

EM ADVANCES

Is computerized tomography of trauma patients associated with a transfer delay to a regional trauma centre?

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ABSTRACT

Objective: Many trauma patients undergo advanced diagnostic imaging before being transferred to a regional trauma centre, but this step can delay definitive care. This study compared the length-of-stay at the primary hospital between patients who underwent CT scans and those who did not.

Methods: This was a medical record review of all consecutive trauma cases transferred to a regional trauma centre servicing 2.2 million people during a 2-year period. Two trained abstractors, blind to each other's results, collected data independently.

Results: Of 249 cases, 79 (31%) underwent a CT scan before being transferred. There was no significant difference in the Injury Severity Score between the 2 groups ($p = 0.16$), yet the CT group remained at the primary hospital approximately 90 minutes longer before transfer ($p < 0.001$).

Conclusion: A significant proportion of trauma patients transferred to a regional trauma centre undergo CT scanning at the primary hospital. These patients experience an increased length-of-stay of 90 minutes, on average, before transfer. This appears to be a common practice that does not appear to contribute to definitive trauma management.

Keywords: trauma, transfer delay, medical record review, computerized tomography, sensitivity analysis

RÉSUMÉ

Objectif : Beaucoup de patients traumatisés subissent des examens d'imagerie diagnostique avancés avant d'être transférés à un centre régional de traumatologie, mais cette étape peut retarder la prise en charge définitive du patient. Au cours de cette étude, on a comparé la durée du séjour à l'hôpital de soins primaires de patients qui ont subi une tomodensitométrie à celle de patients qui n'en ont pas subi.

Méthodes : On a étudié les dossiers médicaux de tous les cas consécutifs de traumatisés transférés à des centres régionaux de traumatologie desservant 2,2 millions de personnes au cours d'une période de deux ans. Deux analystes expérimentés ne connaissant pas leurs résultats respectifs ont recueilli des données indépendamment.

Résultats : Sur 249 cas, 79 (31 %) ont subi une TDM avant d'être transférés. Il n'y avait pas de dif-

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férences significatives au niveau de l'indice de gravité de la blessure entre les deux groupes ($p = 0,16$), mais les patients soumis à une TDM sont demeurés à l'hôpital de soins primaires environ 90 minutes de plus avant le transfert ($p < 0,001$).

Conclusion : Un pourcentage important des patients traumatisés transférés à un centre régional de traumatologie subissent une TDM à l'hôpital de soins primaires. Ces patients y séjournent en moyenne 90 minutes de plus avant le transfert. Cette pratique qui semble courante ne semble pas contribuer à la prise en charge définitive des traumatismes.

Introduction

The National Trauma Registry reported that in 2000 there were 198 040 injury admissions in Canada, of which 6560 people died in hospital.¹ The pattern of mortality in trauma is trimodal. In the first peak, victims die at the scene and efforts to reduce deaths in this area are mainly societal (e.g., drunk driving laws, airbags, speed limit enforcement, gun control laws and trauma prevention education).^{2,3} In the second peak, death occurs within the first hour (the “golden hour”) following the event.⁴ Trauma deaths in the third peak occur in the intensive care unit (ICU), often as a result of postoperative complications and delays to definitive care.⁵ Trauma care is thus extremely time-sensitive. The rapid transport of patients to the most appropriate facility and the timely identification and treatment of injuries are therefore fundamental components of modern trauma systems.^{6–11}

Delays in the transfer of patients to regional trauma centres can occur for a variety of complex reasons, including the lack of available escort staff, the lack of available ambulances, poor weather and ongoing resuscitation procedures.^{11–13} Delays due to ongoing diagnostic imaging studies at the sending facility, however, are often avoidable and do not directly contribute to the patient's well-being. The objectives of this study were to determine what proportion of transfer trauma cases underwent CT scans before being transferred and if this imaging was associated with increased length-of-stay (LOS) at the referring hospital.

Methods

We performed a medical record review study of all consecutive trauma cases referred to a regional trauma centre during a 2-year period. The local institutional ethics review board approved the study as a quality assessment study exempt from formal review.

The primary outcome was the LOS, which was measured as the time from arrival at the primary hospital to the time of departure to the regional trauma centre. All data were abstracted from the trauma patient database and corroborated using the CritiCall (a regional critical care referral

centre) database, ambulance transfer records and patients' charts. The regional trauma centre services 2.2 million people and 24 hospitals over an area of 13 400 km². All patients over 18 years of age initially treated at another hospital and subsequently transferred to the regional trauma centre were selected for analysis. To maintain confidentiality, cases were assigned a unique study number during data abstraction.

The data abstractors were trained and reached an agreement on variable definitions at the outset. Following initial data abstraction, a randomly selected subset of 20% of the cases was reviewed for data extraction accuracy by a second abstractor who was blinded to the study hypothesis and to procedure codes. Comparisons were made with the main sample for consistency by a third researcher.

Mean Injury Severity Scores (ISS) were compared between groups using an unpaired *t* test. Because of the skew of the time interval (LOS) data, both means and medians are reported, and both parametric (*t* test) and nonparametric analyses (Mann–Whitney U Test) were used to compare groups. The impact of missing LOS data was determined by worst case sensitivity analysis (i.e., repeating the data analysis after replacing the missing time intervals LOS in each group with the mean time intervals from the comparison group).

The sample size was calculated based on a pilot study in which we found that the mean LOS for those patients receiving a CT scan at the primary hospital and those who did not was approximately 180 and 120 minutes, respectively, with a standard deviation of 120 minutes. With a desired α of 0.05, power of 0.8 and using a 2-sided test, we estimated that a minimum of 63 patients would be needed in each group to show a significant difference. The inter-rater reliability of the data abstraction process was measured using the intraclass correlation coefficient (ICC).

Results

During the study period, 249 trauma patients were transferred to the regional trauma centre from a primary hospital, of which 79 (31.7%) underwent CT scanning before

transfer. Based on the CritiCall database, none of these patients had surgery at the sending facility, nor was the transfer initiated on the basis of the CT scan. The injury severity scores were similar between the 2 groups. On the other hand, both mean and median LOS intervals were substantially different between groups ($p < 0.001$). Patients who underwent CT scanning before transfer had a median LOS of 213 (interquartile range [IQR] 157, 278) minutes, compared with 118 (IQR 81, 175) minutes for those transferred without CT scans being done (Table 1).

Seven of the CT cases (11%) and 26 of the non-CT cases (15%) had missing time data that precluded calculation of the primary outcome ($\chi^2 = 1.94$, $p = 0.163$). Nevertheless, the substantial difference in LOS persisted in the worst case sensitivity analysis. The ICC of data abstractors for the times of arrival and departure from the primary hospital was 1.0 (perfect).

Discussion

It is widely accepted that trauma patients should be transferred to a trauma centre as soon as possible, provided that they meet the Maryland criteria.^{7-9,11} Despite this time imperative, approximately one-third of patients transferred to our trauma centre from another hospital underwent CT imaging before transfer. This substantial proportion reflects a shift toward increased diagnostic imaging in trauma patients in general, yet these CT scans did not appear to alter patient management at the primary hospital. We did not attempt to explore the reason(s) for performing the CT, whether or not it was repeated at the trauma centre, and whether the increased LOS associated with the CT group had any impact on clinical outcome.

CT scanning is relatively fast. While newer generations of CT scanners are able to acquire high-quality images in a matter of minutes, arriving at our trauma centre with a CT scan "in hand" was associated with a substantially longer stay at the referring hospital that far outweighed

the actual scan time. We have previously shown that patients spend a median time of 1 hour out of the ED for a noncontrast CT of the abdomen for suspected ureteric colic.¹⁴ We suspect that the cumulative time needed for all steps in the CT process is often underestimated by physicians ordering the test.

Limitations

These findings are based on data from a single regional trauma centre, yet we are not aware of any reason why they should not be representative of other regional trauma systems in Canada. We used only the ISS to compare groups for severity. The ISS is the most commonly used measure of injury severity in the Canadian trauma system and it is the only injury severity measure recorded for each patient entered into Ontario regional databases.

As with many medical record reviews, we encountered missing data. Nevertheless, a "worst case scenario" sensitivity analysis demonstrated that the findings were robust. Other methods for managing missing data such as imputation are not amenable to small sample sizes.¹⁵

We did not seek to determine whether the CT findings at the local hospitals guided therapy, which studies were repeated at the trauma centre and whether the increased LOS had any impact on clinical outcome including mortality and subsequent ICU and receiving hospital LOS.

Finally, one of the data abstractors was aware of the study objectives and we did not monitor abstractor performance other than the assessing interrater reliability at the conclusion.^{15,16}

Conclusion

One-third of trauma patients undergo CT scanning at the primary hospital before being transferred to a regional trauma centre. Obtaining a CT scan before transfer is associated with an increased LOS of 90 minutes before

Table 1. Time analysis for 216 trauma patients transferred to a regional trauma centre

Variable	Received a CT scan*		p value
	Yes; n = 72	No; n = 144	
Mean ISS (95% CI)	27.0 (24.3, 29.6)	25.2 (23.7, 26.8)	0.16
Median LOS, min (IQR)	213.0 (157.3, 277.5)	118.0 (81.0, 174.5)	< 0.001
Mean LOS, min (95% CI)	238.5 (209.7, 267.3)	148.1 (119.7, 176.5)	< 0.001
Median sensitivity analysis, min (IQR)	205.0 (140.0, 263.0)	133.0 (85.0, 213.0)	< 0.001
Mean sensitivity analysis, min (95% CI)	230.0 (203.1, 256.9)	162.0 (137.5, 186.5)	< 0.001

CI = confidence interval; ISS = Injury Severity Score; IQR = interquartile range; LOS = length-of-stay.
*A worst case sensitivity analysis imputed missing values for 7 patients in the CT group and 26 in the non-CT group as described in the Methods section.

transfer, on average. This relatively common practice, which would not appear to contribute to definitive trauma management, contradicts the long-standing emphasis on rapid transfer to regional trauma centres in the interest of timely intervention.

Competing interests: None declared.

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