University of Alberta

Reliability and Validity of a Computer-assisted Emergency Department Triage System

by

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Your file *Votre référence*
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Our file *Notre référence*
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To So Lan and Andrew, my parents, who made countless sacrifices and taught me integrity, honesty, and perseverance.

Abstract

This research prospectively evaluated the performance of a computerized triage tool (eTRIAGE©) in an actual emergency department environment. There were several important conclusions from this research. First, a marked discrepancy was demonstrated between triage nurses using the Canadian Triage and Acuity Scale (CTAS) based on memory compared to eTRIAGE© (weighted kappa {κ_w}: 0.36; 95% CI: 0.31, 0.42; n = 693). Second, eTRIAGE© demonstrated greater agreement with a consensus panel assigning triage (eTRIAGE© κ_w: 0.43; 95%CI: 0.29, 0.56 vs. memory CTAS κ_w: 0.26; 95% CI 0:.13, 0.39; n = 97). Third, the agreement between two independent users of eTRIAGE© on the same patients improved to moderate or good (linear κ_w: 0.52; 95% CI: 0.46, 0.57. quadratic κ_w: 0.66; 95% CI: 0.60-0.71; n = 569). Finally, higher acuity CTAS scores using eTRIAGE© were strongly associated with surrogate markers of patient acuity (admission rate [p<0.001)]; death [p<0.001]) and resource consumption (consultations [p<0.001], computed tomography scans [p<0.001], and length of stay [p<0.001]).

Preface

This thesis is presented in the paper format. It consists of five chapters, including an introduction and a conclusion. Each chapter is presented in a format appropriate for medical journal publication with a separate bibliography. Chapter two has been accepted as a manuscript in a peer reviewed journal. Chapters three and four have been submitted for publication at the time this thesis went to press.

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List of Symbols and Abbreviations

ACCS	Acute Care Classification System
ATS	Australasian Triage Scale
CT	computerized tomography
CTAS	Canadian Triage and Acuity Scale
ED	emergency department
ESI	Emergency Severity Index
κ	kappa
κ_W	weighted kappa
κ_{WL}	weighted kappa with linear weights
κ_{WQ}	weighted kappa with quadratic weights
MTS	Manchester Triage Scale
RCT	randomized controlled trial
RAH	Royal Alexandra Hospital

Chapter 1

Introduction

1.1 Context

The International Federation of Emergency Medicine defines emergency medicine as "a field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury ... with a full spectrum of episodic undifferentiated ... disorders."[1] Patients access the emergency department (ED) for a variety of reasons. These can range from catastrophic problems, such as heart attacks and injuries sustained in high speed motor vehicle collisions, to the inappropriate, such as inability to access the primary health care provider for a prescription refill. It is up to the ED staff to identify those in need of urgent care to prevent unnecessary morbidity, disability, and suffering.

Triage (pronounced trE-'äzh) is derived from the French word "trier", meaning "to sort."[2] Its origins have been attributed to Napoleon's chief surgeon, Baron Dominique Jean Larrey, who triaged battlefield victims based on need and not on military rank or social class.[3] As the specialty of emergency medicine developed and emergency departments around the world began to experience volume pressures that overwhelmed their capacity, the concept of triage was re-introduced. Today this spirit of egalitarianism, based on urgency of care only, continues most modern EDs.

Each patient's ED visit begins with the triage process. Patients are assessed by triage staff (in most EDs the staff are skilled and trained nurses) and prioritized based on the urgency of need for medical care. Triage attempts to match a patient's needs to the appropriate resources.[4] Undertriage (assigning a triage level lower than the patient's actual acuity) can compromise patient safety while overtriage (assigning a triage level higher than the patient's actual acuity) can consume scarce ED resources and potentially deny another patient from requiring the same care. Despite the brevity of this initial encounter, it is imperative that triage be as accurate as possible.

Triage data are most often used to guide individual patient care; however, they have also been used to define departmental acuity and provide data for quality assurance reviews.[4;5] If administrators wish to use triage data for benchmarking, funding, or identifying resource needs, the triage process needs to be sensible, reliable, reproducible, and valid. The ideal triage system also needs to be easy to use, easy to implement and train users, and should require minimal training to achieve competence. Moreover the ideal the system should be able to provide feedback to the authors or steering committee, to make them aware of necessary changes to respond to the increasing complexity of the ED climate.

1.2 The triage environment

The triage process is made up of the triage system, the triage staff, and the patient, all in context of the ED environment. Most Canadian EDs are open 24 hours a day, 7 days a week, every day of the year. They assess and treat all patients and are the entrance for a large majority of patients into the health care system. It is a hectic, chaotic and highly unpredictable environment, yet the triage process is required to be uninfluenced by physical space (or lack thereof), distraction of non-triage duties, and ED overcrowding.

Unfortunately, given this unique health care environment, much of the performance of triage and its influence by other factors remains unknown. For example, despite the general acceptance of increasing patient acuity and complexity, a recent report indicated 17% *decrease* in ED acuity.[6] This apparent discrepancy has been given the term "triage drift" and has been attributed to non-patient factors influencing triage decisions. Moreover, an unscientific poll of local colleagues revealed a climate in which patients who would be purposely undertriaged in order to be able to be placed in the waiting room due to a lack of ED beds.

1.3 Review of current triage systems

This review of ED triage systems was conducted by searching three electronic databases MEDLINE, (1966 to April 2005), CINAHL (1982 to April 2005), and EMBAES (1996 to Week 16, 2005) using "Triage" as a search term; by searching the bibliographies of relevant journal articles; and by hand searching relevant emergency medicine journals (*Academic Emergency Medicine*, *Annals of Emergency Medicine*, *Canadian Journal of Emergency Medicine*, *Emergency Medicine Australasia*).

There are currently numerous triage systems. Outside of the United States, five level triage systems are becoming the standards. In the United Kingdom, the Manchester Triage Scale (MTS) has been used since 1997.[7] Retrospective studies of MTS have reported moderate inter-rater agreement[8] and ability to predict critically ill patients.[9] The Australasian Triage Scale (ATS), formerly known as the National Triage Scale, is used in every ED in Australia.[10] The ATS has been evaluated using simulated case scenarios; agreement was found to be "good" and an improvement over previous the triage system was demonstrated.[11]

In Canada, the Canadian Triage and Acuity Scale (CTAS) is widely used. It was developed largely by consensus of emergency physicians and nurses in the 1990s and assigns a triage score from a five-level scale (1 = Resuscitation, 2 = Emergent, 3 = Urgent, 4 = Semi-urgent, 5 = Non-urgent). While other triage systems are used in Canada, CTAS is the nationally recognized standard.[4;12] It has been extensively tested and has demonstrated good reliability[13;14] and validity.[15;16] Validity has also been studied in the context of overcrowding.[17] A pediatric version of the CTAS has also been developed and deployed in Canada.[18] None of the other systems described above have a separate pediatric component.

The MTS, ATS, and CTAS are complaint based triage systems in which the user chooses from a number of complaint types and are given a number of discriminators to determine triage level. In contrast, the Emergency Severity Index (ESI) tasks the user to initially identify the critically ill, and then predict the number of resources (laboratory investigations, diagnostic imaging, procedure, consultation) the patient will required in the ED.[19] The ESI has been found to be reliable and valid.[19-23] Despite these promising results, the ESI is only used in a small proportion of EDs in the United States while the majority use three-level triage, which has been shown to be inferior to five-level triage.[24;25]

A summary of the systems available and their psychometric properties are displayed in **Table 1.1.**

1.4 Electronic decision support

Although the original triage system manuals and documentation are comprehensive, application and implementation are still largely based on memory and experience. The CTAS implementation guidelines provide eleven pages of text defining the characteristics of patients in each of the five levels and six pages of specific examples.[4] Busy nurses cannot be expected to refer to the original paper documents nor be expected to remember every discriminator for each complaint type. CTAS wall posters and pocket guides are available; however, the majority of triage nurses still rely on memory and experience.

Decision support tools have the potential to decrease subjectivity in the triage process. The promise of improved clinical processes and outcomes with the use of electronic clinical supports has not realized to the extent expected. In the State-of-Science Review commissioned by the Alberta Heritage Fund for Medical Research in 2003[26], Klassen's group identified 57 randomized controlled trials (RCTs) and 10 systematic reviews involving computer-based evidence delivery. Overall, the usefulness of computer-based evidence delivery remains in question as the results of the included studies varied (i.e., some found a benefit, some did not). While process of care improved, impact on patient health outcomes was harder to demonstrate. The authors concluded that additional higher quality research was needed.

An electronic revolution is occurring in health care, especially in Alberta. For example, electronic health records and electronic decision support tools have become more readily available. Emergency physicians in Edmonton have had access to electronic clinical practice guidelines for approximately 5 years. Finally, the development of ED computerized tracking systems have enabled many larger EDs to employ this information technology with a variety of applications. As a consequence of EDs becoming more electronically sophisticated, electronic triage support tools should become more available. Computer assisted triage also offers the advantage of advanced data collection for surveillance and research.

Most research on computerized triage use proprietary triage systems[27-29] There is only a single study which showed good reliability for computer-linked triage based on the CTAS, in which the user is directed toward the preferred level for each patient complaint.[30]

1.5 The University of Alberta's eTRIAGE© system

Responding to the need to minimize subjectivity in the triage process, a web-based triage decision support tool (eTRIAGE©) based on the CTAS has been developed at the University of Alberta. This system has been deployed in ten hospital sites across Canada and the United States.[31] The application requires the user to select from a standardized complaint set, each of which generates the appropriate CTAS-based template to assist the user in choosing the appropriate triage level. **Figure 1.1** is a screen shot of a CTAS-based template for chest pain generated by eTRIAGE©. The user is able to override the computer if the clinical impression disagrees, but must provide a reason for the decision. One additional advantage of eTRIAGE© is the ability to collect feedback based on the overrides and provide feedback back to the CTAS steering committee to make future modifications to the CTAS. Since the psychometric properties of these tools are as important as other clinical tools in practice, this thesis will focus on the use of the eTRIAGE© tool and examine its reliability and validity.

1.6 Measuring reliability

Reliability is defined as the agreement based on repeated observation.[3] A variety of reliability measurements have been described, including inter-rater and intra-rater reliability. Inter-rater reliability is the ability of two users to arrive at the same observed outcome using the same tool. Intra-rater reliability is the ability of same observer to arrive at the same outcome using the same tool at different times. A synonym for this psychometric property is *reproducibility.*

In the case of triage, reliability is the ability of two users to assign the same triage score to a patient (inter-rater agreement). The ideal triage system would have high reliability in different settings such as rural and urban EDs, different experience levels of triage staff, and variations in ED overcrowding. A valid system without good reliability would impair the ability to make benchmark comparisons or define fluctuations in department acuity.

Inter-rater agreement can be measured using a variety of effect measures; however, the most common method of reporting agreement is with the kappa (κ) statistic. Kappa describes the probability of two observers achieving agreement beyond chance alone.[32;33] Unweighted κ, also called exact level agreement, assigns no credit for partial agreement, while weighted kappa (κ_w) assigns some credit for partial agreement. Disagreement can diminish κ_w in a linear or quadratic (exponential) fashion. Within-1 kappa is a specific form of κ_w used in triage research in which agreement within one category is given full credit while all other disagreements are given no credit. Most studies report quadratic κ_w[13;14;19;21;22;29;34], while others report and advocate exact level agreement.[30;35]

Regardless of weighting method, inter-rater agreement using the kappa statistic is generally defined as excellent ($\kappa \geq 0.8$), good ($0.6 \leq \kappa < 0.8$), moderate ($0.4 \leq \kappa < 0.6$), fair ($0.2 \leq \kappa < 0.4$) or poor ($\kappa < 0.2$) using the format originally proposed by Landis and Koch.[33]

1.7 Measuring validity

While kappa, in some form, is the accepted measure of inter-rater agreement in triage literature, there is currently no "gold standard" for validity. Validity refers to the ability of a measurement to reflect the truth. A common synonym for this psychometric property is *accuracy*.

A variety of measurements for triage validity have been used. Mortality, admission rate, length of stay, need for critical intervention, patient care costs, resource utilization, have been used as surrogate markers of patient acuity.[8;9;15;21;23;36] Mortality is the most easily determined outcome measure with theoretically absolute inter-rater agreement. However, as described in Chapter 4, mortality is a rare outcome in the ED and as such would not serve as a practical measure of validity. The other proposed measures are confounded by variations in ED volume, hospital bed and staffing shortages, speed of diagnostic imaging and laboratory services, and other factors independent of a patient's presenting problem.[3] Until a reliable, robust and sensible measure of triage validity emerges, these markers will likely continue to be used.

1.8 Thesis outline

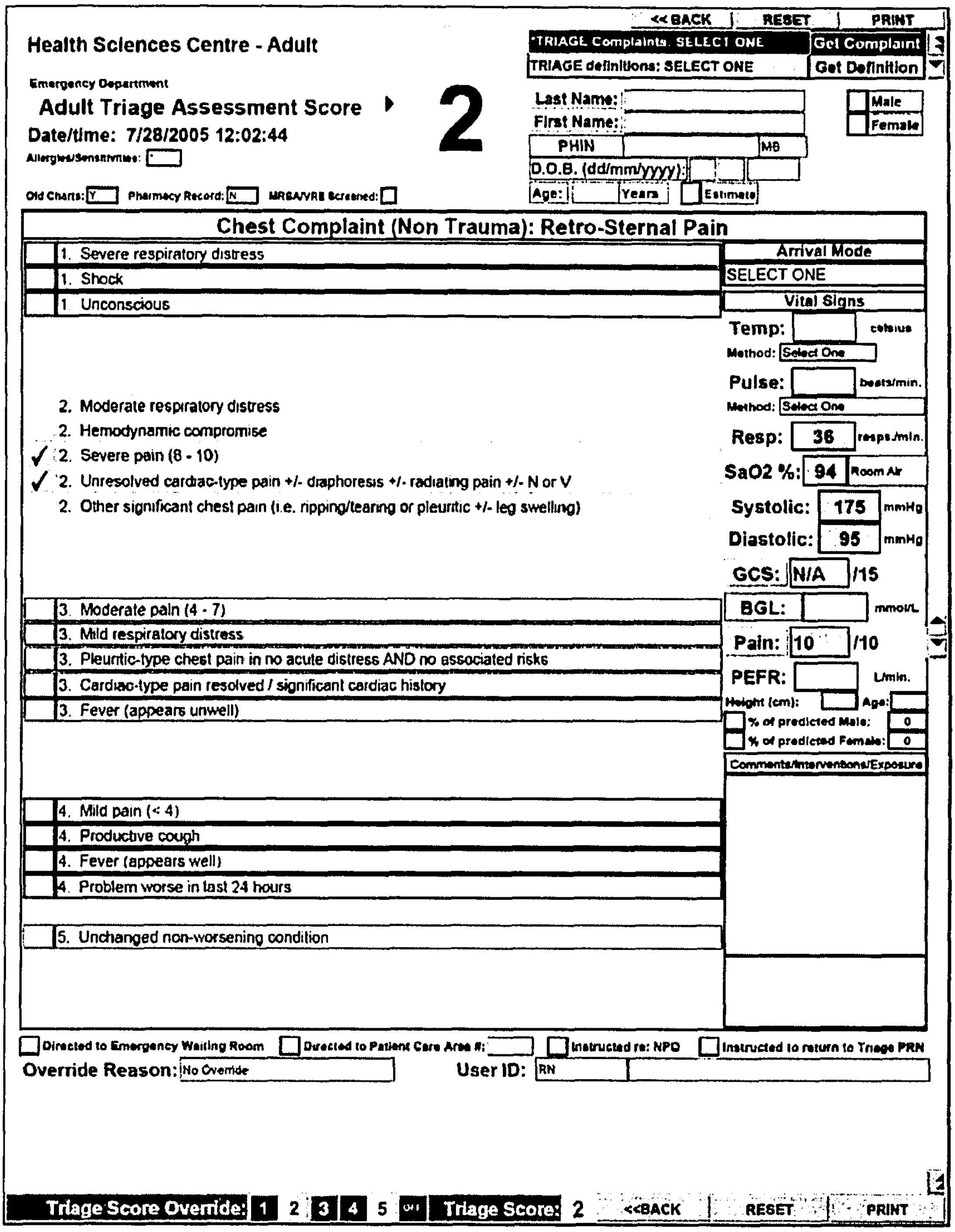
This thesis will examine the reliability and validity of eTRIAGE©. The work consisted of three studies conducted over an eighteen month period in a large, urban, tertiary care ED in a Canadian inner city teaching hospital. During this time, the ED made a transition from using the CTAS as a memory-based triage system to eTRIAGE©. The first study prospectively compares agreement between triage nurses using CTAS and study nurses using eTRIAGE© in a live environment. After eTRIAGE© deployment, the second study compared agreement between two nurses, both using eTRIAGE©, also in a prospective fashion in a live environment. The third study examined the ability of eTRIAGE© to predict ED resource utilization and patient acuity through data extraction from a large administrative database.

Table 1.1. A review of triage systems and psychometric properties

Scale	Reference	Objective	Live environment-time study	Outcomes
Manchester	Goodacre[8]	Agreement	No	$\kappa = 0.31\text{-}0.63$
Manchester	Cooke[9]	Predict hospital admission	No	67% patients admitted to critical care area received triage scores of 1 and 2
Australasian	Jelinek[11]	Agreement	No	86% within 1 level of agreement
CTAS	Beveridge[13]	Agreement	No	$\kappa = 0.80$
CTAS	Grafstein[30]	Agreement	Yes	$\kappa = 0.75$; computer assisted triage
CTAS	Manos[14]	Agreement	No	$\kappa = 0.77$
CTAS	Spence[15]	Validity	Yes	CTAS levels accurately predicted admission to hospital
CTAS	Stenstrom[36]	Validity	Yes	CTAS levels accurately predicted resource utilization and hospital admission
ESI	Wuerz[19]	Agreement & validity	No	$\kappa = 0.80$; good prediction of hospital admission
ESI	Wuerz[20]	Validity	Yes	Good prediction of time in the ED and cost
ESI	Eitel[21]	Agreement & validity	Yes	$\kappa = 0.69\text{-}0.87$; good predictor of hospitalization and mortality
ESI	Tanabe[22]	Agreement & validity	No	$\kappa = 0.89$; good predictor of hospitalization
ESI	Tanabe[23]	Validity	No	ESI predicted resource utilization
ESI	Travers[24]	Agreement & validity	No	$\kappa = 0.68$; 12% undertriage with ESI
ESI	Travers[25]	Agreement & validity	No	$\kappa = 0.58$; undertriage rate was 60% for ESI level 2

CTAS = Canadian Triage and Acuity Scale; ESI = Emergency Severity Index

Figure 1.1 eTRIAGE© screen shot


<< BACK | RESET | PRINT

Health Sciences Centre - Adult

*TRIAGE Complaints: SELECT ONE | Get Complaint

TRIAGE definitions: SELECT ONE | Get Definition

Emergency Department

Adult Triage Assessment Score 2

Date/time: 7/28/2005 12:02:44

Allergies/Sensitivities:

Last Name:

First Name:

PHIN | MB

D.O.B. (dd/mm/yyyy):

Age: Years Estimate

Male

Female

Old Charts: Y Pharmacy Record: N MRSA/VRE Screened:

Chest Complaint (Non Trauma): Retro-Sternal Pain

1. Severe respiratory distress
1. Shock
1. Unconscious

2. Moderate respiratory distress
2. Hemodynamic compromise
✓ 2. Severe pain (8 - 10)
✓ 2. Unresolved cardiac-type pain +/- diaphoresis +/- radiating pain +/- N or V
2. Other significant chest pain (i.e. ripping/tearing or pleuritic +/- leg swelling)

3. Moderate pain (4 - 7)
3. Mild respiratory distress
3. Pleuritic-type chest pain in no acute distress AND no associated risks
3. Cardiac-type pain resolved / significant cardiac history
3. Fever (appears unwell)

4. Mild pain (< 4)
4. Productive cough
4. Fever (appears well)
4. Problem worse in last 24 hours

5. Unchanged non-worsening condition

Arrival Mode

SELECT ONE

Vital Signs

Temp: celsius

Method: Select One

Pulse: beats/min.

Method: Select One

Resp: 36 resps./min.

SaO2 %: 94 Room Air

Systolic: 175 mmHg

Diastolic: 95 mmHg

GCS: N/A /15

BGL: mmol/L

Pain: 10 /10

PEFR: L/min.

Height (cm): Age:

% of predicted Male: 0

% of predicted Female: 0

Comments/Interventions/Exposure

Directed to Emergency Waiting Room | Directed to Patient Care Area #: | Instructed re: NPO | Instructed to return to Triage PRN

Override Reason: No Override

User ID: RN

Triage Score Override: 1 2 3 4 5 | Triage Score: 2 | <<BACK | RESET | PRINT

1.9 References

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Chapter 2

Comparing eTRIAGE© to Standard Triage[1]

2.1 Introduction

Emergency department (ED) triage staff prioritizes patients for urgency of care based upon a brief initial clinical assessment. A number of different ED triage systems have been developed.[1-5] In Canada, the Canadian Triage and Acuity Scale (CTAS), a 5-level acuity scale, is the nationally recognized standard.[4-6] The original implementation guidelines provide 11 pages of text defining the characteristics of patients in each of the 5 levels and 6 pages of specific examples. CTAS wall posters and pocket guides are available; however, most busy triage nurses rely on memory and experience. Recent research has demonstrated that CTAS can predict ED resource utilization as a measure of validity, an important measure of psychometric performance.[7;8] The other psychometric performance variable is reliability, or agreement.

Two previous studies using standardized patient scenarios found very good inter-rater agreement between CTAS users. The weighted kappa (κ) statistic (which is a measure of observed agreement beyond chance and assigns partial credit, in the form of

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[1] Data from this project were partially presented at the American College of Emergency Physicians (ACEP) Annual Scientific Assembly, Boston, Massachusetts, October 12-15, 2003, and the Canadian Association of Emergency Physicians (CAEP) Annual Conference, Montreal, Quebec, April 26-29, 2004.
Manuscript has been published: S. L. Dong, M. J. Bullard, D. P. Meurer, I. Colman, S. Blitz, B. R. Holroyd, B. H. Rowe. Emergency Triage: Comparing a novel computer triage program with standard triage. *Acad Emerg Med.* 2005; 12:502-7.

weights, for minor disagreement on scaled items) ranged from 0.77 to 0.80 among all users.[9;10] Overall, the psychometric properties (e.g., reliability and validity) of triage systems are recognized as an area of urgent research need.

One common problem with traditional triage methods is their reliance on memory, which is often framed by experience and flawed by a lack of time and recall. Memory enhancements (e.g., reminders, card prompts, electronic decision support tools, etc) may improve reliability. A sophisticated electronic triage tool may be able to display the key elements for each complaint in such a manner to identify which patients meet the criteria for one triage level over another. With ED computerized tracking systems becoming more prevalent and programs continuing to evolve, standardized electronic triage support systems should become more accessible.

A web-based triage decision support tool (eTRIAGE©) based on CTAS has been developed in Canada and is now employed in a number of regions. The application requires the user to select from a standardized complaint set[5], each of which brings up the appropriate CTAS-based template to assist the user in assigning the appropriate triage level. The user is able to "override" the computer-generated triage if their clinical impression disagrees; however, the reason for the override must be recorded before continuing. An implementation trial comparing eTRIAGE© to the standard paper-based method demonstrated that it was easy to learn even for novice computer users, did not increase triage nurse assessment time, and was widely accepted by triage nurses.[11] The current study evaluated inter-rater reliability between standard, memory-based triage compared to the electronic program in a real time setting in a large, busy, urban ED.

2.2 Methods

Study Population & Setting

This study was conducted in a large Canadian urban tertiary care teaching hospital with an annual volume of approximately 63,886 ED visits (Capital Health, Clinical Information Performance Unit). Volunteer experienced emergency triage nurses were recruited to participate in the study and provided written informed consent prior to their participation (Appendices). During the study 37 of the 77 ED triage nurses at this hospital participated. All triage nurses in the study were familiar with CTAS as a memory-based triage system, which this ED implemented in 1997. No triage nurses refused to participate in the study. The study was approved by the Health Research Ethics Board at the University of Alberta.

Two research study nurses were employed to use the eTRIAGE© application and were compared to a wide variety of experienced triage nurses performing traditional triage. These nurses were trained to use eTRIAGE© in a single three hour training session. The study was conducted on consecutive weekday afternoons and evenings over a five-week period between January and February, 2003. The time of day was chosen in order to maximize the number of patient observations per study shift.

Study Protocol

All adult ($\geq$ 17 years of age) patients presenting to the ED during a scheduled study nurse shift were eligible for inclusion. The regular duty triage nurse, using standard memory-based triage, assessed patients who presented during the study period. The patients were then placed either in the waiting room or directed to the patient care area, based on the triage score and ED volume. After verbal consent was obtained from the patient, the study nurse completed a second independent assessment using the electronic triage tool in a separate area or at the bedside. If the patient was critically ill the need for consent was waived providing the study nurse did not interfere with patient care. Critically ill patients are normally sent directly to a bed by the triage nurse or nurse supervisor. The study nurse was blinded to the triage assessment and triage score assigned by the triage nurse. The triage information from both assessors and the final patient disposition from the ED were collected.

Following completion of the study, a random sample of one hundred patient records was selected for review by an expert panel (5 members of the Regional Triage Committee who had been working both nationally and locally on revisions to the CTAS guidelines, the national complaint list, and developing and delivering CTAS teaching to regional and national audiences for several years). The panel made use of all CTAS reference documentation; however, they were blinded to the triage scores assigned by both the on-duty and study triage nurses, bedside nurse and physician assessments, investigation, management, and outcomes. Based on the data available at the triage assessment, the panel arrived at a consensus "reference standard" triage score for each patient.

Measurements

Each patient's official triage score and admission status were collected by the study nurse at the end of the shift and entered into a password protected computer database. The patients' relevant vital signs and discriminating triage data were recorded in real time in the eTRIAGE© database. The database also captured the number of times the study nurse elected to override the computer's assigned score in favor of an alternate score and the reason. Overrides are not a component of paper-based triage.

Data Analysis

Inter-rater reliability between memory-based triage and the electronic triage score was calculated using kappa statistics. Unweighted kappa, weighted kappa with quadratic weights, and unweighted kappa defining agreement as being within 1 triage level were calculated for each triage score.[12] The same calculations were used when comparing the expert panel scores to the duty triage nurse and electronic triage scores, respectively. Kappa agreement was defined *a priori* as excellent ($\kappa \geq 0.8$), good ($0.6 \leq \kappa < 0.8$), moderate ($0.4 \leq \kappa < 0.6$), fair ($0.2 \leq \kappa < 0.4$) or poor ($\kappa < 0.2$).[13] Statistical calculations were conducted with SPSS (Chicago, IL), and SAS (Cary, NC) software packages.

2.3 Results

Sample

There were 722 patients enrolled and assessed by both a volunteer duty triage nurse using standard memory-based CTAS and one of two study nurses using eTRIAGE©. Complete data were available for 693 (96%) patient encounters and used in agreement calculations. Twelve cases (1.7%) had no paper triage score and seventeen (2.4%) had no electronically generated score. The mean patient age was 48 years old and 49% were male.

Triage data

The number of patients assigned to each triage score by the respective methods is shown in Table 2.1 and Figure 2.1. Agreement between the two methods is shown in Table 2.2. Agreement was poor to fair when defined as exact triage level; however, this improved when using weighted κ and when agreement was defined as being within one triage level. When using memory based triage, 94.1% of the patients were in either CTAS level 3 or 4, while only 72.7% were in those levels when using the electronic triage tool.

The study nurses used the override function 51 times (7.4%), assigning a higher acuity score in 25 patients (49%) and a lower acuity score in 26 patients (51%).

Triage vs outcomes

Patient admission rates based on triage score and method are shown in Figure 2.2. The largest difference in admission rates was seen in CTAS level 2 (73.7% admission for memory based triage vs 37.2% for eTRIAGE©).

Expert Panel

Of the 100 patient encounters selected for review by the expert panel, 97 were included. Two encounters were excluded because the original patient data could not be linked to the electronic record; one case was excluded because the paper triage score was not recorded. Agreement between the volunteer duty triage nurses and study nurses within these randomly selected encounters was similar to the full dataset (Table 2.3). Figure 2.3 compares the triage scores assigned by the triage nurses and the review panel. The review panel selections showed *fair* agreement with the volunteer duty triage nurse but improved to *moderate* agreement with the study nurse using eTRIAGE© (Table 2.3) when using unweighted κ. This difference was maintained when using weighted κ; however, disappeared when agreement was defined as within 1 level.

2.4 Discussion

This study compared a novel electronic triage system to memory-driven paper-based triage in a typical urban, frequently over-crowded Canadian ED. The research identified significant discrepancy among nurses using CTAS as a memory-driven paper-based triage process compared to an electronic triage system with decision supports and memory prompts. Moreover, when compared to a consensus panel of triage experts, the eTRIAGE© tool demonstrated higher agreement than the memory-driven paper-based triage system.

Potential reasons for this discrepancy include: difficulty ensuring the same skill level from a large group of triage nurses; no current resources to provide quality oversight assessing accuracy and consistency; and triage drift, which refers to the behavior by triage nurses of subjectively "down" or "up" stratifying patients based on the current state of the ED environment.[14] The duty triage nurses appeared to select only the sickest patients for CTAS level 2 and assign the stable high-risk patients to level 3. This down triaging has important implications to patient safety, as physician evaluation may be delayed even more than current timing for these high-risk patients. The small number of CTAS level 2 patients assigned by the duty triage nurse (denominator) as well as selecting only those who were overtly unstable, explains the high admission rate in that group when compared to the study nurse using an electronic triage tool. The percentage of CTAS 2 patients identified by the consensus panel among the random 100 cases was similar to the study nurses (24.7% vs. 20.6%). Down-triaging has administrative and funding implications for any ED using triage data to help establish resource needs.

Several alternatives to CTAS currently exist. The Emergency Severity Index (ESI), another five-point triage system used primarily in the US, is algorithm-based. Triage scores are driven based on the need for resuscitation, anticipated need for ED resources, and vital signs. Inter-rater reliability between nurses in the live environment using ESI has been promising (κ range = 0.69 to 0.8).[15;16] The Australian National Triage System has demonstrated good inter-rater agreement (κ = 0.76) with simulated patient scenarios between nurses with three years of experience with that system.[17] Finally, the Manchester triage scale has been employed in other jurisdictions.[3;18] All of these alternatives have strengths and weaknesses that make them different from the CTAS system described here.

Although the original CTAS document is comprehensive, its application is based on memory and experience. Busy nurses cannot be expected to refer to the paper version during work, nor accurately recall the entire contents from memory, leading to subjectivity and inconsistency in the triage process. Anecdotally, this reference does not occur due to the frenetic activity in most busy triage ED locations. This does not mean that triage staff should abandon clinical judgment and become totally dependent on a clinical tool. The goal is to continue to develop tools that clinicians can trust, which not only permit but encourage overrides when clinical impression requires it. The feedback from these overrides can then be used to make future modifications to the decision support tool. Moreover, these clinical overrides can even be use to adjust the information source used to develop the tool, as in this case the CTAS guidelines. Decision support, such as an electronic triage tool, can assist those performing triage by displaying the key elements for each complaint that help define the criteria for each triage level. It is expected that experienced triage staff are better able to estimate a triage level based on their initial clinical assessment than those with less experience giving them greater confidence to override the tool if their gestalt requires it.[19]

We compared exact level agreement (unweighted κ), weighted κ, and agreement as defined as being within one CTAS level (κ within 1 level) . As would be expected there was a significant improvement in agreement with the latter definitions. Demonstrating a high level of agreement using exact level agreement would be an ideal demonstration of reliability. However, this may be an unrealistic goal and there has been recent debate on this matter in the literature.[20;21] We suggest that using "within one level" as a measure of agreement has the potential to overestimate reliability and that weighted κ may be the most appropriate measure for the ED environment.

This was a prospective study conducted real time in a busy ED environment. Studies demonstrating greater agreement between triage assessments using the same triage method have been limited to simulated patient scenarios.[9;10;17] In a simulated case scenario, the same "patient" data, including vital signs, are provided to both assessors. In the live environment, the patient undergoes interrogation by two different nursing staff. This history is not scripted and the vital signs may not be exactly the same between even minimally separated assessments. Furthermore, the chaotic activity in a live busy ED environment cannot be simulated in the case-based scenarios. Therefore, the real time testing reported here is more appropriate and generalizable and should be used in future triage research.

The ED is undergoing an information technology revolution and clinical applications are becoming ubiquitous in this setting. Patient tracking systems, computerized ordering of investigations, accessing laboratory results, and instant online access to medical literature are now commonplace in most EDs. Paperless charting, electronic access to best practice guidelines, and computerized decision tools promise to improve patient care and ED function. Prior to their incorporation and promotion, it is necessary to ensure that these electronic systems are both sensible and psychometrically sound in an ED setting. Recent work on other computerized triage assessment tools have been reported in abstract form only, promising both reliability and validity.[22]

From a quality improvement perspective, an electronic triage tool will allow monitoring of CTAS guidelines and facilitate changes and their dissemination. All sites can be updated simultaneously, maintaining standardization. Furthermore, a standardized triage decision support tool allows for site to site and region to region comparison and validated benchmarking. With ED overcrowding an increasing challenge to the safe provision of care[23], matching of resources to need through efficient and effective ED triage will be a critical component of quality health care.

2.5 Limitations

This prospective observational study was conducted at a single, large urban Canadian tertiary-care emergency department, which serves a predominantly inner-city population. The data may only be generalizable to similar centers and performance in smaller, non-urban locations needs to be evaluated. Coupled with potential variations in triage training between sites, there may be significant site to site variation in assigned patient acuity. However, we feel that these limitations only underline the need for a standardized triage process including point-of-care decision support.

In this study, patients were triaged by the volunteer triage nurse using the standard, paper-based method prior to being assessed by the study nurse using the electronic triage tool. This assessment sequence was necessary in order to ensure patient care and maintain patient safety. Although the second assessments were conducted with as little delay as possible, it is possible that patients may have had a chance to ruminate about their responses to the triage questions and potentially provide a different history to the second nurse. A patient may even volunteer a different chief complaint to the second nurse, prompting a different CTAS template altogether. For example, a patient with pneumonia may complain of "fever" to one nurse and of "cough" to the second. This is a *potential* cause for lack of agreement; fortunately, most eTRIAGE© templates will generate the same triage score regardless of chief complaint based on common sets of vital sign and acuity variables.

The triage desk in any emergency department is a chaotic area. The triage nurse faces numerous demands above and beyond triaging patients. Telephone calls, inquiries from patients in the waiting room and from family members, and other distractions can put undue pressure on the triage nurse and potentially hasten the triage assessment. By contrast, the study nurse using the electronic triage tool did not face any such distractions and had more time to assess each patient. Despite this concern, the mean time to triage using electronic and paper or memory based systems has been shown to be similar in this setting[11], and we discouraged the study nurse from excessively prolonging the assessment period.

A final limitation is the consensus standard review by the expert panel. Unlike the triage and study nurses, they had no visual or verbal clues from the patients and made their assessments based on the information summarized from both sets of triage information. This would be expected to predispose the panel to triage each patient based on the information from whichever initial interviewer documented the highest triage level discriminator. Future attempts at providing a consensus standard in a real time ED environment may require an expert to observe both interviews (directly or via video record) and then generate an independent assessment. Such resources were beyond the scope of this study.

2.6 Conclusions

We believe the results of this prospective study to be reliable and valid. Past studies on emergency department triage demonstrating high reliability have been limited to small series using paper-based patient scenarios. "Real time" studies have demonstrated more modest results. We employed a web application triage tool with complaint-based templates derived from CTAS guidelines to assist nurses in assessing patients. This study showed significant discrepancy between current paper-based triage methods and the electronic process, and closer agreement between nurses using an electronic triage tool and an expert review panel.

Figure 2.1. Patients in each triage category by triage method.

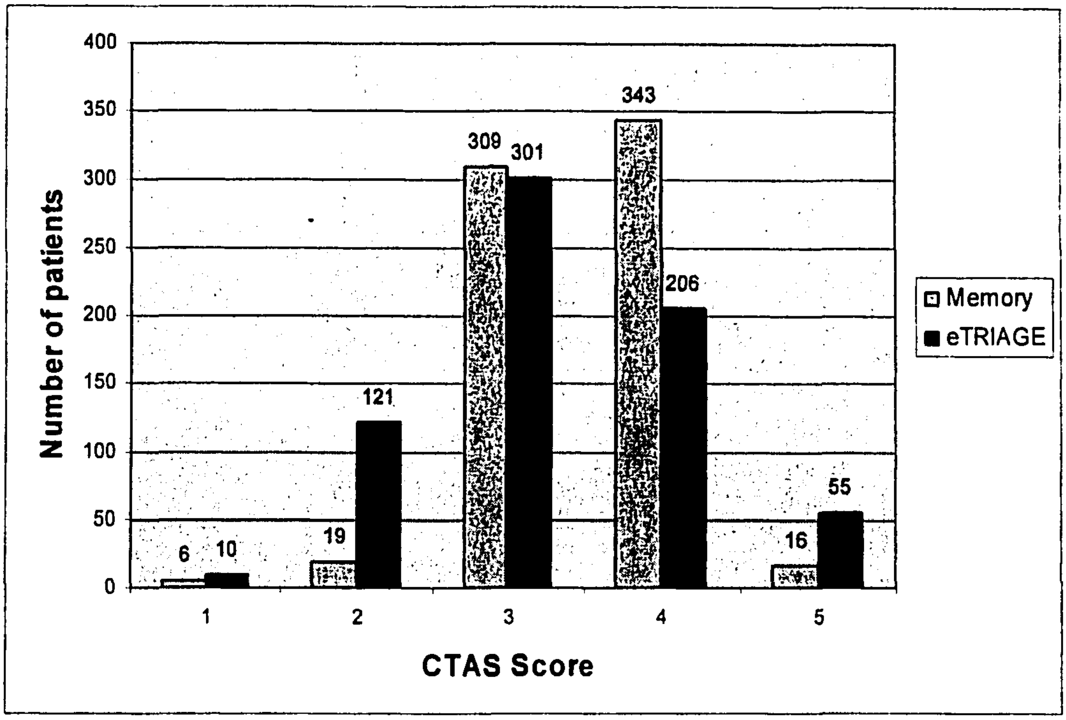


Table 2.1. Distribution of CTAS scores by method

		eTRIAGE ©					Total
Memory		1	2	3	4	5	
	1	5	1	0	0	0	6
	2	5	11	3	0	0	19
	3	0	91	161	50	7	309
	4	0	17	131	151	44	343
	5	0	1	6	5	4	16
	Total	10	121	301	206	55	693

Table 2.2. Agreement by triage method.

	N	κ (95% CI)	**Weighted κ** (95% CI)	**κ within 1 triage level** (95% CI)
Memory vs. eTRIAGE©	93	0.20 (0.15, 0.25)	0.36 (0.31, 0.42)	0.73 (0.64, 0.82)

Figure 2.2. Admission rates by triage score and triage method.

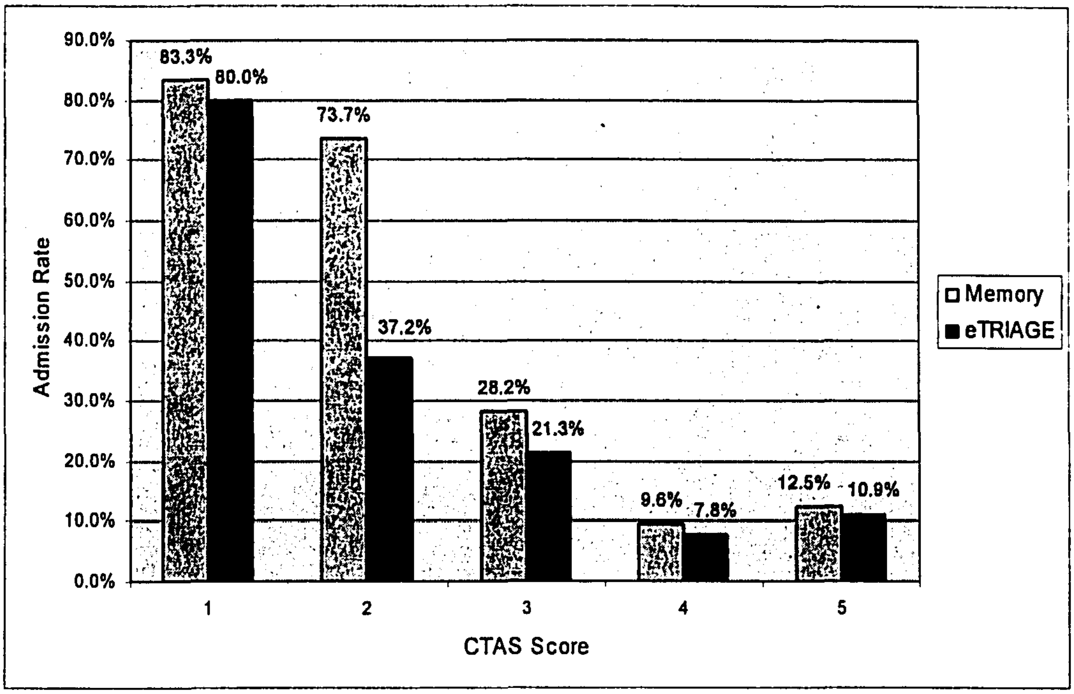
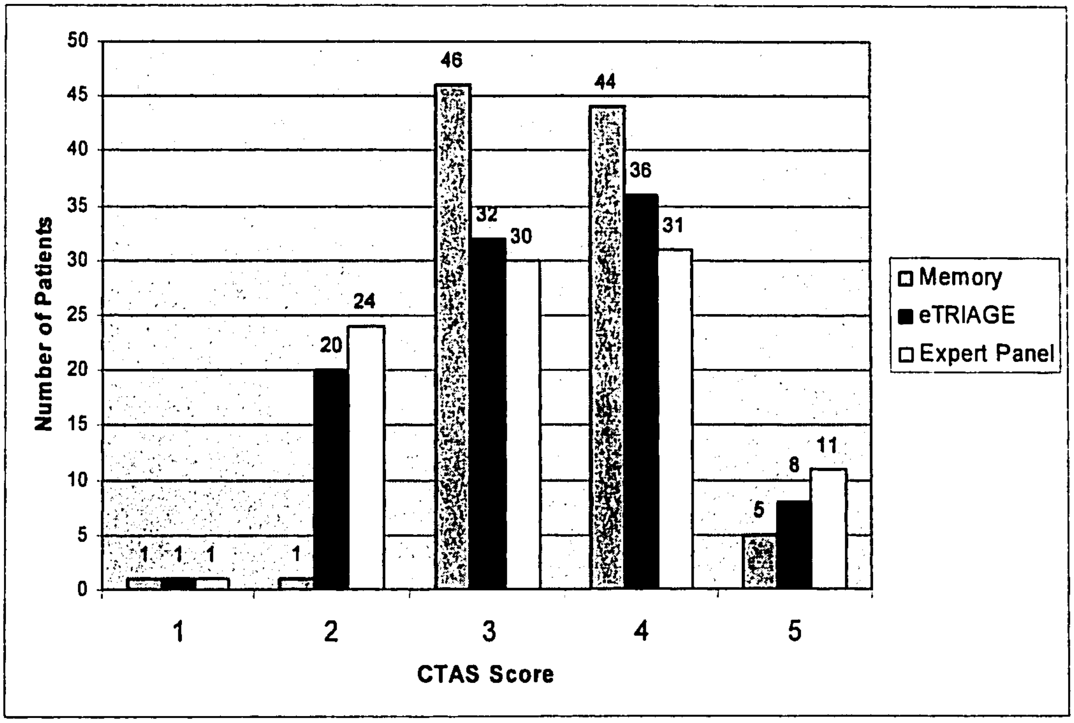


Table 2.3. Agreement by triage method within the 97 randomly selected subset.

	N	κ (95% CI)	Weighted κ (95% CI)	**κ within 1 triage level** (95% CI)
Memory versus eTRIAGE©	7	0.18 (0.05, 0.32)	0.33 (0.17, 0.49)	0.56 (0.28, 0.84)
Review Panel versus Memory	7	0.26 (0.13, 0.39)	0.53 (0.41, 0.65)	0.91 (0.78, 1.00)
Review Panel versus eTRIAGE©	7	0.43 (0.29, 0.56)	0.65 (0.54, 0.76)	0.89 (0.77, 1.00)

Figure 2.3. Patient in each triage category in the random subset.



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Chapter 3

Computerized emergency triage: the effects of overcrowding on triage reliability[2]

3.1 Introduction

Patients are prioritized by triage staff for urgency in the emergency department (ED) based upon a brief initial clinical assessment. In Canada, the Canadian Triage and Acuity Scale (CTAS), a 5-level acuity scale (1 = Resuscitation, 2 = Emergent, 3 = Urgent, 4 = Semi-urgent, 5 = Non-urgent), is the nationally recognized ED triage standard.[1-3] Recent research has demonstrated the ability of CTAS to predict ED resource utilization as a measure of validity.[4;5]

One problem with traditional triage methods is reliance on memory, which may be flawed by a lack of time and recall. Furthermore, ED crowding status and duties at the triage desk not related to triaging may distract triage nurses and potential impair the triage process. ED overcrowding has become a common occurrence in developed countries.[6;7] Most overcrowding increases delays to seeing a physician, increases the frustration of patients and staff, and leads to increased numbers of patients leaving prior to assessment. The triage desk is a central location in the overcrowded ED. Not surprisingly, many believe that a patient's triage score may be influenced by ED

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[2] Data from this project were partially presented at the Canadian Association of Emergency Physicians (CAEP) Annual Conference, Edmonton, Alberta, May 29-June 1, 2005.

crowding[8] which necessitates the holding of patients in the waiting room, potentially affecting patient safety.[9]

In addition to ED overcrowding, there is emerging evidence to suggest that triage reliability may be sub-optimal.[10] Memory enhancements (e.g., reminders, card prompts, electronic decision support tools, etc) may improve triage reliability. A computerized triage tool can display the key discriminators for each complaint to assist in assigning the appropriate triage level. Computerization within EDs is becoming more prevalent and with enhancements in software programs, standardized electronic decision support should become more widely available.

A web-based triage decision support tool (eTRIAGE©) based on CTAS has been developed in Canada and is now employed in a number of emergency departments. The application requires the user to select from a standardized complaint set, each of which brings up an appropriate CTAS-based template displaying all appropriate discriminators to assist the user in assigning the appropriate triage level. The user is able to "override" the computer generated triage score if their clinical impression disagrees; however, the reason for the override must be recorded. Previous research demonstrated eTRIAGE© was easy to learn even for novice computer users, did not increase triage nurse assessment time, and was widely accepted by triage nurses.[11] Triage nurses using eTRIAGE© also had better agreement with a consensus standard than with nurses using memory based triage.[10]

The current study compared the reliability of two groups of nurses using eTRIAGE© on the same patients in real time. The study also examined the effects of ED overcrowding on reliability using eTRIAGE©.

3.2 Methods

Study Population & Setting

This study was conducted in the Emergency Department of a large Canadian urban tertiary care teaching hospital with 52 patient care beds and an annual volume of approximately 63,886 ED visits (Capital Health, Clinical Information Performance Unit). The ED implemented a 5 level triage in May, 1996. CTAS was implemented in 1997 as a memory-based system; eTRIAGE© was deployed in July, 2003. Eight volunteer emergency triage nurses were recruited to participate in the study and provided written informed consent. The eight nurses were recruited based on their triage experience (median = 7 years; IQR: 3, 12). Each volunteer nurse received one additional three hour eTRIAGE© training session, which was beyond the standard departmental training.

Two study nurses were employed to perform the second independent eTRIAGE© assessment. These nurses were also trained to use eTRIAGE© in a single three hour training session and had prior experience as study nurses in a previous study of eTRIAGE© reliability.[10] The study nurses paired up with volunteer nurses during the volunteer's regular on-duty triage shifts (each triage shift is four hours long) on afternoons and evenings over a nine-week period between April and June 2004. The time of day was chosen in order to maximize the number of patient observations per study shift. The study was approved by the Health Research Ethics Board at the University of Alberta.

Study Protocol

All adult (≥ 17 years of age) patients presenting to the ED during a scheduled study nurse shift were eligible for inclusion. Volunteer triage nurses, using eTRIAGE©, assessed patients presenting during the study period. The patients were then placed either in the waiting room or directed to the patient care area, based on the triage score and ED bed availability. Critically ill patients were sent directly to a bed rather than stopping at triage. After verbal consent was obtained from the patient, a study nurse completed the second, independent assessment, using eTRIAGE© in a separate area or at the bedside. The study nurse was blinded to the triage assessment and triage score assigned by the triage nurse. For critically ill patients, the need for consent was waived, providing the study nurse did not interfere with patient care.

Every two hours during the study shifts, measurements of ED overcrowding: diversion status (whether or not the ED was accepting ambulances); number of admitted inpatients in the ED awaiting ward beds; number of patients in the waiting room; number of patients arriving in the ED in the previous two hours; and the triage nurse's perception of ED overcrowding on a seven point Likert scale were collected.

Measurements

Each patient's relevant vital signs and discriminating triage data were documented separately by the duty and study nurses and recorded in real time in two independent eTRIAGE© databases. The databases also captured the number of times the nurses elected to override the computer's assigned score in favor of an alternate score and the reason for the override.

Data Analysis

The study's primary outcome measure was inter-rater reliability between the two triage scores, calculated using kappa statistics. Unweighted, linear, and quadratic kappa (κ, κ_{WL}, and κ_{WQ}) were calculated for each triage score. Kappa agreement was defined *a priori* as excellent ($\kappa \geq 0.8$), good ($0.6 \leq \kappa < 0.8$), moderate ($0.4 \leq \kappa < 0.6$), fair ($0.2 \leq \kappa < 0.4$) or poor ($\kappa < 0.2$).[12]

Secondary measures were agreement statistics for patients who were triaged during different periods of overcrowding, as measured by the ED's diversion status and patient volumes, number of admitted patients and perceived busyness above and below the median. These measures of period of overcrowding were defined *a priori*. Statistical calculations were conducted with SPSS® (Chicago, IL), and SAS® (Cary, NC) software packages.

3.3 Results

Sample

There were 575 patients assessed and enrolled by both a volunteer duty triage nurse and a study nurse, each using eTRIAGE©. Complete data were available in 569 (99%) patient encounters and used in agreement calculations. The six (1%) incomplete cases had no duty nurse score. The mean patient age was 49.4 years old and 51% were male.

The duty nurses used the override function 26 times (4.6%), assigning a higher acuity score in 10 patients (38.5%), a lower acuity score in 5 patients (19.2%), and did not select a template option in 11 patients (42.3%) opting to input a manual override score only. The distribution of patients between study nurses was 322 (56.6%) and 247 (43.4%). The study nurses used the override function 47 times (8.3%), assigning a higher acuity score in 13 patients (27.7%), a lower score in 31 patients (66.9%), and a manual override score in 3 patients (6.4%).

Agreement

The number of patients assigned to each triage score by the respective nurses is shown in **Table 3.1** and **Figure 3.1**. For all patients, agreement between two nurses using eTRIAGE© was *fair* using unweighted κ (κ: 0.40; 95% CI: 0.34, 0.46), improved to *moderate* using linear weighted κ (κ_{WL}: 0.52; 95% CI: 0.46, 0.57), and *good* using quadratic weighted κ (κ_{WQ}: 0.66; 95% CI: 0.60, 0.71). The two study nurses did not differ significantly in their agreement with the duty nurses. (Nurse 1 κ_{WL}: 0.53; 95% CI:

0.46, 0.61. Nurse 1 κ_{WQ}: 0.67; 95% CI: 0.60, 0.74. Nurse 2 κ_{WL}: 0.50; 95% CI: 0.41, 0.58. Nurse 2 κ_{WQ}: 0.64; 95% CI: 0.55, 0.72.)

Effect of ED activity

Of the 66 two-hour periods, the study nurses reported being too busy performing triage duties to collect activity data in 23 (34.8%) of the two-hour periods. This resulted in 216 patient assessments (38.0%) for which no ED activity data were available. Agreement was not significantly different between periods in which overcrowding data was available (κ_{WL}: 0.56; 95% CI: 0.49, 0.64. κ_{WQ}: 0.70; 95% CI: 0.63, 0.76) or not available (κ_{WL}: 0.45; 95% CI: 0.35, 0.54. κ_{WQ}: 0.57; 95% CI: 0.48, 0.67).

The ED was on diversion or had requested diversion during periods accounting for 87 of the patient assessments (24.6%). The median number of admitted inpatients (Emergency In-Patients, EIPs) waiting in the ED for hospital beds during the study shifts was 15, or 37.5% of the available patient care areas in the ED. The median number of patients in the waiting room during the study shifts was 13, and the median number of patients registering in the previous two hours was 18.

Table 3.2 and **Figures 3.2** and **3.3** display the agreement statistics for patients assessed during the different periods of overcrowding. Overall, there were no statistically or clinically important differences in agreement.

3.4 Discussion

This study examined agreement between two groups of experienced triage nurses using eTRIAGE© in a real time ED environment. We found moderate to good agreement in this setting, compared to only *poor* agreement between traditional triage relying on memory and eTRIAGE©.[9] Moreover, agreement did not seem to differ significantly during changes in ED crowding, assessed using a variety of ED measures previously employed in overcrowding research.

This study reported agreement using unweighted kappa and weighted kappa with both linear and quadratic weights. As expected, unweighted kappa had the lowest value compared to weighted kappa. However, there was significant improvement in kappa (*moderate* to *good*) when using weighted kappa with linear or quadratic weights. When specified, most triage studies report quadratic kappa.[13-15] Many triage agreement studies do not report the type of weighted kappa.[16-18] In the interest of clarity, we recommend that studies specify the type of weighted kappa used in calculations.

This was a prospective study conducted real time in a busy ED environment. Conversely, many agreement studies have been limited to simulated patient scenarios.[13;16;19] In a simulated case scenario, the same "patient" data, including vital signs, are provided to both assessors. In this real time environment, each patient underwent separate interrogations by two different triage nurses. The history is not scripted and the vital signs may vary slightly even between assessments carried out within minutes of each other. Furthermore, the chaotic activity in a busy ED environment is not simulated in the case-based scenario studies. Therefore, the real time testing reported here is more appropriate and generalizable.

To our knowledge, eTRIAGE© is the only triage software that incorporates the templates of a nationally recognized triage system. The user chooses the complaint and is presented with the triage level discriminators as outlined in the CTAS reference documents.[2;3;20;21] Several alternatives to eTRIAGE© exist. For example, early work by Berman on a computerized triage system in a military setting demonstrated the ability to triage military personnel to either the acute care clinic or the ED.[22] This system is not applicable to the vast majority of civilian settings and essentially uses two-level triage (acute care clinic vs. the ED). More recently, Grafstein demonstrated good reliability with PC-linked triage, in which each presenting complaint was linked to specific CTAS levels, thus directing the triage nurse toward the preferred triage levels for each complaint type.[14] Maningas demonstrated excellent reliability for independent users of the Soterion Rapid Triage System, a complaint driven, algorithm based computerized triage system.[23]

Currently, clinical applications of all major nationally recognized triage systems including CTAS, the Australasian Triage Scale[24], the Emergency Severity Index in the United States[17;25], and the Manchester Triage Scale in the United Kingdom[26], are based on training, memory and experience. Busy nurses cannot be expected to refer to paper documents for reference during busy clinical shifts, nor accurately recall the entire contents from memory. This may lead to subjectivity and inconsistency in the triage process, especially in a climate of increased ED crowding. Decision support tools, like eTRIAGE©, are designed to assist those performing triage by displaying the key discriminators for each complaint that help define the triage level. These decision support tools are not intended to replace clinical judgment and should not promote total dependence on an electronic tool. The goal is to develop tools that users can trust, which not only permit, but also encourage overrides when the clinical impression requires it. Moreover, capturing and analyzing these clinical overrides can be used to modify the source reference used to develop the tool, in this case the CTAS guidelines.

ED overcrowding is a widely recognized problem and is defined as "a situation in which demand for service exceeds the ability to provide care within a reasonable time, causing physicians and nurses to be unable to provide quality care"[6]; however, it is difficult to measure and quantify overcrowding. In two separate studies, Richardson used a pre-defined number of patients registering in a 24 hour period[27] and the median number of patients in a 24 hour period as to define "busy".[8] Similarly, Hollis used a pre-defined number of patients registering in a two hour period to determine ED activity.[28] Spence defined high volume and low volume days as patient volumes above the 75th percentile and below the 25th percentile, respectively.[29] We elected to quantify ED crowding with a variety of important administrative and qualitative measures. The first was whether the ED was accepting ambulances (diversion status normal) or was not accepting ambulances (on diversion). In our region, only two of five EDs can be on diversion at any given time. If more than two EDs request diversion, the third ED is temporarily given a "pending diversion" status. We felt that being "on diversion" and "pending diversion" were equivalent and both indicated a period of greater crowding. The second measure of ED crowding was the number of emergency inpatients, defined as patients who were admitted to the hospital but were still in the ED waiting for a ward bed. The boarding of admitted inpatients is recognized as the leading cause of ED overcrowding.[6] Our ED has 52 patient care stretchers and during this study the number of admitted inpatients filling those stretchers ranged from 4 (7.7%) to 27 (51.9%), with a median of 15 (28.8%). We used the median number of inpatients as the threshold for overcrowding. Similarly, we used the median number of patients in the waiting room (median = 13, IQR 7, 20) and number of patients registering in the two-hour period (median = 18, IQR 14, 23), as thresholds for ED crowding. Finally, the duty nurses were asked to mark their perception of busyness on a seven point Likert scale, and we used this *perceived busyness* scale to represent overcrowding when nurses scored a 2-hour period > 4. It should be noted that during most periods that the busyness data were collected, the ED was "crowded". The reason the study nurses gave for not collecting the data was that they were too busy, suggesting that the periods of missed data were periods of even greater ED overcrowding. This implies that all the measures of eTRIAGE© interrater reliability were obtained during ED overcrowding. Interrater agreement between two nurses using eTRIAGE© did not show any statistically significant or clinically meaningful difference when the level of overcrowding varied.

3.5 Limitations and future directions

This prospective observational study was conducted at a single, large urban Canadian tertiary-care emergency department, which serves a predominantly inner-city population. The data may only be generalizable to similar centers and performance in smaller, non-urban locations needs to be evaluated.

In this study, the duty triage nurse performed the initial assessment using eTRIAGE©. The study nurse performed an independent assessment using eTRIAGE© after the duty nurse's assessment. This has the advantage of ensuring blinding; however it has the disadvantage of potentially obtaining different patient responses. In Grafstein's study, the study nurse performed the assessment while observing the duty nurse's triage assessment. Each nurse input their own triage information into the computer to derive a separate triage score. Although blinded to the duty nurse's triage score, the study nurse did not perform an independent assessment.[14] These differences in patient information gathering may account for some of the difference in agreement between the two studies.

Although we attempted to quantify ED crowding in this study, it seems that with a minimum of ten percent of the patient care stretchers being occupied by admitted patients and a possible conclusion is that the ED was always in a state of overcrowding during the study. Our attempts to quantify ED overcrowding may have succeeded only in determining the degree of overcrowding when not out of control, but was not successful in identifying periods when crowding did not exist. A uniform quantitative definition of overcrowding would be extremely useful not only for future triage studies, but also for research in many areas of ED administration.

3.6 Conclusions

Past studies of electronic triage systems have either been based on proprietary triage systems or have not been studied in "real time" with two nurses each performing independent assessments. We employed a web-based triage tool with complaint-based templates derived from CTAS guidelines to assist nurses in assessing patients. This study showed moderate to good agreement between two users of this tool independently performing blinded assessments during a climate of high ED crowding, and the level of agreement did not seem to be affected by fluctuations in ED crowding.

Figure 3.1. CTAS score distribution by two nurses using eTRIAGE.

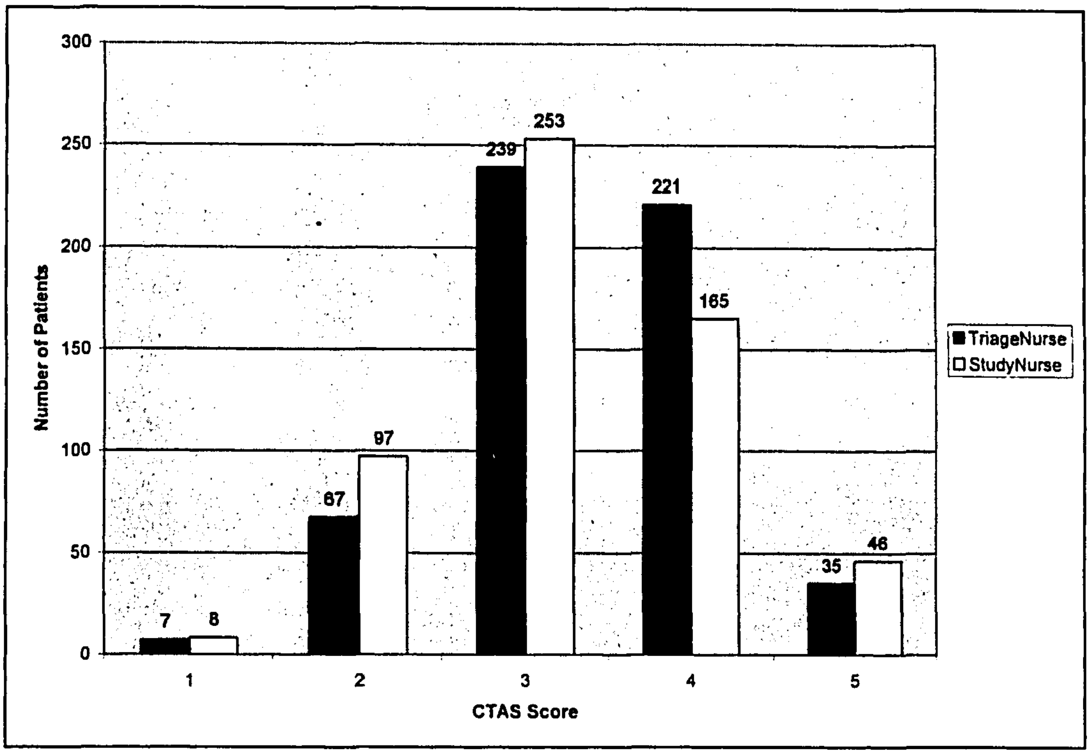


Table 3.1. Distribution of CTAS scores by Nurses using eTRIAGE.

	Study	Nurse					Total
Duty		1	2	3	4	5	
Nurse	1	**5**	2	0	0	0	7
	2	3	**48**	13	3	0	67
	3	0	43	**151**	36	9	239
	4	0	4	87	**113**	17	221
	5	0	0	2	13	**20**	35
	Total	8	97	253	165	46	569

Table 3.2. Agreement between two nurses using eTRIAGE divided into different periods of overcrowding.

Comparison	N	κ	95% CI	$κ_{WL}$	95% CI	$κ_{WQ}$	95% CI
Not on Diversion	266	0.44	0.35-0.52	0.56	0.49-0.64	0.70	0.63-0.77
On Diversion or Pending Diversion	87	0.41	0.25-0.57	0.53	0.39-0.68	0.68	0.54-0.82
EIPs* ≤ 15[a]	214	0.40	0.30-0.50	0.53	0.45-0.62	0.68	0.56-0.75
EIPs* > 15[a]	139	0.48	0.36-0.60	0.60	0.49-0.70	0.73	0.63-0.82
Waiting Room ≤ 13[b]	182	0.41	0.31-0.52	0.55	0.46-0.64	0.70	0.62-0.78
Waiting Room > 13[b]	171	0.45	0.35-0.56	0.56	0.47-0.66	0.69	0.59-0.78
Patients registered in 2 hours ≤ 18[c]	211	0.44	0.34-0.53	0.58	0.49-0.66	0.73	0.65-0.80
Patients registered in 2 hours > 18[c]	142	0.43	0.31-0.55	0.53	0.42-0.64	0.64	0.53-0.76
Perceived Busyness < 4	184	0.41	0.30-0.51	0.58	0.49-0.66	0.74	0.67-0.81
Perceived Busyness > 4	86	0.42	0.27-0.57	0.48	0.33-0.62	0.55	0.38-0.72

κ = Unweighted kappa
$κ_{WL}$ = Linear weighted kappa
$κ_{WQ}$ = Quadratic weighted kappa
* EIPs = Emergency Inpatients: patients admitted to hospital awaiting a ward bed.
[a] Median # of EIPs in ED during study shifts = 15 (out of 40 beds).
[b] Median # patients in waiting room during study shifts = 13.
[c] Median # of patients registered in 2 hours during study shifts = 18.

Figure 3.2. Agreement between two nurses using eTRIAGE during different periods of overcrowding using linear kappa.

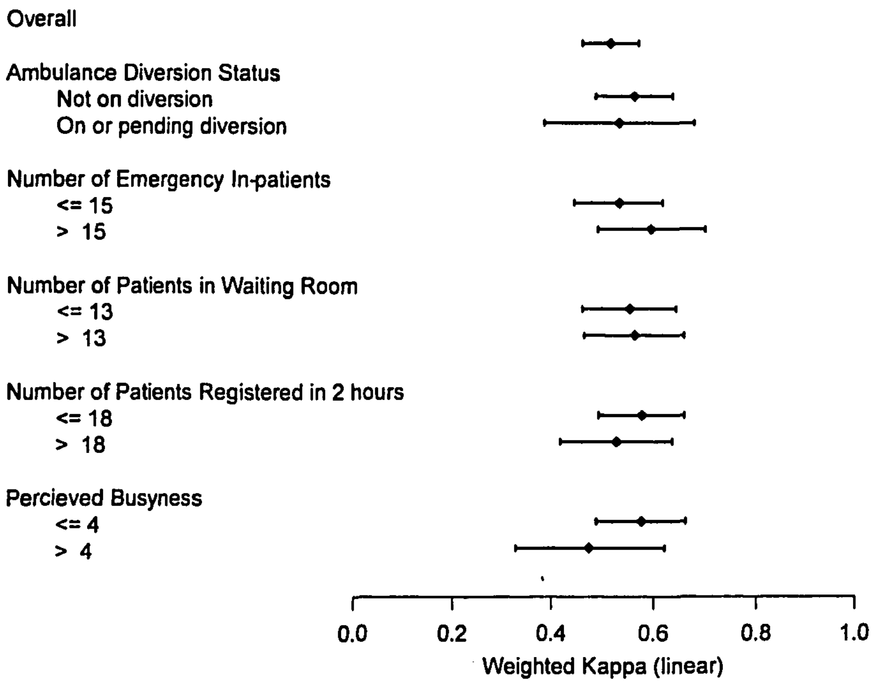
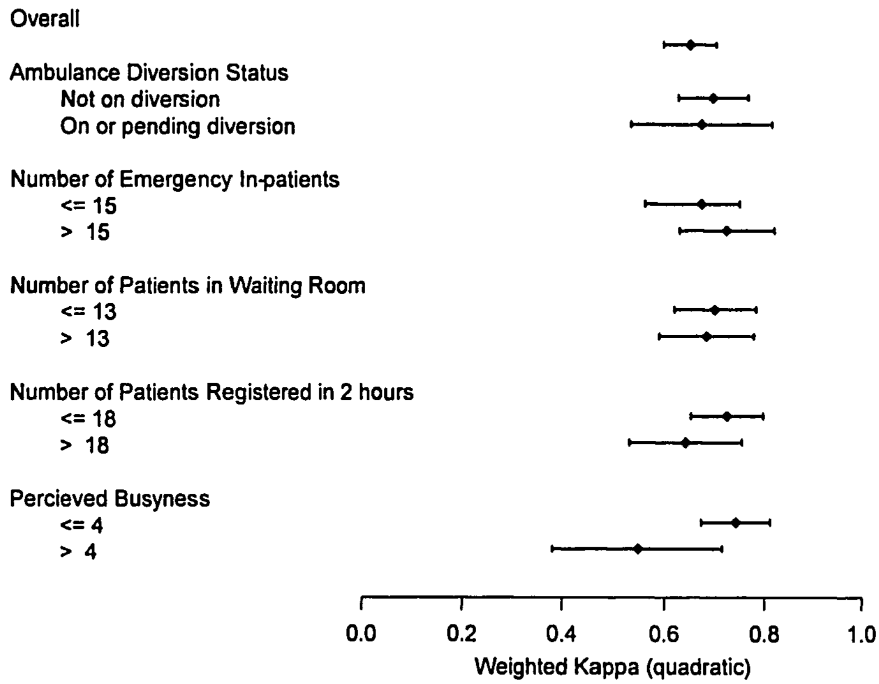


Figure 3.3. Agreement between two nurses using eTRIAGE during different periods of overcrowding using quadratic kappa.



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Chapter 4

Predictive Validity of a Computerized Emergency Triage Tool

4.1 Introduction

Patients are prioritized by triage staff for urgency in the emergency department (ED) based upon a brief initial clinical assessment. In Canada, the Canadian Triage and Acuity Scale (CTAS), a 5-level acuity scale (1 = Resuscitation, 2 = Emergent, 3 = Urgent, 4 = Semi-urgent, 5 = Non-urgent), is the nationally recognized ED triage standard.[1-3] Recent research has demonstrated the ability of CTAS to predict ED resource utilization as a measure of validity.[4;5]

A web-based triage decision support tool (eTRIAGE©) based on CTAS has been developed in Canada and is now employed in a number of emergency departments.[6] The user selects from a standardized complaint set, each of which brings up an appropriate CTAS-based template displaying all appropriate modifiers, to assist in assigning the appropriate triage level. The user is able to "override" the computer-assisted triage level if their clinical impression disagrees; however, the reason for the override must be recorded. Previous research demonstrated eTRIAGE© was easy to learn, even for novice computer users, did not increase triage nurse assessment time, and was widely accepted by triage nurses.[7] Triage nurses using eTRIAGE© also demonstrated higher agreement with a consensus standard than with nurses using memory based triage.[8] Finally, two triage nurses using eTRIAGE© also demonstrated moderate agreement, when compared in real time in a hectic ED setting.

Despite the recent interest in measuring the validity of CTAS, given the aforementioned problems with reliability, the evidence produced in validity studies may be subject to bias. The objective of this study was to use an administrative database to evaluate the validity of more reliable triage scoring system (eTRIAGE©) to predict acuity and resource utilization in an urban tertiary care ED over a six-month period.

4.2 Methods

Data Source

The data for this study were obtained from the Ambulatory Care Classification System (ACCS). This database tracks all emergency services within the region and contributes to a province of Alberta registry. Since the Canadian health care system is a public, single payer system, the ACCS database captures every emergency service except for those provided to non-residents and foreign visitors. Each record in the ACCS includes the personal health number (a unique identifier for each person in the province), the service provided, the date and time of the visit, the diagnosis, and disposition status. Data are entered into the ACCS by trained medical records nosologists at the hospital level.

The data were extracted from the ACCS for an ED of a large Canadian urban tertiary care teaching hospital with an annual volume of approximately 63, 886 visits. CTAS was implemented in the ED in 1997; eTRIAGE© was deployed in the Royal Alexandra Hospital (RAH) ED in July 2003. Data from all adult patients (≥ 17 years of age) presenting to the ED between January 1 and June 30, 2004, were used for this study.

The study was approved by the Health Research Ethics Board at the University of Alberta.

Variables Presented

The following data are captured by ACCS for each individual patient visit and were used in this study:

Demographics: Each patient's age and gender.

Triage score: Each patient's triage score (CTAS score), assigned by triage nurses using eTRIAGE©.

Resource utilization: This study used specialist consultation, use of computerized tomography (CT), and ED length of stay as markers of resource utilization.

Patient Acuity: Disposition is coded in the ACCS into five categories: discharged, admitted to hospital, transfer to another facility, left without being seen or against medical advice, and death while in the ED. As a tertiary care hospital, the vast majority of patients transferred to another facility were transferred for admission because of bed shortages. This study used death rate and admission to hospital or morgue as measures of patient acuity.

Data Analysis

Correlation between each categorical variable (e.g., consultation, CT, death, and admission) and CTAS score was tested using a logistic regression model. The CTAS score with the most number of patients was used as the "reference risk". Length of stay data was normalized with a square root transformation. Correlation between the transformed length of stay and CTAS score was tested with univariate ANOVA.

Statistical calculations were conducted with SPSS® version 13.0 (Chicago, IL) software package.

4.3 Results

Sample

There were 29,447 adult patient visits to the ED between January 1 and June 30, 2004. Complete data were available in 29,346 (99.7%) patients and were used for all calculations. The mean patient age was 46.7 years old and 52.2% were male. **Figure 4.1** shows the CTAS score distribution. CTAS 3 was the score with the highest number of patients and was used as the "reference risk".

Resource utilization

There were significant differences in the proportion of patients requiring specialist consultation or CT scan based on CTAS score. **Figure 4.2** shows the proportion of specialist consultation by CTAS score. **Figure 4.3** shows the proportion of CT scan by CTAS score. The odds ratios for consultation and CT scan for each CTAS level, compared to CTAS 3, is shown in **Table 4.1** and graphically depicted in **Figure 4.4**. Overall, for both consultation and CT scan ordering, patients with CTAS 1 scores had the highest proportion of CT and consultation ordering, while CTAS 5 had the lowest.

Figure 4.5 shows the median lengths of stay for each CTAS score. The differences were consistent across all CTAS scores. Median length of stay for patients who died in the ED was 230 minutes compared to 253 minutes for those who did not die. **Figure 4.6** shows the median lengths of stay for each CTAS score after removing the patients who died while in the ED. With or without the data from the in-ED deaths, the length of stay showed a significant correlation with CTAS score (Spearman's $\rho = 0.295$ with death, $\rho = 0.312$ without death, $p < 0.001$).

Patient acuity

There were 70 patient deaths while in the ED (0.2%). The distribution is demonstrated in **Figure 4.7.** The small number of patients in the CTAS 2 – 5 categories prevented the development of a meaningful logistic regression model. A logistic regression model was developed using CTAS 1 as one category and CTAS 2-5, collectively, as another category. In this model, the OR of in-emergency death for patients in CTAS 1 compared to CTAS 2-5 was 664.2 (95% CI: 357.7, 1233.3).

The overall admission rate was 18.6%. **Figure 4.8** depicts the admission rate by CTAS Score. Compared to CTAS 3, the odds ratio of admission was 4.45 (95% CI: 3.45, 5.73), 2.22 (95% CI: 2.04, 2.41), 0.36 (95% CI: 0.33, 0.39), and 0.16 (95% CI: 0.13, 0.20) for CTAS 1, 2, 4, and 5, respectively. The odds ratios are graphically depicted in **Figure 4.4.**

4.4 Discussion

Triage is a complex process in the emergency setting, which may be influenced by a number of factors. In Canada, triage nurses traditionally use memory-based knowledge to assign a score, which has been shown to lack reliability. Memory supports, such as computerized triage decision support tools, have been developed; eTRIAGE© is one such tool. The present study was designed to examine the validity of eTRIAGE© using a variety of clinically meaningful outcomes for patients presenting to a large, urban, tertiary care ED. Overall, this study demonstrated excellent predictive validity of eTRIAGE©. For example, the highest odds ratios for resource utilization (e.g., CT scan, consultation), outcomes (e.g., admission), and length of stay were associated with scores of 1 or 2.

We believe the differences in the outcomes when stratified by CTAS level are clinically meaningful. A valid triage system is necessary to identify patients in greatest need of medical attention, minimize delays in patient care, and define a department's acuity.[9] Previous work by our group demonstrated better agreement by nurses using eTRIAGE© than with no decision support, when compared to a consensus standard triage score by an expert panel.[8] With a reliable and valid triage system, administrators should feel confident using CTAS scores generated by eTRIAGE© to define resource needs, make comparisons with and among sites and regions, and perform benchmarking comparisons. The Canadian Association of Emergency Physicians and the National Emergency Nurses Affiliation identify consistent triage and prospective data collection to be important steps in the campaign to quantify and address ED overcrowding.[10]

Other triage systems have demonstrated the ability to predict patient outcomes. CTAS, without electronic decision support, was demonstrated by Spence[5] and Stenstrom[11] to have good predictive validity in terms of hospital admission, use of imaging, use of a complete blood count, and length of stay in the ED. Cooke evaluated the ability of the Manchester triage system to detect patients requiring critical intervention on arrival to the ED.[12] Eitel and Tanabe have demonstrated the Emergency Severity Index (ESI) in two different versions, to be able to predict hospital admission, intensive care admission, and resource consumption.[13-15] These results are important; however, ESI is not widely used, and the other two evaluations were not electronic nor driven by decision support capabilities.

While there are widely accepted measures of inter-rater reliability for ED triage, there is currently no reference standard for validity. A patient's urgency for medical attention does not necessarily correlate with the measures of resource utilization or patient acuity used in this or other studies. For example, a patient with severe anaphylaxis may meet criteria for CTAS 1 due to the need for immediate physician assessment; however, with medical therapy and observation, anaphylaxis patients often do not require hospitalization, and may not require any laboratory investigation or imaging. Another patient with a request for an asthma prescription refill would be assigned a CTAS 5; however, may require treatment, investigation and prolonged LOS. On the other hand, an elderly patient may present after a fall, be unable to ambulate due to hip pain, but have non-diagnostic plain radiographs. This patient may require prolonged LOS, more detailed imaging (including CT scan, bone scan, or magnetic resonance imaging), and eventually be admitted to hospital, despite a lower acuity score.

There are numerous clinical scenarios such as these in which the need for urgent medical assessment may not correlate with resource utilization or hospital admission.

One possible way to resolve this apparent disconnect would be consider the different needs of the users of triage data. Researchers are initially interested in measuring the reliability and validity of the overall triage system. They ask the question, "How well does the triage system identify patients in urgent need of medical assessment?" On the other hand, administrators are interested in establishing a means of identifying resource need, benchmarking standards, and department efficiency. They ask, "How well can we predict the resources required to effectively serve our patients and community?" The clinicians (nurses and physicians) are interested in an efficient system that accurately prioritizes patients based on acuity. They ask "How well can does triage perform in the clinical setting and does it assign urgency based on valid outcomes?" The researcher's agenda may be better served by avoiding outcome measures such as admission proportions and diagnostic imaging usage. Instead, triage accuracy may be best measured by retrospective review by an expert panel using the triage data and video capture of the encounter in order to use the important visual cues.

In this study, the mean length of stay of patients in the CTAS 1 cohort was less than those of patients in CTAS 2 or 3. There are a few reasons that may account for this pattern. Patients who are dead upon arrival and are not successfully resuscitated can be transported to the hospital morgue relatively quickly. Similarly, the severely critically ill have relatively easy dispositions and may be transferred to the intensive care bed or operating room with relative speed, depending on hospital bed availability. This is a potential pitfall of using ED length of stay as a measure of resource utilization. If these critically ill or dead patients are quickly removed from the ED, then despite the high patient acuity, these patients tend not to use up ED bed space.

Four patients died in the ED who were triaged as CTAS 3, and two died who were triaged as CTAS 4. Retrospective review of these cases revealed that the CTAS 3 patients presented with problems of "altered level of consciousness", "hypoglycemia", "upper abdominal pain", and "possible overdose". The CTAS 4 patients presented with "falling from wheelchair", and "nausea/vomiting and weakness x 3 days". It appeared that all of these patients presented with conditions that deteriorated while in the ED.

4.5 Limitations and future questions

This study was conducted in a single tertiary care urban teaching hospital. The triage nurses had been using CTAS, a five level triage system, for almost seven years. This study may not be generalizable to other centres with different volumes and CTAS experience. The eTRIAGE© application was introduced six months prior to the study date. It is unclear how long a user needs to be using eTRIAGE© to achieve competency or expertise and this may affect the findings in this study.

This study examined data from over 29,000 patients. This large sample size may reduce efficiency and increase the probability of type I error. However, the differences in outcomes stratified by CTAS level are clinically meaningful despite narrow confidence intervals resulting from the large sample size.

The rate of user error with eTRIAGE© is not known. Similarly, the extent of mis-coding of the ACCS database is not known. Mis-coding would cause data contamination and would result in an underestimation of the differences in outcome, contributing to the probability of type II error. Audits and observed data entry may provide useful information on the rate of error.

Further study on validity in a more homogeneous subgroup of patient complaint type (e.g., shortness of breath or chest pain) may provide additional insight into eTRIAGE©'s performance.

4.6 Conclusions

This study demonstrated excellent ability of triage nurses using eTRIAGE© to predict patient acuity and resource utilization, measured by consultation, use of CT scanning, death rate, and patient disposition. We also comment on the need for consensus on a "gold standard" for measuring the validity of a triage system.

Figure 4.1. CTAS Score distribution

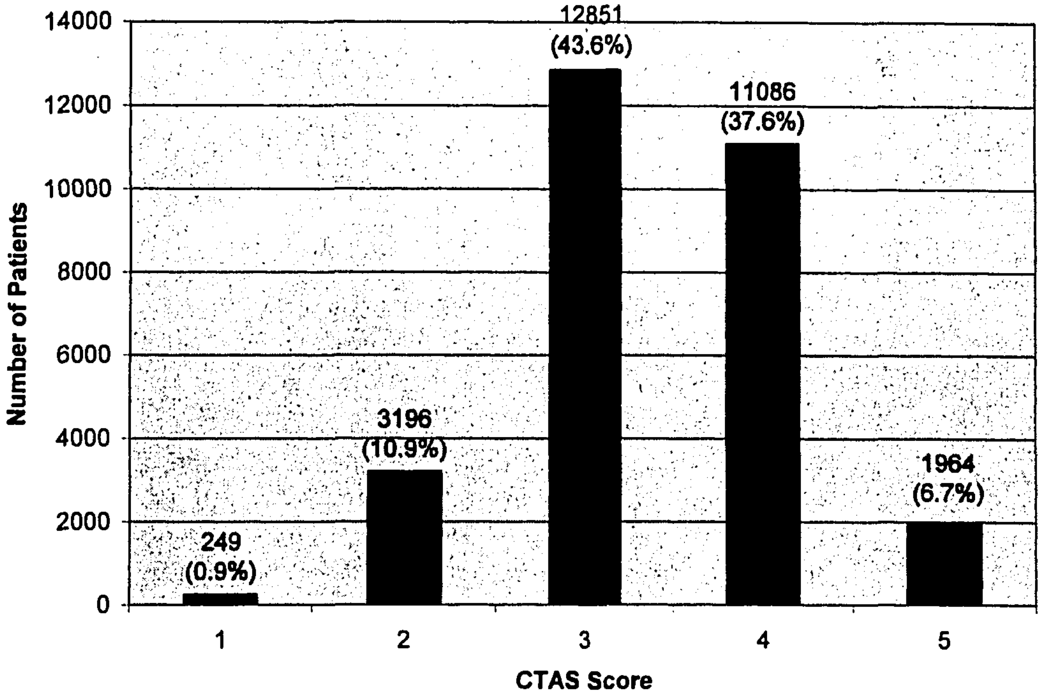


Figure 4.2. Proportion of Patients Requiring Consultation by CTAS Score.

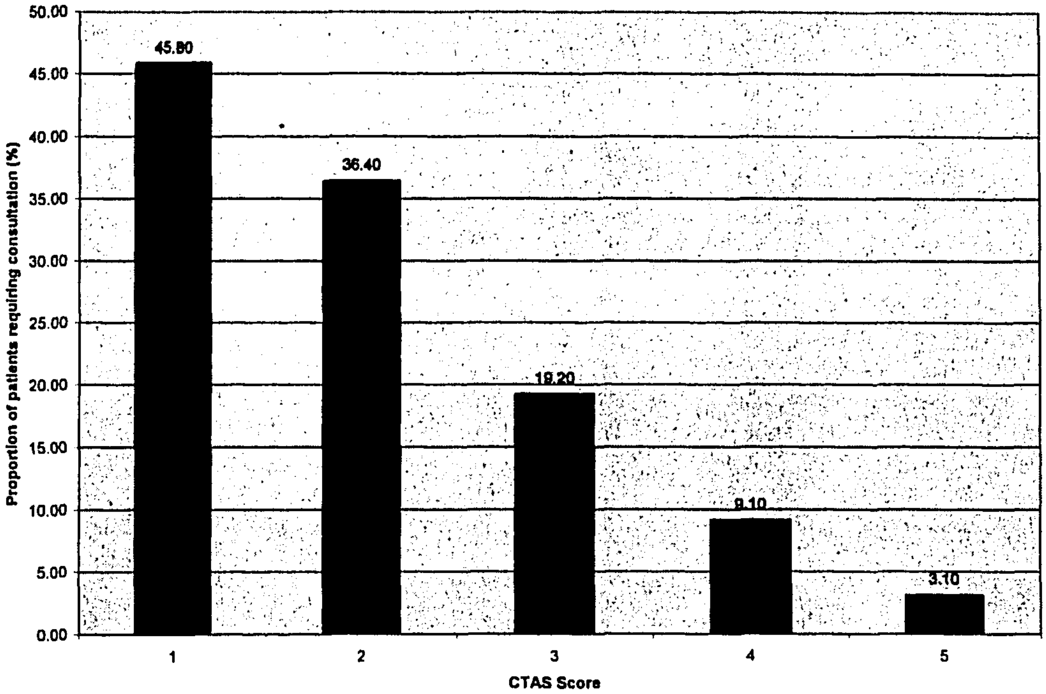


Figure 4.3. Proportion of Patients Requiring CT Imaging by CTAS Score

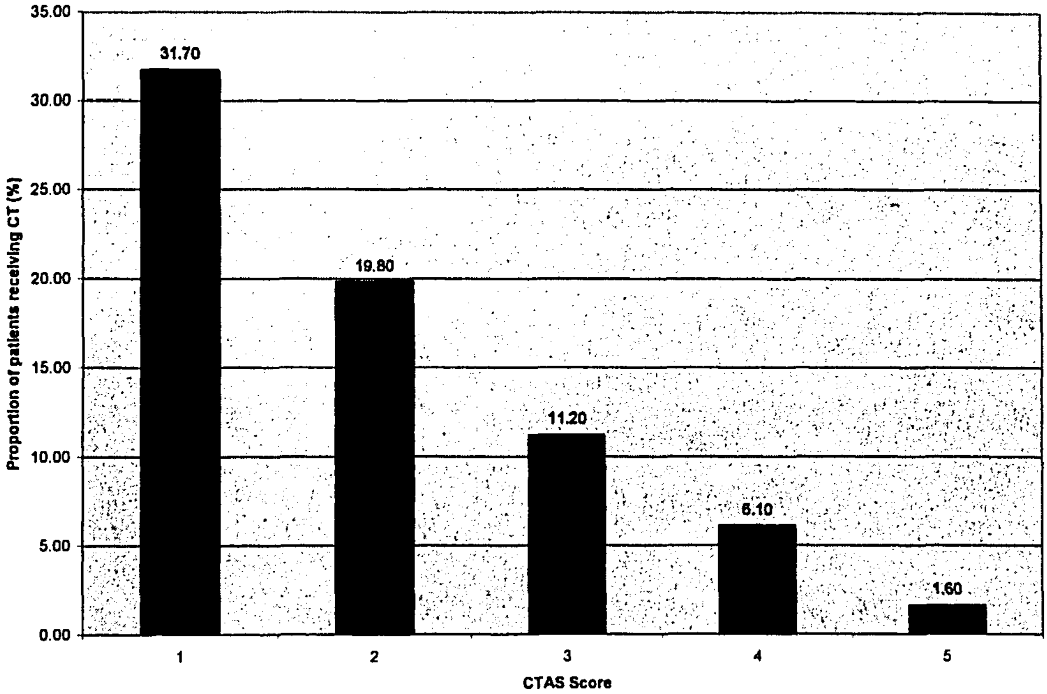


Table 4.1. Odds Ratios for Measures of Resource Utilization by CTAS Score

CTAS Score	**1**	**2**	**3**	**4**	**5**
OR for Consult (95%CI)	3.54 (2.75, 4.57)	2.40 (2.21, 2.62)	1.00	0.42 (0.39, 0.46)	0.14 (0.10, 0.17)
OR for CT Scan (95%CI)	3.70 (2.82, 4.86)	1.97 (1.77, 2.18)	1.00	0.52 (0.47, 0.57)	0.13 (0.09, 0.18)

Figure 4.4. Odds ratios for Consult, CT Scan, and Admission by CTAS Score

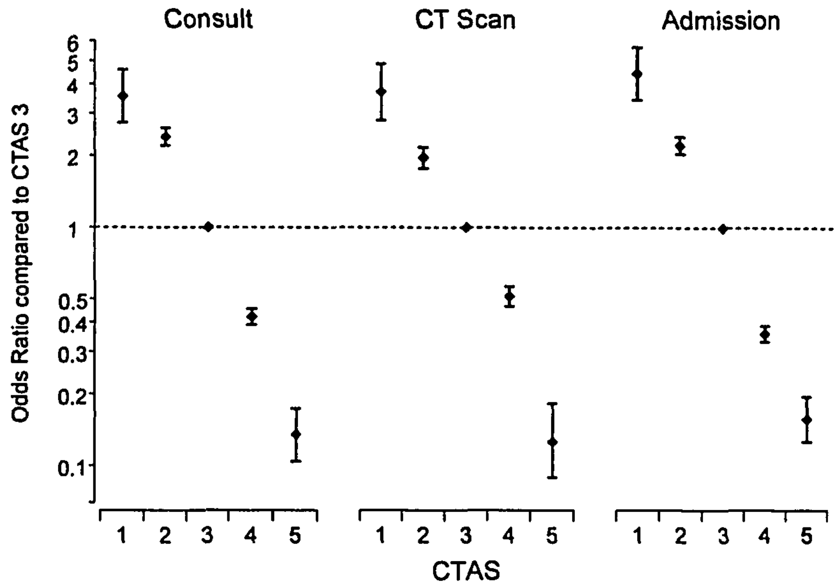


Figure 4.5. Length of Stay by CTAS Score

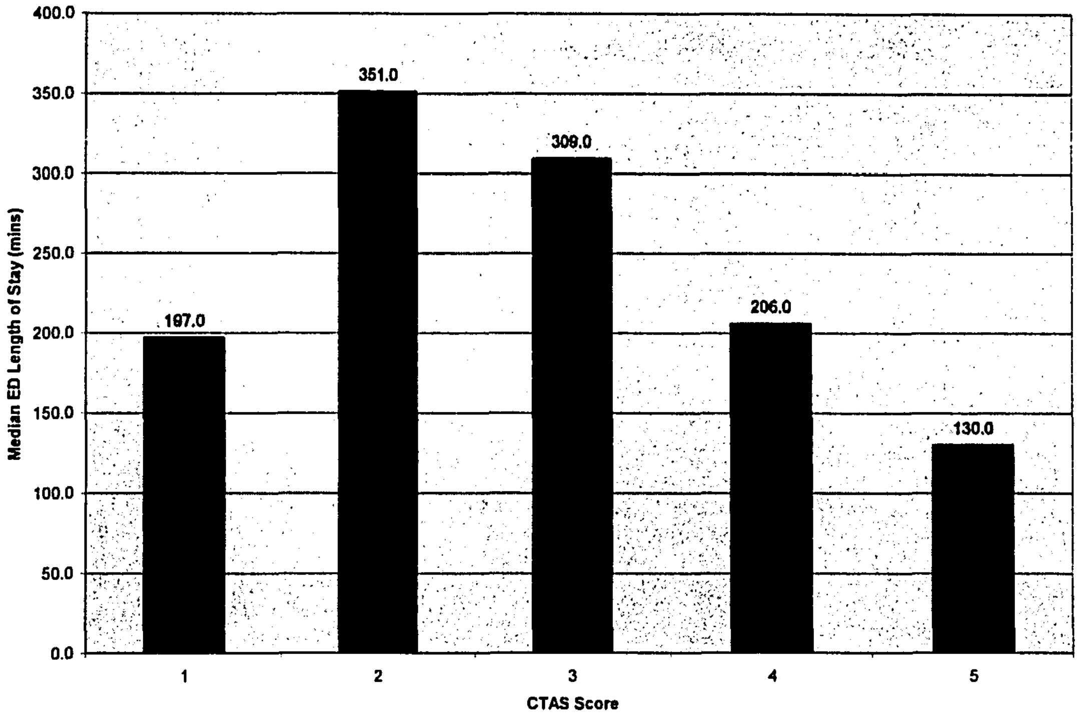


Figure 4.6. Length of Stay by CTAS Score without in-Emergency Deaths

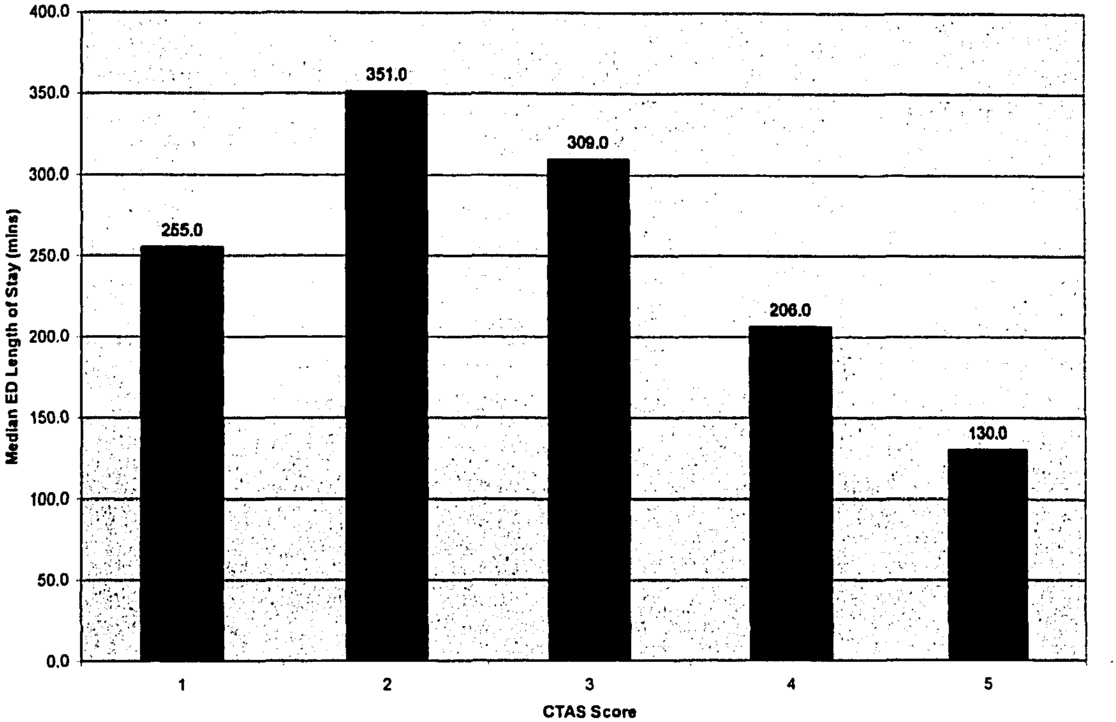


Figure 4.7. Proportion of Patients Dying in ED

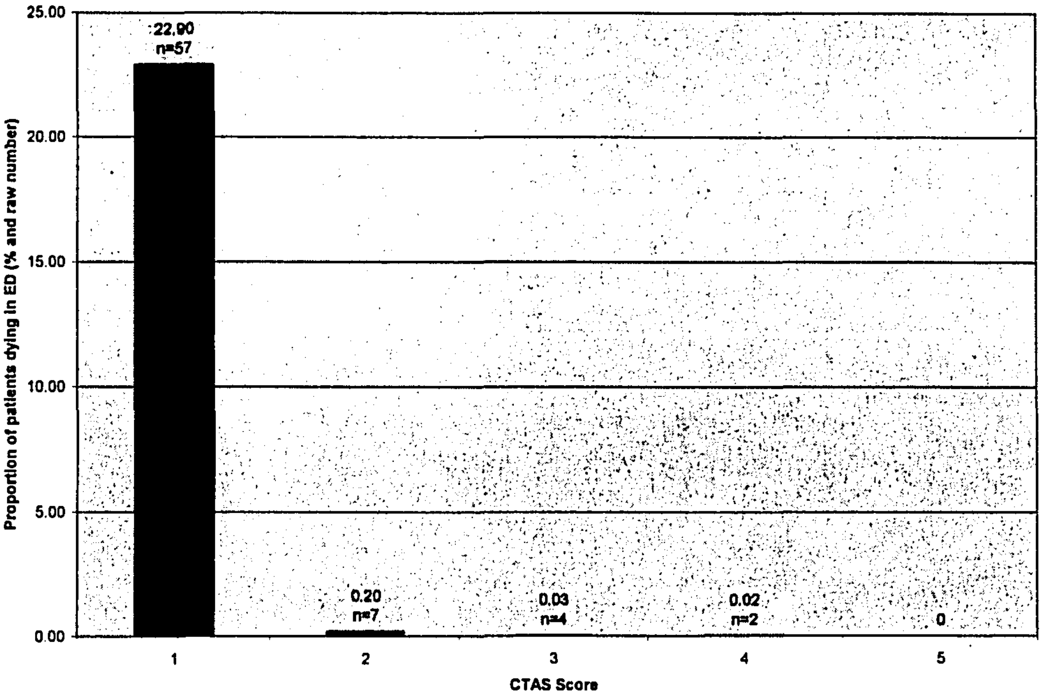
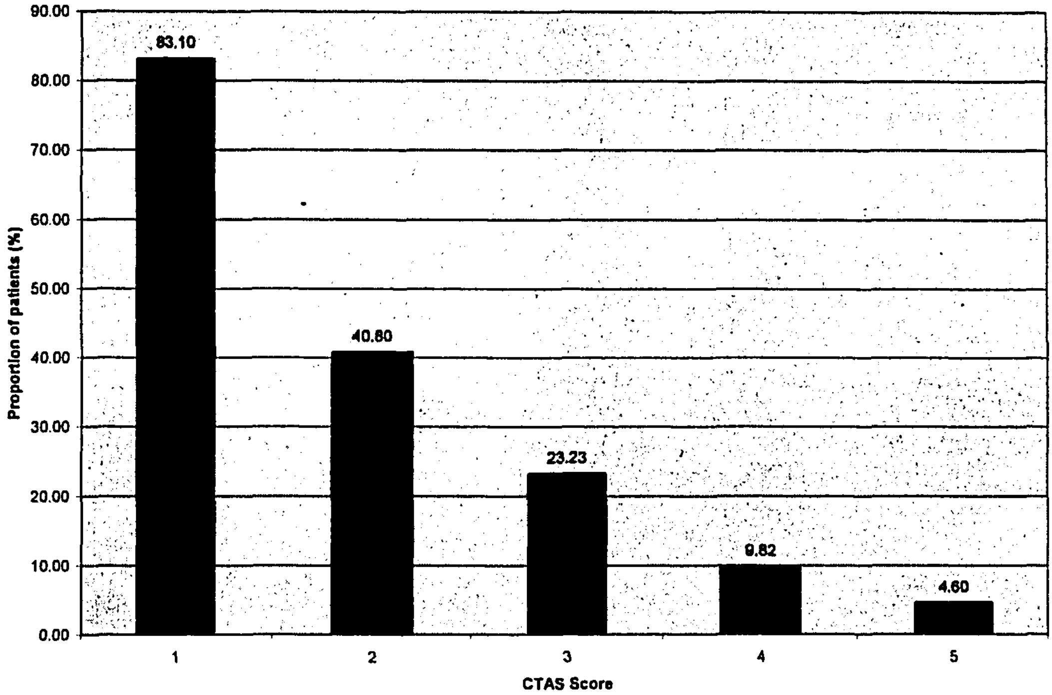


Figure 4.8. Proportion of Patients Requiring Admission or Transfer for Admission



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Chapter 5

General Discussion and Conclusions

5.1 Overview

This research examined the performance of triage using a computerized triage tool (eTRIAGE©). There were several important conclusions from this research. First, a marked discrepancy was demonstrated between triage nurses using the Canadian Triage and Acuity Scale (CTAS) based on memory compared to eTRIAGE© (weighted kappa {κ_W}: 0.36, 95%CI 0.31, 0.42; n = 693). Second, eTRIAGE© demonstrated greater agreement with a consensus panel (eTRIAGE© κ_W = 0.43, 95%CI 0.29, 0.56 vs. memory CTAS κ_W: 0.26, 95%CI 0.13, 0.39; n = 97).

Third, the agreement between two independent users of eTRIAGE© on the same patients improved to moderate (linear κ_W: 0.52, 95%CI 0.46, 0.57. quadratic κ_W: 0.66; 95% CI: 0.60-0.71; n = 569). Moreover, the agreement level did not appear to be affected by different levels of overcrowding.

Finally, higher acuity CTAS scores using eTRIAGE© were strongly associated with surrogate markers of patient acuity (admission rate [p<0.001]; death [p<0.001]) and resource consumption (consultation [p<0.001], computed tomography scan [p<0.001], and length of stay [p<0.001]).

5.2 Further research questions

This research was conducted in a single, large, inner-city tertiary care Canadian emergency department (ED). Performance of eTRIAGE© in other EDs would help to confirm these findings. ED factors to consider when generalizing these results include nurses' expertise in triage; nurses' computer expertise; level of ED overcrowding; population differences in the ED patients, (such as EDs in suburban residential surrounding communities versus EDs in industrial centres; and rural, lower volume EDs.)

The optimal conditions for eTRIAGE© training and skill retention is not yet known. In this ED, the software was implemented following format 3-hour training of 24 of the 77 triage nurses as eTRIAGE© "experts." These staff were then expected to disseminate this knowledge to their colleagues during regular work hours. The research in Chapter 3 paired the study nurse with a targeted duty triage nurse who was provided a further three hours of eTRIAGE© training. Preliminary analysis has identified worse agreement when the study nurse was paired with non-targeted duty nurses.[1]

The conditions for optimal eTRIAGE© skill retention are also unclear. As with any skill, it is presumed that expertise comes with product familiarity over time, clinical acumen, as well as clinical confidence. The frequency of triage shifts necessary to maintain this competence remains to be examined by others.

5.3 Identified issues in triage research

This research evaluated interrater agreement by having the study and duty nurses perform independent, blinded triage assessments. For reasons of patient safety, the order of assessment could not be altered; the duty nurse always made the first assessment. The study nurse then performed the independent assessment in a separate location. While ensuring blinding and independence between the two nurses, this method has a number of potential flaws. The patient may provide different responses to triage queries over time and/or their status might change. In order to address these issues we attempted to re-triage quickly. An alternative method would be to have the duty nurse perform the triage assessment while the study nurse observed the responses without being able to see the data input into the duty nurse's computer.[2] Although this method may have improved the agreement values found in this study, it potentially undermines the independence of the observations.

The bulk of current triage reliability research is based on simulated case scenarios.[3-10] Even if these scenarios are based on real clinical presentations, it is difficult to recreate the live ED environment, which includes distractions by non-triage duties, ED overcrowding, often non-ideal physical space, and numerous factors that can be deleterious to performing triage assessments (e.g., fatigue, hunger, duration of shift, nurse health, etc.). This research adds to the few studies performed in the live environment.[2;11] Although posing more logistic difficulties, real-time studies should be the pursued in the future when possible.

Reliability in triage research is most commonly reported using some form of agreement statistics, such as the kappa statistic.[12] Advocates of the unweighted kappa (κ)

statistic, or exact level agreement, argue that weighted kappa overestimates agreement by giving partial credit for non-agreement.[13] Proponents of weighted kappa counter with the argument that κ treats all disagreement as the same.[14] For example, κ would treat a CTAS 1 and CTAS 5 observation pair the same as a CTAS 1 and CTAS 2 observation pair. κ_W, on the other hand, would give the first data pair a more severe negative impact on the kappa statistic than the second.

This research found a significant difference between two types of weighted κ, linear κ_W and quadratic κ_W. Quadratic κ_W yields a higher value and, when specified, is more commonly used in the literature. Furthermore, a third type of kappa statistic, the within-1 κ, in which full credit is given for all adjacent observations (e.g., CTAS 1 and CTAS 2), greatly overestimates the level of agreement. Based on these arguments and findings, the triage literature needs to abandon the within-1 κ and arrive at a consensus between κ_W or κ, and if it agrees on κ_W, whether it is to be linear or quadratically weighted. It is clinically meaningful to discredit very poor agreement more than closer agreement. If the concern is the qualitative description of agreement[15] based on kappa score, then the narrative can be abandoned by future triage literature in favor of consistent reporting with weighted kappa.

There is currently no "gold standard" of triage validity. Instead, studies use hospital admission rates, ICU admission rates, length of stay, and resource utilization to approximate validity.[5;11;16;17] This research explored problems with using these as surrogate markers. One approximation of validity for one type of patient may not be appropriate for others. For example, admission rate, especially ICU admission, for patients with chest pain may be appropriate, but admission rate for overdose patients may not be as appropriate. The latter patient would be resource intensive, but with medical care would result in little morbidity. Further research on triage validity may need to focus on specific complaint types. This granular examination of triage performance may elicit more meaningful results.

Finally, the eTRIAGE© program is but on of the many programs available to use in emergency medicine. Its advantages are ease and rapidity of use, acceptance by triage staff[18], and the psychometric properties explored in this research. Despite these advantages, additional research is required on this and other triage systems.

5.4 Conclusion

The eTRIAGE© program has been found to be sensible, more reliable than paper or memory-based triage, and valid when traditional measures are employed. Despite the findings of this program of research, additional triage research is urgently needed. In general, research on other triage processes (i.e., comparison of different triage tools), electronic programs, and examination within different environments are needed to expand this important area of clinical care.

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Appendices

1. **Informed Consent Form**
2. **eTRIAGE Questionnaire**
3. **eTRIAGE Busyness Evaluation Form**

Date (dd/mm): __ __/__ __ / 2004 Nurse Initials: __ __

eTRIAGE Questionnaire
Pre-Phase IIb
Royal Alexandra Hospital

Demographics

1. Gender: ___ Male ___ Female
2. Age: ___ 20-29; ___ 30-39; ___ 40-49; ___ 50-59; ___ 60+
3. Years practicing as a nurse:_______
4. Years/months practicing in Emergency Nursing:____ ___ years; or ____ months (if < 1yr)
5. Years/months practicing as an Emergency Triage Nurse or Charge Nurse doing triage: ___ years; or ____ months (if < 1yr)
6. Training: ___ 2.5-3 year Diploma ____ Bachelor's Degree ___ MN/MSc
7. General computer use: ____<1 year ____<5 years ____>5 years
8. How would you rate your computer expertise:

   ___ Novice (use infrequently)

   ___ Intermediate (use for more than 1 program several times a month)

   ___ Expert (Use more than 5 different programs; often using a computer)

Triage Practice

1. How important is the accuracy of your triage assessment to you?

|--------------|--------------|--------------|--------------|--------------|--------------|

1	2	3	4	5	6	7
Extremely Unimportant		Moderately Unimportant		Moderately Important		Extremely Important

2. How important is it to complete your triage assessment quickly?

|--------------|--------------|--------------|--------------|--------------|--------------|

1	2	3	4	5	6	7
Extremely Unimportant		Moderately Unimportant		Moderately Important		Extremely Important

Date (dd/mm): __ __/__ __/ 2004 Nurse Initials: __ __

3. How would you rate the importance of triage to patient outcomes?

1	2	3	4	5	6	7
Extremely Unimportant		Moderately Unimportant		Moderately Important		Extremely Important

4. Please provide your opinion on the statement: electronic triage tools will improve triage assessment.

1	2	3	4	5	6	7
Completely Disagree		Somewhat Disagree		Somewhat Agree		Completely Agree

5. How comfortable do you feel with the overall use of the eTRIAGE application?

1	2	3	4	5	6	7
Extremely uncomfortable		Moderately uncomfortable		Moderately comfortable		Extremely comfortable

6. Please provide your opinion on the statement: *eTRIAGE makes my triage assessment easier.*

1	2	3	4	5	6	7
Completely Disagree		Somewhat Disagree		Somewhat Agree		Completely Agree

7. How often does eTRIAGE tool help prompt you with the selection of appropriate triage assessment items?

1	2	3	4	5	6	7
Never prompts		Sometimes prompts		Usually prompts		Always prompts

8. How frequently do you disagree with the eTRIAGE tool?

1	2	3	4	5	6	7
Never disagree		Sometimes disagree		Often disagree		Always disagree

Date (dd/mm): __ __/__ __ / 2004 Nurse Initials: __ __

9. Of the times you disagree with the eTRIAGE tool, how often do you not override?

|---------|---------|---------|---------|---------|---------|

1	2	3	4	5	6	7
Never		Sometimes		Often		Always

10. Does eTRIAGE interfere detrimentally with your interaction with patients?

|---------|---------|---------|---------|---------|---------|

1	2	3	4	5	6	7
Never interferes		Sometimes interferes		Often interferes		Always interferes

11. How often does the eTRIAGE tool increase the time required to complete each patient assessment?

|---------|---------|---------|---------|---------|---------|

1	2	3	4	5	6	7
Never increases		Sometimes increases		Often increases		Always increases

Thank you for your assistance!
Please return your form to: Maria Janik or Sandy Dong

Electronic Triage Validation Study Intra-shift Questionnaire - Phase IIb-RAH

eTRIAGE Busyness Evaluation Form

Survey: Date (mm/dd): __ __/__ __/ 2004; Time:_______
Site:_______
Shift time: __ __: __ __ to __ __: __ __
Triage Nurse Initials: __ __
Study Nurse Initials: __ __

eTriage Busyness Questionnaire (Triage nurse to complete):

1. During the last two hours, how busy were you with triaging patients?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet		Moderately Busy		Very Busy		Extremely Busy

2. During the last two hours, how busy were you with general questions at the triage desk (e.g. providing directions, direct person-person contact NOT related to triaging a patient, etc.)?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet		Moderately Busy		Very Busy		Extremely Busy

3. During the last two hours, how busy were you with non-urgent phone calls (e.g., regarding patient location, family questions, general information, etc.)?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet		Moderately Busy		Very Busy		Extremely Busy

4. During the last two hours, how busy were you with urgent phone calls (e.g., critically ill patient, EMS patch phone, STARS related call, etc.)?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet		Moderately Busy		Very Busy		Extremely Busy

5. During the last two hours, how busy were you with providing patient care at triage (e.g. performing EKGs, medication delivery, care for nausea, psychiatric intervention, minor laceration care, injured joint care, etc.)?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet		Moderately Busy		Very Busy		Extremely Busy

6. During the last two hours, how often were you distracted by non-triage related EMS staff activities (e.g. casual discussion, joking, laughter, questions unrelated to patient care, etc.)?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Never Distracted		Sometimes Distracted		Frequently Distracted		Always Distracted

7. Overall, how busy were you in the last two hours?

|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|

1	2	3	4	5	6	7
Extremely Quiet	Moderately Busy			Very Busy		Extremely Busy

<u>ED Overcrowding Measures (study nurse to complete):</u>

8. # of people registered in the 2 hours: ___________

9. # of patients currently in the waiting room awaiting placement: ___________

10. # of patients currently placed in room but not seen by MD: ___________

11. # of EIPs currently in the department: ___________

12. What is the department's current ambulance diversion status?

___ Redirect ____ Redirect pending ___ Normal