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Accuracy of the Quebec pre-hospital triage scale (EQTPT) in predicting the need for trauma team activation: A retrospective administrative data study

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Abstract

Background: Trauma team activation at a Level 1 trauma centre In Quebec, Canada, is primarily at the emergency department staff's discretion. Trauma teams may be activated prehospital, based on information provided by field paramedics or in the emergency department based on the patient's condition on arrival. In this study, we examined over- and undertriage rates based on present trauma team activation criteria. We also examined if trauma team activation, for those patients solely meeting pre-hospital major trauma criteria, would result in significant overactivation of the trauma team.

Methods: This is a single-centre retrospective medical record review. Primary ambulance transport reports from May 15, 2018 to December 31, 2020, were screened to identify patients aged ≥16 years who met pre-hospital trauma triage criteria to bypass community hospitals to arrive directly at the Level 1 trauma centre. We examined pre-hospital triage criteria, trauma team involvement, Injury Severity Scores (ISS) and final disposition. Patients were evaluated for over- and undertriage and rates were compared to the rates assuming all patients were to have a trauma team activation. We considered patients overtriaged if they had a full trauma team activation but had an ISS <12 and were discharged from the emergency department. Undertriage was defined as any patient with an ISS ≥12 and did not have a trauma team activation.

Results: Of the 371 patients who met study inclusion criteria, 123 (33.3%) did not meet trauma team activation criteria, while 214 (57.7%) had a trauma team activation. Of these, 49 patients (13.2%) were undertriaged and 31 patients (8.4%) were overtriaged and 25.8% of the major trauma patients (ISS ≥ 12) were undertriaged. A trauma team activation for all meeting field triage criteria increased overtriage to 25.3% and brought undertriage rates to 0%, with statistically significant differences based on the Wilcoxon signed ranks test ($p<0.05$).

Conclusions: In this study, undertriage rates were well above 5%. Trauma team activation, based on local field trauma triage criteria adapted from the CDC-ACSCOT field triage criteria, eliminates undertriage and keeps overtriage rates below 35%. This research suggests that field triage criteria accurately predict major trauma

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and the need for the involvement of the trauma team and that the condition of the trauma patient in the pre-hospital setting is accurately predicting the need for advanced trauma care

Keywords: trauma, triage, CDC-ACSCOT, undertriage, overtriage

Background

Trauma team activation (TTA) mobilizes a multidisciplinary team of physicians, surgeons, nurses, respiratory therapists, operating room personnel, radiology, and blood bank staff to provide urgent care for major trauma patients. While the primary response of the TTA is within the emergency department, the outcome of the TTA impacts other areas of the hospital. Inappropriately triaged patients resulting in unnecessary TTA, impacts multiple departments when personnel caring for other patients must pause or stop their current activities to receive the new trauma patient in the emergency department (Schwing et al., 2019).

The American College of Surgeons (ACS) recommends full TTA based on physical signs and symptoms known to be associated with higher rates of morbidity and mortality. These TTA criteria, known as the American College of Surgeons-6 (ACS-6), include systolic blood pressure <90mmHg; penetrating trauma to the head, neck, chest, abdomen, or proximal extremities; a Glasgow Coma Scale score (GCS) <9; blood products being required to maintain vital signs; the need for airway management; or at the emergency department physician's discretion (Tignanelli et al., 2018). Institution-specific TTA criteria, to accommodate specific populations and available resources, are developed at the institution's discretion (Verhoeff et al., 2019). Field triage guidelines to bypass nontrauma hospitals include physiological criteria (e.g., GCS, systolic blood pressure, respiratory rate), anatomical factors (e.g., penetrating injuries to the head, neck, and torso, chest wall instability, crushed extremities, etc.), mechanism of injury (e.g., falls from >6 meters, high-velocity motorcycle crashes, cyclists or pedestrians hit by automobiles with significant impact, etc.), and factors specific to certain patient groups (e.g., age, pregnant females, those with bleeding disorders or who take anticoagulants, etc.; Yoder et al., 2020).

Accreditation Canada criteria require a TTA compliance rate of ≥90% when monitored on audits (Verhoeff et al., 2019). The ACS suggests that the rate of overtriage should be <25%–35%, while the rate of undertriage should not be >5% (Waydhas et al., 2018). While overtriage impacts resource use within the institution, undertriage results in a delay to definitive care and is associated with adverse events and death (Tignanelli et al., 2018). When institutions select TTA criteria, over and undertriage rates are considered when deciding if specific TTA criteria should be applied (Schwing et al., 2019).

The trauma system in the province of Quebec, Canada, is unique in comparison to most trauma systems in North America. Prehospital care is provided by primary care paramedics who provide basic life support (BLS), and hospital transfer is done solely by ground transport. In most areas in Canada and the USA, advanced care paramedics (ALS paramedics) who are authorized to perform procedures, including endotracheal intubation and administering intravenous medications, dominate prehospital care. Primary care paramedics in Quebec use noninvasive techniques and provide basic monitoring and care during transport. With the exception of geographically remote medical evacuation, air ambulances are not currently available in the province of Quebec. Paramedics use the "*Échelle québécoise de triage préhospitalier en traumatologie*" (EQTPT), a prehospital trauma triage protocol based on the Center for Disease Control – American College of Surgeons Committee on Trauma (CDC-ACSCOT), prehospital trauma triage guidelines (Institut national d'excellence en santé et en services sociaux [INESSS] Québec, 2016). In this protocol, trauma patients who meet EQTPT levels 1–2 and are ≤60-minutes transport time from a Level 1 trauma centre, will bypass Level 2 trauma centres or community hospitals and be transported directly to a Level 1 trauma centre. While patients meeting EQTPT Level 3 criteria will bypass nontrauma hospitals, they may be dispatched to a lower-level trauma hospital if located closer to a Level 1 trauma centre.

Definitions of trauma team overtriage and undertriage are inconsistent and vary within the literature (Tignanelli et al., 2018). Factors known to negatively influence timely TTA include borderline systolic blood pressures near 90mmHg or borderline GCS scores of 8–14, and failures in judgement of medical staff responsible for TTA (Tignanelli et al., 2018). Prehospital transport criteria are more plentiful than those criteria used for the initiation of a TTA. While a patient may meet the EQTPT or CDC-ACSCOT prehospital trauma triage guidelines, they may still not meet TTA criteria, including the ACS-6 that are in use in Quebec emergency departments. In this study, we aimed to examine baseline over- and undertriage rates for a population of patients who met EQTPT prehospital trauma triage criteria levels 1–3 transported to a Level 1 trauma centre. We evaluated if overtriage rates were above acceptable levels if the trauma team is activated for all patients meeting EQTPT criteria to be transported directly to a Level 1 trauma centre. We also evaluated which of the field triage criteria patients met who were found to be undertriaged in the emergency department.

Methods

Study Design

This was a single-site retrospective medical record review of all patients aged ≥16 years who sustained a traumatic injury and met the EQTPT prehospital triage criteria to bypass community hospitals and be transported directly to a Level 1 trauma centre between May 15, 2018 and December 31, 2020.

Setting

This study was conducted at one of three Level 1 trauma centres in the province of Quebec. This trauma centre is a university affiliated centre providing the highest level of trauma care. This trauma centre services a geographic area that spans the southern half of the island of Montreal and the south shore Monteregie region and is the referral centre for the northern regions of Quebec. Serving approximately 2.9 million people, the emergency department sees on average 10,000 trauma patients per year, with 1,600 being major trauma patients.

In this centre, TTA criteria include the ACS-6 criteria on patient arrival in the emergency department, along with the addition of TTA for those patients with a mangled or amputated extremity, acute paralysis, and burns to >20% of the body surface. The vital signs TTA criteria (systolic blood pressure <90mmHg and a GCS <9) are based on those of the trauma patient on arrival in the emergency department, regardless of pre-hospital vital signs, unless the physician used their discretion for TTA based on the pre-hospital notification. Nurse-initiated TTA is reserved for four TTA criteria comprising penetrating injury to the head, neck or trunk, crush or amputation above the wrist/ankle, paralysis in the context of a significant mechanism, and burns to >20% of the body surface area. It is only when one of these four TTA criteria are met (based on the prehospital report), that the nurse can initiate a TTA without physician consultation.

Data Sources and Sample

Data were collected from electronic medical records and the local trauma registry database. A deidentified list of primary ambulance transports initiated from the Monteregie region between January 1, 2018 and December 31, 2020, was received from the local health authority. This list was then sorted to include only high-priority transports for major trauma (EQTPT Level ≤3) of patients aged ≥16 years. Using emergency department arrival times, we linked these data to identify the specific patient hospital identifier associated with the ambulance transport. We then accessed electronic medical records to abstract data pertinent to the study. From the local trauma registry, we obtained the Injury Severity Score (ISS) for all included patients who were either admitted to the hospital or who had died in the emergency department. For those patients discharged from the emergency department, ISS scores are not routinely collected; for these patients, the ISS was calculated by the principal investigator and confirmed by a second investigator.

Data Collection & Analysis

A standardized data collection tool was created and used to collect patient data, including prehospital transport times, vital signs prehospital and on arrival in the emergency department, EQTPT triage level, EQTPT criteria met, TTA criteria met, trauma team involvement, ISS, and patient's final disposition. These data were then inputted into an Excel spreadsheet and a second trained reviewer verified 25% of these data to ensure accuracy. Data was represented in tables using descriptive statistics. Differences between the characteristics of the sub-groups were examined using the Kruskal-Wallis Independent-Samples test ($p<0.05$).

Patients were classified as over- or undertriaged based on current practice, if the TTA compliance rate were to be 100% using present TTA criteria and compared to the overtriage rates if all were to have a TTA based on meeting EQTPT levels 1, 2, and 3 criteria. An ISS of <12 was used as the cut-off for major trauma as per local regulating bodies.(Lorthios-Guilledroit, 2020) We considered, a patient *undertriaged* if they had an ISS ≥12 and did not have a TTA. Patients with a TTA and an ISS <12 that were discharged home from the emergency department, were classified as *overtriaged*. A patient with an ISS <12 that was not discharged home from the hospital was considered appropriately triaged. When evaluating the TTA criteria met, "need for airway management," was selected for those with a GCS <9 or who required intubation in the emergency department. When multiple TTA criteria were present, the highest priority in the advanced trauma life support (ATLS) algorithm (airway, breathing, circulation, disability) was recorded. Patients were divided into subgroups based on ISS and undertriage rates were evaluated for major traumas. The EQTPT criteria met by all major trauma patients who were found to be undertriaged were further evaluated.

We created subgroups based on EQTPT triage levels 1, 2, and 3, and over- and undertriage rates were examined for each subgroup and presented as counts and percentages. The changes in over- and undertriage rates were evaluated for statistical significance using the Wilcoxon signed-rank test (two-tailed) and 95% confidence intervals were calculated. We considered p values <0.05 as statistically significant. Nonparametric statistical tests were selected due to nonnormal data distributions with a negative skew, despite data cleaning. We used SPSS version 28 for all statistical analyses. Statistically significant difference, using Independent-Samples Kruskal-Wallis test, in age between patients who were undertriaged (mean 53.5 years) compared to patients who were not undertriaged (mean 45.5), significance level $p<0.05$.

Results

There were 2,148 primary transports from the region to the Level 1 trauma centre; 477 were high priority transports. Of the 477 high-priority transports, 385 were trauma patients. As the EQTPT protocol was officially implemented on May 15, 2018, 14 patients were excluded from transports that occurred before this date and implementation of the protocol. A total of 371 patients were retained for analysis. Sample characteristics are presented in Table 1**.** The sample population was predominantly male (70.1%) with a mean age of 46.6 years (range 16–96 years). The primary mechanism of injury was motor vehicle crashes (49.9%), followed by falls (24.5%) and penetrating trauma (11.1%). Most patients met EQTPT Level 1 criteria (n = 241, 65.0%), while 114 (30.7%) met Level 2 criteria and 16 (4.3%) met Level 3 criteria (Table 2).

While all patients met field triage criteria for major trauma, 123 (33.2%) did not meet the TTA criteria presently in use in the emergency department. The primary TTA criteria met (Table 3) were "need for airway management" (n = 132, 35.6%), followed by "systolic blood pressure <90" (n = 51, 13.7%) and "penetrating injury to head, neck, or torso" (n = 36, 9.7%). TTA at the discretion of the emergency department physician occurred in 37 (10%) patients as they did not meet any other TTA criteria. Of those who met TTA criteria, 49/248 (19.7%) were found to have an ISS <12 and were discharged from the emergency department.

Of the 371 medical records reviewed, 107 patients (28.8%) were discharged home from the emergency department, 80 patients (21.6%) were admitted to the intensive care unit, 80 patients (21.6%) went directly from the emergency department to the operating room, 80 patients (21.6%) were admitted to an in-patient unit, 16 patients (4.3%) were transferred to another

Table 1

Sample Characteristics

	Undertriage *n* (%)	Overtriage *n* (%)	Appropriate triage *n* (%)	Total *n* (%)
Total	49 (13.2)	31 (8.4)	291 (78.4)	371 (100)
Sex				
Male	34 (13.1)	22 (8.5)	204 (78.5)	260 (70.1)
Female	15 (13.5)	9 (8.1)	87 (78.4)	111 (29.9)
Age Category (years)				
16-34	8 (5.9)	16 (11.8)	112 (82.4)	136 (36.7)
35-54	18 (16.4)	9 (8.2)	83 (75.4)	110 (29.6)
55-74	14 (17.1)	6 (7.3)	62 (75.6)	82 (22.1)
75+	9 (20.9)	0 (0)	34 (79.1)	43 (11.6)
Mean age (*SD*)	53.5 (19.8)*	38.2 (15.3)*	46.23 (21.0)	46.6 (20.7)
Age range	19-94	17-65	16-96	16-96
Mechanism of Injury				
Motor vehicle crash	22 (11.9)	18 (9.7)	145 (78.4)	185 (49.9)
Fall	19 (20.9)	4 (4.4)	68 (74.7)	91 (24.5)
Penetrating	0 (0)	8 (19.5)	33 (80.5)	41 (11.1)
Pedestrian	1 (6.7)	1 (6.7)	13 (86.7)	15 (4.0)
Cyclist	5 (35.7)	0 (0)	9 (64.3)	14 (3.8)
Crush	0 (0)	0 (0)	13 (100)	13 (3.5)
Assault	2 (22.2)	0 (0)	7 (77.8)	9 (2.4)
Other	0 (0)	0 (0)	3 (100)	3 (0.8)
Trauma Team Involvement				
TTA	0 (0)	31 (14.5)	183 (85.5)	214 (57.7)
Trauma consult	40 (58.8)	0 (0)	28 (41.2)	68 (18.3)
No TTA or consult	9 (10.1)	0 (0)	80 (89.9)	89 (24.0)

Note. TTA = trauma team activation; SD = standard deviation

No significant difference between sex and triage accuracy using chi-square test, significance level $p < 0.05$.

*Statistically significant difference, using Independent-Samples Kruskal-Wallis test, in age between patients who were undertriaged (mean 53.5 years) compared to patients who were not undertriaged (mean 45.5), significance level $p < 0.05$.

*Statistically significant difference, using Independent-Samples Kruskal-Wallis test, in age distribution between patients who were overtriaged (mean 38.2 years), compared to patients who were not overtriaged (mean 47.31), significance level $p < 0.05$.

No statistically significant difference, using the Independent-Samples Kruskal-Wallis test, in age between patients who were accurately triaged (mean 46.3 years) and patients who were not accurately triaged (mean 47.59), significance level $p < 0.05$.

institution, and 8 patients (2.2%) died in the emergency department. Of those who met EQTPT Level 1 criteria, 61 patients (25.3%) were discharged home from the emergency department, while 73 patients (30.3%) were admitted to the intensive care unit. Based on ISS, 131 patients (35.3%) were considered to have had a "minor" trauma (ISS<9). Of these, 83 patients (63.4%) were discharged home from the emergency department. Of these "minor" traumas, 12 patients (9.2%) were admitted to the intensive care unit, 5 patients (3.8%) went directly to the operating room, and 24 patients (18.2%) required admission to a hospital in-patient unit (Table 4).

A total of 190 patients were found to have an ISS ≥12 (major or profound trauma). The trauma team was not activated in 49 patients (25.8%) with ISS ≥12 and as such were classified as undertriaged (Table 5). Of the patients with an ISS ≥12, 45 patients (23.7%) did not meet any TTA criteria, yet 20 of these patients had a TTA based on the emergency department physician's discretion. Of the 49 patients with an ISS ≥12 who were undertriaged, 11 required airway management, 1 needed blood products during the resuscitation, 5 patients had paralysis, and 7 patients had a systolic blood pressure <90 (Table 3). For those with an ISS of 12–25 indicating major trauma, 28 patients

Table 2

Pre-Hospital Trauma Triage Level Criteria Met by Triage Status

EQTPT Level & Criteria	Undertriage *n* (%)**	Overtriage* *n* (%)**	Total *n* (%)
Level 1	34 (14.1)	51 (21.1)	241 (65.0)
Glasgow coma scale <14	22 (13.5)	37 (22.7)	163 (43.9)
Systolic blood pressure <90	7 (14.3)	11 (22.4)	49 (13.2)
Respiratory rate <10 or >29 or ventilation support	5 (17.2)	3 (10.3)	29 (7.8)
Level 2	12 (10.5)	36 (31.2)	114 (30.7)
Penetrating injury	1 (2.9)	16 (45.7)	35 (9.4)
Suspected pelvic fracture	3 (11.5)	5 (19.2)	26 (7.0)
Acute paralysis	5 (27.8)	8 (44.4)	18 (4.9)
Crush/mangled extremity	0 (0)	4 (23.5)	17 (4.6)
Two or more long bone injuries	2 (28.6)	0 (0)	7 (1.9)
Open/depressed skull fracture	0 (0)	2 (40.0)	5 (1.3)
Chest wall deformity	1 (25.0)	0 (0)	4 (1.1)
Amputation above wrist/ankle	0 (0)	1 (33.3)	3 (0.8)
Level 3	3 (18.8)	7 (43.8)	16 (4.3)
High risk motor vehicle crash	1 (16.7)	3 (50.0)	6 (1.6)
Motorcycle crash >30kph	1 (16.7)	3 (50.0)	6 (1.6)
Pedestrian/cyclist >30kph	1 (50.0)	1 (50.0)	2 (0.5)
Fall >6m	0 (0)	0 (0)	1 (0.3)

Note. EQTPT = Quebec prehospital trauma triage scale (*Echelle Quebecois de triage prehospitalier de trauma*)
*overtriage is based on if all cases were to have a trauma team activation
**percent of criteria that is overtriaged if all cases were to have a trauma team activation

(31.4%) were considered undertriaged and did not have a TTA in the emergency department. The undertriage rate for profound trauma patients with an ISS of 26–75 was 20.8% as 21 of these patients did not have a TTA (Table 5). For those undertriaged patients, the EQTPT criteria met most frequently was a GCS <14 (*n* = 22, 44.9%) followed by a systolic blood pressure <90mmHg (*n* = 6, 12.2%), respiratory compromise (*n* = 5, 10.2%), and acute paralysis (*n* = 5, 10.2%) (Table 5).

Of those who were undertriaged, 67.3% (*n* = 34) met EQTPT Level 1 criteria, 24.5% (*n*=12) met EQTPT Level 2 criteria and 6.1% (*n* = 3) met EQTPT Level 3 criteria. Overtriage of the trauma team occurred in 8.4% (*n* = 31) of the cases (Table 6). Of the 241 patients meeting EQTPT Level 1 criteria, 8.3% (*n* = 20) were overtriaged, and 14.1% (*n* = 34) were undertriaged. A total of 10 (8.8%) of patients meeting EQTPT Level 2 criteria were overtriaged, and 12 (10.5%) were undertriaged. Patients meeting EQTPT Level 3 criteria only accounted for 16/371 (4.3%) of the patients in this study. Of those meeting Level 3 criteria, one patient (6.3%) was overtriaged and 3 patients (18.8%) were undertriaged. Overtriage rates for each individual EQTPT criteria within each level are depicted in Table 2. "Need for airway management" (*n* = 10, 7.6%) was the TTA criteria most frequently met for those who were found to be overtriaged, followed by penetrating injuries (*n* = 9, 25%), discretion of the emergency department physician (*n* = 8), systolic blood pressure <90mmgh (*n* = 3), and paralysis (*n* = 1). Discretion of the emergency department physician was the

Table 3

Primary Reason for Trauma Team Activation (TTA) and Triage Status per TTA Criteria

TTA Criteria	Undertriage *n* (%)	Overtriage *n* (%)	Total *n* (%)
Need for airway management	11 (8.3)	10 (7.6)	132 (35.6)
Systolic blood pressure <90	7 (13.7)	3 (5.9)	51 (13.7)
Penetrating injury to head, neck, or torso	0 (0)	9 (25)	36 (9.7)
Mangled extremity	0 (0)	0 (0)	13 (3.5)
Paralysis	5 (41.7)	1 (8.3)	12 (3.2)
Need for blood transfusion	1 (25.0)	0 (0)	4 (1.1)
Discretion of emergency department physician	0 (0)	8 (21.6)	37 (10.0)
None	25 (29.1)	0 (0)	86 (23.2)
Total	49 (13.2)	31 (8.4)	371 (100)

Note. TTA = trauma team activation

reason for TTA in 37 cases with 8/37 (21.6%) resulting in overtriage and 29/37 (78.4%) being an accurate triage of the trauma team (Table 3). If all patients in this study were to have had a TTA, 49/94 (51.2%) overtriaged patients would also meet present TTA criteria. Of these patients, 17 required the need for airway management, 17 had a systolic blood pressure <90mmHg, 12 had a penetrating injury, and 3 had paralysis when they presented to the emergency department.

By automatically activating all patients meeting field triage for major trauma, statistically significant changes were noted, with overtriage increasing from 8.4% to 25.3% ($p < 0.001$) and undertriage decreasing from 13.2% to 0% ($p < 0.001$). For those meeting the EQTPT Level 1 criteria, automatic TTA would increase the overtriage rate from 8.4% to 21.2%. The overtriage rate for Level 2 traumas rose from 8.8% to 31.6% and 6.3% to 43.8% for those meeting Level 3 criteria. All changes in over and undertriage rates were statistically significant difference using Wilcoxon signed-ranks test, $p < 0.05$.

Discussion

This study examined the over and undertriage rates with the present TTA criteria in use at the emergency department of a Level 1 trauma center and compared this to the over- and undertriage rates if the trauma team were to be activated for all patients meeting pre-hospital major trauma triage criteria. This study also compared the accuracy of predicting major trauma of the EQTPT prehospital trauma triage criteria, which are based on the CDC-ACSCOT prehospital triage guidelines in comparison with present TTA criteria, which includes the ACS-6, that is in use in the host emergency department.

Table 4

Final Disposition from Emergency Department and Severity of Trauma by Injury Severity Score (ISS)

Injury Severity Scores (ISS)	Disposition from Emergency Department *n* (% by row)						
	Discharge from ED	Transfer to another institution	Admission to ICU	OR	Admission to in-patient unit	Death in ED	Total
Minor (0–8)	83 (63.4)	6 (4.6)	12 (9.2)	5 (3.8)	24 (18.3)	1 (0.8)	131 (35.3)
Moderate (9–11)	12 (24.0)	5 (10.0)	7 (14.0)	9 (18.0)	17 (34.0)	0 (0)	50 (13.5)
Major (12–25)	12 (13.5)	5 (5.6)	18 (20.2)	28 (31.5)	26 (29.2)	0 (0)	89 (24.0)
Profound (26–75)	0 (0)	0 (0)	43 (42.6)	38 (37.6)	13 (12.9)	7 (6.9)	101 (27.2)
Total	107 (28.8)	16 (4.3)	80 (21.6)	80 (21.6)	80 (21.6)	8 (2.2)	371 (100)

Note. ED = emergency department; ISS = Injury Severity Score; ICU = intensive care unit; OR = operating room

Table 5

EQTPT Criteria Met for Major or Profound Trauma of Patients Who Did Not Have a Trauma Team Activation

EQTPT CRITERIA	Major trauma ISS 12–25 *n* (%)	Profound trauma ISS 26–75 *n* (%)	Total *n* (%)
GCS <14	12	10	22 (44.9)
SBP <90 mmHg	4	2	6 (12.2)
Respiratory rate <10, >29, or assisted	2	3	5 (10.2)
Penetrating injury to the head, neck, torso, extremities above the elbow or knee	1	0	1 (2.0)
Instability or deformity of the chest	1	0	1 (2.0)
Two or more long bone injuries	0	2	2 (4.1)
Suspected pelvic fracture	2	1	3 (6.1)
Acute paralysis	3	2	5 (10.2)
High risk motor vehicle crash	1	0	1 (2.0)
Pedestrian or cyclist hit >30kph or rolled over	0	1	1 (2.0)
Motorcycle crash >30kph	1	0	1 (2.0)
Total (% of total in ISS range)	28 (31.2%)	21 (20.8%)	49

Note. EQTPT = Quebec pre-hospital trauma triage scale (*Echelle quebecoise de triage prehospitalier de traumatologie*); GCS = Glasgow Coma Scale; ISS = Injury Severity Score; SBP = systolic blood pressure

Table 6

Over -and Undertriage Rates Per Present Trauma Team Activation Criteria and Prehospital Triage

EQTPT level *n* (%)	Current practice			Trauma team activation for all	
	Overtriage *n* (%)	Undertriage *n* (%)	Accurate *n* (%)	Overtriage *n* (%)	Undertriage *n* (%)
Level 1 241 (65.1)	20 (8.3)*	34 (14.1)*	187 (77.6)	51 (21.2)*	0 (0)*
Level 2 114 (30.1)	10 (8.8)*	12 (10.5)*	92 (80.7)	36 (31.6)*	0 (0)*
Level 3 16 (4.3)	1 (6.3)*	3 (18.8)	12 (75.0)	7 (43.8)*	0 (0)*
Total 371 (100)	31 (8.4)*	49 (13.2)*	291 (78.4)	94 (25.3)*	0 (0)*

Note. EQTPT = *Échelle québécoise de triage préhospitalier en traumatologie* pre-hospital trauma triage scale); TTA = trauma team activation; PH = prehospital

Present practice: over- and undertriage rates based on actual practice from medical records reviewed

Trauma team activation for all: over- and undertriage rates based on TTA for all patients meeting EQTPT levels 1-3

*Statistically significant difference using Wilcoxon signed-ranks test, $p < 0.05$

In this study, we found that 8.4% of patients who met prehospital criteria to go to a trauma centre during the study period were overtriaged for TTA in the emergency department, and 13.2% of patients were undertriaged. The undertriage rate in this study is well above the acceptable rate from the American College of Surgeons of 5% while the overtriage rate is far below the acceptable level of 35%. Another quality improvement study carried out in a Canadian trauma centre reported an undertriage rate at 41.2% prior to their quality improvement initiative (Verhoeff et al., 2019). In this study, TTA compliance rates were evaluated based on their institution's activation criteria, regardless of the patient's ISS. Their interventions to improve TTA

compliance included educational sessions along with process changes and regular audits. A similar quality improvement initiative in a pediatric emergency department in the USA reported an inaccurate triage rate (including both over and undertriage) of 27% along with an overly long delay in the arrival of the trauma team prior to their interventions involving educational activities and policy changes (Schwing et al., 2019). A systematic review of 21 studies on mistriage of trauma patients found a vast variability of over- and undertriage levels along with large variability in the definitions used for over- and undertriage. This review found undertriage rates to vary between 1 and 71.9% and overtriage rates to vary between 19 and 79% (Najafi et al., 2019).

Leaving the decision for TTA to the emergency department physician's discretion is one of the TTA criteria suggested in the ACS-6. It does, however, leave the TTA decision-making dependent on the emergency department physicians' judgement. Errors in judgement have been reported as a significant contributing factor to medical errors. Experience and training impact the decision-making of the emergency department physician, and failure to activate the trauma team for moderate to severely injured patients, particularly when they have abnormal presentations, is significantly impacted by the physician's past experiences (Shreyus et al., 2019). ACS guidelines and Accreditation Canada allow for an increased overtriage rate in order to keep undertriage rates lower thereby reducing morbidity and mortality (associated with the delay to advanced care). With 33.2% of the patients in this study not meeting any of the TTA criteria in place, the need for accuracy in emergency department physician judgement was required in a large proportion of the cases.

The low level of overtriage of the trauma team observed with a high level of undertriage indicates that the emergency department physician's discretion may not be adequately activating the trauma team to keep undertriage rates below 5%. With almost one fourth of patients with an ISS ≥12 not meeting TTA criteria, even if the compliance rate with the present criteria (excluding emergency department physician's discretion to activate) was 100%, the undertriage rate for all patients in this study would remain over the accepted value and the overtriage rates would remain low. The actual undertriage rate noted of traumas with an ISS of 12-75 was 25.8% (49/190), while the undertriage rate with 100% compliance in the present TTA criteria, which includes the ACS-6, would be 23.7% (n = 45). Using the EQTPT criteria to activate the trauma team, undertriage rates are eliminated, and overtriage is 25.3% (Table 6). The EQTPT criteria being more comprehensive than the TTA in place in the emergency department seems to be better for predicting severe injury and the need for trauma team involvement in the care of the patients. The emergency department physician's discretion for TTA in the absence of TTA criteria is underestimating the severity of injuries and the need for the care of the trauma team.

While the overtriage rates observed in this study and those calculated assuming 100% TTA criteria compliance are lower than if there was a TTA based on the EQTPT criteria alone, undertriage rates remain above 5% for both the present practice and calculations assuming 100% compliance. Failure to activate the trauma team results in poorer outcomes, increased length of stay in the emergency department, increased time to diagnostic imaging and the operating room and may result in missed injuries (Verhoeff et al., 2019). TTA based on all EQTPT level 1 criteria resulted in an overtriage rate <35%. While some of the individual EQTPT Level 2 criteria resulted in overtriage >35%, the cumulative overtriage rate was <35%. All Level 3 EQTPT criteria resulted in an overtriage rate >35%; however, this was a very small sample size and results should not be generalized to other populations.

Trauma triage audits determining over- and undertriage rates on ISS scores alone, is known to have limitations as it accounts for the worst injury in three body regions. Those with multiple significant injuries in only one body region will have a lower ISS score than their injury severity depicts (Kuo et al., 2017). Single system penetrating traumas and isolated head traumas will often have an ISS associated with minor or moderate trauma, despite the level of advanced care required. Patients who meet TTA criteria for penetrating trauma were frequently overtriaged on ISS calculations. The need for airway management was often because of a decreased GCS. A GCS <14 was the most frequent EQTPT criteria present on undertriaged patients. The need for airway management was also the most frequent TTA criteria present in overtriaged patients. Intoxication in the context of trauma complicates the assessment of the patient and may impact the physician's discretion in TTA. Clinicians should use caution when disregarding a decreased GCS in the context of an intoxicated trauma patient. A recent study found 30.4% of intoxicated head trauma patients had acute traumatic head injuries (Matthew et al., 2020). An ISS calculation is done after all injuries are identified. The ISS score is difficult to evaluate when patients die before obtaining a CT scan. Profoundly unstable patients, who died in the resuscitation room or the operating room, were found to have an ISS classification as a minor trauma. These patients had apparent profound injuries documented in the physical assessment; however, the ISS calculation did not reflect these injuries. In this study, we chose to classify these patients as "profound" trauma for analysis.

Monitoring trauma team undertriage rates is an important quality indicator and is used to assess performance in trauma hospitals. It is critical to quickly identify and intervene in life-threatening injuries to minimize morbidity and mortality (Jeppesen et al., 2020). When a trauma centre is experiencing high undertriage rates, process reviews and modifications to TTA practices are required. Missed traumatic brain injuries are associated with increased mortality (Schellenberg et al., 2019). When patients have a moderately depressed GCS, and their condition does not trigger a TTA, delays occur in the time to intervention (Schellenberg et al., 2021). In this study, 33.2% of patients did not meet TTA criteria, leaving the decision to activate for these patients solely on the emergency department physician's discretion. With the undertriage rate of 13.2% observed in this study, process changes, such as activating all patients meeting EQTPT Level 1 or 2 criteria, should be considered.

Limitations

The accuracy of information used for analysis is dependent on the information available in the electronic medical records and

the interpretation of these data by the reviewer. ISS calculations are dependent on the injuries identified on diagnostic imaging. As the ISS was developed for use in blunt trauma (Baker et al., 1974), and therefore does not reflect the difference in risk of mortality major for injuries in other specific body regions. The ISS scores for single-system traumas, such as head traumas or penetrating traumas, frequently do not reflect the gravity of the injuries (Shi et al., 2018). The definition of overtriage to exclude those with a lower ISS who were admitted to the hospital was used to account for those patients whose injuries required care from the trauma team, despite their lower ISS.

Conclusion

With the current practice in the Quebec-based Level 1 trauma centre, undertriage rates were well above the acceptable rate of <5%, yet the overtriage rates were far below the acceptable rate of 35%. Using current TTA criteria, 25.8% of major trauma patients did not have a TTA. When patients are not meeting TTA criteria in place, the emergency department physician's discretion is underestimating the severity of the injuries and the requirements of the trauma team in the care of the patient. This study indicates that quality improvement initiatives, including the evaluation of the present TTA criteria and present practice, should be reviewed to decrease the risk of increased morbidity and mortality associated with delays in definitive care for major trauma patients. Changes in TTA practices to include TTA based on the EQTPT field triage criteria, eliminates undertriage and keeps overtriage rates below acceptable rates of 35%.

Implications for Emergency Nursing

Triage in the emergency department falls typically under the RN's scope of practice. Using LEAN management concepts, processes are reviewed to identify inefficiencies (Austin et al., 2020). Processes where work is duplicated and found to be inefficient, should be minimized or eliminated.

This study evaluated if TTA for all patients meeting prehospital major trauma triage criteria would result in overactivation of the trauma team and further evaluated if the present practice was meeting standards of care. During the study period, RNs who receive prehospital major trauma notification must discuss the individual case with the emergency department physician, who then decides if there should be a TTA solely based on the prehospital report. The decision for a TTA on arrival of the patient also rested solely on the physician. This process results in the duplication of effort from the prehospital personnel to the RN to the physician. This process resulted in a variability in TTA habits that were found to result in excessive undertriage rates, thus potentially decreasing the quality of care for patients in the emergency department (Bourgeois et al., 2024). When areas of patient care are not meeting benchmarks, a root-cause analysis must be carried out to identify the potential causes, to plan quality improvement initiatives (Verhoeff et al., 2019).

The outcomes of this study suggest there is a source of inefficiencies in the trauma tirage process. By LEAN management concepts, once inefficiencies are identified, teams ought to proceed with making plans to minimize these inefficiencies. For example, the RN who receives the prehospital incoming trauma notification, could be authorized to proceed directly in activating the trauma team based on the prehospital triage tool. This would eliminate the extra step and potential subjectivity when a TTA is left to a single provider's judgement (Jelinek et al., 2014). Assembling the multi-disciplinary trauma team prior to the arrival of the trauma patient will allow necessary preparation, ultimately increasing system efficiency, and improving patient outcomes (Bourgeois et al., 2024).

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Contributions of authorship team & CRedIT author statement

All authors meet the criteria for authorship stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. Specific author contributions are as follows: study concept and design: Jeanesse Bourgeois; data acquisition, preparation: Jeanesse Bourgeois; data analysis: Jeanesse Bourgeois, Jennifer A. Knopp-Sihota; interpretation of results: Jeanesse Bourgeois, Jennifer A. Knopp-Sihota, Greg Clarke, Scott Delaney, Jeremy Grushka; first draft of the manuscript: Jeanesse Bourgeois. All authors critically reviewed the manuscript for important intellectual content and approved the final version to be published.

Ethics Approval

This study was approved by the Athabasca University Research Ethics Board (24272) and the McGill University Health Centre Research Ethics Board (2021-7693).

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Social Media

Trauma team activation based on field triage criteria was found to decrease undertriage without overly inflating overtriage.

#prehospital #traumatriage #codetrauma #quebectrauma

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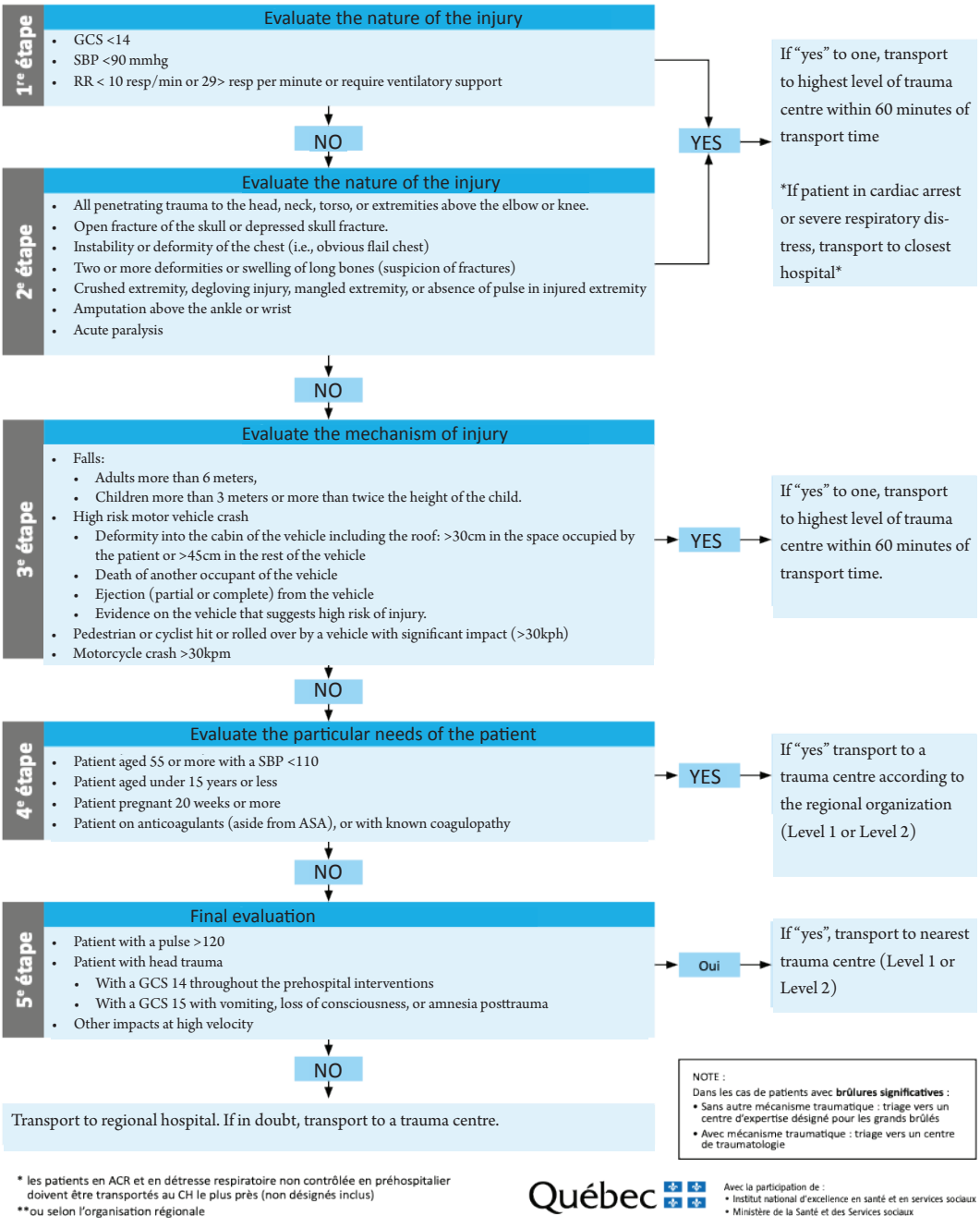
Appendix A

Quebec Prehospital Trauma Triage Scale – EQTPT

Un-official translation – « Echelle quebecoise de triage prehospitalier en traumatologie »



Appendix B

Trauma Team Activation and Consultation Criteria in Use at Level 1 Trauma Center

URGENCE **FEUILLE D'ÉVALUATION DU POLYTRAUMATISÉ** EMERGENCY TRAUMA EVALUATION FORM	**DDN**/DOB ( ) , **NAM**/RAMQ **Exp.** , **Admission-Visite**/Visit **Site:** Emplacement/Location

Critère d'activation de l'équipe de trauma (Cochez tout ce qui s'applique)
Trauma Team Activation (check all those that apply)

	Nécessite le contrôle des voies respiratoires / Need for airway management
	Pression systolique < 90 à l'urgence / Systolic BP < 90 in the emergency department
	Trauma pénétrant tête, cou ou tronc / Penetrating injury to head, neck or trunk
	Extrémité mutilé ou amputation au-dessus du poignet ou de la cheville / Mangled extremity or amputation above wrist/ ankle
	Besoin de CGR à l'urgence (RESUS) / Need for PRBC in the RESUS
	Paralysie / Paralysis
	Brûlure > 20 % surface corporelle / Burn > 20 % body surface area
	Transfert accepté par le TTL (à la discrétion du TTL) / Trauma transfer accepted by TTL (at discretion of TTL)
	Si aucun des critères mentionnés n'est présent, l'urgentologue peut activer à sa discrétion, en particulier : si l'urgentologue, après une évaluation initiale, pense qu'une activation est nécessaire; si l'urgentologue ne peut prendre en charge un patient traumatisé à cause de la charge de travail dans la salle d'ambulance If none of the above criteria are present, the emergency department physician may activate at his/her discretion, in particular: if the emergency staff, after an initial assessment feel that the patient requires a TTA, this will occur if the emergency department physician is unable to attend to a trauma patient due to increased workload in the ambulance room

Critère de consultation en traumatologie (cochez tout ce qui s'applique)

Trauma Consult Criteria (check all those that apply)

Saignement intracrânien / fracture de la base du crâne / Traumatic intracranial bleed / basilar skull fracture
GCS < 10 à l'urgence (excluant CVM) / GCS < 10 in the emergency department (excluding MVC mechanism)
Preuve de lésion de la moelle épinière / Evidence of spinal cord injury
Fracture instable de la colonne vertébrale / Unstable spinal column injury
Médiastin élargi avec mécanisme significatif / Wide mediastinum with a significant mechanism of injury
Trauma abdominal non-pénétrant avec douleur à la palpation / Blunt abdominal trauma with tenderness
Blessure significative à un simple système / Significant injury to a single system: **blessure viscérale à la tomographie** / solid organ injuy on CT scan **volet thoracique / fracture de côtes multiples** / flail chest / multiple rib fractures
Blessures à deux systèmes ou plus / Injuries to two or more body regions
Fractures du bassin / Pelvis fractures
Fracture fémorale (excluant fracture de hanche isolée) / Femur fracture (excluding isolated hip)
Blessure par balles aux extrémités / Proximal extremity gunshot wound
Patiente enceinte > 20 semaines / Pregnant patient > 20 weeks
Blessures thoraco-abdominale, patient doit être admis / Thoraco-abdominal injury, patient needs admission
Si aucun des critères n'est présent, l'urgentologue peut consulter à sa discrétion / If none of the above criteria are present, the emergency department physician may consult at his discretion

Appendix C

STROBE checklist (*STROBE Checklist*, 2023)

STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8*
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for exposed and unexposed groups.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.