# Toowoomba Adult Trauma Triage Tool

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# Executive Summary

Triage in an Emergency Department (ED) context constitutes the formal process of immediate assessment and categorisation of all patients who present seeking treatment [1]. In Australia a five tiered scale for the purpose of differentiating patient acuity levels, called the Australasian Triage Scale (ATS), has been widely adopted to facilitate this process. This provides a uniform method of expressing that prioritisation decision but is not a panacea for expressing which patient conditions should be prioritised to which categories [2]. Consequently, since the introduction of the ATS, a lack of standardisation in its application still exists [3].

The critical nature of the triage decision and the need for uniformity is well recognised [3]. Importantly, a consistent approach to triage will enable equity of access for patients and benchmarking of hospitals to inform opportunities for improving performance [4]. The Toowoomba Adult Trauma Triage Tool (TATTT) has sought to address the deficiency of the present system, albeit in a select group of patients, through the provision of a reproducible, reliable and valid method of triage categorisation.

In order to achieve this goal the TATTT needed to be computerised and scientific validation commenced. As part of this undertaking it became apparent that it would also be necessary to determine the most suitable mechanism for simulating ED patient presentations. Simulated patients are needed to allow for the repeat testing inherent in studies of validity and reliability.

The methods trialled for simulating patient presentations were; coding from written scenarios of trauma cases, coding from video-taped scenarios of simulated trauma cases, and coding from a computer simulation of a trauma case. Preliminary validation was sought by parallel coding of real trauma patient presentations. Development of a computerised version of the application was attempted on a hand held pocket PC.

The results of the study indicated that each method of patient simulation exhibited a high level of inter-rater and intra-rater reliability. There were also advantages and disadvantages identified with each simulation approach. The inter-rater reliability data and participant feedback supported a combination of written and video simulations in future testing of the TATTT. The computer simulation was the least favoured and the most expensive and will not be pursued in further investigations of the tool.

The results obtained during the parallel coding portion of the study showed that 47% of patients triaged received the same triage rating, 38% received a more urgent rating and 16% received a less urgent rating using the TATTT compared with existing practice. In all but one case the level of difference between the TATTT and existing practice was only one triage category. Clinical audits of each case of variance in the parallel coding of real patients in this study concluded that, in each case, the TATTT gave more appropriate scores than current practice.

The TATTT showed high inter-rater and intra-rater reliability. The overall (test retest) kappa statistic was 0.82 for 450 cases of simulated triage, easily meeting the standard of 0.60 as stipulated in the ATS policy document released by the Australasian College for Emergency Medicine (ACEM) [5]. This encouraging result suggests that the tool is easily understood and can readily be applied with a high degree of reproducibility following limited training.

The TATTT application was successfully implemented on a pocket PC computer and participant feedback supported its ease of use.

Participant feedback on the TATTT application was obtained through personal interviews of each participant. The TATTT was generally viewed positively. Participants stated that the TATTT provided clear direction in the triage assessment process and it increased their confidence in the decisions they reached. They felt they would be comfortable adopting the TATTT in clinical practice.

In conclusion the studies results suggest that the TATTT provides more appropriate triage scores compared with current triage practices and is more consistent compared with current triage practices. It will also be safe for use in the clinical environment and is acceptable to users. As such, it can viewed as a viable alternative to current triage practice worthy of further investigation.

# 1.0 INTRODUCTION AND LITERATURE REVIEW

## *1.1 Background*

The word triage is derived from the French verb *trier*, which means 'to sort'. Historically the concept of sorting patients according to the urgency of their need for medical care developed during military conflicts. The growth in demand for emergency care by civilian populations has now led to the need to develop formal triage systems in hospital emergency departments [6].

Triage in an Emergency Department (ED) context constitutes the formal process of immediate assessment and categorisation of all patients who present seeking treatment [1]. In Australia a five tiered scale for the purpose of differentiating patient acuity levels, called the National Triage Scale (NTS), has been widely adopted to facilitate this process. The NTS was formulated in 1993 by the Australasian College for Emergency Medicine (ACEM) with the aim of promoting a standardised approach to triage in Australian EDs [7]. In 2000 the NTS was revised and renamed the Australasian Triage Scale (ATS).

In Australia, triage is predominantly a nursing role [7]. The triage nurse's primary role is the allocation of a triage category utilising the ATS. This requires a clinical decision based on the patient's individual need for care. The process of triage ensures that emergency care is initiated in response to clinical need rather than order of arrival [1]. This process aims to ensure that those most in need of emergency medical care receive that care quickly [6].

Fundamental to the design of both the NTS and ATS is the five tiered categorisation scale which reflects both the severity of the patient's illness or injury and the expected medical response time commensurate with the patient's illness or injury severity [4]. This provides a uniform method of expressing that prioritisation decision but is not a panacea for expressing which patient conditions should be prioritised to which categories [2]. Consequently, since the introduction of the NTS, a lack of standardisation in its application still exists [3].

The critical nature of the triage decision and the need for uniformity is well recognised [3]. FitzGerald (1996) aptly poses the question, 'are there ways of guiding staff in the application of the scale [NTS] which improve further its relevance and repeatability?' [8]. Gilboy et al. (1999) equally suggest that in the 21st century we are challenged to find new ways to ensure accurate, expeditious triage that is universal, reproducible and valid [9]. Importantly, a consistent approach to triage will enable equity of access for patients and benchmarking of hospitals to inform opportunities for improving performance [4]. The Toowoomba Adult Trauma Triage Tool (TATTT) seeks to provide such a mechanism, albeit in a select group of patients.

In order to achieve this goal the tool needed to be computerised and scientifically validated. Before commencing this undertaking it became apparent that it would first be

necessary to develop a suitable mechanism for simulating ED patient presentations. Simulated patients were needed to allow for the repeat testing inherent in studies of validity and reliability.

To provide a background to the need for the TATTT, the literature pertaining to ED triage, methods of assessing triage previously employed, existing approaches to triage and the tools conceptual framework will now be explored.

## *1.2 Literature Review*

### 1.2.1 The Triage Role and its Procedural Significance

Emergency Nurses would agree that the triage role is becoming increasingly demanding and stressful [10]. The complexity of the role and its primary function, the categorisation of patient acuity, is well recognized [11,12]. The reality of the triage environment requires the nurse to make important clinical judgements under conditions of uncertainty, where time and relevant data about the patient's condition may be limited or ambiguous. Such decisions often place the nurse's professional reputation and self esteem on the line and can be associated with significant risk for the patient, the nurse and the organisation [2].

The initiation of emergency care primarily depends on the decisions made by the triage nurse. Triage decisions can therefore have a profound effect on the health outcomes of patients who present for emergency care [3]. The consequence of variation in the triage decisions is discrepancy in the length of time that a patient must wait before receiving medical intervention [13]. If triage nurses fail to categorise patients appropriately then medical attention may be unacceptably delayed or unnecessarily expedited [14]. This has implications both for the patient being triaged and the ability of the ED to function effectively [3]. This failure can lead to patient dissatisfaction, staff stress, unnecessary and avoidable morbidity and even mortality [14].

Another important aspect to the role is in the management of patient workload. The triage nurse has a unique overview of departmental workload and plays a crucial role in managing patient throughput [2]. Appropriate triage is cited as important to the smooth functioning of an ED [14,15]. Where triage can jeopardise ED efficiency in the management of a large volume of patients is when a nurse 'over triages' patients. Over triage refers to the allocation of a triage score that is disproportionately high in relation to the patients presenting complaint. Inappropriate over triage of patients can unduly augment the influx of patients into the ED which excessively ties up departmental resources to the exclusion of concurrent and following patients.

Of increasing significance to triage performance is that the triage process is being used to finance and compare institutions and is becoming more than just a tool to sort patients [13]. This means that triage nurse decisions now have administrative, political and economic implications [3].

### 1.2.2 Existing Approaches to Triage Testing

Traditionally triage performance has been assessed with the aid of paper based scenarios of patient presentations. This common approach has some limitations. These limitations are highlighted by Jelinek and Little (1996) who utilised 100 written patient scenarios in their study on triage inter-rater reliability. They found nurses in their study frequently complained that it was difficult to categorise patients on the limited information provided due to the lack of visual and verbal cues used in the live triage process [16]. As a consequence, the authors proffered an alternative of video-recording mock patient's acting out various conditions.

Whitby et al. (1997) examined triage inter-rater reliability by using blinded paired triage nurses to independently triage the same patient presenting to an ED [17]. This method overcame the difficulties outlined previously but is logistically more difficult to orchestrate.

In a study examining the implementation and refinement of a new instrument for triage, Wuerz et al. (2001) employed two strategies for assessing triage performance [18]. Participants, following training in the instrument, underwent a post-test of 20 scenarios that included brief written descriptions and photos. They also utilised a variation of the approach utilised by Whitby et al. (1997) [17]whereby an investigator, blinded to the patients triage category, retrospectively assigned a triage category utilising the information in the triage history obtained by a triage nurse. A critique of the processes employed was not performed. It would be interesting to know if the provision of a photograph augmented the acceptability of written scenarios by participants or if there were any deficiencies associated with the retrospective triage assigning process.

A comparative study of the relative merits of the different assessment approaches to triage performance has not been the subject of individual research to date. Hence, this question became central to the current study.

### 1.2.3 Consistency in Triage Performance

Given the procedural significance of triage and its utilisation of the ATS, it is relevant to consider how consistently triage is being performed using the ATS. There have been several studies conducted that have investigated the inter-rater reliability of the NTS/ATS.

Jelinek and Little (1996) conducted a study into the inter-rater reliability of the NTS. The study administered 100 written patient scenarios to 115 triage nurses from eight different Western Australian hospital emergency departments [16]. They found that 86% of triage nurses responded within plus or minus one triage category of the most frequent response for all patient scenarios. On this basis they concluded that the inter-rater reliability of the NTS was good. No kappa statistic was calculated. The strength of this assertion is questioned by some given that a discrepancy of this nature would result in significant variations in patient waiting times. For example if a patient received category 3, 4, and 5

ratings the recommended maximum waiting time for this patient may differ from 30 minutes to 2 hours [4].

Doherty (1996) conducted a study into the uniformity of triage between medical and nursing staff and between four different hospitals [19]. The study comprised 12 written patient scenarios administered to two emergency medicine consultants, two emergency medicine registrars and two triage nurses at four NSW public hospitals. He found that no one scenario was triaged the same by all participants and 10 of the 12 scenarios received triage scores encompassing three or more categories. The study concluded that application of the NTS is variable and inter-hospital triage by nurses is not uniform.

Whitby et al. (1997) performed a national study which examined over 11,000 episodes of triage at 10 hospitals of varying size [17]. As part of that study the authors examined the inter-rater reliability of the NTS using actual patient presentations to an ED. Patients presenting were triaged by paired triage nurses independently and blinded to each others score. Data were collected from 41 pairs of triage nurses from three different EDs involving 299 patient presentations. They found the level of inter-rater reliability between the paired triage nurses to be good as evidenced by a kappa statistic of 0.675.

Richardson and Harvey (1997) compared admission rates and triage category profiles according to sentinel diagnoses outlined in the NTS between large and small hospitals within the same city [20]. They found marked differences in the application of the NTS between different hospitals on this basis. For example, otitis externa was categorised to NTS category 5 in anything from 20% to 55% of cases. In conclusion they assert that the use of the NTS as a clinical performance indicator or as a basis for a case-mix payment system required much greater uniformity.

Dilley and Standen (1998) assessed the level of uniformity among Victorian public hospital triage nurses in utilising the NTS [13]. The study comprised 20 written patient scenarios administered to 188 nurses from 14 different Victorian hospital EDs. The authors concluded that the uniformity of application of the NTS was 'reasonable' but conceded that there was room for improvement. The term 'reasonable' seemed optimistic given that no one patient scenario was triaged to the same category by all 188 triage nurses and 75% of scenarios were triaged to four different triage categories. The kappa statistic for inter-rater agreement by all nurses was 0.2537. This falls well short of the ACEM's accepted standard of inter-rater agreement set at a weighted kappa statistic of at least 0.6 as stipulated in its policy document on the ATS [21].

Considine, Ung and Thomas (2000) examined triage nurses level of agreement in the allocation of triage categories using the NTS [3]. They surveyed 31 triage nurses from two institutions with 10 written scenarios. They found that overall triage nurse responses concurred with the expected triage category in 58% of ratings. Six of the scenarios were triaged to two triage categories and four of the scenarios were triaged to three triage categories. No scenario was triaged the same by all participants. They concluded that this level of variability was of concern and that it was unacceptable that a patient may be

allocated varying triage categories depending on who the triage nurse was when the patient presented.

Van Gerven, Delooz and Sermeus (2001) performed a pilot study to evaluate the validity of the NTS for judgement of the urgency of a patient's condition in Belgium [22]. Three thousand six hundred and fifty (3650) patients were evaluated by four nursing staff over a 12 week period using an instrument based on the NTS. From their results they concluded that the lack of strict guidelines and the subjectivity of the instrument raised questions about the reliability of the NTS.

Durojaiye and O'Meara (2002) measured the inter-rater reliability of the NTS when used by triage nurses for the triage of paediatric patients [23]. They assessed 78 nurses in 10 hospitals with 24 written paediatric patient scenarios. They found responses across all five triage categories for two of the patient scenarios and across four triage categories for 14 of the profiles. From these results they concluded that the use of the NTS on paediatric patients by triage nurses was inconsistent with significant differences occurring between mixed presentation departments and paediatric only departments.

Goodacre, Gillet, Harris and Houlihan (1999) performed a retrospective audit of 50 emergency department presentations with four emergency physicians to determine the level of agreement between senior medical staff and nursing triage decisions using the ATS [14]. They identified only fair to moderate consistency between physician reviewers auditing triage decisions retrospectively. This lack of retrospective consensus provides a further corollary to the notion of triage being a complex, subjective and difficult exercise with poor uniformity.

### 1.2.4 Difficulties with the ATS

Given the variability demonstrated in the application of the NTS/ATS possible causes of this variability are now considered. Although the NTS had been shown to be broadly consistent, some refinement of the scale was undertaken in order to address the variability in application of the NTS identified by the ACEM [24]. The resulting ATS can still be viewed as deficient for a number of reasons:

1. The terminology surrounding some of the clinical descriptors is highly subjective;
2. Criteria incorporated are listed without definition; and
3. It makes use of sentinel diagnoses as a guide to acuity assessment.

For example, some terms used within the scales clinical descriptors are:

- "Extreme respiratory distress, severe respiratory distress, moderate shortness of breath."
- "Severe blood loss, moderately severe blood loss, mild haemorrhage."
- "Severe localised trauma – major fracture." [21]

As it can be appreciated, when adjectives such as 'extreme' and 'severe' are used their interpretation will vary between operators. This will be equally so when a classification system of 'mild', 'moderate' and 'severe' are used to delineate between triage categories.

Further compounding this highly subjective classification approach is the lack of clear definitions associated with the descriptors used. The last example pertaining to extremity injury highlights this point. One would ask what constitutes a major fracture as opposed to a minor fracture? Gill, Reese, Diamond (1996) suggest that the subjectivity of urgency definitions may promote variability and that the development of more objective and uniform definitions may help address this problem [25].

The ATS also employs diagnoses as clinical descriptors for each triage category. An example of this is in the category 2 clinical descriptors under high risk history which states: "severe pain suggesting PE, AAA or ectopic pregnancy" [21]. The use of such references is questionable [4] given that the majority of patients presenting to EDs do so with signs and symptoms rather than diagnoses [13]. A further cited limitation is their narrowness of application. Many diagnostic groups have a spectrum of acuity that cannot be confined to a single triage category [4].

Given that the ACEM acknowledge that triage precedes medical diagnosis [1] it seems contradictory to use diagnoses for the purposes of guiding triage practice. As Standen (1998) clearly states, if guidelines are available they should be based on signs and symptoms and not diagnoses [26].

### 1.2.5 Algorithmic Approaches to Triage

The ATS is an acuity scale without any algorithmic components, whereas the TATTT is an algorithm which utilises the ATS. As such it is important to consider perspectives relating to the use of algorithmic approaches to triage.

Algorithms can be used to provide decision support in the assessment of clinical urgency. The benefit of such an approach lies in the direction and structure they provide in guiding the decision for the triage nurse [2]. This concurs with the thoughts of other authors who suggest nurses need to use standard guidelines when assessing patients so that all patients are assessed similarly and according to standards of practice [27]. This need for a systematic method of assessment which is easy to understand and quick to use has been widely recognised [28]. Given the complexity and subjectivity of triage, Gilboy, Travers and Wuerz (1999) assert that algorithms that can be implemented at triage to facilitate patient assessment should be considered in order to improve upon current systems of triage [9].

There are a number of other perceived benefits associated with the use of algorithms for triage purposes. First, they minimise the risk associated with the decision to both the organisation and the individual [2]. Second, if well constructed and prospectively validated, they would improve accuracy [29].

In support of these assertions a study comparing computerised algorithm directed triage and nurse triage in the ED concluded that algorithm directed computerised triage is safe and effective with significantly lower rates of mistriage [30]. Wuerz et al. (2001) also

demonstrated that an algorithmic approach to triage acuity assignment achieved higher levels of inter-rater agreement than other non algorithmic approaches [18].
There are a number of reported limitations of algorithmic approaches to triage:

1. The use of lengthy algorithms may unnecessarily delay a time critical patient at triage [2];
2. They could impose restrictions on performance by limiting the development of more flexible ways of assessing patients at triage [2];
3. Failure of appropriate application was reported as the chief reason for a protocol driven triage system to fail to detect critically ill patients. It was felt that these errors were due to problems with training rather than the system itself [31]; and
4. Patients with more than one presenting complaint may be triaged by more than one pathway, each leading to a different category [14].

### 1.2.6 Algorithms Available for Triage

*The Emergency Severity Index*

In 2000 Wuerz, Milne, Eitel, Travers, and Gilboy introduced a new five level ED triage instrument called the Emergency Severity Index (ESI) [32]. The algorithm, which underwent further implementation and refinement in 2001 is universally applied to all adult presentations regardless of presenting complaint and is based on a five tiered prioritisation system [18]. The algorithm utilises vital signs, clinical criteria, situational criteria and predicted resource usage for the purposes of acuity categorisation. The ESI was found to reproducibly stratify patients into five groups with distinct clinical outcomes [18].

The ESI bears some minor similarities with the TATTT. Consistencies include; the use of vital signs as discriminators of triage category, category 1 criteria of intubated, apneic pulseless or unresponsive, category 2 criteria of severe pain or distress, and triaging proportional to a high risk situation although in the absence of the training material associated with the ESI this criterion was undescribed [18].

The limited vital signs parameters utilised were criticised by some study participants for being to arbitrary and resulting in overtriage of too many patients without serious disease. Version 1 of the tool had a threshold heart rate of 90 beats per minute, which if exceeded resulted in the patient being a category two. This was subsequently revised to a heart rate of 100 to be in line with the standard definition of a tachycardia which the authors felt had the most face validity [18]. It could be anticipated that even utilising a pulse exceeding 100 as the sole criteria pertaining to heart rate and it being associated with category 2 would draw a similar level of concern from Australian triage nurses.

*The Manchester Triage System*

The Manchester Triage System (MTS) was introduced into the United Kingdom (UK) in 1997. It is a series of flow charts for various presentation groups with key discriminators to determine the triage category. A multidisciplinary consensus group developed these

guidelines which have subsequently been adopted widely throughout the UK [31]. There have been no studies published as yet to verify that the consensus group's opinion correlates with the urgency of required clinical care [4,31].

In terms of the MTS there are several presentation flow charts that could be applied in the context of trauma. They are: Major Trauma, Limb problems, Truncal injury, Neck pain, Back pain, Falls, Burns and scalds, Head injury, Wounds, Assault, and Shortness of breath [33].

Contained within each flow chart is a set of general discriminators which are universally applied amongst other specific discriminators. These general discriminators bear some similarity with the TATTT. These include; equivalent category 1 discriminators of closed or insecure airway, absent or inadequate breathing and exsanguinating haemorrhage, category 2 criteria of severe pain and the consideration of high risk mechanisms of injury [33].

One of the deficiencies associated with this system, to which the ATS is similarly afflicted, is the lack of clear definition and explanation attached to the criteria utilised. For example:

- Absent or inadequate breathing is defined as "patients who are failing to breath well enough to maintain adequate oxygenation"[33]. This description seems as subjective as the ATS descriptor of extreme respiratory distress.

A further potential problem with the MTS, as with the ESI, is the criterion weightings. The MTS, for example, equates an impressive mechanism of injury with a category 2 score. It could be anticipated that there would be considerable reluctance on the part of Australian triage nurses and EDs to accept a category two triage rating on the basis of mechanism alone.

### 1.2.7 Educational Frameworks for Supporting Triage

Rowe (1992) outlined the development of a triage assessment tool designed to augment the assessment approach and prioritisation decision for triage [34]. The paper outlined the process of peer review and consensus approach to the development of the tool, however, there was no clinical trial undertaken to validate the tool. The tool was developed by the author in response to inconsistencies in triage decisions noted within the ED in which she worked. She believed that novice triage nurses in the ED were unable to focus on the relevant aspects of the patient's presenting complaint and the patient's objective clinical status. The purpose of the tool was to focus the nurse on the pertinent data and sequence required to facilitate a quality triage decision. Emphasis was placed on the tool not replacing clinical judgement and experience but as facilitating the decision making skills of the triage nurse [34].

The tool utilised a primary survey approach and incorporated objective and subjective assessment criteria and was conceptually similar to the TATTT. The tool was based on a

three tiered categorisation system and was universally applied to all adult presentations. The equivalent to category 1 in the ATS was the emergent category. This category contained some similarities to the TATTT; airway intubated or obstructed/respiratory rate <10 bpm or >28 bpm / heart rate <45 bpm or >120 bpm / cool diaphoretic skin. The tools conceptualisation and consensus view lends support to the TATTT's framework and its similar intention.

Considine, Le Vasseur and Charles (2002) outlined the development of an education strategy to improve the consistency of application of the ATS [35]. As part of the Consistency of Triage in Victoria's Emergency Departments Project (2001), physiological discriminators for the ATS were developed. The authors highlighted that these discriminators were not intended to be used in a stepwise fashion to make triage decisions. They were intended to provide novice triage nurses with a tool against which to reflect on their primary triage decisions and may assist them in justifying their triage decisions to others [36]. The guidelines were arbitrarily divided into columns relating to each element of the primary survey proportional to each triage category in the ATS [36]. The guidelines covered both adult and paediatric patient groups as well as other specific patient presentation groups such as ophthalmic complaints.

In so much as the guidelines are commendable in their intent, conceptually similar to the TATTT, and are indeed improvements on the current ATS clinical descriptors, they perpetuate some of the problems existent in the ATS. The guidelines incorporated the use of mild, moderate and severe terminology prominently, lack clear definitions associated with some criteria, and some of the criteria are not fully delineated. For example:

- Under the heading of hemodynamic compromise: 'Significant alteration in HR' vs 'moderate alteration in HR' vs 'mild alteration in HR'.
- 'Absent respirations or hypoventilation'. No definition of what constituted hypoventilation was provided.
- Category 1 descriptor: 'Uncontrolled haemorrhage'. Would a small superficial laceration to a foot that presented to the triage desk still actively bleeding qualify for a category 1 triage category under this physiological indicator? Equally no other descriptors for bleeding were provided.

There has been no formal evaluative process to date on these guidelines although they have been widely distributed throughout Victoria [35].

### 1.2.8 Other Triage Scales

The Canadian Triage and Acuity Scale (CTAS) in its present form is operationally equivalent to the ATS. It is a five tiered acuity scale incorporating sentinel diagnoses into clinical descriptors per triage category [37]. There are no algorithmic components to the scale but a greater level of description associated with its various criteria than the ATS.

To some extent the level of description provided is quite prescriptive, which provides clear direction. Conversely the descriptors are also clouded by unnecessary dialogue, multitudes of sentinel diagnoses and some vagueness. For example:

- Category 1 descriptor, 'Severe respiratory distress: There are many causes for respiratory distress but benign reasons can only be diagnosed by exclusion. Serious intracranial events, pneumothorax, near death asthma (unable to speak, cyanosis, lethargic/confused, tachycardia/bradycardia, $O_2$ sat <90%) COPD exacerbations, CHF, anaphylaxis and severe metabolic disturbances (renal failure, Diabetic Keto acidosis). These patients require rapid assessment of the ABC's and physician intervention. Medications and equipment for management of respiratory and ventilatory failure (Endotracheal intubation-RSI, BIPAP) bronchodilators, inotropes, and vasodilators need to be made available' [37].

Those signs and symptoms listed for near death asthma are the only clearly stated criteria listed for making a triage decision relative to the descriptor of severe respiratory distress. However, the scale doesn't state whether these criteria can be equally utilised for the universal assessment of severe respiratory distress for the other diagnostic groups listed.

- Category 1 descriptor, 'Shock states: Conditions where there is an imbalance between Oxygen supply (cardiogenic, pulmonary, blood loss, disorders of oxygen affinity) and demand (hyperdynamic states) or utilization (sepsis syndrome). Hypotension and or tachycardia and possibly bradycardia in advanced/pre arrest situations' [37]. A sentinel diagnosis listed for this category is 'traumatic shock' which is undefined.

This descriptor is difficult to interpret and open to interpretation. Equally blood pressure would rarely, if ever, be performed on a category one patient at triage.

Beveridge, Ducharme, Janes, Beaulieu and Walter (1999) studied the inter-rater reliability of the CTAS with a randomly selected cohort of 10 nurses and 10 physicians [38]. Each was administered 50 ED case summaries to which to assign a triage rating. Their results demonstrated a high level of inter-rater agreement suggesting that the scale is understood and interpreted in a similar fashion. This is, however, representational of only one institution.

### 1.2.9 The Toowoomba Adult Trauma Triage Tool

Having now examined the various other available options for facilitating triage decision making, attention will now be focused on the TATTT's construction and its elements.

#### *1.2.9.1 The Tool's Framework*

The TATTT utilises a primary survey framework for the purposes of structuring the assessment process and forming the important clinical criteria of the assessment upon which the categorisation of urgency is based. This utilisation of the primary survey for

assessment of patient urgency in the triage decision making process is advocated by many [39-41] and it is asserted that it should form the basis of all triage decisions [36].

The TATTT utilises 10 assessment parameters which incorporate many of those identified as influential in the triage decision making process [17]. Furthermore, when examining the number of clinical features utilised per triage assessment by nurses, Whitby et al. (1997) found the mean number of clinical features used by triage nurses for making a triage decision was 9.5 [17].

#### *1.2.9.2 The Tool's Scoring System*

The tool's clinical parameters are all individually stratified and weighted against the ATS categories 1 to 5. Thus any individual parameter can define the urgency categorisation of the patient's presentation. In terms of complete assessment the triage score will reflect the highest individually weighted parameter scored on the tool as a minimum score. Added to this is a non linear algorithmic scoring component to the tool such that the more abnormal parameters that are scored per triage category result in a proportional increase in the triage category. Other non-linear aspects of the tool are that components can be completed in any order and that the process stops as soon as a triage code of 1 is suggested. That is, for urgent cases, not all fields have to be completed.

In relation to the individually weighted parameters the ACEM guidelines for implementation of the ATS state that absolute physiological measurements should not be taken as the sole criterion for allocation of an ATS category [21]. This seems contradictory when clear physiological measurements such as a respiratory rate of less than 10 are provided in the Category 1 clinical descriptors. Contra to this opinion, Whitby et al. (1997) state that at the more urgent end of the scale, single descriptors can define urgency in their own right [17]. It is also believed that the non linear algorithmic scoring component of the tool overcomes this stipulation as it aggregates the individual assessment parameter results, thus providing a global assessment of the patient in deriving a triage categorisation.

In terms of the highest individually weighted parameter scored on the tool becoming the minimum score, this is consistent with the ACEM guidelines for implementation which state that the most urgent clinical feature identified determines the ATS category [21]. Further supporting this is Whitby et al. (1997) who state that features which strongly describe the higher urgency categories are exclusions to the lower categories [17].

#### *1.2.9.3 Vital Signs and Triage*

Two vital signs parameters are incorporated into the TATTT assessment framework; they are the heart rate and the respiratory rate. Their inclusion can be substantiated from a number of different perspectives:

- Vital signs measurements are routinely obtained by triage nurses in current practice. In an observational study by Geraci and Geraci (1994) they found the

most frequent physical triage activity was doing physical assessments and obtaining vital signs [42];

- Nurses consider vital signs important elements in the triage decision process. Fry and Burr (2001) in their investigation of current triage practice asked nurses to rank a range of factors in order of importance that they believed influenced the triage decision making process. Vital signs and mechanism of injury were rated 2nd and 3rd on the list of eleven items [11];
- Triage nurses use vital signs as evidence to confirm triage decisions. Whitby et al. (1997) in their investigation of the process of triage identified that indicators of patient safety such as normal respirations and normal colour were frequently utilised to support the triage decision. It was also clear that the surveyed population recognised respiratory status as an important indicator of urgency [17]. This is supported by Derlet (2002) who states that high respiratory rates are one of the most sensitive indicators of severely ill or injured patients [43];
- Failing to assess vital signs may result in an inappropriate triage allocation. Cooper et al. (2002) investigated the effects of vital signs on triage decisions. They concluded that methods of triage that did not determine vital signs may not adequately reflect the urgency of the patient's presentation [44].

#### *1.2.9.4 Physiological Criteria as a Basis for Triage*

The use of physiological criteria such as those incorporated into the TATTT for the purposes of clinical decision making is supported by work conducted into medical emergency response teams and clinical antecedents of cardiorespiratory arrest. Its value is in supporting some of the TATTT's assessment components, supporting some of the category 1 weightings utilised by the TATTT and in establishing the similarity between the early identification criteria of the critically ill patient in a general ward context with that of an acute ED presentation.

Buist et al. (1999) investigated the nature and duration of clinical instability in hospital patients before a cardiac arrest or an unplanned admission to intensive care. They found that these patients frequently manifest abnormalities in simple physical observations prior to a cardiac arrest or an unplanned admission to intensive care [45]. This finding was also supported by Franklin and Mathew (1994) who found that cardiac arrests were commonly preceded by premonitory signs and symptoms [46].

Hourihan et al. (1995) described the utilisation of an emergency team that employed standardised calling criteria to facilitate the early identification and resuscitation of patients who were at risk of cardiopulmonary arrest. They identified that abnormal physiological variables were a factor in 60% of calls received [47].

Lee et al. (1995) outlined the introduction of a Medical Emergency Team (MET) in a large metropolitan teaching hospital. The team was called in response to specific criteria such as a respiratory rate of less than 10 and greater than 30 and altered levels of consciousness. The MET calling criteria were instituted with the aim of identifying patients with substantial risk of serious sequelae if appropriate acute treatment was not

instituted immediately. The calling criterion utilised in the study was found to be highly sensitive in achieving this aim [48].
It can be argued that abnormal physiological parameters can predict patient illness acuity and criteria based on these findings can be used to identify the critically ill patient and thus allow rapid clinical intervention. These medical emergency team concepts and clinical antecedents of cardiorespiratory arrest are adaptable to the triage process of an acutely ill patient presenting to an ED.

Adding support to the use of physiological criteria for the purposes of triage, Whitby et al. (1997) in their investigation of the process of triage, identified that physiological abnormalities were used by triage nurses to identify clinical urgency [17]. Importantly, Considine, Le Vasseur, and Charles (2002) assert that physiological data seemed to demonstrate the highest degree of objectivity and consistency in the triage context [35]. These findings provided useful evidence to support the basis upon which the TATTT is formulated.

### 1.2.10 Summary

Triage in an ED context constitutes the formal process of immediate assessment and categorisation of all patients who present seeking treatment [1]. In Australia, triage is predominantly a nursing role [7]. The triage nurse's primary role is the allocation of a triage category utilising the ATS. The complexity of the role and its primary function is well recognised [11,12].

Traditionally triage performance has been assessed with the aid of paper based scenarios of patient presentations. This common approach has known limitations. A comparative study of the relative merits of the different assessment approaches to triage performance has not been the subject of individual research to date.

Since the introduction of the ATS, a lack of consensus regarding its application has existed [3]. The lack of consistent application of the ATS has been clearly identified by several studies [3,13,19,20,23]. The use of subjective terminology, sentinel diagnoses and undefined criteria can be viewed as the potential aetiology of this variability. Inconsistencies in application produce inequities for patients in that patient's with the same complaint can receive different ratings from different nurses and/or different hospitals. This variability raises concerns regarding potential adverse patient outcomes which place the organisation at risk. Further more, inconsistencies in the application of the ATS limits opportunities to compare hospitals.

Algorithms can be utilised to provide decision support in the allocation of clinical urgency. The benefit of such an approach lies in the direction and structure they provide in guiding the decision making process [2]. There exist a number of algorithms available for guiding triage decision making. The algorithms examined however, contained some deficiencies consistent with those of the ATS. Also, their contextualisation to other health care systems poses challenges for their transferability to triage practice in Australia and one of the systems lacked prospective validation.

As has been identified there is a large amount of supportive evidence for the TATTT's construction and its various elements. The tool uses a standardised assessment approach commonly advocated for triage and incorporates many of the routine assessment components found to be influential in the triage decision process. As such, its viability as an alternative to current practice is worthy of investigation.

# 2.0 METHOD

## *2.1 Project Aims*

The primary aims of this project were to :

- Operationalise the TATTT;
- Determine the most appropriate strategy for simulating traige patients to allow validity and relibaility testing of the TATTT; and
- Commence this validity and reliability testing.

## *2.2 Research Questions*

The research questions were:

- Can the TATTT be successfully loaded onto a palm top computer for easy use?
- What training should be provided to the users of the TATTT package?
- Does the TATTT give different triage codes to patients than the ATS? If so, when and why does this occur?
- Which of the following simulations of patient presentations is most realistic and acceptable to triage nurses: written simulations, video taped simulations or computer-based simulations.
- Is the TATTT a valid tool for assisting the assignment of triage urgency?
- Is the TATTT a reliable tool?
- Do users (triage nurses) find the TATTT to be an acceptable tool for assisting in the assignment of triage urgency?

## *2.3 Principal Outcomes*

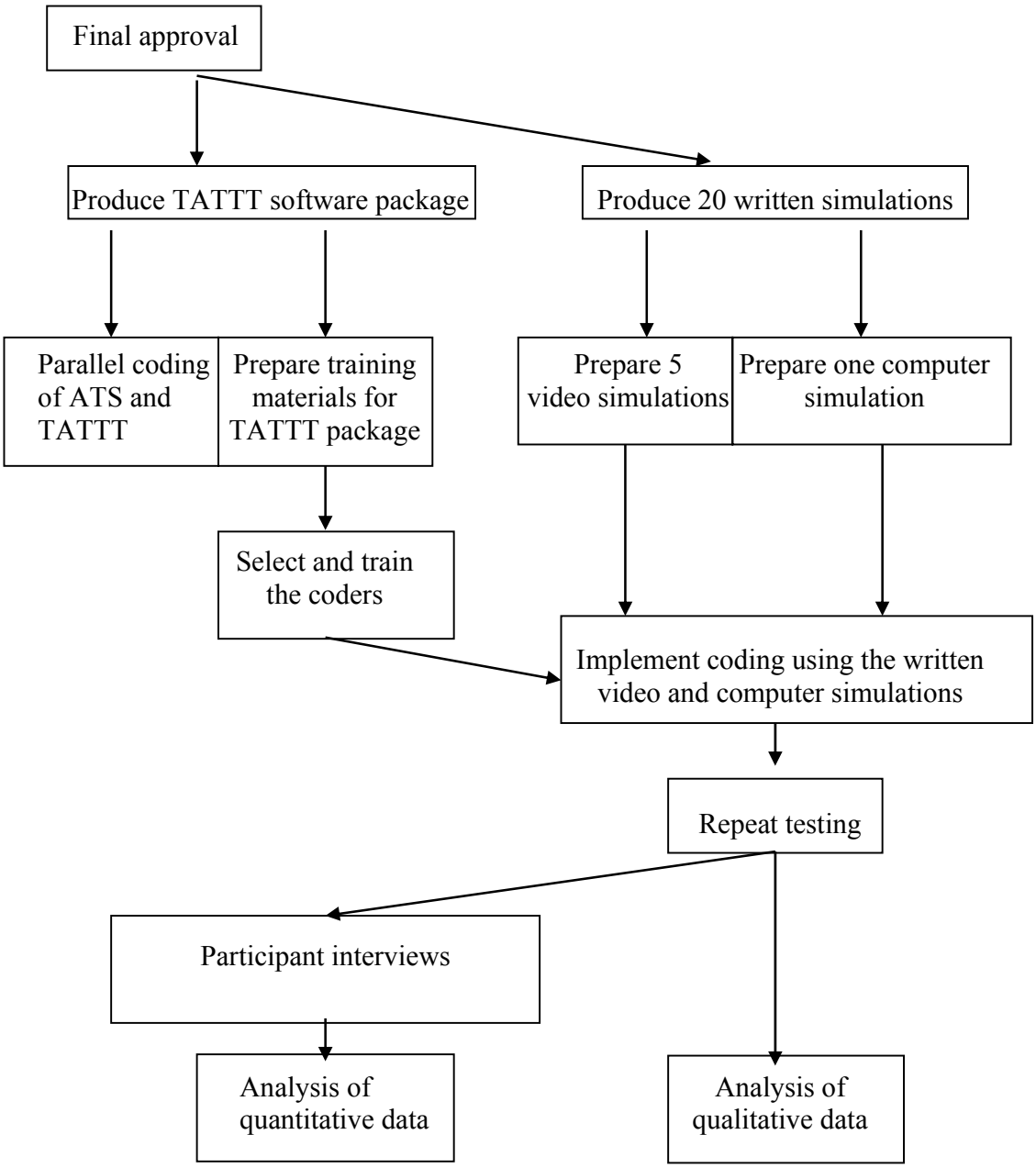
The anticipated outcomes of the project were:

- A computerised TATTT.
- The staff training package for the TATTT.
- A detailed evaluation of how best to test the reliability and validity of the TATTT in a larger scale study.
- Initial evaluation of the validity, reliability and acceptability of the TATTT.

## *2.4 Method*

Figure 2.1 is a flow chart of the main steps in this project. Methods used in each of these steps are detailed in the following pages.

**Figure 2.1: Summary of project steps**



### 2.4.1 Final approval

The study was funded by the Queensland Nursing Council and officially commenced on November 25, 2002. Ethics approval was obtained from the Toowoomba Health Service District and the University of Southern Queensland's Human Research and Ethics Committees.

### 2.4.2 Produce TATTT software

A computer package for the TATTT system was produced by J Wollaston, a member of the research team. The package was written in Visual Basic on a Pocket PC 2002 device running the Windows CE (Compact Edition) 3.0 operating system.

On entry to the TATTT package, users are asked to input their unique user code which was assigned to them by the research team. Each component item of the TATTT appeared as a separate screen. Users recorded the relevant answer for each component by highlighting the selection option with the stylus. Users were able to go to different screens via forward and back keys at the bottom of the screen.

The scoring algorithm was programmed into the package. The final triage score was displayed as soon as it was known. In the case of triage category 1 this may require the user to input just one piece of information. For other triage categories, the user was required to complete all TATTT components.

While considerable work was put into designing and formatting the user interface to be clear and professional, the data recording and collection facilities were more rudimentary. The user interface needed to be as finished as soon as possible to allow fair evaluation of the users' acceptance of the package. We had no justification for putting work into the 'back-end' of the program until the package was shown to be acceptable and useful.

Data were recorded in flat text files, one file per patient reviewed. In its current stage of development, considerable effort is still required to retrieve and compile these data.

### 2.4.3 Produce 20 written simulations

The written simulations formed the basis of all other simulations. Five were later developed into video simulations and one was developed into a computer simulation. Inspiration for the written simulations was obtained from actual case records of patients presenting to Toowoomba Health Service District Emergency Department. Details were altered to protect the confidentiality of actual patients and enhance the simulation as required.

Nine of these simulations were used as written simulations, five were converted into videos and one was converted into a computer simulation. The remaining five scenarios were 'spare'. In an after-thought to the original study plan, the spare scenarios were eventually used in testing the relative reliability of existing (ATS) triage coding practices.

### 2.4.4 Prepare five video simulations

Video simulations were produced with the assistance of the Distance Education Centre at the University of Southern Queensland. Five of the 20 written scenarios were selected for video and had full scripts worked up.

Five different patient presentations at an ED were simulated and video taped. The videos showed patients arriving at the ED and being interviewed by an (off-screen) triage nurse. The scenarios were filmed at the Toowoomba Health Service District Emergency Department at low demand times (early am). Scenarios were acted by a combination of professional actors and ED staff.

Respiratory rate and pulse rate cannot be measured directly by the viewer. To overcome this, the measurements were shown as input on a computer screen at the end of each video.

### 2.4.5 Prepare one computer simulation

The computer simulation was produced with the assistance of the Interactive Multi-Media group within the Distance Education Centre at the University of Southern Queensland. The simulation was produced in the computer program *Flash* and required the (free) flash viewer to be downloaded onto the computer before use.

The simulation was selected from the original 20 written scenarios for work-up into a computer simulation. The computer simulation provided footage of the patient's arrival by ambulance on a stretcher into the ED followed by an interrogation screen. The interrogation screen allows the user (triage nurse) to point and click on 14 different parts of the patient's body to obtain different measurements and readings (e.g. click on wrist to obtain pulse) and to point and click on any of 17 questions which will be answered by the patient. The patient was left on a bed for the triage nurse to approach. The user of the package could then interact with the patient either by taking clinical measurements or by conversing.

To obtain clinical measurements the user pointed and clicked on different parts of the patient's body with the mouse and then selected the measurement they sought. For example, pointing and clicking on the wrist bought up the option of measuring the pulse. Some of the physical measurements opened specific displays. For example, if the assessment of respiratory rate and effort was selected by clicking on the chest, a small clip illustrating the patient's breathing and quantification of the exact respiratory rate was displayed

To converse with the patient the users bought down a dialogue menu which provided a range of different questions or comments. The patient provided a response to each of these questions.

The computer simulation was stored on CD for easy transfer between coders. Again, the user interface was more 'finished' than the 'back end' of the program. However, the

package did produce a log file for each user. The log file recorded each measurement and conversation item selected by the users, the time spent viewing each of these items and the overall time from commencement to completion (assignment of the triage code).

### 2.4.6 Prepare training materials for the TATTT package

A training package was developed to introduce triage nurses to the computerised TATTT system. Training covered the TATTT tool, definitions of each component of the tool, the use of the palm top computer and practice at coding a written scenario. We believed that it was important to not only describe how the TATTT worked but also describe the philosophy and scientific underpinnings on which it was based. Special emphasis was put on components of the TATTT which were not generally incorporated into triage prior to TATTT and components of TATTT which although familiar, had a different interpretation on the TATTT than triage nurses may have been used to.

### 2.4.7 Select and train coders

As we did not require a random sample of coders for this initial investigation of the TATTT, we sought volunteers from among qualified triage nurses employed at the two hospitals involved in this study. Ten triage nurses from Toowoomba Health Service (THS) District and five from Princess Alexandra Hospital (PAH) in Brisbane were enrolled. Coders were paid for their time.

All coders enrolled in the study:

- underwent the TATTT training program;
- participated in coding the triage scenarios;
- provided feedback on the TATTT system and research process via participation in a semi structured individual interview with a member of the research team (DH).

Coders from Toowoomba District Health Service also participated in the parallel coding of the ATS and TATTT.

The self directed training package was provided to participants following administration of the five pre session written scenarios. The 22 page training package required approximately 20 – 30 minutes self directed reading time by participants prior to using the TATTT for rating the various triage simulations. Opportunity to clarify any misunderstandings with a member of the research team (AW) was provided prior to the rating session. Participants were also provided with a short self directed training package on the pocket PC application. This was followed up by a personal demonstration in the use of the pocket PC.

### 2.4.8 Parallel coding of ATS and TATTT

Between April 8, 2003 and May 15, 2003 one member of the research team (AW) parallel coded 59 adult trauma patients presenting to the ED at Toowoomba Health Service.

Patients were interviewed and their triage urgency coded by a triage nurse familiar with the ATS. The second triage coder (AW) watched this triage process and coded it using the TATTT on a palm held computer. The nurse conducting the interview was blind to the TATTT criteria and results (as they were unvalidated and could have distracted from appropriate decision making). AW attempted not to participate in the triage process, except where he believed an error was being made in which case he was ethically bound to discuss his concerns with the nurse conducting the interview.

Data from TATTT coding was stored in temporary, secure files until informed consent could be obtained from the patients involved. Where informed consent was not obtained within two weeks, the data were destroyed. Attempts to obtain informed consent were made in the ED waiting room if the patient was well enough or later in their hospitalisation where necessary. No attempt was made to include people who died or people who were immediately transferred to other hospitals. The proportion of patients for whom informed consent was obtained was 100%

### 2.4.9 Implement coding of written, video and computer simulations

The five coders from PAH all did their coding on the 13th of May 2003. Each attended the training session and then immediately moved on to coding the nine written, five video and one computer simulation in that order.

The ten coders from THS ED all did their coding between the 26th to the 29$^{th}$ of May 2003. Each attended the training session and then immediately moved on to coding the nine written, five video and one computer simulation in that order.

### 2.4.10 Repeat testing

All coders were asked to use the TATTT to recode the same 15 triage (nine written, five video and one computer) simulations one month later. Refresher training was not provided.

Repeat testing was conducted on the 10th of June 2003, for all five coders from PAH, and between the 23$^{rd}$ and the 26$^{th}$ of June for all ten coders from THS. Data were successfully obtained from all 15 coders for all 15 simulations.

### 2.4.11 Interviews with coders

After the completion of the repeat testing session, all 15 coders participated in a semi structured individual interview which focussed on their opinions of the TATTT; the ease of use of the TATTT software; the ease of use of the pocket PC; and their participation in the research project in general. All interviews were conducted by a member of the research team (DH) and lasted approximately 30 minutes. Interviews were tape-recorded and later transcribed verbatim.

### 2.4.12 Analysis of qualitative data

Qualitative data were produced from each individual participant interview. Following transcription, the tape was checked against the transcription to ensure the transcription was accurate. The aim of the data analysis was to identify common themes emerging from the data using six cycles: content analysis; coding of interview texts; comparison through indexing; re-analysis through further text search; re-interpretation of the data; and reconfirming preliminary analysis.

### 2.4.13 Analysis of quantitative data

Sources of quantitative data in this study were:

- The parallel coding of real patients using the TATTT and ATS;
- The coding and recoding of the 15 triage simulations using the TATTT;
- The log file on the usage and timing of the computer simulation; and
- Some practice (pre-intervention) coding of the 5 spare written scenarios using the current (ATS) coding system.

The main focus of the quantitative analysis was on describing the reliability and validity of the TATTT and each component of the TATTT. Other analyses reported below include a description of the functioning of the computer simulation obtained from analysing the log files of this simulation and a description of the inter-coder reliability of current (ATS) coding practices from the five spare written scenarios.

A first impression of validity of the TATTT was obtained by examining the agreement between ATS and TATTT. Quantitative measures of agreement were obtained using percentage agreement and kappa statistics (with associated 95% confidence intervals). Further information was provided by a detailed clinical review of every patient in which the TATTT and ATS codes differed. Where kappa values were low, indicating lack of agreement, a test for bias (based on McNemar's test[*]) was used to determine the direction of the disagreement. Inter-rater reliability was described using descriptive statistics and measured against a 'gold-standard' triage category for each simulation provided by the

[*] For the following frequency table of matched pairs data

| | | Measure 2 | | | |
|---|---|---|---|---|---|
| | | Level 1 | Level 2 | Level $k$ | Total |
| Measure 1 | Level 1 | $n_{11}$ | $n_{12}$ | $n_{1k}$ | $n_{1.}$ |
| | Level 2 | $n_{21}$ | $n_{22}$ | $n_{2k}$ | $n_{2.}$ |
| | Level $k$ | $n_{k1}$ | $n_{k2}$ | $n_{kk}$ | $n_{k.}$ |
| | Total | $n_{.1}$ | $n_{.2}$ | $n_{.k}$ | $n_{..}$ |

The extension to McNemar's test used is given by:

$$\chi^2 = \sum\sum_{i<j} \left[\left(n_{ij} - n_{ji}\right)^2 / \left(n_{ij} + n_{ji}\right)\right]$$

with $k(k-1)/2$ degrees of freedom.

research team. Inter-rater reliability was measured using percentage agreement, kappa statistics and 95% confidence intervals for kappa. It was measured across the 15 coders on:

a) the coding of the nine written scenarios using the TATTT;
b) the coding of the five video simulations using the TATTT;
c) the coding of the computer simulation using the TATTT; and
d) the re-codes of the a), b), and c) one month later.

Intra-rater reliability was measured by comparing initial codes with one-month re-codes of the same scenarios for each of the 15 coders. Intra-rater reliability was measured using percentage agreement, kappa statistics and 95% confidence intervals for kappa.

Percentage agreement over estimates reliability because it does not correct for chance (accidental) agreement between coders. The kappa statistic quantifies agreement after correction for chance. A kappa value of 0 suggests that the agreement observed could have arisen purely through chance, negative values of kappa suggest agreement levels worse than chance and positive values suggest agreement greater than chance. A kappa value of 1 means perfect agreement. Kappa values of 0.6 or above are deemed by the ACEM to be desirable in triage [5]. The 95% confidence interval for kappa was calculated using the formula provided in Fleiss (1981) [49].

Weighted kappa is used to give a greater penalty to more discordant pairs. That is, triage categories of 3 and 5 for the same patient are more discordant than triage categories of 4 and 5 for the same patient. In this study there were two few pairs differing by more than one triage category, to justify the use of weighted kappas.

All other analyses were conducted using descriptive methods.

## *2.5 Limitations of the Study*

The limitations on this study mainly relate to scope: only 15 coders from only 2 hospitals rated only 1 computer, 5 video and 9 written simulations. The coders were not randomly selected. Being interested in research, they may have been more open to new ideas, etc.

Data was largely complete – with just one coder missing one simulation and one computer simulation log file being lost.

Kappa is not sample size dependent (the confidence interval formula does have sample size requirements but we chose as good an approximation as possible).

Participant feedback was collected by a neutral academic nurse who had no links to triage or hospital management.

## *2.6 Results of Quantitative Data Analysis*

### 2.6.1 Parallel coding

Between April 8, 2003 and May 15, 2003 one member of the research team (AW) parallel coded 59 adult trauma patients presenting to the Emergency Department at Toowoomba Health Service. In a subsequent clinical review of all cases, one was excluded as not meeting the inclusions criteria as a trauma patient. While this person had experienced some trauma (stood on a nail), the primary purpose of their presentation to the ED was to seek medication (a tetanus shot) rather than clinical evaluation of their injury.

The agreement between the triage category assigned using existing triage practices and the triage category assigned by the TATTT (operated by AW) are summarised in Table 2.1. The overall percentage agreement between the two Triage systems was approximately 47% with an estimated kappa of $\hat{\kappa} = 0.19$ (95% confidence interval [-0.02, 0.40]).

**Table 2.1: Comparison of triage ratings from parallel coding using existing practices and the TATTT**

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| **Existing triage practice (Multiple coders)** | 1 | | 1 | | | | 1 |
| | 2 | | 1 | | | | 1 |
| | 3 | | 7 | 9 | 2 | | 18 |
| | 4 | | 1 | 14 | 17 | 6 | 38 |
| | 5 | | | | | | |
| | Total | | 10 | 23 | 19 | 6 | 58 |

In total 27 of the 58 patients (47%) received the same triage rating on both methods, 22 (38%) received a more urgent rating on the TATTT than on existing methods and nine (16%) received a less urgent rating on the TATTT than on existing methods. The test for bias produced statistically significant evidence of a bias towards more urgent coding on the TATTT ($\chi^2$=24, df=10, p<0.01).

#### *2.6.1.1 Variation in agreement between triage nurses*

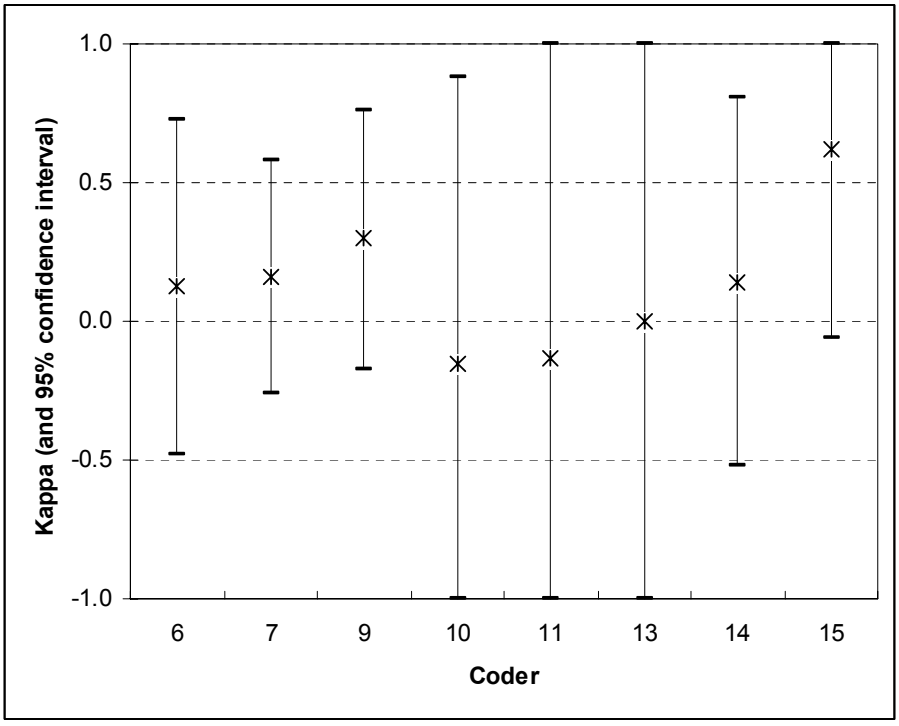
The parallel coding was conducted against eight different triage nurses at Toowoomba Health Service. The number of patients coded against each nurse ranged from 17 to three. It is possible that different nurses have different triage practices, in which case, the combined frequency table above would not provide a valid summary of overall agreement. Stratifying the above analysis by coder we obtained the results summarised in Table 2.2. The frequency tables underlying these analyses are provided in Appendix 1.

**Table 2.2: Comparison of triage ratings from each coder with the TATTT**

| Coder | Patients | % agreement | kappa statistic |
|---|---|---|---|
| 6 | 7 | 57% | 0.13 |
| 7 | 17 | 47% | 0.16 |
| 9 | 10 | 50% | 0.30 |
| 10 | 6 | 17% | -0.13 |
| 11 | 3 | 0% | -0.15 |
| 13 | 4 | 50% | 0.00 |
| 14 | 6 | 50% | 0.15 |
| 15 | 5 | 80% | 0.62 |

From Table 2.2 we can see that there appears to be considerable variation between coders in their agreement with the TATTT codes (ranging from 0% to 80% agreement or from -0.15 to 0.62 in estimated kappa). However, the sample sizes for each of the analyses are very small and these differences are all consistent with chance. For example, Figure 2.2 shows that all confidence intervals cross each other (implying no statistically significant differences between results from different coders). We conclude that the variation in agreement between coders may have been caused by variation in patient caseload (or other day-to-day factors).

**Figure 2.2: Kappa statistics and associated 95% confidence intervals for agreement between each coder's Triage ratings and the TATTT**




### *2.6.1.2 In what areas does the TATTT differ from existing triage processes?*

As previously noted, the TATTT provided a higher urgency rating for 22 (38%) of the patients and a lower urgency rating for nine (16%) patients. In this analysis we attempted

to determine which components of the TATTT were most commonly associated with the differences between the TATTT and existing triage processes.

Two way tables of the relationship between the direction of difference in triage ratings and each component of the TATTT are provided in Appendix 2. Given the relatively small sample size and the unequal number of observations per coder (unequal weightings), the results are, at best, only indicative of possible relationships. Further research will be needed to confirm these results.

The possible relationships are:

- *Respiratory Effort:* Patients with mildly decreased or increased respiratory effort were more likely to receive a more urgent code from the TATTT (compared to existing triage processes) than were patients with normal respiratory effort.
- *Pulse Rate*: Patients with raised or lowered pulse rates were more likely to receive a more urgent code from the TATTT (compared to existing triage processes) than were patients with normal pulse rates.
- *Pain Score:* Patients with higher pain scores were more likely to receive a more urgent code from the TATTT (compared to existing triage processes) than were patients with lower pain scores.
- *Condition of Extremities:* Patients with loss of sensation or deformity were more likely to receive a more urgent code from the TATTT (compared to existing triage processes) than were patients without.

### 2.6.2 Overall TATTT coding of simulations

In total, the fifteen coders were required to code each of the fifteen simulations on two separate occasions one month apart. It appears one coder accidentally missed coding one of the written simulations on the first occasion. Table 2.3 summarises the overall test-retest reliability for all simulations for which we have data.

**Table 2.3: Overall test-retest agreement across all coders and all simulations**

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | |
| **Initial triage category** | 1 | 22 | 6 | 0 | 0 | 0 | 28 |
| | 2 | 1 | 44 | 1 | 0 | 0 | 46 |
| | 3 | 1 | 0 | 62 | 15 | 0 | 78 |
| | 4 | 0 | 0 | 6 | 52 | 0 | 58 |
| | 5 | 0 | 0 | 0 | 0 | 14 | 14 |
| **Total** | | 24 | 50 | 69 | 67 | 14 | 224 |

The overall percentage agreement is 87%. The overall kappa statistic is 0.82 with a 95% confidence interval from 0.76 to 0.88.

For each triage nurse who participated in the study we have test and re-test data on each of the 15 scenarios. The results are shown in Appendix 3 and summarised in Table 2.4.

We can use this to determine whether there is any difference in coding consistency between individuals. As all confidence intervals cross, we conclude that there is no statistically significant evidence of differences in coding reliability between coders.

**Table2. 4: Summary of intra-rater agreement for each coder**

| Coder number | % agreement | Reliability (kappa) | 95% confidence interval |
|---|---|---|---|
| 1 | 93% | 0.91 | 0.74 to 1.00 |
| 2 | 80% | 0.73 | 0.46 to 0.99 |
| 3 | 87% | 0.82 | 0.59 to 1.00 |
| 4 | 80% | 0.73 | 0.45 to 1.00 |
| 5 | 100% | 1.00 | n/a |
| 6 | 80% | 0.74 | 0.48 to 1.00 |
| 7 | 93% | 0.91 | 0.75 to 1.00 |
| 8 | 87% | 0.82 | 0.58 to 1.00 |
| 9 | 79% | 0.72 | 0.44 to 1.00 |
| 10 | 93% | 0.91 | 0.74 to 1.00 |
| 11 | 100% | 1.00 | n/a |
| 12 | 87% | 0.82 | 0.60 to 1.00 |
| 13 | 73% | 0.64 | 0.33 to 0.95 |
| 14 | 80% | 0.74 | 0.46 to 1.00 |
| 15 | 87% | 0.82 | 0.59 to 1.00 |

We also compared each coder's responses to the responses the research team expected. Table 2.5 summarises the results for all coders for all simulations and for Princess Alexandra coders against Toowoomba coders on both the initial coding and on the re-test. It can be seen that the main areas of variation were 'High Risk Mechanisms', 'External Bleeding', 'Respiratory Effort' and 'Appearance of Skin'. These variations seem to be consistent across hospital and test occasion.

**Table 2.5: Number of deviations from expected codes on each element of the TATTT by hospital**

| | Princess Alexandra | | Toowoomba Base | | Total |
|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | |
| **Triage score** | 12/75 (16%) | 16/75 (21%) | 20/149 (13%) | 14/150 (9%) | 62/449 (14%) |
| **Airway** | 1/75 (1%) | 0/75 (0%) | 0/149 (0%) | 0/150 (0%) | 1/449 (0%) |
| **Respiratory Rate** | 0/75 (0%) | 0/75 (0%) | 1/149 (1%) | 0/150 (0%) | 1/449 (0%) |
| **Respiratory Effort** | 7/75 (9%) | 7/75 (9%) | 9/149 (6%) | 11/150 (7%) | 34/449 (8%) |
| **Pulse Rate** | 0/75 (0%) | 0/75 (0%) | 1/149 (1%) | 1/150 (1%) | 2/449 (0%) |
| **Appearance of Skin** | 5/75 (7%) | 7/75 (9%) | 7/149 (5%) | 10/150 (7%) | 29/449 (6%) |
| **External Bleeding** | 7/75 (9%) | 12/75 (16%) | 18/149 (12%) | 21/150 (14%) | 58/449 (13%) |
| **Neurological Status** | 0/75 (0%) | 0/75 (0%) | 0/149 (0%) | 0/150 (0%) | 0/449 (0%) |
| **Pain Score** | 0/75 (0%) | 0/75 (0%) | 2/149 (1%) | 3/150 (2%) | 5/449 (1%) |
| **Condition of Extremities** | 3/75 (4%) | 1/75 (1%) | 3/149 (2%) | 0/150 (0%)0 | 7/449 (2%) |
| **High Risk Mechanisms** | 13/75 (17%) | 20/75 (27%) | 31/149 (21%) | 27/150 (18%) | 91/449 (20%) |

These analyses were further broken down to the level of individual coders to check that the variation was consistent across all coders. The results are presented in Appendix 7. Suffice to say, we observed no systematic differences in coding patterns between individuals.

Of course, it is possible that these results in this section will differ between simulation type and even individual simulations. The next sections present analyses by simulation type and individual simulation.

### 2.6.3 TATTT coding of the computer simulation

All 15 coders applied the TATTT to the computer simulation on two separate occasions, one month apart. The results are summarised in Table 2.6.

**Table 2.6: Agreement attained using the TATTT on the computer simulation.**

| | | Triage category one month later | | Total |
|---|---|---|---|---|
| | | 3 | 4 | |
| **Initial triage** | 3 | 12 | 1 | 13 |
| **category** | 4 | 2 | 0 | 2 |
| **Total** | | 14 | 1 | 15 |

From Table2.6 we can see:

- 13 of the 15 coders (87%) rated the simulated patient as category 3 on the initial triage
- 14 of the 15 coders (93%) rated the simulated patient as category 3 on the re-test

The overall test-retest agreement was 80% (12 out of 15) but the kappa statistic was only $\hat{\kappa} = -0.10$ with an associated 95% confidence interval of -0.53 to 0.33. The low kappa is a product of the lack of variability in the scenario. That is, as there is strong agreement that the 'correct' rating of 3, any deviation from this has a large impact on the kappa statistic.

All three instances in which a triage code of 4 was recorded occurred with Toowoomba triage nurses.

We also looked at the reliability of the individual components of the TATTT. Agreement with the 'correct' result for individual components (as determined by the study team) ranged from 100% to 80%. Tables 2.7a) to 2.7d) show where these differences occurred. Table 2.8 summarises the disagreements.

**Table 2.7a: Variation in coding in Respiratory Rate.**

| | | Code on re-test | | Total |
|---|---|---|---|---|
| | | 13-14; 21-24 | 15-20 | |
| **Code on initial viewing** | 13-14; 21-24 | 12 | 1 | 13 |
| | 15-20 | 0 | 2 | 2 |
| **Total** | | 12 | 3 | 15 |

**Table 2.7b: Variation in coding in Pain Score.**

| | | Code on re-test | | Total |
|---|---|---|---|---|
| | | 5-6 | 3-4 | |
| **Code on initial viewing** | 3-4 | 1 | 13 | 14 |
| | 0-2 | 0 | 1 | 1 |
| **Total** | | 1 | 14 | 15 |

**Table 2.7c: Variation in coding in Condition of Extremity.**

| | | Code on re-test | | Total |
|---|---|---|---|---|
| | | Loss of sensation /deformity | Normal | |
| **Code on initial viewing** | normal | 1 | 14 | 15 |
| **Total** | | 1 | 14 | 15 |

**Table 2.7d: Variation in coding in High Risk Mechanisms.**

| | | Code on re-test | | Total |
|---|---|---|---|---|
| | | High risk | Not high risk | |
| **Code on initial viewing** | High risk | 12 | 1 | 13 |
| | Not high risk | 2 | 0 | 2 |
| **Total** | | 14 | 1 | 15 |

**Table 2.8: Number of 'incorrect' codes using the computer simulation**

| | Initial test | Re-test | % error |
|---|---|---|---|
| Triage score | 2 | 1 | 3/30 (10%) |
| Airway | 0 | 0 | 0/30 (0%) |
| Respiratory Rate | 0 | 0 | 0/30 (0%) |
| Respiratory Effort | 2 | 3 | 5/30 (17%) |
| Pulse Rate | 0 | 0 | 0/30 (0%) |
| Appearance of Skin | 0 | 0 | 0/30 (0%) |
| External Bleeding | 0 | 0 | 0/30 (0%) |
| Neurological Status | 0 | 0 | 0/30 (0%) |
| Pain Score | 1 | 1 | 2/30 (7%) |
| Condition of Extremities | 0 | 1 | 1/30 (3%) |
| High Risk Mechanisms | 2 | 1 | 3/30 (10%) |

More detailed analyses of how the coders interacted with the computer simulation are provided in Appendix 4. The most important finding of this analysis was that the triage nurses appear tempted to explore more clinical investigations on the computer simulation than they would actually do for a real life patient.

### 2.6.4 TATTT coding of the video simulations

All 15 triage nurses were asked to rate each of the five videos using the TATTT. The initial code was conducted in April, 2003 and a repeat, re-test coding was conducted one month later in May, 2003.

One triage nurse coded one of the videos twice, one immediately after the other. On the second coding the 'Condition of Skin' was changed from 'Pale warm and dry' to 'Pale cool and dry' and 'External Bleeding' was changed from 'Large Venous / Small Arterial: uncontrolled' to 'Large Venous / Small Arterial: controlled' The net effect was to change the TATTT triage code from 3 to 2. Assuming the double coding was used to correct errors, the first recording is deleted from the data set and the second recording retained.

The overall agreement attained using the TATTT on the videoed simulations is summarised in Table 2.9. The percentage agreement is 81.3% and the kappa statistic is 0.76 with an associated 95% confidence interval of [0.65, 0.87].

**Table 2.9: Overall agreement obtained using the TATTT on the video simulation.**

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| **Initial triage category** | 1 | 7 | 5 | 0 | 0 | 0 | 12 |
| | 2 | 1 | 15 | 1 | 0 | 0 | 17 |
| | 3 | 1 | 0 | 6 | 4 | 0 | 11 |
| | 4 | 0 | 0 | 2 | 19 | 0 | 21 |
| | 5 | 0 | 0 | 0 | 0 | 14 | 14 |
| **Total** | | 9 | 20 | 9 | 23 | 14 | 75 |

This analysis can be broken down further to determine: a) whether results differed by video; b) which of the individual components of the TATTT are reliable or unreliable; and c) whether results differed by coder.

*a) Differences between videos*

Coders' TATTT ratings of each video simulation were compared to the rating expected by the research team (i.e. those ratings which the research team believed to be correct). These results, together with kappa statistics for the test-retest reliability for each video, are summarised in Table 2.10. Full details are provided in Appendix 5.

**Table 2.10: Summary of agreements obtained on the video simulations**

| Video number | Expected triage | Agreement, time 1 | Agreement, time 2 | Reliability (kappa) | 95% confidence interval |
|---|---|---|---|---|---|
| 1 | 1 | 10/15 | 7/15 | 0.29 | -0.16 to 0.74 |
| 2 | 2 | 13/15 | 13/15 | 0.42 | -0.24 to 1.00 |
| 3 | 3 | 6/15 | 6/16 | 0.44 | -0.02 to 0.91 |
| 4 | 4 | 14/15 | 12/15 | 0.44 | -0.23 to 1.00 |
| 5 | 5 | 14/15 | 14/15 | 1.00 | n/a |

From Table 2.10 it can be seen that there were considerable disagreements between the expected triage code and those actually produced by the triage nurses. Estimated kappa values are provided for the test-retest reliability on each video. However, as the width of the confidence intervals demonstrates, the sample size is too small to produce any reliable estimates.

b*) Which components of the TATTT are reliable or unreliable?*

Table 2.11 displays additional information on the sources of the disagreements between the coders and research team's ratings of the video simulations. It displays disagreements on each individual component of the TATTT. The table highlights difficulties in the coding of:

- 'external bleeding' on videos 1, 2 and 5;
- 'high risk mechanisms' on video 3;
- 'respiratory effort' on video 2; and
- 'appearance of skin' on videos 1 and 2.

*c) Differences between coders*

To investigate whether some coders or groups of coders used the TATTT differently to others on the video simulations we looked at disagreements between individual coders and the research team. Table 2.12 displays results for coders according to which hospital they work at. Equivalent results for each individual coder can be found in Appendix 7.

From Table 2.12 we can see there is no systematic difference in use of TATTT associated with hospital.

**Table 2.11: Number of disagreements between coders and research team on each element of the TATTT for the video simulations**

| | Video 1 | | Video 2 | | Video 3 | | Video 4 | | Video 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **% error** |
| Triage score | 5 | 8 | 2 | 2 | 9 | 9 | 3 | 1 | 1 | 1 | 41/150 (27%) |
| Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/150 (0%) |
| Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/150 (0%) |
| Respiratory Effort | 1 | 2 | 12 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 27/150 (18%) |
| Pulse Rate | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2/150 (1%) |
| Appearance of Skin | 3 | 6 | 3 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 21/150 (14%) |
| External Bleeding | 5 | 9 | 10 | 11 | 0 | 0 | 10 | 13 | 0 | 0 | 58/150 (39%) |
| Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/150 (0%) |
| Pain Score | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1/150 (1%) |
| Condition of Extremities | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2/150 (1%) |
| High Risk Mechanisms | 1 | 5 | 2 | 0 | 9 | 9 | 3 | 1 | 1 | 1 | 32/150 (21%) |

**Table 2.12 Number of disagreements on each element of the TATTT for the video simulations by hospital**

| | Princess Alexandra | | Toowoomba Base | | Total | |
|---|---|---|---|---|---|---|
| | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **Initial test** | **Re-test** |
| Triage score | 8/25 (32%) | 10/25 (40%) | 12/50 (24%) | 11/50 (22%) | 20/75 (27%) | 21/75 (28%) |
| Airway | 0/25 (0%) | 0/25 (0%) | 0/50 (0%) | 0/50 (0%) | 0/75 (0%) | 0/75 (0%) |
| Respiratory Rate | 0/25 (0%) | 0/25 (0%) | 0/50 (0%) | 0/50 (0%) | 0/75 (0%) | 0/75 (0%) |
| Respiratory Effort | 5/25 (20%) | 4/25 (16%) | 8/50 (16%) | 10/50 (20%) | 13/75 (17%) | 14/75 (19%) |
| Pulse Rate | 0/25 (0%) | 0/25 (0%) | 1/50 (2%) | 1/50 (2%) | 1/75 (1%) | 1/75 (1%) |
| Appearance of Skin | 3/25 (12%) | 6/25 (24%) | 4/50 (8%) | 8/50 (16%) | 7/75 (9%) | 14/75 (19%) |
| External Bleeding | 7/25 (28%) | 12/25 (48%) | 18/50 (36%) | 21/50 (42%) | 25/75 (33%) | 33/75 (44%) |
| Neurological Status | 0/25 (0%) | 0/25 (0%) | 0/50 (0%) | 0/50 (0%) | 0/75 (0%) | 0/75 (0%) |
| Pain Score | 0/25 (0%) | 0/25 (0%) | 0/50 (0%) | 1/50 (2%) | 0/75 (0%) | 1/75 (1%) |
| Condition of Extremities | 1/25 (4%) | 0/25 (0%) | 1/50 (2%) | 0/50 (0%) | 2/75 (3%) | 0/75 (0%) |
| High Risk Mechanisms | 5/25 (20%) | 7/25 (28%) | 9/50 (18%) | 9/50 (18%) | 14/75 (19%) | 16/75 (21%) |

### 2.6.5 TATTT coding of the written scenarios

All 15 triage nurses were asked to rate each of the nine written scenarios using the TATTT. One triage nurse did not code the third written scenario (or the results of coding were lost). In two instances, the coder recorded the wrong code number for the video. These have been corrected in the data set. In three instances, a coder immediately re-coded the same video (presumably they made a mistake the first time or wanted to check their answers). Two of these recodes were identical to the first code. One coder changed 'extremities' from a 'present' to 'absent' but got the same overall triage code. Assuming the double coding was used to correct errors, the first recording has been deleted from the data set in each of these cases

The overall agreement attained using the TATTT on the written simulations is summarised in Table 2.13. The percentage agreement is 90.3% and the kappa statistic is 0.86 with an associated 95% confidence interval of [0.79, 0.94].

**Table 2.13: Overall agreement between two time periods on all 9 written scenarios**

| | | Triage category one month later | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| Initial triage category | 1 | 15 | 1 | 0 | 0 | 16 |
| | 2 | 0 | 29 | 0 | 0 | 29 |
| | 3 | 0 | 0 | 44 | 10 | 54 |
| | 4 | 0 | 0 | 2 | 33 | 35 |
| Total | | 15 | 30 | 46 | 43 | 134 |

This analysis can be broken down further to determine:

a) whether results differed from simulation to simulation;
b) which of the individual components of the TATTT are reliable or unreliable;
c) whether coding differed by coder.

*a) Differences between simulations*

Coder's TATTT ratings of each written simulation were compared to the rating expected by the research team. These results, together with kappa statistics for the test-retest reliability for each simulation, are summarised in Table 2.14. Full details of these analyses are provided in Appendix 6.

**Table 2.14: Summary of agreements obtained on the written scenarios**

| Written scenario number | Expected triage | Agreement, time 1 | Agreement, time 2 | Reliability (kappa) | 95% confidence interval |
|---|---|---|---|---|---|
| 1 | 3 | 15/15 | 11/15 | 0.00 | -1.00 to 1.00 |
| 2 | 4 | 10/15 | 12/15 | 0.33 | -0.21 to 0.88 |
| 3 | 3 | 14/14 | 14/14 | 1.00 | n/a |
| 4 | 4 | 15/15 | 15/15 | 1.00 | n/a |
| 5 | 5 | 15/15 | 15/15 | 1.00 | n/a |
| 6 | 2 | 14/15 | 15/15 | 0.00 | -1.00 to 1.00 |
| 7 | 1 | 15/15 | 15/15 | 1.00 | n/a |
| 8 | 4 | 11/15 | 13/15 | 0.19 | -0.44 to 0.81 |
| 9 | 2 | 15/15 | 15/15 | 1.00 | n/a |

From Table 2.14 it can be seen that there was much less disagreement between the expected triage code and those actually produced by the triage nurses than there was for the video simulations. Estimated kappa values are provided for the test-retest reliability on each video. However, as the confidence intervals demonstrate, the sample size is too small to produce any reliable estimates.

*b) Which components of the TATTT are reliable or unreliable?*

Table 2.15 displays additional information on the sources of the disagreements between the coders and the research team's ratings of the written simulations. It displays disagreements on each individual component of the TATTT. The table highlights the reliability of the coding from written scenarios, except for 'High Risk Mechanisms' (particularly in simulation nine). The only potential area of confusion was the coding of 'appearance of skin' in written scenario six.

It may be argued that the written scenarios allow too little variation in interpretations to provide a realistic simulation of a triage patient.

*c) Differences between coders*

To investigate whether some coders or groups of coders used the TATTT differently to other s on the written simulations we looked at disagreements between individual coders and the research team. Table 2.16 displays results for coders according to which hospital they work at. Results for each individual coder are presented in Appendix 7.

From Table 2.16 we can see there is no systematic difference in use of TATTT associated with hospital.

**Table 2.15: Number of 'incorrect' codes using the written simulations**

| | Written scenario 1 | | Written scenario 2 | | Written scenario 3 | | Written scenario 4 | | Written scenario 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test (n=14) | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 0 | 4 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| - External Bleeding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - High Risk Mechanisms | 0 | 4 | 4 | 3 | 0 | 0 | 6 | 8 | 0 | 0 |

| | Written scenario 6 | | Written scenario 7 | | Written scenario 8 | | Written scenario 9 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | % error |
| Triage score | 1 | 0 | 0 | 0 | 4 | 2 | 0 | 0 | 19/269 (7%) |
| - Airway | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1/269 (0%) |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1/269 (0%) |
| - Respiratory Effort | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2/269 (1%) |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/269 (0%) |
| - Appearance of Skin | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 8/269 (3%) |
| - External Bleeding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/269 (0%) |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0/269 (0%) |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2/269 (1%) |
| - Condition of Extremities | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4/269 (1%) |
| - High Risk Mechanisms | 0 | 0 | 0 | 0 | 4 | 2 | 14 | 13 | 58/269 (22%) |

**Table 2.16: Number of disagreements on each element of the TATTT for the written simulations by hospital**

| | Princess Alexandra | | Toowoomba Base | | Total | |
|---|---|---|---|---|---|---|
| | **Initial test** | **Re-test** | **Initial test** | **Re-test** | **Initial test** | **Re-test** |
| Triage score | 4/45 (9%) | 6/45 (13%) | 6/89 (7%) | 3/90 (3%) | 10/134 (7%) | 9/135 (7%) |
| - Airway | 1/45 (2%) | 0/45 (0%) | 0/89 (0%) | 0/90 (0%) | 1/134 (1%) | 0/135 (0%) |
| - Respiratory Rate | 0/45 (0%) | 0/45 (0%) | 1/8 9(1%) | 0/90 (0%) | 1/134 (1%) | 0/135 (0%) |
| - Respiratory Effort | 1/45 (2%) | 1/45 (2%) | 0/89 (0%) | 0/90 (0%) | 1/134 (1%) | 1/135 (1%) |
| - Pulse Rate | 0/45 (0%) | 0/45 (0%) | 0/89 (0%) | 0/90 (0%) | 0/134 (0%) | 0/135 (0%) |
| - Appearance of Skin | 2/45 (4%) | 1/45 (2%) | 3/89 (3%) | 2/90 (2%) | 5/134 (4%) | 3/135 (2%) |
| - External Bleeding | 0/45 (0%) | 0/45 (0%) | 0/89 (0%) | 0/90 (0%) | 0/134 (0%) | 0/135 (0%) |
| - Neurological Status | 0/45 (0%) | 0/45 (0%) | 0/89 (0%) | 0/90 (0%) | 0/134 (0%) | 0/135 (0%) |
| - Pain Score | 0/45 (0%) | 0/45 (0%) | 1/89 (1%) | 2/90 (2%) | 1/134 (1%) | 2/135 (1%) |
| - Condition of Extremities | 2/45 (4%) | 0/45 (0%) | 2/89 (2%) | 0/90 (0%) | 4/134 (3%) | 0/135 (0%) |
| - High Risk Mechanisms | 8/45 (18%) | 13/45 (29%) | 20/89 (22%) | 17/90 (19%) | 28/134 (21%) | 30/135 (22%) |

### 2.6.6 ATS coding of written simulations

Of the original 20 simulations one was converted to a computer simulation, five were converted to video simulations and 14 were left as written simulations. Nine of the 14 written simulations were selected at random for testing the TATTT while the remaining five were left as 'spare'.

Given this opportunity, we decided to address an additional research question: 'Is TATTT coding more reliable than the existing ATS codes?'

All 15 coders were asked to code the five spare written scenarios using their existing techniques and knowledge before they received any training on the TATTT. The results are shown in Table 2.17. The data in Table 2.17 show that there is considerable difference in coding of written scenarios under the current ATS system. None of the five simulations received full agreement across all 15 coders. Three of the five simulations showed close to 50:50 spreads across two triage categories and one simulation had results spread across 3 triage categories.

**Table 2.17 Coding of written scenarios using the ATS**

| Simulation | ATS triage code | | | | | Total |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| w10 | 0 | 9 | 6 | 0 | 0 | 15 |
| w11 | 0 | 0 | 8 | 7 | 0 | 15 |
| w12 | 10 | 4 | 1 | 0 | 0 | 15 |
| w13 | 13 | 2 | 0 | 0 | 0 | 15 |
| w14 | 0 | 0 | 7 | 8 | 0 | 15 |
| Total | 23 | 15 | 22 | 15 | 0 | 75 |

Data from the TATTT coding of the other nine written scenarios appear to be much more consistent. Five of the nine simulations recorded full agreement across all 15 coders and none varied across more than two triage codes.

**Table 2.18 Coding of written scenarios using the TATTT**

| Simulation | TATTT triage code | | | | | Total |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| w1 | 0 | 0 | 15 | 0 | 0 | 15 |
| w2 | 0 | 0 | 5 | 10 | 0 | 15 |
| w3 | 0 | 0 | 0 | 14 | 0 | 14 |
| w4 | 0 | 0 | 15 | 0 | 0 | 15 |
| w5 | 0 | 0 | 15 | 0 | 0 | 15 |
| w6 | 1 | 14 | 0 | 0 | 0 | 15 |
| w7 | 15 | 0 | 0 | 0 | 0 | 15 |
| w8 | 0 | 0 | 4 | 11 | 0 | 15 |
| w9 | 0 | 15 | 0 | 0 | 0 | 15 |
| Total | 16 | 29 | 54 | 35 | 0 | 134 |

Of course, we cannot resolve whether this difference in coding patterns is caused by the TATTT, the training or some combination of the two.

### 2.6.7 Summary of results from quantitative analyses

Overall we have shown that the levels of reliability for the TATTT coding to be high. We have raised the possibility that the reliability is perhaps an artefact of the use of simulations. None of the three forms of simulation used were able to fully test 'real life' clinical observation or communication skills.

The computer simulation provided very rich data but was limited to a single simulation by cost. There was some indication that users were 'playing with' all of the functionality of the computer simulation rather than concentrating on the questions and tests relevant to the particular simulation.

The video simulations provide some opportunity to test clinical judgement in areas such as 'high risk mechanisms' but could be criticised for actually contributing to the variation in responses to 'appearance of skin', 'respiratory effort' and 'external bleeding'. The videos provided no direct information on 'real world' variation in triage nurses' clinical measurements such as the measurement of pulse rates or pain levels.

The written scenarios also provided the opportunity to variation in coding of 'high risk mechanisms' but all other components of the TATTT were provided in an artificially direct form.

The parallel coding showed that the TATTT represented a systematically different coding system to the ATS and the pre-coding of the 'spare' written scenarios suggested that the TATTT provided much more standardised triage codes.

## *2.7 Results of qualitative data analysis*

The qualitative data collected from the coder's centrered around five major questions:

1. What were their experiences of the simulations (asked to comment on each one);
2. Their perception of the TATTT as a tool to aid triage decisions (including its strengths and limitations);
3. What they thought of the training package/program and any improvements that could be made to it;
4. Their perceptions of being involved in the study; and, for the nurses at THS only
5. Their experience of parallel coding.

Each of the major themes of the study will now be discussed.

### 2.7.1 Simulations

Eighty percent of nurses from THS made positive comments on all the simulations. In contrast, sixty percent of nurses from PAH made positive comments on the video simulations, forty percent on the paper simulations and twenty percent on the computer simulations. Overall, however, the majority of the participants believed that while the three methods all had advantages and disadvantages that '… I think a mixture's good.' One respondent noted that there should be many more scenarios developed than what was available for this project.

#### *2.7.1.1 Video Simulations*

On the whole, the respondents believed that the video simulations reflected what they would do as a triage nurse. For example:

*The video one is more realistic.*

*I suppose the video is good in the fact that you don't get all the information, you actually have to glean some of the information from looking at the patients.*

All of the negative comments on the video simulations related to the fact that the skin assessment was difficult. For example:

*I guess with the circulation, skin pale, warm, clammy and all that sort of stuff ... it's hard to assess ... without touching the patient.* Several nurses believed that a *'voice over' on the videos where one person could discuss the skin assessment would overcome this problem.*

One respondent believed that the patient's blood pressure should also be shown on the video simulations. However, when asked, three other respondents believed that this was not necessary.

A further comment for improvement was that the patients were very well behaved in the video simulations. For example, they noted that:

*we had very obliging patients ... who did not stand there grinning [saying their pain score was] 10 out of 10, 20 out of 20, you know.*

#### *2.7.1.2 Computer Simulations*

Some participants believed that the computer simulation was *... very easy to use as well.* They noted that it took *a couple of seconds to figure it out, to work your way around it. Once you've got the gist, I found that quite simple to use*. Another nurse noted that the computer simulations was *... more of a hands-on sort of thing*.

The negative comments about the computer simulation related to the level of their computer skills. For example: *not being computer literate it was hard, initially, hard ...*

and *I found it quite confusing … I found I got a lot more information than I wanted by the time [I had worked out how to use it] … but I guess in the real world that's what happens too.*

#### *2.7.1.3 Paper Simulations*

The majority of the participants noted that the paper simulations were what they were used to working with. They particularly noted that with the paper simulations ... *everything you need is just there and you don't really have to think about it.* This was seen both as a positive aspect of paper simulations as well as a negative aspect, particularly in training situations. For example:

*because if you're trying to train somebody in triage, you don't want them to go through every little bit of information when there's airway obstruction, you just want them to stop where they are.*

One participant noted that *cost wise and resource wise [they were better as] … you don't have to worry about finding somewhere that has a television, a computer and a video.*

#### *2.7.1.4 The simulations and the Palm as a triage teaching tool.*

All of the participants at both hospitals believed that the Palm and the simulations were excellent teaching tools for people learning to triage. A participant new to triage explained:

*… It helps me to get into that whole process of thinking what to look for. What sort of things I should be concentrating on, what not to concentrate on … It helps to get me into a system.*

Other more experienced triage nurses noted that they *'probably would be good actually as a teaching tool. It would make people think more about how they triage'*. Others were more enthusiastic. For example

*Fabulous. I think it's a great learning tool. I think we could get people into a triage role a lot more quicker than we do now.*

### 2.7.2 Perceptions of the TATTT

#### *2.7.2.1 Positive Comments*

Ten nurses from THS and three from PAH made overall positive comments about the tool. These related to the ease of use: *It was very easy to use once I got used to it*, as well as overall very positive comments about the tool itself. For example:

*I actually think it's a fabulous tool and that it has such great potential*.

For more experienced triage nurses the fact that the tool came up with what they saw as the *'right'* answer, increased their confidence in the tool. For example:

*I thought it was good because in my mind it seemed to come up with the right categories for me ... I would have questioned it had my feelings about the certain triage category ... varied considerably from what the tool came up with. ... It appears to be an accurate assessment tool.*

Another nurse noted that the tool made triage less subjective. For example:

*It's going to be good no matter what, even if nothing else comes [of it], even if we don't get to play with the toy.*

Three nurses from THS and two from PAH noted that the tool increased their confidence. These comments were from both experienced and inexperienced triage nurses. For the less experienced nurses, the tool was seen to be able to guide them through decision making. As one nurse noted:

*...just to give a guideline ... not support, but an idea of what to look for and where to look for it, I think that's probably where I like the tool more than anything.*

Another inexperienced nurse believed that it would give *... a bit more confidence in what category you have given someone ... you feel like you can explain a bit better why they have got that category.*

In contrast, a more experienced triage nurse noted that *you can triage eighty people per shift ... you're saying that [a] person can wait for an hour. Sometimes that doesn't sit comfortably with me ... It gives me something extra to fall back on.*

Three nurses from PAH and four from THS noted that the TATTT made triaging clear-cut. For example:

*There are times when you have to think to yourself, now I think this person needs to be a category 2, however, they could be a category 3. There are times when you really hover between a category ... I think the tool makes it more clear-cut.*

Another nurse spoke along similar lines, but believed that the tool could be used to make the decision for the person if they were reluctant to do so themselves: *I really don't know what I want to do with this person, are they a 3 or a 4? What does the little box [TATTT] say?* The same nurse noted that others, who may be having a day where they did not want to make a decision, will *just put ... five, five, five, because they're having a bad day, so you have to be pretty sick to get past them. Which is terrible, but you can see it.*

#### *2.7.2.2 TATTT is an adjunct to normal triage*

The tool, therefore, was seen by some to been an adjunct which would assist them to validate their triage rating. This was particularly important as triage at present is seen as very subjective and often more senior nurses or medical practitioners will question the nurse's triage score. The TATTT was seen by some, therefore, to assist them to validate their score with others. For example,

*I have found [validating my own triage score] to be extremely difficult. I am not saying that I came to the wrong decision, but when I'm told to validate [the score] ... I get uncomfortable as I am not used to doing that.*

Three people noted that the TATTT would only be used as an adjunct to their own triage score. The comments varied between: *It's an adjunct to make a decision, it ... guides your decision making process ... in a logical manner.* In contrast, another nurse noted that *... it's backup from a legal point of view as well, like, you can say, I did address this, this and this and this, as indicated by the record on the TATTT.*

#### *2.7.2.3 Agreement with triage rating*

Several participants also mentioned that they would use the TATTT's triage rating as long as it related to the score they would arrive at using the previous system. They spoke about this as a safety mechanism until they felt confident that the TATTT was rating at the same level they would expect. For example:

*Although obviously if you weren't happy with the category that came up using the tool, you would override that because I think you need to feel comfortable with the triage category that you give your patient*.

In all cases, the nurses noted that they would go with the higher score, regardless of whether it came from the TATTT or an independent assessment. As one nurse explains:

*... Just to be on the safe side, I need to go for that higher category because I'm not sure whether this is going on or that's going on.*

However, the respondents did note that at times they would override the category to a lower score *if I had 50 people in my emergency department, I probably would have given them a 4 not a 3.*

#### *2.7.2.4 TATTT and benchmarking*

Another major aspect about the use of the tool was that it could be used to benchmark practice from one hospital to another. For example:

*we are benchmarked between hospitals the same size, bigger and smaller than us … on our wait[ing] times … but there is nothing to say that those categories [are the same from one hospital to another]*.

In contrast, other nurses noted that the tool could be used to audit the performance not of the facility, but of the individual nurse. For one nurse this was a negative aspect of the tool in that it could be used to *show whether someone is sufficiently capable to function as a triage nurse*. In other cases, the nurses were happy to use to tool to ascertain their own performance over time and they believed that the tool could then be used almost as continuing professional education.

*2.7.2.5 Use of TATTT at triage desk*

The participants were asked if they would use the TATTT at the triage desk. The majority of nurses stated they would. For example:

*I'd probably use it 99% of the time*.

Another nurse noted that again they would use the tool, but they would want to also use it *often enough and … because [it became] normal, you'd tend to rely on it more*. Other nurses were more enthusiastic stating: *I think it's wonderful, you can take it to a private area and you can have your computer with you and record what you need.*

Only four nurses stated they would not use it at the triage desk. Two nurses were unhappy about having to carry the Palm with them and would have preferred the system to be on a desk-top.

*We're already carrying a mobile phone and if you had to carry the Palm pilot as well, you start to feel like you need a utility belt … it would be great to have the Palm pilot and use it, but I can see it would be put down, forgotten where it was ….*

One nurse was very against the introduction of the tool stating:

*too many if's … The danger being that it would be the monkey out the front going and bingo, and you still need all those years of experience, you still need the knowledge, you still need to see a nurse … as a teaching tool it's probably a good thing, but I wouldn't fancy it at the triage desk.*

*2.7.2.6 Role erosion cause by the TATTT*

This particular nurse raised the issue of role erosion which was explored with other participants. The main concern was that if the tool was universally used it could mean that anybody could triage a patient. For example:

*A clerk would be doing it [triage], and I think the clerk would get it wrong. … You'd be sued in the first week, and it'd be tossed out in the car park. That's what would happen.*

Three other nurses agreed with this statement saying: *I think that with the tool anyone could triage…..* However, this nurse also said that they did not *have a problem with that.*

Others agreed that the tool could not be used by non-nurses. For example:

*you would still need training and I mean you are calling upon years of assessment techniques and you know, to make these quick decisions … you would still need a nurse using the tool to be comfortable with the decision.*

There was some concern, however, that the experience in assessment that nurses had developed would be eroded by the tool. As one nurse said *I guess the only problem with the tool is that you wouldn't be … Maybe you wouldn't develop the triage skills that you would without it.*

*2.7.2.7 Areas in which the tool could be improved*

There were several areas where the nurses believed that the TATTT could be improved. The major area was in the mechanisms of injury where one person believed that the age of the person would change the category given. Others noted that what they *… struggled with … was [deciding on whether it was] a high risk injury or not. That is always the question.* Another noted that they would want to know *… the height of a fall … just little bits of detail … if it was a penetrating injury or if it was a motorbike accident or a car accident, the speed it was at, where [the patient] was hit….* Others believed that the mechanisms of injury were *unclear to me, when I reviewed the tape. Mainly about high and low impact I think.*

Three other areas suggested for improvement were respiration, bleeding and the possibility of defaulting to a 2 as well as a 1. For example one participant noted that respiration was difficult *… because there were so many choices. It could be combined down a bit.* Another nurse noted that increased respirations may be caused by panic attacks and that the hyperventilating is *probably going to [result in] … an increased effort where it may in fact get a higher triage category because of that but there are other factors that come into that ….*

One nurse believed that it would be best to have the tool default to a category 2 *[if] … certain parameters [were] … met. [They could say] 'Well that's a category 2; good I can now move on and get that patient sorted'.* Another nurse disagreed with this and believed that defaulting to a 2 was *… most lazy really. If you are going to triage someone … 1 is fine … If you want to get down to a 2, you … should fully access A, B, C, D and E.*

With regard to bleeding, one nurse noted that:

*…the main bleeding with the larger artery and the smaller artery … may become a bit blurred for some people. … People who were not experts may not pick up on [the source of] bleeding '[be]cause they see blood coming and they would probably go for the one rather than the two.*

Finally, the participants had mixed feelings about the rating of pain and its use in the TATTT. It was apparent that some nurses would give an initial triage scale and then, using nurse initiated analgesia, would provide pain relief and then re-triage the patient. This was particularly evident at the PAH For example:

*… We can instigate Morphine. There's a whole list of drugs we can give, that we don't need doctors orders for so … they probably don't even need to be a 3 now, if you gave them adequate pain relief.*

Only one nurse at THS noted that they *could get them something stronger from a doctor and then put them into another category.*

As mentioned previously, some of the triage nurses also spoke about the issue of assigning a pain scale to a patient who rated their pain as a 20 out of 20 who did not have the associated behavioural and physiological changes associated with severe pain. However, the majority of the nurses believed that where as *sometimes you don't think people have the amount … of pain that they say they have, you have got to take them at their word.*

With regard to the parameters for the TATTT seven of the nurses commented that they could not suggest any improvements. The main areas, as previously discussed for consideration were the mechanisms of injury, bleeding and respiration.

*2.7.2.8 Use of the tool in other settings other than ED.*

Four nurses noted that the TATTT could be used in other settings other than large EDs. In particular it was noted that it would be useful for nurses working in rural and remote areas. Other users included the QAS: *There is a need for ambulance personnel to be able to triage and determine what goes to hospital first*. Additionally, one nurse believed that it could be used at *the roadside or a major disaster. You can have your Palm held and you can go and triage people … before they get to the hospital.*

*2.7.2.9 Speed of the tool*

One nurse describes how they believe the tool could be used successfully in the ED.

*If you have three ambulances come through … you could walk and you could stand near the first one and go ABCDE , get a quick score, move to the next one ….*

### 2.7.3 Training Package

Four of the PA participants and all of the THS participants believed that the training package was *'good'*. For example:

*As a packet of criteria if nothing else alone it's very good. … I think it's valuable …*

Some comments for improvement were that the package could be supplemented with some face-to-face teaching on how to use the Palm. Several respondents believed that it was better to have someone sit *'down with the little Palm and [go] ... through it with me ... Just show me how to do it and let me do it'.*

### 2.7.4 Involvement in the study

Nurses were asked how they felt about being involved in the study. Whilst the majority noted that it *'was fun'* or that they felt it had been good, one nurse at the PAH noted that it had been quite time consuming and that some estimate of the time needed and the need for rostering should be factored in for future work.

### 2.7.5 Parallel Coding

Parallel coding was only carried out with eight of the 10 nurses at THS. All of the eight nurses commented positively on the way that AW had coded in parallel with them. For example:

*... I triaged and he listened ... I didn't really have a big idea of what he was doing at that stage .... He used to ask some questions that I hadn't ... It was good though.* and:

*... It didn't worry me greatly, probably because I have worked with Anthony. ... You are always a bit on edge when someone is beside you, but you concentrate on what you are doing anyway ... Probably ... if anything ... made you think a bit more about what you were doing.*

However, one nurse noted that the parallel triaging could be improved in that they did not feel prepared for the role. For example:

*... I think at first I was a little bit ... [confused] because I didn't know what he wanted me to triage. ... I felt like ... I was being tested. ... He wouldn't say if my triage was right or wrong.*

Another nurse commented that she *found someone else hanging over me was a bit of an issue. Anthony certainly knew when to stand back and he certainly didn't interfere*. In fact, several of the nurses noted that while they felt quite comfortable with Anthony working with them, that if it was someone unknown to them, that they would not have felt as comfortable.

# 3.0 DISCUSSION

The study's primary research question was: What is the most appropriate mechanism for establishing the validity and reliability of a new tool (TATTT) for the assignment of a triage category?

The methods trailled were:

- Coding from written scenarios of adult trauma presentations;
- Coding from video-taped scenarios of simulated adult trauma presentations;
- Coding from a computer simulation of an adult trauma presentation; and
- Simultaneous parallel coding of actual adult trauma presentations.

Each method of simulation exhibited a high level of inter-rater and intra-rater reliability. Each method had advantages and disadvantages associated with its use so consideration of the pros and cons associated with each method will now be examined.

## *3.1 Simulations*

### 3.1.1 Written Scenarios

The overall level of agreement for the written scenarios was 90.3% and the kappa statistic was 0.86. The more subjective and less prescriptive assessment component of assignment of a 'high risk mechanism' was responsible for most of the variability across the nine written scenarios.

All of the written scenarios were based upon actual ED presentations minus identifying information and incorporated the vital signs and assessment findings taken on presentation at triage. In the factual presentation of this information care was taken to provide the level of detail thought to be generally obtained for the purpose of making a triage decision. Each case was reviewed by the research team for completeness and consensus with regard to the triage category assigned by the TATTT. This process was relatively easy to accomplish, not very time consuming and involved little cost; hence the attractiveness of this method of simulation. Of equal positive note was that they were viewed positively by participants due to their simplicity. This may also reflect some familiarity by participants with this means of simulation as written scenarios have been the sole method of simulation utilised in the past for the purposes of triage training and assessment.

In terms of disadvantages, there is some concern that the reason the written scenarios produced such high levels of agreement is because they require no personal interaction, no clinical assessment to be performed and provide information to the coder they may have not sought under their own auspices. There is, for example, no opportunity to fail to measure pain, because the pain score is provided in each scenario. Equally, there is little

opportunity to incorrectly assess one of the clinical parameters as a definitive result is provided. For this reason one approach to future inter-rater reliability testing we would like to attempt, as performed by Whitby et al. (1997) [17], to use random pairs of triage nurses triaging the same patient on presentation to the ED utilising the TATTT. This would provide more realistic field data on the inter-rater reliability of the TATTT.

### 3.1.2 Video Scenarios

The overall level of agreement for the video scenarios was 81.3% and the kappa statistic was 0.76. From these results it can be seen that the written and video simulations displayed different reliability characteristics. The written scenarios delivered highly reliable results (relatively little disagreement between nurses or within nurses over time). The video scenarios, in contrast, produced a corresponding lower reliability score. This is attributed to the fact that the presentation of a simulation on video requires the viewer to use more of their own clinical judgement skills, even though there is no direct interaction with the patient. This greater variability was due to the requirement for a greater level of user interpretation of the more subjective elements of the tool such as 'cutaneous perfusion status' and 'respiratory effort'. Contributing to this variability were some deficiencies in the representation of some of the assessment criteria required for entry into the TATTT. For example, skin temperature is unable to be visually represented and was not provided in the videos by an alternative means. This oversight will be addressed in the future with attempts made to rectify this deficiency in the current videos.

The benefit of the video simulations over the written simulations was that they were viewed as more realistic by participants as they provided valuable sensory information regarding the patient which was frequently incorporated into the assessment of patients. For example, in a video, the participant can see how the patient moves and hear their verbal interaction. The disadvantages of this simulation approach are the cost and time associated with their development. In terms of cost the video simulations cost approximately $1000 per finished minute of footage. In terms of time, videos required lengthy preparation and planning, casting, rehearsing, negotiating access at an appropriate time to film in the ED and the assembling of multiple individuals. The added burden of video simulations was the requirement to organise a video player or late generation PC for their use.

### 3.1.3 Computer Scenario

The overall level of agreement for the computer simulation was 80%, but the kappa statistic was only -0.10. The low kappa is an artefact of the lack of variability in the scenario. The more subjective and less prescriptive assessment component of assignment of a 'high risk mechanism' was responsible for most of this variability.

There are a number of advantages associated with this simulation approach. First, it was possible to digitally manipulate images to suit the scenario. For example the flank bruise abrasion in the simulation was produced digitally. Second, the simulation allowed the user to dictate the flow of information. The user assessed the patient according to their preferred approach. They obtained as little or as much information as they liked and

reassessed the patient if they had forgotten something. Third, the simulation kept a log of each assessment parameter chosen by the operator for later analysis.

The disadvantages with this simulation method were the cost and time associated with development. The computer simulation was five times more expensive to develop than the next most expensive simulation, the videos. In terms of time, it required a lengthy period of preparation, planning, organisation of resources and pilot testing to complete. The added burden of computer simulation, in contrast to written, is the requirement to organise a late generation PC for its use.

In terms of participant feedback, the computer simulation was acceptable to some nurses but others, who were less computer literate, found it difficult. The computer simulation required some pre-requisite skills (such as mouse skills) to which some nurses were unaccustomed and some intial time spent on learning how to operate the simulation in order to derive the required information. Familiarity and comfort may have been increased if more simulations were available for rating purposes as only one simulation was produced.

## *3.2 Simultaneous Parallel Coding*

The simultaneous parallel coding component of the study enabled the application to be tested in real time with real patients and get a direct comparison between the TATTT and current practice. From the results obtained, 47% of patients triaged received the same triage rating, 38% received a more urgent rating and 16% received a less urgent rating using the TATTT compared with existing practice. In all but one case the level of difference between the TATTT and existing practice was only by a factor of 1 category. Pain was the chief difference leading to an increase in the triage score. This point will be addressed later.

An example of a patient whose triage score was increased is: an elderly woman presented in a wheel chair following a fall off a chair and landed on her left buttock. The accident was attributable to incoordination. She has difficulty mobilising, has a slight tachycardia and rated her pain as 5/10 on a numeric rating scale. This patient was then given a triage categorisation of 4 where as the TATTT would have given the patient a triage category of 3 proportional to that level of self-reported pain and on the basis of her tachycardia.

An example of a patient whose triage score was decreased is: a young male patient presented with a painful knee joint following a football match the previous day. He was partial weight bearing, neurovascularly intact, nil obvious deformity, had utilised ‘RICE’ appropriately, rated his pain as 2/10 at rest, declined analgesia and had normal vital signs. This patient was then given a triage categorisation of 4, which is consistent with the traditional notion of acute presentation (within 24 hours) of a minor orthopaedic complaint, whereas the TATTT would have given the patient a triage category of 5 proportional to all these assessment findings.

Clinical audit of all cases of variance was undertaken by the research team and it was concluded that the TATTT gave more appropriate scores than current practice in each case. This audit process and the simultaneous parallel triaging (see Appendix 8) process generally also provided valuable information for the further refinement of the TATTT.

The difficulties associated with this process are; first it can be perceived as disconcerting by participants initially and second obtaining retrospective patient consent was a time consuming process. In reference to the first point, this apprehension was readily overcome with explanation and familiarity with the researcher. The qualitative feedback from participants also supported the acceptability of this process.

## *3.3 Inter-rater Reliability of the TATTT*

The study's overall (test re-test) kappa statistic was 0.82 for 450 cases of simulated triage. This level of inter-rater agreement exceeds that of previous studies on the NTS, CTAS and by the ESI [13,17,18,32,38]. This result also exceeds the ATS reproducibility standard specified by the ACEM of a weighted kappa statistic of at least 0.60 [5]. In making this comparison it is important to note that this study only involved one patient presentation group and simulated presentations. In contrast, all of the studies previously cited involved the full gamete of adult ED presentations and some also involved real patient presentations. This could reasonably be conceived as adding to the degree of variability in those studies. The encouraging results from the TATTT, however, suggest that the tool is easily understood and can readily be applied with a high degree of reproducibility following limited training.

## *3.4 Algorithms and Triage*

Algorithms can be utilized to provide decision support in the allocation of clinical urgency [2]. Stephens, Pokorny and Bowmen (1997) suggest this is required so that all patients are assessed similarly and according to standards of practice [27]. This need for a systematic method of assessment has been widely recognised [28]. The TATTT aims to address this need by its provision of a consistent, systematic approach to the assessment of patients which also supports the decision making process. The parallel triage component of the project highlighted this need as it was evident for example, that pain assessment was not performed on every patient in the sample group. The TATTT's systematic approach mandates people to assess a patient's level of pain on a numeric rating scale as part of the triage assessment process. It was also shown that even when pain was assessed, the TATTT appeared to be more responsive to the patients' self reported pain rating than current triage practice. For example a patient from a motor bike accident presented with a clearly deformed forearm which he rated as being 9/10 on a numeric rating scale for pain and was allocated a triage score of 3. This acuity rating may be due to this triage nurse's interpretation of the ATS category 3 clinical discriptor pertaining to pain of, "moderately severe pain any cause – requiring analgesia" [21]. It may also be consistent with the well documented tendency of healthcare providers to under assess pain relative to the patient's report [50]. The TATTT's standardised rating of acuity

proportional to each assessment component of the tool meant that with respect to this pain score the patient would have received a triage score of 2 which is more commensurate with this patients needs.

There were a number of reported limitations of algorithmic approaches to triage cited in the literature review. They were:

a) The use of lengthy algorithms may unnecessarily delay a time critical patient at triage [2];
b) They impose restrictions on performance by limiting the development of more flexible ways of assessing patients at triage [2];
c) Failure of appropriate application was reported as the chief reason for a protocol driven triage system to detect critically ill patients. It was felt that these errors were due to problems with training rather than the system itself [31]; and
d) Patients with more than one presenting complaint may be triaged by more than one pathway, each leading to a different category [14].

It is important to consider these limitations individually in relation to the TATTT.

a) It is anticipated that the TATTT will require no longer time frame to complete in entirety than current practice affords for the purposes of triage assessment. Equally it will not delay the time to treatment in the critical patient as the application allows the operator to select the most glaringly obvious presenting feature equivalent to a category one at which point the application closes such that the entire tool does not have to be completed. Also the tool's internal accumulative scoring feature means that when a threshold number of critical features have been reached the tool automatically displays a triage category score of one without looking for any further information.

b) Measures have been taken to allow for some flexibility in the tool which reflects the complexity of the clinical practice environment and to respect the individual clinical judgement of the triage nurse. For example, the TATTT allows for the assignment of a high risk mechanism of injury on the basis of the assessment performed by that triage nurse. Equally the tool explicitly states in the training material:

> *The TATTT provides a useful framework to guide the decision making process during triage. However, there may be times when the triage nurse may choose to disregard the score obtained from the application of the tool according to their own clinical judgement, due to unusual circumstances surrounding that presentation. In providing flexibility to allow for the intuition of individual operators, it is important to have a mechanism in place to review those cases whereby the applications score was overridden by the operator.*

c) In order to address the "failure of application" issue a very detailed training package about each individual element of the TATTT was produced and provided to

each participant for self directed perusal. Given the study's overall high level of inter-rater reliability, the TATTT's construction and its bias toward 'up triage' it can be argued that the critically ill patient will always be detected. Equally, given the limited level of self directed training that occurred, it is anticipated that the level of inter-rater reliability for the TATTT can be improved upon with a face to face teaching session to augment this self directed component.

d) The TATTT is a universal algorithm applied to all adult injury based presentations regardless of the aetiology of the patients presenting complaint. This nullifies the potential for conflicting choices of algorithms producing differing results.

Brillman et al. (1996) suggested, in the developing of standardized protocols for triage, the following criteria be utilized: they should not be population or resource specific; agreement between triageurs must be demonstrated; they must be prospectively validated; must be applicable to the vast majority of ED patients; can be performed in a short period of time; and can be used after only a few days of specialized training [29]. The Research Team has been mindful of these criteria during the development and substantiation of the TATTT. The major features therefore can be seen as:

- The TATTT is not population specific in relation to gender, race, or geography, nor is it resource specific;
- Inter-rater agreement and prospective validation has been sort at a preliminary level;
- It applies to a large percentage of an ED's workload; and
- It is anticipated that it will be quick to use and will not require lengthy training by operators prior to its envisaged use in clinical practice.

The TATTT also offers a very powerful advantage in that the operator can see (and analyse) every clinical component of the tool. This means that in addition to overall reliability, the TATTT can also drill down to each individual clinical measurement and pinpoint where further improvements in the system or further training of triage staff are required.

## *3.5 Participant Feedback*

Following a semi structured interview of all participants involved in the study the following general perspectives were able to be made:

- The TATTT application was viewed positively;
- The pocket PC was found to be easy to use;
- Participants believed that the TATTT provided clear direction in the triage assessment process;
- The TATTT increased the level of confidence participants felt with the decision reached; and

- Participants felt they would be comfortable adopting the TATTT in clinical practice.

Valuable information was also received from participants regarding the TATTT training package and training process which will be used for refinement of the package/training for future implementation.

To quote some of the study participants:

- *... you feel like you can explain a bit better why they have got that category.*
- *There are times when you really hover between a category ... I think the tool makes it more clear-cut.*
- *... it helps me to get into that whole process of thinking what to look for.*
- *...it guides your decision making process ... in a logical manner.*
- *If you have three ambulances come through ... you could walk and you could stand near the first one and go ABCDE , get a quick score, move to the next one.*
- *I think we could get people into a triage role a lot more quicker than we do now.*
- *It was very easy to use once I got used to it.*
- *I actually think it's a fabulous tool and that it has such great potential.*

This level of participant endorsement of the TATTT is an important indicator of the likely success of future attempts at implementation.

## *3.6 Overall Conclusion*

Information to date has suggested that the TATTT system provides systematically different results compared to current triage practices; has greater reliability than current triage practices; will be safe for use in the clinical environment; and is acceptable to users. As such, it can viewed as a viable alternative to current triage practice worthy of further investigation.

Given the results of this study it is anticipated that a combination of written and video simulations and parallel coding will be adopted in future testing of the TATTT. The least favoured and most expensive simulation method, that of the computer simulation, will not be pursued in further investigations of the tool.

Further evaluation of the TATTT application in a larger prospective trial is required to further validate the reproducibility of the system, its sensitivity to patient acuity and stratification of patient presentations. Expansion of the TATTT to non trauma and paediatric patient presentations is also being considered due to the universal nature of the tools construction.

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# Appendices

## *Appendix 1: Agreement between coders during parallel coding*

The tables in this appendix describe the agreement between the TATTT-based triage rating and current practices of each of eight triage nurses as obtained during the parallel coding of 58 actual triage patients.

*Table A1.1 Comparison between coder #6 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 6 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | 1 | | | | 1 |
| | 4 | | | 1 | 4 | 1 | 6 |
| | 5 | | | | | | |
| | Total | | 1 | 1 | 4 | 1 | 7 |

Percentage agreement =57%, kappa = 0.13, with 95% CI = [-0.48, 0.73]

*Table A1.2 Comparison between coder #7 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 7 (existing triage methods) | 1 | | 1 | | | | 1 |
| | 2 | | | | | | |
| | 3 | | 1 | 3 | 1 | | 5 |
| | 4 | | | 5 | 5 | 1 | 11 |
| | 5 | | | | | | |
| | Total | | 2 | 8 | 6 | 1 | 17 |

Percentage agreement =47%, kappa = 0.16, with 95% CI = [-0.26, 0.58]

*Table A1.3 Comparison between coder #9 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 9 (existing triage methods) | 1 | | | | | | |
| | 2 | | 1 | | | | 1 |
| | 3 | | 2 | 2 | | | 4 |
| | 4 | | | 2 | 2 | 1 | 5 |
| | 5 | | | | | | |
| | Total | | 3 | 4 | 2 | 1 | 10 |

Percentage agreement =50%, kappa = 0.30, with 95% CI = [-0.17, 0.76]

*Table A1.4 Comparison between coder #10 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 10 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | 2 | | | | 2 |
| | 4 | | | 3 | 1 | | 4 |
| | 5 | | | | | | |
| | Total | | 2 | 3 | 1 | | 6 |

Percentage agreement =17%, kappa = -0.13, with 95% CI = [-1.00, 0.88]

*Table A1.5 Comparison between coder #11 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 11 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | 1 | | | | 1 |
| | 4 | | | 1 | | 1 | 2 |
| | 5 | | | | | | |
| | Total | | 1 | 1 | | 1 | 3 |

Percentage agreement =0%, kappa = -0.15, with 95% CI = [-1.00, 1.00]

*Table A1.6 Comparison between coder #13 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 13 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | | | | | |
| | 4 | | 1 | | 2 | 1 | 4 |
| | 5 | | | | | | |
| | Total | | 1 | | 2 | 1 | 4 |

Percentage agreement =50%, kappa = 0.00, with 95% CI = [-1.00, 1.00]

*Table A1.7 Comparison between coder #14 and TATTT*

| | | TATTT Triage (AW) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 14 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | | 2 | 1 | | 3 |
| | 4 | | | 1 | 1 | 1 | 3 |
| | 5 | | | | | | |
| | Total | | | 3 | 2 | 1 | 6 |

Percentage agreement =50%, kappa = 0.15, with 95% CI = [-0.52, 0.81]

*Table A1.8 Comparison between coder #15 and TATTT*

| | | **TATTT Triage (AW)** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **Total** |
| Coder 15 (existing triage methods) | 1 | | | | | | |
| | 2 | | | | | | |
| | 3 | | | 2 | | | 2 |
| | 4 | | | 1 | 2 | | 3 |
| | 5 | | | | | | |
| | Total | | | 3 | 2 | | 5 |

Percentage agreement =80%, kappa = 0.62, with 95% CI = [-0.06, 1.00]

## *Appendix 2: Agreement between coding systems during parallel coding*

The tables in this appendix summarise the relationships between each individual component of the TATTT and whether the TATTT code assigned during the parallel coding was more or less urgent than the triage code assigned using current (ATS) practices.

*Table A2.1 Relationship between Airway and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| No obstruction | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

No analysis required.

*Table A2.2 Relationship between Respiratory Rate and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| 13-14; 21-24 | Count | 8 | 4 | 1 | 13 |
| | Row % | 61.5% | 30.8% | 7.7% | 100.0% |
| 15-20 | Count | 14 | 23 | 8 | 45 |
| | Row % | 31.1% | 51.1% | 17.8% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 4.02$, $df=2$, $p=0.134$. Not valid: too many small cells.

*Table A2.3 Relationship between Respiratory Effort and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| mildly decreased or increased | Count | 7 | 2 | 1 | 10 |
| | Row % | 70.0% | 20.0% | 10.0% | 100.0% |
| normal effort | Count | 15 | 25 | 8 | 48 |
| | Row % | 31.3% | 52.1% | 16.7% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 5.34$, $df=2$, $p=0.069$. Not valid: too many small cells.

*Table A2.4 Relationship between Pulse and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| 101-115 | Count | 4 | 0 | 0 | 4 |
| | Row % | 100.0% | 0.0% | 0.0% | 100.0% |
| 50-59; 91-100 | Count | 8 | 8 | 0 | 16 |
| | Row % | 50.0% | 50.0% | 0.0% | 100.0% |
| 60-90 | Count | 10 | 19 | 9 | 38 |
| | Row % | 26.3% | 50.0% | 23.7% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 12.77$, $df=4$, $p=0.012$. Not valid: too many small cells.

*Table A2.5 Relationship between Skin Appearance and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| pale, cool, dry | Count | 0 | 1 | 0 | 1 |
| | Row % | 0.0% | 100.0% | 0.0% | 100.0% |
| pale, warm, dry | Count | 5 | 3 | 2 | 10 |
| | Row % | 50.0% | 30.0% | 20.0% | 100.0% |
| pink, warm, dry | Count | 17 | 23 | 7 | 47 |
| | Row % | 36.2% | 48.9% | 14.9% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 2.36$, $df=4$, $p=0.670$. Not valid: too many small cells.

*Table A2.6 Relationship between External Bleeding and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| Large venous/small arterial uncontrolled | Count | 0 | 1 | 0 | 1 |
| | Row % | 0.0% | 100.0% | 0.0% | 100.0% |
| small venous controlled | Count | 3 | 11 | 1 | 15 |
| | Row % | 20.0% | 73.3% | 6.7% | 100.0% |
| no external bleeding | Count | 19 | 15 | 8 | 42 |
| | Row % | 45.2% | 35.7% | 19.0% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 7.48$, $df=4$, $p=0.113$. Not valid: too many small cells.

*Table A2.7 Relationship between Glasgow Coma Score and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| GCS: 13 | Count | 1 | 1 | 1 | 3 |
| | Row % | 33.3% | 33.3% | 33.3% | 100.0% |
| GCS: 15 | Count | 21 | 26 | 8 | 55 |
| | Row % | 38.2% | 47.3% | 14.5% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 0.78$, $df=2$, $p=0.676$. Not valid: too many small cells.

*Table A2.8 Relationship between Pain Score and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| 7-10 | Count | 8 | 0 | 0 | 8 |
| | Row % | 100.0% | 0.0% | 0.0% | 100.0% |
| 5-6 | Count | 12 | 4 | 1 | 17 |
| | Row % | 70.6% | 23.5% | 5.9% | 100.0% |
| 3-4 | Count | 0 | 14 | 2 | 16 |
| | Row % | 0.0% | 87.5% | 12.5% | 100.0% |
| 0-2 | Count | 2 | 9 | 6 | 17 |
| | Row % | 11.8% | 52.9% | 35.3% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 40.25$, $df=6$, $p<0.001$. Not valid: too many small cells.

*Table A2.9 Relationship between Condition of Extremities and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| loss of sensation or deformity | Count | 7 | 1 | 0 | 8 |
| | Row % | 87.5% | 12.5% | 0.0% | 100.0% |
| Not | Count | 15 | 26 | 9 | 50 |
| | Row % | 30.0% | 52.0% | 18.0% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 9.76$, $df=2$, $p=0.008$. Not valid: too many small cells.

*Table A2.10 Relationship between High Risk Mechanisms and differences in coding*

| | | TATTT more urgent | No difference | TATTT less urgent | Total |
|---|---|---|---|---|---|
| high risk | Count | 5 | 3 | 1 | 9 |
| | Row % | 55.6% | 33.3% | 11.1% | 100.0% |
| not high risk | Count | 17 | 24 | 8 | 49 |
| | Row % | 34.7% | 49.0% | 16.3% | 100.0% |
| Total | Count | 22 | 27 | 9 | 58 |
| | Row % | 37.9% | 46.6% | 15.5% | 100.0% |

Pearson's Chi-square: $\chi^2 = 1.41$, $df=2$, $p=0.495$. Not valid: too many small cells.

## *Appendix 3: Overall intra-rater reliability for each coder*

*Table A3.1 Coder 1 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial Triage category | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| | 3 | 0 | 0 | 3 | 1 | 0 | 4 |
| | 4 | 0 | 0 | 0 | 5 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 3 | 6 | 1 | 15 |

Percent agreement = 93%, Kappa = 0.91 with 95% CI = [0.74, 1.00]

*Table A3.2 Coder 2 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial triage category | 1 | 1 | 2 | 0 | 0 | 0 | 3 |
| | 2 | 0 | 2 | 0 | 0 | 0 | 2 |
| | 3 | 0 | 0 | 6 | 1 | 0 | 7 |
| | 4 | 0 | 0 | 0 | 2 | 0 | 2 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 4 | 6 | 3 | 1 | 15 |

Percent agreement = 80%, kappa = 0.73 with 95% CI = [0.46, 0.99]

*Table A3.3 Coder 3 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial triage category | 1 | 1 | 1 | 0 | 0 | 0 | 2 |
| | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| | 3 | 0 | 0 | 3 | 1 | 0 | 4 |
| | 4 | 0 | 0 | 0 | 5 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 4 | 3 | 6 | 1 | 15 |

Percent agreement = 87%, kappa = 0.82 with 95% CI = [0.59, 1.00]

*Table A 3.4 Coder 4 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial triage category | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| | 2 | 0 | 3 | 1 | 0 | 0 | 4 |
| | 3 | 0 | 0 | 3 | 1 | 0 | 4 |
| | 4 | 0 | 0 | 1 | 4 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 3 | 5 | 5 | 1 | 15 |

Percent agreement = 80%, kappa = 0.73 with 95% CI = [0.45, 1.00]

*Table A3.5 Coder 5 - One month intra-rater reliability*

| | | Triage category one month later | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| Initial triage category | 1 | 2 | 0 | 0 | 0 | 2 |
| | 2 | 0 | 3 | 0 | 0 | 3 |
| | 3 | 0 | 0 | 8 | 0 | 8 |
| | 4 | 0 | 0 | 0 | 2 | 2 |
| Total | | 2 | 3 | 8 | 2 | 15 |

Percent agreement = 100%, kappa = 1.00 with 95% CI not applicable

*Table A3.6 Coder 6 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial triage category | 1 | 2 | 1 | 0 | 0 | 0 | 3 |
| | 2 | 0 | 2 | 0 | 0 | 0 | 2 |
| | 3 | 0 | 0 | 4 | 2 | 0 | 6 |
| | 4 | 0 | 0 | 0 | 3 | 0 | 3 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 4 | 5 | 1 | 15 |

Percent agreement = 80%, kappa = 0.74 with 95% CI = [0.48, 1.00]

*Table A3.7 Coder 7 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Initial triage category | 1 | 1 | 1 | 0 | 0 | 0 | 2 |
| | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| | 3 | 0 | 0 | 4 | 0 | 0 | 4 |
| | 4 | 0 | 0 | 0 | 5 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 4 | 4 | 5 | 1 | 15 |

Percent agreement = 93%, kappa = 0.91 with 95% CI = [0.75, 1.00]

*Table A3.8 Coder 8 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| Initial | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| triage | 3 | 0 | 0 | 5 | 1 | 0 | 6 |
| category | 4 | 0 | 0 | 1 | 2 | 0 | 3 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 6 | 3 | 1 | 15 |

Percent agreement = 87%, kappa = 0.82 with 95% CI = [0.58, 1.00]

*Table A3.9 Coder 9 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Initial | 2 | 0 | 4 | 0 | 0 | 0 | 4 |
| Triage | 3 | 0 | 0 | 3 | 3 | 0 | 6 |
| Category | 4 | 0 | 0 | 0 | 2 | 0 | 2 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 4 | 3 | 5 | 1 | 14 |

Percent agreement = 79%, kappa = 0.72 with 95% CI = [0.44, 1.00]

*Table A3.10 Coder 10 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Initial | 2 | 0 | 4 | 0 | 0 | 0 | 4 |
| triage | 3 | 0 | 0 | 3 | 1 | 0 | 4 |
| category | 4 | 0 | 0 | 0 | 5 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 4 | 3 | 6 | 1 | 15 |

Percent agreement = 93%, kappa = 0.91 with 95% CI = [0.74, 1.00]

*Table A3.11 Coder 11 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| Initial | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| triage | 3 | 0 | 0 | 6 | 0 | 0 | 6 |
| category | 4 | 0 | 0 | 0 | 3 | 0 | 3 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 6 | 3 | 1 | 15 |

Percent agreement = 100%, kappa = 1.00 with 95% not applicable

*Table A3.12 Coder 12 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 1 | 1 | 0 | 0 | 0 | 2 |
| Initial | 2 | 1 | 2 | 0 | 0 | 0 | 3 |
| triage | 3 | 0 | 0 | 4 | 0 | 0 | 4 |
| category | 4 | 0 | 0 | 0 | 5 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 4 | 5 | 1 | 15 |

Percent agreement = 87%, kappa = 0.82 with 95% CI = [0.60, 1.00]

*Table A3.13 Coder 13 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| Initial | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| triage | 3 | 0 | 0 | 4 | 3 | 0 | 7 |
| category | 4 | 0 | 0 | 1 | 1 | 0 | 2 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 5 | 4 | 1 | 15 |

Percent agreement = 73%, kappa = 0.64 with 95% CI = [0.33, 0.95]

*Table A3.14 Coder 14 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| Initial | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| triage | 3 | 0 | 0 | 3 | 1 | 0 | 4 |
| category | 4 | 0 | 0 | 2 | 3 | 0 | 5 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 5 | 4 | 1 | 15 |

Percent agreement = 80%, kappa = 0.74 with 95% CI = [0.46, 1.00]

*Table A3.15 Coder 15 - One month intra-rater reliability*

| | | Triage category one month later | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Initial | 2 | 0 | 3 | 0 | 0 | 0 | 3 |
| triage | 3 | 1 | 0 | 3 | 0 | 0 | 4 |
| category | 4 | 0 | 0 | 1 | 5 | 0 | 6 |
| | 5 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | | 2 | 3 | 4 | 5 | 1 | 15 |

Percent agreement = 87%, kappa = 0.82 with 95% CI = [0.59, 1.00]

## *Appendix 4: How coders operated the computer simulation*

To help evaluate how the computer simulation was being used, we tracked the triage nurses use of the computer options. Specifically we recorded which option had been selected when, during the triage process. The log file for the first triage nurse on the initial viewing was accidentally lost.

*Table A4.1: Utilization statistics for each element of the computer scenario*

| Simulation element | Initial viewing | | One month re-test | |
|---|---|---|---|---|
| | Number of coders | More than once | Number of coders | More than once |
| pupil reactivity to light | 4 (29%) | | 1 (7%) | |
| airway patency | 7 (50%) | | 6 (40%) | 1 |
| Respiratory rate and effort | 14 (100%) | 3 | 15 (100%) | 5 |
| inspect and palpate chest wall | 7 (50%) | | 11 (73%) | |
| symmetrical rise/fall of chest | 10 (71%) | | 7 (47%) | |
| inspect and palpate flank | 5 (36%) | | 5 (33%) | |
| inspect and palpate abdomen | 7 (50%) | | 5 (33%) | 1 |
| assess neurovascular status | 14 (100%) | | 8 (53%) | 1 |
| assess pulse | 14 (100%) | 2 | 15 (100%) | 1 |
| perfusion - lower arm | 12 (86%) | | 11 (73%) | |
| signs of bleeding | 10 (71%) | | 10 (67%) | |
| assess capillary refill | 9 (64%) | | 4 (27%) | |
| assess neurovascular status | 3 (21%) | | 6 (40%) | 1 |
| perfusion - lower leg | 2 (14%) | | 5 (33%) | 1 |
| ?Tell me what happened? | 14 (100%) | | 13 (87%) | |
| ?How are you feeling now? | 9 (64%) | | 12 (80%) | |
| ?Do you have any allergies? | 5 (36%) | | 6 (40%) | |
| ?Do you have any medical problems? | 3 (21%) | | 3 (20%) | |
| ?Have you ever had an operation? | 3 (21%) | | 3 (20%) | |
| ?Any regular medications? | 2 (14%) | | 3 (20%) | |
| ?Where does it hurt? | 11 (79%) | | 12 (80%) | |
| ?Pain all the time? | 8 (57%) | | 6 (40%) | |
| ?Hurt when breath or move? | 10 (71%) | 1 | 9 (60%) | |
| ?Rate pain from 1 to 10? | 14 (100%) | 2 | 15 (100%) | 3 |
| ?Had a pee since? | 6 (43%) | | 7 (47%) | |
| ?When last eat or drink? | 2 (14%) | | 3 (20%) | |
| ?Where are you now? | 9 (64%) | | 9 (60%) | 1 |
| ?How did you get here? | 6 (43%) | 1 | 6 (40%) | |
| ?Were you knocked out? | 11 (79%) | 1 | 11 (73%) | 1 |
| ?How is your hand? | 8 (57%) | | 8 (53%) | |
| ?Touch and wiggle fingers? | 11 (79%) | 1 | 10 (67%) | |
| **Total** | **250** | | **245** | |

Table A4.1 shows the number of coders who accessed each element of the simulation and the number of coders who accessed particular elements more than once. The Table shows that each element of the computer simulation was accessed by at least one of the 15 triage nurses – even though a number were of no direct importance to the triage process. It is unlikely that the triage nurse would have embarked upon such a range of irrelevant questions and tests with a real patient. So this is one area where the computer simulation is providing a different experience to reality.

We can also see from Table A4.1 that the only elements of the computer simulation which were accessed every time the TATTT was applied were i/ assessing respiratory rate and effort, ii/ accessing pulse and iii/ asking the patient to rate their pain. At the initial coding, all triage nurses assessed neurological status and asked the patient "Tell me what happened?"

The mean number of elements accessed by the triage nurses were (250/14=) 17.9 on the initial viewing and (245/15=) 16.3 on the re-test. The mean number of elements accessed by triage nurses from Princess Alexandria Hospital at the first and second coding was 14 and 14.6 respectively compared to 19.4 and 17.2 for the Toowoomba Base Hospital triage nurses.

Table A4.2 shows the mean amount of time spent examining each response (that is the time in seconds between when the triage nurse asked for the item till when they asked for the next item). The last item requested on each TATTT session is excluded because the finish time was not recorded.

The mean time per element was 13.8 seconds during the initial viewing and 12.2 seconds during the one month re-test. The mean time on the simulation (excluding the last element) was 5 minutes 10 seconds during the initial visit and 4 minutes 11 seconds at the one month follow-up. The mean times for triage nurses from Princess Alexandria Hospital were 4 minutes 53 seconds during the initial visit and 3 minutes 46 seconds at the one month follow-up. The equivalent results for triage nurses from Toowoomba Base Hospital are 5 minutes 17 seconds and 4 minutes 23 seconds.

*Table A4.2: Mean time in seconds spent examining each component of the simulation*

| ITEM | Initial viewing | | | One month re-test | | |
|---|---|---|---|---|---|---|
| | No. times accessed | Mean (secs) | Std dev (secs) | No times accessed | Mean (secs) | Std dev (secs) |
| pupil reactivity to light | 4 | 12.8 | 4.8 | 1 | 5.0 | n/a |
| airway patency | 6 | 27.2 | 30.3 | 7 | 9.6 | 9.5 |
| Respiratory rate and effort | 14 | 23.0 | 19.7 | 17 | 23.4 | 24.1 |
| inspect and palpate chest wall | 7 | 4.9 | 2.5 | 11 | 9.8 | 7.2 |
| symmetrical rise/fall of chest | 10 | 20.8 | 11.2 | 7 | 12.9 | 10.1 |
| inspect and palpate flank | 5 | 38.0 | 37.8 | 5 | 9.6 | 7.7 |
| inspect and palpate abdomen | 7 | 19.6 | 11.8 | 6 | 13.3 | 8.8 |
| assess neurovascular status | 10 | 5.1 | 4.3 | 9 | 4.9 | 6.9 |
| assess pulse | 16 | 9.8 | 7.2 | 15 | 13.9 | 14.1 |
| perfusion - lower arm | 11 | 11.6 | 17.4 | 7 | 12.0 | 17.5 |
| signs of bleeding | 10 | 5.4 | 8.0 | 9 | 13.0 | 15.0 |
| assess capillary refill | 8 | 22.9 | 18.7 | 4 | 31.5 | 21.5 |
| assess neurovascular status | 3 | 4.7 | 3.8 | 6 | 6.8 | 11.4 |
| perfusion - lower leg | 2 | 8.5 | 2.1 | 4 | 12.5 | 11.8 |
| | | | | | | |
| Tell me what happened? | 14 | 20.7 | 12.1 | 13 | 18.7 | 15.0 |
| How are you feeling now? | 9 | 10.8 | 6.1 | 12 | 25.2 | 34.1 |
| Do you have any allergies? | 5 | 9.4 | 4.3 | 6 | 13.0 | 18.9 |
| Do you have any medical problems? | 3 | 3.7 | 0.6 | 3 | 3.0 | 1.0 |
| Have you ever had an operation? | 3 | 4.3 | 0.6 | 3 | 3.7 | 0.6 |
| Any regular medications? | 2 | 6.5 | 2.1 | 3 | 1.7 | 0.6 |
| Where does it hurt? | 11 | 8.9 | 5.5 | 12 | 7.1 | 5.7 |
| Pain all the time? | 8 | 3.3 | 1.3 | 6 | 3.2 | 1.2 |
| Hurt when breath or move? | 11 | 5.7 | 3.1 | 9 | 12.2 | 6.9 |
| Rate pain from 1 to 10? | 14 | 24.9 | 10.8 | 14 | 20.9 | 17.5 |
| Had a pee since? | 6 | 16.5 | 14.0 | 7 | 5.9 | 3.2 |
| When last eat or drink? | 2 | 6.5 | 2.1 | 3 | 5.3 | 5.1 |
| Where are you now? | 9 | 3.4 | 1.7 | 10 | 3.0 | 1.8 |
| How did you get here? | 7 | 3.1 | 1.8 | 6 | 1.8 | 0.8 |
| Were you knocked out? | 12 | 16.9 | 23.5 | 12 | 7.0 | 7.2 |
| How is your hand? | 8 | 4.8 | 4.3 | 8 | 3.3 | 1.9 |
| Touch and wiggle fingers? | 11 | 26.4 | 19.6 | 10 | 17.4 | 11.3 |
| Total | 248 | 13.8 | 15.4 | 245 | 12.2 | 15.4 |

## *Appendix 5: Analysis of the coding of the video simulations*

*Analysis of video number 1*

In the opinion of the research team, the 'correct' triage rating for this video simulation is 1. Table A5.1 shows there is considerable variation in triage codes assigned to this simulation by the triage nurses. At the initial triage two thirds of triage nurses produced a triage rating of 1 but at the one month re-test less than half of the nurses gave this rating.

The test / re-test reliability had an overall agreement of 60% with a kappa statistic $\hat{\kappa} = 0.29$ with an associated 95% confidence interval of [-0.16, 0.74].

*Table A5.1 The distribution of TATTT ratings for video number 1*

| | | Triage category - One month re-test | | | Total |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | |
| Triage category- Initial triage | 1 | 6 | 4 | 0 | 10 |
| | 2 | 0 | 3 | 1 | 4 |
| | 3 | 1 | 0 | 0 | 1 |
| Total | | 7 | 7 | 1 | 15 |

Looking at the coding of the individual elements of the TATTT for video number 1 we find the variations shown in Tables A5.2a to A5.2f. In summary:

- Respiratory Effort was expected to be coded as level 5, but 3 coders varied their codes between levels 4 and 5.
- Appearance of Skin was expected to be coded as level 4 (pale, warm and dry). Only eight of the 15 triage nurses gave this code on both occasions. Other coders varied across the full range of all possible outcomes (there is no code 3 for this variable).
- External Bleeding was expected to be coded at level 1 (large arterial, controlled). The maximum possible number of 'successes' on this element is only 6 out of 15 (if the 2 non-applicable results would have selected a code of 1). The other coders appeared to opt for an inconsistent mixture of small arterial / large venous controlled or uncontrolled.
- Pain Score was expected to be coded at level 3 (5 out of 10). One triage nurse coded it as level 2 (7 or more out of 10) at the one month re-test.
- Condition of Extremities was incorrectly coded as a 3 once by one of the triage nurses.
- High Risk Mechanisms was incorrectly coded as present by one triage nurse on both coding occasions and was incorrectly coded as present by two other nurses on one occasion each.

*Table A5.2a Variation in coding Respiratory Effort for Video 1*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 4 | 5 | |
| Triage category- Initial triage | 4 | 0 | 1 | 1 |
| | 5 | 2 | 12 | 14 |
| Total | | 2 | 13 | 15 |

*Table A5.2b Variation in coding Appearance of Skin for Video 1*

| | | Triage category - One month re-test | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 4 | 5 | |
| Triage category- Initial triage | 2 | 0 | 0 | 1 | 0 | 1 |
| | 4 | 2 | 2 | 8 | 0 | 12 |
| | 5 | 0 | 0 | 0 | 2 | 2 |
| Total | | 2 | 2 | 9 | 2 | 15 |

*Table A5.2c Variation in coding External Bleeding for Video 1*

| | | Triage category - One month re-test | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | n/a | |
| Triage category- Initial triage | 1 | 4 | 4 | 0 | 2 | 10 |
| | 2 | 0 | 1 | 3 | 0 | 4 |
| | 3 | 0 | 1 | 0 | 0 | 1 |
| Total | | 4 | 6 | 3 | 2 | 15 |

*Table A5.2d Variation in coding Pain Score for Video 1*

| | | Triage category - One month re-test | | | Total |
|---|---|---|---|---|---|
| | | 2 | 3 | n/a | |
| Triage category- Initial triage | 3 | 1 | 4 | 0 | 5 |
| | n/a | 0 | 4 | 6 | 10 |
| Total | | 1 | 8 | 6 | 15 |

*Table A5.2e Variation in coding Condition of Extremities for Video 1*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 5 | n/a | |
| Triage category- Initial triage | 3 | 1 | 0 | 1 |
| | 5 | 3 | 1 | 4 |
| | n/a | 4 | 6 | 10 |
| Total | | 8 | 7 | 15 |

*Table A5.2f Variation in coding High Risk Mechanisms for Video 1*

| | | Triage category - One month re-test | | | Total |
|---|---|---|---|---|---|
| | | 3 | 5 | n/a | |
| Triage category- | 3 | 1 | 0 | 0 | 1 |
| Initial triage | 5 | 2 | 1 | 1 | 4 |
| | n/a | 2 | 2 | 6 | 10 |
| Total | | 5 | 3 | 7 | 15 |

*Analysis of video number 2*

In the opinion of the research team, the 'correct' triage rating for this video simulation is 2. Table A5.3 shows that most triage nurses arrived at a TATTT rating of 2 for video number 2. However, one triage nurse consistently produced a rating of 1 and two others alternated between ratings of 1 and 2.

The test / re-test reliability had an overall agreement of 87% with a kappa statistic $\hat{\kappa} = 0.42$ with an associated 95% confidence interval of [-0.24, 1.00].

*Table A5.3 The distribution of TATTT ratings for video number 2*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 1 | 2 | |
| Triage category- | 1 | 1 | 1 | 2 |
| Initial triage | 2 | 1 | 12 | 13 |
| Total | | 2 | 13 | 15 |

Looking at the coding of the individual elements of the TATTT for video number 2 we find the variations shown in Tables A5.4a to A5.4d. In summary:

- Respiratory Effort was expected to be coded as level 2 (laboured), but only one of the 15 triage nurses selected this rating on both occasions. The code most commonly selected was 4 (mildly decreased / increased).
- Appearance of Skin was expected to be coded as 4 (pale, warm, dry). Only 7 of the 15 triage nurses gave this code on both occasions. Other coders varied across the full range of all possible outcomes. One triage nurse selected a code of 1 (pale, cool, clammy) on both occasions while another selected the complete opposite code of 5 (pink warm and dry) on both occasions.
- External Bleeding was expected to be coded as 5 (No signs of external bleeding). Only two triage nurses consistently obtained this code. The most frequently used code was 4 (Small venous: controlled).
- Condition of Extremities was expected to be coded 5. One triage nurse coded it as 3 on one occasion.

*Table A5.4a Variation in coding Respiratory Effort for Video 2*

| | | Triage category - One month re-test | | | Total |
|---|---|---|---|---|---|
| | | 2 | 4 | 5 | |
| Triage category- Initial triage | 2 | 1 | 2 | 0 | 3 |
| | 4 | 2 | 8 | 1 | 11 |
| | 5 | 0 | 1 | 0 | 1 |
| Total | | 3 | 11 | 1 | 15 |

*Table A5.4b Variation in coding Appearance of Skin for Video 2*

| | | Triage category - One month re-test | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 4 | 5 | |
| Triage category- Initial triage | 1 | 1 | 0 | 0 | 0 | 1 |
| | 2 | 0 | 0 | 1 | 0 | 1 |
| | 4 | 0 | 1 | 7 | 4 | 12 |
| | 5 | 0 | 0 | 0 | 1 | 1 |
| Total | | 1 | 1 | 8 | 5 | 15 |

*Table A5.4c Variation in coding External Bleeding for Video 2*

| | | Triage category - One month re-test | | | Total |
|---|---|---|---|---|---|
| | | 4 | 5 | n/a | |
| Triage category- Initial triage | 3 | 2 | 0 | 0 | 2 |
| | 4 | 7 | 1 | 0 | 8 |
| | 5 | 2 | 2 | 0 | 4 |
| | n/a | 0 | 0 | 1 | 1 |
| Total | | 11 | 3 | 1 | 15 |

*Table A5.4d Variation in coding Condition of Extremities for Video 2*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 5 | n/a | |
| Triage category- Initial triage | 3 | 1 | 0 | 1 |
| | 5 | 11 | 1 | 12 |
| | n/a | 1 | 1 | 2 |
| Total | | 13 | 2 | 15 |

*Analysis of video number 3*

In the opinion of the research team, the 'correct' triage rating for this video simulation is 3. Table A5.5 shows there was considerable disagreement on the TATTT code for video number 3. Only four of the triage nurses consistently recorded a triage rating of 3. Seven triage nurses consistently rated this simulation as a 4 while the remaining four triage nurses varied between ratings of 3 and 4 alternatives.

The test / re-test reliability had an overall agreement of 73% with a kappa statistic $\hat{\kappa} = 0.44$ with an associated 95% confidence interval of [-0.02, 0.91].

*Table A5.5 The distribution of TATTT ratings for video number 3*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 4 | |
| Triage category- Initial triage | 3 | 4 | 2 | 6 |
| | 4 | 2 | 7 | 9 |
| Total | | 6 | 9 | 15 |

Looking at the coding of the individual elements of the TATTT for video number 3 we find the variations shown in Tables A5.6a to A5.6c. In summary:

- Pulse Rate was expected to be coded as level 5 (between 60 and 90), but only one of the 13 triage nurses selected this rating on both occasions. The other two varied between codes of 4 and 5.
- Appearance of Skin was expected to be coded as 5 (pink, warm, dry). While the majority of triage nurses selected this code, one triage nurse selected a code of 4 (pale, warm, dry) on both coding occasions.
- High Risk Mechanism was expected to be coded as 3 (high risk mechanism present). Four of the triage nurses recorded the presence of a high risk mechanism on both occasions and seven did not record it on either occasion. The remaining four varied their coding between the two occasions.

*Table A5.6a Variation in coding Pulse Rate for Video 3*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 4 | 5 | |
| Triage category- Initial triage | 4 | 0 | 1 | 1 |
| | 5 | 1 | 13 | 14 |
| Total | | 1 | 14 | 15 |

*Table A5.6b Variation in coding Appearance of Skin for Video 3*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 4 | 5 | |
| Triage category- Initial triage | 4 | 1 | 0 | 1 |
| | 5 | 0 | 14 | 14 |
| Total | | 1 | 14 | 15 |

*Table A5.6c Variation in coding High Risk Mechanism for Video 3*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 4 | 2 | 6 |
| | 5 | 2 | 7 | 9 |
| Total | | 6 | 9 | 15 |

*Analysis of video number 4*

In the opinion of the research team, the 'correct' triage rating for this video simulation is 4. Table A5.7 shows that using video number 4 most triage nurses arrived at a TATTT rating of 4. However, one triage nurse consistently produced a rating of 3 for this video and two others wavered between ratings of 3 and 4 between the initial triage and re-test.

The test / re-test reliability had an overall agreement of 87% with a kappa statistic $\hat{\kappa} = 0.44$ with an associated 95% confidence interval of [-0.23, 1.00].

*Table A5.7 The distribution of TATTT ratings for video number 4*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 4 | |
| Triage category- Initial triage | 3 | 1 | 2 | 3 |
| | 4 | 0 | 12 | 12 |
| Total | | 1 | 14 | 15 |

Looking at the coding of the individual elements of the TATTT for video number 4 we find the variations shown in Tables A5.8a and A5.8b. In summary:

- External Bleeding was expected to be coded as 5 (No signs of external bleeding). Only two triage nurses consistently obtained this code. The most frequently used code was 4 (Small venous: controlled).
- High Risk Mechanism was expected to be coded as 5 (no high risk mechanism). One triage nurse recorded the presence of a high risk mechanism on both occasions and twelve did not record it on either occasion. The remaining two varied their coding between the two occasions.

*Table A5.8a Variation in coding External Bleeding for Video 4*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 4 | 5 | |
| Triage category- Initial triage | 4 | 10 | 0 | 10 |
| | 5 | 3 | 2 | 5 |
| Total | | 13 | 2 | 15 |

*Table A5.8b Variation in coding High Risk Mechanism for Video 4*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 1 | 2 | 3 |
| | 5 | 0 | 12 | 12 |
| Total | | 1 | 14 | 15 |

*Analysis of video number 5*

In the opinion of the research team, the 'correct' triage rating for this video simulation is 5. Table A5.9 shows while the test-retest agreement for video number 5 was 100% ($\hat{\kappa} = 1.00$),one of the triage nurses was consistently arriving at a triage rating of 3 while all others were all producing a triage rating of 5.

*Table A5.9 The distribution of TATTT ratings for video number 5*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 1 | 0 | 1 |
| | 5 | 0 | 14 | 14 |
| Total | | 1 | 14 | 15 |

The only difference in the coding of the individual elements of the TATTT for video number 5 was that one triage nurse recorded the presence of a high risk mechanism on both occasions (Table A5.10).

*Table A5.10 Variation in coding High Risk Mechanism for Video 5*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 1 | 0 | 1 |
| | 5 | 0 | 14 | 14 |
| Total | | 1 | 14 | 15 |

## *Appendix 6: Analysis of the coding of the written scenarios*

*Analysis of written scenario 1*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 3. Table A6.1 shows that while all triage ratings conformed to the research team's opinion in the initial triage session, four triage nurses changed their rating to 4 at the one month re-test.

The test / re-test reliability had an overall agreement of 73% with a kappa statistic $\hat{\kappa} = 0.00$ with an associated 95% confidence interval of [-1.00, 1.00].

*Table A6.1 The distribution of TATTT ratings for written scenario 1*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 3 | 4 | |
| Triage category- 3 Initial triage | 11 | 4 | 15 |
| Total | 11 | 4 | 15 |

Looking at the coding of the individual elements of the TATTT for written scenario 1 we find the variations shown in Tables A6.2a to A6.2d. In summary:

- Skin Appearance was incorrectly coded as 'pale' on one occasion by one triage nurse.
- Pain Score was incorrectly coded as 5 on one occasion by one triage nurse.
- Condition of extremities was expected to be coded as 5 (nothing unusual). While two triage nurses coded it as 3 at the initial coding session, all conformed to the expected code at the one month re-test.
- High Risk Mechanisms was expected to be coded as 3 (present). While all triage nurses conformed with this expectation at the initial triage, four failed to record high risk mechanisms at the one month re-test.

*Table A6.2a Variation in coding Skin Appearance for written scenario 1*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 5 | |
| Triage category- 4 | 1 | 1 |
| Initial triage 5 | 14 | 14 |
| Total | 15 | 15 |

*Table A6.2b Variation in coding Pain Score for written scenario 1*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 4 | 5 | |
| Triage category- Initial triage 4 | 14 | 1 | 15 |
| Total | 14 | 1 | 15 |

*Table A6.2c Variation in coding Condition of Extremities for written scenario 1*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 5 | |
| Triage category- Initial triage 3 | 2 | 2 |
| 5 | 13 | 13 |
| Total | 15 | 15 |

*Table A6.2d Variation in coding High Risk Mechanisms for written scenario 1*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 3 | 5 | |
| Triage category- Initial triage 3 | 11 | 4 | 15 |
| Total | 11 | 4 | 15 |

*Analysis of written scenario 2*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 4. Table A6.3 shows that only 9 (60%) of triage nurses produced a rating of 4 on both trials. Two nurses produced a rating of 3 on both occasions and 4 alternated between ratings of 3 and 4.

The test / re-test reliability had an overall agreement of 73% with a kappa statistic $\hat{\kappa} = 0.33$ with an associated 95% confidence interval of [-0.21, 0.88].

*Table A6.3 The distribution of TATTT ratings for written scenario 2*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 3 | 4 | |
| Triage category- Initial triage 3 | 2 | 3 | 5 |
| 4 | 1 | 9 | 10 |
| Total | 3 | 12 | 15 |

Looking at the coding of the individual elements of the TATTT for written scenario 2 we find the variations shown in Tables A6.4a to A6.4d. In summary:

- Respiratory effort was incorrectly coded as '15-20' once on the initial assessment.

- Pain Score was incorrectly coded as 5 on one occasion by one triage nurse.
- Condition of extremities was expected to be coded as 5 (nothing unusual) but one triage nurses coded it as 3 at the initial coding session.
- High Risk Mechanisms was expected to be coded as 5 (absent). Only 10 of the 15 triage nurses used this code on both occasions. Two nurses were consistently believed high risk mechanism to be present and 3 others had different views at the different coding occasions.

*Table A6.4a Variation in coding Respiratory Effort for written scenario 2*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 4 | |
| Triage category- Initial triage | 4 | 14 | 14 |
| | 5 | 1 | 1 |
| Total | | 15 | 15 |

*Table A6.4b Variation in coding Pain Score for written scenario 2*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 4 | |
| Triage category- Initial triage | 4 | 14 | 14 |
| | 5 | 1 | 1 |
| Total | | 15 | 15 |

*Table A6.4c Variation in coding Condition of Extremities for written scenario 2*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 5 | |
| Triage category- Initial triage | 3 | 1 | 1 |
| | 5 | 14 | 14 |
| Total | | 15 | 15 |

*Table A6.4d Variation in coding High Risk Mechanisms for written scenario 2*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 2 | 2 | 4 |
| | 5 | 1 | 10 | 11 |
| Total | | 3 | 12 | 15 |

*Analysis of written scenario 3*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 4. Table A6.5 shows that all triage nurses produced the expected rating on both trials. All elements of the TATTT conformed to expectations for all raters.

The test / re-test reliability had an overall agreement of 100% with a kappa statistic $\hat{\kappa} = 1.00$.

*Table A6.5 The distribution of TATTT ratings for written scenario 3*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 4 | |
| Triage category- Initial triage 4 | 14 | 14 |
| Total | 14 | 14 |

*Analysis of written scenario 4*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 3. Table A6.6 shows that all triage nurses produced the expected rating on both trials.

The test / re-test reliability had an overall agreement of 100% with a kappa statistic $\hat{\kappa} = 1.00$.

*Table A6.6 The distribution of TATTT ratings for written scenario 4*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 3 | |
| Triage category- Initial triage 3 | 15 | 15 |
| Total | 15 | 15 |

Tables A6.7a and A6.7b show that there was some variation in the coding of the individual elements of the TATTT, even though these did not alter the overall triage code. In summary:

- Respiratory effort was incorrectly coded as '15-20' once.
- High Risk Mechanisms was unexpectedly coded as 5 (absent) once.

*Table A6.7a Variation in coding Respiratory Effort for written scenario 4*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 4 | 5 | |
| Triage category- Initial triage 4 | 14 | 1 | 15 |
| Total | 14 | 1 | 15 |

*Table A6.7b Variation in coding High Risk Mechanism for written scenario 4*

| | Triage category - One month re-test | | Total |
|---|---|---|---|
| | 3 | 5 | |
| Triage category- Initial triage 3 | 5 | 1 | 6 |
| 5 | 3 | 6 | 9 |
| Total | 8 | 7 | 15 |

*Analysis of written scenario 5*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 3. Table A6.8 shows that all triage nurses produced the expected rating on both trials.

The test / re-test reliability had an overall agreement of 100% with a kappa statistic $\hat{\kappa} = 1.00$.

*Table A6.8 The distribution of TATTT ratings for written scenario 5*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 3 | |
| Triage category- Initial triage 3 | 15 | 15 |
| Total | 15 | 15 |

Table A6.9 shows that two triage nurses unexpectedly coded skin appearance as 'pale, warm and dry' instead of 'pink, warm and dry' on the initial assessment.

*Table A6.9 Variation in coding Appearance of Skin for written scenario 5*

| | Triage category - One month re-test | Total |
|---|---|---|
| | 5 | |
| Triage category- 4 | 2 | 2 |
| Initial triage 5 | 13 | 13 |
| Total | 15 | 15 |

*Analysis of written scenario 6*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 2. Table A6.10 shows that one of triage nurses produced a rating of 1 on initial assessment.

The test / re-test reliability had an overall agreement of 93% with a kappa statistic $\hat{\kappa} = 0.00$ with an associated 95% confidence interval of [-1.00, 1.00].

*Table A6.10 The distributions of TATTT ratings for written scenario 6*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 2 | |
| Triage category- Initial triage | 1 | 1 | 1 |
| | 2 | 14 | 14 |
| Total | | 15 | 15 |

Looking at the coding of the individual elements of the TATTT for written scenario 6 we find the variations shown in Tables A6.11a to A6.11c. In summary:

- Airways was incorrectly coded as 'unable to breath' instead of 'no obstruction'. Presumably this was an error in data collection rather than an error in clinical judgment.
- Pain Score was incorrectly coded as 5 on both occasions by one of the triage nurses. It was also coded as 5 by two other nurses on different occasions.
- Condition of extremities was expected to be coded as 5 (nothing unusual) but one triage nurses coded it as 3 at the initial coding session.

*Table A6.11a Variation in coding Condition of Airway for written scenario 6*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 5 | |
| Triage category- Initial triage | 1 | 1 | 1 |
| | 5 | 14 | 14 |
| Total | | 15 | 15 |

*Table A6.11b Variation in coding Appearance of Skin for written scenario 6*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 4 | 5 | |
| Triage category- Initial triage | 4 | 11 | 1 | 12 |
| | 5 | 1 | 1 | 2 |
| | n/a | 0 | 1 | 1 |
| Total | | 12 | 3 | 15 |

*Table A6.11c Variation in coding Condition of Extremities for written scenario 6*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 5 | |
| Triage category- Initial triage | 3 | 1 | 1 |
| | 5 | 13 | 13 |
| | n/a | 1 | 1 |
| Total | | 15 | 15 |

*Analysis of written scenario 7*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 1. Table A6.12 shows that all triage nurses produced this rating on both assessments.

The test / re-test reliability had an overall agreement of 100% with a kappa statistic $\hat{\kappa} = 1.00$.

*Table A6.12 The distribution of TATTT ratings for written scenario 7*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 1 | |
| Triage category- Initial triage | 1 | 15 | 15 |
| Total | | 15 | 15 |

*Analysis of written scenario 8*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 4. Table A6.13 shows that only 10 (67%) of triage nurses produced a rating of 4 on both trials. One nurse produced a rating of 3 on both occasions and 4 alternated between ratings of 3 and 4.

The test / re-test reliability had an overall agreement of 73% with a kappa statistic $\hat{\kappa} = 0.19$ with an associated 95% confidence interval of [-0.44, 0.81].

*Table A6.13 The distribution of TATTT ratings for written scenario 8*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 4 | |
| Triage category- Initial triage | 3 | 1 | 3 | 4 |
| | 4 | 1 | 10 | 11 |
| Total | | 2 | 13 | 15 |

Looking at the coding of the individual elements of the TATTT for written scenario 6 we find the variations shown in Tables A6.14a and A6.14b. In summary:

- Respiratory rate was incorrectly coded as '15-20' on one initial assessment.
- High risk mechanism was unexpectedly deemed 'present' at both coding sessions by one nurse and at one coding session by four of the other nurses.

*Table A6.14a Variation in coding Respiratory Rate for written scenario 8*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 4 | |
| Triage category- Initial triage | 4 | 14 | 14 |
| | 5 | 1 | 1 |
| Total | | 15 | 15 |

*Table A6.14b Variation in coding High Risk Mechanisms for written scenario 8*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 1 | 3 | 4 |
| | 5 | 1 | 10 | 11 |
| Total | | 2 | 13 | 15 |

*Analysis of written scenario 9*

In the opinion of the research team, the 'correct' triage rating for this written simulation is 2. Table A6.15 shows all triage nurses produced the expected code on both coding occasions.

The test / re-test reliability had an overall agreement of 100% with a kappa statistic $\hat{\kappa} = 1.00$.

*Table A6.15 The distribution of TATTT ratings for written scenario 9*

| | | Triage category - One month re-test | Total |
|---|---|---|---|
| | | 2 | |
| Triage category- Initial triage | 2 | 15 | 15 |
| Total | | 15 | 15 |

Despite universal agreement with the study team on the overall triage code, there was almost universal disagreement on the presence of 'high risk mechanism'. The study team coded high risk mechanism as 'absent' but most nurses coded it as 'present' (see Table A6.16).

*Table A6.16 Variation in coding High Risk Mechanisms for written scenario 9*

| | | Triage category - One month re-test | | Total |
|---|---|---|---|---|
| | | 3 | 5 | |
| Triage category- Initial triage | 3 | 13 | 1 | 14 |
| | 5 | 0 | 1 | 1 |
| Total | | 13 | 2 | 15 |

## *Appendix 7: Deviations from expected codes by coder*

The three tables in this Appendix show the number of times each coder recorded a different code to that expected by the research team – both for overall TATTT and each component of the TATTT. Table A7.1 summarises results across all 15 simulations, Table A7.2 shows results for the 5 video simulations and Table 7.3 shows results for the 9 written scenarios.

The conclusions are that there is some variation in coding between triage nurses, but the greatest differences lie between results for the video simulations and the written simulations. All nurses have a higher number of deviations from the expected codes when rating video simulations than when rating written simulations.

*Table A7.1 Number of deviations from expected codes by triage nurse – all 15 simulations*

| | Nurse 1 | | Nurse 2 | | Nurse 3 | | Nurse 4 | | Nurse 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 4 | 5 | 5 |
| - Airway | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| - External Bleeding | 2 | 2 | 2 | 3 | 0 | 3 | 1 | 2 | 2 | 2 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 |
| - High Risk Mechanisms | 1 | 3 | 4 | 4 | 2 | 3 | 2 | 4 | 4 | 6 |

| | Nurse 6 | | Nurse 7 | | Nurse 8 | | Nurse 9 | | Nurse 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test ($n$=14) | Re-test | Initial test | Re-test |
| Triage score | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 3 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 3 | 2 |
| - Pulse Rate | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| - Appearance of Skin | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 3 |
| - External Bleeding | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| - High Risk Mechanisms | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 4 | 4 | 5 |

*Table A7.1 (continued) Number of deviations from expected codes by triage nurse – all 15 simulations*

| | Nurse 11 | | Nurse 12 | | Nurse 13 | | Nurse 14 | | Nurse 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 1 | 1 | 1 | 2 | 4 | 0 | 3 | 0 | 3 | 1 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 2 |
| - External Bleeding | 2 | 2 | 1 | 3 | 2 | 2 | 0 | 0 | 3 | 3 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - High Risk Mechanisms | 3 | 3 | 3 | 4 | 5 | 1 | 4 | 1 | 3 | 2 |

*Table A7.2 Number of deviations from expected codes by triage nurse for the video simulations*

| | Nurse 1 | | Nurse 2 | | Nurse 3 | | Nurse 4 | | Nurse 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 1 | 1 | 0 | 1 | 1 | 2 | 2 | 2 | 4 | 4 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 0 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| - External Bleeding | 2 | 2 | 2 | 3 | 0 | 3 | 1 | 2 | 2 | 2 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| - High Risk Mechanisms | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |

| | Nurse 6 | | Nurse 7 | | Nurse 8 | | Nurse 9 | | Nurse 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 2 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 2 | 1 |
| - Pulse Rate | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| - Appearance of Skin | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| - External Bleeding | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| - High Risk Mechanisms | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 2 | 2 |

*Table A7.2 (continued) Number of deviations from expected codes by triage nurse for the video simulations*

| | Nurse 11 | | Nurse 12 | | Nurse 13 | | Nurse 14 | | Nurse 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 0 | 0 | 1 | 3 | 2 | 0 | 2 | 0 | 2 | 1 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 2 |
| - External Bleeding | 2 | 2 | 1 | 3 | 2 | 2 | 0 | 0 | 3 | 3 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - High Risk Mechanisms | 0 | 0 | 1 | 2 | 2 | 0 | 2 | 0 | 1 | 1 |

*Table A7.3 Number of deviations from expected codes by triage nurse for the written simulations*

| | Nurse 1 | | Nurse 2 | | Nurse 3 | | Nurse 4 | | Nurse 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 0 | 1 | 3 | 1 | 0 | 1 | 0 | 2 | 1 | 1 |
| - Airway | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| - External Bleeding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| - High Risk Mechanisms | 0 | 2 | 4 | 3 | 1 | 2 | 1 | 3 | 2 | 3 |

| | Nurse 6 | | Nurse 7 | | Nurse 8 | | Nurse 9 | | Nurse 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test ($n$=8) | Re-test | Initial test | Re-test |
| Triage score | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| - External Bleeding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| - High Risk Mechanisms | 2 | 0 | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 3 |

*Table A7.3 (continued) Number of deviations from expected codes by triage nurse for the written simulations*

| | Nurse 11 | | Nurse 12 | | Nurse 13 | | Nurse 14 | | Nurse 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test | Initial test | Re-test |
| Triage score | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| - Airway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Respiratory Effort | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pulse Rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Appearance of Skin | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| - External Bleeding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Neurological Status | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - Pain Score | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - Condition of Extremities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - High Risk Mechanisms | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 |

## *Appendix 8: Audit of Parallel Triaging*

| ATS Triage Score | TATTT Triage Score | Presenting complaint | Parameter of difference | Team Consensus Triage Category | Comment |
|---|---|---|---|---|---|
| 3 | 2 | Painful hip | Pain | 2 | Pain 8/10 recorded by triage nurse |
| 4 | 3 | Painful ankle | Pain/pulse | 3 | Pain not asked obs not done |
| 4 | 5 | Painful toes | | 5 | Delayed presentation (5days) pain score at rest 0-2 |
| 4 | 3 | MVA | Mechanism | 3 | Inaccurate assessment of mechanism triage |
| 4 | 3 | Kicked in ribs – football, pain on inspiration | Pain | 3 | Pain score not assessed formally at triage |
| 3 | 2 | Fall on metal rail | Pain | 2 | Pain score not assessed formally at triage |
| 4 | 5 | Lump of wood on shoulder – yesterday | | 5 | Minor injury within 24/24 |
| 3 | 2 | ?Clavicle #- tree branch on from 25m | Pain | 2 | Pain score not assess formally at triage |
| 4 | 3 | Crush injury finger in car door – ring needs cutting off | Pain | 3 | |
| 4 | 3 | MBA- driver yester now pain ribs left leg left arm | Pain/ mechanism | 3 | Pain score not assessed formally at triage, lack on appreciation of mechanism |
| 4 | 5 | Painful arm MBA | | 5 | Pain not assessed |
| 3 | 2 | Painful hand, fall prone to blackouts | Pain | 2 | Pain score not assessed formally at triage |
| 3 | 4 | Painful ankle | Pain | 4 | Pain 3-4, pain not assessed |
| 4 | 5 | Painful thumb caught on steering wheel 3/7 delayed presentation | | 5 | Pain 7/8 on moving, inappropriate use of pain score – pain at rest vs pain at movement |
| 4 | 3 | Painful R knee – playing football | Pain | 3 | Pain score not assessed formally at triage |
| 3 | 2 | Fall painful wrist, cold fingers, pain 8/10 despite QAS analgesia | Pain | 2 | Pain score done – ignored |
| 5 | 4 | Stood on tack – needs tetanus | | 5 | Case deleted as not presented because of trauma – presented for medication |
| 4 | 3 | Hit by broom on arm | Pain | 3 | Pain score not assessed formally at triage |
| 3 | 4 | Fall on even surface – back/abdo | Pain | 4 | Pain score inappropriately applied – relatively lower pain as rest |
| 4 | 3 | Burn wrist and hand following seizure | Lost of distal sensation | 3 | Burn not assessed by triage nurse |

| ATS Triage Score | TATTT Triage Score | Presenting complaint | Parameter of difference | Team Consensus Triage Category | Comment |
|---|---|---|---|---|---|
| 4 | 5 | Painful knee joint – football 1/7 delay | | 5 | Pain score less than 2 at rest |
| 4 | 3 | Laceration finger altered sensation to tip | Pain/loss of sensation | 3 | Pain score not formally assessed at Triage |
| 4 | 5 | Painful knee joint post fall – delayed presentation | | 4 | Variability in patient reporting |
| 3 | 2 | MBA – driver pain both keens, multiple abrasions. Pain 9/10 | Pain | 2 | Pain score done – ignored |
| 3 | 2 | MBA painful arm altered sensation , chest pain, speed 40mh/hr | Pain/ mechanism | 2 | Pain score not formally assessed at triage |
| 4 | 3 | Fall from scaffolding 2/7 ago pain R hip knee and ankle | Pain/ mechanism | 3 | Pain not assessed |
| 1 | 2 | Fall 3m from vehicle GCS 14, LOC pain 5/10 back and neck, bleeding from left ear | Pain/mechanism/LOC | 2 | Overtriaged |
| 4 | 3 | Painful foot, kicked by friend while kickboxing | Pain/box theory | 3 | Pain score not assessed at triage |
| 4 | 3 | Painful knee – kicked by cow | Pain/ tachycardia | 3 | Pain score ignored |
| 4 | 3 | Painful knee – hit against bus seat yesterday | Pain | 3 | Pain not assessed |
| 4 | 2 | Large laceration with flap to planter surface right foot | Pain/ tachycardia/ resps | 2 | Pain not assessed |
| 4 | 3 | Fall from sitting height, elderly lady | Pain/ Tachycardia | 3 | Pain not assessed |
| 4 | 5 | Hit hand with hammer 2/7 ago affecting ability to work | | 5 | Delayed presentation with minimal pain at rest |

## *Appendix 9: Plain Language Statements and Consent forms*

**PLAIN LANGUAGE STATEMENT AND CONSENT FORM - NURSES**

The Toowoomba Health Service Emergency Department is developing a tool that will assist nurses to undertake triage ratings in a less subjective manner. The tool has been developed from the Australasian Triage Scale (ATS) and it has been peer reviewed in 2002, by being sent to experienced Emergency Department nurses and doctors who have made suggestions to improve its efficiency.

In this study, we aim to establish the most appropriate mechanism for establishing the validity and reliability of this tool for the measurement of triage category.

As an Emergency Department Registered Nurse we are asking you to participate in several ways. First, we ask if you would use the Toowoomba Adult Trauma Triage Tool (TATTT) to triage scenarios presented to you on paper, video and computer. We will ask you to do this twice. Second, we ask that you participate in a thirty-minute interview with Professor Hegney. Professor Hegney will ask for your impressions of the TATTT and its usefulness in the triage of adult trauma patients.

You do not have to participate in this study. If you choose not to participate, your employment will not be jeopardised in any way. If you wish to withdraw from the study you can do so at any time by contacting Professor Hegney. If you do withdraw the tape of your interview will be returned to you and the ratings by using the TATTT will be removed from the data.

CONSENT

I .....

Of .....
have read the information above and agree to participate in the study. I am aware that I can withdraw from the study at any time by contacting Professor Hegney and that the information I have provided will not be used in the study. I agree that the information from this study can be published as long as I cannot be identified in any way.

.....
Signed

Date

.....
Witness

Date

**Any questions with regard to this project may be directed to:**
Professor Desley Hegney, Chair of Rural Nursing, University of Southern Queensland and Toowoomba Health Service District, Centre for Rural and Remote Area Health, USQ, Toowoomba, QLD, 4350. Telephone: 4631 5456; Fax: 46431 5452; Email: hegney@usq.edu.au

**Any concerns regarding the project implementation may be directed to:**
The Secretary, Human Research Ethics Committee USQ or telephone (07) 4631 2956.

**PLAIN LANGUAGE STATEMENT AND CONSENT FORM – PATIENTS AND GUARDIANS**

The Toowoomba Health Service Emergency Department is developing a tool that will assist nurses to undertake triage ratings. A triage rating is a score of between 1 and 5 that nurses allocate to all patients presenting to the Emergency Department for Treatment and it reflects the urgency of the condition and therefore how quickly patients are seen by a medical officer.

The tool has been developed from the Australasian Triage Scale (ATS) and it has been sent to experienced Emergency Department nurses and doctors who have made suggestions to improve its efficiency.

In this study, we aim to establish if the tool, when used by a triage nurse, is able to determine the triage category better than the current process (which does not use a tool). As the aim of the study is to establish the worth of the tool, we are not collecting any personal data about patients. We are only comparing triage scale ratings between two nurses.

To determine if the tool is reliable we will have an experience Emergency Department nurse sit next to the nurse who is actually carrying out the triage. Both nurses will undertake the triage and will not share their findings with each other. This will ensure that the triage is undertaken in the way it is normally undertaken in the Emergency Department. The research team will compare the ratings between the two nurses to ascertain if there are differences and what these differences are.

As we do not want to interfere with the way your treatment is being given, we are asking your permission to include your triage score after the triaging has been carried out. If you do not wish for your triage score to be included into the study, you can choose not to agree to this and we will remove all the information we have collected. We assure you that any treatment you have received or will receive in the future will not be affected by your willingness to agree to participate in this project.

You should also be aware that you can withdraw from the study at any time. If you wish to do this, you should notify Professor Hegney on the numbers provided below, and she will ensure that this occurs.

**CONSENT**

I .....

Of .....

have read the information above and agree to participate in the study. I am aware that I can withdraw from the study at any time by contacting Professor Hegney and that the information I have provided will not be used in the study. I agree that the information from this study can be published as long as I cannot be identified in any way.

.....

Signed

Date

.....

Witness Date

**Any questions with regard to this project may be directed to:**

Professor Desley Hegney, Chair of Rural Nursing, University of Southern Queensland, Department of Nursing, Toowoomba, QLD, 4350. Telephone: 4631 5456; Fax: 46431 5452; Email: hegney@usq.edu.au

**Any concerns regarding the project implementation may be directed to:**

The Secretary, Human Research Ethics Committee USQ or telephone (07) 4631 2956.

**PLAIN LANGUAGE STATEMENT AND CONSENT FORM - NURSES**

The Toowoomba Health Service Emergency Department is developing a tool that will assist nurses to undertake triage ratings in a less subjective manner. The tool has been developed from the Australasian Triage Scale (ATS) and it has been peer reviewed in 2002, by being sent to experienced Emergency Department nurses and doctors who have made suggestions to improve its efficiency.

In this study, we aim to establish the most appropriate mechanism for establishing the validity and reliability of this tool for the measurement of triage category.

As an Emergency Department Registered Nurse we are asking you to participate in several ways. First, we ask if you would use the Toowoomba Adult Trauma Triage Tool (TATTT) to triage scenarios presented to you on paper, video and computer. We will ask you to do this twice. Second, we ask if you will consent to have Mr. Wollaston sit beside you and when you triage a patient presenting to the ED, he will also triage the patient, but you will use the ATS and he will use the TATTT. Third, we ask that you participate in a thirty-minute interview with Professor Hegney. Professor Hegney will ask for your impressions of the TATTT and its usefulness in the triage of adult trauma patients.

You do not have to participate in this study. If you choose not to participate, your employment will not be jeopardised in any way. If you wish to withdraw from the study you can do so at any time by contacting Professor Hegney. If you do withdraw the tape of your interview will be returned to you and the ratings by using the TATTT will be removed from the data.

CONSENT

I .....

Of .....
have read the information above and agree to participate in the study. I am aware that I can withdraw from the study at any time by contacting Professor Hegney and that the information I have provided will not be used in the study. I agree that the information from this study can be published as long as I cannot be identified in any way.

.....
Signed

Date

.....
Witness

Date

**Any questions with regard to this project may be directed to:**
Professor Desley Hegney, Chair of Rural Nursing, University of Southern Queensland and Toowoomba Health Service District, Centre for Rural and Remote Area Health, USQ, Toowoomba, QLD, 4350. Telephone: 4631 5456; Fax: 46431 5452; Email: hegney@usq.edu.au

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