Effect of an Emergency Medicine Resident as Team Leader on Outcomes of Trauma Team Activations

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ABSTRACT

Objectives: Traditionally, a surgeon has served as trauma team leader (TTL). However, this role is increasingly being performed by emergency medicine (EM) physicians. At the Halifax Infirmary, we utilize a resident TTL (rTTL) under supervision of a staff traumatologist, a duty shared between EM and surgical residents. Our objective was to compare outcomes between cases led by EM and surgical rTTLs.

Methods: This was a retrospective case-control study of data collected from the Nova Scotia Trauma Registry. Eligible cases were attended to by the trauma team from April 4, 2014, to March 31, 2015. Primary outcome of interest was in-hospital mortality. Secondary outcomes included hospital admission, hospital length of stay (LOS), intensive care unit (ICU) admission, ICU LOS, ventilator requirement, operating room use, and time to operating room. Univariate comparisons were made using t-tests and Fisher's test. We used logistic and linear regression to adjust for confounding.

Results: A total of 571 patients were included in the analysis. A total of 179 (31.3%) were managed by an EM resident and the remainder were managed by a surgical resident. There was no statistical difference in mortality or secondary outcomes on the crude or adjusted estimates. Eighteen patients (10.1%) in the EM group died compared to 37 (9.4%) in the surgical group.

Conclusions: There was no difference in any patient outcome between cases managed by EM and surgical rTTLs. These findings support the philosophy that both groups are effective as rTTLs and should be trained in trauma leadership. Further research is warranted in introducing the rTTL into other systems.

Trauma is a complex disease that requires a multiple disciplinary approach to provide care in a coordinated and efficient manner. Based on the recommendations of the American College of Surgeons and the Advanced Trauma Life Support (ATLS) course,¹ many trauma systems have a formalized trauma team responsible for rapidly resuscitating and stabilizing major trauma

patients.² This team approach allows for distribution of tasks involved in assessment and resuscitation, thereby reducing time from injury to diagnosis and treatment.² An essential component of this team approach is a dedicated trauma team leader (TTL) who is responsible for the overall resuscitation and ensures adherence to ATLS guidelines³ in a coordinated fashion.⁴ The optimal

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structure and style of leadership are influenced by the composition of the trauma team and the characteristics of the trauma patient.⁴

Traditionally, the role of TTL has been performed by a surgeon. However, in Canada the TTL is frequently an emergency medicine (EM) physician.⁵ Accordingly, trauma care and management has been incorporated as part of EM residency training programs, in addition to other residency programs such as orthopedics, neurosurgery, and anesthesia. The Royal College of Physicians and Surgeons of Canada have outlined specific objectives of training in general surgery (GS) and EM.^{6,7} These objectives include establishing and maintaining the clinical knowledge, skills, and attitudes necessary to provide appropriate trauma care.

How residents gain the proper experience, leadership skills, knowledge, and procedural competence to become an effective TTL is unclear. An important facet of trauma leadership training is the role of resident TTL (rTTL); a trainee who works closely yet semi-independently with a TTL. Formal evaluation of rTTL role has not been performed. Certainly, the training of competent TTLs in a system where many TTLs do not have a surgical specialty requires investigation. Previous studies have compared trauma care led by surgeon and nonsurgeon TTLs and have demonstrated that patient outcomes were similar.^{8,9} It is unknown whether this lack of difference in outcomes between cases led by surgeon and nonsurgeon is generalizable to the rTTLs.

The purpose of this study was to compare the effect of having an EM resident compared to a GS resident as the rTTL on patient outcomes at a Level I trauma center. Our primary hypothesis was that mortality would be similar in major trauma cases led by surgeon and nonsurgeon rTTLs.

METHODS

Study Setting and Population

The Charles P. Keating Emergency Department at the Queen Elizabeth II Health Sciences Centre (QEII HSC) is an adult (age ≥ 16 years) academic emergency department (ED) that serves Halifax and the surrounding area. It is a Level I trauma center that also serves as the primary trauma referral center in the province of Nova Scotia (NS), with a population of approximately 1 million (2015). All adult patients who sustain major trauma in NS are transferred to the QEII HSC for assessment by the Trauma Nova Scotia (TNS) Trauma Service, where an EM physician is the TTL over 50% of the time.

The Nova Scotia Trauma Registry (NSTR) definition for “major trauma” is any injury with an Injury Severity Score (ISS) ≥ 12 and an appropriate International Classification of Disease External Cause of Injury Code. Penetrating injury cases with an ISS ≥ 9 are also considered to be major traumas, as well as any trauma team activations (TTAs) regardless of ISS. The criteria for TTA include physiologic, anatomic, mechanistic, and logistic considerations.¹⁰

Prior to April 1, 2014, the on-call GS resident served as the dedicated rTTL, a defined role within the trauma team. At each trauma activation, the rTTL was formally introduced as the leader, and all decisions regarding the care of trauma patients were discussed between the rTTL and TTL (who was present at all trauma team activations), with the rTTL charged with all communication and coordination of the trauma team. Unless clinically necessitated, the rTTL did not actively perform patient assessments or invasive procedures and would delegate these tasks to other members of the trauma team that included residents from anesthesia, orthopedics, radiology, and an alternative GS resident.

On April 1, 2014, a shared rTTL model was instituted which allowed a senior FRCPC (Fellow of the Royal College of Physicians of Canada) EM resident to act as rTTL for 2 days of each week. The remainder of the trauma team members remained the same, including the presence of a GS senior resident who was present should the patient require immediate transport to the operating room. The functions and expectations of the rTTL role are identical for both EM and GS residents. Residents in both specialties start performing the rTTL role in their third year of residency training.

Study Design and Eligibility Criteria

This was a retrospective study of TTAs at a Level I trauma center over a 1-year study period. We included all adult (age ≥ 16 years) trauma patients who presented to the QEII HSC and were attended to by the trauma team between April 1, 2014, and March 30, 2015. Excluded were any cases of trauma caused by drowning, asphyxiation, or burns. This study was performed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies.¹¹ Ethical approval was obtained from the Nova Scotia Health Authority (NSHA) Research Ethics Board. Funding was provided through the Research in Medicine program of Dalhousie Medical School.

Data Collection

Data for this study were collected from the NSTR. The NSTR is a provincial registry that is administered by TNS and includes in-depth information about every patient seen by a trauma team at a Nova Scotian institution. Data elements collected from the NSTR included demographics (age, sex), injury type (blunt or penetrating), ISS-90, Abbreviated Injury Scale (AIS-90) score, specialty of trauma team leader, time to presentation, time to operating room, length of stay (LOS) in-hospital, LOS in the intensive care unit (ICU), days requiring mechanical ventilation, and in-hospital mortality.

Outcome Measures

The primary outcome of interest was in-hospital mortality for patients managed by an EM rTTL and those managed by a GS rTTL. As secondary outcomes, we assessed hospital admission, hospital LOS, ICU admission, ICU LOS, ventilator requirement, ventilator days, decision to go to the operating room, and time to operating room.

Data Analysis

We utilized logistic and linear regression models to adjust for possible confounders. These additional predictors included patient age, patient sex, the service of the supervising TTL (anesthesia, EM, surgery or a “mixed call” [i.e., the shift was covered by EM and another service]), injury mechanism (penetrating vs. blunt), ISS-90, and the maximum AIS-90 score for each body region. We made univariate comparisons using Welch’s *t*-test for continuous variables, and we used Fisher’s test for comparisons of count variables. Crude and adjusted odd ratios (ORs) are reported for the measurement of effect size, with 95% confidence intervals (CIs). The dynamic between the rTTL’s service and the supervising TTLs service was studied using a logistic regression model, including a second-order interaction effect between the service types outlined above. This was done to assess whether the mere presence of the supervising TTL would overwrite the rTTL’s decisions regardless of service.

RESULTS

The selection of cases for this study is shown in Figure 1. Overall, a total of 571 trauma patients were included in the analysis. Of these 179 (31.3%) were managed by an EM rTTL. The breakdown of trauma

patient and supervising staff characteristics is shown in Table 1. Patients seen by GS rTTLs and EM rTTLs were similar in age, sex, injury severity, and time to presentation. Although the majority of TTLs were EM-based, there were some differences in the distribution of supervising TTL staff person between the two groups, with a higher frequency of anesthesia staff supervising the EM rTTL, compared to a higher relative frequency of GS staff supervising the surgery rTTL.

The unadjusted effect estimates are shown in Table 2, and the adjusted analyses are summarized in Table 3. The crude effects model demonstrated no differences between the two groups for mortality and the secondary outcomes. After age, sex, specialty of supervising TTL, injury mechanism, ISS-90, and maximum AIS-90 score for each body region were controlled for, there was no difference in patient mortality between EM and GS rTTLs. Additionally, there was no effect demonstrated by the discipline of the supervising TTL on the case.

Age was associated with increased probability of mortality and increased hospital LOS. ISS-90 was associated with increased mortality, ventilator requirement, ventilator days, ICU admission, ICU LOS, hospital admission, hospital LOS, and operating room use. However, increased ISS-90 was not associated with time to operating room. Traumatic brain injury (TBI) was associated with increased probability of mortality, decreased probability of going to the operating room, and decreased ICU LOS. When secondary outcomes were considered, we did not find any difference

Figure 1. Selection of trauma cases managed by EM and GS (rTTLs). EM = emergency medicine; GS = general surgery; rTTLs = resident trauma team leaders.

Table 1
Demographics of Cases Managed by EM and Surgical rTTLs

Variable	EM rTTL (n = 179)	GS rTTL (n = 392)	p-value
Age (years)	49.9 (± 22.0)	53.5 (± 22.9)	0.08
Sex, male	126 (70.3)	268 (68.4)	0.70
Injury type			1.000
Blunt	166 (92.7)	363 (92.6)	
Penetrating	13 (7.3)	29 (7.4)	
ISS-90	19.0 (± 9.8)	18.9 (± 9.7)	0.87
TBI (AIS ≥ 3)	65 (36.3)	186 (47.5)	0.014
Attending TTL services			<0.001
Emergency	109 (60.9)	249 (63.5)	
Anesthesia	23 (12.8)	22 (5.6)	
GS	6 (3.3)	49 (12.5)	
Orthopedic surgery	39 (21.8)	74 (18.9)	
Neurosurgery	7 (3.9)	9 (2.3)	
Time to presentation (hours)	7.76 (± 28.1)	11.4 (± 47.1)	0.31

Data are reported as mean ($\pm$ SD) or *n* (%).

AIS = Abbreviated Injury Scale; EM = emergency medicine; GS = general surgery; ISS = Injury Severity Score; rTTL = resident trauma team leader; TBI = traumatic brain injury.

Table 2
Univariate Estimates for Primary and Secondary Outcomes

Outcome	EM rTTL (n = 179)	Non-EM rTTL (n = 392)	p-value
Mortality	18 (10.1)	37 (9.4)	0.88
Ventilator requirement	47 (26.3)	91 (23.2)	0.46
Ventilator days	3.4 (± 3.8)	4.4 (± 5.0)	0.21
ICU admission	51 (28.5)	87 (22.2)	0.11
ICU LOS (days)	4.8 (± 4.6)	6.5 (± 6.4)	0.08
Hospital admission	159 (88.8)	349 (89.0)	1.00
Hospital LOS (days)	15.8 (± 27.4)	15.5 (± 21.1)	0.90
Operating theater use	64 (35.8)	140 (35.7)	1.00
Time to operating room (hours)	11.7 (± 6.0)	11.4 (± 6.5)	0.78

Data are reported as *n* (%) or mean ($\pm$ SD).

EM = emergency medicine; ICU = intensive care unit; LOS = length of stay; rTTL = resident trauma team leader.

between cases managed by EM and GS rTTLs, nor was there any effect due to the discipline of the supervising staff. In general, more severely injured patients (per the ISS-90 score) tended to have worse outcomes. The logistic regression model studying the interaction between supervising TTL service and rTTL service did not show any statistically significant associations for patient mortality.

DISCUSSION

Trauma care in Canada varies by province, reflecting their unique geography and the variance in the proportion of the area considered rural and urban. In

Ontario 84.8% of the population live within a 1-hour drive to a Level I or II trauma center.¹² In contrast, 42.3% of the population in Newfoundland live more than four hours from the nearest Level I or II trauma center.¹² One solution for patients that are remote from definitive trauma care is for local hospitals to be involved in early trauma care and triage. The implementation of an inclusive trauma system requires that nonsurgeon physicians and other health care providers have expertise in trauma resuscitation to improve patient outcome. How to train physicians in trauma resuscitation leadership within their residency programs has not been fully investigated. Although the effect of the presence of an EM residency program at

Table 3
Adjusted Estimates for Primary and Secondary Outcomes

Effect	Mortality	Ventilator Requirement	Ventilator Days	ICU Admission	ICU LOS (Days)	Hospital Admission	Hospital LOS (Days)	Operating Theater Use	Time to Operating Room (Hours)
EM resident	0.98 (0.47 to 2.06); 0.961	1.08 (0.66 to 1.79); 0.756	-0.37 (-0.97 to 0.23); 0.226	1.44 (0.88 to 2.38); 0.148	-0.35 (-1.14 to 0.44); 0.390	1.10 (0.51 to 2.40); 0.807	1.37 (-3.12 to 5.87); 0.549	0.84 (0.53 to 1.31); 0.437	0.08 (-2.01 to 2.18); 0.939
Staff service									
Anesthesia (ref)	1.00 (NA)	1.00 (NA)	0.00 (NA)	1.00 (NA)	0.00 (NA)	1.00 (NA)	0.00 (NA)	1.00 (NA)	0.00 (NA)
Emergency	1.87 (0.39 to 9.03); 0.437	1.94 (0.69 to 5.45); 0.211	-0.39 (-1.45 to 0.66); 0.461	2.09 (0.75 to 5.84); 0.161	-0.28 (-1.68 to 1.11); 0.691	0.83 (0.22 to 3.07); 0.780	-1.70 (-9.62 to 6.22); 0.674	1.17 (0.53 to 2.62); 0.694	1.18 (-2.06 to 4.42); 0.473
Surgery	1.48 (0.29 to 7.62); 0.639	2.24 (0.77 to 6.56); 0.141	-0.60 (-1.71 to 0.51); 0.290	2.45 (0.84 to 7.12); 0.100	-0.46 (-1.93 to 1.02); 0.544	0.59 (0.15 to 2.36); 0.460	-3.72 (-12.1 to 4.64); 0.382	0.86 (0.37 to 2.01); 0.725	-0.28 (-3.93 to 3.37); 0.881
Mixed call	2.25 (0.16 to 31.8); 0.550	3.91 (0.6 to 25.42); 0.153	-0.36 (-2.49 to 1.77); 0.740	3.96 (0.62 to 25.3); 0.145	0.58 (-2.25 to 3.40); 0.688	1.26 (0.08 to 2.00); 0.872	-10.5 (-26.5 to 5.56); 0.200	0.23 (0.02 to 2.23); 0.204	2.18 (-4.6 to 8.97); 0.526
Age	1.04 (1.02 to 1.05); <0.001	0.99 (0.98 to 1.01); 0.104	-0.01 (-0.02 to 0.01); 0.231	0.99 (0.98 to 1.00); 0.057	-0.01 (-0.03 to 0.01); 0.327	1.00 (0.99 to 1.02); 0.750	0.15 (0.06 to 0.25); 0.002	0.99 (0.99 to 1.01); 0.204	0.04 (0.00 to 0.08); 0.067
Male sex	1.14 (0.57 to 2.28); 0.720	1.50 (0.88 to 2.56); 0.135	0.73 (0.14 to 1.33); 0.016	1.24 (0.73 to 2.10); 0.428	0.71 (-0.08 to 1.50); 0.076	0.97 (0.46 to 2.02); 0.928	1.22 (-3.26 to 5.71); 0.592	1.06 (0.67 to 1.67); 0.811	-0.06 (-2.17 to 2.05); 0.956
Penetrating injury	2.96 (0.71 to 12.3); 0.135	4.17 (1.83 to 9.48); <0.001	0.06 (-0.98 to 1.09); 0.914	2.31 (0.98 to 5.47); 0.057	-0.05 (-1.43 to 1.32); 0.938	1.60 (0.55 to 4.59); 0.387	-0.25 (-8.04 to 7.53); 0.949	1.87 (0.88 to 3.96); 0.102	-6.44 (-9.62 to -3.25); <0.001
ISS-90	1.07 (1.03 to 1.11); <0.001	1.10 (1.07 to 1.14); <0.001	0.15 (0.12 to 0.18); <0.001	1.11 (1.08 to 1.15); <0.001	0.20 (0.16 to 0.24); <0.001	1.22 (1.15 to 1.30); <0.001	0.81 (0.58 to 1.04); <0.001	1.06 (1.03 to 1.08); <0.001	-0.03 (-0.15 to 0.09); 0.639
TBI	2.48 (1.17 to 5.28); 0.018	1.33 (0.78 to 2.25); 0.290	-0.63 (-1.30 to 0.03); 0.061	1.04 (0.61 to 1.77); 0.892	-1.14 (-2.02 to -0.26); 0.011	0.84 (0.27 to 2.62); 0.771	-0.73 (-5.72 to 4.25); 0.774	0.41 (0.25 to 0.69); <0.001	-0.55 (-2.76 to 1.66); 0.626
Hours to presentation	1.00 (0.99 to 1.01); 0.635	1.00 (0.99 to 1.01); 0.611	0.00 (-0.01 to 0.01); 0.163	1.00 (0.99 to 1.01); 0.599	0.00 (-0.01 to 0.01); 0.259	1.03 (0.97 to 1.09); 0.330	0.00 (-0.05 to 0.05); 0.954	1.00 (0.99 to 1.01); 0.915	0.02 (-0.01 to 0.04); 0.141

Data are presented as OR (95% CI); p-value.

EM = emergency medicine; ISS = Injury Severity Score; ICU = intensive care unit; LOS = length of stay; NA = not applicable; rTTL = resident trauma team leader; TBI = traumatic brain injury.

Level I trauma centers has been studied,¹³ the impact of having an EM residency trainee as the rTTL has not been previously characterized.

The complex nature and variability of traumatic injuries complicates the accurate measurement of TTL/rTTL performance. Indeed, there is no consensus on the most effective tool to measure leadership or teamwork. To date, the Leader Behavior Description Questionnaire is the most widely used and validated tool.⁴ As a proxy of rTTL performance, we chose to evaluate the outcomes of cases requiring activation of the trauma team. Ours is the first study to examine to the impact of resident specialty as the trauma resuscitation leader on patient outcomes. In our investigation, we did not observe a difference in patient mortality or other outcomes between TTAs managed by an EM rTTL and those managed by a GS rTTL after controlling for potential confounding factors, which is similar to prior studies that concluded that the specialty of the staff TTL does not impact long-term patient outcomes. In 2007, Cummings and Mayes⁹ observed no difference in mortality or ED LOS between patient who were managed by surgeon and EM TTLs, a finding that was replicated by Ahmed and colleagues.⁸ In 2013, Cole et al.¹⁴ found that senior consultants specifically trained in trauma tended to bring patients to definitive imaging or intervention more quickly when compared to EM residents, although there was no difference in mortality or ICU outcomes. Hoff et al.¹⁵ stressed that most of the adherence to ATLS and performance came from merely having a leader present regardless of the level of training of the surgeon, although senior residents were less likely than staff or fellows to establish a definitive care plan. Similarly, our study did not show any association between patient outcomes and the specialty of the TTL supervisor, suggesting that trauma management may be best thought of as its own isolated, multidisciplinary specialty.

Instead of a focus on postgraduate discipline, a focus on trauma education earlier in training may be appropriate. Kensinger et al.¹⁶ described a model for surgical residents in which senior residents are utilized to teach junior residents via lecture and trauma scenario simulation. The authors also described a pilot course directed toward senior medical students as they prepare to begin their surgical residency. A similar model has been described with EM training in medical school.¹⁷ Academic programs in Canada have identified teaching as an essential part of residency training.¹⁸ The “resident-as-teacher” model

lends itself to the rTTL model that we have employed in our trauma system in NS, as well as open the possibility of extending such training to the undergraduate level. Impetus for earlier training may be found in work by Leeper et al.¹⁹ who found the rate of missed injury in trauma patients was almost twice as much among EM physicians in comparison to surgeons (20.1% vs. 10.6%). Another point in favor of earlier education is that there may be a tacit expectation that EM trainees are expected to begin managing trauma cases during their residency. Indeed, a study by Howell and colleagues²⁰ reported that EM residents at Level I trauma centers directed trauma resuscitations a mean of 52.0% of the time, a finding that increased on average to 70.0% in non–Level I centers.

In addition to having technical expertise in resuscitation, the rTTL must learn to be adept in certain nontechnical skills. Effective communication is necessary to coordinate and supervise the activities of team members. This includes nonverbal communication, which can have a decisive role in the interaction between members of the team.²¹ The quality of leadership is another important key to the performance of the trauma team. The team’s perception of leadership has a positive association with clinical efficiency.²² Resuscitation leadership training programs that employ a combination of didactic teaching with simulations have been shown to improve team performance.⁴ Comprehensive training is essential for trainees to master both the technical and the nontechnical skills that are required to become a competent and effective TTL.

LIMITATIONS

Our study is limited by its retrospective design. We did not perform a formal power calculation, so it is possible our study was underpowered to detect clinically significant outcomes. It is our hope that future research would be able to use our measurements to inform their power analyses. Assuming that the effect we observed for our primary outcome is true, one would need a much larger sample size of 64,516 patients to detect this effect. Although the NSTR has multiple quality control procedures in place to ensure data element quality, it is not tailored to address our specific research question.

It is possible that our findings may be due to unmeasured confounders that were not included in

our models. One such example is the overrepresentation of an anesthesia staff person and underrepresentation of TBI in the EM resident group. TBI was associated with increased mortality. The mortality difference was 7.4% greater in the EM group, although this difference was not statistically significant. Had there been a similar distribution of TBI between our study groups, it may have increased the mortality difference and affected our conclusions. More research is required to determine whether there is a mortality difference between EM rTTLs and GS rTTLs for this subset of patients. Another example is the presence of a TTL at all cases. If it is the TTL that is the most important member of the team, then this may be a limitation of our study. Although we attempted to control for the specialty of the supervising TTL, this is an area that needs further investigation. While we did not find a statistically significant interaction between the TTL and the rTTL services, this interaction would be best studied prospectively by measuring how often the TTL changes the rTTL's plan. This question could be addressed in future, prospective research. Additionally, a senior GS resident is always present for every trauma, and it is possible that they could have participated in trauma decisions if asked as a member of the team.

The geography of our trauma system may affect the external validity of our results. NS is a province with a single Level I trauma center and a single out-of-hospital paramedic service. As such, it is unclear whether our results are generalizable to larger trauma systems with multiple Level I centers. Our study also included patients that may have been stabilized at other centers before being transferred to our institution. The interventions at these preceding institutions may have affected our estimates. While our study has emphasized the importance of trauma education, it is possible that there are differences in the quality and quantity of education between the EM and GS residency training programs that were not measured as part of this study. Although there were no differences in patient outcomes between cases managed by EM and GS rTTLs, we did not evaluate adverse events that occurred during the trauma as well as the rate of imaging. Furthermore, it is possible the incidence of adverse events may be different between cases managed by EM and GS rTTLs; this is a subject deserving of further study. Finally, as noted above, 59.8% of our TTLs are EM practitioners. Our results may

not be generalizable to centers where the majority of the TTLs are surgeons.

CONCLUSIONS

In this investigation of trauma resuscitations, we found no differences in mortality or secondary outcomes between trauma cases managed by emergency medicine and surgical resident trauma team leaders. Emergency medicine residents provide care as part of a multidisciplinary trauma team with similar outcomes to general surgery residents. Further research on the effect of having an emergency medicine resident as an resident trauma team leader is warranted in other trauma systems.

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