A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department

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ABSTRACT

Objective To compare the Danish Emergency Process Triage (DEPT) with a quick clinical assessment (Eyeball triage) as predictors of short-term mortality in patients in the emergency department (ED).

Methods The investigation was designed as a prospective cohort study conducted at North Zealand University Hospital. All patient visits to the ED from September 2013 to December 2013 except minor injuries were included. DEPT was performed by nurses. Eyeball triage was a quick non-systematic clinical assessment based on patient appearance performed by phlebotomists. Both triage methods categorised patients as green (not urgent), yellow, orange or red (most urgent). Primary analysis assessed the association between triage level and 30-day mortality for each triage method. Secondary analyses investigated the relation between triage level and 48-hour mortality as well as the agreement between DEPT and Eyeball triage.

Results A total of 6383 patient visits were included. DEPT was performed for 6290 (98.5%) and Eyeball triage for 6382 (~100%) of the patient visits. Only patients with both triage assessments were included. The hazard ratio (HR) for 48-hour mortality for patients categorised as yellow was 0.9 (95% CI 0.4 to 1.9) for DEPT compared with 4.2 (95% CI 1.2 to 14.6) for Eyeball triage (green is reference). For orange the HR for DEPT was 2.2 (95% CI 1.1 to 4.4) and 17.1 (95% CI 5.1 to 57.1) for Eyeball triage. For red the HR was 30.9 (95% CI 12.3 to 77.4) for DEPT and 128.7 (95% CI 37.9 to 436.8) for Eyeball triage. For 30-day mortality the HR for patients categorised as yellow was 1.7 (95% CI 1.2 to 2.4) for DEPT and 2.4 (95% CI 1.6 to 3.5) for Eyeball triage. For orange the HR was 2.6 (95% CI 1.8 to 3.6) for DEPT and 7.6 (95% CI 5.1 to 11.2) for Eyeball triage, and for red the HR was 19.1 (95% CI 10.4 to 35.2) for DEPT and 27.1 (95% CI 16.9 to 43.5) for Eyeball triage. Agreement between the two systems was poor (kappa 0.05).

Conclusion Agreement between formalised triage and clinical assessment is poor. A simple clinical assessment by phlebotomists is superior to a formalised triage system to predict short-term mortality in ED patients.

INTRODUCTION

The intention behind triage is to prioritise patients in terms of their clinical urgency and to divide them into categories of acuity.1 Prior to introduction of formalised triage in emergency departments (EDs), patients were prioritised based on clinical assumption in the form of informally structured triage.2 Since the 1970s,3 several formalised triage systems have evolved and different scales are in use all over the world.4–5

The majority of triage systems are derived from expert opinion and supported by limited scientific research.4–5 Several studies investigating triage scales have methodological limitations and previous research has concluded that most triage scales are supported by ‘limited and often insufficient evidence’.6 To date there is no universal consensus on which parameters to include in a formalised triage system.4–5 Because there is no agreed proxy for ‘acuity’, the validation of formalised triage has focused on investigating predictive validity—that is, association between triage category and different outcome measures such as resource use, length of stay, admission, hospital charges and mortality.5–8 Currently there is no evidence establishing that formalised triage is superior to informally structured triage with regard to the prediction of clinical endpoints.7 The purpose of this study was to investigate how a simple clinical evaluation (ie, Eyeball triage) compares with a presently used formalised triage system and to determine how accurate each method is in predicting short-term mortality in ED patients.
METHOD
Study design and participants
All data derive from the ‘Triage study’, which is a prospective observational cohort study previously described in detail elsewhere.9 The aim of the study was to optimise risk stratification and develop methods to identify low-risk patients appropriate for early ED discharge.

The ‘Triage study’ was performed at North Zealand University Hospital, which is a regional hospital in the Capital Region of Denmark. The hospital has a 24-hours acute care facility offering emergency level 2 trauma, medical, surgical and intensive care services for 310,000 citizens in North Zealand. The ED has approximately 68,000 patient contacts annually and handles all patients except level 1 trauma patients, patients with identified ST-segment elevation myocardial infarction in the prehospital setting and hospital preferences by the patients.10 The ‘Triage study’ included all patients visiting the ED during the period from September 2013 to December 2013. Inclusion criteria were age > 16 years. Patients with minor complaints and injuries were excluded (ie, no patients in the least acute triage group (blue) were included). For 108 (1.7%) patient visits there was a loss to follow-up mainly due to emigration and patients seen in the ED without a Danish Central Person Registry number.

Triage standard
North Zealand University Hospital introduced the use of formalised triage in 2009 and since 2011 Danish Emergency Process Triage (DEPT) has been the triage standard. Trained nurses perform triage before beginning diagnostics and before the patient is seen by a physician. DEPT ranks patients into five colour-coded triage categories. Each patient is assigned a triage level based on the two main descriptors: (1) vital signs and (2) presenting complaint. The more urgent of these two determines the final triage category. The nurse can categorise the patient to a triage category of higher acuity, one level above that determined by DEPT, if she believes the patient would benefit from a higher priority. Triage to a lower triage category than prescribed by DEPT can only occur after the patient has been seen by a physician.11 The triage categories are: (1) red (resuscitation, constant re-evaluation); (2) orange (emergent, re-evaluation every 15 min); (3) yellow (potentially unstable, re-evaluation every 60 min); (4) green (non-urgent, re-evaluation every 180 min); and blue (minor injuries or complaints, re-evaluation every 240 min). The resulting triage category is used to initiate some immediate tests and other diagnostic procedures. DEPT is currently the most widely used triage system in Denmark12 and has previously been described in detail.11 DEPT is inspired by and almost identical to the Swedish Adaptive Process Triage model (ADAPT)12 13 which has an approach to patient sorting identical to the internationally established Canadian Triage and Acuity Scale (CTAS).3

Sixty-four nurses performed DEPT during the data inclusion period. The nurses had different levels of experience but all had attended formal training in the use of DEPT before working in the ED.

Eyeball triage
Eyeball triage was performed as an immediate clinical assessment by hospital staff without formal training in patient evaluation or experience with formalised triage. The staff performing Eyeball triage consisted of a group of 10 trained phlebotomists and 10 medical students working as phlebotomists from the Department of Clinical Biochemistry. Raters were instructed to base their Eyeball triage on a quick look at the patient and if possible to ask the patient for their main complaint. Phlebotomists were instructed to assess the patients based on acuity with regard to who they believed required the most immediate attention and treatment. Eyeball triage applied the same categorisation as DEPT and raters were asked to allocate the patients into the same colour-coded categories. None of the persons performing Eyeball triage were informed of the endpoint (ie, mortality) chosen in the study. The Eyeball triage was performed in immediate succession to DEPT and blinded from the resulting DEPT category including any information obtained during triage.

Data collection
A TRIAGE database was built using the following entries:

DEPT data
During triage the nurse registered the DEPT category using the programme CETREA Emergency, Version 3.11.

Eyeball triage
Eyeball triage category was manually filled out on a paper form during patient assessment and later entered into the TRIAGE database. Random quality checks were carried out to ensure that entries were registered correctly.

Mortality
Information about vital status was obtained from the Danish Central Office of Civil Registration which continuously records the vital status of all Danish residents.

Patients were identified and all data merged using the Central Personal Registry (CPR) number which uniquely identifies all Danish citizens.

Statistical analysis
Patients who were not assessed by both triage methods were excluded from the statistical analysis.

The baseline characteristics of the population were reported using descriptive statistics.

The primary analysis assessed the association between triage category and 30-day mortality. Secondary analyses assessed the association between triage category and 48-hour mortality and also investigated the agreement between DEPT and Eyeball triage. Hazard ratios (HR) for DEPT and Eyeball triage were calculated using Cox regression.

Positive predictive value (PPV), negative predictive value (NPV), sensitivity and specificity were calculated with standard methods for DEPT and Eyeball triage grouping into either green/yellow or orange/red patient groups. Kappa statistics were used to describe the agreement between DEPT and Eyeball triage. Kappa values were evaluated using the descriptions from Landis and Koch.14

Data were analysed using SPSS Statistics Version 22 (IBM, 2013).

RESULTS
During the study period 6383 encounters were recorded with a total of 5568 unique patients. DEPT was performed for 6290 (98.5%) and Eyeball triage for 6382 (~100%) of the patient visits. A total of 6290 encounters received both triage assessments and were included in the statistical analysis. Of the included sample, 3116 (49.5%) were male and the overall mean (SD) age was 60.2 (20.0) years. According to DEPT, 38 patients (0.6%) were categorised as red, 1704 (27.1%) as orange, 2487 (39.5%) as yellow and 2061 patients (32.8%) as...
green. According to Eyeball triage, 118 patients (1.9%) were categorised as red, 1016 (16.2%) as orange, 2804 (44.6%) as green and 2352 patients (37.4%) as yellow (P<0.001 for difference between triage methods).

The baseline characteristics of the overall population are shown in table 1. Baseline characteristics for patients in the different DEPT and Eyeball triage categories are available in the online supplementary appendix table 1.1 and table 1.2).

### 48-hour mortality

Within 48 hours, 58 (0.9%) of the patients died. Mortality in relation to triage category for both DEPT and Eyeball triage is shown in table 2.

With only one exception (patients in the yellow DEPT group), the HR for death increased with higher level of triage category for both DEPT and Eyeball triage, with Eyeball triage being the best discriminator of the two (table 2).

### 30-day mortality

Of the total 6290 patient visits, 263 (4.2%) died within 30 days. Mortality in relation to triage category as well as HR is shown in table 3.

Cox analyses of 30-day mortality showed that the HR for patients increased with triage category for both DEPT and Eyeball triage (table 3).

Test characteristics for DEPT and Eyeball triage in relation to prediction of patients at high and low risk of 30-day mortality is shown in table 4.

Eyeball triage had an overall higher sensitivity and specificity as well as a better positive and negative predictive value in terms of predicting patients at high and low risk of 30-day mortality. The same was found for 48-hour mortality. These data are available in the online supplementary appendix table 2.

### Agreement between DEPT and Eyeball triage

The agreement between DEPT and Eyeball triage was found to be 0.05 (95% CI 0.04 to 0.07) using unweighted kappa statistics, which is regarded as very low agreement.14 Linear weighted kappa was found to be slightly higher but still represents a very low level of agreement of 0.10 (95% CI 0.08 to 0.12).14

Table 5 shows the distribution of patients between DEPT and Eyeball triage.

### DISCUSSION

Triage is an essential element of modern emergency care and traditionally the triage process has been an integral element of ED nursing practice. In this prospective study we found that a simple clinical assessment by non-clinician hospital staff was a significantly better predictor of death in an unselected ED patient group. Eyeball triage was a better discriminator for 48-hour and 30-day mortality for all triage groups than DEPT. We also found the agreement between DEPT and Eyeball triage to be very low.

There have been few reports on how a clinical assessment compares to formalised triage in predicting patient outcome. One study by Storm-Versloot et al15 compared the two triage algorithms Emergency Severity Index and Manchester Triage System with a clinical assessment by a triage nurse. The study investigated predictive performance for all three triage methods in relation to resource use and length of stay and found no...
significant difference between them. They also investigated the effectiveness of triage using a reference standard derived from expert opinion and found that informally structured triage had the highest level of agreement. Despite this finding, the study concluded that it was preferable to use a formalised triage algorithm since it assured uniformity and transparency in the triage decisions. Although triage algorithms provide some level of transparency, we were not able to identify studies that investigated whether the reliability (ie, interobserver agreement) of formalised triage is greater than that of informally structured triage. Current studies investigating interobserver agreement of triage algorithms report heterogeneous results ranging from slight to almost perfect agreement.

The existing literature on limitations in the validation of triage scales points out that examining validity of triage is generally quite difficult. As previously stated by Twomey et al, “validity refers to the degree with which the measured acuity level reflects the patient’s true acuity at the time of triage. The term valid implies that there is some sort of external reference or ‘gold standard’ which by definition has absolute accuracy.” No such measure exists for triage. Validation of DEPT is related to precur- standard which by definition has absolute accuracy. No such measure exits for triage. Validation of DEPT is related to precur-

The study had a similar distribution of patients to ADAPT categories as ours to DEPT categories, but with fewer patients in the orange triage group and more patients in the red triage group. The study found an overall 28-day mortality which was equal to the overall 30-day mortality found in our cohort. Barfod et al also investigated the Odds ratio for in-hospital mortality in relation to ADAPT; the results were similar and with overlapping confidence intervals to our calculated HR for 30-day mortality in relation to DEPT.

Several studies have addressed the issue of time-consuming triage algorithms, but only a few have investigated the associated time spent on performing formalised triage. This is intriguing since an inefficient triage system could lead to ED crowding which is known to be a negative prognostic factor in relation to patient outcome. A previous retrospective cross-sectional study conducted at an urban academic ED in the USA found that less than half of high-acuity patients completed triage within time frames recommended by the Emergency Severity Index, concluding that the value and safety of the triage process should be reassessed. As has previously been stated, “being quickly assessed in a treatment bed is better than sitting in a waiting room not receiving any care.”

Different approaches to optimising triage have been investigated. Previous research has documented that implementing additional triage officers in the triage units will improve efficiency and implementing physician-assisted triage could decrease ED length of stay. It is yet to be investigated if simply applying Eyeball triage could result in similar results.

Strengths and limitations of this study

While previous validation studies of formalised triage have mainly focused on standardised patient scenarios or predictive validity for surrogate measures of acuity, we chose to sample ‘real-life’ patients and compared triage categories with an

| Table 3 30-Day mortality and hazard ratios (HR) in relation to 30-day mortality for Danish Emergency Process Triage (DEPT) category and Eyeball triage category |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | DEPT            | DEPT            | DEPT            | DEPT            | DEPT            |
|                  | Red             | Orange          | Yellow          | Green           | Total           |
| Deaths, n (%)    | 13 (34.2%)      | 102 (6.0%)      | 99 (4.0%)       | 49 (2.4%)       | 263 (4.2%)      |
| HR (95% CI)      | 19.1 (10.4 to 35.2) | 2.6 (1.8 to 3.6) | 1.7 (1.2 to 2.4) | 1               |                  |
| Eyeball triage   | 118             | 1016            | 2804            | 2352            | 6290            |
| Deaths, n (%)    | 36 (30.5%)      | 103 (10.1%)     | 91 (3.3%)       | 33 (1.4%)       | 263 (4.2%)      |
| HR (95% CI)      | 27.1 (16.9 to 43.5) | 7.6 (5.1 to 11.2) | 2.4 (1.6 to 3.5) | 1               |                  |

'Total' refers to the total number of patient visits in each triage category. 'Deaths' refers to the number of deaths within 30 days.

| Table 4 Prognostic performance of Danish Emergency Process Triage (DEPT) and Eyeball triage. Discriminatory ability for DEPT and Eyeball triage in relation to prediction of patients in high and low risk of 30-day mortality when using grouping into either green/yellow or orange/red patient groups |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | DEPT            | DEPT            | DEPT            | DEPT            | DEPT            |
|                  | Orange/red      | Green/yellow    | Orange/red      | Green/yellow    |                  |
| Sensitivity %    | 43.7 (37.9 to 49.8) | 73.0 (71.9 to 74.1) | 52.9 (46.8 to 58.8) | 83.5 (82.5 to 84.4) |                  |
| Specificity %    | 43.7 (37.9 to 49.8) | 73.0 (71.9 to 74.1) | 52.9 (46.8 to 58.8) | 83.5 (82.5 to 84.4) |                  |
| PPV %            | 96.7 (96.2 to 97.2) | 97.6 (97.1 to 98.0) | 97.6 (97.1 to 98.0) | 97.6 (97.1 to 98.0) |                  |
| NPV %            | 66.0 (55.5 to 7.9) | 66.0 (55.5 to 7.9) | 66.0 (55.5 to 7.9) | 66.0 (55.5 to 7.9) |                  |
| Accuracy (%)     | 71.8            | 71.8            | 71.8            | 71.8            |                  |

DEPT

Orange/red 115 (43.7%) 43.7 (37.9 to 49.8) 73.0 (71.9 to 74.1) 96.7 (96.2 to 97.2) 6.6 (5.5 to 7.9) 71.8

Green/yellow 148 (56.3%) 43.7 (37.9 to 49.8) 73.0 (71.9 to 74.1) 96.7 (96.2 to 97.2) 6.6 (5.5 to 7.9) 71.8

Eyeball triage

Orange/red 139 (52.9%) 52.9 (46.8 to 58.8) 83.5 (82.5 to 84.4) 97.6 (97.1 to 98.0) 12.3 (10.5 to 14.3) 82.2

Green/yellow 124 (47.1%) 52.9 (46.8 to 58.8) 83.5 (82.5 to 84.4) 97.6 (97.1 to 98.0) 12.3 (10.5 to 14.3) 82.2

Percentages may not equal 100% due to rounding.

PPV, positive predictive value; NPV, negative predictive value.

p < 0.05 for all.
Table 5 Association between Danish Emergency Process Triage and Eyeball triage categories in emergency department patients

<table>
<thead>
<tr>
<th>DEPT</th>
<th>Eyeball</th>
<th>Green</th>
<th>Yellow</th>
<th>Orange</th>
<th>Red</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>857 (13.6%)</td>
<td>925</td>
<td>256</td>
<td>23</td>
<td>32.8%</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>994</td>
<td>1110 (17.7%)</td>
<td>359</td>
<td>24</td>
<td>39.5%</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>500</td>
<td>767</td>
<td>387 (6.2%)</td>
<td>50</td>
<td>27.1%</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>1</td>
<td>2</td>
<td>14</td>
<td>21 (0.3%)</td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37.4%</td>
<td>44.6%</td>
</tr>
</tbody>
</table>

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Contributors KKI is the primary initiator of the 'Triage study' and wrote the first draft of the study protocol AKS wrote the manuscript, performed the statistical analyses and participated in the data collection. MK and RMD participated in the data collection and critically revised the manuscript. LC, GS, JLF, OE-O, LSR and MS participated with interpretation of the data and critically reviewed the manuscript.

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