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Accuracy of the Manchester Triage System in predicting need for time-critical treatment: Retrospective diagnostic accuracy cohort study

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Abstract:	

**Accuracy of the Manchester Triage System in predicting need for time-critical treatment:
Retrospective diagnostic accuracy cohort study**

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Emergency department (ED) overcrowding is a major global health issue resulting in delayed management, avoidable harm, and worse outcomes.[1] Initial triage of patients arriving at the ED is essential to identify patients with emergent conditions, prioritise time-critical treatments, and mitigate these risks.[2]

The Manchester Triage System (MTS) is used internationally in the initial assessment of patients presenting to EDs. It uses symptom specific flow charts to classify patients into five priority levels, ranging from 1 (immediate) to 5 (non-urgent).[3] Systematic reviews and meta-analysis have shown that the MTS has moderate to good predictive ability for short-term mortality, intensive care admission, and hospital admission.[2, 4] However, these outcomes may not reflect the primary purpose of ED triage to prioritise patients for early treatment based on illness acuity.[5]

A secondary analysis of the 'Evaluation of the National Early Warning Score version 2 (NEWS2) in the initial assessment of adults attending the emergency department' study was therefore performed to determine the accuracy with which the MTS predicts the need for time-critical treatment among adults attending the ED. This single centre retrospective observational cohort diagnostic accuracy study is reported in detail elsewhere.[6]

The source population comprised all adults (aged 16 or over) presenting to the tertiary level Northern General Hospital ED in Sheffield, UK, during 2022. The subsequent study population included all first ED attendances where vital signs were recorded. A cohort of 4000 attendances was then randomly sampled to account for seasonality. The final study sample comprised all patients with an MTS level recorded prior to receiving any time-critical intervention.

Routinely collected data was extracted from each patient's electronic health records. The index test was MTS level, ordinarily performed on all attendances to the ED. The primary reference standard was the need for a time-critical intervention, previously defined by an expert consensus process, and adjudicated by independent emergency medicine experts after review of hospital records.[6]

Secondary reference standards were death within 7 days of ED attendance, critical care admission, and hospital admission.

Receiving-operator characteristic (ROC) analysis was performed to determine the discriminant value of MTS levels for predicting need for time critical interventions and secondary reference standards. The diagnostic accuracy of dichotomised MTS levels was specifically evaluated at two thresholds: the 2 highest priority codes 1 (immediate) and 2 (very urgent); and separately the 3 highest priority codes 1,2 and 3 (urgent), calculating sensitivity, specificity, positive and negative predictive values with their 95% confidence intervals. Characteristics of false negative cases were examined descriptively.

The NEWS2 study was funded by the United Kingdom National Institute for Health Research (NIHR) Research for Patient Benefit (RfPB) programme (project reference NIHR204935). The Health Research Authority and Health and Care Research Wales provided ethical approval (reference 23/HRA/4572). As a secondary analysis of an existing data a power calculation was not performed with the 95% confidence interval (CI) width indicating the precision of results. Statistical analyses were conducted in R version 4.4.0 (R Foundation for Statistical Computing, Vienna, Austria) and Stata Statistical Software: Release 18. (StataCorp. 2023, College Station, TX: StataCorp LLC).

From 85499 first ED attendances in 2022 there were 56,145 cases with vital signs recorded. From the 4000 randomly sampled adults the final study sample included 3,714 cases with a MTS level recorded prior to receiving any time-critical intervention.

The median age was 51 years, 45.3% were male, 74.1% were white British ethnicity, and median NEWS2 score was 1. Overall, 125/3714 (3.4%) required a time critical intervention. The prevalence of the secondary reference standards were 57/3714 deaths within 7 days (1.5%), 856/3714 hospital admissions (23.0%) and 14/3714 (0.4%) critical care admissions.

ROC analysis demonstrated a c-statistic of 0.80 (95% CI 0.76-0.84, Figure 1) for time critical interventions. Sensitivity, specificity, negative and positive predictive values for MTS dichotomised

into higher and lower priority codes are detailed in Figure 1. MTS had a sensitivity of 51.2% and 86.4%, and specificity of 92.3%, and 56.8%, respectively at MTS thresholds of 2 and 3. Discrimination of MTS for death within 7 days was similar (c-statistic=0.80, 95%CI 0.75-0.85), lower for ED admission (0.66, 95%CI 0.64-0.68), and higher for critical care admission (0.93, 95%CI 0.87-0.98). Derivation of the study sample, distribution of time-critical interventions, prevalence of each reference standard at each triage, and characteristics of false negative cases are detailed in the supplementary materials.

These findings show that using a higher MTS threshold of level 1 or 2 for expediting care results in a significant proportion (48.9%) of patients requiring time-critical interventions being assigned to a lower priority. However, due to the low prevalence of time critical interventions, high specificity is necessary to maintain an acceptable positive predictive value. Using a lower MTS threshold of levels 1,2, or 3 would reduce false negatives, but could result in a potentially unmanageable number of prioritised patients, mostly not requiring time critical interventions.

Many previous studies have validated the MTS against short-term mortality, generally demonstrating similar performance reported in the current study.[2, 4, 7] The findings of higher accuracy for critical care and lower accuracy for hospital admission are also comparable to previous research. However, the primary purpose of triage is to characterize urgency, and these reference standards, although convenient, are conceptually problematic. Timely treatment could prevent death, critical care may not be appropriate despite the need for urgent treatment, and ED discharge could occur after a successful emergency intervention. Although a limited range of emergency treatments have been previously evaluated in a composite outcome,[8] this study appears to be the first to comprehensively evaluate the outcome of time critical ED interventions.

There are some potential limitations with this study. Excluding patients who did not have vital signs or triage status recorded could introduce selection bias, although most of these patients were treated for minor injuries or streamed for primary care assessment. Although a formal consensus

process was followed, the definition of time-critical interventions is open to debate. As a single-centre study, the findings may not be generalisable to EDs in different settings, serving other demographics or with varying case mixes.

Our findings suggest that EDs should not solely rely on the MTS to prioritise patients in the initial assessment of patients. Further research should be undertaken to confirm these findings in other environments, identify which time-critical interventions the MTS predicts poorly, and to explore approaches to augment MTS performance, for example the added value of early warning scores.

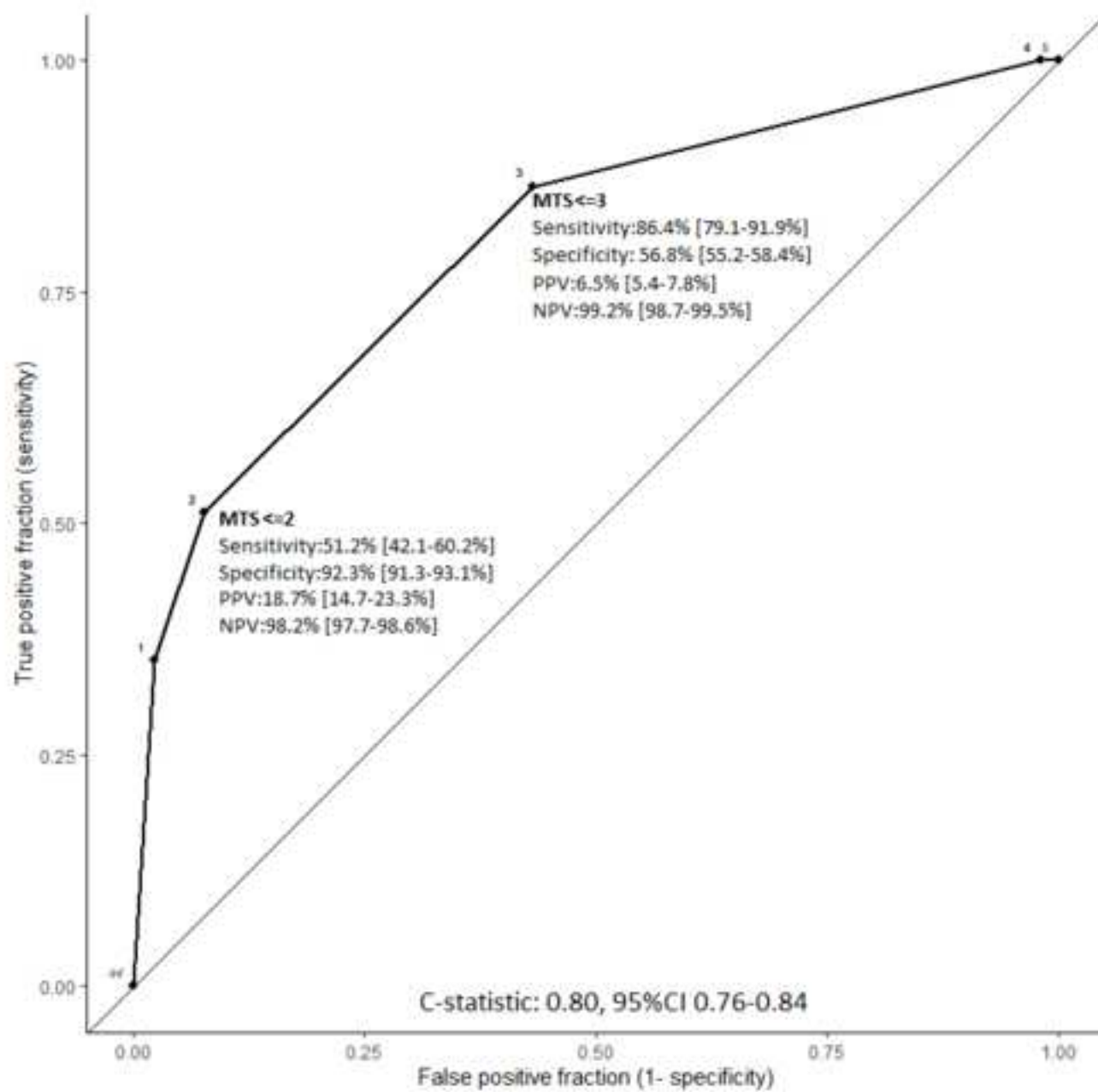
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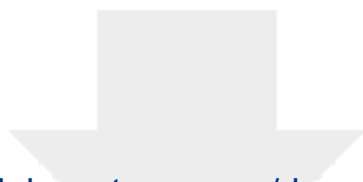
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Figure 1. Receiver operating characteristic curve demonstrating the discrimination of MTS for the need for time critical interventions in adult ED patients. PPV=positive predictive value; NPV=negative predictive value. 95%CI confidence intervals are detailed within square brackets.



Reference standard status	MTS Level				
	5	4	3	2	1
No time critical intervention	70	1969	1272	195	83
Needed time critical intervention	0	17	44	20	44



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