Title

Triage system performance: understanding reliability, validity, and decision-making in the context of emergency centre practice

Abstract

Triage systems have come a long way in recent times with the use of tiered acuity to achieve a balance between patient need and resource availability. Triage is a form of sorting patients based on acuity, irrespective of the setting i.e. telephonic, pre-hospital, or in-hospital. The growth of the paramedic profession has seen paramedics now working in emergency centres and having to contend with the concept of triage in this setting. The nature of emergency centres and the variety of patient presentations makes it near impossible to have a perfect system that is both consistent and accurate all the time. It is important for paramedics as decision makers to understand the underlying concepts of what makes a triage system perform well; so that best practice can be adopted with specific goals in mind. There is a patient centred focus to do the most for the most at any given time and to ensure that resources align to the need of patients. It is vital to monitor a triage systems performance so that improvements or adjustments can be reactive to patient population needs over time. This commentary focusses on the main principles of triage system performance measures and what factors should be taken into consideration during clinical practice. Highlighting the concepts of triage reliability, validity, and decision-making should aid paramedics to understand the importance of conscious decision-making practice.

Background

Triage systems are used throughout the world to aid in the sorting of patients based on their acuity and the provision of timely medical care. These systems were developed and reviewed over time to have high clinical predictive value [1]. The broad aim is to match the treatment needs of a patient with the appropriate and available resources within an Emergency Centre (EC). It relies heavily on the determination of a patient's acuity when they arrive at an EC [2]. During the process of triage, usually conducted by non-physician medical staff, a brief snapshot is taken of a patient's clinical signs and symptoms [3]. These are then utilised to formulate a broad understanding of a patient's illness or injury severity that leads to their acuity profile.

A goal of triage systems over the years has been to standardise the assessment and process of triaging patients in a more objective manner based on researched clinical evidence [4]. The culmination of years of clinical outcome research has led to more accurate predictive models of patients' acuity, leading to decreased mortality rates [4]. In simple terms, if a patient's acuity can be accurately determined at the stage of triage, there is a higher likelihood they will receive appropriate treatment in a timely manner. This also forms the basis of triage categorisation, the allocation of an acuity level that is interlinked with set timeframes associated with best outcome time-to-treatment [5]. Patients in emergency centres are usually categorised into different tiers; structuring the order in which they are attended to [6]. Each tier differentiates acuity levels and provides guidance as to how long a patient could clinically wait before requiring treatment. In ideal circumstances all patients would receive some sort of attendance immediately upon arrival at an EC; however, resource limitations make this a near impossible task [7]. Well researched clinical outcome predictors are relied upon to guide clinicians in the sorting of patients to ensure that the most critically ill or injured patients are seen first.

There are two main factors that influence the performance of a triage system; the design of the system itself and the individuals applying that system. It is assumed that the system design provides an objective view of acuity whereas individuals provide a more subjective interpretation. Testing the reliability and validity of a triage system is widely considered as the best way of evaluating its performance [6]. This not only provides a measurable

benchmark of system outputs, but also incorporates the application of that system. To fully understand the application of a triage system it requires an appreciation of triage decision-making; the process though which an individual applies a triage system [8].

Triage reliability

Reliability in broad terms refer to the consistency of quality and performance [9]. Relating to triage, it has been referred to as: a measure of standardised application, agreement between clinicians, and the variability between them [10–12]. It is concurred that the reliability of a triage system addresses mainly the consistency of its performance (i.e. coming up with the same answer every time). This means that the identification, classification, and prioritisation of patients should be the same for each case presentation, irrespective of who conducts the triaging.

In statistical terms, when measuring reliability, the focus is on the precision of the measure to produce similar results under consistent conditions [13]. To evaluate the reliability of a triage system, two variables namely EC conditions and clinicians need to be evaluated for consistency [12]. Firstly, reproducing consistent (the same) conditions within an EC is near impossible and secondly, clinician dynamics vary considerably based on the individual's background, training, exposure, experience and understanding of the triage system [14–16]. Assessing these two variables will determine the reliability strength of a triage system by its ability to produce similar results under inconsistent conditions and between different clinicians.

There is an almost unlimited number of possible patient presentations to an EC and the conditions under which a triage system is applied cannot be consistently replicated [17]. It is acknowledged that patients with similar conditions can be grouped together (i.e. cardiac, respiratory, abdominal, etc.) and will commonly have similar or consistent presentations (i.e. signs and symptoms) [18]. The number of clinicians is usually confined to a group of individuals within an EC that can be evaluated. When clinicians apply a triage system, the outcome is the allocation of a triage category that reflects the patient's acuity. The relationship measured between clinicians is commonly referred to as inter-rater

reliability/agreement [19]. Thus, the degree of agreement is measured between two or more clinicians to determine how they relate to an outcome (i.e. triage category allocation) [12].

The measure of reliability within most triage studies focus on the level of inter-rater agreement [19–21]. There are several methods to measure and evaluate inter-rater agreement, including joint probability of agreement, kappa statistics, correlation coefficients, limits of agreement and Krippendorff's alpha [22–26]. Joint probability of agreement is simply the number of times a rating is assigned by a clinician divided by the total number of ratings [22]. Kappa statistics goes further by taking into account the amount of agreement that could be expected through chance [23]. Correlation coefficients evaluate the agreement or relationship between groups of clinicians [24]. Limits of agreement uses paired clinician means to determine how much random variation may influence individual ratings [25]. Krippendorff's alpha is used to assess the agreement among clinician who allocate measurable values to unstructured phenomena to determine whether the data can be trusted [26]. The most commonly used measures of reliability in triage is that of chance-corrected Cohen's kappa and inter-class correlation coefficients [19,27,28]. Since it is widely used within triage research it helps to cross-compare the outcome measurements between systems to determine their relationship to each other, i.e. which one is more reliable in a given setting.

Paramedics need to understand how to apply a triage system consistently to aid in their clinical decision making; appreciating the impact such consistency has on patient outcome and EC flow. It is important to keep monitoring one's own consistency in triage category allocation and ensure there is reliability among colleagues.

Triage validity

Validity in broad terms refer to the quality of being logically or factually sound [29]. Relating to triage, it has been referred to as: a measure of how close an acuity rating is to a patient's true acuity, the correct identification of true acuity, and the degree to which true acuity can be predicted [1,10]. It is concurred that the validity of a triage system addresses mainly the accuracy of its performance (i.e. coming up with the right answer). This means that the

identification, classification, and prioritisation of patients should be correct and accurate in its prediction of acuity.

The validity of a triage system can be measured either subjectively or objectively. The subjective measures relate to the outcomes achieved based on the triage category allocation and is usually chosen arbitrarily to reflect the predictive accuracy of the triage system within a specific EC setting (e.g. length of stay, admission rate, mortality, etc.) [6]. These subjective reference standards can be picked purposefully based on the EC's needs, resources, economic gain or any other goal [10]. In most cases, the reference standard is chosen to reflect a high level of safety and focus on patient outcomes [30]. Since there is no ultimate right or wrong answer as to which reference standard to use, it becomes difficult to compare the validity between triage systems when their outcomes are measured differently [31].

The objective measures relate to the accuracy of a clinician using the triage system to be able to correctly assign a triage category to the correct patient acuity. Performance indicators are the most common tools for measuring the objective validity of a triage system, i.e. sensitivity, specificity, over- and under-triage [1,32]. Sensitivity refers to the true positive rate where the proportion of positives are correctly identified, and specificity refers to the true negative rate where the proportion of negatives are correctly identified [33]. This means that the sensitivity measure is good at ruling out negative results and the specificity measure is good at ruling in positive results. A balance is needed between the sensitivity and specificity of a triage system to allow for accuracy, but also provide a level of safety to include outlying variables. Over-triage is the measure of overestimating a patient's acuity and allocating a higher triage category than required while under-triage is the measure of underestimating the patient's acuity and allocating a lower triage category than required [1]. To underestimate a patient's priority is of more concern as it may be detrimental to a patient to wait longer for treatment, especially for high acuity patients. Overestimating a patient's priority is less concerning as it allows for a safety margin, although this may have negative impacts on the service delivery of an EC by depleting its resources.

An acceptable balance of performance indicators is necessary for a triage system to be valid as they are inversely proportional to each other. In other words, when one goes up the other

goes down. The benefit of measuring performance indicators is that studies on triage system performance can be compared against each other to determine whether one system is more valid than another for a specific setting. The limitation however, is similar to that of the subjective measures as there are no fixed or agreed upon standard levels of sensitivity, specificity, over-triage and under-triage [33]. It is difficult to compare the performance of a triage system as no gold-standard exists, and the standard also depends largely on what goals the EC wants to attain. The measure of performance is thus an internal process (i.e. internal validity) of evaluating the subjective and objective indicators to attain a desired outcome. In most cases, an external evaluation process (i.e. external validity) provides a better reflection of a triage system's performance as it can be compared to the performance of other triage systems throughout the world [34].

To identify a patient's acuity in the emergency setting has been a great strength in paramedic practice. This leads to confidence in clinical accuracy that can be applied not only to the pre-hospital, but also to the in-hospital setting. Being able to assign an accurate triage category should ensure a more efficient allocation of resources.

Triage decision-making

Although the reliability and validity of certain triage systems in particular settings have been established, triage strategies and decision-making are complex processes that are not well understood [31,35,36]. In many developed countries, triage is frequently performed by registered nurses [16,37]. It follows that these nurses are also commonly the first healthcare providers patients encounter when presenting to an EC; however, this is changing with the introduction of paramedics into this setting [16,37]. The triage decision-making process is dependent on the knowledge and experience of clinicians gathering and evaluating the information required to make a triage decision [14,38]. It involves clinical judgements to be made within a relatively short time-frame [39]. As a result, the triage decision-making process aims to cope with these circumstances and requires critical thinking, and rapid evaluation – a strong trait within paramedic practice [8,40].

Critical thinking is defined as the objective analysis and evaluation of an issue in order to form a judgement [29]. The question can then be asked: why is critical thinking a necessary part of

triage when the purpose of a triage system is to consistently replicate a similar outcome using a formalised triage reference tool? Critical thinking therefore brings a level of subjectivity (clinical acumen) to the triage process which may seem counter acted by the objective purpose of a triage system.

To understand this surface contradiction, it should be understood that triage is a process with several intertwined steps [39]. Most triage systems have triage reference tools that are usually only a single, or in some cases a few pages long. These reference tools are used on a daily basis to help guide the triage process, however, they only highlight a small number of common patient presentations [17,18]. The reference tool only provides an aid to the clinician in the process of triage decision-making. This is evident in the extensive triage manuals accompanying the triage systems which contain training information on all the aspects of the triage decision-making process [17,18]. The dynamics of the individual triage system also plays a large role in allowing for critical thinking to take place [8,35]. For example, some triage systems only provide a small reference tool with an emphasis on clinical judgement to reach a triage allocation while others have larger reference tools that need to be followed more stringently. The clinical scope of individuals performing triage is another factor to take into consideration [41]. For example, in some countries, individuals may be allowed a broad scope of independence and thus wide clinical judgement is allowed for, while in other countries, the limitations of practise (i.e. limited scope) deter clinical judgement from individuals conducting triage. There is no one scenario that is better than the other and thus cognisance of the needs of the setting ought to be taken when selecting a triage system.

The biggest determinant to clinical decision-making is the individuals themselves, including their background, training, experience and understanding of the triage system [16,38,39]. Appropriate triage training and including a sound understanding of triage theory and its relationship to triage practice plays a vital role in the eventual outcome and quality of the decision-making process [16,38,39]. It can be argued that better qualified individuals (like paramedics) will need less training and refreshing than less qualified individuals, which saves resources in maintaining triage performance standards in the form of reliability and validity [36,37,39]. Implementing a triage system to a specific setting from a decision-making standpoint is therefore dependant on the environment it will be used in, the individuals who

will be using the system, the scope of clinical judgements that are allowed and the level of training that needs to be undertaken. Paramedics are independent clinicians and have show to be able to use reasoned clinical judgement and integrate decision-making tools such as triage systems in their daily practice.

Conclusion

Emergency centre triage goals can be quite different to those paramedics are used to in their pre-hospital practice. Applying EC based systems may feel awkward at first, however, the principles of triage remain the same – matching patients with resources. The ideal outcome for any triage system would be to accurately assess all patients and their acuities every single time. Although this can be the goal, the effects of 'real-life' variances in population dynamics, illness and injury profiles, medical staffing, and available resources make such a goal difficult to attain. It is important to continue evaluating a triage systems performance to allow for continual improvements to be made. Paramedics moving to the in-hospital EC setting will find themselves having to adjust their mindset and practice to be cognisant of the principles that underpin triage system performance.

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