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Tertiary Survey Performance in a Regional Trauma Hospital Without a Dedicated Trauma Service

Gerben B. Keijzers · Don Campbell · Jeffrey Hooper · Nerolie Bost · Julia Crilly · Michael Craig Steele · Blake Eddington · Leo M. G. Geeraedts Jr.

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Abstract

Background Initial management of trauma patients is focused on identifying life- and limb-threatening injuries and may lead to missed injuries. A tertiary survey can minimise the number and effect of missed injuries and involves a physical re-examination and review of all investigations within 24 h of admission. There is little information on current practice of tertiary survey performance in hospitals without a dedicated trauma service. We aimed to determine the rate of tertiary survey performance and the detail of documentation as well as the baseline rate of missed injuries.

Methods We performed a retrospective, descriptive study of all multitrauma patients who presented to an Australian level II regional trauma centre without a dedicated trauma service between May 2008 and February 2009. A medical records review was conducted to determine tertiary survey performance and missed injury rate.

Results Of 252 included trauma patients, 20% ($n = 51$) had a tertiary survey performed. A total of nine missed injuries were detected in eight patients (3.2%). Of the multiple components of the tertiary survey, most were poorly documented. Documentation was more comprehensive in the subgroup of patients who did have a formal tertiary survey.

Conclusions Tertiary survey performance was poor, as indicated by low documentation rates. The baseline missed injury rate was comparable to previous that of retrospective studies, although in this study an underestimation of true missed injury rates is likely. Implementing a formal, institutional tertiary survey may lead to improved tertiary

G. B. Keijzers
Emergency Department, Gold Coast Health Service District, Gold Coast, QLD, Australia

G. B. Keijzers · M. C. Steele
Faculty of Health Sciences and Medicine, Bond University, Gold Coast, QLD, Australia
e-mail: misteele@bond.edu.au

G. B. Keijzers (✉)
Emergency Department, Gold Coast Hospital, 108 Nerang Street, Southport, QLD 4215, Australia
e-mail: gerben_keijzers@health.qld.gov.au

D. Campbell · J. Hooper · N. Bost
Emergency Department, Gold Coast Hospital, 108 Nerang Street, Southport, QLD 4225, Australia
e-mail: Don_Campbell@health.qld.gov.au

J. Hooper
e-mail: Jeffrey_Hooper@health.qld.gov.au

N. Bost
e-mail: Nerolie_Bost@health.qld.gov.au

J. Crilly
Emergency Department Clinical Network, Gold Coast Hospital, 108 Nerang Street, Southport, QLD 4225, Australia
e-mail: Julia_Crilly@health.qld.gov.au

J. Crilly
Research Centre for Clinical and Community Practice Innovation, Griffith University, Gold Coast, QLD 4222, Australia

B. Eddington
Emergency Department, The Tweed Heads Hospital, Tweed Heads, NSW, Australia
e-mail: blakee@exemail.com

L. M. G. Geeraedts Jr.
Department of Surgery, VU University Medical Centre, P.O. Box 7057, 1007 MB Amsterdam, The Netherlands
e-mail: l.geeraedts@vumc.nl

survey performance and documentation and therefore improved trauma care in hospitals without a dedicated trauma service.

Introduction

Assessment and management of multitrauma patients in the Emergency Department (ED) are time-critical and complex. All life- and limb-threatening injuries must be identified quickly while not missing any other injuries. Furthermore, an altered level of consciousness (due to central nervous system injury, intoxication, or sedation), a distracting injury, or need for emergent surgery may result in an incomplete initial examination, leading to undetected injuries. These missed injuries can cause extensive morbidity [1–12] and mortality [3, 5–7, 13, 14]. The standardized primary and secondary surveys of trauma patients have been shown to miss injuries at a rate that varies from 1.2 to 65% [1–11].

Because of the potential for missed injuries, a tertiary survey (TS) should follow the emergency care (including emergency surgery or interventional radiology). The term "tertiary survey" was first coined by Enderson et al. [1]. It is a comprehensive general physical re-examination and review of all investigations, including diagnostic imaging and blood results, within 24 h [6, 9, 10], and again when the patient is conscious, cooperative, and walking [1, 6, 11].

Three retrospective studies in a setting with a dedicated trauma service reported missed injury rates from 1.2 to 4% [3–5], but it is unclear from the literature the missed injury rates that occur in hospitals without a dedicated trauma service. Our concern is that in such a setting, the use and documentation of a tertiary survey in trauma patients may be inconsistent, leading to more missed injuries.

This aims of this study were to (1) determine tertiary survey performance by investigating the rate and detail of tertiary survey documentation and (2) determine the baseline rate of missed injuries in admitted trauma patients in an institution that does not have a dedicated trauma service.

Materials and methods

Design and setting

This is a retrospective, descriptive study of all multitrauma patients who presented to the Gold Coast Hospital between May 2008 and February 2009. The Gold Coast Hospital (Queensland, Australia) is a teaching hospital with 570 beds and the Emergency Department had 67,000 presentations in 2009, of which 0.7% were multitrauma patients. It is the designated level II [15] regional trauma hospital for the area and covers all major specialties, excluding cardiothoracic surgery and burns. There is currently no dedicated trauma service or formalized process for review of trauma patients who are admitted. Patients are currently managed on the ward at the discretion of the admitting general or subspecialty surgical consultant and team (registrar, one or two residents, and one intern) and by the intensive care team during any stay in the ICU. Which admitting team member performs the patient review (including tertiary survey) and the frequency and detail of this review is judged by the admitting team. Consultations from other specialties are requested at the discretion of the admitting team. The local Health District Human Research Ethics Committee approved this study.

Patients

All admitted trauma patients were identified using the Emergency Department Information System (EDIS) and the hospital information system (HBCIS). The accuracy of the resultant database of patients was cross-checked with the Queensland Trauma Registry (QTR).

Patients were included in the study if they were 16 years old or older and were admitted for at least 24 h, AND they met any of the four following criteria: (1) injuries in two or more body regions, (2) a high-impact mechanism (high-speed motor vehicle collision, pedestrian versus car, fall $>$1.5 m), (3) chest or abdominal injuries, or (4) a fractured neck of the femur and under the age of 65 years. The medical records of the included 252 patients were reviewed.

Data collection

A dedicated research assistant reviewed the medical records of all included patients. Data collection included demographic variables, data on the ED stay, and hospital inpatient admission. Data related to the ED admission included mechanism of injury, Australian Triage Scale (ATS) category [16], and Glasgow Coma Scale (GCS) on arrival. If no GCS was documented but the patient was noted to be "alert," this was coded as a GCS of 15. The QTR provided the Injury Severity Score (ISS) [17] scores for our data set.

Data collection from the medical records focused on whether a formal TS was performed during admission. We noted the documentation rate for all components of the TS (re-examination, laboratory tests, and diagnostic imaging). Provisional reports of advanced imaging by radiologists were not classed as part of the TS; however, who reviewed the diagnostic imaging as part of the TS was noted. We defined a formal TS as "performed" when (at least) the re-examination component of the TS was documented

Table 1 Definitions of formal tertiary survey performance and missed injury

Formal tertiary survey (TS) performed:
Within 24 h of admission AND
Documentation of either partial TS (re-examination of patient) or complete TS (re-examination, pathology, and diagnostic imaging)
Formal tertiary survey NOT performed:
Performed after 24 h OR
No review documented OR
Only the area known to be injured was reviewed
Missed injury:
Any injury detected after primary and secondary surveys and initial investigation in the operating room

within 24 h of admission (Table 1). A TS was defined as "not performed" if there was no documentation of a TS and specifically if there was no documented review outside the area known to be injured. When a TS was not performed, data were collected on which parts of the examination were documented. If a patient was admitted under more than one team, we used the most extensive review for data collection. Data collection took place without the knowledge of the inpatient team(s) performing the reviews. A missed injury was defined as an injury that was not detected on the primary and the secondary survey and on the initial investigation in the operating room. Data on all in-hospital missed injuries were collected, including any resultant management.

Statistical analysis

De-identified data taken from all completed data collection sheets were collated using Excel spreadsheet software (Microsoft Corp., Redmond, WA, USA) and was coded prior to transfer to SPSS v17.0 software (SPSS Inc., Chicago, IL, USA) for statistical analysis. Before analysis, all variables were reviewed for accuracy of data entry, missing values, and outliers. For continuous variables, we used an independent *t*-test and analysis of variance (ANOVA) to compare demographic groups. For categorical variables, the χ^2 test was used to compare differences in proportions. A P value of 0.05 or less was deemed statistically significant.

Results

The baseline characteristics of the 252 patients are summarized in Table 2. The patients had a mean age of 35 years (SD 16) and 79% were male. The average ISS was 13 (SD 9.8), with a quarter of patients admitted to the ICU.

Table 2 Characteristics of the study population

Demographics[a]	Total ($n = 252$)	Tertiary survey performed ($n = 51$)	No tertiary survey performed ($n = 201$)
Age (years)	35.2 (16)	36.7(18)	34.8 (15)
Male	199 (79)	40 (78)	159 (79)
Australian triage scale			
1	64 (25)	29 (57)	35 (17)**
2	111 (44)	19 (37)	92 (46)
3	68 (27)	3 (6)	65 (32)
4	9 (4)	0 (0)	9 (4)
ISS Score	13.0 (10)	23.0 (12.4)	10.4 (6.9)**
ISS > 15	74 (30)	37 (73)	37 (18)**
GCS < 15	69 (28)	27 (53)	42 (21)**
Mechanism of injury			
MVA, high speed	32 (13)	12 (24)	20 (10)*
MVA, moderate speed	25 (10)	4 (8)	21 (10)
MBA	57 (23)	9 (18)	48 (24)
Fall from height >1.5 m	46 (18)	8 (16)	38 (19)
Pedestrian vs. car	22 (9)	9 (18)	13 (6)*
Other mechanism	70 (28)	9 (18)	61 (30)
Disposition			
Surgical ward	87 (35)	5 (10)	82 (41)**
Orthopaedic ward	95 (38)	5 (10)	90 (45)**
ICU	65 (26)	41 (80)	24 (12)**
Other	5 (2)	0 (0)	5 (2)

Values are number (n) and percentage (%) in parenthesis, except for age and ISS score which are mean (SD)

ISS injury severity score, *GCS* Glasgow coma scale, *MVA* motor vehicle accident, *MBA* motor bike accident, *ICU* intensive care unit

* $P < 0.01$; ** $P < 0.001$, χ^2 test comparing patients who received tertiary survey versus those who did not

Of the 252 patients, 51 (20%) had a formal tertiary survey (TS) performed during their hospital stay. The mean ISS of patients who had received a formal TS was higher than that of patients who did not have a TS performed (23.0 vs. 10.4, $P < 0.001$). Only 50% of the severely injured (ISS > 15) and 39% with an abnormal level of consciousness (GCS < 15) had a TS performed during their ward admission. More TSs were performed in the ICU than in the general wards (63% vs. 5%, $P < 0.001$).

Missed injuries

Table 3 outlines the nine missed injuries in eight (3.2%) patients. Of these, six injuries were detected in patients who had a TS. Two injuries were deemed clinically significant. Of these, one patient had a fractured proximal phalanx of the big toe (patient did not have TS) and one patient had a fractured calcaneus that was detected on TS.

Table 3 Description of newly detected injuries (missed injuries), investigations, and management

	Area of injury	Further investigation and subsequent management
Formal TS performed		
Patient 1	L hand	X-ray – NAD
Patient 2	Tender R foot	X-ray – NAD
Patient 3	L elbow	X-ray– NAD, orthopaedic consult: conservative management
	R shoulder	X-ray – NAD, orthopaedic consult: conservative management
Patient 4	R knee	X-ray – NAD
Patient 5	L ankle	X-ray – fractured calcaneus, orthopaedic consultation with plaster immobilisation
No formal TS performed		
Patient 6	Left knee	Mobilisation
Patient 7	L knee deformity	X-ray – NAD, orthopaedic consult: conservative management
Patient 8	Toe	X-ray – fractured toe, patient self-discharged

NAD no abnormality detected, *TS* tertiary survey, *L* left, *R* right

Table 4 Documentation rates of vital signs

Vital signs	Total ($n = 252$)	Tertiary survey performed ($n = 51$)	No tertiary survey performed ($n = 201$)
Glasgow coma score documented	24	61	15**
Temperature documented	43	63	38*
Blood pressure documented	31	77	20**
Heart rate documented	31	80	17**
Respiratory rate documented	15	41	8**
Oxygen saturations documented	31	63	23**

All values are percent (%)

* $P < 0.01$; ** $P < 0.001$ based on χ^2 test comparing patients who received a tertiary survey with those who did not

Tertiary survey documentation: vital signs

In the group without formal TS, vital signs were poorly documented, varying between 15% for respiratory rate to 43% for temperature. In the group of patients who did have a formal TS, these rates varied from 41% for respiratory rate to 80% for the heart rate (Table 4).

Tertiary survey documentation: physical examination

Overall, the documentation rate of the physical examination was poor, with 27% for both abdominal and chest examinations, 26% for the lower limbs, and 33% for the upper limbs. Other areas, as outlined in Table 5, were documented in less than 10% of all patients. In patients who did have a formal TS performed, these percentages were markedly higher, with 69% documenting the abdominal examination and 59% the chest examination. Upper- and lower-limb documentation occurred in 53 and 65% of patients, respectively.

Tertiary survey documentation: pathology and diagnostic imaging

Overall, the full blood count or haemoglobin was documented in 23% of patients, whereas this rate was 71% in the subgroup of patients who had a formal TS. Plain film review occurred in 14% of all patients and in 43% of patients who had a TS. Formal review by the radiology registrar or consultant occurred twice (Table 6).

Advanced imaging (CT, MRI, and ultrasound) review by a treating team member was documented in 13% of all patients and in 37% of patients who had a TS. There were provisional radiology reports of advanced imaging noted, but no documented review by a radiology registrar or consultant as a result of patient review (or TS) by the admitting team.

Discussion

A formal tertiary survey (either partial or complete depending on documentation) was performed for only 20% of all admitted trauma patients, and the missed injury rate was 3.2%. This study found overall poor documentation rates of re-examination of the trauma patients after admission. The majority of tertiary survey components was poorly documented by the admitting team. Although documentation was better in the group that did receive a formal TS, a substantial proportion of this group did not have relevant TS components documented.

As expected, the more injured patients (ISS > 15) were more likely to have a TS documented, although half of

Table 5 Documentation rates of physical examination

Location of physical exam	Total ($n = 252$)	Tertiary survey performed ($n = 51$)	No tertiary survey performed ($n = 201$)
Scalp documented	5	12	3**
Face documented	7	20	3***
Eyes documented	16	52	7***
Ears documented	0.4	2	0
Mouth documented	2	6	1
Cranial nerves documented	1	4	0.5
Neck documented	6	17	3***
Trachea documented	1	0	1
C-spine documented	8	25	4***
Chest (including ribs) documented	27	58	19***
Sternum documented	6	18	3***
Shoulder/clavicle documented	9	27	5***
ICC documented	9	25	4***
ICC not applicable	63	47	68**
Abdomen documented	28	69	17***
Pelvis documented	7	27	2***
Genitalia documented	2	7	0
Back documented	3	12	1
T + L spine documented	4	14	2
Upper limb documented	25	53	19***
Lower limb documented	32	65	24***
Pulses documented	6	12	4*

All values are percent (%)

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$ based on χ^2 test comparing patients who received a tertiary survey with those who did not

Table 6 Documentation rates of pathology and radiology

Pathology or plain radiology	Total ($n = 252$)	Tertiary survey performed ($n = 51$)	No tertiary survey performed ($n = 201$)
FBC documented	23	71	10***
COAGS documented	11	39	4***
UELFTs documented	17	55	7***
Plain X-ray documented	14	43	7***
Plain X-ray reviewed by			
Intern	0.4	2	0
Resident	3	6	3
Registrar	6	22	3***
Consultant	3	10	2
Radiology registrar	0.4	2	0
Radiology consultant	0.4	0	0.5
Not applicable	85	57	92***
CT/MRI/USS reviewed by			
Intern	0.4	2	0 (0)
Resident	2	4	3 (1.5)
Registrar	8	2	6 (3)***
Consultant	2	5 (10)	0 (0)
Radiology registrar	2	0 (0)	4 (2)
Radiology consultant	0	0	0
Not applicable	86	29 (58)	183 (93)***

Values are percent (%)

FBC full blood count, *COAGS* coagulation studies, *UELFTs* electrolytes, renal and liver function tests, *n* number, *CT* computerized tomography scan, *MRI* magnetic resonance imaging scan, *USS* ultrasound scan

these patients did not have a formal TS performed. We also found that formal TS performance and documentation rates were higher in patients who were admitted to the ICU compared to those of patients who were admitted to a surgical or orthopaedic ward (63 vs. 5%). This may be due to a more holistic and structured approach to examination and documentation by the intensive care medical staff.

In our study, the missed injury rate was 3.2%. This is low and consistent with that of previous retrospective studies of trauma admissions with similar ISS (1.2–4%), albeit in hospitals with a trauma service [3–5, 9, 10]. It is likely that our study underestimates the true missed injury rate since we did not follow up patients after hospital discharge. Enderson et al. [1] found that the missed injury incidence changed from 2% when studied retrospectively to 9% when studied prospectively in the same institution. Our current missed injury rate will serve as a baseline comparison for future studies at our institution. The low missed injury rate seems paradoxical as this study highlights the poor performance and documentation of tertiary surveys, and one may have expected more missed injuries as a result. It is not possible to determine how many patients in our study were discharged with missed injuries. Caution is required when interpreting missed injury rates as there are inconsistent definitions of this term in the literature [1–6, 10–12, 18]. This inconsistency of the definition of "missed injury" has been highlighted by two recent review articles on missed injuries [19, 20] and should guide interpretation, although we used a common definition, i.e., "any injury identified after primary and secondary survey or initial investigations in the operating room" [6, 10–12].

Our low missed injury rate may be explained by the fact that (most) conscious patients could indicate all their injuries. A second explanation is that tertiary surveys may have been performed but not documented. It is possible that only *new* findings on patient re-examination, blood tests, or diagnostic imaging were documented. Although this may be understandable in the face of time, staffing, and resource pressures, incomplete documentation may have

both medical and medicolegal implications. It remains important to document important negative findings, or the absence of so-called "red flags" on re-examination. A final explanation for the low rates of missed injuries and TS documentation may be the absence of a dedicated trauma service in our institution. The admitting team may have reviewed the patients with a disproportionate focus on the primary reason for their admission, potentially missing injuries in other body systems and discharging patients with missed injuries.

An interesting finding was that as a result of repeat examination by the admitting team, additional diagnostic imaging review by a radiologist occurred only twice. Both times this involved plain film imaging and no documented radiologist review of advanced imaging occurred. Prospective studies have demonstrated more accurate and earlier detection of missed injuries when diagnostic imaging is reviewed by a radiologist [8, 21]. One prospective study of 432 trauma patients showed that 9% had missed injuries detected the following day by a radiology consultant, of which 40% were clinically significant fractures [21].

Previous studies have suggested that there are different types of human error when classifying missed injuries [20, 22]. The lack of review of diagnostic imaging, as noted in our study, can be classed as either a delay in requesting imaging or consultation that may lead to a delay in diagnosis (or missed injury), or an error in diagnosis. A trauma service can be part of a system where recognized error patterns can be prevented [22]. Two recent studies suggest that inclusive trauma systems reduce trauma-related mortality [23, 24], and implementing a dedicated trauma service could be a first appropriate step for regional hospitals to achieve such a system.

This study has several limitations. First, it is a retrospective study that limits data collection to what is available in the medical records, which probably resulted in an underestimation of the missed injury rate [1]. Second, this study is subject to all limitations associated with medical record review, such as chart ambiguity, omission, illegibility, and data entry error. We minimized this by cross-checking our data with the Queensland Trauma Registry, which accesses electronic hospital administrative databases in conjunction with the medical record. Furthermore, our recruitment criteria included patients with a fractured neck of femur under the age of 65, considering the mechanism required to sustain this injury in a younger person. Although this group of patients has traditionally not been included in studies on multiply injured patients, only four patients with this diagnosis were included, therefore limiting the impact of their inclusion on the study outcomes. Finally, although we used a reasonable cohort size, this study covered a single site and results may not be reflective of other facilities.

Conclusions

Currently in our designated trauma-receiving hospital without a dedicated trauma service, a tertiary survey occurs for only 20% of all trauma admissions. Despite this suboptimal practice, the missed injury rate was 3.2%, which is comparable to other retrospective studies, although it is likely an underestimation. There is a role for a more formalized review of diagnostic imaging, potentially leading to more accurate clinical correlation and fewer missed injuries. This study highlights areas of trauma care that can be improved, which may be facilitated by implementing a dedicated trauma service. Meanwhile, we have commenced data collection for a larger, prospective study with a 6-month follow-up to more accurately assess the missed injury rate and associated morbidity after patients are discharged. We plan to implement a formal, institutional tertiary survey for all trauma admissions in our setting to improve documentation practice.

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