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Timing of trauma team involvement and the impact on the length of stay and time to definitive care in the emergency department: A retrospective administrative data and chart review

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Abstract

Background: For patients sustaining major trauma, decreasing time to definitive care remains a primary goal. Specialized trauma team involvement is essential for coordinating the emergency department care of complex major trauma patients. The aim of this study was to evaluate if the timing of trauma team involvement impacts the length of stay and time to definitive care in the emergency department.

Methods: This is a single-centre retrospective medical record review, including patients meeting Quebec pre-hospital triage criteria for major trauma from May 15, 2018, to December 31, 2020. We assessed the time from patient arrival until departure from the resuscitation room, time to CT scan, time to disposition, and overall length of emergency department stay. Patients were grouped according to the timing of trauma team activation (TTA) as (1) pre-hospital notification, (2) on arrival in the emergency department, (3) receiving a trauma consult only, or (4) no trauma team involvement. Mean times and standard deviations were calculated, and group differences were assessed using the Kruskal-Wallis test and the independent sample Mann-Whitney U test.

Results: We identified 371 patients meeting our inclusion criteria; there were no differences between groups in mean time spent in the resuscitation room based on the timing of trauma team involvement (45–51 minutes, $p = 0.422$). A trauma team activation with pre-hospital notification was associated with a statistically significant shorter time to CT scan (62–81 minutes, $p = 0.010$), time to disposition (6:37–13:41, $p < 0.001$), and total emergency department length of stay (9:22–23:16 hours:minutes, $p < 0.001$).

Conclusion: Appropriate trauma team activation improves performance indicators used to evaluate the quality of care in the emergency department. This research suggests that pre-hospital trauma team activation should be considered the standard of care for all patients meeting pre-hospital field triage criteria for major trauma.

Keywords: trauma, triage, pre-hospital, trauma team activation, trauma quality indicators

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To decrease morbidity and mortality, trauma systems must provide timely and appropriate care to those sustaining life-threatening injuries. Trauma care is provided on a continuum from pre-hospital, the emergency department and other in-hospital services to post-hospital care, including rehabilitation (Lorthios-Guilledroit, 2020). When critically injured patients do not receive the appropriate care, death may occur within hours of injury, primarily from uncontrolled hemorrhage and brain injury (Wandling & Cotton, 2020). Appropriate resource utilization depends on accurate trauma triage in the pre-hospital and in-hospital settings. Accurate triage ensures that a multidisciplinary trauma team assesses patients with life-threatening injuries, allowing for rapid diagnosis and treatment (Jelinek et al., 2014). While many debate specific strategies to provide optimal trauma care, the goal of all trauma systems remains the same, to decrease patient morbidity and mortality.

Field triage guidelines, including the Quebec pre-hospital trauma triage scale "Echelle Quebecois de Triage Pre-Hospitalier de Trauma" (EQTPT) and the Centers for Disease Control – American College of Surgeons Committee on Trauma (CDC-ACSCOT) Guidelines for Field Triage of Injured Patients (Frieden, 2012), assist pre-hospital personnel in identifying trauma patients for transport to the appropriate hospital that can provide the level of trauma care required for the patient. These tools also assist pre-hospital personnel in providing necessary information to emergency department personnel to establish the need for trauma team activation (TTA) before the patient's arrival. TTA with the pre-hospital notification is dependent on the accuracy of information provided by pre-hospital personnel (McCullough et al., 2014). To determine which patients are appropriate for TTA, trauma centres use physiological criteria (e.g., systolic blood pressure, respiratory status, Glasgow Coma Scale) to identify patients likely to have severe injuries associated with increased morbidity and mortality (Tignanelli et al., 2018). In contrast, field triage guidelines, such as the EQTPT (Echelle quebecoise de triage prehospitalier en traumatologie, 2016), are not only based on physiological criteria but also high-risk mechanisms of injury.

In the province of Quebec, pre-hospital services implemented the EQTPT pre-hospital triage tool (adapted from the CDC-ACSCOT Guidelines for Field Triage of Injured Patients) on May 15, 2018 (gouvernement du Québec et al., 2016). These triage tools classify trauma patients based on physiological criteria and mechanism of injury to rank them from level 1 (highest) to level 5. Trauma patients in Quebec ranked levels 1–3 are transported ≤60 minutes by ground ambulance (air transport is not available in the province of Quebec) directly to a Level 1 trauma centre. Pre-hospital care is predominantly provided by primary care paramedics who focus on providing basic life support (BLS) while providing rapid transport to the emergency department. Unlike advanced care paramedics authorized to perform procedures such as endotracheal intubation and administer intravenous medications, BLS paramedics use non-invasive techniques and provide basic monitoring and care during transport (Yoder et al., 2020).

Process indicators used when evaluating the quality of care and performance of trauma centres in the province of Quebec include (1) a length of stay in the emergency department of <4 hours for major trauma patients, (2) appropriate under- and over-triage/TTA rates, (3) airway management in the emergency department, and (4) stabilizing of hemorrhagic pelvic fractures within ≤3 hours of arrival in the emergency department (Lorthios-Guilledroit, 2020). Accuracy in TTA is pivotal in providing safe, systematic trauma patient care (Schwing et al., 2019). We hypothesize that patients who meet field triage criteria for major trauma, such as those who met EQTPT levels 1–3 criteria, would benefit from the timely involvement of the trauma team in their care upon arrival to the emergency department of a Level I trauma centre. This study aimed to evaluate if the timing of trauma team involvement impacts the length of stay and time to definitive care in the emergency department.

Methods

Study design

This was a single-site retrospective cross-sectional descriptive study utilizing retrospective administrative and electronic medical records. We included patients aged ≥16 years who sustained a traumatic injury and met the EQTPT pre-hospital 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 in a Level 1 trauma centre in the province of Quebec, Canada. A level 1 trauma centre is the highest level of trauma care providing specialized trauma care within a trauma system, typically at a university-affiliated teaching institution (Tallon, 2011). This level 1 trauma centre has a catchment population of 2.9 million people, serving approximately 10,000 trauma patients per year, with 1,600 being major trauma patients. The trauma centre services the southern half of the island of Montreal, the greater Montreal south shore (Monteregie) region, and northern Quebec. In this centre, trauma teams include a trauma team leader (emergency department physician, surgeon, or anesthetist), a trauma surgeon, trauma residents, registered nurses, respiratory therapists, and patient care attendants. The emergency department physician may choose to activate the trauma team at the time of pre-hospital notification of an incoming trauma or decide to first assess the patient themselves and determine whether the patient meets TTA or trauma consult (partial team called on a non-emergent basis) criteria after their evaluation.

Data sources and sample

Data were collected from the electronic medical files and the local trauma registry. A de-identified list of primary ambulance transports initiated from the Monteregie region between January 1, 2018, and December 31, 2020, were received from the local health authority (Centre intégré de santé et de services sociaux [CISSS] Montérégie-Centre). This list included transport dates and times along with transport codes. We excluded non-urgent transports, defined as patients with an EQTPT level >3, as these patients would not require high-priority transportation. We also excluded those patients transported before the official implementation of the EQTPT protocol. From this list, emergency department arrival times were searched identifying patients meeting our inclusion criteria – all major trauma patients (EQTPT levels 1, 2, and 3) aged ≥16 years who originated in the Monteregie region and bypassed community hospitals to be transported directly to the Level 1 trauma centre. We subsequently excluded those in

which the timing of the TTA could not be determined and those with any individual missing data points from statistical analysis. The primary researcher did the initial data collection. Two trained reviewers conducted a secondary review of 25% of the charts to ensure accuracy in data collection.

Data collection and analysis

A standardized data collection form was created and used to document patient demographics, pre-hospital transport times, mechanism of injury, pre-hospital triage level, triage criteria met, final disposition, along with time spent in the resuscitation room, time from arrival to CT scan, time until disposition decision, and total length of stay in the emergency department. These data were then inputted into an Excel spreadsheet, and a second trained reviewer verified 25% of the medical records to ensure accuracy (Kaji et al., 2014). We classified and grouped subjects by the timing of TTA as (1) no trauma team involvement, (2) TTA after arrival in the emergency department, (3) TTA with pre-hospital notification, (4) receiving a trauma consult only.

Descriptive statistics were used to assess patient characteristics and other quality indicators selected for analysis, including time spent in the resuscitation room, time from arrival until CT scan, length of time from arrival to decision of the final disposition, and total length of stay in the emergency department(Lorthios-Guilledroit, 2020). Continuous variables are presented as means with standard deviations and categorical variables as counts and percentages. TTA subgroups were compared using the Kruskal-Wallis test and 95% confidence intervals were calculated. We considered p values <0.05 as statistically significant. Nonparametric statistical tests were selected due to non-normal data distributions with a negative skew, despite data cleaning. We used SPSS version 28 for statistical analysis.

A priori, we planned to separate the sample and conduct the same analysis, including only those subjects who met EQTPT level 1 criteria (GCS <14 or SBP <90, RR <10 or RR >29, or requiring ventilation), as this group would represent the most severely injured with the least variability in the patient population. We chose to analyze this group separately to decrease the impact of less severely injured patients in the EQTPT levels 2 and 3 groups from impacting the level of urgency that the trauma team felt in the treatment of the patients that could potentially impact the times spent in the ED. The same quality indicators were compared for those meeting EQTPT level 1 criteria and had a 1) TTA with pre-hospital notification or 2) TTA after arrival in the emergency department. These groups were compared using the independent samples Mann-Whitney U test using a 95% confidence interval with p <0.05 considered statistically significant.

We calculated the starting time point as the time point recorded on pre-hospital documents for arrival to the emergency department site to avoid time discrepancies associated with any delays from arrival to triage from emergency department personnel. Time in the resuscitation room was determined from documentation in nursing notes of the patient leaving the resuscitation room or from the timestamp of the patient's location change in the electronic medical record. The time for CT scan was determined from the automatic timestamp for the first CT scan in the electronic medical record. Time of disposition was determined by the automatic timestamp applied when the request for admission, transfer, or discharge was registered in the electronic medical record. The total length of stay was determined by departure time recorded in the electronic medical record. For those who died in the emergency department, disposition time, and end of the length of stay were recorded as the time of death. Ethical approval was obtained by the The Athabasca University Research Ethics Board (REB) (24272) and the McGill University Health Center Research Ethics Board (2021-7693).

Results

During the study period, 2,148 patients were transported directly to the Level 1 trauma centre from the Monteregie region, of which 477 were high-priority transports. Of these, 14 patients were excluded for being from transports that occurred before the implementation of the trauma triage protocol. A total of 371 individual patients were found to meet inclusion criteria and were reviewed; 33 patients were subsequently excluded from statistical analysis as the timing of TTA was undetermined. Sample characteristics are depicted in Table 1. Subjects were primarily male (70.1%) with a mean age of 47 years (range 16–96). Motor vehicle crashes (n = 185, 49.9%) were the primary source of injury followed by falls (n = 91, 24.5%), and penetrating trauma (n = 41, 11.1%).

TTA was done for 63.3% (n = 214) of patients; of these 121 patients had pre-hospital notification (35.8%), 60 patients had a TTA after arrival in the emergency department (17.8%), 33 (8.9%) of the patients who had a TTA were missing documentation of the timing of the TTA, and 68 patients (20.1%) had a trauma consult without a TTA. There were 89 patients (26.3%) who did not have any involvement with the trauma team, either through a TTA or trauma consult, during their stay in the emergency department. Those who did not have trauma team involvement were used as a comparison group to evaluate the impact of the involvement of the trauma team on the different quality indicators. A total of 241 patients (65%) met EQTPT level 1 criteria, while 114 patients (30.7%) met level 2 criteria and 16 (4.3%) met level 3 criteria.

Mean times in the resuscitation room ranged from 0:45–0:51 minutes (p = 0.147), while mean time to CT scan ranged from 1:02–1:21 minutes (p = 0.023). Mean times from arrival to disposition were statistically significant and ranged from 6:37–13:41 minutes (p < 0.001) and mean total length of stay ranged from 9:22–23:16 minutes (p < 0.001). Mean times in all categories were found to be shortest for those who had a full TTA with pre-hospital notification and longest for those who had a trauma consult without TTA. Mean time intervals are represented in Table 2.

For those patients meeting EQTPT level 1 field triage criteria, when the trauma team was activated with pre-hospital notification, as compared to activation on arrival in the emergency department, there were statistically significant decreases in mean time spent in the resuscitation room (0:49 to 0:44 minutes, p = 0.039) and mean time to CT scan (1:11 to 1:00 minutes, p = 0.005). While not statistically significant, time to disposition increased from 5:07 to 6:29 minutes (p = 0.912), and the total length of stay increased from 7:23 to 8:35 minutes (p = 0.654). This data is represented in Table 3.

Table 1

Sample Characteristics

	Total *n* (%)	TTA PH notification *n* (%)	TTA after arrival *n* (%)	Trauma consult alone *n* (%)	No trauma team *n* (%)
Total	338 (100)	121 (35.8)	60 (17.8)	68 (20.1)	89 (26.3)
Sex					
Male	260 (70.1)	89 (37.7)	45 (19.1)	46 (19.5)	56 (23.7)
Female	111 (29.9)	32 (32.4)	15 (14.7)	22 (21.6)	33 (32.4)
Age Category (years)					
16–34	124 (36.7)	48 (38.7)	25 (20.2)	22 (17.7)	29 (23.4)
35–54	100 (29.6)	37 (37.0)	14 (14.0)	24 (24.0)	25 (25.0)
55–74	73 (21.6)	24 (32.9)	13 (17.8)	13 (17.8)	23 (29.3)
75+	42 (12.1)	12 (29.3)	8 (19.5)	9 (22.0)	12 (29.3)
Mean age (SD)	46.6 (20.7)	45.8 (20.1)	45.7 (20.8)	46.4 (20.1)	48.9 (22.5)
Age range (years)	16–96	16–96	17–91	16–93	17–96
Mechanism of Injury					
Motor vehicle crash	168 (49.7)	72 (42.9)	33 (19.6)	36 (21.4)	27 (16.1)
Fall	90 (26.6)	19 (21.1)	16 (17.8)	20 (22.2)	35 (38.9)
Penetrating	33 (9.8)	20 (60.6)	4 (12.1)	3 (9.1)	6 (18.2)
Pedestrian	10 (3.0)	3 (30.0)	3 (30.0)	0 (0)	4 (40.0)
Cyclist	13 (3.8)	4 (30.8)	2 (15.4)	5 (38.4)	2 (15.4)
Crush	13 (3.5)	2 (15.4)	2 (15.4)	1 (7.7)	8 (61.5)
Assault	9 (2.7)	0 (0)	0 (0)	3 (33.3)	6 (66.7)
Other	2 (0.6)	1 (50.0)	0 (0)	0 (0)	1 (50.0)

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

No significant difference in sex for timing of TTA using the chi-square test, statistical significance level $p < 0.05$.

Distribution of age is the same across categories using the Independent-Samples Kruskal Wallis test, statistical significance level $p < 0.05$.

Discussion

In this single-site retrospective review of administrative data including 371 individual patients, we found that the time to CT scan was shorter when a full TTA was done. Patients who had a TTA with pre-hospital notification were found to have the fastest time from arrival to CT scan. The time from arrival to disposition decision and total length of stay was the shortest for those with a full TTA. Time spent in the resuscitation room did not vary significantly among groups. When directly comparing those who had a pre-hospital TTA to those who had a TTA after arrival in the emergency department, time spent in resuscitation, time to disposition, and length of stay did not vary significantly. However, the time from arrival until CT scan was found to be shorter when TTA was done before the emergency department arrival of the patient. Past studies found that early TTA was associated with a decrease in the time to definitive care (Yoo & Mun, 2014) and that the trauma team arriving prior to the arrival of the patient allowed for better coordination of the team and the resources, decreasing the time to definitive care and a decreased length of stay in the emergency department(Polovitch et al., 2019). While the groups who had a TTA had shorter times noted on all time points when compared to those who did not have a TTA, the only timepoint that had a statistically significant improvement with pre-hospital TTA compared to a TTA after the arrival of the patient was the time from arrival to CT scan.

Reasons for under-triage and poor TTA compliance have been reported and primarily attributed to subjective TTA criteria, different triage rates based on professional experience, unclear roles and responsibilities of the trauma team, and the emergency

Table 2

Emergency Department Times and Timing of Trauma Team Involvement

Timing in Relation to TTA		Total *n* (%)	Mean time minutes (SD)	*p* value*
Time in resuscitation room	No TTA	81 (21.6)	0:45 (0:28)	0.147
	TTA after arrival	53 (14.2)	0:49 (0:26)	
	TTA pre-hospital notification	107 (28.8)	0:45 (0:27)	
	Trauma consult only	60 (16.2)	0:51 (0:32)	
	Total	301	0:47 (0:28)	
	Missing	70 (18.9)		
Time from arrival to CT scan	No TTA	83 (22.3)	1:17 (0:52)	0.023
	TTA after arrival	55 (14.8)	1:10 (0:32)	
	TTA pre-hospital notification	103 (27.8)	1:02 (0:25)	
	Trauma consult only	66 (17.8)	1:21 (0:43)	
	Total	307	1:11 (0:40)	
	Missing	64 (17.2)		
Time from arrival to disposition	No TTA	88 (23.7)	9:28 (7:35)	<0.001
	TTA after arrival	59 (15.9)	6:49 (7:33)	
	TTA pre-hospital notification	120 (32.3)	6:37 (8:40)	
	Trauma consult only	67 (18.1)	13:41 (15:58)	
	Total	334	8:49 (10:28)	
	Missing	35 (9.4)		
Total length of stay in emergency department	No TTA	87 (23.5)	12:37 (12:19)	<0.001
	TTA after arrival	60 (16.2)	10:36 (17:26)	
	TTA pre-hospital notification	120 (32.3)	9:22 (13:51)	
	Trauma consult only	68 (18.3)	23:16 (23:53)	
	Total	335	14:16 (18:05)	
	Missing	36 (9.7)		

Note. TTA = trauma team activation; PH = pre-hospital; SD = standard deviation
*Independent-Samples Kruskal-Wallis test, statistical significance level $p < 0.05$

department physicians feeling comfortable managing the injuries without the trauma team(Verhoeff et al., 2019). It was speculated that there was a hesitancy to launch a TTA before arrival to the emergency department using only information acquired from the pre-hospital notification due to the assumption that the trauma team could be quickly involved after the initial assessment if required, along with a perception that the patient would spend longer in the resuscitation room if the trauma team were called to assess the patient and would have a longer length of stay in the emergency department. As the emergency department physician is responsible for supervising the trauma team members until the trauma team leader arrives in the emergency department, decreasing the time that the emergency department physician spends in the resuscitation room is of interest, as it allows for more time to manage other patients in the emergency department. In a crowded emergency department, significant time in the resuscitation room with one patient impacts patient flow within all areas of the department. Citizens utilizing the emergency department have a right to access timely assessment and management of their care (Agency for Healthcare Research and Quality, 2022).

The six domains of healthcare quality described by the Institute of Medicine aim to provide safe, effective, patient-centred, timely, efficient and equitable care(Six Domains of Health

Table 3

Emergency Department Quality Indicators for EQTPT Level 1 Traumas and Timing of Trauma Team Activation

Timing in Relation to TTA		*n* (%)	Mean time minutes (SD)**	*p* value*
Time in resuscitation room	TTA after arrival	33 (25.0)	0:49 (0:19)	0.374
	TTA pre-hospital notification	81 (61.4)	0:44 (0:29)	
	Missing	18		
Time to CT scan	TTA after arrival	36 (27.3)	1:11 (0:27)	0.022
	TTA pre-hospital notification	80 (60.6)	1:00 (0:22)	
	Missing	16		
Time from arrival to disposition	TTA after arrival	38 (28.8)	5:07 (6:31)	0.400
	TTA pre-hospital notification	92 (69.7)	6:29 (9:05)	
	Missing	2		
Total length of stay in ED	TTA after arrival	39 (29.5)	7:23 (12:58)	0.620
	TTA pre-hospital notification	92 (69.7)	8:35 (12:19)	
	Missing	1		

Note. TTA = trauma team activation; ED = emergency department

*Independent samples Mann-Whitney U test, statistical significance level $p < 0.05$

** time presented as hours:minutes

Care Quality, 2018). Assuring timely care involves monitoring the time it takes for clinicians to assess a patient. Patients requiring admission ought to be promptly moved to inpatient units, thereby reducing the total length of stay in the emergency department (Hansen, 2019). Involving the trauma team allows the specialized team to focus on the care of the major trauma patient and allows the emergency department physician to focus on the other patients under their care. The American College of Surgeons requires the trauma team leader to be present in the emergency department within 15 minutes of the patient's arrival (Schwing et al., 2019). By activating the trauma team based on information provided in the pre-hospital notification, which in the trauma centre studied is frequently more than 10 minutes before the arrival of the patient to the emergency department, the trauma team leader has adequate time to arrive before the patient arrival thus liberating the emergency department physician to provide other care. Fundamental priorities in emergency medicine include access to critical care when the patient's condition requires and early access to care from specialists(Hansen, 2019). When the trauma team is activated pre-hospital and involved upon patient arrival in the emergency department, the trauma team can efficiently organize and evaluate all aspects of care (i.e., specialist referral) as required.

Timely care also involves access to services for those with conditions requiring immediate interventions and treatment requires appropriate access to diagnostic services in the emergency department (Hansen, 2019). Access to CT scan for the trauma patient is a rate-limiting step for those not profoundly hemodynamically unstable and requiring immediate surgery. TTA gives the patient priority access to CT scans, allowing the trauma team to diagnose injuries requiring urgent intervention rapidly. The benchmark goal for Quebec emergency departments is to have a head CT scan, for patients with evidence of traumatic brain injury, within one hour of arrival in the emergency department (Lorthios-Guilledroit, 2020). In a recent study, a CT scan of the head done within the first hour after arrival was defined as an "immediate" CT head, and a CT of the head done within one to six hours was considered "delayed." Those who had an immediate CT of the head were found to have shorter times to interventions, such as a craniotomy or intracranial pressure monitor insertion, and shorter lengths of stay in the emergency department (Schellenberg et al., 2021). Identifying solid organ injury on CT scan is essential to establish the need for angioembolization. Delays to angioembolization for those patients with solid organ injury have been found to have an increase in 24-hour mortality rates (Chehab et al., 2020). For patients with pelvic fractures requiring angioembolization, longer times to treatment also were associated with increased in-hospital mortality, with rates rising for each hour of delay (Matsushima et al., 2018). The length of time from arrival until CT scan ranged from 0:14 minutes to 5:35 hours. The mean time for all groups was >1 hour, with the shortest mean time being 1:02 hours for the group with a pre-hospital TTA. The coordinated care from the entire trauma team being present from the arrival of

the patient, combined with the CT scan being reserved for major trauma patients once a TTA is called, aids in decreasing the time from arrival until CT scan.

Multiple process indicators in use for quality of care evaluation are based on maximum delays from arrival to interventions, including the length of stay in the emergency department of <4 hours and stabilizing pelvic fractures within 3 hours of arrival in the emergency department (Lorthios-Guilledroit, 2020). Many reasons could be attributed to the significant increase in length of stay for those who had a trauma consult without a TTA. These patients are typically not as acutely injured but still may have substantial injuries. They do not usually require emergent surgery or intervention but require additional care. Those who have no injuries requiring a trauma team consult can be discharged home more quickly, leaving the patients who had a trauma team consult needing more time to establish a care plan.

Limitations

As with most retrospective studies, the accuracy of information gathered is dependent on the accuracy of the information available in the medical records. Incomplete documentation resulted in the inability to establish the timing of trauma team involvement for a portion of the charts reviewed. As most chart data are in narrative form, data collected from documentation pertinent to this study may be subject to interpretation by the reviewer. Conflicting times in the resuscitation room were noted between the documented times in nursing notes and timestamps in electronic medical records. When the time was recorded in nursing notes, this time was selected for use in the analysis. Being that this was a single-site study, a larger, multi-site study would be needed to confirm and generalize the findings.

Conclusion

When trauma team care is required, early involvement of the trauma team through pre-hospital TTA significantly decreases time to CT scan, time spent in the emergency department without a disposition, and overall emergency department length of stay. Early TTA improves performance indicators used to evaluate the quality of care in the emergency department. This research suggests that when minutes count, pre-hospital TTA should be considered the standard of care for all major trauma patients meeting TTA criteria.

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