Analyzing the usability of the 5-Level Canadian Triage and Acuity Scale by paramedics in the prehospital environment

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Abstract:

Introduction: ED crowding negatively affects throughput, quality of care, and outcomes. Paramedics do not have an evidence-based, feasible triage instrument to guide classification of patients. No studies have compared the Canadian Triage and Acuity Scale (CTAS) used by prehospital paramedics against the Emergency Severity Index (ESI) used by nurses in the emergency department. This study sought to determine if a relationship exists between paramedics' triage scores and emergency nurses' scores in the emergency department using 2 common 5-level triage instruments, as well as to determine whether either instrument correlates with patient admission. **Methods:** CTAS scores determined by paramedics on arrival at the emergency department were compared with the initial ESI scores determined by emergency nurses. Both scores were compared with the patient's disposition status. Data analyses included descriptive statistics, χ^2 statistics, and hierarchical regression analysis. **Results:** The analysis included 2,222 patients. There was a poor relationship between the CTAS and the ESI at the facility ($P = .599$, $\kappa = -0.003$). The final regression model explained 32.9% of the admission variance ($P < .001$). The model correctly predicted 61.5% of admissions, with an 82% accuracy rate for all other forms of disposition and an overall model prediction rate of 73.7%. **Discussion:** Using the CTAS, paramedics can predict admission comparably with nurses using the ESI. However, both instruments showed weakness in over- and under-triage rates. Additional studies are indicated to better understand prehospital paramedic triage and its impact on throughput.

Keywords: paramedics | emergency nurses | triage | CTAS | ESI

Article:

Emergency department crowding is a hospital-wide problem that challenges the input-throughput-output model of ED care.[1, 2] Diagnostic testing in triage is associated with a significant reduction in ED treatment times, and when associated with admission prediction, improves throughput in the emergency department.[3, 4] Increased ED length of stay due to crowding is associated with adverse clinical outcomes, emergency medical services (EMS) diversion, and patient and clinician dissatisfaction.[3]

A standardized, moldable, and developing triage system is imperative to ensure the maximization of resources while maintaining a safe and efficient health care delivery system.[5] The Emergency Nurses Association (ENA), in 2003, and the American College of Emergency Physicians, in 2005, recommended the use of a 5-level triage system in the emergency department, which was updated in 2010 to include the use of either the Emergency Severity Index (ESI) or a similar 5-level instrument.[6, 7] Although this addressed the need for ED triage, the patient experience often begins with paramedics in the prehospital environment. On average, ambulances are used as the primary mode of transportation for 15.8% of ED patients.[8, 9] Currently, paramedics do not have an evidence-based, feasible, reliable, or valid triage instrument to guide identification or classification of patients in the prehospital setting or direct handover of care to nurses in the emergency department.[10]

Often providing care in extreme situations, paramedics must have confidence, trust, critical-thinking skills, and strong interpersonal and intraprofessional communication to protect life, limit loss, and improve outcomes.[11] Studies indicate that paramedics are unable to determine effectively, among noncritical patients, those who need admission or require additional resources, including laboratory, radiology, or specialist referral, or to determine triage category according to acuity or resource need, with reported under-triage rates varying from 5% to 17.9%.[12, 13, 14, 15] The literature supports the need for standardized, evidence-based guideline (EBG) development for paramedics.[12, 13] A review published by the Institute of Medicine (IOM) in 2007 encouraged the National EMS Advisory Council and the Federal Interagency Committee on EMS to establish an EBG development team to address the lack of a standard triage instrument for paramedics.[16]

ESI and Canadian Triage and Acuity Scale

The ESI and the Canadian Triage and Acuity Scale (CTAS) are two 5-level triage instruments with similar reliability and validity findings. Both the ESI and the CTAS measure patient acuity; however, they have shown limited success predicting admission.[4, 17] Both triage instruments classify patient acuity on a scale from 1 to 5, with 1 being most urgent and 5 being least urgent.

The ESI triage process uses an algorithm based on patient acuity and anticipated resource need to determine triage category.[16] In a review of 12 analyses of reliability and validity, the ESI had a significant correlation with hospital mortality rate and resource utilization, with good to excellent interobserver reliability.[16] However, there are concerns with the ESI relative to older patients and the increasing number of comorbidities, as well as challenges with atypical complaints.[18] One study indicated moderate agreement in ESI level designation by paramedics and nurses (0.409; 95% confidence interval [CI], 0.256-0.562).[19] Limitations to ESI use include the lack of a common language; differences in training between paramedics and nurses; differences in purpose and understanding of triage regarding the chronically ill/injured; and the need to limit under-triage.[20]

In contrast to the structure of the ESI, the CTAS uses an extensive list of clinical complaints, symptoms, and modifiers, at strategic times, to direct users toward a specific classification.[16] The CTAS is a 5-level triage system that has become the national triage system in Canada and other countries.[20] Contrary to the challenges faced by the ESI, the CTAS has shown strong reliability

and validity among pediatric and adult populations and has shown a strong correlation (quadratic $\kappa = 0.69$; 95% CI, 0.68-0.71) with severity and resource need among elderly persons.[20]

Despite extensive use of the ESI and CTAS instruments by emergency nurses, neither has been declared the gold standard in the United States, based on the belief that more testing is needed to support the psychometric properties of feasibility, reliability, and validity. Although studies exist comparing use of the ESI by paramedics in the field with that of nurses in the emergency department, no studies have compared the association of CTAS triage scoring used by paramedics with ESI scoring used by emergency triage nurses.[19]

The purpose of this study was to determine whether triage score determination by paramedics in the prehospital environment using the CTAS was associated with the triage scores determined by emergency nurses using the ESI. In addition, we sought to evaluate how triage scores related to patient disposition, specifically admission status. This study is the first step in a multistep process that seeks to develop a reliable and valid triage instrument for use by paramedics in the prehospital environment. Because paramedics function as the initial point of contact for emergency care of ill and injured persons across the spectrum of care, it is imperative that we seek to identify all factors that affect paramedics' ability to determine acuity and resource need. In turn, this information may improve information dissemination between paramedics in the field and nurses, advanced practice providers, and physicians in the tertiary care environment.

Methods

Design/Setting

This descriptive correlational study was conducted with the city of Columbus (Ohio) Division of Fire (CFD) and The Ohio State University (OSU). The CFD operates a full-time fire and EMS division composed of seven battalions, 32 fire stations, and 1,500 employees. In 2012 the CFD responded to 129,711 EMS incidents.[21] The OSU Medical Center operates 2 medical facilities. OSU Main is a 976-bed Level I academic trauma center and OSU East is a 404-bed, Level III community hospital, with a combined 56,592 admissions and nearly 120,000 annual ED visits in 2013.[22]

Study Participants

This study was a secondary analysis of a newly created patient database. Included in the database were all persons to whom EMS was dispatched; these persons were included in the study using a serial enrollment process. The exclusion criteria included persons (1) who were not transported by the CFD, (2) who denied a need for assistance, or (3) who were pronounced dead on the scene. Paramedics were also study participants in that they completed the CTAS score and provided demographic information.

The University of Virginia Institutional Review Board (IRB) for health sciences research and the OSU IRB approved this study. Because the study database did not involve protected health information, an alteration in care, an intervention or present any serious risk to human subjects, patient consent was not required. The paramedic-specific CFD identification number was

replaced with a randomly generated 5-digit number. Because paramedic consent would be the only record linking the paramedics to the research and because the CTAS training was being provided to all paramedics within the department as continuing education, consent from paramedics was not obtained.

Procedures

Paramedics were notified of the study using the CFD Internet-based interdivisional training system CentreLearn. The CTAS PowerPoint (Microsoft, Redmond, WA) training system was reformatted for CentreLearn to match, as closely as possible, the training system used for nurses and paramedics in Canada. The online training, which could be viewed as needed, included a post-test for verification of accuracy and an opportunity to direct questions by e-mail to "super-users" within the CFD. These super-users were EMS coordinators and senior paramedics who were directly trained by CTAS instructors in a "train-the-trainer" program. Paramedics completed a demographic survey and returned it to the principal investigator (PI) through the CFD interdivisional mail system in a self-addressed stamped envelope.

CTAS resource manuals were provided for each transport vehicle. Paramedics were required to enter 3 CTAS scores into the electronic medical record: on first impression, at initiation of transport, and on arrival at the hospital. Three scores were required to file the electronic patient care report successfully. Study data from the CFD were collated and submitted in batches to the OSU research physician, who verified and combined the patient's ED record with the study data into one Excel (Microsoft) database; patient identifiers were then deleted. The ED record included the ESI score determined by the primary nurse on the patient's arrival at the emergency department. This new, de-identified database was forwarded to the PI. On receipt, the PI removed the paramedic identifier and substituted it with a random 5-digit number to create a totally de-identified database.

Data Analyses

Data analysis was conducted using the SPSS statistical software package (version 21; IBM, Armonk, NY), with an Excel spreadsheet used to manage data. Descriptive statistics, χ^2 statistics, and correlation analysis and hierarchical regression analysis, as well as sensitivity and specificity values, were evaluated. The following independent variables were included in the analysis: CTAS scores and ESI scores. Patient age was a covariate. Admission status as the dependant variable (DV) in the statistical analysis was chosen for 2 reasons: (1) past studies that evaluated triage also considered admission status as the DV and (2) the determination of admission likelihood is an important factor in the development of a new triage instrument. Missing-data analysis revealed that fewer than 5% of data were missing. Finally, a hierarchical logistic regression was performed to evaluate the influence of these variables on admission status. Diagnostics and evaluation of the collinearity statistics showed no violations of multicollinearity or normality. Intrarater reliability and inter-rater reliability were not assessed because these would have placed an undue burden on the CFD to accommodate the extra personnel needed to function as a second triage paramedic.

Results

A total of 2,222 patients were included in the analysis (Table 1). The majority of patients were female patients (n = 1,187, 53%), black (n = 1,315, 58.8%), and not Hispanic or Latino (n = 2,218, 99.1%). The patients' mean age was 48.97 ± 18.76 years, with a range of 15 to 89 years. A total of 31.1% (n = 112) of 360 active paramedics returned demographic surveys. Most paramedics (n = 109, 97.3%) were men and were not Hispanic or Latino. The mean paramedic age was 42.46 ± 8.18 years, with a range of 18 to 59 years. The paramedics' mean length of experience was 11.33 ± 6.01 years, with a range of 1 to 27 years, and their mean length of education was 13.99 ± 1.66 years, with a range of 12 to 19 years.

Table 1. Ten most common diagnostic impressions as assessed by paramedics

	n	Discharge, % (n)	Admit, % (n)	Transfer, % (n)	Died, % (n)	LWBS, LAMA, and eloped, % (n)	ED observation, % (n)
General illness	284	13.6% (169)	11.8% (97)	3% (1)	0	29.4% (5)	14.3% (12)
Abdominal pain	151	7.3% (91)	6.1% (50)	3% (1)	0	22.7% (4)	6% (5)
Chest pain	139	4.6% (57)	8.7% (72)	0	0	17.8% (3)	8.3% (7)
Cold/flu symptoms	92	4% (50)	4.4% (36)	0	0	22.7% (3)	3.6% (3)
Back pain	87	5% (62)	2.2% (18)	0	0	38.5% (6)	1.2% (1)
Leg pain	70	4.1% (51)	1.6% (13)	0	0	20.3% (3)	3.6% (3)
Respiratory distress	66	0.8% (10)	6.8% (56)	0	0	0	0
Weakness	64	1% (13)	57% (47)	0	0	0	4.8% (4)
Anxiety	64	3.5% (43)	1.6% (13)	9.1% (3)	0	20.3% (4)	1.2% (1)
Alcohol abuse	57	3.5% (43)	1.6% (13)	0	0	4.5% (1)	0
Cut	57	3.6% (45)	1%(8)	6.1% (2)	0	4.5% (1)	1.2% (1)
Total	51% (1,131)	28.5% (634)	19% (423)	< 1% (8)	0 (0)	1% (30)	< 1% (37)

LAMA, left against medical advice; LWBS, left without being seen.

Table 2. Comparison of CTAS scores at facility and ESI scores with general outcomes.

	CTAS 1, % (n)	CTAS 2, % (n)	CTAS 3, % (n)	CTAS 4, % (n)	CTAS 5, % (n)	ESI 1, % (n)	ESI 2, % (n)	ESI 3, % (n)	ESI 4, % (n)	ESI 5, % (n)	Total, % (n)
Discharged	30.8% (12)	25% (25)	38.3% (130)	49.4% (299)	67.7% (771)	5.8% (3)	30.7% (230)	66.2% (756)	89% (243)	71.4% (5)	55.7% (1,237)
Admitted	59% (23)	70% (70)	55.8% (189)	43.9% (255)	26.3% (300)	84.6% (44)	63.1% (472)	27.4% (313)	6.6% (18)	14.3% (1)	38.1% (848)
Deceased	10.3% (4)	0	0	0	0	7.7% (4)	0	0	0	0	0.2% (4)
LWBS, LAMA, and eloped	0	1% (1)	0.9% (3)	2.8% (17)	2.4% (27)	0	10.5% (12)	2.3% (27)	3% (8)	14.3% (1)	2.2% (48)
ED observation	0	4.5% (4)	5% (17)	3.8% (23)	3.5% (40)	1.9% (1)	4.5% (34)	3.9% (45)	1.5% (4)	0	3.8% (84)
Total per triage category	1.7% (39)	4.5% (100)	15.1% (339)	27% (605)	50.9% (1,139)	2.3% (52)	33.8% (756)	51.2% (1,142)	12.3% (276)	0.4% (7)	100% (2,222)

The triage categories were as follows: 1, resuscitation; 2, emergent; 3, urgent; 4, semi-urgent; and 5, nonurgent. CTAS, Canadian Triage and Acuity Scale; ESI, Emergency Severity Index; LAMA, left against medical advice; LWBS, left without being seen.

A comparison of patient admissions according to triage category is shown in Table 2. To understand the impact of each variable on admission likelihood, a hierarchical regression

analysis was performed. In the first block, patient age was significant and explained 14.7% of the variance in admission likelihood. As patient age increased by 1 year, the likelihood of admission decreased by 3.3%. In the second block, the CTAS score determined by paramedics on arrival at the hospital was significant ($P < .001$), explaining an additional 12.3% of the admission variance. In the final block, the ESI was added to the model and explained an additional 6% of the variance in disposition status ($P < .001$). The overall model was significant (n = 2,222; $P < .001$; Akaike information criterion (AIC) = 575.150) and explained 32.9% of the admission variance. In addition, the model correctly predicted 61.5% of admissions and 82% of all remaining ED dispositions, with an overall model prediction rate of 73.7%.

Further analysis of the CTAS and ESI data showed varying admission rates based on triage category. CTAS category 1 was not a significant predictor of admission; however, as the CTAS scores improved from category 2 to category 3, the likelihood of admission decreased by 60.3%. Similarly, as the CTAS scores improved from category 3 to category 4, the likelihood of admission decreased by 51.1%. Finally, as the CTAS scores increased from category 4 to category 5, the likelihood of admission decreased by 35.7%. ESI data were notably different. As the ESI scores improved from category 1 to category 2, the likelihood of admission decreased by 95.9%. All remaining ESI categories were not significant predictors of admission. CTAS scores on arrival at the emergency department showed a sensitivity of 10.77% (95% CI, 8.73%-13.10%) and specificity of 93.97% (95% CI, 92.52%-95.21%), with a positive predictive value (PPV) of 53.3% (95% CI, 45.42%-61.13%) and a negative predictive value (NPV) of 62.21% (95% CI, 60%-64.38%). The initial ESI scores showed a sensitivity of 47.44% (95% CI, 43.47%-51.44%) and specificity of 60.87% (95% CI, 57.8%-63.7%), with a PPV of 39.76% (95% CI, 36.23%-43.37%) and an NPV of 68.03% (95% CI, 65.08%-70.87%).

Discussion

Paramedics are an integral component of the modern US health care delivery system. Our findings indicate that paramedics can, with limited success, triage emergency patients using the CTAS with results similar to those of emergency nurses using the ESI when admission is used as the outcome. The results from this study provide support for the feasibility and usability of the CTAS by paramedics in one large fire division in the US. Paramedics have many opportunities to provide emergent and lifesaving interventions, alleviate pain, reduce emotional distress, offer professional guidance regarding community resource availability, and promote healthy living and wellness. They also prepare the patient and the receiving facility, to the best of their ability, so that the transition of care is error free and efficient, promoting optimal outcomes. Flow management is one of the primary goals of triage. This study, when compared with data from a prior study using the ESI among paramedics, suggests that the CTAS may be the most appropriate initial triage instrument used by paramedics for further evaluation. This collaborative, complex, interprofessional/intraprofessional relationship is of paramount importance to ensure a smooth transition of care from the paramedics to the ED nursing and medical staff.

This study is the necessary first step in a series of planned studies that builds a new foundation on which an investigation into the many aspects of prehospital triage can occur. Demonstrating paramedic ability to use a standardized instrument sets the stage for further studies using the ESI,

CTAS, and perhaps, components of other existing triage instruments that will aid in factor identification, which ultimately may lead to the development of a new triage instrument for paramedic use in the prehospital setting. Furthermore, support for the validity of the CTAS was shown with moderate predictive ability using admission as a triage outcome. Interestingly, there was a lack of convergence between triage instruments used by the paramedics and nurses. In addition, the notable differences in CTAS and ESI totals in categories 2 through 5 suggest extreme differences in evaluation parameters. Further studies are necessary to evaluate the impact these differences may have on acuity identification, resource need, and ultimately, outcomes.

Limitations

Several limitations must be considered when interpreting the findings of this study. The CTAS training was conducted live only for the super-users. The remaining paramedics viewed the same cases used in the live training in an online PowerPoint format. To improve understanding, a voice-over was provided to clarify confusion initially expressed by users. Further analysis is necessary to evaluate the training methods and case studies because there exists the potential for interpretation error without the opportunity for clarification, which existed in the live training sessions. Bias may exist when comparing the final CTAS and ESI scores because of the possibility that paramedics communicated their scores to the receiving nurses in the emergency department. Another possible limitation is the small sample sizes in CTAS category 1, CTAS category 2, ESI category 1, and ESI category 5.

A high call volume and user fatigue may inhibit paramedics' use of the CTAS instrument, forcing them simply to "enter a number" so that they can complete the electronic report and respond to the next call, given that all 3 CTAS scores were required to close the electronic patient care record. Use of the spiral-bound CTAS field guide booklets instead of the electronic version may limit the accuracy of scores because paramedics may choose not to take the time necessary to work through the algorithm. The lack of an electronic tracking method for the algorithm chosen by the paramedics limits interpretation of the scores. The results are not generalizable because they are the result of only one study in one full-time career fire division. Finally, because data collection failed to start on time, it is estimated that nearly 6,000 cases were lost, which may have an impact on interpretation of the results.

Implications for Emergency Nurses

Significant to emergency nursing is support for the feasibility and usability of the CTAS instrument by paramedics in the prehospital environment. This study showed that paramedics could use a structured triage instrument. The establishment of a reliable and valid system that accurately identifies patient needs, determines patient acuity, and predicts the likelihood of admission may improve timeliness of care, management of in-house resources, and overall outcomes. The availability of a prehospital triage score that is reliable, valid, and evidence based might offer beneficial data that triage nurses and nurse managers can use to control patient placement in the emergency department more accurately. Improved ED placement may ensure that the right patient is placed in the right area in a timely manner with the availability of the right resources. These improvements might maximize patient outcomes while minimizing patient

and staff dissatisfaction. The ability to predict discharge disposition based on CTAS scoring by paramedics may decrease the time required of ED staff to notify admissions, specialty services, and admitting units, thereby decreasing ED length of stay and boarding times. Finally, reliable and valid acuity determination by paramedics in the field may aid in the early implementation of triage protocols when patients are transported directly to the ED triage area, ultimately reducing the time to results, which is likely to improve disposition times by the emergency care provider (physician, nurse practitioner, or physician assistant).

Conclusions

The empirical knowledge gained from this study provides the foundation necessary for future studies to continue the evaluation of factors that aid in the development of a uniform triage and communication strategy for paramedics and emergency nurses. These strategies support the goals established by the IOM and the ENA to improve outcomes, reduce mortality rates, and improve throughput in the emergency department. Additional research is urgently needed to evaluate existing and unknown factors that affect patient disposition, including development of triage systems that are feasible for both paramedics and nurses using a multidisciplinary and collaborative interprofessional approach to emergency care and outcomes management.

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