Manchester triage system version II and resource utilisation in emergency department

André Peralta Santos,1 Paulo Freitas,2 Henrique Manuel Gil Martins3

ABSTRACT
Emergency department (ED) triage systems aim to direct the best clinical assistance to those who are in the greatest urgency and guarantee that resources are efficiently applied.

The study’s purpose was to determine whether the Manchester Triage System (MTS) second version is a useful instrument for determining the risk of hospital admission, intrahospital death and resource utilisation in ED and to compare it with the MTS first version.

This was a prospective study of patients who attended the ED at a large hospital. It comprised a total of 25 218 cases that were triaged between 11 July and 13 October 2011. The MTS codes were grouped into two clusters: red and orange into a ‘high acuity/priority’ (HP) cluster, and yellow, green and blue into a ‘low acuity/priority’ cluster.

The risk of hospital admission in the HP cluster was 4.86 times that of the LP cluster for both admission route and ages. The percentage of patient hospital admission between medical and surgical specialties, in high and low priority clusters, was similar. We found the risk of death in the HP cluster to be 5.58 times that of the risk of the low acuity/priority cluster. The MTS had an inconsistent association relative to the utilisation of x-ray, while it seemed to portray a consistent association between ECG and laboratory utilisation and MTS cluster.

There were no differences between medical and surgical specialties risk of admission. This suggests that improvements were made in the second version of MTS, particularly in the discriminators of patients triaged to surgical specialties, because this was not true for the first version of MTS.

INTRODUCTION
The emergency department (ED) triage system’s purpose is to provide the best clinical assistance to those who are in greater urgency or need, and to guarantee that the department’s resources are efficiently applied to this end.1

The worldwide disseminated triage systems are the Australian Triage Scale, the Canadian Emergency Department Triage Scale and the Manchester Triage System (MTS).2 All of these are five level scales based on the work of Fitzgerald.3

Introduced in 1996 in the UK, the MTS was developed by a group of emergency care experts. It consists of specific procedures in which the patient’s principal complaint is allocated to one of 52 flowcharts diagrams. Each of these flowcharts uses key discriminators to determine the triage category.4 5

It divides and prioritises the patients into the following subgroups: emergent, very urgent, urgent, less urgent and non-urgent. Of these emergent signifies the need for immediate medical attention, while very urgent, urgent, less urgent and non-urgent mean the necessity of medical attention in 10, 60, 120 and in 240 min, respectively. Patients who should not be seen in ED because the problem is suitable to resolution in a non-ED setting are coded as white; usually they are referred to the ED by the assistant doctor.

Since its implementation, several studies have proven that MTS is a reliable and sensitive instrument and is widely validated, including paediatric patients.1 6 The usefulness of triage systems surpasses the objective for which they have been built; it is proven that they can be predictors of resource utilisation, hospital cost,7 likelihood of admission and risk of short-term death.8 A second version of MTS has been designed upon improvements from the original version.

MTS is presently used throughout Europe, although no systematic review of utilisation exists. The MTS triage group is used in Norway, Sweden, Holland, Germany, Austria, Spain, Slovenia, UK and Portugal. In Portugal, all National Health System hospitals have implemented the MTSs at Hospital Professor Dr Professor Doutor Fernando da Fonseca (HFF) it has been used since 2000, via a computerised protocol.5

In July 2011, the second version of the MTS was implemented in HFF for all patients admitted in the ED (general adults, gynaecology and obstetrics, paediatric cases and basis emergency services). This, associated with the newly implemented electronic health record of every patient in the institution, provided the opportunity to gather qualitative and quantitative information regarding the immediate outcomes of patients’ treatment. Such data mining capacities were almost impossible using the previous electronic health record.

The aim of this study is to determine whether the MTS second version is a useful instrument for determining the risk of hospital admission, intrahospital death and utilisation of diagnostic tools (x-ray—roentgenogram, ECG, laboratory analysis) in the ED. Furthermore, we attempt to analyse the consistency of the outcomes, according to patient age and route of admission (via medical or surgical specialties). Our second objective is to assess whether the second version of MTS is better than the first version in determining risk of hospital admission and risk of intrahospital death according to route of admission. In previous studies MTS was not an equally powerful discriminator when considering admissions via medical and surgical specialties.8

METHODS
This was a prospective study, based on the electronic health records database of patient cases...
between 11 July and 13 October 2011 attended at the HFF ED. For data consistency we only included patients observed by the general ED (excluding those who presented directly to the gynaecology and obstetrics, pediatrics and basic ED). The variables analysed were: age, sex, MTS code, admission, route, hospital admission, death outcome and utilisation of diagnostic tools.

After the initial triage, patients can be sent for observation through two admission routes, either through medical specialties (general medicine, neurology or psychiatry) or surgical specialties (general surgery, minor surgery, ophthalmology, orthopaedics or ENT).

We carried out a descriptive and inferential analysis. The sample was divided in age quartiles and by admission route. For statistical and clinical rationale, the MTS codes were grouped into two clusters: red and orange into a statistical and clinical rationale, the MTS codes were grouped into two clusters: red and orange into a ‘high acuity/priority’ cluster, and yellow, green and blue into a ‘low acuity/priority’ cluster.

The MTS was not developed for the purpose of exploring the association with admission, mortality or resources utilisation. However, to this specific objective and after a first data analysis we suggest grouping MTS codes in ‘high acuity/priority’ and ‘low acuity/priority’. Although we acknowledge that triage scales were developed as measures of acuity and not severity, such acuity is likely to be reflected on priority of care given to the patient; thus, a mix term is used in the grouping.

This study comprises a total of 25,218 cases that were triaged between the time intervals considered. We performed a complete analysis of the database; cases with missing data about the patient; thus, a mix term is used in the grouping.

The high acuity/priority cluster represented 14.4% of the patients triaged, while the low acuity/priority represented 81.1%, and the white code represented the remaining 4.5%.

### RESULTS

From a total of 24,721 cases, there were 13,876 (56.1%) female and 10,485 (43.9%) males patients; the mean age was 52.3 years (SD 19.9). The 25, 50 and 75 age percentiles were respectively 35.4, 51.1 and 69.0 years. The main findings are presented in tables 1 and 2.

The high acuity/priority cluster represented 14.4% of the patients triaged, while the low acuity/priority represented 81.1%, and the white code represented the remaining 4.5%.

### Table 1

*Summarises the distribution of the sample regarding admission, all-cause death outcome and consumption of x-ray, ECG and laboratory tests*

<table>
<thead>
<tr>
<th>MTS code</th>
<th>Triaged</th>
<th>Admitted (%)</th>
<th>Deaths (%)</th>
<th>Utilisation at ED (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x-Ray</td>
</tr>
<tr>
<td>Red</td>
<td>All</td>
<td>98</td>
<td>58 (59.2)</td>
<td>30 (30.6)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>83</td>
<td>56 (67.5)</td>
<td>29 (34.9)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>15</td>
<td>2 (13.3)</td>
<td>1 (6.7)</td>
</tr>
<tr>
<td>Orange</td>
<td>All</td>
<td>3467</td>
<td>427 (12.3)</td>
<td>113 (3.3)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>3076</td>
<td>374 (12.2)</td>
<td>107 (3.5)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>391</td>
<td>53 (13.6)</td>
<td>6 (1.5)</td>
</tr>
<tr>
<td>High acuity/priority</td>
<td>All</td>
<td>3556</td>
<td>485 (13.6)</td>
<td>143 (4.0)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>3159</td>
<td>430 (13.6)</td>
<td>136 (4.3)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>406</td>
<td>55 (13.5)</td>
<td>7 (1.7)</td>
</tr>
<tr>
<td>Yellow</td>
<td>All</td>
<td>8150</td>
<td>386 (4.7)</td>
<td>72 (0.9)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>5523</td>
<td>234 (4.2)</td>
<td>60 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>2627</td>
<td>152 (5.8)</td>
<td>12 (0.5)</td>
</tr>
<tr>
<td>Green</td>
<td>All</td>
<td>10,982</td>
<td>146 (1.3)</td>
<td>32 (0.3)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>4950</td>
<td>74 (1.5)</td>
<td>23 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>6032</td>
<td>72 (1.2)</td>
<td>1 (0.1)</td>
</tr>
<tr>
<td>Blue</td>
<td>All</td>
<td>918</td>
<td>3 (0.3)</td>
<td>3 (0.3)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>389</td>
<td>2 (0.5)</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>529</td>
<td>1 (0.2)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Low acuity/priority</td>
<td>All</td>
<td>20,050</td>
<td>535 (2.7)</td>
<td>107 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>10,862</td>
<td>310 (2.9)</td>
<td>85 (0.8)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>9188</td>
<td>225 (2.4)</td>
<td>22 (0.2)</td>
</tr>
<tr>
<td>White</td>
<td>All</td>
<td>1106</td>
<td>108 (9.8)</td>
<td>26 (2.4)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>309</td>
<td>68 (22)</td>
<td>20 (6.5)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>797</td>
<td>40 (5.0)</td>
<td>6 (0.8)</td>
</tr>
<tr>
<td>Total</td>
<td>All</td>
<td>24,721</td>
<td>1128 (4.6)</td>
<td>276 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>14,330</td>
<td>808 (5.6)</td>
<td>241 (1.7)</td>
</tr>
<tr>
<td></td>
<td>Surg</td>
<td>10,391</td>
<td>320 (3.1)</td>
<td>35 (0.3)</td>
</tr>
</tbody>
</table>

ED, emergency department; MTS, Manchester Triage System.
Patients were sent to medical and surgical specialties in 58% and 42% of the cases, respectively.

Admission to the hospital
The total hospital admission rate was 4.6%, of which the medical specialties were responsible for more than 71.6% of all hospital admissions. The admission rate was significantly different between high and low acuity/priority clusters (13.6% and 2.7%, respectively) for patients triaged through both admission routes (medicine and surgery) (p values <0.001). We observed a trend of a higher proportion of admission in higher age groups in both acuity/priority clusters (high acuity/priority and low acuity/priority, p value <0.001; low acuity/priority compared to high acuity/priority, p value <0.001). The percentage of patient hospital admissions between medical and surgical specialties in high acuity/priority was 13.6% and 2.7%, respectively, for patients triaged through both admission routes (13.6% and 2.7%). However, the association was not constant for all the age groups. In the 18–35-year-old groups there was only one death in the low acuity/priority cluster to be 5.58 times that of the risk of the low acuity/priority cluster. The association remained significant when considering the admission routes with higher risk of death in the high acuity/priority cluster, as shown in table 2. However, the association was not constant for all the age groups. In the 18–35-year-old groups there was only one death in the low acuity/priority cluster admitted by medical specialities; therefore, it was impossible to compute the relative risk. In the medical admission route, the association was true for all the other age groups. In the surgical admission route, only the two older groups were possible to compute the relative risk. We found the differences significant only for patients over 70 years old.

Utilisation of diagnostic tools at ED
x-Ray utilisation
The MTS had an inconsistent association relative to the utilisation of x-ray. In the lower age groups (18–70-years-old), there was no difference in utilisation. However, in the oldest group (over 70), x-ray was more used in the high acuity/priority cluster. Globally, x-ray was more used by the surgical specialties; however, there was no association between the utilisation of x-ray and the MTS acuity/priority clusters, as expected. Nevertheless, in the medical specialties it seemed that MTS acuity/priority clusters were associated with the utilisation in two older age groups, as shown in table 2.

ECG and laboratory utilisation
The overall utilisation of ECG and laboratory analysis was higher in the medical specialties. The highest proportion of ECG and laboratory analysis utilisation occurred in the orange MTS code cluster (see table 1). There was a clear association between acuity/priority cluster and death rate. We found the risk in the high acuity/priority cluster to be 5.58 times that of the risk of the low acuity/priority cluster. The association remained significant when considering the admission routes with higher risk of death in the high acuity/priority cluster, as shown in table 2. However, the association was not constant for all the age groups. In the 18–35-year-old groups there was only one death in the low acuity/priority cluster admitted by medical specialities; therefore, it was impossible to compute the relative risk. In the medical admission route, the association was true for all the other age groups. In the surgical admission route, only the two older groups were possible to compute the relative risk. We found the differences significant only for patients over 70 years old.
MTS acuity/priority clusters, in both medical and surgical specialties, across the age groups. The relative risk of using those diagnostic tools in the surgical specialties was consistently higher compared with the medical specialties. However, for the utilisation of laboratory analysis, the proportions between medical and surgical specialties were not homogenous, p value <0.05, as well as for the ECG in the older age groups.

**DISCUSSION**

Generally MTS proved that there is an increased risk of death in the high acuity/priority cluster, with a 5.58-fold increase in combined risk of death, for both specialties in conjunction as well as isolated. When stratifying the risk of death by age group, we found inconsistent results, whereby it seemed that in medical specialties the MTS performed better than in surgical specialties. However, in most age groups the numbers of deaths in surgical specialties were too small to find a statistical difference, although this appeared to be a tendency in especially younger age groups.

To prove that there is no association between MTS and death in surgical specialties for younger age groups, we need a higher sample size with more cases of death for these age groups.

We hypothesised a strong association among MTS and risk of hospital admission, risk of death, and use of diagnostic tools. In medical specialties, the MTS had a fair association with the utilisation of x-rays in the older age groups. Regarding x-rays, no difference between high and low acuity/priority priority was seen. It is possible that x-rays may be of diagnostic use in younger patients of a lower acuity/priority cluster due to the increased frequency of upper respiratory symptoms and minor trauma-related symptoms. X-Rays can justifiably be used as a first auxiliary for differential diagnosis and hence were found to be used in this group as much as in high acuity/priority patients.

Concerning ECG and laboratory analysis, MTS prioritisation showed an association between MTS acuity/priority clusters, with higher acuity/priority clusters meaning a higher use of resources. This relationship was true for both admission groups and translatable to all age groups analysed. Although surgical specialties used ECG and laboratorial analysis less frequently than the medical specialties, both received a similar proportion of hospital admissions. This may indicate that surgical specialties need fewer resources for admission.

We should acknowledge the possibility of confounding factors in the study of resource utilisation. Portuguese hospitals are paid according to a diagnostic-related groups system, providing hospitals a financial incentive to overinvestigate in the ED, especially in patients triaged as low acuity/priority. This could lead to weaker association between MTS acuity/priority cluster and resource utilisation. Another factor to consider is the occurrence of overtriage (triaging a patient into a higher acuity/priority category) in order to achieve higher returns in ED when funding is adjusted by MTS prioritisation. This ‘gaming’ phenomena has been reported by other authors; this is not likely to have occurred in this scenario because all cases are paid equally according to present funding rules for Portuguese hospitals.

Besides these constraints, the study of resource utilisation in the ED is a promising approach in two problematic areas of EDs: overcrowding and funding. The low acuity/priority and low consumer patient profile could be explored further as these individuals may be redirected to primary care facilities, although some studies affirm that these low complexity patients have no impact on length of stay in ED and time to first physician contact of high complexity patients. Regarding funding, the study of resource utilisation by MTS code and by diagnoses could help to build an algorithm to accurately estimate the cost of each episode. However, further investigation is needed to explore the resource utilisation in different diagnostic categories and to ensure the comparability of ED in different settings. Such studies would need to take into account that differences in outcomes after triage are not due to factors other than the real different levels of workload complexity.

Comparing the findings in this paper with those from MTS version I, Martins et al. is only possible at an aggregated level due to study methods. The first data on MTS version I show a higher number of patients triaged in the high acuity/priority cluster: 25.9% against 15.1% revealed in this paper. There may have been a slight change in the pattern of population access to ED with opening of some basic emergency services in 25% of the population served but equally there may be a difference in the prioritisation between versions I and II. Table 3 shows the brief comparative analysis.

Regarding hospital admission, the MTS prioritisation showed a consistent association: the high acuity/priority cluster had higher admission rates, across age groups and admission routes. Comparing with Martins et al., MTS version II shows a reduction in overall admission rates to half in both high and low acuity/priority clusters. In high acuity/priority clusters, Martins et al. had an admission rate of 22.3% while this paper shows a rate of 12.8%. The decrease was also observed in the low acuity/priority clusters, with a previous rate of 5.3% which is now 2.7%. The seasonal variation of hospital admission cannot be discounted (higher rates during winter season) but is unlikely to account for such a large difference. With a larger timeframe of MTS version II it will be possible to compare the two versions considering seasonal admission variation. Death rates were not compared due to small number on MTS version II data and significant methodological differences between the papers.

Regarding routes of admission, the data shown on MTS version II suggests that there are no significant differences between medical and surgical specialties in risk of admission to the hospital. In Martins et al., the findings suggested more differences between the admission routes and propensity for

### Table 3 Comparison between versions I and II of MTS, concerning the patients triaged and hospital admission

<table>
<thead>
<tr>
<th>MTS version I*</th>
<th>MTS version II†</th>
<th>p Value</th>
<th>OR</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Triaged</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High acuity/priority</td>
<td>82 068 (25.9%)</td>
<td>3565 (15.1%)</td>
<td>&lt;0.0001</td>
<td>1.97</td>
</tr>
<tr>
<td>Low acuity/priority</td>
<td>234 554 (7.1%)</td>
<td>20 050 (84.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Admitted</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High acuity/priority</td>
<td>18 285 (22.3%)</td>
<td>485 (12.8%)</td>
<td>&lt;0.0001</td>
<td>1.63</td>
</tr>
<tr>
<td>Low acuity/priority</td>
<td>12 464 (5.31%)</td>
<td>535 (2.67%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: the number of triaged patients do not account for patients triaged as white.

†Data from 1 November till 13 October 2011.

MTS, Manchester Triage System.
admission to the hospital. This suggests that improvements were made in the second version of MTS, particularly in the discriminators of patients triaged to surgical specialties.

CONCLUSIONS
From our knowledge, this was the first paper that was able to stratify by age, the risks of hospital admission and death for MTS. We conclude that high acuity/priority groups have a higher risk of hospital admission, in both medical and surgical specialties across ages. The risk of admission in MTS version II is about five times higher for high acuity/priority (red and orange) compared with low acuity/priority groups (yellow, green and blue) and that of death during hospitalisation is 5.5 times higher.

Overall the risk of death was higher in higher MTS codes for both medical and surgical specialties.

MTS proved to be a good discriminator of the utilisation of diagnostic tools in the ED department, except for x-ray utilisation. In the future, MTS may have some value as a tool for cost estimation or a predictor of resource utilisation.

There were no differences between the risk of admission for medical and surgical specialties. This suggests that improvements were made in the second version of MTS, particularly in the discriminators of patients triaged to surgical specialties because this was not true for the first version of MTS. Future research should address the association of MTS with admission and risk of death by diagnostic groups.

Acknowledgements The authors would like to acknowledge Diogo Emida, IT engineer, for the data extraction and Professor Baltazar Nunes for his support with statistical appraisal of data.

Contributors APS was responsible for the data analysis and interpretation and writing the first draft of the article. PF revised the article and added some important intellectual content. HMGM designed, revised the article and gave the final approval.

Competing interests Dr P Freitas is a member of the Portuguese Triage group and the International working group for triage; no other competing interests are declared.

Provenance and peer review Not commissioned; externally peer reviewed.

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Emerg Med J published online January 23, 2013
doi: 10.1136/emergmed-2012-201782

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