Combining the National Early Warning Score with an early warning score based on common laboratory test results better discriminates patients at risk of hospital mortality

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Aim

To determine whether combining an early warning score (EWS) based exclusively on laboratory tests (LDT-EWS[1,2]) with the National Early Warning Score (NEWS[3]) would improve the discrimination of hospital mortality compared with each system individually.

Introduction

In the UK, most hospitals use an EWS to identify patients at highest risk and provide appropriate care. These are based on measurements of vital signs (e.g., pulse rate, blood pressure, breathing rate and conscious level). Use of the National Early Warning Score (NEWS, Table 1) is recommended[3].

Although measured less often than vital signs, laboratory tests are subject to strict quality control and have independently been identified as risk factors for poor patient outcome[4]. LDT-EWS (Table 2), an EWS based exclusively on laboratory test results, has been shown to discriminate patients at risk of hospital mortality[1,2].

We hypothesised that combining LDT-EWS with NEWS would improve the discrimination of hospital mortality compared with each system individually. As both EWS are calculated by summing scores for measured values, it would be simple to combine them by summing the NEWS and LDT-EWS scores for a given patient.

	3	2	1	0	1	2	3
Resp. Rate (/min)	≤8		9–11	12–20		21–24	≥25
SpO_2 (%)	≤91	92–93	94–95	≥96			
Supplemental O_2		Yes		No			
Temperature (°C)	≤35.0		35.1-36.0	36.1–38.0	38.1–39.0	≥39.1	
Systolic BP (mmHg)	≤90	91–100	101–110	111–219			≥220
Heart rate (/min)	≤40		41–50	51–90	91–110	111–130	≥131
Conscious level				Alert			Not alert

Table 1: NEWS, the National Early Warning Score.

Methods

We used a combined electronic database of haematology, biochemistry and vital signs measurements collected routinely soon after admission for 88695 adult admissions for whom the admission speciality was Medicine.

MALE	3	2	1	0	1	2	3
Hb		≤11.1	11.2-12.8	≥12.9			
WCC				≤9.3	9.4-16.6	≥16.7	
U				≤9.4	9.5-13.7		≥13.8
Cr				≤114	115-179	≥180	
Na		≤132		133-140	≥141		
K			≤3.7	3.8-4.4	4.5-4.7	≥4.8	
Alb		≤30	31-34	≥35			

FEMALE	3	2	1	0	1	2	3
Hb			≤12.0	12.1-14.8	≥14.9		
WCC				≤12.6	12.7-14.8	≥14.9	
U				≤8.4	8.5-13.8		≥13.9
Cr				≤91	92-157	≥158	
Na			≤134	135-140	≥141		
K			≤3.3	3.4-4.5	≥4.6		
Alb		≤28	29-34	≥35			

Table 2: LDT-EWS for males (top) and females (bottom).

The data were divided into 23 sets (Q1-Q23), each corresponding to three months. LDT-EWS was generated using decision tree analysis of haematology and biochemistry results for episodes from set Q1 (n=3762)[1,2].

LDT-EWS was applied to haematology and biochemistry results and NEWS was applied to vital signs measurements in 22 discrete test data sets each of three months long (Q2, Q3.....Q23) (range of n = 3580 to 4186).

A combined EWS was determined for each episode by summing, for each episode, the values for NEWS and LDT-EWS.

The abilities of NEWS, LDT-EWS and the combined EWS to discriminate in-hospital death were assessed using the area under the receiver-operating characteristic (AUROC) curve and by plotting EWS efficiency curves. The efficiency curves provide a relative measure, for a given trigger value in an EWS, of the number of triggers and number of patients subsequently dying that would be visited.

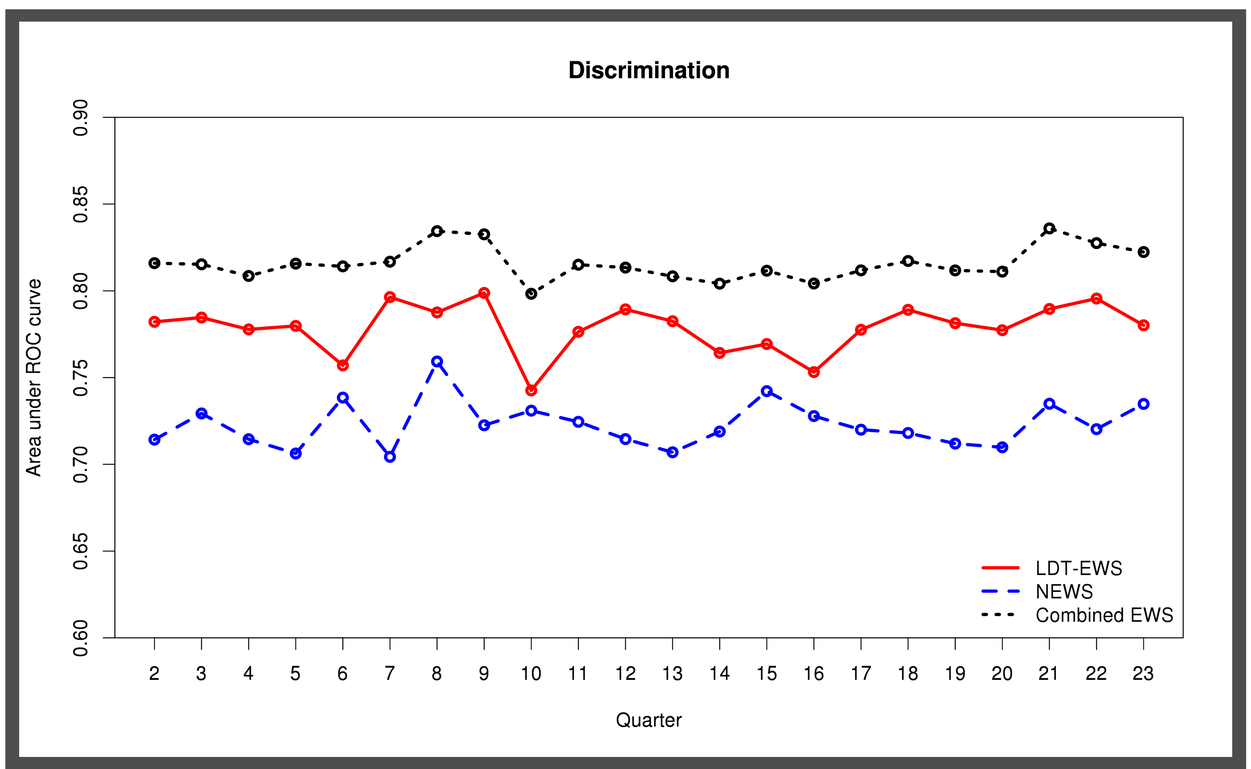

Fig. 1: Areas under the receiver operating characteristic curve for LDT-EWS, NEWS and the combined EWS, against hospital mortality.

Results

The combined EWS offered the best discrimination of hospital mortality in each of the 22 test data sets (Fig. 1). The range of AUROC values (95% CI) were:

- LDT-EWS: 0.743 (0.718 to 0.768) (Q10) to 0.799 (0.773 to 0.825) (Q9)
- NEWS: 0.704 (0.675 to 0.733) (Q7) to 0.759 (0.732 to 0.786) (Q8)
- Combined EWS: 0.799 (0.776 to 0.822) (Q10) to 0.836 (0.813 to 0.861) (Q21)

The combined EWS also offered better performance than LDT-EWS or NEWS as measured by an EWS efficiency curve (Fig. 2).

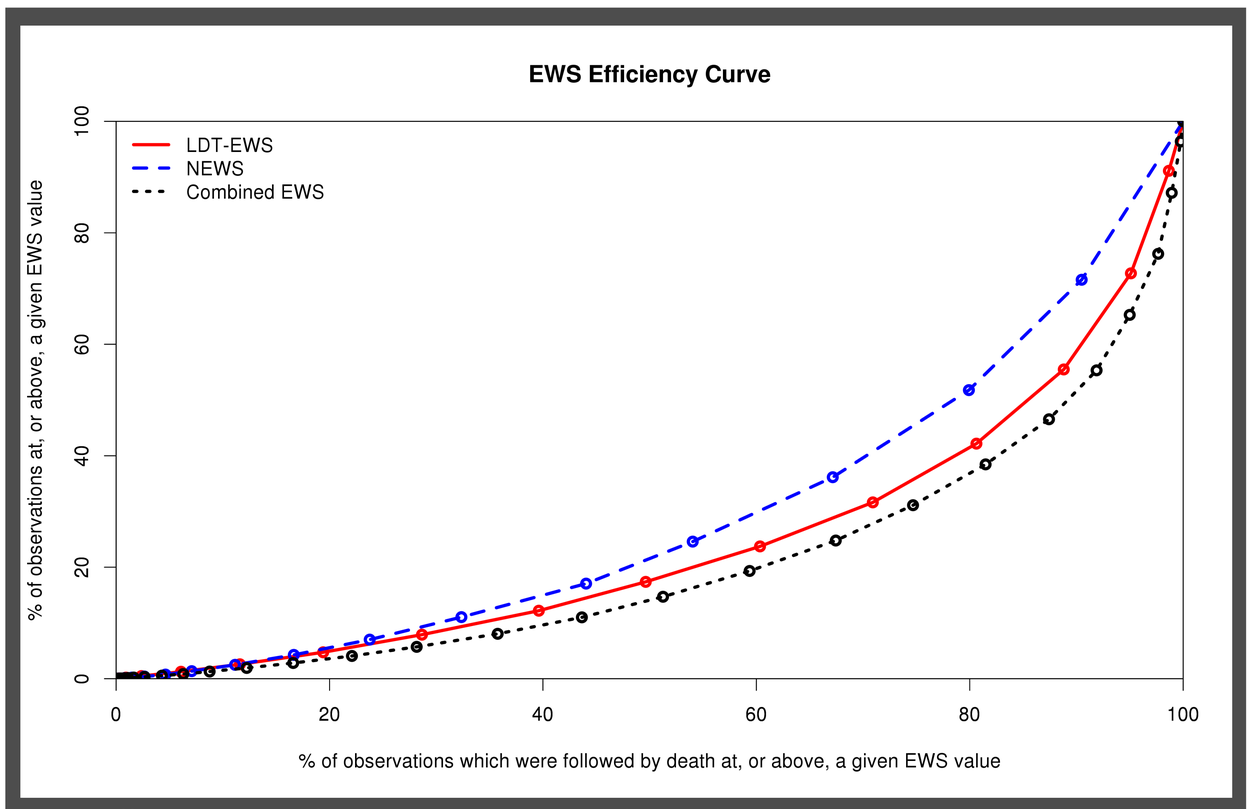

Fig. 2: Efficiency curves for LDT-EWS, NEWS and the combined EWS against hospital mortality.

Conclusions

This study provides evidence that a combined EWS using commonly measured laboratory tests and vital signs better discriminates in-hospital mortality than using either an EWS based on laboratory data or vital signs alone. We hypothesise that, with appropriate modification, the combined EWS could be used for identification of patients at high risk of death in the short term (for example, 24 hour mortality).

References

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