ADVANCES

A comparative study of designated trauma team leaders on trauma patient survival and emergency department length-of-stay

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ABSTRACT

Objectives: There is controversy over who should serve as the Trauma Team Leader (TTL) at trauma-receiving centres. This study compared survival and emergency department (ED) length-of-stay between patients cared for by 3 different groups of TTLs: surgeons, emergency physicians (EPs) on call for trauma cases and EPs on shift in the ED.

Methods: We performed a retrospective cohort study involving all adult major blunt trauma patients (aged 17 and older) who were admitted to 2 level I trauma centres and who were entered into a provincial Trauma Registry between March 2000 and April 2002. The study was designed to compare the effect of TTL-type on survival and ED length-of-stay, while controlling for sex, age, and trauma severity as defined by the Injury Severity Score (ISS) and the Revised Trauma Score (RTS). Analysis was performed using linear regression modeling (for the ED lenght-of-stay outcome variable), and logistic regression modeling (for the surivial outcome variable).

Results: There were 1412 patients enrolled in the study. The study population comprised 74% men and 26% women, with a mean age of 44.7 years (43.1, 46.6 and 42.8 years for surgeons, on-call EPs and on-shift EPs, respectively). The overall mean ISS was 23.2 (23.7 for surgeons, 22.9 for on-call EPs and 23.3 for on-shift EPs) and the overall average RTS was 7.6 (7.6 for surgeons, 7.6 for on-call EPs and 7.5 for on-shift EPs). The overall median ED length-of-stay was 5.3 hours (4.5, 5.3 and 5.6 hours for surgeons, on-call EPs and on-shift EPs, respectively; $p = 0.07$) and the overall survival was 87% (86% surgeon, 88% on-call EP, 87% on-shift EP; $p = 0.08$). No statistically significant relationship was found between TTL-type and ED length-of-stay ($p = 0.42$) or survival ($p = 0.43$) using multivariate modeling.

Conclusion: Our results suggest that surgeons, on-call EPs, or on-shift EPs can act as the TTL without a negative impact on patient survival or ED length-of-stay.

Key words: trauma team leader, ED length-of-stay, survival, blunt trauma

RÉSUMÉ

Objectifs : Il y a controverse quant à la personne qui devrait agir à titre de chef d'équipe en traumatologie (CET) dans les centres qui accueillent des traumatisés. La présente étude a comparé le taux de survie et la durée de séjour à l'urgence des patients traités par trois groupes différents de

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CET : chirurgiens, médecins urgentistes (MU) sur appel pour les cas de traumatisme et les MU en service à l'urgence.
Méthodes : Nous avons réalisé une étude rétrospective de cohortes de tous les patients adultes (17 ans et plus) ayant reçu un traumatisme contondant important, qui ont été admis dans deux centres de traumatologie de niveau I et inscrits dans un registre provincial des traumatismes entre mars 2000 et avril 2002. L'étude avait pour but de comparer l'incidence du type de CET sur la survie et la durée du séjour à l'urgence, tout en tenant compte du sexe, de l'âge et de la gravité du traumatisme définie par l'indice de gravité de la blessure (Injury Severity Score - ISS) et par l'indice révisé du traumatisme (Revised Trauma Score - RTS). L'analyse s'est faite à l'aide d'un modèle de régression linéaire (pour la variable issue du séjour à l'urgence) et d'un modèle de régression logistique (pour la variable survie).
Résultats : Au total, 1412 patients ont été inscrits à l'étude. La population étudiée comprenait 74 % d'hommes et 26 % de femmes, d'un âge moyen de 44,7 ans (43,1, 46,6 et 42,8 ans pour les chirurgiens, les MU sur appel et les MU en service, respectivement). L'ISS global moyen a été de 23,2 (23,7 pour les chirurgiens, 22,9 pour les MU sur appel et 23,3 pour les MU en service) tandis que le RTS global moyen s'est établi à 7,6 (7,6 pour les chirurgiens, 7,6 pour les MU sur appel et 7,5 pour les MU en service). La durée de séjour médiane globale à l'urgence a été de 5,3 heures (4,5, 5,3 et 5,6 heures pour les chirurgiens, les MU sur appel et les MU en service, respectivement; p = 0,07) et le taux global de survie a été de 87 % (86 % pour les chirurgiens, 88 % pour les MU sur appel et 87 % pour les MU en service; p = 0,08). On n'a trouvé à l'aide d'une modélisation multivariables aucune relation statistiquement significative entre le type de CET et la durée du séjour à l'urgence (p = 0,42) ou le taux de survie (p = 0,43).
Conclusion : Nos résultats laissent entendre que les chirurgiens, les MU sur appel ou les MU en service peuvent agir à titre de CET sans que cela ait des répercussions négatives sur la survie du patient ou la durée du séjour à l'urgence.

Introduction

Over the past 2 decades, there have been great improvements in the care of major trauma patients in North America. Research indicates that the following factors are associated with positive patient outcomes in major trauma: emergency department (ED) response by a trauma team,[1] the use of trauma team activation criteria,[2] and specific roles and accountabilities for trauma team members and the trauma team leader (TTL).[3,4] There is still controversy over who should serve as the TTL. Historically, trauma was viewed as a condition necessitating surgeon leadership in all phases of patient care. This perception has continued in some centres despite a reduction in the indications for surgical intervention in trauma patients, the development of specialty training in emergency medicine and the challenges resulting from an overall reduction in surgical personnel.[5] A 2003 Canadian study surveyed 30 trauma centres in 9 provinces to determine who carried out the role of TTL.[6] The results showed that surgeons and emergency physicians (EPs) carried out the role of TTL in 25 of 30 (83%) and 18 of 30 (60%) hospitals, respectively. This study did not report outcomes by the 2 types of TTL.

The purpose of this retrospective cohort study was to comparatively analyze survival and ED length-of-stay between patients cared for by 3 different types of TTLs: surgeons, EPs on-call for trauma cases, and EPs on regular shift duty in the ED at 2 tertiary care trauma centres. We hypothesized that the type of TTL designated would not have an effect on survival or ED length-of-stay for adult blunt trauma patients.

Methods

Setting

This study was carried out in Edmonton, a city with a population of approximately 1 million people and a large rural referral base, where regionalization has resulted in the consolidation of trauma care into 2 tertiary hospitals. The evolution of the trauma team and its delivery system differed at each site. One hospital had a system in which, in about 95% of cases, an on-call EP functioned as the TTL and provided the initial assessment and stabilization in conjunction with a surgeon. Delivery systems of this nature have been referred to as a "tiered response model".[7] At the other hospital, surgeons more frequently functioned as TTLs.

Twenty-four-hour daily TTL coverage, within the limits of staff availability, was scheduled at both hospitals. When paged, the on-call TTL was expected to arrive within 20 minutes and attend only to the trauma patient and his or

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her family. The TTL arrived at the ED either before the patient, or shortly thereafter, depending on when they were paged and the whether the ED had advance notification of the patient's arrival. When no on-call TTL was available, the EP on shift in the ED assumed the role of TTL.

Both hospitals were classified as trauma centres, but neither was accredited with level I status as this process was in its infancy in Canada during the study period. Surgeons at both hospitals were Royal College fellowship certified general surgeons, with variable amounts of additional postgraduate specialty training in trauma care. The EPs at both hospitals were either Royal College fellowship certified (FRCP), or family physicians with 1 year of emergency training (CCFP-EM). The study received ethics approval from the regional Health Ethics Review Board.

Data sources

We obtained data from a census of patients entered into the Alberta Trauma Registry between March 2000 and April 2002 (n = 1532). All patients entered in the trauma registry had an Injury Severity Score (ISS) ≥ 12 (a threshold defining "major trauma") and a recorded Revised Trauma Score (RTS). Information on the patient's ED and hospital course was entered into the registry prospectively by registry personnel employed by the health authority. The research team provided specific data questions to the registry personnel to obtain the study data set.

Variables analyzed

Independent variables

We obtained data for 5 independent variables: age, sex, ISS, RTS and TTL-type. Age was captured as a continuous variable and subsequently categorized as ≤ 55-years-old or > 55-years-old, as done by previous investigators.[8] ISS is a continuous variable, calculated by adding the squares of the 3 highest Abbreviated Injury Scale (AIS) scores in predefined regions of the body.[9–11] The AIS score ranges from 0 to 5, and thus the maximum possible ISS is 75.[8,12] The RTS was calculated from respiratory rate, systolic blood pressure and Glasgow Coma Scale score on ED arrival. We then multiplied the calculated value by a weighted factor derived from the Washington Hospital Center database.[13] TTL was categorized as surgeon, an on-call EP, or an on-shift EP.

Dependent (outcome) variables

We evaluated 2 outcome variables: ED length-of-stay and survival. ED length-of-stay was a continuous variable measured in hours from the time the patient arrived in the ED to the time the patient was transferred to the operating room or to an inpatient bed. Survival was coded as alive or deceased at the time of departure from the hospital.

Model fitting and covariate inclusion

The study was designed to determine the effect of TTL-type on ED length-of-stay and survival for both trauma centres combined and not for making comparisons between the trauma centres. We used multivariate linear regression modeling for ED length-of-stay and multivariate logistic regression modeling for survival to analyze the relation between TTL and outcome while controlling for the influence of sex, age, ISS and RTS. All calculations and analyses were performed using SPSS 12.0 statistical software (SPSS Inc., Chicago).

Results

Of the 1532 patients entered in the trauma registry over the study period, 120 (7.8%) were excluded; 31 (2%) had penetrating trauma and 89 (5.8%) were missing information on key independent or dependent variables. Patients with missing data were individually reviewed by the investigators to ensure that there was no systematic reason for the missing data and that no sampling bias would be introduced by the exclusion of these cases. The remaining 1412 patients composed the study population.

Table 1 provides the summary statistics for demographic, RTS and trauma centre variables categorized by TTL-type. The study population of 1412 patients comprised 74% men and 26% women with a mean age of 44.7 years (43.1 surgeon, 46.6 on-call EP, 42.8 on-shift EP). The overall mean ISS was 23.2 (23.7 surgeon, 22.9 on-call EP 23.3, on-shift EP), and the overall average RTS was 7.6 (7.6 surgeon, 7.6 on-call EP, 7.5 on-shift EP).

ED length-of-stay

Exploratory analysis before the modeling indicated that the distribution of ED length-of-stay was skewed to the right. This variable was therefore transformed using its natural logarithm, thus providing an appropriately normal distribution for modeling as indicated by a quantile–quantile plot.

Although sex, categorized age, ISS and RTS were measured to control for confounding biases, the regression modeling indicated that age, sex and RTS were not significantly associated with ED length-of-stay ($p > 0.05$). In addition, when comparing a full model (including all independent variables) with a reduced model (sex, age and RTS removed), the regression coefficient for TTL-type remained stable, indicating that these variables did not confound the relation between TTL-type and ED length-of-stay. As a result,

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these variables were excluded from the final model. In contrast, ISS was retained as it was significantly associated with ED length-of-stay and did impact the TTL-type regression coefficient when removed from the full model. The final ED length-of-stay model, therefore, included ISS and TTL-type as independent variables. The results were interpreted and are reported on the original (non-transformed) scale.

Table 2 provides unadjusted summary statistics categorized by TTL-types. With regression modeling, we found no statistically significant associations between TTL-type and ED length-of-stay ($p = 0.37$, power > 80%). The mean ED lengths of stay, adjusted for ISS, arising from this model were: 4.75 hours (95% confidence interval [CI] 4.19–5.39) for surgeons, 5.13 hours (95% CI 4.82–5.47) for on-call EPs and 4.85 hours (95% CI 4.52–5.19) for on-shift EPs. A scatter plot of predicted and residual values adequately fit the data (r^2 [adjusted] = 30%) and confirmed that model assumptions had not been violated.

Survival

Using the same stepwise statistical approach described for ED length-of-stay, we determined that age, ISS and RTS may confound the relation between TTL-type and survival, and therefore these variables were retained in the final survival model.

Table 3 provides unadjusted summary statistics categorized by TTL-type. Using logistic regression modeling, we found no statistically significant associations between TTL-type and survival ($p = 0.58$, power > 80%). The odds ratios, (adjusted for age, ISS and RTS) arising from this model were: 0.98 (95% CI 0.47–2.01) for the on-call EP group relative to the surgeon group, 0.74 (95% CI 0.36–1.51) for the on-shift EP group relative to the surgeon group and 1.33 (95% CI 0.84–2.10) for on-call EP group relative to the on-shift EP group. The Hosmer and Lemeshow test for goodness of fit resulted in a chi-square value of 15 with 8 degrees of freedom ($p = 0.06$), which lead us to conclude that the model adequately fit the data.

Discussion

As early as 1976, the American College of Surgeons (ACS) called for dedicated hospital resources, facilities and personnel for the care of seriously injured patients.[8,14]

Table 1. Patient demographics, RTS and trauma centre variables by trauma team leader (*n* = 1412*).

	Trauma team leader			
Patient variables	Total	Surgeon (*n* = 172)	On-call EP (*n* = 677)	On-shift EP (*n* = 563)
Sex				
Male, *n* (%)	1052 (74.5)	130 (75.6)	487 (71.9)	435 (77.3)
Female, *n* (%)	360 (25.5)	42 (24.4)	190 (28.1)	128 (22.7)
Age, years				
Mean	44.7	43.1	46.6	42.8
Minimum	17	17	17	17
Maximum	97	84	97	93
Range	80	67	80	76
ISS score				
Mean	23.2	23.7	22.9	23.3
Minimum	12	13	12	12
Maximum	75	75	75	75
Range	63	62	63	63
RTS score				
Mean	7.6	7.6	7.6	7.5
Minimum	0	0	0	0
Maximum	7.8	7.8	7.8	7.8
Range	7.8	7.8	7.8	7.8
Trauma Centre†				
Hospital A, *n* (%)	523	20 (3.8)	268 (51.2)	235 (44.9)
Hospital B, *n* (%)	889	152 (17.1)	409 (46.0)	328 (36.9)

*Annual emergency patient volume at 2 study trauma sites = 145 000.
†Trauma centre was not entered as an independent variable in subsequent analyses but is shown here to highlight the data source and distribution.
EP = emergency physician; ISS = Injury Severity Score; RTS = Revised Trauma Score

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The implementation of this recommendation led to the development of trauma systems. Trauma systems are active in the areas of prevention, medical care, education and research. The medical care component of trauma systems is built on 4 pillars: access to care, pre-hospital care, hospital care and rehabilitation.[8] The ACS advocated for commitment from the hospital and its medical staff because "trauma is a surgical disease,"[8] and in 1981 they published a position statement asserting that the initial evaluation, stabilization and resuscitation of trauma patients should be performed by a surgeon.[9]

In 1982, the American College of Emergency Physicians stated that fellowship trained EPs could assume a leadership role in the resuscitation and stabilization of critically traumatized patients.[10] In a 1986 publication, the ACS recommended that trauma teams have appropriate structure and leadership; specifically, a trauma team approach with a team leader who was a qualified surgeon competent in all aspects of trauma care.[8] This publication stated that the initial evaluation and resuscitation of trauma patients should be led by surgical staff in level I and II trauma centres and by EPs in other locations.[8]

The ACS described 4 levels of trauma care where the most severe trauma patients are referred to levels I and II hospitals. Levels III and IV trauma centres provide initial stabilization followed by transfer to major centres if required.[15] In Canada, the Royal College of Physicians and Surgeons established the Trauma Association of Canada (TAC) in 1983.[16] In 1993, TAC released guidelines for trauma care based on the 1981 ACS position statement. These guidelines focused on inclusiveness of trauma care rather than specifying trauma team composition. TAC described 3 levels for trauma care: tertiary trauma care centres, district trauma care centres and primary trauma centres.[17]

The results of our study indicate that the length of time that trauma patients were in the ED is not significantly influenced by who fills the role of TTL. This finding contrasts with the findings of a 2001 study by Porter and Ursic,[18] who concluded that the presence of a surgeon in the ED shortened the time to the operating room, therefore, reflecting less time in the ED. Although the adjusted mean time in the ED when surgeons acted as TTL was 23 minutes shorter than the on-call EPs and 17 minutes shorter than the on-shift EPs, this difference was not statistically significant, nor did it appear to have clinical relevance as there was no statistical difference in survival rates for the various TTL-types after controlling for sex, age, ISS and RTS. Moreover, when the on-shift EP acted as TTL, the survival and ED length-of-stay were not significantly different from on-call EPs or surgeons.

Table 2. ED length-of-stay (in hours) by Trauma Team Leader (*n* = 1412).

	Trauma team leader			
ED length-of-stay	Total	Surgeon (*n* = 172)	On-call EP (*n* = 677)	On-shift EP (*n* = 563)
Median*	5.3	4.5	5.3	5.6
Mean	6.7	6.0	7.0	6.6
Minimum	0.1	0.1	0.1	0.2
Maximum	50.6	23.2	50.6	44.2
Range	50.5	23.1	50.5	44.0

*Based on median test, $\chi^2 = 5.2$ based on 2 degrees of freedom. Not statistically significant based on type 1 error of 0.05. Note that the median, not the mean, was tested due to the severe positive skew (and non-parametric nature) of ED length-of-stay distribution.

Limitations

The limitations of this study arise primarily from the retrospective nature of trauma registry data. The broad enrollment of blunt trauma patients may have undermined our ability to detect outcome differences in subgroups with varying survival rates (e.g., falls and motor vehicle crashes). The differences in survival rates in such subgroups cannot be controlled for using data from most trauma registries.[19–22] The results of our study should also be interpreted in light of our inability to control for patient comorbidities. In many cases, trauma patients are unable to disclose their medical history on arrival at a trauma centre. Finally, this study did not gather data on or control for institutional factors that could influence patient survival, such as procedures and time in the operating room, inpatient unit care or ICU care. Such factors may be important and merit further research.

Conclusion

This study is unlikely to completely resolve the controversy regarding who should serve as the TTL in Canadian

Table 3. Patient survival by trauma team leader type (*n* = 1412).

	Trauma team leader			
	Total	Surgeon (*n* = 172)	On-call EP (*n* = 677)	On-shift EP (*n* = 563)
Patient survival (%)*	87.0	86.0	88.0	87.0

*$p = 0.08$; $\chi^2 = 0.5$ based on 2 degrees of freedom. Not statistically significant based on type 1 error of 0.05.

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trauma centres. However, our results suggest that this role can be filled outside of the traditional surgical disciplines by certified EPs either on-call as TTLs or on-shift in the ED. Given the looming shortages of physicians and surgeons, and the desire to maintain our collective accomplishments in trauma care, the results of this study suggest that trauma programs can be flexible in scheduling TTL coverage. Future research that examines the influence of all aspects of the trauma system on patient outcomes would advance our knowledge of this field.

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