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Pre-hospital T-MACS and HEART scores in the prediction of myocardial infarction – a prospective evaluation

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COMPETING INTEREST STATEMENT
RB has undertaken consultancy with Roche, Abbott, Siemens, Beckman Coulter, Radiometer, Aptamer Group, and Lumira Dx, has recent research grants with Abbott Point of Care and Siemens and has conducted research involving donation of reagents by Roche, all unrelated to this work. NLM has received research grants to the University of Edinburgh, and honoraria or consultancy from Abbott Diagnostics, Roche Diagnostics, Siemens Healthineers, and LumiraDx that are unrelated to this work. None of the other authors have any competing interests to declare.

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ETHICAL STATEMENT
This study was approved by the National Ethics Committee (REC 14/NS/1037), registered in the Research Registry (UIN 2671), and was conducted in accordance with the Declaration of Helsinki.
CONTRIBUTORSHIP STATEMENT
JGC and RB conceived the study and its design. JGC, LAD and AJC acquired the data. JGC performed the analysis. JGC, RB and NLM interpreted the data. JGC, RB and NLM drafted the manuscript. All authors reviewed the manuscript critically for intellectually important content and provided their final approval of the version to be submitted. All authors are accountable for the work. JGC is the guarantor.

PRESENTATION
These results have not been presented

DATA SHARING STATEMENT
No additional data available

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Chest pain suspicious for an acute myocardial infarction (MI) is a common reason for emergency ambulance contact. Most patients have a non-diagnostic electrocardiogram and transport to hospital for troponin testing is the rule. In the Emergency Department (ED), tools such as the T-MACS decision aid (1) and the HEART score (2) are used to identify those at low-risk of MI and consideration of early discharge. Recently, the HE-MACS decision aid (3) and the HEAR score (4) have been developed, aiming to identify low-risk patients without troponin testing. We previously demonstrated the feasibility of paramedics using the HEAR and HEART score (5,6), but performance did not enable safe rule-out of MI in this setting. Whether the T-MACS or HE-MACS scores would perform better and enable paramedics to manage low-risk patients without hospital transfer is uncertain.

The Ambulance Cardiac Chest pain Evaluation in Scotland Study (ACCESS) was performed in northeast Scotland (5). Patients with chest pain suspicious for MI were approached by study-trained paramedics. A subset of the study population provided contemporaneous pre-hospital data for HE-MACS, HEAR and HEART and T-MACS (Supplementary Material) scores and had blood drawn for later testing with the Abbott ARCHITECT STAT high sensitivity cardiac troponin I assay. This assay has a limit of detection of 2 ng/L (LOD), an optimised rule-out threshold of 5 ng/L and sex-specific 99th percentile upper reference limits (URL) of 16 ng/L (women) and 34 ng/L (men).

Patients were followed up for type 1, type 4b or type 4c MI or cardiac death at 30-days. All patients with myocardial injury and all deaths were independently adjudicated by two cardiologists as previously described (5). We calculated the sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) with 95% confidence intervals (CI) for score thresholds that defined low-risk: HEAR ≤1, HEART, and modified HEART (troponin component 0 if <LOD, 1 if between LOD and URL, 2 if >URL) ≤3, and the very-low-risk (VLR) threshold for HE-MACS and T-MACS.
Of 261 eligible patients, 247 (mean 66 [standard deviation 16] years, 44% women) had complete data for all scores, of whom 40 (16%) had a MI or cardiac death at 30-days (Figure 1) (Tables S1 and S2). Both the HEAR score ≤1 and HE-MACS VLR outcome had 100% (95% CI 91.2 to 100%) sensitivity, but only identified 4% of patients as low-risk. A HEART score ≤3 identified 26% of patients as low-risk with a sensitivity of 92.5% (95% CI 80.1 to 97.4%) and NPV of 95.3% (95% CI 87.1 to 95.3%). A modified HEART score ≤3 identified fewer patients as low-risk (16%), but with a sensitivity and NPV of 100%. Similarly, T-MACS identified 20% of patients as very low-risk with a sensitivity and NPV of 100% (Table 1).

In patients with chest pain in the pre-hospital setting, our findings demonstrate that paramedics may be able to use the T-MACS decision aid and a modified HEART score ≤3 to recognise 1 in 5 patients as low-risk of MI or cardiac death with excellent sensitivity and NPV. Strategies not involving troponin testing are clearly attractive, but only identified 1 in 25 patients as low-risk, something that may hinder adoption of those methods into practice.

We acknowledge that incorporation of a core laboratory performed cardiac troponin test into pre-hospital clinical assessment is theoretical. However, our results are very similar to those described in a recent multicentre diagnostic study (7) and provide some external validation to these findings. The T-MACS decision aid and modified HEART score are promising tools to evaluate further in the pre-hospital setting, ideally using a high-sensitivity troponin test at the point of care.
REFERENCES


Figure 1. Patient Flow Chart
**Table 1.** Rule-out performance of low-risk strategies for myocardial infarction or cardiac death at 30-days.

<table>
<thead>
<tr>
<th>Rule-out</th>
<th>Myocardial Infarction or Cardiac Death at 30 days</th>
<th>No Myocardial Infarction or Cardiac Death at 30 days</th>
<th>Sensitivity (95% CI)</th>
<th>Specificity (95% CI)</th>
<th>PPV (95% CI)</th>
<th>NPV (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proportion low-risk</td>
<td>Not low-risk</td>
<td>Low-risk</td>
<td>Not low-risk</td>
<td>Low-risk</td>
<td></td>
</tr>
<tr>
<td>HE-MACS VLR</td>
<td>9 (4%)</td>
<td>40</td>
<td>0</td>
<td>198</td>
<td>9</td>
<td>100%</td>
</tr>
<tr>
<td>T-MACS VLR</td>
<td>50 (20%)</td>
<td>40</td>
<td>0</td>
<td>157</td>
<td>50</td>
<td>100%</td>
</tr>
<tr>
<td>HEAR ≤1</td>
<td>11 (4%)</td>
<td>40</td>
<td>0</td>
<td>196</td>
<td>11</td>
<td>100%</td>
</tr>
<tr>
<td>HEAR ≤3</td>
<td>69 (28%)</td>
<td>35</td>
<td>5</td>
<td>143</td>
<td>64</td>
<td>87.5%</td>
</tr>
<tr>
<td>HEART ≤3</td>
<td>64 (26%)</td>
<td>37</td>
<td>3</td>
<td>146</td>
<td>61</td>
<td>92.5%</td>
</tr>
<tr>
<td>Modified HEART ≤3</td>
<td>39 (16%)</td>
<td>40</td>
<td>0</td>
<td>168</td>
<td>39</td>
<td>100%</td>
</tr>
</tbody>
</table>

Abbreviations: CI = confidence interval; HE-MACS = history and electrocardiogram only – Manchester acute coronary syndromes decision aid; LR = likelihood ratio; NPV = negative predictive value; PPV = positive predictive value; T-MACS = troponin only – Manchester acute coronary syndromes decision aid; VLR = very low risk.