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RESEARCH ARTICLE

Characteristics and Predictors of High Acuity Pediatric Patients Presenting to a Regional Community Healthcare System Who Require Transfer to a Tertiary Pediatric Center

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ABSTRACT

Purpose: To identify the characteristics at triage of high acuity pediatric patients who presented to community emergency departments and determine predictors for those who require transfer to a tertiary care pediatric center.

Patients and methods: We conducted a retrospective study of all pediatric Canadian Triage and Acuity Scale (CTAS) I patients presenting to five semirural hospital sites from January to December 2018. Univariate tests were used to identify significant predictors for transfer based on age, gender, Pediatric Early Warning Score (PEWS) score and presenting complaint. A multivariate model was developed based on backward selection from the significant factors from the univariate analysis to identify predictors for transfer.

Results: There were 1,137 subjects with an average age of 5.08 years (SD: 5.03) of whom, 559 (49.2%) were males. Sixty patients (5.3%) were transferred to a tertiary care center (60.9% <4 years). A PEWS score ≥ 3 (OR 3.005, 95% CI 1.623–5.563), presenting with trauma (OR 6.617, 95% CI 2.820–15.531), mental health issues (OR 5.131, 95% CI 1.444–18.232), or neurological issue (OR 3.057, 95% CI 1.355–6.896) were associated with transfer. Patients with fever (OR 0.113, 95% CI 0.031–0.407) and respiratory symptoms (OR 0.345, 95% CI 0.142–0.840) were less likely to be transferred.

Conclusion: Predictors of transfer from a community hospital to a pediatric tertiary care center were a PEWS score ≥ 3 , trauma patients, those presenting with mental health issues, and patients with neurological symptoms. Early recognition can facilitate quicker transfer of these high acuity patients requiring tertiary care management.

Keywords: pediatric, transfer, high acuity

Introduction

Pediatric patients contribute to approximately 20%–30% of all emergency department (ED) visits, and over 80% of these visits occur at a non-pediatric center¹⁻⁴. Emergency physicians working in community and rural hospitals have varying comfort levels in managing this population due to limited exposure to pediatric cases, the absence of an on-call pediatrician, insufficient skills in pediatric resuscitation, and lack of resources⁵⁻⁷. This translates to inconsistent pediatric care or early transfer to a more specialized regional center^{2,6,8}. Approximately 1%–5% of all pediatric visits are critically ill children and this specific subgroup poses an even greater challenge in management by community emergency physicians^{2,5}. Early recognition of critically ill patients is important to ensure timely access to specialized care.

Triaging in the ED is essential to prioritize the sequence in which patients are seen. A patient's initial vital signs as well as changes in vital signs play an important part recognizing the need for prompt management. Usually, the acute deterioration of an ill patient is identified by changes in the vital signs or is preceded by physiological changes. The pediatric Canadian Triage and Acuity Scale (pCTAS) is a five-tier triage scale that is used across Canada. It uses the pediatric assessment triangle⁹ and first-order modifiers (i.e., level of consciousness, respiratory effort, heart rate, and circulatory status) and second-order modifiers (i.e., fever, pain, mechanism of injury, and coagulation disorders) and the patient's presenting complaint to determine a

triage category^{10,11}. Patients classified as CTAS I are considered the sickest, and the expectation is that these patients ought to be attended to immediately. However, it is unclear which of these patients may need transfer to a tertiary care centre.

Early warning systems, also known as track and trigger systems, provide a means of identifying patients who are at risk for clinical deterioration so as to prevent adverse events^{12,13}. Recognizing which children require early specialized care can help with mobilizing resources and facilitating early transfer of a patient to a more specialized health facility. PEWS has been shown to be a valid and reliable tool in recognizing pediatric patients who are at risk for deterioration and require escalated care^{12,14-16}. While many of these studies have shown the benefit of PEWS for admitted patients, it is unclear what the benefits are from data collected at triage.

In this study, we characterized pediatric patients who presented to community hospitals who were triaged as CTAS I and subsequently required transfer to a tertiary care pediatric center with a view to identify predictive factors of transfer that are readily available at triage.

Methods

Study design and setting

This study was conducted over 5 community hospital sites across a semirural area of southeastern Ontario, Canada. Pediatric patients (≤ 17 year of age) who presented to any of the five sites and were registered as

CTAS I from January 1, 2018 to December 31, 2018 were included. Of the five sites, one has an inpatient pediatric ward and Neonatal Intensive Care Unit, with a pediatrician who is on site available 24/7 for consults and taking care of the admitted patients. All patients requiring specialized or advanced care are transferred to a regional pediatric tertiary care center, and the two pediatric centers are 30 and 90 min away by land transfer. The majority of patients are transferred to the closest center, unless the patient is followed at the farther center or the closer site cannot accept the patient. This study was approved by the Hamilton integrated Research Ethics Board (2019-7118-C), who waived the requirement for consent given the nature of the study.

Selection of participants

The study population consisted of all pediatric CTAS I patients who presented between January 1, 2018 and December 31, 2018. During the study period, there were a total of 196,948 patient visits across the five sites with 15.7% being pediatric patients.

Measurements

For each visit, we collected information on the patient's age and gender. Physician initial assessment times were calculated from registration time to when the patient was seen by the doctor. The ED length of stay was from the time of registration to the time the patient left the department.

The Pediatric Early Warning Score (PEWS) was calculated based on the triage assessment. We used the Brighton PEWS, which is based

on three parameters, namely cardiovascular, respiratory, and behavioral, and each component is scored to a maximum of three. The higher the number, the sicker the patient is. Patient disposition (death, home/left against medical advice, admit to local pediatric site, and transfer to tertiary care center) were obtained from the clinical decision unit. The initial presenting complaint was also distributed into ten categories.

Two authors (MK and HS) independently reviewed the charts. For any discrepancies, a senior emergency physician (RV) reviewed the chart, and the team reached agreement based on consensus.

Outcomes

Our primary outcome was to identify predictors of transfer to a pediatric tertiary care center among pediatric CTAS I patients who present to a community ED. We selected parameters that are easily captured at triage to identify a model that could predict transfer early in the clinical course. We included all patients during this time period.

Analysis

All statistical analyses were performed using IBM SPSS Version 25 statistical package. Descriptive analysis was carried out to assess the distribution of traits within the study sample. Data for continuous variables were reported using mean, standard deviation, median, interquartile range, maximum, and minimum values, whereas categorical data were described using counts/frequencies and percentages. Univariate tests were carried out

for gender, age (age \leq 4 years), PEWS \geq 3, seasons, and presenting complaint, using χ^2 tests and Fisher's exact tests, as appropriate, to identify factors that predict transfer. A multivariate model was then developed based on backward selection from the set of factors with significance on univariate analysis. All retention criteria were set at $p < 0.05$.

Results

Characteristics of study subjects

There were 31,004 pediatric visits over the study period, and 1,140 visits were triaged as CTAS I (See Table 1). Baseline characteristics of the study population are listed in Table 2.

Three patient visits were excluded due to incomplete documentation of vital signs or assessment at triage, leaving 1,137 patients that were included in the study sample. Of all patients included, 49.2% were male. The average age of the patients was 5.07 years (SD 5.02), with a median age of 3 years, and 60.9% were aged 4 years or younger. The winter months accounted for 30.26% of patient visits. The most common presenting problems at triage with a CTAS I were respiratory problems (N = 389, 34.2%), fever (N = 377, 33.2%), and neurological issues (N = 83, 7.3%).

Table 1: Patient volume and pediatric CTAS I patients based on location

SITE	Total number of visits	Pediatric patient visits	CTAS I pediatric patients
1*	76,131	12,059	478
2	47,098	5,444	165
3	31,215	3,490	179
4	22,789	5,439	175
5	19,715	4,572	143
Total	196,948	31,004	1,140

*Site with local pediatrician available

Table 2: Baseline characteristics for the entire cohort and those transferred to a pediatric tertiary care center.

	Total cohort	Patients transferred
Number of patients	1137	60
Male	559 (49.2%)	30 (50%)
Female	578 (50.8%)	30 (50%)
Age	5.07 years (SD: 5.02)	7.00 years (SD 6.48)
PEWS ≥ 3	447 (39.3%)	35 (58.3%)
Presenting complaint		
Cardiovascular	17 (1.5%)	2 (3.3%)
Allergic reaction	27 (2.4%)	2 (3.3%)
Fever (temperature ≥ 38.0 °C)	377 (33.2%)	3 (5.0%)
Gastrointestinal	84 (7.4%)	2 (3.3%)
Mental health	23 (2.0%)	4 (6.7%)
Neurological	83 (7.3%)	17 (28.3%)
Respiratory	389 (34.2%)	9 (15%)
Toxicological	34 (3.0%)	4 (6.7%)
Trauma	58 (5.1%)	15 (25%)
Other	45 (4.0%)	2 (3.3%)

Main results

Sixty patients (5.3% of the pediatric CTAS I patients or 0.2% of all pediatric patient visits) were transferred to a pediatric tertiary care center, with a median length of stay of 184 min (IQR: 85–269 min) in the ED. There were an equal proportion of male to female patients transferred, and the average age was 7.00 years (SD 6.48). The majority were due to neurological issues (N = 17), trauma (N = 15), and respiratory problems (N = 9). Of the patients transferred, 58.3% had a PEWS score ≥ 3 and 31.7% had a PEWS score ≥ 4 .

The results of the univariate and multivariate analyses of the factors for transfer are

summarized in Table 3. On univariate analysis, age ≤ 4 years, PEWS score ≥ 3 years, and presentation with fever, mental health, neurological issues, respiratory issues, and trauma were significantly associated with transfer ($p < 0.05$). In the multivariable analysis, a PEWS score ≥ 3 (OR 3.005, 95% CI 1.623–5.563) and presenting with trauma (OR 6.617, 95% CI 2.820–15.531), mental health issues (OR 5.131, 95% CI 1.444–18.232), or neurological issues (OR 3.057, 95% CI 1.355–6.896) were associated with transfer out. Presenting with fever (OR 0.113, 95% CI 0.031–0.407) and respiratory symptoms (OR 0.345, 95% CI 0.142–0.840) were less likely to be transferred.

Table 3: Univariate and multivariate analyses for factors associated with transfer to a pediatric tertiary care center

Variable	Univariate analysis p-value	Multivariate analysis OR	Multivariate analysis (95% CI)	p-value
Gender	0.895			
Age ≤4	0.042*	1.025	0.558–1.884	0.936
PEWS ≥ 3	0.003*	3.005	1.623–5.563	<0.01*
Chief complaint				
Cardiovascular	0.225			
Allergic reaction	0.651			
Fever	<0.01	0.113	0.031–0.407	0.001*
Gastrointestinal	0.310			
Mental health	0.029	5.131	1.444–18.232	0.011*
Neurological	<0.01	3.057	1.355–6.896	0.007*
Respiratory	0.001	0.345	0.142–0.840	0.019*
Toxicological	0.099			
Trauma	0<0.01	6.617	2.820–15.531	<0.01*

Discussion

In this study, we characterized high acuity pediatric patients who required transfer to a tertiary care pediatric center. Recognizing that most transfers would occur in the sickest of the patients, we only included CTAS I patients. We found that a PEWS score ≥3, or those with a presenting complaint related to trauma, mental health issues, or neurological issue were associated with transfer. Since the majority of pediatric emergency care is not provided in high volume pediatric centers, community physicians need to have the knowledge and skills in managing these patients and determine which ones require transfer to a specialized center in time^{2,3,17}. Unlike adult cases for acute myocardial

infarction or stroke, there are no studies to show that diversion of pediatric CTAS I patients to a pediatric center improves outcome. This is the first study to our knowledge that identifies predictors that are easily captured at triage for those patients who required transfer to a pediatric center from a community or rural site.

CTAS I patients are identified as the sickest of those presenting to the ED. Abnormal vital signs at presentation or acute deterioration, if recognized early, can prevent adverse events and mortality¹⁴. By selecting CTAS I patients only for this study, we would avoid simple neurological issues, such as mild headache. Instead, the selection of CTAS I patients

would point toward patients with complex seizure disorders or status epilepticus. Rosenthal et al. looked at the national administrative database to look at interfacility transfer of pediatric patients¹⁸. The study showed 4.4% of transferred patients were admitted, whereas our rate of transfer out was 0.2% of all pediatric visits or 5.3% of the CTAS I cohort. They also found principal diagnosis, and specifically mood disorders, was the most common reason for transfer. Leroux et al. looked at all triage categories of pediatric transfer, and while they found that most patients were CTAS I, their study also indicated that the most common reasons were trauma (45.7%) and neurological complaints (14.7%)¹⁹. Our results are consistent with trauma, mental health, and neurological complaints needing specialized care.

PEWS has also been advocated as a mechanism to aid in recognizing pediatric patients at risk and hence, in need of escalated care^{12,20}. There are several PEWS described in the literature using anywhere from 3 to 16 items, and we chose the Brighton model for its simplicity of only looking at three clinical variables and parameters that are easily available at triage²¹⁻²⁴. A PEWS score ≥ 3 is 93% specific for predicting hospital admission and severe illness, which is the reason we used this cutoff as a predictor¹⁵. The PEWS score can be easily implemented alongside CTAS triaging and has been shown to be useful in pediatric care management^{15,25}. Our study showed that a PEWS score ≥ 3 had an odds ratio of 3.01 to predict transfer out to a pediatric center, revealing the importance of

this initial assessment score. We were able to capture the components of the PEWS score easily from the triage assessment, suggesting that the process would not be too onerous to complete at the time of triage.

As expected, fever and respiratory illness were protective against transfer. The CTAS uses modifiers to determine the final score. Febrile children account for 15% of ED visits, and the outcomes are dependent on the age of the patient, immunization status, comorbidities, and the clinical appearance of the child^{26,27}. Febrile patients usually present with other abnormal signs, such as tachycardia and tachypnea; therefore, they tend to be categorized in a higher triage category. Most of these patients are given antipyretics and observed in the ED if they are not toxic looking. If the patient warrants further investigation or requires admission, they are transferred to a local site that has a pediatrician and do not require specialized care at a pediatric center. In our study, less than 1% of the CTAS I febrile children were transferred out which suggests these patients can be managed locally.

Of the CTAS I patients with respiratory presentation, 2.3% were transferred out. The majority of respiratory complaints in our study consisted of asthma exacerbations, bronchiolitis, croup, and pneumonia. Since these conditions can be easily managed at a community hospital, respiratory complaints were not predictive of transfer. Contrarily, pediatric trauma requires specialized care, and this was the predictor that most influenced transfer.

To the best of our knowledge, this is the first study to identify predictors of high acuity pediatric patients to a specialized center from a regional community health system. However, there are limitations to this study. First, this study was based on semirural region which may not be applicable to all community or rural EDs. The lack of subspecialist pediatric services is consistent with other semirural and rural areas, which means that any patient requiring specialized or advanced care is transferred to a regional pediatric tertiary care center. While our sites have access to computed tomography, ultrasound, and magnetic resonance imaging diagnostic capabilities, not all of them can be completed or interpreted either due to logistic issues (sedation, availability of low dose scans) or radiologist comfort; therefore, transfer to a dedicated pediatric tertiary care center is required. The proximity to the two major pediatric centers (30 min and 90 min away) may also impact on the decision to transfer. The ease of transfer within the provincial health care system decreases barriers related to costs or insurance.

We included all patients who presented as a triage CTAS I and only looked at the PEWS score at triage rather than a trend over time. This was necessary as we wanted to find predictors that could be assessed easily at the time the patient presents to the ED. Presenting complaints, such as fever, can elicit a higher triage category as described earlier and may not truly represent a true high acuity patient. However, since all Canadian EDs use

the same categorization, this would maintain consistency across the country. Moreover, there may have been patients in other triage categories that required transfer, which is what explains the difference in transfer rates when compared to other studies. However, our objective was to only look at those who were identified early as high acuity.

Conclusion

In summary, this study showed that CTAS I pediatric patients with a PEWS score ≥ 3 or presenting with trauma, mental health issues, or neurological issue were more likely to be transferred to a pediatric center from a community ED. These patient characteristics are easily identifiable at triage and can be used to support early recognition and preparation for transfer. Further studies are needed to look at the clinical impact of early transfer on pediatric patients.

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Conflicts of interest:

None to declare.

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Meetings:

The findings of this study were presented at the Canadian Association of Emergency Physicians Conference 2021 and the International Conference of Emergency Medicine 2021.

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