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Australasian College for Emergency Medicine (ACEM) Literature Review on the Australasian Triage Scale (ATS)

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Foreword:

For more than 20 years, triage has been the cornerstone of emergency department (ED) operations in Australasia, determining not only the priority for individual patients but also providing a description of the urgency mix of ED patient populations. The Australasian Triage Scale (ATS) was developed and validated by a number of researchers as a means of providing standardisation of triage and has formed the basis of other triage systems in operation internationally. More recently, the ATS has been used for performance evaluation of EDs and has been proposed as the basis for future funding models.

However, increasing demand for EDs, increased complexity and severity of patients and their care, combined with Access Block has resulted in considerable ED overcrowding. This has attracted new management strategies and questions being asked about triage and its relevance to modern ED practice.

This review endorses continuation of the ATS in the role for which it was originally intended – to categorise patients by urgency. It recognises that urgency is fundamentally different to patient severity and complexity and identifies the need for research to examine the relationship between the three concepts. Complexity and severity measures should be parallel dimensions but at the same time the possibility of incorporating complexity and severity measures with ATS should be investigated. The review also recognises the need for complementary management strategies to improve the efficiency and effectiveness of ED management. It also upholds the view that triage is not, and should not be a "single point control mechanism for many non critical functions including regulatory requirements" as suggested recently in the August issue of *Annals of Emergency Medicine*. [1, 2]

The Australasian College for Emergency Medicine (ACEM) also encourages the need for further research into the relationship between triage descriptions and clinical and process outcomes. This includes the potential impact of the Four-Hour National Emergency Access Target on triage. There is also a need to explore other dimensions such as complexity and severity, and to develop and validate consistent complexity measures. As predicted more than 20 years ago: "shifting the queue and developing formal triage structures may become so complex that by themselves they become a source of delay for patients. As a result of this process, the patient, instead of waiting for medical care, is waiting for triage. Clearly such a system negates many of the advantages claimed for a formal triage system." [3]

There is also a need to identify potential misuse of the ATS such as extensive delays on Category 5 due to a continuing flow of higher triage category patients in the ED (cats 1-4). ACEM is committed to assess and supporting future initiatives to improve emergency patient reception, patient processes and care in the ED taking into consideration workforce issues and ensuring a national approach to ED care.

Executive Summary

Purpose

The purpose of the review is to draw on evidence from the literature to assess the current status and relevance of the Australasian College for Emergency Medicine's (ACEM's) policy document on the Australasian Triage Scale (ATS). In particular, the review explores some current issues such as: the validity and reliability of the ATS for differentiating clinical urgency for ED patients; the role of ATS in prioritising workload; and the role of the ATS in assessing the burden of work.

Scope of the review

The review focuses on the evidence linking the ATS to timeliness of assessment, treatment and disposition, and workload, and explores the validity of the ATS in relation to different types of point scales, in the context of the existing evidence surrounding their validity and reliability.

Methods

We used Google, Google Scholar, Medline, Embase, CINAHL and the Cochrane Collaboration for each of the research questions. For question 1, 31 out of 181 papers found in the databases were related to the question of validity, reliability and time thresholds. For question 2, 15 out of 25 papers recommended that the ATS and similar scales are still valid for differentiating clinical urgency for ED patients. For question 3, 35 out of 665 papers were deemed relevant. For question 4, nine out of 38 articles were identified in the database as potentially answering the research question.

This document addresses four main research questions developed by the ACEM Triage subcommittee:

1. What is the evidence for the validity of the current maximum waiting times and performance thresholds?
2. Is the ATS still a valid tool for differentiating clinical urgency for ED patients?
3. How do triage tools satisfy other dimensions of acuity such as provider related intensity, staff workload and complexity of patient condition?
4. What is the evidence for time thresholds and the role of the ATS in prioritising workload and assessment of the burden of work?

Main Findings and Recommendations

The literature review shows that the ATS is valid for determining urgency. Five-point scales have more validity than three or four-point scales. Triage categories 1 and 2 appear to be more reliable than categories 3, 4 and 5. This review has found no evidence that

supports the validity of the ATS in determining waiting time performance indicators. Neither was there evidence for the validity of the ATS in determining other measures such as severity, complexity, workload or staffing.

Question 1: What is the evidence for the validity of the current maximum waiting times and performance thresholds?

There are no validation studies directly linking the reliability of maximum waiting times and performance thresholds. Most studies have shown that, indirectly, triage categories do relate to certain medical conditions that are time sensitive. However, very few papers have recommended alternative triage systems to complement the initial triage assessment. There is evidence, albeit limited, suggesting that the maximum waiting times support the performance threshold. Research focusing on categories 3 and 4, has shown that, in general, outcomes do not change significantly between these categories. The validity of maximum waiting times varies according to triage category. The ATS has been shown to be more reliable at the critical level for categories 1 and 2, but not for lower categories such as 3 to 5. Some dimensions of care cannot be addressed in the ED. This includes the advanced nature or pre-existence of a condition before ED presentation which cannot be measured in the hospital setting.

Question 2.Is the ATS still a valid tool for differentiating clinical urgency for ED patients?

The ATS is a valid scale for differentiating the clinical urgency with which a patient needs to be seen. Most studies concur that ATS categories 1 and 2 are reliable. ATS categories 3 and 4 comprise the majority of ED work and ATS category 5 patients are usually treated and identified reliably. The review concludes that the ATS is valid and reliable for the most acute categories (ATS 1 and 2); however, it is less reliable for lower triage categories (ATS 3, 4 and 5). It is important to note that the majority of reliability studies in Australia were conducted before the implementation of a national approach to triage education and national use of the ATS. In relation to overall reliability, there is some evidence that triage nurse education has increased decision reliability in Australia, where nationally standardised education programs have been established.

Question 3.How do triage tools satisfy other dimensions of acuity such as provider related intensity, staff workload and complexity of patient diagnosis?

Triage tools have not been shown to be valid for dimensions apart from urgency, such as complexity and the relationship between triage and workforce. The investigation for question 3 drew on studies of various triage tools used internationally, revealing

associations between triaging and the workload of ED staff, busyness of the department, and complexity of patient conditions. However, these associations were more able to be inferred rather than having been explicitly made in the studies.

Question 4.What is the evidence for time thresholds and the role of the ATS in prioritising workload and for the assessment of the burden of work?

The ATS alone is an insufficient indicator of workload in the ED. This also applies to other versions such as the Canadian Triage and Acuity Scale (CTAS). There is some evidence suggesting that a simple relationship between triage category and workload, to the exclusion of other variables, is unhelpful for assessing and managing ED workload because other dimensions such as procedural work required, arrival by ambulance, level of trauma, patient complexity and other co-morbidities contribute to patient volume and perceived acuity.

Recommendations and Future Directions.

The review points to the following directions for future deliberation:

1. The ATS in its current form should only be used to describe urgency.
2. Separate measures are needed to describe severity, complexity, workload and staffing.
3. Separate measures are needed to assess quality of care – in terms of both clinical quality and system wide quality.
4. Standard definitions are needed for many terms such as urgency, severity and complexity, because they are used interchangeably by some, contributing to conceptual confusion.

The findings of this review are consistent with other reviews available in the literature. The following specific recommendations have been made regarding policy changes required to the ACEM policy document (P06) based on this literature review. These include:

1. Update references regarding the validity and reliability of the ATS
2. A need for the ACEM to explore the ATS policy in the context of current and future changes required in the field, such as the potential impact on triage of the Four-Hour National Emergency Access Target (NEAT) in different states in Australia and the "six-hour rule" in New Zealand.
3. A need for further research and a systematic approach to assessing policy developments in Australia and internationally.

Glossary of Terms

Acuity	Acuity is a synonym for urgency, and they can be used interchangeably. An acuity-based description should answer the question: How soon should a patient be seen?
Admission	Admission is a decision process of determining the needs of a patient beyond emergency care, in particular, residence in an inpatient hospital ward. This can be determined by a combination of factors, including investigations, diagnoses and required treatments for the presenting condition(s).
ATS	The Australasian Triage Scale (ATS) is designed for use in hospital-based emergency services throughout Australia and New Zealand. It is a scale for rating clinical urgency and is comprised as a five-point descending scale. The ATS replaced the National Triage Scale (NTS) in 2002. (See policy document P06 as Attachment 1).
Complexity	Complexity relates to the difficulty of the presenting complaint and the resources involved in finding a solution to the complaint. A low ATS category with a highly complex problem may consume more resources and workload than a high acuity ATS presentation.
CTAS	Canadian Triage and Acuity Scale. It also has a paediatric version known as P-C TAS.
EMUs	Emergency medicine units, observation or short stay wards, are areas for time-limited inpatient management, generally for no longer than 24- 48 hours.
ESI	Emergency Severity Index. Mainly used in the United Stated and Canada.
Fast-Track	An ambulatory care area, a service designed for the timely assessment, treatment and discharge of patients with non-complex or single system conditions.
IpTS	Ipswich Triage Scale. It was adopted by ACEM in 1990.
ITS	International Triage Scale is a five point scale which is supported by an international collaborative towards a triage research agenda. This agenda would seek to further develop application and moderating tools and to utilise validated scales for international benchmarking and research programmes.
MTS	The Manchester Triage Scale is used in some parts of the UK and Europe.
NTS	National Triage Scale. It replaced the IpTS in 1994 and was replaced by the ATS in 2002.
Observation	A period of clinical monitoring of a patient to evaluate progress of a clinical condition, response to treatment or requirement for ongoing

	treatment.
OW	Observation Wards are areas within a hospital configured to facilitate short term clinical monitoring of patients. See "EMUs".
Re-admission	Re-admission refers to the admission of patients who have been previously admitted as an inpatient, in a short, defined period of time, for example in the last 48 hours.
Re-presentation	The act of a person presenting to the ED following a recent presentation, in a short, defined period of time, for example in the last 48 hours, for a similar presenting problem.
Severity	Severity of illness or injury is defined as the extent of musculoskeletal or organ system derangement or physiologic decompensation for an individual patient with the condition. Patients with higher severity of illness are more likely to consume greater healthcare resources and stay longer in hospital than patients with lower severity for the same diagnosis. Severity does not necessarily overlap with acuity, in that a non-acute patient might nonetheless be relatively severely ill.
Triage	A process of assessment of a patient on arrival to the ED to determine the priority for medical care based on the clinical urgency of the patient's presenting condition. Triage enables allocation of limited resources to obtain the maximum clinical utility for all patients presenting to the emergency department. The triage staff apply an ATS category in response to the question: "This patient should wait for assessment and treatment no longer than…."
Urgency	Defined in the triage assessment, urgency describes how quickly a patient needs to be seen in order to initiate treatment and prevent deterioration or further pain and suffering. It may not reflect the time, space, material and staff resources and workload consumed and, alone, is not an adequate indicator of resource and workload requirements.

Literature Review

1. Introduction and Background

The ATS was developed to prioritise patient care in the face of limited time, space, material and staff resources, and provide a consistent approach to triage practice at the national level. [4] It was developed in the 1990s and it has been modified a number of times. Triage scales are important tools in emergency medicine. They facilitate the categorisation of urgency with which patients need to be assessed and treated. [4-8] Compliance with performance indicator thresholds of the ATS is currently being used as a key performance indicator in Australian hospitals. Triage is a resource rationing process that is critical to the effective management of modern EDs.

Triage scales are often used to indicate clinical urgency and match the patient with the appropriate medical and nursing needs.[9] Other definitions to determine patient acuity such as severity, intensity and disease diagnosis are also investigated in this review. In particular, the review focuses on the use of the ATS to assess patients' urgency versus its use as a predictive tool to measure changes in morbidity/mortality, budgets and case management needs. [9] Triage systems aim not only to ensure clinical fairness for the patient, but also to provide an effective tool for departmental prioritisation, organisation, monitoring and evaluation. Triage has been described as a risk management tool for busy periods to prevent patients with time critical illnesses waiting an excessively long time for care. [10] Over the last 20 years, triage systems have been standardised in a number of countries and efforts made to ensure consistency of application. [6, 11]

The review covers not only the ATS, but also earlier versions of it, such as the IpTS and the NTS [3, 7, 11-15]. The review features scales used beyond Australia, such as adaptations of the ATS, including the CTAS [16-20]; the ESI used in the US and Canada[21-24]; the MTS in the UK and Europe[25-29]; the more recent ITS[6, 7, 11]; and other less commonly-used scales such as the Taiwan Triage System (TTS). These scales are examined in the context of the general evidence regarding the validity and reliability of emergency triaging. Comparing them individually is beyond the scope of this report. For a non-exhaustive list of triage scales, see Table A.1 in Appendix 2.

Aims of the literature review

This literature review aims to discern evidence for the reliability and validity of the ATS, and triage scales generally, and the relationship between triage and workload, organisation and ED management. The review also aims to discern implications from evidence for the ACEM ATS policy. As indicated earlier, the review focuses on the

current version of the ATS and similar tools, including those developed in Australia as well as others derived from other sources or disciplines.[6, 11]

2 Methods

The ACEM has designated a subcommittee to address the above issues. They have commissioned Dr Roberto Forero from The Simpson Centre for Health Services Research in the South Western Sydney Clinical School, affiliated with the Australian Institute of Health Innovation (AIHI) University of NSW, to undertake a review of the policy document and the literature on triage scales. Dr Forero enlisted Dr Peter Nugus, also from the Australian Institute of Health Innovation, to co-conduct the review. The review was developed in two stages. First, a comprehensive review of the empirical literature was explored to answer the research questions. Second, the ACEM Policy Document (P06) was reviewed and the comments were incorporated for endorsement by the Triage Subcommittee (see document attached with annotated comments as Appendix 1).

Research questions associated with the review were developed during the scoping phase by the subcommittee:

1. What is the evidence for the validity of the current maximum waiting times and performance thresholds?
2. Is the ATS still a valid tool for differentiating clinical urgency for ED patients?
3. How do triage tools satisfy other dimensions of acuity such as provider related intensity, staff workload and complexity of patient condition?
4. What is the evidence for time thresholds and the role of the ATS in prioritising workload and assessment of the burden of work?

For the purposes of this review, we have examined the literature to analyse studies that describe, validate or evaluate the ATS, and triage tools used in other countries, both as clinical indicators and as tools for work and performance management. However, the published literature may refer to different triage scales depending on the number of categories such as 3, 4 or 5, or their country or region, such as Australia, New Zealand, Canada, the United States, Europe or elsewhere. Therefore, the review concentrates mainly on the existing five-category triage scales and analyses them as a group without focusing on cross-validation of particular categories within the triage scales.

Review of the ACEM Policy Document (P06)

Once the literature review was undertaken, the ATS policy document was revised in order to assess what steps are required by ACEM committee members to update and

modify ACEM's ATS policy. The authors have made annotated comments in the Policy Document (see Appendix 1).

The methodology for this review was tailored to the four basic research questions addressing the ATS validity as an acuity tool or as a management tool. Following is a description of the strategy used for searching and for selecting the published articles and reports. The search engines used in this research include the Cochrane Library, Google Scholar, Medline, CINAHL and Embase for each of the research questions.

Inclusion / exclusion criteria were as follows. Papers were excluded if they were: conference abstracts; in languages other than English; and commentary (or a study protocol) rather than empirical articles.

All identified papers (citation, abstracts and available Portable Document Format-PDF documents) were exported into the Endnote reference management system, listed in alphabetical order, and printed with abstracts. Table 1 illustrates how data sources were used for this literature review.

Table 1. Databases and search strategy (September 2010; update March-April 2011).

Databases searched	**Strategy (key words, search date, inclusion/exclusion criteria, methods used to assess and interpret the evidence)**
Cochrane Library	Keywords: *Triage*, *Triage scales*. Search dates: 10 September 2010. Update 18 March 2011. We found 24 reviews. Inclusion/exclusion criteria: English, Subject inclusion criteria, measured outcomes, study validity, study conclusions, opportunity for bias, and capacity to answer the research question. All reviews related to validity and reliability. Of these, none was relevant for question s 1, 2 and 3. For question four, only one review by Bunn.et al., [30] was relevant as it was associated with triage scales and workload assessment.
Google Scholar	Keywords: *Triage*, *Triage scales* Search dates: July 2010. Updates: September 2010; March 2011. Inclusion/exclusion criteria: peer reviewed articles in Medicine, Pharmacology or veterinary science. The Google search found 4,370 documents comprising peer reviewed articles, reports and website documents. Most of these documents were already included in the Medline and Embase searches, and all of those chosen for analysis and integration into the review were included in the Medline and Embase searches. For question 1: Only one series of reports found in this search strategy was found relevant and was included in the review. [8, 31] This project was conducted by the Victorian Department of Health between 2000 and 2001 and was based on the consistency of triage in Victoria's Emergency Departments. It produced a series of five reports but only two were included in the review. The first document of these series is one of the earliest literature reviews conducted in the field.[31] It summarised the evidence from the creation of the early triage scales, the

	development and validation processes of several triage categories until 2000.[31] The second report presented evidence on the consistency of triage categories. The authors found that a five-point triage scale, similar to the ATS, is more effective in producing consistency of triage than 3 point triage scales. Many of these studies have explored the reliability of different triage scales, including inter-rater reliability, the use of clinical characteristics and the consistency of triage related to ED activity. Some of these studies identified varying degrees of inconsistency of the application of the ATS. [32-34]. For questions 2, 3 and 4 no additional papers were found.
Medline	Keywords variously used (appropriate to each question): *triage*, *triage scale*, *reproducibility of results, validity*, *sensitivity, specificity, Manchester triage system*, *international, emergency severity index, urgency*, *acuity*, *severity*, *complexity*, *waiting time*, *workload*, *diagnosis*, *tool*, *priority*, *threshold*, *burden*, *performance*. Search dates: July 2010. Updates September 2010; 18 March 2011 Inclusion/exclusion criteria: English only, studies (not commentaries / discussion papers. The combination of these strategies identified over 9296 articles on *triage* and 600 articles on *triage and scale*. There were 90 articles found on *triage* and *categories.* There were also found 120 articles on *triage category*. Of these, there were four documents that reported on the current status of the literature on *triage categories*.[6, 9, 11, 35] For question 1 and 2, the Medline search produced 116 articles. For question 2, we also documented the papers' first author and reference, type of triage scale, study design, and use or suggested use of additional dimensions such as secondary triage, method and outcomes. This is because question two addresses the unambiguous goal of the ATS – validity of its measurement of clinical urgency. For question 3 we found 152 documents, and for question 4, 14 documents.
Embase	Keywords variously used (appropriate to each question): *Australia, Scale*, *Reproducibility of results*, *validity*, *urgency*, *acuity*, *severity*, *complexity*, *waiting time*, *workload*, *diagnosis*, *tool*, *priority*, *threshold*, *burden*, *and performance*. Search dates: 18 march 2011 Inclusion/exclusion criteria: English only, studies (not commentaries / discussion papers. Embase was also used to explore additional sources for each research question. For question 1 and 2, the Embase search produced 221 articles. For question 3 we found 501 documents, and for question 4, 24 documents.
CINAHL	The Keyword search used in Medline was replicated; *Triage, Scale*, *Reproducibility of results*, *validity*, *and reliability,* Search date: 22 September 2011 Inclusion/exclusion criteria: English only, studies (not commentaries / discussion papers.

The studies were appraised according to the characteristics indicated in Table 1 and then according to the following step-wise strategy:

1. Conduct search.
2. Exclude articles not meeting criteria by reading titles.
3. Download selected references.

4. Classify articles into relevant groups by research questions.
5. Downland selected documents and attach to the Endnote database.
6. Read and evaluate articles, including for the quality and level of evidence.
7. Draft report on the basis of the review process and results.
8. Re-draft report in consultation with the ACEM Triage Committee.

3. Results

Once the first round of reviewed papers was completed in October 2010, additional searches were conducted in March-April 2011, yielding no additional papers. As part of the second round search, Medline and Embase were mined to acquire additional publications for each research question which were not included or were not available in the first round, as listed in Table 1. Similar searches were also repeated of the Cochrane Collaboration, Google and Google Scholar. The search in CINAHL did not deliver any additional articles relevant to the topic.

In answering the questions, no papers were located in Google, Google Scholar or the Cochrane Collaboration that had not already been included from the searches of the Medline and Embase databases. Therefore, the review does not elaborate on the search from these sources.

Across both rounds of searching, for questions 1 and 2, the Cochrane search identified 17 possible Cochrane reviews. Of these, three were selected for review, [36-38]. Bunn et al. [30, 38] conducted a review of triage by telephone and found mixed results. 65 additional papers were found after excluding 54 duplicated papers from the Medline search. In addition we looked at the evidence of validity and reliability and the need for additional secondary triage scales on complementary dimensions such as complexity [9, 34, 39-41] and trauma scores.[24, 42-59].

The database search for question 3 produced 665 articles, 152 from Medline and 513 from Embase. Of these, 130 articles duplicated from the Medline set were removed from the Embase set, leaving 383 from Embase, and collectively, 535 articles. Of the 535 articles, 129 Medline and 371 Embase articles (500) were deemed irrelevant either because: they were conference abstracts (42); they were in languages other than English (32); they were commentary (or a study protocol) rather than empirical articles (six); they were related to triage but were not related to busyness or patient complexity (390); they were not directly related to triage (25); or they were not related to triage, busyness or patient complexity (five). Therefore, 42 studies were included in one way or another in the review.

For question 4, 38 articles were identified in the database searches, 14 from Medline and 24 from Embase. Twelve articles duplicated from the Medline set were removed from the Embase set, leaving 12 from Embase, and collectively, 26 articles. Nine of the 14 Medline and 10 Embase articles (19) were deemed irrelevant either because: they were abstracts (three); they were not in English (one article in German); they were commentary rather than empirical articles (one article); they related to clinical conditions only (two articles); they related to workload or work stress only, or workload or work stress and job or patient satisfaction and not triage categories (five articles); or they combined a focus on condition and workload but did not focus on triage or categorisation scales (seven articles). Therefore, seven out of the 26 articles were found to be relevant (five of the 14 from Medline and two out of the 12 from Embase). We turn to answer the four questions posed.

Question 1. What is the evidence for the validity of the maximum waiting times and performance threshold?

We found 28 out of the 181 papers in Medline and Embase relevant to this research question. Few studies provided direct evidence of the validity of the maximum waiting times and performance threshold. Asaro et al. [60, 61] reported the effects of a modification in triage process on triage acuity distribution in general and among patients with conditions requiring time-sensitive therapy. They retrospectively reviewed triage acuity distributions before and after modification of their triage process that entailed conversion from the CTAS to ESI. They found shifts from higher to lower acuity levels for all subsets, with odds ratios ranging from 2.8 to 2.9 for all patients. The authors found similar effects for patients presenting with chest pain. They concluded that monitoring for changes in the sensitivity of the triage process for detecting patients with potentially time-sensitive conditions should be considered when modifying triage processes. They reported as cause for concern potential loss of sensitivity as institutions convert from one triage scale to another. They also found an increase from the 20th to the 80th percentile in ED arrivals which resulted in increases of 42 minutes in waiting time, 49 minutes in length of stay (LOS) of admitted patients, and 24 minutes in access block. The authors concluded that, in order to achieve significant improvement in ED throughput, it is also necessary to determine which are the most important factors associated with process outcomes, and taking measures to address variations between ED input and bottlenecks in the ED output stream.

Bernstein et al. [62] used the ESI triage scale to develop a quantitative measure of ED crowding and busyness, known as the Emergency Department Work Index (EDWIN). They used a modified ESI to calculate workload via the EDWIN every two hours in a

convenience sample of 60 eight-hour shifts. With each measurement, the in-charge attending physician and nurses estimated how busy or crowded the ED was, using a Likert scale. Nurse and physician assessments were averaged and compared with EDWIN scores. A total of 2,647 adult patients were assessed at 225 time points over 35 consecutive days. Nurses and physicians showed high inter-rater agreement of crowding assessment (weighted kappa=0.61). The authors concluded that EDWIN correlated well with staff assessment of ED crowding and diversion. EDWIN has been programmed into tracking software for use as a "dashboard" to alert staff when the ED is approaching crisis.

In Canada, Beveridge et al. [16, 63], indicated that the CTAS has been used for assessment purposes. They concluded that triage scales are dynamic instruments that evolve with the health care delivery system. They reported that the CTAS has been used as an important tool to define case mix, predict resource use, develop funding models, and facilitate comparisons between diverse institutions and care providers. However, the authors did not provide evidence that maximum waiting times were associated with performance thresholds. Dong et al. [17, 18, 64-68] also conducted extensive research on the validity and reliability of the CTAS on the basis of resource use and cost as measures of acuity. They indicated that the CTAS had a high level of predictive validity for resource use and ED and hospital costs.

Feldman et al. [19] reported a moderate sensitivity (68%) and specificity (66%) between the Medical Priority Dispatch System (MPDS) and CTAS amongst Canadian EDs and Emergency Medical Services (EMS) to prioritise patient care requirements. The most sensitive protocol for detecting high acuity of illness was the breathing-problem protocol, with a sensitivity of 99%, whereas the most specific protocol was the one for psychiatric problems, with a specificity of 98%. The cardiac-arrest protocol had the highest PPV (92.6%), whereas the convulsions protocol had the highest NPV (85%). The best-performing protocol overall was the cardiac-arrest protocol, and the protocol with the overall poorest performance was the one for unknown problems. They concluded that this performance analysis may be used to identify target protocols across the system to explore future improvements.

Champion et al. [69] found that injury severity scales of proven reliability and validity are essential for the appropriate allocation of therapeutic resources, for prediction of outcome, and for evaluation of the quantity and quality of emergency medical care in differing facilities and over time. However, they indicated that existing scales are too imprecise to permit comparisons of management or systems of care. As a result, they developed a triage index for early, rapid, non-invasive and accurate patient assessment of trauma patients. Fernandes et al. [70, 71] found high triage inter-rater scores between

doctors and nurses (0.75) using the CTAS. Inter-rater agreement of nurses and physicians was substantial for ED monitoring, and moderate to substantial for other triage assessments. They also suggested that more research was necessary to identify areas of variation. Bullard, Dong and colleagues in Canada have conducted extensive reliability and validity analyses as well as using multiple applications such as computerised versions of the CTAS. They continue to propose updates and revisions based on feedback from both users and expert consensus. The authors have argued that one important aspect driving these changes is the worsening effect of ED overcrowding. ED overcrowding is the main driver for the increasing need to prioritise patients to be seen based on acuity (or urgency). [17, 18, 64-68, 72-77]

In Australia, Considine.et al. [32, 78-83] found that ATS categories are associated with predictors of critical care admission in ED patients triaged as low to moderate urgency, the need for which may be apparent early in the ED episode of care. They used a retrospective case control design. All participants were aged over 18 years, triaged to ATS categories 3, 4 or 5, and attended an ED in 2004-2005. The authors found that critical care admissions were associated with presenting complaints of nausea, vomiting and diarrhoea, heart rate abnormalities, temperature abnormalities, respiratory rate and heart rate abnormalities at first nursing assessment. They concluded that variations in temperature, respiratory rate and heart appear to increase the risk of critical care admission. The authors also indicated that further research was required to explore other parameters with the high predictive validity, clinical utility, and the optimal timing for data collection, to more firmly establish association between maximum waiting times and performance threshold.

In addition, Creaton et al., [84] reported that the rate inter-rater reliability of the ATS for mental health patients in ED is inadequate. In a prospective descriptive study, conducted in a busy ED, they found a need to develop and implement a validated, standardised national triage tool for mental health patients.

The ATS *per se* is insufficient to ensure acceptable inter-rater reliability, particularly during busy periods in the ED, given the over-emphasis of the ATS on key outcomes. Durojaiye et al. [85] explored the inter-rater reliability of the NTS in paediatric EDs in Australia in 1999 and found that the use of the scale was not consistent, there being significant differences between the triage practices of paediatric and mixed EDs.

Dutch et al.[86] found that the NTS was associated with shorter or longer waiting times when compared with matched controls. They examined a large sample of case-control pairs and found that three of the five most frequent presenting problems (dislocations, fractures, and palpitations) had significantly shorter waiting times. Significantly more

patients with those presenting problems were seen within the recommended waiting times than those with other presenting problems [86]. In contrast, three of the five presenting problems most disliked by staff (dizziness, constipation, and back pain) had significantly longer waiting times, and significantly fewer such patients were seen within the recommended waiting times than those with other presenting problems. Other presenting problems showed similar trends. The authors concluded that waiting times for patients with particular presenting problems were significantly associated with triage presenting complaint descriptions.

Fatovich et al. [87] found that the NTS was a key performance indicator for Australasian EDs. One critical issue identified was that the point at which the clock starts to measure waiting time was not clearly defined at that time. The authors found that the measurement of this key performance indicator was not consistent across Australia and that operational definitions were required when comparing data across EDs.

In summary, there are no validation studies which directly link the reliability of maximum waiting times with performance thresholds. Most studies have shown that triage categories do relate indirectly to particular medical conditions that are time sensitive, but very few papers have recommended alternative triage systems to complement the initial triage assessment. There is some evidence, albeit limited, which suggests that the maximum waiting times support the use of performance thresholds.

Research into the allocation of triage categories 3 and 4 have shown that, in general, outcomes do not change significantly between these categories, although the complexity of the conditions of patients allocated these triage categories might differ from the relative urgency of their conditions, as indicated by triage category allocated. The validity of maximum waiting times varies according to triage category. Studies have shown triage scales to be more reliable at the critical level (i.e. categories 1 and 2), but not for lower categories such as 3 to 5. The inability of the ED to address dimensions such as the advanced nature or pre-existence of a condition before ED presentation, owing to their inability to be measured in the hospital setting might explain the lack of association between maximum waiting times and performance threshold. The limited control over such conditions lends weight to the case for de-coupling, rather than associating, maximum waiting times with organisational performance measures.

Question 2. Is the ATS still a valid tool for differentiating clinical urgency for ED patients?

Of the 116 papers identified in round 1, 15 out of 25 studies suggested that the ATS is a valid tool for differentiating clinical indicators for patients. Atack et al, [88, 89] found that the adoption of a new triage system places heavy training demands on ED nurses and physicians. They found that the five-category CTAS improved nurses' triage practice. Nurses believed that their patient assessments were more thorough, accurate, and consistent throughout the department. Nurses reported improved communication between staff and with patients and families, and high triage accuracy. The overall agreement between CTAS graduates and the chart auditor/expert within one CTAS level was 99.7%. The authors concluded that online training is useful but that further research was needed regarding the use of multimedia and computer online chat options.[88]

Several researchers have used the ATS in the decision-making process and to estimate the duration of the triage process.[35, 90, 91] Scott et al.,[92] demonstrated that Rapid Assessment Units are effective in reducing time delays. However, evidence for an association between maximum waiting times and performance threshold has not been directly established. Ieraci et al., [38] evaluated patient flow on the basis of complexity rather than acuity, severity or disposition and found significant improvements in several key ED performance indicators such as mean waiting time (reduced from 55 to 32 min) and mean treatment time (reduced from 209 to 191 min). Prominent features giving rise to improved performance included the use of dedicated senior staff for "fast track" patients – those with a clear pathway allowing efficient disposition – and quarantining of clinical resources. The authors concluded that this approach was an ideal focus for advanced nursing practice. [39]

A qualification to the reliability of the ATS might be that most studies in Australia were conducted prior to the replacement of the NTS by the ATS. However, this did not affect the implementation of a national approach to triage education and national application of the ATS. There have been no large scale studies of ATS reliability since its introduction. There is some evidence that triage nurse education and knowledge have increased decision-making reliability in Australia where a standardised education program has been achieved. [35]In relation to triage decisions, Considine et al., found that 61% of triage decisions were "expected triage" with 18% " over-triage" and 21% " under-triage decisions".[32]

Cooke et al., [8, 92] also suggested that Rapid Assessment Teams (RATs) could be more efficient than triage scales to deal with busy periods in European EDs. They suggested that, increasingly, EDs are being organised in similar ways in the US, Canada, Australia and New Zealand; however, the systems in Europe are still very different. The former have a specialty of emergency medicine and these specialists are the first contact for many patients presenting to hospital with urgent conditions. European systems rapidly

triage patients to inpatient specialties for care and have a wider system of community facilities for those with less severe conditions. Britain has more similarities with the non-European systems except it has traditionally undertaken less extensive investigation of complex medical problems, although this is changing with time. The organisation of whole health care systems is very different in all these countries. Therefore it can be difficult to extrapolate changes in one system to the UK system.[10, 93]

Acworth et al., [94] indicated that the paediatric population has special needs because the large majority of this population is sent home from the ED and deaths are very rare. They found that presentations usually peak in late Winter and early Spring and a large number occur during evening hours, and children were more likely to leave without been seen than adults.[95, 96] Gravel and colleagues have also produced extensive validations of the CTAS for paediatric populations. [37, 97-102]

According to Considine et al., [80] there are some inconsistencies in the application of the ATS, including a wide variation in the experiential and educational requirements of triage nurses to the specific clinical characteristics of the triaged patient. In 2002, an Australia-wide evidence-based training framework (ETEK) was implemented. [103] The paper to outline the framework discussed the development of particular physiological discriminators of the ATS such as airways, breathing and disability. Gerdtz and Bucknall [90] found that there were limitations regarding physiological data to decide patient acuity, and large variability in the duration of triage decisions observed. They also found differences between triage duration and a range of nurse, patient and environmental variables. They concluded that these variables affect the development of practice standards and triage education. This suggests that the inclusion of arbitrary time frames for triage assessment in practice standards is not an appropriate method of evaluating triage decision-making in frontline practice. Several authors have indicated that use of the ATS in the rural context may have significant limitations due to the limited size of EDs and staffing levels.[58, 104]

Bezzina et al. [105] conducted a literature review and found a total of 34 articles showing the relationship between ATS triage categories 4 and 5 and potential 'primary care', 'general practice', or 'inappropriate' patients in ED. This definition has been applied both prospectively and retrospectively and has caused considerable controversy. For instance, Nagree et al. [106] indicated that about 41% of low triage attendances have been described by the Australian Institute of Health and Welfare (AIHW) as potentially general practice (GP) cases. The AIHW proposes that the ATS category 4 and 5 patients attending EDs, who are not admitted or conveyed to the ED by ambulance or police, are potentially GP cases. However, there has been little clinical input into the determination of this definition and it has not been methodologically validated.

Nagree et al. [106] suggested that this definition is flawed for a number of reasons. Principally, the ATS is an urgency not a complexity scale. A patient can have a low triage category but need complex care. Some patients, such as older patients with limb fracture, can be considered as low urgency but high complexity because extended consultation with a multidisciplinary team, including occupational therapy, physiotherapy and social work, will be required to ensure that such a patient can be safely discharged home. Such a patient cannot easily be managed in a general practice environment. The converse also applies with some high urgency patients being of low complexity. For example, a young patient with fever and a rash should be seen quickly to exclude serious illness such as meningococcal septicaemia. However, once such an illness has been excluded, the patient can often be discharged. Such patient might be equally well managed in a general practice environment as a patient allocated a lower triage category.

Caterino et al. [45] showed that self-assessment of symptom severity by patients and remote assessment (by telephone) by emergency physicians is not reliable. Reliance on either patient symptom self-assessment or physician screening assessment by telephone to determine appropriateness of an ED visit is not safe.

Doherty et al. [107] established the incidence of death after admission via the ED for each of the five categories of the ATS and examined the causes of death in each category. They found significant differences in mortality per ED presentation for categories 2, 3 and 4 and significant differences in mortality per inpatient admission for ATS categories 2 and 3. The most common causes of death were acute cardiac/respiratory and malignancy related conditions. Triage category 3 patients had both the highest number of total admissions and the highest number of deaths post admission. The authors pointed out that their findings differed from published data where category 4 represented the largest number of admissions and of in-hospital deaths following admission. [108]

In summary, the ATS is a valid scale for differentiating clinical urgency i.e. the time within which a patient must be seen. There is agreement in the literature that ATS categories 1 and 2 are reliable. ATS categories 3 and 4 comprise the majority of ED work and ATS category 5 patients are usually treated and identified reliably. Therefore, the ATS is valid and reliable for the most acute categories (ATS 1 and 2). However, it is less reliable for lower triage categories (ATS 3, 4 and 5) .[35]).

Question 3. How do triage tools satisfy other dimensions of acuity such as provider related intensity, staff workload and complexity of patient diagnosis?

We found no studies directly addressing the causal relationship between all three variables of triage categorisation, patient complexity and ED busyness. In some of the following studies, relationships or associations could be inferred, especially between triage categorisation and workload. A recent review of the literature found that triage scales have limited ability to predict outcomes, and their reliability across triage scales is limited.[109]

In relation to the mixed use of acuity and complexity terms, Brennan and Daly [9] suggested several dimensions associated with patient acuity. They indicated that this term is often used without specifying its exact meaning. The authors argued for conceptual clarity, concluding that the attributes of acuity are: severity, intensity and measurement indicators. Such attributes have physical and psychological dimensions. They determine and are influenced by nursing care needs, workload, complexity, case-mix, patient classification systems, and urgency/triage scales. They concluded that researchers should be encouraged to specify which attribute of acuity they are studying and to develop measurement tools specific to that attribute. This demonstrates the point indicated in the glossary about lack of consistency in this area.

The association between acuity and workload is evident in Ma et al.'s study which found a correlation between the Canadian Paediatric and Emergency Triage Scale and nursing and physician time use.[110] The greater the acuity, the more time spent. Such an association was also found by Ng et al., [111], comparing the 5-point CTAS and the four-level TTS [111]. Ng et al., also reported an application of "lean" principles to a Canadian ED to produce improvements in patient flow and satisfaction, and substantial reductions in time waiting for patients in triage categories three and four.[112] Such patients might not be urgently sick but might still have complex medical conditions. In their study of ED use in a Saudi Arabian hospital, Rehmani and Norain [113] found that, over a three-year period, patients requiring hospital admission increased, as did the length of their stay, and that 60% of ED visits were for triage category four and five patients. A medical classification criteria tool (MCCT) was found by Loos et al. [114] to enhance communication, and facilitate easier working, between prehospital and ED personnel.

To the extent that workload is associated with acuity, ED triage categories have been found to be associated with efficiency of patient processing. Gerdtz and Bucknall [91] found that the ATS is useful for defining time-to-treatment and quality of service. The ESI has been found to be potentially useful for addressing ED overcrowding [115] and to assist triage nurses with patient categorisation [116]. While the association between triage category and workload has been established, Bergeron et al., [117] found different perceptions about relevance of the CTAS among nurses, physicians and patients.

In terms of patient complexity, Reilly et al.'s [118] study of ED discharges of trauma patients found that the severity injury and number of patient hours devoted to care had significantly increased over a five-year period. Sprivulis [119] found patient age to be correlated with the number of procedures, investigations or consultations performed, making age a useful proxy for complexity, especially if used with validated age-versus-complexity tables. Dong et al., [18] found the CTAS valid for predicting patient outcomes. Bezzina et al., [105] found that the ATS is particularly relevant for distinguishing primary care patients, patients with conditions of low urgency, and predicting unlikely admissions. The ESI was found by Bourgeois et al (2008) [120] and Baumann et al (2005) [23] to be relevant for patients with conditions of low acuity, patients who did not wait (DNW) and children. Bauman et al [121] also found it to be relevant for older populations.

Efficiency can be increased by fast-tracking patients in lower urgency triage categories without affecting the care of patients in more urgent categories. [122-124] Asaro et al., [60] found an association between triage categorisation system and the way clinicians distributed patients in terms of acuity, by showing modifications to such distribution following the introduction of a new categorisation system. O'Brien et al. [125] study in an Australian ED also found that streaming fast track patients can reduce length of stay and waiting times for discharged patients without increasing waiting times for admitted patients, even in an ED which sees relatively few low acuity patients. Fast-track is one of several strategies for using the ATS to prioritise workload.

Considine et al. examined the effect of fast-track on ED length of stay, and found that fast-track patients had a significantly lower time duration within 2 h (53% vs. 44%, $p<0.01$) and 4 h (92% vs. 84%, $p<0.01$). They concluded that ED fast-track decreased ED LOS for non-admitted patients without compromising waiting times and ED LOS for other ED patients. [79] Kwa and Blake found that a designated fast-track area produced a significant increase in the proportion of all ATS 2-5 patients to be seen within their target times without deterioration in performance or waiting time for ATS 1. In addition, there was a decreasing trend in the proportion of patients who did not wait for treatment. These improvements occurred despite a 12% increase in patient attendances and no change in medical staffing levels. They also demonstrated that fast-track has been effective in paediatric hospitals in Australia. [124] Ieraci et al., also evaluated the fast-track system and found significant improvements in several key ED performance indicators such as mean waiting time (reduced from 55 to 32 min), mean treatment time (reduced from 209 to 191 min), compliance with New South Wales Department of Health waiting-time benchmarks (increased from 59% to 77%) and the proporion of patients who did not wait decreased from 6% to 3%. The concluded that the success of the system included use of dedicated senior staff for fast-track patients, and quarantining of clinical resources. [39]

Wrenn et al., [126] found work stress level among emergency medicine residents to be associated with adverse events and the anticipation of overtime work, rather than overcrowding and traditional measures of workload. Over triaging – defined as breaches of the American College of Surgeon's Commit on Trauma field triage criteria – was found to be costly and labour-intensive in a level one trauma centre [127].

Ornato et al., [128] found that qualitative judgments of paramedics or emergency medical technicians were almost as reliable as the trauma score (TS) and CRAMS (Circulation, Respiration, Abdomen, Motor and Speech) scale were equally reliable in identifying patients sent from the ED to the operating theatre, but equally unreliable in identifying as major trauma. Huang et al., [129] found that the greater the injury in life-threatening or severe trauma (indicated by triage category), the greater the staff workload, underpinning a new resuscitation workload scoring system presented by the authors.

Patient complexity is evident in the need for frequent over-rides of previously allocated triage categories. The implementation of triage training programmes might have reduced this need. [103] There is a well known link between triage and patient complexity. Cusick et al., [130] found that patients in lower triage categories tend to present with complex conditions requiring multiple services such as rehabilitation services and community support. The complexity of patients with lower urgency conditions is frequent in EDs. [106] This is most clear when complex patients with low triage scores tend to re-present to the ED within 72 hours at a higher rate than patients of higher urgency [131].

Non-urgent patients attend the ED for various reasons, including accessibility and perception of urgency or severity of need [132, 133]. Historically, non-urgent cases have been associated with taking more time in assessment and treatment [134]. In the 1980s they represented a large proportion of ED presentations [135]. At present, ATS category 4 and 5 patients represent approximately 41% of ED presentations.[106] Atzema et al., [136] showed that half of all patients with acute myocardial infarction received low triage categories which led to extensive delays in electro-cardiogram (ECG) acquisition and reperfusion therapy. Queuing (in coronary angiography), in the absence of formal triage protocols, was found by Alter et.al., [137] to have a highly significant ($p < 0.001$) and independently predictive relationship with the nature of the physicians' familiarity with the catheterisation facility. In terms of organisational performance, Beveridge et al., [16, 63] found that the CTAS could facilitate cost and outcome comparisons, as well as health care systems research. They also suggested three main dimensions in triage: utility, relevance and validity. There is little to question to continued relevance of these dimensions relevant and it might be beneficial to apply them to other triage scales.

In summary, triage scales have limited ability to predict outcomes; the reliability across triage scales is limited and has not been established for dimensions other than urgency, such as complexity and workforce issues. The investigation for question 3 drew on studies of various triage tools used internationally, revealing associations between triaging and the complexity of patient conditions, busyness of the department, and workload of ED staff. However, these associations were better able to be inferred rather than having been explicitly made in the studies.

Question 4. What is the evidence for time thresholds and the role of the ATS in prioritising workload and for the assessment of the burden of work?

There is evidence for an association between triage category and workload. In the late 1990s, Cameron [138] demonstrated that triage categories were consistent with time thresholds. 'Non-urgent cases' were shown in a descriptive prospective study in a large Greek ED to consume the most time in assessment and treatment.[139] Gedmintas et al. [140] study of six EDs in Queensland, Australia, showed that the higher the triage category, the greater the emergency care workload unit. They recommended validating their tools to appreciate the manner and extent to which they can be used in EDs for workload prediction and management. An extension can be implied from this evidence to the assessment of the burden of work in relation to triage categories, and the practice of prioritising workload. Some of the evidence for the association between triage category and workload comes indirectly, through a small number of studies showing that clinical categorisation on the basis of urgency or acuity is associated with workload, rather than directly through a focus on triage categories.

Westbrook et al., [141] conducted a before-and-after study of a Virtual Critical Care Unit (ViCCU) allowing for audio-visual communication from a larger ED to support a smaller ED. They found lower admissions and transfers for moderate trauma patients and variable results for other categories (critical and major trauma). Interviews conducted as part of the study revealed increased responsibility and workloads in the larger hospital and less stress (for nurses) and less autonomy (for doctors) in the smaller hospital. [141]

Gerdtz and Bucknall [91] initially found that agreement on the validity of the ATS ranged according to rater and subjective influence but a more comprehensive study by the same authors found better agreement levels.[35, 142]. Therefore, consideration of the impact of time thresholds on workload and its assessment needs to take account of the complexity of and cultures impacting on the ED’s organisational context [143, 144].

The use of Rapid Assessment Teams (RATs) in the UK [10, 93] can be difficult to extrapolate in the Australian environment. However, RATs have been successfully implemented in Australia. [145] . In another context, Caterino et al. [45] showed that symptom severity assessment by patients and emergency physicians may not be reliable when there is too much emphasis on symptom self-assessment or physician screening assessment by telephone. Symptom severity assessment might not be reliably safe, and prospective ED visit severity assessment cannot reliably identify "unnecessary" ED visits.

Bunn et al. [30, 38] conducted a Cochrane review exploring telephone consultation and triage as a response to increased demand for GP and ED care. They explored randomised controlled trials (RCTs), controlled studies, controlled before/after studies (CBAs) and interrupted time series (ITSs) of telephone consultation or triage in a general health care setting. Disease-specific phone lines were excluded. They found nine studies. Of these, three of five studies found a decrease in visits to GPs, but two found a significant increase in return consultations. They concluded that telephone consultation appears to reduce the number of surgery contacts and out-of-hours visits by GPs, but more research is needed to establish any conclusive effect on service use.[30, 38]

Categorisation, in general, impacts on workload (and workflow) in the broader context of the relationship between the hospital and the ED. Drawing on internet-accessible workload and pre-hospital ATS allocations, Sprivulis and Gerrard [146] found that, in Western Australia (WA), pre-hospital triage and ambulance diversion only reduced ambulance diversion when hospital inpatient flow and the balance between acute and elective surgical inpatient accommodation increased.

The potential for the triage categories based on urgency to be an appropriate and consistent means of predicting workload has been established. Korner et al., [147] found, through a simulated disaster management study, that computed tomography (CT) triage of patients was feasible, and that a dedicated CT protocol for the triage of patients was feasible and produced constant results.

There is evidence that triage category alone is an insufficient indicator of workload in the ED. Anderson et al. [148] found significant variability across 11 hospitals and considerable variation in physician time spent for each CTAS triage category. This casts doubt on the appropriateness of using CTAS alone to predict suitable emergency physician staffing levels in the ED. [148]

There is evidence to suggest that a simple and direct relationship between triage category and workload, to the exclusion of other variables, is unhelpful for assessing and

managing ED workload. Innes et al., [149] internally validated a workload estimation tool within their hospital, from analysing 585 patient visits, then 314 visits for model derivation, and 271 ED visits for model validation. They found an association between ED workload and triage level, among other variables. Because they found ED workload also to be a function of the procedure required, arrival by ambulance, Glasgow Coma Scale (GCS) score, age, having any co-morbidities, and number of prior visits, they caution against, and suggest an alternative to, simplistic models based solely on patient volume and perceived acuity. Tescher and Chen [104] indicated that, as key performance indicators in small rural EDs, the ATS places restrictions on the ability of an unfunded rural hospital to match the performance of major metropolitan EDs, due to their small size and lack of dedicated ED staff [104]. They recommended that ATS guidelines be revised to improve clarity and reflect the different performance capabilities between metropolitan and rural centres.

In summary, the ATS alone is an insufficient indicator of workload in the ED. This also applies to other triage scales, such as the CTAS. Furthermore, there is evidence to suggest that a simple and direct relationship between triage category and workload, to the exclusion of other variables, is unhelpful for assessing and managing ED workload because other dimensions such as procedural work required, arrival by ambulance, level of trauma, patient complexity and other co-morbidities might also contribute to patient volume and perceived acuity.

4. Discussion

Triage transitions are important when considering the quantification of input and output factors on ED processes. Fitzgerald et.al., [6, 7, 11] have argued that it is timely to accept the diversity across countries in regard to ED structures and practices of emergency medicine. They also suggest developing and testing an ITS which is supported by an international collaborative approach towards a triage research agenda in order to develop application, and moderating tools and to utilise the scales for international benchmarking and research programmes. [6, 7, 11]

This review was conducted to explore the current status of triage systems around the world and to make recommendations accordingly. The review found that multiple triage systems have been developed in the last 20 years and their validity and reliability scores ranged from low/moderate [21, 23, 24, 29, 32, 58, 91, 98, 117, 150] to high. [16, 18, 22, 27, 28, 34, 41, 49, 73, 77, 151-160]

The most important conclusion to be drawn from these papers is that the existing five-point rating scales implemented in Australia, Canada and UK are generally well accepted

by researchers and clinicians.[4, 8, 116, 161] There are other studies which have demonstrated with various degrees of confidence that triage categories are reliable [23, 35, 41, 44, 54, 58, 66, 67, 70, 89, 121, 152-154, 157, 162-169] and valid.[17, 23-25, 28, 34, 41, 44, 48, 54, 57, 58, 64, 66, 67, 81, 101, 116, 121, 151-153, 157, 158, 160, 162-165, 167, 169-187] There are many others that have suggested complementary triage scales such as paediatric versions (P-CTAS, etc)[57, 80, 85, 94, 97, 99-102, 124, 183], Trauma Scores (ISS, PHI-MOI, etc) [24, 42-59] , and complexity scores. [9, 34, 39-41]

With the recent developments of the four-hour rule in the UK and WA, it is important to evaluate how the ATS will be used under the new policy requirement. According to Cooke et al., [10] triage scales are not the only measures of ED performance in the UK, with the limited exemption of the MTS. [188] In relation to the changes in triage categories, five-category triage scales have been found to be more stable, reliable and valid than three and four-category scales. However, it is unclear how triage tools can be used in relation to future policy interventions such as the four-hour rule.

The studies relating to questions 1 and 2 showed that there is evidence for the appropriateness of triage tools generally for measuring overcrowding, resource use and costs. Inter-rater reliability of triage categorisation is generally moderate to high. A consequence of ED overcrowding is the need to prioritise patients on the basis of urgency. There is little evidence for the appropriateness of triage scales for assessing performance against key performance indicators based on efficiency measures alone. The definition of "appropriateness" also requires careful consideration in light of a legitimate role for the ED in primary care, and the need to balance resources between primary care and emergency medicine in local settings.

Among the noteworthy results for question 3 is Wrenn et al.'s, [126] finding that work stress level among emergency medicine residents is associated with adverse events and the anticipation of overtime work, rather than overcrowding and traditional measures of workload. However, given that adverse events are confounded by patient complexity, hospitalisation, and extra work, we need to identify how these variables relate to higher acuity categories. It is likely that interventions and processes which help streamline triage or categorisation will decrease workload by saving time.

Apparently "non-urgent" cases were found by Agouridakis et al., [134] to consume more time than other cases in a Greek ED. However, given that patient perception is central to ED presentation, investigation and interventions related to workload need to take account of the complexity of patient conditions. Although not directly related to triage, and therefore excluded from this review, MacCormick et al., [189] found an association

between the way patients are prioritised for elective general surgery and "socio-political/logistic", among other factors.

Studies not related specifically to time thresholds in the form of triage categories were excluded from analysis for answering question 4. However, in general, researchers have focused on work pressure in the ED. [62, 126] Such research might be able to be associated with prioritising workload and assessment of the burden of work in lieu of a specific focus on triage categories, because the ED is focused on efficient throughput and processing continual, unplanned presentations. Although, as stated, Agouridakis et al., [134] showed "non-urgent cases" to consume most time in a Greek ED, this study did not account for the potential complexity or severity of those conditions, in relation to their admission rates, or the degree to which the longer time taken with those patients might have prevented their admission (or re-presentation to the ED).

In Appendix 2, Table A.2 we describe the major papers that relate to identifying the main issues, methods and results of this review. In relation to additional dimensions, seven papers were presented and summarised. Most papers concluded that five-category triage scales are the most common and preferred by researchers in different contexts. In relation to the evidence of time thresholds, the evidence is inconclusive in many areas, but they are commonly used. In relation to secondary triage scales, the most common are used for paediatric populations, and complex and trauma patients. Baxt et al [190] reported that clinical prediction rules are used extensively in most regionalised trauma systems to identify which patients have sustained major injuries. They found high misclassification rates for the Trauma Score, the CRAMS Scale, the Revised Trauma Score, and the Prehospital Index. All scales accurately predicted mortality with a minimum sensitivity and specificity of 85%. However, not one of the rules was able accurately to identify surviving patients who had sustained major injuries. In this instance, no rule was able to achieve a sensitivity of at least 70% while achieving a specificity of 70%. Recent studies have indicated that high sensitivity can be achieved, without causing significant over-triage, when prediction rules are refined using comprehensive clinical datasets now available through electronic recording of real clinical data[191]

In conclusion, the review implies that it may be beneficial to develop additional tools to address complexity as well as severity, workload and staffing factors. This might not be possible with one instrument. Separate measures are needed to assess quality of care, in terms of both clinical quality and system quality indicators. This may be able to be achieved through collecting more information at triage. Challenges are that greater information collection would: slow the triage process and potentially delay access to care; take a long time to develop; and may not be valid after all of this work. It is possible that much of these data can be collected retrospectively.

To understand the practice of triage, work might progress along four themes. First, investigation might determine if the ATS ought to continue to be used in its current format as a guide to urgency alone, or if there are any modifications needed or a new, or different, tool. One possibility is that simple addendums might be able to be used to guide particular processes, such as separating, at triage, areas such as " fast-track" or patients based on likely disposition (i.e. propensity for admission versus discharge).

Second, a separate workload measure might be able to be developed that can be used to guide comparison between departments and assist the development of staffing profiles. An inexhaustive list of factors this could recognise includes: numbers; urgency; severity; complexity; and temporal patterns of attendance.

Third, a separate measure might be used to determine the overall quality (both clinical quality and system wide quality) of ED performance. This could take the form of a "balanced scorecard" that includes factors such as: process measures and efficiency (e.g. time to care, DNW and length of stay); and quality of clinical care measures (e.g. time to analgesia; time to lysis/catheter lab, taking into account overlap with processing). Other tools could be developed that could include, for example, standardised case definitions and outcomes with performance measured through factors including, but not limited to: complaints to compliments ratios, falls and injuries in ED; and re-presentation ratios.

Fourth, a separate measure of "overall quality" of an ED could be developed, recognising broader outputs than direct patient care alone. This could include for example: ED performance as suggested above; academic performance (e.g. trainee pass rates in examinations, conference presentations, publications, medical student teaching); system contribution (e.g. College, hospital, state and federal health department committee involvement); and staff happiness index (e.g. satisfaction, leave, sick rates); as macro measures of clinician attempts to provide optimal ED care.

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Appendix 1

ACEM Policy Document Review

Australasian College for Emergency Medicine

POLICY ON
THE AUSTRALASIAN TRIAGE SCALE

1. INTRODUCTION

The Australasian Triage Scale (ATS) is designed for use in hospital-based emergency services throughout Australia and New Zealand. It is a scale for rating clinical urgency. Although primarily a clinical tool for ensuring that patients are seen in a timely manner, commensurate with their clinical urgency, the ATS is also a useful case mix measure. [1.1] The scale directly relates triage code with a range of outcome measures (inpatient length of stay, ICU admission, mortality rate) and resource consumption (staff time, cost). It provides an opportunity for analysis of a number of performance parameters in the Emergency Department (case mix, operational efficiency, utilisation review, outcome effectiveness and cost). [1.2]

2. PRACTICALITY AND REPRODUCIBILITY

As the ATS is a primarily clinical tool, the practicalities of patient flow must be balanced with attempts to maximise inter-rater reproducibility [1.3]. It is recognised that no case mix measure reaches perfect reproducibility. Reproducibility within and between emergency departments can be maximised by application of the Guidelines for Implementation and widespread use of the training package.

Triage accuracy and system evaluation can be assessed by comparison against guidelines. Patterns of triage category distribution, ICU admission and mortality by triage category should be comparable between peer hospitals of similar role delineation. Admission rate by triage category is also a useful comparison between peer hospitals for the higher urgency categories. [1.4] These benchmarks for Emergency Departments of different role delineation should be reviewed from time to time as disposition practices change.

Standards of consistency should also be regularly checked with studies of inter-rater reliability. An acceptable standard of inter-rater agreement is represented by a weighted Kappa Statistic of at least 0.6. [1.5]

3. APPLICATION

3.1 Procedure

All patients presenting to an Emergency Department should be triaged on arrival by a specifically trained and experienced registered nurse. [1.6] The triage

assessment and ATS code allocated must be recorded. The triage nurse should ensure continuous reassessment of patients who remain waiting, and, if the clinical features change, re-triage the patient accordingly. [1.7] The triage nurse may also initiate appropriate investigations or initial management according to organisational guidelines.

The triage nurse applies an ATS category in response to the question: "This patient should wait for medical assessment and treatment no longer than…."

3.2 Environmental and Equipment Requirements [1.8]

The triage area must be immediately accessible and clearly sign-posted. Its size and design must allow for patient examination, privacy and visual access to the entrance and waiting areas, as well as for staff security.

The area should be equipped with emergency equipment, facilities for standard precautions (hand-washing facilities, gloves), security measures (duress alarms or ready access to security assistance), adequate communications devices (telephone and/or intercom etc) and facilities for recording triage information.

4. DESCRIPTION OF SCALE [1.9]

ATS CATEGORY	TREATMENT ACUITY (Maximum waiting time)	PERFORMANCE INDICATOR THRESHOLD [1.10]
ATS 1	Immediate	100%
ATS 2	10 minutes	80%
ATS 3	30 minutes	75%
ATS 4	60 minutes	70%
ATS 5	120 minutes	70%

5. PERFORMANCE INDICATOR THRESHOLDS

The indicator threshold represents the percentage of patients assigned Triage Code 1 through to 5 who commence medical assessment and treatment within the relevant waiting time from their time of arrival. Staff and other resources should be deployed so that thresholds are achieved progressively from ATS Categories 1 through to 5. The performance indicator thresholds shown are appropriate for the period 1998 – 2002 [1.11] inclusive1, and should be achievable in all Emergency

Departments. Performance indicator thresholds must be kept under regular review.

Where Emergency Department resources are chronically restricted, or during periods of transient patient overload, staff should be deployed so that performance is maintained in the more urgent categories. [1.12]

It is neither clinically nor ethically acceptable to routinely expect any patient or group of patients to wait longer than two (2) hours for medical attention. Prolonged waiting times for undifferentiated patients presenting for emergency care is viewed as a failure of both access and quality.

6. QUALITY ASSURANCE

Triage accuracy and system evaluation may be undertaken in part by reviewing the triage allocation against guidelines, triage category "footprint" of example diagnoses, average waiting time, admission rates and mortality rates in each triage category with peer hospitals. As practices such as disposition change over time, these benchmarks should be periodically reviewed. [1.13]

7. REFERENCE

Commonwealth Department of Health and Family Services, Coopers and Lybrand Consultants. Development of Agreed Set of National Access Performance Indicators for: Elective Surgery, Emergency Departments and Outpatient Services. Canberra, July 1997, p106. [1.14]

Reviewed March 2006 (no changes made)
Revised November 2000
Adopted by Council November 1993 [1.15]

Comments on the document:

1.1 The document states in this paragraph that "ATS is also a useful casemix measure". The utility of the ATS as a casemix measure needs to be defined, justified and periodically reviewed, because it is not clear what is meant by casemix measure and how its ongoing usefulness can be assured. "

1.2 The introduction of the ACEM document states "it provides an opportunity for analysis of a number of performance parameters in the Emergency Department (case mix, operational efficiency, utilisation review, outcome effectiveness and cost)". It is not clear that evidence supports this statement. Therefore a reference indicating the specific evidence supporting this statement is needed.

1.3 In this document, the first paragraph, second line, uses the term " inter-rater reproducibility". Is this an appropriate term? (The term " inter-rater reliability" is also used in the document, and raises the need for consistency).

1.4 The third and fourth lines of the second paragraph indicate that the ATS " is a useful comparison between peer hospitals for the higher urgency categories". The document might also consider its comparability for lower urgency categories.

1.5 The last paragraph of this section may no longer be appropriate given that the ATS urgency scale is no longer the only component to be assessed. This paragraph should be deleted or modified accordingly.

1.6 The document implies that all patients should be triaged by a nurse. Consideration ought to be given to including the principle of triage by doctors also, given suggestions in practice, policy and research for physician streaming of patients for discharge or admission. One option would it be to replace the term "nurse" with "clinical assessment team".

1.7 In the same paragraph, the document states that "continuous reassessment of patients who remain waiting should be re-triaged". One wonders whether this would happen in practice. This might need to be re-phrased, either to be more realistic, or to suggest how this might be monitored or audited, or otherwise assured.

1.8 Section 3.2 concerns the environmental and equipment requirements. Consideration needs to be given to whether these two paragraphs are still relevant and are required.

1.9 The particular dimensions of categorisation might need to be revised for example, to see if columns such as for clinical indicators, complexity, etc, are required.

1.10 The second column entitled "performance indicators threshold" might no longer be appropriate given that it is described in section 5 of the document.

1.11 In the first paragraph, lines four and five, the year period "1998-2002" needs to be updated.

1.12 In the second paragraph, should we include limitations, such as ED overcrowding and access block? For example we could say "unless potential severity of particular cases, or the efficient streaming of particular cases is determined by the staff specialist in charge to be the most efficient use of human resources to maximise the efficiency, quality and safety of patient care in the department".

1.13 In lines three and four of the paragraph, the document states that "practices should be reviewed periodically". As for point 1.6, this might need to be re-phrased,

either to be more realistic, or to suggest how this might be monitored or audited, or otherwise assured.

1.14 An updated list of references, based on this review ,is required. For example: Nagree et al. [106], etc.,..

1.15 The dates for review need to be updated.

Appendix 2

Different triage systems have been developed in different countries. Countries such as Australia and New Zealand, US, UK and Canada have developed alternative scales. They are described in Tables 1 and 2.

Table A.1. Summary of triage scales by country and version.

Triage Scale	Country of origin	Current version
ATS (Australasian Triage Scale) -formerly National Triage Scale (NTS)[82]	Australian & New Zealand	ATS[4, 5, 32, 35, 80, 83, 90, 94, 124]
MTS (Manchester Triage Scale)	United Kingdom	MTS[25-28, 57]
ESI (Emergency Severity Index)	United States-Canada	ESI[23, 24, 45, 53, 121, 150, 153, 157, 166-168, 173, 179, 192-194]
CTAS (Canadian Triage Scale) and Paediatric CTAS	Canada	CTAS[16-20, 22, 48, 59, 63, 72, 74, 97, 98, 100, 102, 117, 154, 155, 159, 163, 172, 195-198]
RACHN (Navarra's Hospital Classification Scale)	Spain (regional?)	RACHN[151]
FRENCH (French Emergency Nurses Classification in Hospital Scale)	France	FRENCH v.2[41]
TSSS (Triage Severity Scoring System)	Canada?	TSSS [29]
TTS (Taiwan Triage System)	Taiwan	TTS [111]
(ITS) International Triage Scale	Australia?	ITS [6],[7]

Table A.2. Summary of review papers by research question

Reference	Type of Scale	Study design	Dimensions	Methods	Outcomes
What dimensions should be included?					
Ieraci et al [39]	ATS	Triage and complexity	Complexity was able to be assessed and senior staff was able to fast-track patients directly.	Before and after implementation of Fast-track	Significant improvements were observed. Mean waiting time was reduced from 55 to 32 mins and mean treatment time was reduced from 209 to 191 mins. Consistent with other studies. [9, 34, 39-41, 77, 199]
[redacted]					
Bergeron et al[117, 150]	P-CTAS	Paediatric scale developed from the adult CTAS.	Comparisons between paediatric nurses and physicians.	Reliability study using simulated written case scenarios.	Moderate agreement between RNs and PEPs (Kappa=0.51)
[redacted]					
[redacted]					

Cannon and West[198]	CTAS	CTAS and oncology emergencies	Develop alternative scale for oncological cases.	Discussion paper on how oncological emergencies should be assessed.	Main reasons for ED presentation: pain, bleeding, dyspnoea, not feeling well Level 1-resuscitative Level 2-emergent Level 3- urgent Level 4- less urgent Level 5- non urgent
What is the evidence of time thresholds?					
Ritchie et al [200]	ATS	Nursing training	Training using EDTAC.	Cross-sectional survey of triage nurses.	Cross-sectional survey of 159 nurses in 43 selected hospitals across ACT and NSW. Explored nursing needs for standardised training on ATS use. Identified strong need for rapid assessment skills.
[redacted]					
Martins et al [26]	MTS	MTS in Portugal	1 Epidemiological study of data collected between 2005-2007	Statistical analysis of MTS, death outcomes and other factors.	Statistical analysis of MTS, death outcomes, admission and admission routes. The study found a clear association between the priority group and short-term mortality.
Secondary Triage Scales					

Wollaston et al [58]	TATT	Toowoomba adult trauma triage tool (TATT)	This study has indicated that ATS has not succeeded in differentiating patient acuity levels for all patients. This study evaluates a secondary triage system.	Simulation case studies in two hospitals in Queensland.	Developed to analyse nine written scenarios, five on video and one computer simulated scenario. Overall percentage agreement was 87%. Kappa= 0.82. Provides different results to ATS.
Sartorius [55]	MGAP	Mechanism, Glasgow Coma Scale in France	To predict in-hospital death in trauma patients	Multicenter prospective observational study.	High risk= <18 Intermediate=18-22 Low=23-29
Bond et al[43]	ISS, PHI, MOI	Trauma using physiologic triage score.	To improve triage of trauma patients	Prospective study.	Physiologic triage + MOI score. Better predictor than trauma severity score alone. 3147 patients were reviewed. PHI alone had sensitivity =41%; MOI=73%; combined PHI/MOI has sensitivity= 78%. The study suggests that over-triage was reduced. The combined score did not identify all major trauma patients.