor service in the city of Helsinki and a helicopter doctor service in surrounding cities, and the doctors working in pre-hospital assets are specialized in emergency care. The coverage of pre-hospital emergency care doctor is good in Helsinki University Hospital region, only seldom is the major trauma patient taken into hospital without an accompanying doctor. The emergency facilities with surgical capacity, radiological and intervention-radiological (angio-embolization) services, and number of intensive care beds are appropriate in both Töölö and Meilahti hospitals. Töölö hospital admits normally all the orthopedic trauma, blunt trauma and neuro trauma; the majority of trauma patients in Helsinki University Hospitals. Meilahti Hospital admits mostly patients with penetrating torso injuries and isolated blunt thoracic and abdominal organ injuries.

A sample of 92 English hospitals’ TARN outcomes was compared to that of Helsinki University Hospitals. Seventy-seven of these hospitals are essentially level 2 trauma centers and 15 hospitals in addition to level 2 facilities have specialist neurosurgery on site, only 2 hospitals within this sample fulfill level 1 criteria. Trauma patients in England are brought to the nearest level 2 center with secondary transfers subsequently occurring for specialist care (mainly neurotrauma).

The statistical calculations were performed with the Statistical Package for the Social Sciences (SPSS) using the Chi-square test in comparing percentages and t test in comparing ages. When the differences of means are compared between the groups, they are presented with 95% confidence intervals (CI). Intervals excluding 0 and p values < 0.05 were considered statistically significant.

Inclusion Criteria and Comparative Analyses
Identification of included patients and patient data collection in Helsinki was performed by specially trained physician and two nurses. The inclusion criteria were the ones of TARN, UK. Patients transferred to another hospital for further rehabilitation care but whose final outcome (e.g., discharge status
Table 1. Criterion for patients qualifying for the database.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Details</th>
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<tbody>
<tr>
<td>All trauma patients irrespective of age who met any of the following</td>
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<td>criteria:</td>
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<tr>
<td>all trauma admissions whose length of stay was 72 h or more</td>
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<td>all trauma patients admitted to an intensive care or high dependency</td>
<td></td>
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<tr>
<td>area</td>
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<tr>
<td>all deaths of injured patients occurring in the hospital (even if the</td>
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<tr>
<td>cause was medical)</td>
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<tr>
<td>all trauma patients transferred to another hospital for further</td>
<td></td>
</tr>
<tr>
<td>emergency care or admitted to a high dependency area or died from</td>
<td></td>
</tr>
<tr>
<td>injuries</td>
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<tr>
<td>Irrespective of the above, following patients were not included:</td>
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<tr>
<td>isolated fractures of the femoral neck or single pubic rami fractures</td>
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<td>aged 65 years or more</td>
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<td>isolated closed, undisplaced or not comminuted limb injuries</td>
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<tr>
<td>soft tissue spinal strains</td>
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<tr>
<td>closed or undisplaced facial injuries</td>
<td></td>
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<tr>
<td>simple penetrating injuries not involving deeper structures or less</td>
<td></td>
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<tr>
<td>than 20% blood loss</td>
<td></td>
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<tr>
<td>uncomplicated skin injuries</td>
<td></td>
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<tr>
<td>less than 10% superficial or partial thickness burns</td>
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alive or dead) was known, were excluded from the study. Patients qualifying for the study included all admitted trauma patients who met any of the criteria presented in Table 1. Submitted data included patient demographics, assessments of physiologic status both at the injury scene and on arrival at hospital, definitive injury diagnoses, type of injury (blunt versus penetrating), cause of injury and patient outcome (i.e. survival or death at discharge). Additional data regarding the transfer was submitted if the patient was referred to another hospital. When necessary, hospitals were asked to clarify or supplement inaccurate or missing data.

Data forms were sent to TARN, Manchester, UK, where anatomic injury descriptions were coded for severity according to the abbreviated injury scale (AIS) 98 update of 1990 revision [12]. Coding was performed by uniformly trained persons to minimize inter coder variation and errors. The squares of the three highest AIS scores in predetermined regions of the body were added together in assessing ISS [13]. In patients who were intubated on admission to hospital, Glasgow coma scale (GCS) was scored based on values documented immediately before intubation (pre-hospital or referring hospital patient charts) to obtain sufficient inclusion of severely injured patients. If even this information was lacking, the missing GCS was substituted with the median value for that element from the ISS category the patient belonged to (derived data) [9].

The probability of survival (Ps) was estimated with the TARN prediction model [14], which is based on a transformation of the ISS, the GCS, age, gender and age by gender interaction. Ps is a mathematical calculation and not an absolute measure of mortality. Thus, Ps is not applicable as such for an individual patient but can be used in a group of patients when compared to their actual survival. The relationship between the Ps and the actual survival is characterized by “Ws” (standardized W) statistic, in which the W statistic (the difference between observed and predicted survival rates per 100 patients) is standardized with respect to injury severities which enables the comparisons despite case mix variation [15]. A Ws of +3 indicates that out of 100 patients in a study population, three more survived than would have been expected from calculations based on the reference data. Conversely, a negative Ws indicates a higher mortality than expected.

Results

Study Database

Helsinki University Hospital submitted data to TARN from 1 September 2004 to 31 August 2005. In that 12-month period, a total of 1,717 patients aged over 16 years were recorded as having fulfilled the study entry criteria at Helsinki University Hospital, and 16,774 were recorded at the hospitals in England. In Helsinki, 82 (4.7%) and in England 1,505 (9.0%) patients were excluded due to transfer to another hospital with unknown discharge status, so that the analyses were only conducted on the remaining eligible cases in each sample (1,635 in Helsinki and 15,269 in England). Out of 1,635 eligible cases in Helsinki, 106 (6.5%) were from Meilahti Hospital and the rest 1,529 (93.5%) from Töölö Hospital. If physiological data was missing (GCS) and it was not imputed by standardized method [9], 6.2 and 14.9% of patients would be excluded from analyses in Helsinki and England, respectively. The characteristic database figures are presented in Table 2.

Study Patient Characteristics

Of the included eligible patients, significantly larger proportion were referred from another hospital in Helsinki than in England; 440 (26.9%) in Helsinki and 1,198 (7.8%) in England (p < 0.0001). Patient characteristics are presented in Table 3. After excluding patients less than 16 years, the age range in this study population was from 16 to 98 in Helsinki (mean 54 years) and 16 to 110 in England (mean 49). The patients were significantly older in Helsinki than in
England (p < 0.0001). The proportion of male patients was 62.2% in Helsinki and 58.6% in England, also this difference being statistically significant (p < 0.005). The mean ISS was 14 in Helsinki (median 9, range 1–75) and 11 in England (median 9, range 1–75). The 25th percentile of ISS range was 9 in both groups, but 75th percentile 17 in Helsinki and 10 in England. The proportion of ISS > 15 and ISS > 22 was significantly higher in Helsinki, 33.4 versus 16.6% (p < 0.0001) and 18.5 versus 8.7% (p < 0.0001), respectively.

Causes of Injury
The causes and types of injury are presented in Table 4. Type of injury was blunt in 95.7 and 97.1% of the cases in Helsinki and England, respectively. The slightly higher proportion of penetrating injuries in Helsinki (4.3 vs. 2.9%) was statistically significant (p < 0.05). In both groups, stabbing was more common compared to gun shot wounds (2.9 vs. 1.0% in Helsinki and 2.4 vs. 0.4% in English hospitals). The two most common causes of injury in both groups were falling from less than 2 m high (Helsinki 52.4%, England 43.5%) and road traffic crash (RTC; Helsinki 18.0%, England 27.4%). Falling from more than 2 m was the fourth commonest cause of injury in both groups (7.5% in Helsinki and 11.7% in England) after miscellaneous blunt injuries (18.0% in Helsinki and 14.8% in England). However, the proportion of total injuries caused by RTC and falls > 2 m were significantly increased in the English sample (27.4 vs. 18.1%, 11.7 vs. 7.5%, p < 0.005).

Outcome Performance using Standardized W (Ws) Statistics
The survival rate was 95.5% in Helsinki and 94.5% in England. Both survived and non-survived patients tended to stay longer in hospital in England (survived mean 13, range 1–97, non-survived mean 10, range 1–93) than in Helsinki (survived mean 10, range 1–93, non-survived mean 4, range 1–37). After excluding patients with unknown discharge status, 1,635 patients in Helsinki (95.2% of the total) and 15,269 patients in England (91.0% of the total) were used to assess Ws statistics. The Ws for all patients treated in Helsinki was +3.0 (95% CI +2.3 to +3.8) compared to +0.2 (95% CI 0.0 to +0.6) for the English hospitals, indicating almost three more survived trauma patients out of 100 patients in a study population in Helsinki compared to England. Due to the significantly larger proportion of the referred patients in Helsinki, the Ws statistics was also calculated after the referred patients were excluded, being +2.8 (CI +2.0 to +3.7) in Helsinki and +0.1 (CI −0.2 to +0.4). If only cases with no missing data were examined the results for Ws were similar, +3.0 (95% CI +2.3 to +3.7) and +0.3 (95% CI 0.0 to +0.6) for Helsinki and England, respectively.
In the present study, lacking GCS on hospital admission was scored based on pre-hospital values documented immediately before intubation or, if even this value was missing, it was substituted with the derived value from the ISS category the patient belonged to. That may give some bias if such a study population is compared to reference database not including patients with missing values scored by same manner. However, we argue that the practice used in the present study is not biasing the performance results but making them more reliable and more comparable, since in Helsinki 6.2% and in England 14.9% of the patients would be excluded from analyses.

**Differences between Trauma Systems in Helsinki and England**

Helsinki University Hospital has three separate emergency care providing units. The two largest of them, Töölö Hospital and Meilahti Hospital, provide the acute trauma care normally only for patients older than 16 years. That would have resulted in biased study population regarding patient ages, thus the adolescent patients were excluded from the present study. Meilahti Hospital provides care for patients with penetrating torso injuries and isolated blunt thoracic and abdominal organ injuries, whereas Töölö Hospital admits the majority of patients with blunt trauma, and all patients with orthopedic, head and maxillofacial injuries, comprising 94% of all recorded cases in Helsinki.

The pre-hospital system including the ambulance and helicopter services, the personnel and the overall level of pre-hospital care is an important factor as a whole affecting the performance of the complete trauma system. However, a detailed examination of the pre-hospital care of the trauma patient is difficult to undertake because of the many variables involved. In the present study, no data capture on pre-hospital issues other than type and cause of injury was performed. It is thus impossible to draw any conclusions on the effect of the differences in pre-hospital systems, but it has to be stated that the differences in overall performance is due to the differences between the complete trauma systems.

The possible additional effect of hospitals size can either be excluded when interpreting the results of the present study. In the light of the annual number of trauma patients, Töölö Hospital is one of the largest trauma care providing units in the Nordic countries. In addition to experienced and continuously trained emergency department staff and trauma surgeons, the imaging and interventional radiological facilities linked with intensive care unit dedicated only to trauma patients, may also be linked with observed differences in

**Table 4. Causes and Types of Injury.**

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Helsinki</th>
<th>Engalnd</th>
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<tbody>
<tr>
<td>Blunt</td>
<td>95.7%</td>
<td>97.1%</td>
</tr>
<tr>
<td>Penetrating</td>
<td>4.3%*</td>
<td>2.9%</td>
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<table>
<thead>
<tr>
<th>Cause of injury</th>
<th>Helsinki</th>
<th>England</th>
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<tbody>
<tr>
<td>n (%) 95% CI</td>
<td>n (%) 95% CI</td>
<td></td>
</tr>
<tr>
<td>Fall &lt; 2 m</td>
<td>857 (52.4) 50–54.8</td>
<td>6,607 (43.3) 42.5–44.1</td>
</tr>
<tr>
<td>Traffic accident</td>
<td>295 (18.1) 16.2–20</td>
<td>4,186 (27.4) 26.7–28.1</td>
</tr>
<tr>
<td>Other blunt injury</td>
<td>296 (18.1) 16.2–20</td>
<td>2,256 (14.8) 14.2–15.4</td>
</tr>
<tr>
<td>Fall &gt; 2 m</td>
<td>123 (7.5) 6.2–8.8</td>
<td>1,787 (11.7) 11.2–12.2</td>
</tr>
<tr>
<td>Stab Injury</td>
<td>48 (2.9) 2.1–3.7</td>
<td>371 (2.4) 2.2–2.6</td>
</tr>
<tr>
<td>Gun shot injury</td>
<td>16 (1.0) 0.5–1.5</td>
<td>64 (0.4) 0.3–0.5</td>
</tr>
</tbody>
</table>

* \( \chi^2 = 7.06, p < 0.05 \)

**Discussion**

When all eligible patients in these two datasets were compared using the TARN prediction model, the case mix-adjusted survival in the Helsinki population was found to be greater than would have been expected and significantly better than in English centers (Ws + 3.0 vs. + 0.2). The result indicates three more survived trauma patients out of 100 patients in Helsinki compared to England. This may seem like a small difference, however, when one considers that the crude mortality of the present sample was 4.5% then this represents a relative improvement of 62% in terms of case mix adjusted fatality. However, the results of the present study are not reflecting only the differences between the hospitals but between the complete trauma systems. It is also important to recognize that although the only studied outcome in the present study was mortality, is there a significant impact of injury also on the other aspects of health including functional and emotional outcome. However, such analyses cannot be conducted with methods used in the present study.

**Including Patients with Lacking GCS**

The TARN prediction model-methodology for Ps calculation demands GCS scores on hospital admission. In practice, that will often lead to unacceptable high data loss due to missing parameters mainly in severely injured patient with physiologic compromise, such as deep unconsciousness or inappropriate breathing, who are intubated before hospital admission [5, 16]. However, these patients have normally high mortality rate up to 25% emphasizing them as an important subgroup that should be included in performance evaluation [16].
the outcome between Helsinki and England. Head injuries are an important cause of death; our previous research indicated the importance of specialist care for those with severe head injury [17]. Due to the system in Helsinki all severe head injury patients would have received specialist care whereas this is not the case currently in England [17].

Differences between Study Populations in Helsinki and England

The proportion of referred patients was significantly higher in Helsinki due to the role of Helsinki University Hospital as a tertiary referral hospital with highest responsibilities, which is not a case with all the hospitals submitting the English cases. The higher proportion of more severely injured patients in Helsinki, both patients with ISS > 15 and ISS > 22, is also most likely related to higher proportion of referred patients being more often more severely injured and needing further trauma care in tertiary hospital. On the other hand, although referred patients possibly having more severe injuries (higher ISS) than patients taken directly from the scene, the referred patients may sometimes have better physiologic parameters (GCS) on admission due to the resuscitative maneuvers conducted in referring hospital. However, regardless the higher proportion of referred patients and more severe injuries (higher ISS), the Ws outcome performance was statistically better in Helsinki. After all, exclusion of the referred patients had very little effect on the Ws performance in both groups, indicating that the outcome of the referred patients did not differ much from non-referred.

The most common cause of injury both in Helsinki and in England was fall from less than 2 m. Those patients are usually older individuals with pre-existing diseases possibly affecting the survival and thus influencing the outcome. However, pre-existing diseases were not recorded in the present study, since the known major difficulties in assessing their severity consistently in a large group of patients. More over, the TARN prediction model-methodology does not correct for pre-existing disease. Thus, the non-recorded data on possible pre-existing diseases did not have an effect on calculating Ps and Ws. Age, as an individual factor itself, has an effect especially on the outcome of older trauma patients. Although the patients in the present study were statistically significantly older in Helsinki than in English hospitals, was the mean age still below 55 years in Helsinki thus probably not having clinically significant effect on the results. However, if there was such an effect caused by a higher age, it would be in favor for the results in Helsinki.

The proportion of penetrating trauma was low in both Helsinki and English hospitals if compared to US [5]. However, in the present study it was found to be statistically higher in Helsinki than in England. That may indicate the incidence of penetrating trauma being truly higher in Helsinki, or it may be biased by some reason. One such biasing reason might be the higher proportion of referred patients in Helsinki, since in case of penetrating torso trauma without physiological abnormalities such patients might be referred more easily to be ruled out for underlying injuries than in case of blunt trauma.

Conclusions

The present study is the first major outcome study on the performance of trauma care in Finland. In addition to the weaknesses of the study described above, the present study only covers the southern part of Finland with urban and sub-urban areas, thus not reflecting fully the overall situation in Finland. However, the results are still promising in the light of the current situation in trauma care in Helsinki University Hospital. In part of the present study, there is an obvious need to establish a continuous trauma audit protocol not only for Helsinki but also for all large Finnish trauma-admitting hospitals. It is important to work towards similar institutional inclusion criteria and outcome definitions to make reliable inter-institutional comparisons possible in terms of improving the quality of trauma care.

References


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