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Validation of the Interagency Integrated Triage Tool in a resource-limited, urban emergency department in Papua New Guinea: a pilot study

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ABSTRACT

Background: The Interagency Integrated Triage Tool (IITT) is a three-tier triage system designed for resource-limited emergency care (EC) settings. This study sought to assess the validity and reliability of a pilot version of the tool in an urban emergency department (ED) in Papua New Guinea.

Methods: A pragmatic observational study was conducted at Gerehu General Hospital in Port Moresby, commencing eight weeks after IITT implementation. All ED patients presenting within the subsequent two-month period were included. Triage assessments were performed by a variety of ED clinicians, including community health workers, nurses and doctors. The primary outcome was sensitivity for the detection of time-critical illness, defined by ten pre-specified diagnoses. The association between triage category and ED outcomes was examined using Cramer's V correlation coefficient. Reliability was assessed by inter-rater agreement between a local and an experienced, external triage officer.

Findings: Among 4512 presentations during the study period, 58 (1.3%) were classified as category one (emergency), 967 (21.6%) as category two (priority) and 3478 (77.1%) as category three (non-urgent). The tool's sensitivity for detecting the pre-specified set of time-sensitive conditions was 70.8% (95%CI 58.2-81.4%), with negative predictive values of 97.3% (95%CI 96.7 - 97.8%) for admission/transfer and 99.9% (95%CI 99.7 - 100.0%) for death. The admission/transfer rate was 44.8% (26/58) among emergency patients, 22.9% (223/976) among priority patients and 2.7% (94/3478) among non-urgent patients (Cramer's V=0.351, p=0.00). Four of 58 (6.9%) emergency patients, 19/976 (2.0%) priority patients and 3/3478 (0.1%) non-urgent patients died in the ED (Cramer's V=0.14, p=0.00). The under-triage rate was 2.7% (94/3477) and the over-triage rate 48.2% (28/58), both within pre-specified limits of acceptability. On average, it took staff 3 minutes 34 seconds (SD 1:06) to determine and document a triage category. Among 70 observed assessments, weighted κ was 0.84 (excellent agreement).

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Interpretation: The pilot version of the IITT demonstrated acceptable performance characteristics, and validation in other EC settings is warranted.

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Research in context

Evidence before this study

- The Interagency Integrated Triage Tool, developed collaboratively by the World Health Organization (WHO), International Committee of the Red Cross (ICRC) and Médecins Sans Frontières (MSF), is a novel, three-tier triage system designed for resource-limited emergency care (EC) settings
- The system has been initially released as part of a WHO tool-kit for clinicians in low- and middle-income countries responding to the COVID-19 pandemic
- There is no published data regarding the validity and reliability of the tool

Added value of this study

- Following implementation of a pilot version of the system in the resource-limited, urban ED setting of Gerehu General Hospital in Papua New Guinea, the tool's performance characteristics were assessed
- The IITT demonstrated adequate predictive validity (within the range reported for other triage tools), excellent reliability and a low under-triage rate, a key marker of system safety
- The majority of triage assessments were undertaken by community health workers, suggesting that the tool can be effectively applied by clinicians with limited formal training

Implications of all the available evidence

- The COVID-19 pandemic has highlighted the value of simple tools that can identify patients with urgent care needs, especially in resource-limited contexts
- This study provides initial evidence that the IITT is valid and reliable, but assessment in other EC settings is required
- Given a lack of published data regarding the real-world performance of the system, these findings are timely and important

1. Introduction

Emergency departments (EDs) require systems for identifying and prioritising patients with urgent care needs. This process, referred to as triage, is particularly important when demand for care exceeds the available resources. [1]

In the 50 years since triage was first applied to civilian medicine, [2] a large number of triage scales have been developed. [1] These differ in terms of structure (number of tiers or categories) and composition (assessment criteria). [3–5] High-income countries generally utilise five-tier systems, such as the Emergency Severity Index and Australasian Triage Scale, but these instruments are not well-suited to resource-limited emergency care (EC) settings. [1,3–5]

1.1. ED triage in resource-limited settings

Although the evidence underpinning triage in low- and middle-income countries (LMICs) is limited, the value of simple and context-specific approaches is widely acknowledged. [6–14] Among the small number of tools purpose-designed for resource-limited environments, the four-tier South African Triage Scale (SATS) has been researched most extensively. [15] Adequate validity and reliability has been demonstrated in a number of countries and contexts, [16–27] but the tool has been found to be too complex for some settings, requiring provider capacity that is not universally available. [28] Although SATS has been widely implemented, recent systematic reviews of adult and paediatric triage scales in LMICs have found an absence of high-quality evidence favouring any particular tool. [6,7]

The evaluation of ED triage systems is complicated by the lack of a definitive reference standard for urgency. [1,29] As a consequence, studies commonly assess predictive validity using ED outcomes (such as admission and mortality) as surrogate measures. In light of the contextual and methodological variation in the literature, [1,4,5,29] triage has been identified as a priority area for global EC research. [30,31]

1.2. The Interagency Integrated Triage Tool

The Integrated Interagency Triage Tool (IITT), developed collaboratively by the World Health Organization (WHO), International Committee of the Red Cross (ICRC) and Médecins Sans Frontières (MSF), is a novel, three-tier system purpose designed for resource-limited EC settings. Tools utilising three categories are well-suited to developing EDs because they are intuitive and efficient. [10–12,14] The IITT has been recommended by WHO in guidance related to the COVID-19 pandemic, but there are no published data regarding its performance. [32,33]

As with most triage systems, the IITT is designed to be applied at the point of ED arrival. It allocates patients into a colour-coded category based on the presence of specific signs and symptoms (categories one and two) or the absence of high-risk vital signs (category three). The triage assessment process is summarised in Figure 1 and the specific criteria, as applied in this pilot, are listed in Appendix 1. [34] Unlike SATS, the IITT does not require calculation of a triage early warning score. [15,28]

This study assessed the validity and reliability of the pilot version of the IITT in a resource-limited ED in Port Moresby, Papua New Guinea (PNG). To the knowledge of the authors, this represents the first published data regarding the tool's performance in an urban setting. Triage has been identified as a priority for EC development in the Pacific, [13] and this project formed part of

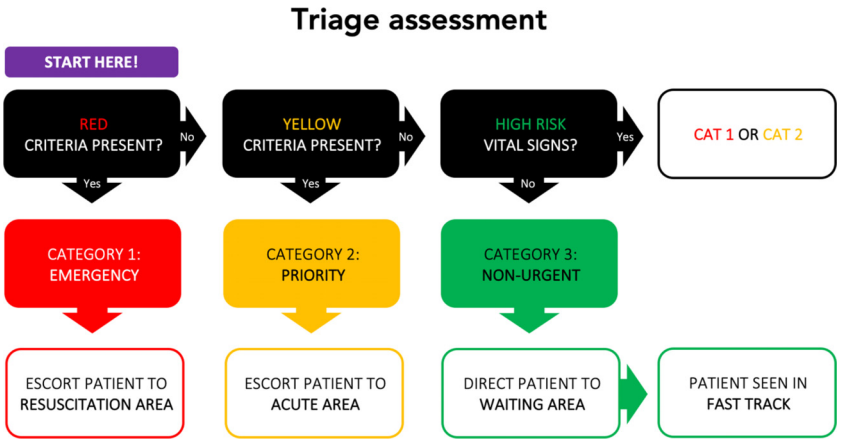

Figure 1. IITT triage assessment flowchart, as adapted for this pilot study

a collaborative initiative to improve ED systems across the region. [34]

2. Methods

2.1. Design and participants

A retrospective observational study was performed at Gerehu General Hospital (GGH). All ED patients presenting during the study period were included. There were no exclusion criteria.

2.2. Setting

Port Moresby, with a population of approximately 365,000, is PNG's capital city. Healthcare challenges affecting the country include a limited health workforce, a high burden of communicable disease and an increasing prevalence of non-communicable illness. [35,36] National healthcare standards exist for triage and EC, but have not been widely adopted. [37] The standards do not specify a particular triage instrument, but require that "there is a triage system to assess patients for urgency of care…and to help ensure that they receive care appropriate to their needs". [37]

GGH is Port Moresby's secondary public hospital. The ED provides EC for adults and children outside of business hours, but a separate children's outpatient department receives paediatric patients during the day. Total ED staff comprises four emergency physicians, seven registrars (specialists-in-training), seven health extension officers (HEOs) and approximately 24 nurses and community health workers (CHWs). The role of HEOs is similar to clinical officers in other LMICs, [38] while CHWs have a similar scope of practice to nursing staff. [39]

The ED comprises two resuscitation bays and six acute beds. Basic pathology services are available but there is no on-site radiology. The hospital has inpatient units for medicine and paediatrics (each with access to an eight-bed ward), but patients requiring surgery, critical care or admission under another service are transferred to Port Moresby General Hospital. As a result of limited inpatient capacity, a 'virtual' short stay unit (operating from within the existing ED bed stock) enables ED staff to provide care to selected patients (who are unlikely to require admission) for an extended period of time.

Prior to implementation of the IITT, GGH was utilising a bespoke four-tier triage system adapted from the Australasian Triage Scale. Few ED staff had received any formal training in triage. Given space and human resource constraints, GGH clinicians had identified that a three-tier tool would better suit their needs, and after considering the available options, selected the IITT as the best fit.

2.3. IITT implementation process

The process for transitioning to the IITT has been described in detail elsewhere. [34] In summary, the tool was installed as part of a suite of ED systems improvements, facilitated through a collaborative partnership between PNG and Australian EC clinicians. [34]

Given the novel nature of the IITT, a number of resources were developed to facilitate the operation of the system. These included colour-coded flowcharts for triage assessment and patient flow (Figure 1, Appendix 1 and Appendix 2), summarising the treatment pathways for category one (emergency/red), category two (priority/yellow) and category three (non-urgent/green) cases. Laminated cards for IITT emergency signs and symptoms, priority signs and symptoms, vital sign parameters, high-risk trauma criteria and locally recommended time targets were also produced. [33,34] To support the system's requirement for three streams of care, designated areas were developed for emergency (resuscitation/red zone), priority (acute/yellow zone) and non-urgent patients (fast track [FT]/green zone). [34]

A clear process was required to operationalise the IITT. Leveraging a strategy used elsewhere, [12] a manual sorting system, linked with the triage assessment workflow, was developed. Under this process, all patients presenting to triage are allocated a clipboard and a Patient Triage and Registration Form (PRTF). After completion of the triage assessment, the clipboard and PRTF are placed at the back of a designated, category-specific box. To ensure that patients are seen in the correct order, clinicians select a clipboard from the front of the box and prioritise 'red before yellow' and 'yellow before green'. At the conclusion of a patient's episode of care, clipboards are placed in a designated 'discharge' box and returned to triage for re-use. [34]

A multi-disciplinary team of experienced Australian EC clinicians delivered training in the new system. This comprised a five-hour classroom session incorporating case studies and role plays. GGH leaders determined that all ED staff should undertake the training, such that doctors, HEOs, nurses and CHWs would all have capacity to undertake the triage officer role. The new system was implemented 24 hours after the conclusion of the classroom teaching sessions, but with direct support and mentoring from the visiting clinicians for a one-week period.

2.4. Study period

This study commenced eight weeks after the implementation of the IITT (1 November 2019) and ceased two months later (31 December 2019). Reliability data was collected mid-way through the study period as part of a post-implementation monitoring and evaluation visit. The gap between installation of the new system and commencement of the study period was instigated to allow sufficient time for the new system to become embedded in local practice, and to offset any honeymoon effect.

2.5. Outcomes, sample size and analysis

The primary outcome was sensitivity for the detection of time-critical illness, defined by ten, pre-selected diagnoses (severe trauma, major burns, severe head injury, ruptured ectopic pregnancy, septic shock, myocardial infarction, severe asthma/chronic obstructive pulmonary disease, severe pneumonia, meningitis and appendicitis). These conditions represent common medical problems that require timely recognition and treatment, and were selected through a consensus approach involving Australian and PNG emergency physicians. Specific definitions for these diagnoses can be found in Appendix 3.

Sensitivity was calculated using a dichotomised triage categorisation (category one and two as urgent, and category three as non-urgent), expressed with a 95% confidence interval (CI). The presence of one of the ten time-critical diagnoses relied on identification of the condition by the treating clinician at the time of definitive management (ie, independent of the triage assessment), and recording on the PRTF (using a simple 'checkbox' system). The study definitions for these conditions were displayed on posters in the ED office.

Algorithms derived from Buderer's formula were used to determine the sample size for the primary outcome. [40–42] Calculations assumed a sensitivity of 70% (an approximation based on previous observations of triage system performance for detecting time-critical diagnoses) [4] and a prevalence of 20% (ie, that one in five patients presenting to GGH ED would have one of the ten, pre-specified, time-critical diagnoses), an estimate by local clinicians. Based on these conditions, a sample of 1615 patients was required to achieve a point estimate with a confidence interval of .05 (+/- 5%). Daily ED attendance was predicted to be approximately 60 patients, such that a period of at least 27 days was required. Given the uncertainty around presentation numbers, a study duration of two months was adopted.

Secondary measures of the tool's performance were the relationship between triage category and ED outcomes (mortality and hospital admission), expressed using sensitivity and specificity. As above, these were calculated using a dichotomised triage categorisation and reported with a 95% CI. This approach has been used in a large number of triage studies. [4,5] In the setting of three, ordinal triage categories, these relationships were also assessed using Chi-Square and a correlation coefficient derived by Cramer's V, a methodology employed elsewhere. [26] For all analyses, a p-value of less than 0.05 was considered statistically significant.

Under- and over-triage rates, using disposition as a reference standard, were also calculated. As discussed below, this approach has limitations but has been widely employed. [18,19,25–27] Under-triage was defined as the proportion of non-urgent (category three) patients who were admitted or transferred (either directly from the ED or via the integrated short stay unit). Over-triage was defined as the proportion of emergency (category one) patients who were discharged (again, either directly from the ED or via the integrated short stay unit). Rates were benchmarked against the acceptable under- and over-triage rates utilised in similar studies: an under-triage rate of less than 10% and an over-triage rate of 30–50%. [18,19,25,26]

Differences between triage categories for time to treatment (ie, triage to definitive management) and ED length of stay (LOS) were also assessed. The data were summarised using median and interquartile range (IQR) and compared using the Kruskal-Wallis test for non-parametric data.

To test reliability (ie, the reproducibility of IITT triage assessments), [29] inter-rater agreement between a local triage officer and an experienced Australian triage nurse was assessed. Triage assessment was undertaken simultaneously (ie, both clinicians listened to the presenting complaint at the same time), but the participating clinicians independently determined the triage category. To minimise the risk of bias, both clinicians were blinded to the other's assessment.

Reliability testing utilised continuous samples of patients across two consecutive day shifts, and involved a range of local triage officers. The time taken for the local clinician to finalise and document the triage decision was recorded. Inter-rater agreement for the assigned triage category was measured using Cohen's Kappa statistic (κ) [linearly weighted], and time data was summarised by mean and standard deviation (SD). $\kappa > 0.8$ was pre-defined as excellent agreement. Statistical analysis was performed in Stata v16 (College Station, Texas, United States of America), and the reporting framework is consistent with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. [43]

2.6. Data sources and ethics

All validation data utilised in this study were recorded by clinicians, as part of routine clinical care, using the PRTF. When patients depart the ED, data for the PRTF are entered by administration staff into an electronic registry housed in Microsoft Excel. Data used in this study were exported from the registry and provided in de-identified format to the researchers. Ethics approval was obtained from Monash University (MUHREC 22581) and endorsed by the PNG Medical Research Advisory Committee (MRAC 20.12).

2.7. Role of the funding sources

Funders of this project had no role in study design, results analysis or manuscript preparation.

3. Results

In the two-month study period there were 4512 presentations to the ED, equating to an average of 74 per day. The median age was 30 (IQR 19-42) and 2198 (48.7%) were female. Demographic and clinical characteristics of the sample are summarised in Table 1.

All patients presenting to the ED had a documented triage category. Fifty eight (1.3%) were categorised as emergency patients, 967 (21.6%) as priority patients and 3478 (77.1%) as non-urgent patients (Table 1). Of these, 65 (1.4%) were assigned an ED diagnosis of one of the ten, pre-specified diagnoses, and 46 were allocated a category 1 or 2. Accordingly, the sensitivity for detecting this group of conditions representing time-critical illness was 70.8% (95% CI 58.2 - 81.4%).

Death in the ED occurred in 4/58 (6.9%) emergency patients, 19/976 (2.0%) priority patients and 3/3478 (0.1%) non-urgent patients (χ^2=87.0, Cramer's V=0.14, p=0.00) [Figure 2A]. Meanwhile, the admission/transfer rate was 44.8% (26/58) among emergency patients, 22.9% (223/976) among priority patients and 2.7% (94/3478) among non-urgent patients (χ^2=556.3, Cramer's V=0.351, p=0.00) [Figure 2B].

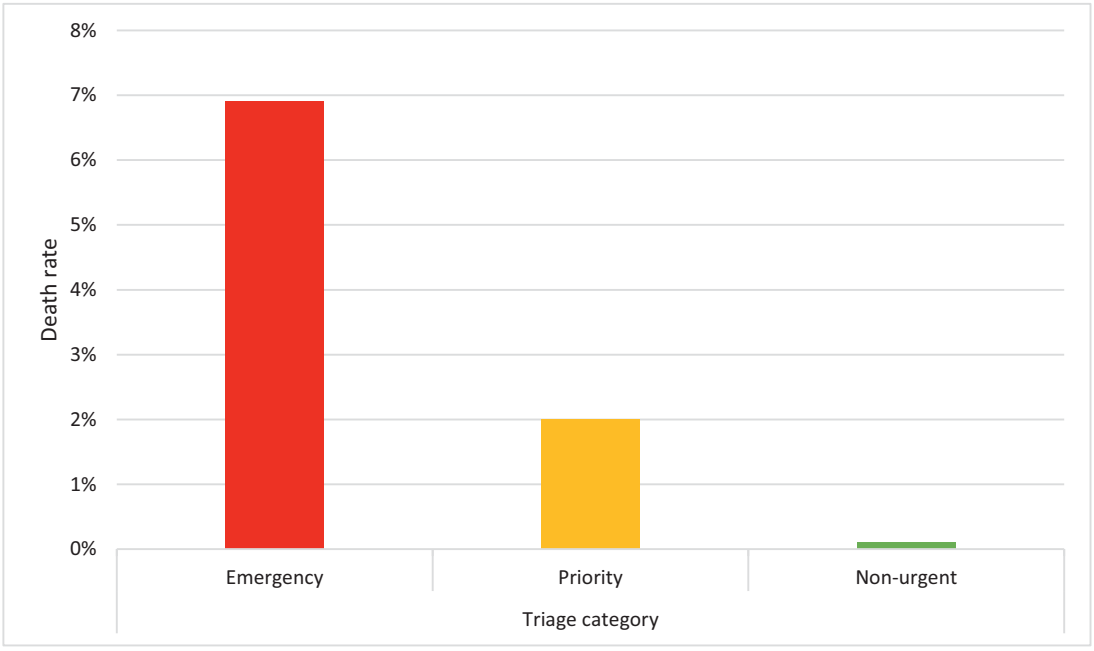

Figure 2. A: Association between triage category and death in the ED B: Association between triage category and hospital admission or transfer

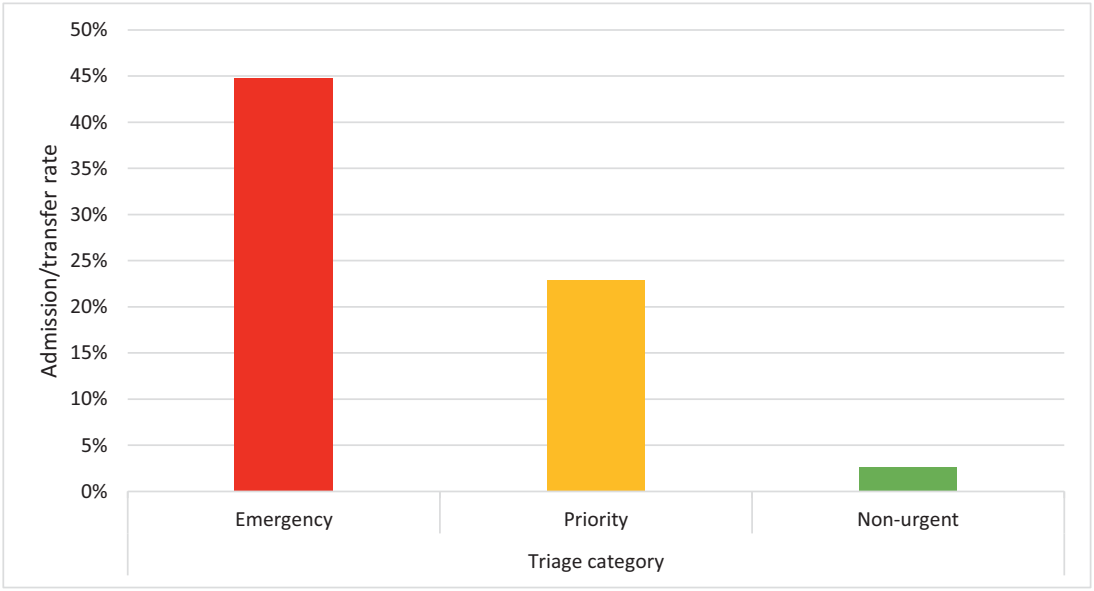

Figure 2. Continued

Applying the pre-specified criteria for under- and over-triage, the under-triage rate was 2.7% (94/3477) and the over-triage rate 48.2% (28/58). Both fell within the pre-determined range of acceptability. Sensitivity, specificity, predictive values and likelihood ratios for death and admission/transfer are summarised in Table 2. The negative predictive value for both outcomes was greater than 97%.

Time to treatment (TTT) and ED LOS, stratified by triage category, are summarised in Table 3. TTT increased across triage categories, while the opposite was true for LOS. Differences were statistically significant.

Triage assessments were performed by CHWs in 2389 (53.0%) cases, nurses in 1628 (36.1%), HEOs in 375 (8.3%) and medical officers in 119 (2.6%). Among 70 observed triage assessments (including nurses and CHWs), weighted κ was 0.84, indicating excellent agreement. It took staff an average of 3 minutes and 34 seconds (SD 1:06) to complete a triage assessment.

4. Discussion

The IITT is a novel triage tool, and this study provides the first published data on its performance in an urban ED setting. Key findings include sensitivities of 70.8% for the detection of time-critical diagnoses, 72.6% for admission or transfer and 88.5% for death in the ED. There was a clear association between triage category and patient disposition, and under- and over-triage rates fell with pre-specified limits of acceptance. The system also demonstrated excellent reliability, with an average triage assessment time of just over three and a half minutes.

Table 1
Demographic and clinical characteristics of patients presenting to GGH during the study period

	Variable	n (%)
Gender	Female	2198 (48.7%)
Age	<18	1017 (22.5%)
	18-39	2109 (45.7%)
	≥40	1386 (30.7%)
	Age not recorded	0 (0.0%)
Triage category	1	58 (1.3%)
	2	976 (21.6%)
	3	3478 (77.1%)
	Not recorded	0 (0.0%)
Disposition	Admitted	90 (2.0%)
	Transferred	253 (5.6%)
	Deceased	26 (0.6%)
	Discharged	2841 (63.0%)
	Short Stay Unit	1299 (28.8%)
	No disposition recorded	3 (0.1%)

Table 2
Performance characteristics

Performance measure	Outcomes	
	Death	Admission or transfer
Sensitivity (95% CI)	88.5% (69.8 – 97.6)	72.6% (67.5 – 77.2)
Specificity (95% CI)	77.5% (76.2 – 78.7)	81.2% (80.0 – 82.3)
PPV (95% CI)	2.2% (1.4 - 3.3)	24.1% (21.5 – 26.8)
NPV (95% CI)	99.9% (99.7 – 100.0)	97.3% (96.7 – 97.8)
+ LR (95% CI)	3.9 (3.4 – 4.6)	3.9 (3.5 – 4.2)
- LR (95% CI)	0.2 (0.1 – 0.4)	0.3 (0.3 – 0.4)

* PPV = positive predictive value; NPV = negative predictive value; LR = likelihood ratio

Table 3
Time to treatment and ED length of stay by triage category

Triage category	Time to treatment		ED length of stay	
	Median (IQR) [mins]	*p-value*	*Median (IQR) [mins]*	*p-value*
Emergency (1)	5 (0 – 30)	<0.01	230 (107.5 - 997.5)	<0.01
Priority (2)	55 (20 – 128)		175 (70 – 630)	
Non-urgent (3)	65 (22 – 135)		89.5 (35 – 170)	

These are satisfactory performance characteristics for a triage tool newly deployed in a resource-limited setting. GGH ED is a challenging environment, with numerous barriers to timely care and a large burden of low acuity patients. Few staff have experience in more advanced EC settings and, prior to the implementation of the IITT, the ED did not have a well-developed triage system. The findings should be interpreted in this context.

While the sensitivities and specificities identified in this study may appear sub-optimal when compared with values for diagnostic tests, they are similar to those reported for other triage tools. [4–6] A recent systematic review of triage system performance identified a wide spectrum of published sensitivities for the detection of "critical illness" diagnoses, varying from 36 to 92%. [4] A similar systematic review, focussed on triage systems in high-resource settings, identified sensitivities for the detection of "high-urgency" adult patients ranging between 58 and 88% (using intensive care unit admission as the reference standard). [5] With respect to LMICs, reported sensitivities for the prediction of mortality vary between 48% and 77%, with specificities of 56% to 79%. [6] Significant heterogeneity in research findings, both within and between tools, suggests that factors such as setting, population and system characteristics may all influence performance.

The low under-triage rate in this study is an important finding because it is an indicator of system safety. [18,25] The over-triage rate of 48.2% is also acceptable, and reflects the inclusive nature of the signs and symptoms listed for IITT categories one and two. This is an appropriate strategy in a resource-limited context where demands for care come predominantly from non-urgent patients. The rate also reflects the prolonged LOS and 'access block' experienced by some category one and two patients (Table 3), such that they improve and are able to be discharged before ever being admitted.

A challenge in interpreting these data is the absence of a definitive measure of urgency. [29] Use of admission as a surrogate marker is problematic because some patients with urgent medical problems (eg, anaphylaxis and joint dislocations) do not necessarily require inpatient care after initial treatment. The corollary is that patients with severe but non-urgent conditions (such as metastatic cancer) frequently warrant admission. Similarly, mortality also carries limitations as an outcome measure. For instance, death in the ED may occur among patients with chronic conditions that are unlikely to benefit from acute interventions. These issues are widely recognised in triage research, and complicate the assessment of predictive validity. [29] Finally, although the diagnoses used to define the primary outcome of time-critical illness were selected because they stand to benefit from early recognition and management, these conditions also present in different ways. There may have been patients with appendicitis, for example, for whom a low acuity designation was appropriate, even though they would have been counted as 'missed' by the tool.

The under- and over-triage rate thresholds used in this study should also be interpreted with caution. Although these values have been used for triage tool assessment in other resource-limited settings, [18,19,25,26] they are derived from American College of Surgeons Committee on Trauma criteria. [44] Their appropriateness is questionable, given that recommendations for trauma triage do not necessarily apply to other disease categories, and performance targets applicable in North America may not be relevant to the LMIC context.

In interpreting these findings, it is important to recognise that they reflect the operation of the IITT in a real-world setting and not the innate performance characteristics of the tool. For instance, it is possible that triage officers may have applied the tool incorrectly (eg, by neglecting to perform a complete set of vital signs when indicated), leading to under-triage of time-critical conditions. Given the study utilised routinely collected data, it was not possible to determine the proportion of patients that had a comprehensive triage assessment as per the IITT process (Figure 1). Although the reliability data indicated excellent inter-rater agreement, it relied on observation by an external, Australian nurse who was also fulfilling a mentoring function, and may therefore have been subject to bias through the Hawthorne effect. The study was intentionally pragmatic, and further research is required to determine how the IITT's performance might compare in more controlled circumstances.

There are several further limitations to this study. First, it was undertaken at a single site, and the tool's performance is likely to have been influenced by contextual factors (such as clinician capacity and demands for care). The negative and positive predictive values are therefore only relevant to this setting. Second, the number of patients who met criteria for one of the ten pre-defined time-sensitive diagnoses was lower than expected, possibly as a result of under-reporting. This compromises the precision of the findings, but reflects the real-world challenges of data capture and clinical research in resource-limited ED settings. [30] It is also consistent with the methodological challenges reported in other LMIC triage studies. [6,29,30] Third, outcome measures related to mortality only included patients who died in the ED, and additional deaths may have occurred shortly after departure. Finally, in comparing the performance of the IITT with other triage instruments,

it should be recognised that the sensitivity of a three-tier system is intrinsically likely to be higher than a four-tier or five-tier system.

Given these limitations, additional research is underway to evaluate IITT performance in other Pacific EDs. The varied nature of EC systems and practice means the tool should also be validated in other resource-limited contexts, and caution should be applied in implementing the system until additional data are available. Since this study was undertaken, minor adjustments to the red and yellow criteria (Appendix 1) have already been made. [33]

Notwithstanding these issues, the implications of the study results are significant. Advantages of the IITT include simplicity, efficiency and low resource utilisation, as well as a high level of acceptance among clinicians. [34] Further, the education program used to train staff in the system was brief, suggesting that implementation can be achieved at little cost with minimal disruption to clinical services. [34] The inclusion of CHWs as triage officers in the study demonstrates that the IITT can be applied by clinicians with limited formal training.

COVID-19 has illustrated the importance of safe and effective EC, [45–48] and consistent with the aspirations of global EC providers [13] and the World Health Assembly, [49] there is likely to be increasing demand from LMICs for valid and reliable triage systems. [48] In this context, the present study provides a timely, critical and important review of the IITT. Further research will help clarify its benefits and disadvantages, relative to rapid visual assessment using 'system 1 reasoning' [50] and established tools such as SATS. [15]

5. Conclusion

This pragmatic study assessed the performance of the IITT in a resource-limited urban ED. The pilot version of the tool demonstrated adequate predictive validity and excellent reliability, with under- and over-triage rates within pre-specified limits of acceptability. Performance characteristics were comparable with established triage systems. Subject to further validation studies, the tool may be applicable in other resource-limited EC settings.

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Contribution statement

RM led the project and was primarily responsible for study design, data analysis and manuscript preparation. OB, GN, JT, WV and SJ were essential local collaborators and played important roles in IITT implementation. CB, SB, TH and TC participated in the training and mentoring process. SKo assisted with project management, while GOR, PC and TR provided advice on planning, analysis and interpretation. All co-authors reviewed the manuscript.

Data sharing statement

The data that underpin these findings may be released in de-identified form following reasonable written request to the corresponding author and Gerehu General Hospital.

Declaration of Competing Interest

RM reports grants from the Australian Government Department of Foreign Affairs and Trade and Australasian College for Emergency Medicine Foundation, as well as scholarships from the National Health and Medical Research Council and Monash University, related to this study. GOR reports that he is the recipient of a National Health and Medical Research Council Early Career Research Fellowship. PC reports that he is supported by a Medical Research Future Fund Practitioner Fellowship.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2021.100194.

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