Emergency department triage in a resource constrained setting: application of the World Health Organization Triage Scale in regional Papua New Guinea

Study protocol

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Research team

Chief investigator: Peter Cameron FACEM MD
Director of Academic Programs, Emergency & Trauma Centre, Alfred Health
Professor, Department of Epidemiology & Preventive Medicine, Monash University

Student researcher: Rob Mitchell FACEM
Emergency Physician, Emergency & Trauma Centre, Alfred Health
PhD Candidate, Department of Epidemiology & Preventive Medicine, Monash University

Co-investigators: John Jr. McKup MMed (EM)
Emergency Physician, Mount Hagen Provincial Hospital

Scotty Kandelyo Med (EM)
Emergency Physician and Regional Chief of Emergency Medicine, Highlands Region

Gerard O'Reilly FACEM PhD
Emergency Physician and Director of International Programs, Emergency & Trauma Centre, Alfred Health
Associate Professor, Department of Epidemiology & Preventive Medicine, Monash University

Colin Banks FACEM
Emergency Physician, Townsville Hospital

Teri Reynolds MD MS PhD
Lead, Emergency, Trauma and Acute Care Program, World Health Organization

Background

Triage is an important component of emergency care (EC). It aims to sort patients based on the urgency of their condition such that the highest acuity patients are prioritised for assessment and treatment. Grounded in the ethical principles of equity and justice, triage is necessary whenever there is a mismatch between demand for EC and the availability of resources.

Globally, a large number of triage scales are in use. These differ in the data required to categorise patients as well as the number of tiers.[1] Developed settings tend to utilise five-tier systems, principally based on validation studies performed in Australia in the 1990s.[2] The triage process is less efficient in these models, because triage nurses (who typically perform emergency department triage) take longer to assess and differentiate category three and four patients.[3]

There have been few attempts to compare the performance of triage scales. A 2011 systematic review concluded that current scales were supported by limited or insufficient evidence, and suggested that "head-to-head comparisons are required to determine whether any of the scales have advantages over the others".[1]

Triage in developing emergency care systems

Despite the established role of emergency departments (EDs) in developed countries, most of the world's population does not have access to timely and effective emergency care. This situation is slowly being addressed as the global health community recognises the value of EC systems.[4]

Little is known about the prevalence of triage in low- and middle-income countries (LMICs), including in the Pacific region. There is also limited evidence about the utility, validity and reliability of triage scales in these contexts.[5] While a landmark study in a paediatric ED in Malawi demonstrated that training staff in emergency skills, introducing triage and improving flow, substantially reduced case fatality rates, the mortality reduction attributable to triage is unknown.[6]

A small number of triage scales have been developed for resource-limited (RL) environments. The most widely studied is the four-tier South African Triage Scale (SATS), which has demonstrated reasonable reliability and validity.[5] A recent systematic review of adult triage scales in LMICs found that the evidence supporting any particular triage scale was moderate at best.[5]

In the Pacific region, SATS has provided a foundation for the three-tier Solomon Islands Triage Scale (SITS), which has recently been piloted in Honiara.[7] The World Health Organization (WHO) is also preparing to release a three-tier triage scale [personal communication, T Reynolds]. Neither of these instruments has been prospectively validated.

Although the potential value of triage systems in resource-limited EDs is increasingly recognised, the current evidence base is limited. The impact on process indicators (eg, time to assessment) and clinical outcomes (eg, mortality) for time-critical conditions is largely unknown.

Evaluating triage systems

One of the challenges in evaluating and comparing triage systems is a lack of consistent methodology. Most studies have focussed on reliability and validity as markers of performance.

Reliability is an essential component of a triage system, and refers to the degree to which repeated assessments of the same patient will deliver the same category of urgency.[8] This is typically assessed using inter-rater agreement.

The validity of a triage system refers to its ability to reflect the true urgency of the patient's condition. A major challenge in validity assessment is the absence of a definitive or 'gold standard' measure of urgency.[2] A range of surrogate markers have therefore been used to assess criterion and predictive validity, namely ED outcomes such as admission rate, mortality and length of stay. Some authors have suggested that a Delphi approach might also be useful for the evaluation of triage systems in developing settings.[8]

Several studies have calculated under- and over-triage rates as a measure of validity.[9–12] These typically use acceptable limits defined by the American College of Surgeons Committee on Trauma (ACS COT) as a reference standard.[13]

Emergency care and triage in Papua New Guinea

Papua New Guinea (PNG), a Pacific Island Country (PIC) with a population of approximately 8 million, is faced by significant challenges in healthcare delivery. These include sunder-resourcing, a limited health workforce, a high burden of communicable disease (including significant rates of HIV/AIDS and tuberculosis) as well an increasing prevalence of non-communicable illness and injury.[14]

Despite an increasing number of emergency physicians, most provinces outside of Port Moresby (the nation's capital) have under-developed primary and secondary care systems to facilitate emergency care.[15] There is little data on the epidemiology of emergency presentations, and most EDs are not utilising triage scales. Triage has been identified as a priority for emergency care development for PICs, including PNG [personal communication, G Phillips].

Aims

The primary objective of this study is to measure the impact of a triage system on process indicators and clinical outcomes in a regional ED in PNG.

The secondary objective of this study is to determine the validity and reliability of the World Health Organization Triage Scale in this setting.

Methods

Setting

This study will be conducted in the ED of the Mount Hagen Provincial Hospital (MHPH) in the Western Highlands Province of PNG. The hospital is managed by the Western Highlands Provincial Health Authority (WHPHA).

Mount Hagen is the third largest city in PNG, with a population of approximately 50,000. It is the capital of the Western Highlands Province (population approximately 400,000), and a major administrative centre for the Highlands region.

MHPH is the city's major health facility. There is limited primary care infrastructure within the province, so patients rely on MHPH for the majority of their healthcare needs. As in other parts of the country, there is a large burden of both communicable and non-communicable disease, including HIV/AIDS, tuberculosis diabetes, cardiovascular disease, chronic respiratory conditions and trauma.

The ED receives approximately 150 presentations per day, and is staffed by one emergency physician, three registrars (specialists in training), five health extension officers (HEOs) and approximately thirty nurses. The ED has recently been redeveloped, and now includes four resuscitation bays, 16 acute beds and five short-stay beds. Basic pathology and radiology services are available.

Under current arrangements, the ED has no triage system and manual data collection processes are leading to gross under-reporting of presentation numbers. Major challenges for the ED include understaffing, a large burden of primary care patients and access block.

A new electronic database of ED patients has recently been implemented to capture basic attendance data. This system will facilitate data capture for the study.

Design

This study will utilise pre-post intervention methodology and will be prospectively registered as a clinical trial with the United States National Library of Medicine Clinical Trials Register at clinicaltrials.gov.

Pre-intervention

A new MHPH ED Patient Registration and Triage Form (PRTF) will be created to facilitate the new system and capture relevant data items, such as demographics and initial vital signs (Appendix 1). This form will be based on an existing MHPH ED discharge form, as well as a triage form successfully implemented in another Pacific setting.[7]

Data from the PRTF will be entered by ward clerks into the ED's electronic patient registration system (recently implemented as part of a hospital-wide data improvement project). This system forms part of the MHPH medical records database.

After a trial period of staff testing the new form, the PRTF will be implemented and baseline data captured in the database. During this period, the PRTF will not include any triage information (Appendix 1A). Based on a power calculation (see below), two months of pre-intervention data will be collected.

In order to identify patients who meet inclusion criteria, as defined below, the PRTF will require the treating clinician to indicate whether the patient had one of the ten sentinel conditions (listed below).

Intervention

The intervention will comprise implementation of a new triage and patient flow system facilitated through staff training and clinical redesign.

The three-tier World Health Organization Triage Scale (WHOTS) will be used as the triage instrument. This tool, developed collaboratively by the WHO, International Committee of the Red Cross (ICRC) and Médecins Sans Frontières (MSF), incorporates features of the SATS but has been modified for application in a wide variety of RL settings. WHOTS documents are provided in Appendix 2.

At the end of the baseline data collection period, MHPH ED staff will be trained in the new system. A variety of ED clinicians (who will subsequently take on the triage role) will be the focus of this training program. This will include nurses, community health workers and health extension officers in order to provide flexibility in the staffing model. Triage training will be delivered by an experienced Australasian volunteer nurse(s) and comprise workshops on triage principles, paper-based scenarios and simulation exercises.

Signage will be introduced to facilitate the new system of flow, and the ED will begin utilising the version of the PRTF that incorporates triage data (Appendix 1B). The triage instrument will be piloted over a one-month period (approximately). Modifications will be made based on real-time feedback as well as observations by the visiting team.

Post-intervention

After completion of the trial period, the new triage and flow system will be implemented under the leadership of local clinicians. The ED registration database will be updated to capture triage category data.

For admitted patients, hospital length-of-stay (LOS) and inpatient mortality data will be obtained from the WHPHA medical records database. These patients will be identified by the patient's unique hospital identification number.

Outcomes

Primary objective

The primary outcome will be time-to-assessment (TTA) by an ED clinician for ten time-critical conditions:

- Severe trauma
- Major burns
- Severe head injury
- Ruptured ectopic pregnancy
- Septic shock
- Myocardial infarction
- Severe asthma/COPD
- Severe pneumonia
- Meningitis
- Appendicitis

Pragmatic definitions for these conditions are provided at Appendix 3.

The primary outcome will also be analysed by the proportion of patients with these clinical syndromes that are seen within a clinically appropriate timeframe (defined as 15 minutes, as discussed below).

Secondary outcomes will include:

- Length of hospital stay
- ED mortality
- Inpatient mortality

These are also defined in Appendix 3.

Secondary objectives

Validity of the WHOTS will be assessed through its ability to predict ED outcomes. This will include the relationship between triage category and admission rates and ED mortality.

Under- or over-triage rates will also be calculated using disposition as a reference standard. This approach has limitations (see below) but is widely used in triage research.

Over-triage will be defined as the proportion of emergency (category 1) patients who are discharged. Under-triage will be defined as the proportion of non-urgent (category 3) patients who are admitted. Rates will be compared with the acceptable under- and over-triage rates recommended by ACS COT[13] (and widely referenced in triage research) and then benchmarked against other published data. This approach has limitations (given that not all category 1 patients will required admission, and many category 3 patients could reasonably be expected to; recommendations for triage in trauma do not necessarily apply to other disease categories; and the performance targets provided by an American society do not necessarily apply to other contexts) but will be undertaken to enable comparison with other triage research from LMICs.

Reliability will be assessed through inter-rater agreement between two local triage nurses as well as a local nurse and independent expert triage nurse.

Analysis

All data will be obtained from the MHPH medical records database. Hospital medical records staff will export de-identified into an Excel document, which will be provided to researchers and stored on a secure, password protected Monash University drive. All data will be analysed using Stata. No identifiable data will be available to the researchers.

Primary objectives

For the primary outcomes, Student's t-test will be used to compare the difference in TTA for the ten sentinel conditions (assuming parametric data). Chi-Square will be used to determine the difference in proportions of patients seen within 15 minutes.

For the secondary outcomes of ED mortality, hospital mortality and hospital LOS, Student's t-test or Chi-Square will be used as appropriate.

Secondary objectives

For predictive validity, Chi-Square and correlation coefficient derived by Cramer's V will be used to investigate the relationship between triage category and admission rates & ED mortality.

Under- and over-triage rates will be calculated using the definitions above. Acceptable limits set by the American College of Surgeons Committee on Trauma (an under-triage rate of less than 10% and an over-triage rate of 30–50%) will be used as the reference standard.[13] This approach is consistent with that used in other triage research, despite the limitations discussed above.[9–12]

For reliability, the modified Kappa statistic will be used to test inter-rater agreement between triage nurses.

Sample size

It is estimated that approximately 15 patients per day present with one of the ten sentinel syndromes and wait an average of 20 minutes to be seen. A clinically significant improvement in the TTA for these patients is thought be five minutes. Although Australasian guidelines recommend that high acuity presentations (equivalent to categories one and two in the Australasian Triage Scale) are seen within 10 minutes of arrival,[16] a target of 15 minutes is thought to be acceptable in the resource limited context of MHPH.

Based on these figures, a sample size of 34 (17 per group) will be required to demonstrate a clinically significant decrease in TTA for the selected time-critical conditions at an alpha of 0.05 and beta of 0.8.

The primary outcome will also be analysed by the proportion of patients seen within 15 minutes of arrival. Assuming baseline performance is 45%, an absolute improvement of 10% (to 55%) will require a sample size of 784 (392 per group) at an alpha of 0.05 and beta of 0.8.

The secondary outcome of mortality will require a larger sample. In order to demonstrate an absolute reduction in mortality of 5% (from an estimated baseline mortality rate of 15%), a sample size of 1372 (686 per group) is required at an alpha of 0.05 and beta of 0.8.

To ensure a satisfactory sample size to demonstrate all outcomes, pre- and post-intervention periods of 8 weeks will be utilised. This is based on a total sample size of 1372 for the secondary outcome of mortality (with a buffer of 10%) at an estimated presentation rate of 15 per day. This requires pre- and post-intervention periods of at least 50 days.

Ethics

Ethics approval, including a waiver of consent, will be sought from Monash University. Consistent with local processes, approval to conduct this research will then be sought from the Medical Research Advisory Committee within the Papua New Guinean National Department of Health.

Limitations

This study has been designed to ensure it is methodologically robust. There are, however, several limitations that will be need to be considered when interpreting the results.

The pre-post nature of the design means that the study may be subject to confounding. A particular risk is that a new and efficient triage system may prompt an increase in ED presentations, and a change in the overall acuity of the patient cohort. For this reason, the primary outcome will focus on ten clearly-defined time critical conditions.

Other factors may also influence the primary outcome, such as changes in staffing levels and acute fluctuations in demand for emergency care (for instance, in the setting of disaster or outbreak). Within the influence of the researchers, attempts will be made to control these factors and minimise variation across the study period.

There is a risk that the study will be subject to the Hawthorne effect. Although treating clinicians will be blinded to the primary outcome, they will have knowledge of the ten sentinel conditions by virtue of their inclusion on the PTRF. It is therefore possible that patients presenting with these syndromes will be prioritised for care.

These limitations reflect the real-world challenges of conducting research in developing settings. The proposed study design is an attempt to balance methodological rigour with the practical considerations of emergency care delivery and research at MHPH.

Conclusion

Triage is an essential component of EC systems, especially in developing settings where demand for care typically exceeds the available resources. This study, using pre-post intervention methodology, will determine whether the introduction of a triage system leads to a clinically significant decrease in TTA for selected time-critical syndromes. It will also describe the impact on ED mortality, hospital mortality and total LOS.

A secondary objective of this study is to assess the validity and reliability of the WHO triage scale. There is currently no published data on the performance of this system.

This study will provide important data on the impact of triage on clinical and process outcomes for patients presenting with time-critical conditions to a resource-limited ED. It will help inform the future development and application of triage systems in other developing settings, and allow comparison of the WHOTS with other triage instruments.

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Appendix 1

Appendix 1A – Pre-intervention Patient Registration and Triage Form
Appendix 1B – Post-intervention Patient Registration and Triage Form

See attached.

Appendix 2

World Health Organization Triage Scale – user guidance

See attached.

Appendix 3

Definitions for primary and secondary outcomes

Definitions related to primary outcomes

- Major trauma – any injury requiring blood transfusion or an intercostal catheter in the ED, or transfer direct to the operating theatre
- Severe head injury – any patient with objective evidence of a head injury and a Glasgow Coma Scale less than nine
- Major burns – any burn of greater than 15% total body surface area, as estimated by the treating clinician
- Myocardial infarction – an ECG positive for ST-elevation myocardial infarction, or raised troponin based on the threshold defined by the local laboratory
- Septic shock - fever (temperature >37.5°C) and hypotension (systolic BP $\leq$90mmHg)
- Ruptured ectopic pregnancy – objective evidence of pregnancy (extra-uterine gestational sac on ultrasound or positive urine βHCG) and free fluid on ultrasound
- Severe asthma/COPD – any patient with an oxygen requirement where the most likely diagnosis is an exacerbation of asthma or chronic obstructive pulmonary disease
- Severe pneumonia – any patient with an oxygen requirement where the most likely diagnosis is pneumonia
- Meningitis – any patient where the most likely clinical diagnosis is meningitis
- Appendicitis - any patient where the most likely clinical diagnosis is appendicitis

Time to assessment - the time interval in minutes between patient arrival at ED reception and the time of first assessment by the treating clinician

Definitions related to secondary outcomes

- Length of hospital stay – the number of days from presentation to discharge
- ED mortality –any death that occurs while the patient was physically in the ED, excluding patients who meet criteria for 'deceased on arrival'
- Inpatient mortality - any death that occurs while the patient was admitted to hospitals, excluding any deaths that occur in the ED

Deceased on arrival is defined as any patient who is obviously deceased on arrival, as determined by the treating clinician.