Impact of a Triage Liaison Physician on Emergency Department Overcrowding and Throughput: A Randomized Controlled Trial

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Abstract

Background: Triage liaison physicians (TLPs) have been employed in overcrowded emergency departments (EDs); however, their effectiveness remains unclear.

Objectives: To evaluate the implementation of TLP shifts at an academic tertiary care adult ED using comprehensive outcome reporting.

Methods: A six-week TLP clinical research project was conducted between December 9, 2005, and February 9, 2006. A TLP was deployed for nine hours (11 AM to 8 PM) daily to initiate patient management, assist triage nurses, answer all medical consult or transfer calls, and manage ED administrative matters. The study was divided into three two-week blocks; within each block, seven days were randomized to TLP shifts and the other seven to control shifts. Outcomes included patient length of stay, proportion of patients who left without complete assessment, staff satisfaction, and episodes of ambulance diversion.

Results: TLPs assessed a median of 14 patients per shift (interquartile range, 13–17), received 15 telephone calls per shift (interquartile range, 14–20), and spent 17–81 minutes per shift consulting on the telephone. The number of patients and their age, gender, and triage score during the TLP and control shifts were similar. Overall, length of stay was decreased by 36 minutes compared with control days (4:21 vs. 4:57; $p = 0.001$). Left without complete assessment cases decreased from 6.6% to 5.4% (a 20% relative decrease) during the TLP coverage. The ambulance wait time and number of episodes of ambulance diversion were similar on TLP and control days.

Conclusions: A TLP improved important outcomes in an overcrowded ED and could improve delivery of emergency medical care in similar tertiary care EDs.

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Keywords: triage, overcrowding, emergency department, randomized controlled trial

Overcrowding of emergency departments (EDs) has been defined by many emergency care providers as "a situation in which the demand for emergency services exceeds the ability to provide quality care within a reasonable time."[1,2] ED overcrowding is one of the most complex and challenging issues currently facing health care systems worldwide. A recent Canadian report suggested that ED overcrowding is more common in urban, teaching, and high-volume EDs and that the problem arises from system-wide factors.[3] Moreover, evidence also suggests that a variety of interventions to reduce ED overcrowding have been attempted; however, the quality of the research was low and hence potentially unreliable.

To systematically address the problem and establish effective interventions to reduce the profoundly complex problem of ED overcrowding, it is imperative to accurately assess the flow of patients through the ED and to thoroughly understand the many processes taking place in the ED. The input-throughput-output model has generally been accepted as a conceptual model (Figure 1)

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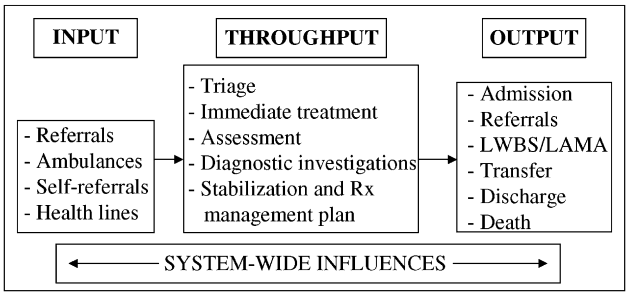

Figure 1. The input-throughput-output model adapted from Asplin et al.[4] and Fatovich[5] to conceptualize ED processes and to identify strategies for reducing ED overcrowding. LWBS = left without being seen; LAMA = left against medical advice; Rx = treatment.

for ED overcrowding.[4] The model allows a comprehensive view of the multidimensional nature of the problem and clarifies the various operational processes in the ED that may be optimized to help alleviate overcrowding. Input refers to the various modes of ED patient arrival. Throughput refers to ED work processes that are related to medical decision-making such as triage, assessment, diagnostic testing, and treatment. Output refers to patient disposition from the ED such as admission, transfer, or discharge home.

ED overcrowding has a myriad of negative effects on quality of care, patient satisfaction, and staff-related outcomes, including decreased productivity, poor morale, and staff dissatisfaction.[6] A significant proportion of morbidity and mortality cases are attributed to delays in diagnosis and treatment occurring in the ED, especially with time-sensitive diagnoses such as myocardial infarction, pneumonia, and stroke.[7] Given the increased risk of adverse outcomes associated with ED overcrowding, there is an urgent need for valid studies evaluating interventions to mitigate ED overcrowding.

This study reports a quantitative evaluation of the effect of introducing a triage liaison physician (TLP) shift in a large urban adult ED where serious overcrowding existed. A role for an emergency physician (EP) evaluating patients and initiating early investigation and treatment of ED patients before their reaching traditional patient care areas has previously been described as an experienced EP who can be assigned to the triage area to assist with the throughput process. This role has been implemented elsewhere[8–11]; however, the quality of the evaluation research identified is low. This study examines the effect of a TLP on important ED overcrowding measures such as ED length of stay (LOS) and left without being seen (LWBS) rates.

METHODS

Study Design

This was a randomized controlled trial to describe a novel physician shift in an overcrowded urban teaching hospital. The study received approval from the research ethics board (panel A) at the University of Alberta. All physicians and nurses involved in the study provided informed written consent to participate. Finally, all data were entered by staff without knowledge of the objectives of this study and these data were reported anonymously and in aggregate.

Study Setting and Population

This study was conducted over a six-week period between December 9, 2005, and February 9, 2006, with a hiatus during the holiday period (December 23, 2005, to January 12, 2006). The trial period was divided into three two-week blocks. Within each two-week block, using computer-generated random numbers, TLP shifts (from 11 AM to 8 PM) in addition to standard EP clinical shifts or standard EP clinical shifts only (control) were assigned for seven days. While the study was obviously not blinded, the outcome assessments were obtained through administrative data resources, where data analysts were unaware of the TLP assignment or the purpose of this study.

The study was performed at the University of Alberta Hospital (UAH), an urban tertiary care ED serving 55,000 adult (age older than 17 years) patients per year with well-documented ED overcrowding issues. The UAH ED is staffed by full-time EPs and provides 56 hours of scheduled attending EP coverage per day (reimbursed on a fee-for-service basis). It is an academic teaching hospital with an EM residency training program and with residents typically providing the initial ED consultation for other specialty services. Patient throughput in the ED is primarily the responsibility of attending EP staff. UAH is the primary receiving hospital for patients from north-central Alberta, Nunavut, and parts of Saskatchewan and British Columbia with trauma, burn, neurosurgical, and most other serious or complex subspecialty problems. During the control shifts, no additional EP staff in typical patient care roles was available, and the nursing complement remained unchanged. Full-time EPs with more than one year of clinical experience were asked to volunteer for the TLP shifts. Not all physicians volunteered; however, seven EPs completed shifts during the study period.

All adult patients (17 years or older) seen in the UAH ED during the study blocks were considered. Patients younger than 17 years were seen in the pediatric ED, whose physicians also took all their own outside calls and were not involved in the study.

Study Protocol

During the TLP shifts, a physician was assigned to the ED for the purpose of mitigating those factors impeding throughput. The main roles of the TLP were to answer all incoming physician calls, to support and assist triage nurses, to evaluate ambulance patients awaiting ED bed placement to determine who could safely wait, to initiate clinical patient evaluation and diagnostic studies to shorten ED time when stretchers became available, to initiate treatment if appropriate, and to deal with administrative issues should they arise. The TLP was not involved in the primary process of triage, which was performed by dedicated ED triage nurses. Only if a specific question arose during the triage process would the TLP be involved in the specifics of ED triage. The roles and responsibilities of the TLP are summarized in Appendix A (available as an online Data Supplement at http://www.aemj.org/cgi/content/full/j.aem.2007.04.018/DC1). The TLP role was not designed with a goal of "see and

treat"[12,13]; however, if the TLP was able to safely complete the workup in the waiting room or the dedicated triage treatment area (two dedicated beds for triage only), a scheduled EP was able to complete the patients' assessment and discharge the patient.

The role of the TLP was approved by the UAH physician group, and funding for the TLP for each shift was provided by Capital Health. Two TLP pilot shifts were completed in the fall of 2005 to refine the TLP role and job description.

The UAH Emergency Department Information System (EDIS) database records ED patient demographics, times of routine ED events, and ED work processes, as well as allowing for the anonymous administrative evaluation and report generation. The call log of the TLP-assigned portable telephone was interrogated for the duration of each nine-hour TLP shift and minutes of use recorded. Ambulance diversion data were obtained through Capital Health from a separate database. All data comparisons included the whole 24-hour period (0000–2359) for both TLP shift days and controls.

TLP activities were recorded on data log sheets. The TLP documented each patient assessed, the problem, and the outcome of the encounter. When missing, information was recorded from the patient care sheet by a research assistant. In addition, a TLP telephone registry was maintained to determine the nature of the telephone interactions. The same dedicated portable telephone was used for all TLP shifts, and personal calls were discouraged. Finally, formal surveys of staff, including EPs and nurses, regarding their perception of the ED overcrowding issue and how the ED overcrowding problem affected them during the shift, were collected for TLP shifts only (see Appendix B, available as an online Data Supplement at http://www.aemj.org/cgi/content/full/j.aem.2007.04.018/DC2). Full qualitative analysis of the TLP role with focus groups was also performed but will be reported elsewhere.

Outcomes included number of patients presenting to the ED, LOS, triage acuity level based on the Canadian Triage and Acuity Scale (CTAS), LWBS proportion, and frequency and duration of ambulance diversion. The number of consultation and administration-related calls by the TLP and the duration of time on the phone were also recorded.

CTAS is a national standard in Canadian EDs. It is used to score the levels of severity of patients and thereby ensures that patients who need immediate care get to be seen by the physician(s) first. Acuity levels are categorized into five CTAS classes, ranging from CTAS 1, which is the most life-threatening condition and requires immediate ED care, to CTAS 5, which is the least urgent condition for which investigations or interventions could be delayed.[14,15]

Data Analysis

Median and interquartile ranges (IQRs) are reported for continuous skewed data. Comparisons of continuous data were performed using either a t-test or Mann-Whitney test depending on the distribution of the data. Proportions were calculated for categorical variables, and their statistical significance was determined by chi-square test. Mixed modeling methods were used to account for the correlated nature of the data. These models assumed that data collected within each 24-hour study day were correlated and that the TLP effect would be nested within that level. A mixed linear regression model was developed to determine the most significant factor(s) influencing LOS. Similarly, a generalized estimation equation logistic model was developed to determine significant factor(s) influencing patients' LWBS. All statistical tests were performed at the 0.05 level.

RESULTS

Measure of TLP Activity

During the intervention shifts, the TLPs assessed a median of 14 patients (IQR, 13–17) per shift and received a median of 15 (IQR, 14–20) medical consultation calls. Duration of actual time spent on the telephone ranged from 17 to 81 minutes during the TLP shift.

Shift Comparisons

During the 21 days of TLP shifts, a total of 2,831 patients registered with a median of 136 (IQR, 131–141) per day, compared with 2,887 with a median of 133 (IQR, 128–146) per day during the 21 days of control shifts. The mean ages of patients between the TLP and control shifts were similar (45.8 vs. 46.3 years, respectively; Table 1). Patient gender, proportion of patients at different CTAS levels, and mode of arrival were similar between the two groups.

Patient LOS

ED patients spent a median (IQR) of four hours 21 minutes (2:20–8:36) in the ED before disposition during TLP shifts, compared with four hours 57 minutes (2:38–9:21) during the control shifts (Table 2). Overall median LOS was reduced by 36 minutes. Reduction was highest for CTAS level 1 (53 minutes), although this was the smallest overall group; CTAS level 3 was the largest patient group and experienced a 39-minute reduction (Table 2).

Table 1
Baseline Characteristics of Patients Visiting the Emergency Department during the Triage Liaison and Control Shifts

Factors	Triage Liaison Physician Shifts (n = 2,831)	Control Shifts (n = 2,887)
Patients registered/ 24 hr, median (IQR)	136 (131–141)	133 (128–146)
Age (yr), mean (±SD)	46 (±20)	46 (±21)
Male patients, n (%)	1,529 (54)	1,497 (52)
Canadian Triage and Acuity Scale levels (%)		
1	1	1
2	13	14
3	51	50
4	31	31
5	4	4
Mode of arrival (%)*		
Ambulatory	71	70
Ground ambulance	26	26
Air ambulances	1	2
Others	1	3

* Values do not add to 100% due to rounding.

Table 2
Median Lengths of Stays for the Emergency Department during the Triage Liaison and Control Shifts

	Triage Liaison Physician Shifts (n = 2,841)		Control Shifts (n = 2,892)		Difference in Median (min)
Median (IQR) length of stay (hr:min)	4:21	(2:20–8:36)	4:57	(2:38–9:21)	36
Canadian Triage and Acuity Scale levels					
1	3:40	(2:28–6:39)	4:33	(2:39–9:40)	53
2	8:03	(3:45–15:53)	8:05	(3:59–17:12)	2
3	5:27	(2:56–9:46)	6:06	(3:27–10:45)	39
4	2:50	(1:33–5:03)	3:23	(1:56–5:51)	33
5	1:45	(0:59–3:01)	2:10	(1:09–4:03)	25

Variability of LOS does not appear to be related to the day of the week or CTAS level (Table 3). Using a mixed linear regression model, we identified that TLP was a significant predictor of reduced LOS after controlling for CTAS levels, disposition, age, and gender (Table 3).

Patient LWBS

Including patients who left without being registered (i.e., after triage), LWBS by a physician, left against medical advice, and left before completion of treatment, there were 179 LWBS patients during the TLP shifts and 229 during the control shifts (Table 4). Overall, LWBS was reduced by 20% with the presence of a TLP (6.3% TLP shifts vs. 7.9% control shifts; unadjusted $\rho = 0.02$). After adjusting for the correlated nature of the data, however, this reduction was no longer significant ($p = 0.20$). None of the hypothesized covariates (CTAS levels, age, and gender) were significantly associated with this outcome.

Ambulance Diversion

The median number of diversions was 13 (IQR, 11–18) during the TLP shifts compared with 13 (IQR, 13–18) during the control shifts ($p = 0.36$). The median time on diversion or pending diversion was neither clinically nor statistically different: 11 hours 59 minutes (IQR, 10:09–14:35) during the TLP shifts compared with 12 hours 35 minutes (IQR, 11:47–16:41) during the control shifts ($p = 0.27$).

Satisfaction

The majority of nurses (90%) and physicians (80%) agreed that overall patient care was improved. Eighty percent of nurses and more than 70% of physicians strongly agreed that TLPs provided valuable services in assisting patient assessment and prioritization in the triage process. In addition, nurses and physicians somewhat or strongly agreed that TLPs had a positive impact on rapidity of access to care for ambulance patients (80% of nurses and more than 70% physicians), efficiency in fulfilling clinical responsibilities (approximately 75% of nurses and nearly 80% of physicians), and communication with patients (approximately 80% of nurses and 70% of physicians).

DISCUSSION

Overcrowding is a serious problem that is impacting the quality of emergency care in many North American EDs. Despite its importance, surprisingly few high-quality studies have been published on interventions to reduce overcrowding, especially using a role similar to that of the TLP.[8,9] This randomized controlled trial describes a

Table 3
Mixed Regression Model for Identifying the Major Predictor to Reduced Length of Stay

	Estimate	95% CI	Overall F	p-value
Triage liaison physician on shift	−0.09	(−0.16, −0.02)	6.15	0.01
Disposition				
Discharged	−0.92	(−0.98, −0.86)	937.88	<0.001
Canadian Triage and Acuity Scale levels				
1	−0.03	(−0.27, 0.22)	131.48	<0.001
2	0.95	(0.82, 1.08)		
3	0.86	(0.75, 0.98)		
4	0.41	(0.29, 0.52)		
5	Reference			
Age/year	0.007	(0.006, 0.008)	136.22	<0.001
Gender				
Female	0.05	(0.008, 0.10)	5.39	0.02

Table 4
Total and Proportion of Patients Who Left the Emergency Department during the Triage Liaison and Control Shifts

	Triage Liaison Physician Shifts (n = 2,831)		Control Shifts (n = 2,887)	
Outcomes	n	%	n	%
Left without being registered	0	—	6	0.21
Left without being seen	154	5.42	192	6.64
CTAS 2	0		3	
CTAS 3	87		90	
CTAS 4	63		87	
CTAS 5	4		12	
Left against medical advice	18	0.63	20	0.69
Left before completion of treatment	7	0.25	11	0.38
Total left without being seen	179	6.32	229	7.93
Unadjusted odds ratio (95% CI)	0.77		(0.63, 0.96)	
Adjusted odds ratio (95% CI)	0.77		(0.54, 1.10)	

CTAS = Canadian Triage and Acuity Scale.

novel physician shift in an overcrowded urban teaching hospital. Overall, this study indicates that the TLP shift is partially effective in reducing ED overcrowding.

There are several important findings of this study that warrant comments. First, the presence of the TLP shifts reduced the average LOS of patients seen in the ED during a 24-hour day during which the TLP shift occurred. Second, using mixed regression modeling, LOS was found to be related to a variety of factors, and the TLP influence remained significant after adjustment. Third, the proportion of LWBS patients was reduced, although the difference was not significant after appropriate adjustment. Recent research from this center indicates that LWBS patients represent potential medical-legal risks due to further delays in assessment and treatment.[16] Fourth, the qualitative surveys suggest that the TLP was well received by the nurse and physician staff in the ED. The nurses appreciated the assistance of a physician to share the burden of decision making and controlling the chaotic waiting room environment (with higher-acuity patients waiting longer for an ED bed assignment). For the staff physicians, the major benefit was a significant decrease in the number of interruptions in tasks that were a big part of their normal shifts,[17] as well as having appropriate patient workups already initiated on some patients.

The EPs in the TLP role recognized that their ability to evaluate patients was quite limited due to persistent access block.[18] The TLP could not fully evaluate a complex patient with presenting problems such as syncope, generalized weakness and dizziness, or abdominal pain in the waiting room. Patients with such complex complaints, however, still received a brief assessment from the TLP where diagnostic studies were initiated while awaiting placement in an appropriate patient care area.

It has been widely recognized that ED overcrowding is a system-wide problem with no simple or immediate solutions.[2,3] This problem leads to important delays in patient care and frustration for patients and creates staff dissatisfaction. It is no surprise that, where examined, emergency services are consistently rated the lowest in health quality surveys.[19] Given the frequency and severity of ED overcrowding in Canada, it is surprising that there have been so few published studies addressing the problem, as compared with the wide documentation of the same problem in the United States. The extent of overcrowding, the type of EDs affected, the perceived causes, and the adverse effects have been reported primarily in the United States, with a few U.K. and Canadian studies.[3,6,7,20–23] A recent systematic review of the medical literature that examines interventions to address ED overcrowding identified a wide variety of strategies designed to reduce the burden of this problem on the institution under study.[3] Many studies dealt with fast-track systems, triage, physician order entry, and system-wide or multiple interventions. Overall, most of the interventions, except triage, resulted in improvements in the measures of ED overcrowding. Only four other studies identified TLP-type approaches.[8–11]

One of the strengths of this study was the availability of EDIS data to accurately compare time outcome measures. In many EDs, there are serious limitations of current local, provincial, and federal efforts to accurately document the degree of ED activity and, therefore, ED overcrowding.[24] Accurate data collection on ED workflow and intervals involved in patient throughput is essential to the evaluation of any intervention to address ED overcrowding. An EDIS to track patients and log their flow through the ED offers an ideal tool to support this data acquisition.

In 2005, the U.S. Joint Commission on the Accreditation of Healthcare Organizations instituted a new standard to identify and mitigate obstacles to the efficient flow of patients throughout hospitals. The new standard recognizes the ED as being particularly susceptible to poor management of patient flow.[24] In the United Kingdom, the Department of Health has given priority to reducing wait times in Accident and Emergency Departments, with impressive results. In Canada, the Canadian Association of Emergency Physicians, in collaboration with National Emergency Nurses Affiliation, has initiated the "Stop the Waiting" campaign.[20] These efforts are designed to educate the public and health care workers of the dangers of excessive waiting times and overcrowding in the ED and to help lobby for change.

LIMITATIONS

There are a number of limitations to this study that require comment. First, the TLPs were not a random selection of EPs, and these results would apply to centers where EPs with a working knowledge of the institution are available.

Second, there is no definitive measure of ED overcrowding. While complex systems for measuring the state of ED overcrowding have been developed,[25] there is a recent move toward the simple and more complete measuring of ED LOS.[26] This study examined important consequences of ED overcrowding, however, including LOS, LWBS, and ambulance diversion. Third, we did not conduct a formal cost evaluation; however, it is important to note that the EP group practices in a fee-for-service environment. The TLP was paid a fixed stipend per shift and did not bill for patient care activities.

Fourth, the TLP intervention had positive effects on patient throughput in the study site, a tertiary care, teaching, regional referral hospital with significant ED overcrowding. While the ED practice environment (i.e., complex patients, multiple consultation and transfer telephone calls for EPs) resulting from this role may have had an impact on the success of the TLP role, it is not clear what the impact of a TLP role would be in a community hospital ED.

Fifth, the TLP intervention is considered a throughput intervention and may not address the most important issues contributing to ED overcrowding. A 2005 Canadian survey of ED directors concluded that many (62%) urban EDs experienced severe overcrowding and most directors (85%) perceived access block, or an insufficient number of inpatient beds, to be the main cause of overcrowding.[3] To resolve the problem of an insufficient number of inpatient beds would likely require a health system infrastructure change on par with the recently implemented four-hour rule in the United Kingdom.[23]

Sixth, the unblinded nature of the study introduces a possible Hawthorne effect; however, the primary outcomes were quantitative and could not be easily influenced by this bias. Any biases would be introduced to the survey collection of opinion. Finally, while adding another staff physician may have been similarly effective, we believe the unique function of the TLP was critical to improving patient throughput. Adding another staff physician would not have decreased telephone interruptions or relieved crowding. As the EPs reviewed strategies to address ED crowding and lack of throughput, a variety of options, including increased typical EP coverage, were considered. Frequently, EPs on shift were idle, unable to care for waiting patients due to lack of available patient care spaces in the ED. A strong consensus was developed by physician and nursing staff that, given the current circumstances, simply adding more of the same format of physician coverage would be ineffectual in addressing the impact of ED crowding and lack of throughput.

CONCLUSIONS

Notwithstanding the above concerns, using high-quality research methods, comprehensive outcome reporting, and blind outcome ascertainment, the results of the present study indicate that a TLP reduces LOS and, to a lesser degree, the number of patients LWBS in an overcrowded ED. In addition, there was high nurse satisfaction due to increased physician support and high physician satisfaction due to improved quality of work life. The findings suggest that implementation of this type of intervention could provide significant improvement in the provision of medical care in an ED in a tertiary care institution. Further research evaluating the impact of this intervention in other settings and assessing other interventions to address ED crowding and throughput is required.

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Erratum

In the print issue of the supplement to the May 2007 issue of *Academic Emergency Medicine*, abstract 233 by Rocker JA, Antony J, and Krief W (Estimated Measurements of Radiation Exposure to Pediatric Patients during a Trauma Evaluation, Acad Emerg Med 2007; 14[5, suppl1]:S95) was mistakenly listed as "Withdrawn." The text of this abstract appears below, and we apologize to the authors for this error.

233 Estimated Measurements of Radiation Exposure to Pediatric Patients during a Trauma Evaluation

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Background: Multiple radiological studies are often requested in the evaluation of trauma patients. Recent literature has demonstrated an increased risk of cancer from exposure to medical radiation. Additionally, children are more sensitive to radiation-induced cancers and will have a greater lifetime exposure to medical radiation than adults.
Objective: The objective of this study is to quantify the radiation effective dose (RED) delivered to pediatric patients during a trauma evaluation.
Design/methods: We performed a prospective observational study at a pediatric level I trauma center. Patients <18 years who presented for an initial trauma evaluation requiring the activation of the pediatric trauma team were eligible. During the trauma evaluation, a standardized data collection sheet documented mechanism of injury, Pediatric Trauma Score (PTS), interventions performed in the ED, patient disposition, and the radiological studies performed. PTS is a validated predictor of injury severity scoring scale with a score of ≤ 8 predicting a significant mortality risk. The RED was determined for each radiological study based on estimations made using size-based anthropomorphic phantoms in the pediatric ED's computed tomography (CT) scanner.
Results: A convenience sample of 33 pediatric trauma patients was evaluated. Mean age 11.5 years (SD $\pm$3.92 years), 64% males. A total of 32 patients (97%) experienced blunt trauma, with 25 patients (75.8%) as a pedestrian or bicyclist struck by a motor vehicle. The median PTS was 11 (IQR: 9, 11). A median of 2 CTs (IQR: 1, 4) was performed per patient. The mean total RED was 1,709 mrem (95% CI: 1278, 2141).

Comparision of Radiation Effective Dose Based on PTS (mrem)

Variable (95% CI)	PTS ≤ 8 (N = 6)	PTS >8 (N = 27)	Mean risk difference
Mean RED from X-ray	104 (13, 195)	179 (120, 239)	−75 (−205, 55)
Mean RED from CT	1988 (1002, 2973)	1445 (952, 1938)	543 (−474, 1559)
Mean RED Total	2092 (1162, 3022)	1624 (1119, 2129)	468 (−504, 1439)

Conclusions: This study quantified the RED that pediatric patients are exposed to during a trauma evaluation at our level I trauma center. CTs are responsible for the vast majority of the radiation exposure. The amount of radiation that pediatric trauma patients with a PTS of >8 were exposed to was not significantly different than those with a PTS <8.