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ED Administration

Predictors of admission to hospital of patients triaged as nonurgent using the Canadian Triage and Acuity Scale

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ABSTRACT

Objectives: To identify factors known prior to triage that might have predicted hospital admission for patients triaged by the Canadian Triage Acuity Scale (CTAS) as level 5 (CTAS 5, nonurgent) and to determine whether inappropriate triage occurred in the admitted CTAS 5 patients.

Methods: We reviewed the triage records of patients triaged as CTAS 5 at the emergency departments (EDs) of three tertiary care hospitals between April 2002 and September 2009. Two triage nurses unaware of the study objective independently assigned the CTAS level in 20% of randomly selected CTAS 5 patients who were admitted. We used the kappa statistic (κ) to measure the agreement among the raters in CTAS level between the assessment of the research nurses and the original triage assessment and regression analysis to identify independent predictors of admission to hospital.

Results: Of the 37,416 CTAS 5 patients included in this study, 587 (1.6%) were admitted. Agreement on CTAS assignment in CTAS 5 patients who were admitted was κ -0.9, (95% confidence interval [CI] -0.96 to -0.84). Age over 65 (odds ratio [OR] 5.46, 95% CI 4.57 to 6.53) and arrival by ambulance (OR 7.42, 95% CI 6.15 to 8.96) predicted hospital admission in CTAS 5 patients.

Conclusions: Most of the CTAS 5 patients who were subsequently admitted to hospital may have qualified for a higher triage category. Two potential modifiers, age over 65 and arrival by ambulance, may have improved the prediction of admission in CTAS 5 patients. However, the consistent application of existing CTAS criteria may also be important to prevent incorrect triage.

RÉSUMÉ

Objectifs: L'étude visait à cerner des facteurs connus avant le triage, susceptibles d'améliorer les prévisions d'hospitalisation chez les patients considérés comme des cas non urgents (niveau 5) selon l'Échelle canadienne de triage et de gravité (ECTG-5), et à déterminer si les patients concernés avaient été mal triés avant leur hospitalisation.

Méthode: Nous avons passé en revue les dossiers des patients classés ECTG-5, d'avril 2002 à septembre 2009, au service des urgences de trois centres hospitaliers de soins tertiaires. Deux membres du personnel infirmier, affectés au triage et ignorants des objectifs de l'étude ont attribué, chacun de leur côté, une cote selon l'ECTG à 20% des patients choisis au hasard, qui avaient été considérés comme des cas non urgents et qui finalement avaient été hospitalisés. La valeur statistique kappa (κ) a servi à mesurer le degré de concordance, quant au degré de gravité selon l'ECTG, entre les évaluateurs qui ont participé à l'étude et ceux qui avaient attribué initialement la cote de triage; et l'analyse de régression, à cerner des facteurs prévisionnels indépendants d'hospitalisation.

Résultats: Sur les 37,416 patients classés ECTG-5 et retenus dans l'étude, 587 (1.6%) ont été hospitalisés. Le degré de concordance (κ) quant à l'estimation du degré de gravité, selon l'ECTG, de l'état des patients qui avaient reçu une cote 5 et qui finalement avaient été hospitalisés était de -0.9 (intervalle de confiance [IC] à 95% -0.96 à -0.84). Un âge de plus de 65 ans (risque relatif approché [RRA] 5.46; IC à 95% 4.57 à 6.53) et l'arrivée en ambulance (RRA 7.42; IC à 95% 6.15 à 8.96) se sont révélés des facteurs prévisionnels d'hospitalisation chez les patients classés ECTG-5.

Conclusions: La plupart des patients qui avaient reçu une cote ECTG-5 et qui, par la suite, ont été hospitalisés auraient pu être classés dans une catégorie supérieure de triage. Deux facteurs possibles, soit un âge de plus de 65 ans et l'arrivée en ambulance, auraient pu améliorer les prévisions d'hospitalisation chez les patients considérés comme des cas non urgents. Toutefois, l'application uniforme des critères de l'ECTG pourrait aussi être un facteur important de prévention de mauvais triage.

Keywords: admission, Canadian Triage and Acuity Scale, interrater reliability

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The goal of emergency department (ED) triage is to assign priority to patients who need more immediate care and to predict the scope of care required.[1] Most Canadian EDs employ the five-level Canadian Triage and Acuity Scale (CTAS) for this purpose. The most appropriate CTAS level for each patient is based on the presenting complaint, with modifiers including vital signs, level of consciousness, pain severity, mechanism of injury, pregnancy, and blood glucose.[2,3] The primary operational objective of this triage tool is the time to see a physician, with the five acuity levels ranging from level 1, resuscitation, to level 5, nonurgent. The assigned CTAS level has also been shown to predict hospital admission, ED length of stay, need for diagnostic evaluation, and in-hospital mortality.[4–6] Misclassification of triage level has been demonstrated to result in delays in management.[7]

Because CTAS level 5 (CTAS 5) patients are the lowest acuity, they "can be delayed and/or referred to other areas of the health care system."[3] In some settings, a registered nurse can refer CTAS 5 patients out of the ED or defer their care without contacting a physician.[2] Whether due to an error in the application of the triage tool or the tool itself, CTAS 5 patients occasionally are admitted to hospital. Deferral of timely ED care in these patients can potentially cause harm.[7–9]

The objectives of this study were to identify factors known prior to triage that might have predicted hospital admission for patients triaged as CTAS 5 and to determine whether inappropriate triage occurred in these admitted patients.

METHODS

Study design

Our local, university-affiliated hospital research ethics board reviewed and approved this study. The ED records of all patients triaged as CTAS 5 from April 1, 2002, to September 30, 2009, were examined from a prospectively collected hospital ED patient database at three tertiary care hospitals in Hamilton, Ontario (population 505,000). At the time of the ED visit, all ED patients were assigned a CTAS level by a registered nurse using memory and paper-based prompts. During the study period, there were two CTAS revisions, and the triage nurses used the most current revision available at the time of triage.

We used the medical record review method criteria described by Gilbert and colleagues to design the chart review portion of this study.[10] Using a random number generator, we selected 120 (20%) of the charts of all CTAS 5 patients who were admitted to hospital during the study period. We removed the patient identifiers, original CTAS rating, ED bed placement, and discharge information from the charts. Two research nurses were then asked to independently review these charts for the presenting complaint and CTAS modifiers and assign CTAS scores on standardized data entry forms using the most current CTAS version and their current standard of practice to determine if the original CTAS 5 assignment was appropriate. A case was ruled as inappropriately triaged as CTAS 5 only when both nurses independently assigned a triage acuity greater than level 5. In making their evaluations, the nurses had access to the remaining deidentified data to assign a triage level: the patient's age, sex, chief complaint, vital signs, Glasgow Coma Scale, capillary glucose, pain level, medications, past medical history, allergies, immunization status, pregnancy status, mode of arrival, ambulation status, subjective and objective nursing notes, paramedic interventions, mechanism of injury, and weight. The triage nurses each had at least 8 years of CTAS experience, were not employed at the study hospitals, were trained at the same time using practice triage records, and were directly monitored for performance by one of the investigators (D.L.).

Primary data analysis

We calculated the mean and standard deviation of continuous variables and percentages for categorical variables. We calculated the kappa statistic (κ) as the measure of agreement (interrater reliability [IRR]) between the original CTAS assessment and the CTAS assessments of the research nurses. Kappa was prospectively qualitatively classified as described by Altman: poor (< 0.20), fair (0.21–0.40), moderate (0.41–0.60), good (0.61–0.80), or very good (0.81–1.00).[11] For candidate predictor variables, we selected only variables that were known prior to triage and not already a CTAS modifier: age, sex, and arrival by ambulance. We did not include other potential predictors because they were already a CTAS modifier or could not be known without a thorough medical examination. Our goal was to examine factors known prior to triage. For the univariate analysis, the chi-square test was used for

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nominal data, and the *t*-test was used for interval data. We conducted logistic regression analysis to determine independent predictors of admission and calculated their odds ratios (ORs) with 95% confidence intervals (CIs). Age was dichotomized for the regression analysis using receiver operating curve analysis for the most accurate cutpoint. We used the *Statistical Package for the Social Sciences* (IBM Corporation, Somers, NY), version 20, for the statistical analysis.

RESULTS

There were 704,995 patient visits during the study period, of which 5.3% (37,416) were triaged as CTAS 5. The median patient age from all CTAS 5 visits was 34 years (interquartile range [IQR] 50−21 years, range 0−104 years). Of the CTAS 5 patients, 84.0% (31,411) were discharged, 12.2% (4,580) left before discharge, 2.2% (838) were transferred, and 1.6% (587) were admitted to hospital. The median hospital stay of admitted CTAS 5 patients was 4 days (IQR 10−2 days, range 1−97 days). A comparison of the mean age, percent male, and number of patients between non-admitted and admitted CTAS 5 patients is provided in Table 1.

The most common discharge diagnoses were fractures (61; 10.4%), malignancy (27; 4.6%), cellulitis (26; 4.4%), postoperative complications (23; 3.9%), pneumonia (18; 3.1%), acute coronary syndrome (16; 2.7%), urinary tract infection (15; 2.6%), complications of diabetes (15; 2.6%), biliary tract disease (15; 2.6%), chronic obstructive pulmonary disease (13; 2.2%), electrolyte abnormalities (9; 1.5%), syncope (8; 1.4%), cerebral infarctions (8; 1.4%), congestive heart failure (7; 1.2%), arrhythmia (7; 1.2%), gastrointestinal bleeding (6; 1.0%), and acute renal failure (6; 1.0%).

There were several high-risk emergency medicine diagnoses in admitted patients triaged as CTAS 5, including intracranial bleeding (4; 0.68%), meningitis (2; 0.34%), Fournier gangrene (2; 0.34%), hemothorax (1; 0.17%), septic joint (1; 0.17%), epiglotitis (1; 0.17%), ectopic pregnancy (1; 0.17%), and cerebral artery dissection (1; 0.17%).

Interventional treatments for 178 patients (30.3%) included open reduction and internal fixation (48; 8.2%), surgical drainage (34; 5.8%), surgical biopsy (34; 5.8%), medical device implantation (10; 1.7%), tendon repair (9; 1.5%), bowel surgery (9; 1.5%), biliary surgery (7; 1.2%), neurosurgery (6; 1.0%), urologic surgery (6; 1.0%), vascular surgery (6; 1.0%), amputation (5; 0.85%), appendectomy (5; 0.85%), other orthopedic surgery (5; 0.85%), other plastic surgery (4; 0.68%), spinal surgery (4; 0.68%), cardiac surgery (2; 0.34%), gynecologic surgery (2; 0.34%), and ophthalmologic surgery (2; 0.34%). In addition, a major procedure was required in 25 patients (4.3%): endotracheal intubation was required in 3 patients (0.51%); percutaneous coronary intervention was done in 4 patients (0.68%); endoscopy was done in 15 patients (2.6%); and bronchoscopy was done in 3 patients (0.51%).

The agreement in the CTAS level between the two research nurses was 95.8%. The IRR between the research nurse assignments of CTAS levels and the original triage score of CTAS 5 for admitted patients gave a κ of −0.9 (95% CI −0.96 to −0.84), representing poor agreement. The research nurses independently found that 90% of the admitted CTAS 5 patients should have been triaged higher than CTAS 5.

Age over 65 was used as the most accurate age cutpoint, with an area under the curve of 0.74 (95% CI 0.72 to 0.77). For patients initially triaged as CTAS 5, the regression model revealed that admission to hospital was independently predicted by age over 65 (OR = 5.46, 95% CI 4.57 to 6.53) and arrival by ambulance (OR = 7.42, 95% CI 6.15 to 8.96). Sex was not a significant, independent predictor of hospital admission for this population (OR = 0.98, 95% CI 0.83 to 1.16). The Nagelkerke R^2 statistic was 0.164. Of the 587 admitted patients, 43 (7.3%) arrived by ambulance, 121 (20.6%) were over 65, and 177

Table 1. Demographic comparison and univariate analysis of nonadmitted and admitted CTAS level 5 patients

Variable	Nonadmitted CTAS 5 (n = 36,829)	Admitted CTAS 5 (n = 587)	p value
Mean age	36.6 (SD 20.4)	58.3 (SD 25.9)	< 0.001
Male gender, n (%)	20,338 (55.1)	296 (50.4)	0.020
Arrival by ambulance, n (%)	1,631 (4.4)	220 (37.5)	< 0.001

CTAS = Canadian Triage and Acuity Scale.

(30.1%) belonged in both categories. If these two predictors had been used to prevent triaging a patient to CTAS 5, then 341 patients (58.1%) who required admission would not have been triaged to CTAS 5.

DISCUSSION

Although the primary operational objective of the CTAS is related to time to see a physician, the CTAS has been demonstrated (and applied) as a useful surrogate for illness severity and resource use.[2,4,6] The 2008 CTAS revisions included a section on the rural protocol for CTAS 5 that allowed a registered nurse, without contacting a physician, to refer CTAS 5 patients to another service provider or to defer care to a later time.[2] Some authors have raised concern with the deferral of the care for nonurgent patients from the ED regardless of the community setting.[7,9] We found that 1.6% of CTAS 5 patients in our study required admission, which is similar to other studies using the CTAS.[1,9] Although admission was rare, the admitted CTAS 5 patients stayed in hospital for a median of 4 days; 30.3% required operative management, and 4.3% required a major procedure. The triage of patients who later require admission into a category that is defined by "nonhospital care" can delay timely diagnosis, treatment, and specialist referral of time-sensitive illnesses.[7–9] If all of the CTAS 5 patients in our study had been referred away from the hospital, then 587 patients may not have received the care they ultimately required, such as admission, an operation, or a major procedure.

Adult and pediatric studies using paper and computerized triage have demonstrated moderate to good agreement in IRR using the CTAS.[1,12–14] A recent study by Dallaire and colleagues demonstrated fair to moderate agreement in paper-based triage for experienced triage nurses, perhaps due to increased reliance on experience rather than specific CTAS criteria.[15] In contrast, our study found poor agreement between the research triage nurses and the original triage nurses in their CTAS assignment. The finding of negative κ means that there was more disagreement in triage between the research nurses and the original triage nurses than could be accounted for by chance alone.[16] This suggests a problem with either the application of the triage tool (inappropriate triage) or the triage tool itself (improvement to the CTAS needed), both of which are discussed next.

Inappropriate triage

For both research nurses to independently conclude that a patient qualified for a higher triage level than the original assigned CTAS 5, they must have found information in the original triage notes created by the original triage nurses to lead them to this conclusion. The triage record might not have contained all of the information on which the original triage decision was made, such as a subjective assessment of the patient by the triage original nurse that provided a gestalt, or intuitive judgment, of nonurgency in the admitted CTAS 5 patients. The triage record did include objective CTAS modifiers such as complaint, mechanism of injury, vital signs, level of consciousness, pain severity, pregnancy, and glucose levels that led to both research nurses assigning a more urgent CTAS level 90% of the time. Objective reliance on existing modifiers may greatly improve the consistency and accuracy of appropriate triage. In some studies, computer-based prompts improved reliability.[12–15] In our study, the two research nurses using paper-based triage with objective information only (no patient in front of them) had 95.8% agreement. As with the study by Dallaire and colleagues,[15] original triage nurses in this study used paper-based triage, which may have led to inappropriate application of the CTAS due to subjective factors, such as reliance on experience or intuition rather than only objective factors. It is possible that if these modifiers mandated a more urgent assignment than CTAS 5, then additional objective CTAS modifiers that were known prior to triage may have prevented these errors in judgment.

Improvement to CTAS needed

This study found two objective factors known prior to triage that should be considered potential modifiers in future CTAS revisions to improve the prediction of the scope of care required and prevent subjective errors in triage: age and arrival by ambulance. The evidence used to include new modifiers in the 2008 CTAS revision was derived from updated clinical practice guidelines (e.g., sepsis, hemophilia, anticoagulation reversal, and suicide) rather than any study on the ability of specific modifiers to predict an appropriate triage level.[2] Although many studies have shown that higher CTAS acuity predicts increased resource use, no previous studies have examined specific modifiers to improve the triage tool.[4,6,7] Elderly patients sometimes have atypical vital signs or presentations that can allow them to be misclassified in the CTAS system.[17] Patients who arrive by ambulance are more likely to have factors associated with more acute conditions that preclude self-transport or transport by family.[18] A recent study done in a Singapore ED found that age greater than 65 (OR = 2.5−5.3) and arrival by ambulance (OR = 1.7) were associated with admission in a ED patients, although the association was not as strong as in our study of only CTAS 5 patients.[19] Currently, age over 65 and arrival by ambulance are not modifiers in the CTAS; however, we found that admissions were strongly associated with age over 65 and arrival by ambulance in CTAS 5 patients. Adoption of these two modifiers might improve the discriminatory and predictive power of CTAS by preventing deferral of care or referral from hospital for inappropriately triaged patients at higher risk for admission. Application of these two modifiers to CTAS 5 patients would have resulted in 58.1% fewer admitted CTAS 5 patients. To the best of our knowledge, this is the first study to evaluate the prognostic value of individual modifiers in the CTAS score.

Limitations

The CTAS was designed to determine the urgency of initial physician assessment, although subsequent studies have found the CTAS to predict patient outcomes and resource use.[2−6] This study used the primary outcome of admission, which is not the same as urgency of initial physician assessment because some patients who require admission do not need to see the physician immediately. This study was designed to focus on admitted CTAS 5 patients because in some settings, CTAS 5 patients may be referred away from the ED or have their care deferred, precluding an initial physician assessment altogether and resulting in harm.[2,3,7−9] In the admitted CTAS 5 patients, we found that some had time-sensitive diagnoses or time-sensitive procedures. On the other hand, only 1.6% of 37,416 patients triaged as CTAS 5 were admitted during the study period, and of these, only 34.6% needed an operation or major procedure. Improvements to triage objectivity, including improved application of the CTAS and consideration of potential CTAS modifiers found in this study, should be considered in the context of an already overall accurate triage system.

One of the objectives of this study was to determine new factors that determine admission in CTAS 5 patients; thus, existing CTAS modifiers were not included in the statistical model. Given that we also found that the existing modifiers may not have been correctly applied in the admitted CTAS 5 patients, further research is required to assess how correctly applied existing modifiers affect the model. Our centre used paper-based triage, whereas other centres use computer-based triage. It has been shown that computer-based triage improves the reliability of the CTAS.[13,14] It is unclear whether these study findings would be applicable to centres with computer-based triage. This study shows that in a real-world situation, the CTAS may not always be correctly applied due to human error. Simple mandatory modifiers that are known prior to triage may prevent a false nonurgent triage assignment, thereby avoiding deferral of care for the majority of CTAS 5 patients who require admission.

Although we examined 37,416 patient visits at three EDs to achieve our findings, the study was only in one city. It is unclear if these findings can be generalized to all EDs, in particular rural EDs, where CTAS 5 may mean discharge from the ED without physician assessment. Prospective validation of age and ambulance modifiers in multiple settings is needed to demonstrate the real-world validity of the model.

CONCLUSION

Most CTAS 5 patients who are subsequently admitted to hospital may have qualified for a higher triage category. If two potential modifiers, age over 65 and arrival by ambulance, were used to prevent a triage assignment of nonurgent, then most CTAS 5 patients who required hospital admission may have been triaged in a more urgent category. These potential triage modifiers should be considered in future CTAS guidelines to avoid misclassification of patients at high risk for admission to a triage category defined by delayed or deferred care.

Competing interests: None declared.

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