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The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study

Catherine McCabe[a,*], Margaurita O'Brien[b], Mary B. Quirke[c]

[a] Trinity College Dublin, School of Nursing & Midwifery, 24 D'Olier Street, Dublin 2, Ireland
[b] Tallaght University Hospital, Tallaght D 24, Ireland
[c] Trinity Centre for Practice and Healthcare Innovation, School of Nursing and Midwifery, Trinity College Dublin, D'Olier St., Dublin 2, Ireland

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ABSTRACT

Background: The combined use of the Manchester Triage System (MTS) with the Early Warning Score (EWS) may be useful in ensuring both appropriate prioritisation and continued monitoring in the Emergency Department (ED) leading to early intervention for deteriorating patients thus improving patient outcomes especially in overcrowded EDs.

Purpose: Determine the effect of the EWS and MTS on accuracy of the MTS and ED waiting times.

Methods: A retrospective cohort chart review of all adult patients who presented to the ED in one large hospital in Ireland (n = 10,048) at three time points between 1st September 2015-30th September 2016; 3 months prior to EWS introduction, implementation month and 9 months post-implementation.

Results: Patients were significantly more likely to be categorised as an MTS category 2 (rather than 3–5) after the EWS was introduced ($p < 0.001$). Waiting times between triage and clinician review ($p < 0.05$) increased as did total time in the ED ($p > 0.001$). A similar finding was observed for patients with an MTS of 3–5.

Conclusion: Although positive in terms of patient outcomes, the effective and sustained combined use of the MTS and EWS requires increased bed capacity and experienced clinical staff to ensure that the ED journey time reduced rather than increased.

1. Background

Triage is the process used in emergency care to rate the urgency of a patients clinical condition. Many triage scales exist, for example the *Australian Triage Scale (ATS); the Canadian Emergency Department Triage and Acuity Scale (CTAS);* South African Triage Scale and Rapid/Medical Triage and the Swedish Treatment System (RETTS/METTS) [1–5]. The Manchester Triage System (MTS) is perhaps most commonly used in the United Kingdom and Ireland. These scales are generally regarded as having moderate to good validity [6] but interrater reliability can be problematic [1]. In addition Jo and colleagues [7] suggest that while effective for prioritising patients, they are not used for continued monitoring in the Emergency Department (ED). Consequently the potential for patient deterioration to go unrecognised in ED poses a serious patient safety risk where there are long waiting times [8].

The introduction of an early warning track and trigger system such as the Early Warning Score may help minimise this risk and help ED staff recognise the need for intervention earlier. The potential for this has been assessed in three studies which demonstrated that using the EWS in conjunction with the MTS can improve early detection of patient deterioration as they journey through the ED [8–10]. However a systematic review by Wuytack et al. (2017) concludes that there is insufficient to support this view and that more evidence is needed [11]. Table 1 provides an outline of the current Irish national EWS track and trigger system developed by the Health Service Executive (HSE) in 2011[12], alongside the UK National Health Service MTS interpretation system.

The aim of this study was to determine the effect of the Early Warning Score (EWS) in conjunction with the Manchester Triage System (MTS) on the accuracy of the MTS and waiting times for patients in the ED.

2. Methods

2.1. Study design

This cohort study comprised a retrospective chart review of all adult patients who presented to the ED in one large hospital in Ireland over a

* Corresponding author.
E-mail address: camccabe@tcd.ie (C. McCabe).

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Table 1
Irish Health Service Executive (HSE) national early warning score track and trigger system [9] and UK National Health Service (NHS) Manchester Triage System (MTS) interpretation system.

EWS score	Response/Clinician review times
1	Nurse in charge to review if new score
2	Nurse in charge to review
3	Senior House Officer (SHO) to review within 1 h
4–6	SHO to review within 30 min
>/=7	Registrar to review immediately
MTS category	**Interpretation**
5	Non-urgent (Patients whose condition are not true accidents or emergencies)
4	Standard (Standard cases without immediate danger or distress)
3	Urgent (patient with serious problem, apparently stable condition)
2	Very urgent (Seriously ill or injured patients: lives are not in immediate danger)
1	Immediate resuscitation (Patient in need of immediate treatment for the preservation of life)

one month period at three separate time points: (1) Three month prior to the introduction of the EWS (September 2015); (2) Month of intervention implementation (December 2015); (3) Nine months post introduction (September 2016). Thus, in total, three patient cohorts were included. The time points were chosen as this complete dataset provides information of the period of pre implementation, the period of implementation itself, and a post-follow up period that reflects the pre implementation period. In this way seasonal factors can be accounted for (i.e. peak holiday periods etc.). This data collection approach was taken to achieve as wide a time frame as feasible to include a representative patient sample of the hospital ED setting.

The study site is an acute teaching hospital located in Dublin, Ireland. There are approximately 550 in-patient beds providing adult and age-related healthcare, as well as local, regional and national clinical specialities. In 2016, the hospital had approximately 50,000 ED presentations and over 18,000 admissions.

Ethical approval was obtained from the ethics committee at the study site (2016 – 05 Chairman's action [6]).

2.2. Implementation process of the EWS

Implementation of the EWS was led by an ED Clinical Nurse Specialist (CNS) and a quality improvement cycle approach was used. During this implementation period, workshop training on the use of the MTS was also provided to all clinical staff working in the Emergency Department at the study site. The CNS was available to answer any queries or concerns by staff and was available during the initial month of implementation to support staff. At six-weeks post implementation, a review of Triage Category and EWS at triage was completed and it was determined that some patients were incorrectly triaged. Further education was provided to ED staff on the 3rd edition update of Manchester Triage and introduction of EWS at triage in ED. At 6-weeks post follow-up education, an audit of ED presentations using Manchester Triage and the EWS demonstrated improvement in the accuracy of the triage categorisation.

2.3. Sample size

The sample comprised 10,048 patient ED presentations, collected at three time points over a 12-month period.

2.4. Data collection

A retrospective patient chart review was conducted using data collected on the ED 'Symphony' database. The data collection study period ran from 1st September 2015-30th September 2016. A clinical member of the research team with access to the patient cohorts as part of their clinical role, requested data from the ED systems manager for the relevant study periods. After cleaning and screening for duplicates, this data was coded and pseudo-anonymized onsite. The clinical member of the team retained the code key in line with data protection guidelines at the time of the study. Once the data was audited and cleaned, the code key was deleted. The dataset was fully anonymised and shared with the research team for analysis. The anonymized data set will be stored on a password protected computer for a period of 5 years in accordance with the research teams' affiliated university data retention policy.

The following coded patient information were extracted and used to assess the outcome of the introduction of the EWS: (1) EWS score; (2) Manchester Triage Category; (3) Waiting time from triage to seeing a clinician; (4) Waiting time from triage to ED discharge; (5) Patient outcome; (6) Patient disposition (destination); (7) Non-identifiable patient profile data (age, gender, diagnosis).

2.5. Data analysis

The data were audited and cleaned using Microsoft Excel and transferred to SPSS (version 22, IBM Corporation, Armonk, New York, United States) for analysis. Medians were presented for continuous variables and frequencies and percentages presented for categorical variables. Means (with standard deviation) were also included for normally distributed data with few outliers. For non-normally distributed data, statistical analysis of medians was most appropriate (Kruskal-Wallis). Pearson Chi-Square, and Fisher Exact tests were used as appropriate for categorical analysis. A p-value of less than 0.05 was considered significant. Given the nature of the data source, very few incidence of missing data occured. Where data were missing, this patient was removed from specific analysis.

3. Results

Data on 10,048 patients were included. A little over half were female (51%) with a mean age of 46.4 years (SD = 20.1; range 16–100 years). Over two-thirds (67%) self-referred and, whilst there was a broad range of presenting complaints, the most common was abdominal pain (16%), followed by limb problems (14%). Table 2 below further details the profile of patients.

3.1. Effect of EWS on MTS

Over the period of data collection, a very small proportion (1%) of patients were categorised with an MTS 1, 24% were assigned a category 2 with the remaining patients allocated a lower MTS score [3–5] (Table 2). Whilst three-quarters of patients are allocated an MTS category 3, 4, or 5, this group were merged together for analysis as, based on the MTS system (see Table 1), they were all considered stable patients. The most urgent cases (i.e. MTS 1 and MTS 2), whilst a minority sub-group, are of most relevance in the current study. Associations between MTS allocation and pre/post EWS introduction are presented in Table 3. It is evident that the proportion of patients allocated an MTS category 1 score remains stable across time. However, patients were significantly more likely to be categorised as a MTS category 2 (rather than a 3–5) after the introduction of the EWS (28%) than pre the EWS introduction (19%) ($\chi^2 = 94.14$, $p < 0.001$). Thus, as is further evidenced in Table 3 below, aside from MTS category 1, patients were significantly more likely to be assigned a higher category after the introduction of the EWS.

Table 2
Overview of patient profile across data collection times (n = 10048).

Category	% (n)
Age	Mean = 46.4 years (SD = 20.1) Median = 43 years
Sex	
Male	49% (4888)
Female	51% (5160)
Source of referral	
Self	67% (6700)
GP with letter	27% (2684)
Other	6% (664)
Attendance type	
New	90% (9044)
Unscheduled return	10% (1004)
Arrival mode	
Car	70% (7043)
Ambulance	24% (2420)
Other	6% (585)
Clinical group	
Medical	56% (5649)
Surgery	39% (3912)
Other	5% (487)
Most common presenting Complaint*	
Abdominal pain	16% (1553)
Limb problems	14% (1395)
Chest pain	10% (1017)
Breathlessness	8% (809)
Manchester Triage System category at triage	(10027)
Category 1	1% (104)
Category 2	24% (2412)
Category 3	51% (5102)
Category 4	21% (2155)
Category 5	3% (254)

* An additional n = 44 different presenting complaints of similar frequency (all < 8%) were recorded and so only the four most common are presented here.

Table 3
Overview of MTS categorisation of patients (n = 10027).

	Pre EWS (3940)	Post EWS+ (6087)	p	Chiˆ
MTS 1 (Yes vs others)	1% (47)	1% (57)	0.227	1.53
MTS 2 (Yes vs others)	19% (745)	28% (1667)	< 0.001*	94.1
MTS 3–5 (Yes vs others	80% (3148)	72% (4363)	< 0.001*	86.01

* Significant.
ˆ Each Chi analysis is based on dichotomous groupings (i.e. named category versus others grouped together).
+ No sig difference in % for EWS implementation month and 12 months post follow up so data was merged for this analysis.

3.2. Patient waiting times

Median patient waiting times were also examined. Table 4 below set out the median time (minutes) that patients waited between triage and being seen by a clinician. Total time between triage and leaving the ED (pre vs post introduction of EWS) based on MTS category was also assessed. For MTS category 1 patients (Table 4), a Kruskal-Wallis test revealed no statistical significant difference in median time waiting between triage and being seen by a clinician across the three different time points χ^2 (2, n = 92) = 4.3, $p > 0.05$. Similarly, no statistical significant difference in time waiting between triage and time left the ED χ^2 (2, n = 104) = 3.8, $p > 0.05$. This again indicates that the care and management of the most serious patients remained consistent over time.

However, for MTS category 2 patients, a significant difference was observed in time waiting between triage and being seen by a clinician across the three different time points χ^2 (2, n = 2301) = 6.79, $p < 0.05$, with patients waiting significantly longer post the introduction of the EWS. A Kruskal-Wallis test also revealed a statistical significant difference in time waiting between triage and time left the ED across the three different time points χ^2 (2, n = 2412) = 48.8, $p > 0.001$ (Table 4). A similar finding was observed for patients with an MTS of 3–5 with waiting time between triage and clinician review as well as overall time in department significantly likely to be longer for patients post the introduction of the EWS (Table 4).

An analysis of MTS categories at follow-up reveals that, of patients with a EWS of 0–3 (n = 2850), a small but consistent proportion of patients are still categorised as the most urgent requiring immediate resuscitation (MTS of 1 = 0.3%/n = 9) and (MTS 2 = 23%/n = 649). At the other end of the scale, of all patients with an EWS of > 6 (n = 69), only one was given an MTS category of 3–5. This patient presented with breathlessness and was diagnosed with a lower respiratory tract infection. A lack of association between MTS allocation and the timing of EWS introduction in comparison with 9 months post follow-up indicates little change in how the staff used the EWS in conjunction with the MTS during these two time periods.

A more detailed examination (at 9 months follow-up) of those patients with a EWS > 6 (n = 160) (i.e. the most serious patients) reveals that the median waiting time to see a clinician still differed depending on whether patients were assigned a MTS category of 1 (11 min), a category 2 (16 min) or category 3–5 (63 min), however this finding was not significant (Kruskal-Wallis, $p > 0.5$). Whilst not statistically significant, the 6 fold increase in waiting time for these patients with a high scoring EWS who have a less serious triage allocation is of clinical interest and highlights the variation in care pathways for some patients with high EWS. This also indicates that the EWS may be a more sensitive indicator of deterioration and, if in conjunction with the MTS, could provide a more conservative approach to patient management. Indeed, the vast majority of patients (91%) with a EWS of > 6 went on to be admitted to hospital regardless of MTS category.

4. Discussion

The purpose of this study was to determine the effect of the Early Warning Score (EWS) in conjunction with the Manchester Triage System (MTS) on the accuracy of the MTS and waiting times for patients in the ED regardless of their presenting condition. The findings highlight that although identification of the most serious patients (i.e. MTS 1) remained stable over the course of the study, patients were significantly more likely to be allocated an MTS score of 2 instead of a 3–5 following the introduction of the EWS ($p < 0.001$). This suggests that staff were more likely to place patients in a higher risk category following introduction of the EWS. This is a positive outcome given the conclusion of Parenti et al. [3] that the Manchester Triage System safety was low because of the high rate of under triage and the low sensitivity in predicting higher urgency levels. Other studies have considered specific patient profiles in the ED such as those with Sepsis [6] and the acutely dyspnoeic patient [13] and also support its use. Similarly Wireklint et al. [14] concluded that the Swedish triage scale RETTS was also unable to distinguish between stable/unstable patients. Farrohknia et al. [15] assessed 6 triage scales for reliability (Australian Triage Scale; Canadian Emergency Department Triage and Acuity Scale; Emergency Severity Index; Manchester Triage Scale; Medical Emergency Triage and Treatment System; and the Soterion Rapid Triage Scale). They concluded that overall quality of evidence was judged as insufficient for all.

Examination of actual median waiting times revealed that the waiting time for MTS category 1 patients also remained stable over time suggesting that staff deal with the most serious patients in a consistent way. However, following the introduction of the EWS, more patients were allocated a MTS of 2 and fewer were allocated an MTS of 3–5 but

Table 4
Analysis of patient waiting times comparing pre, early implementation and post implementation of EWS based on MTS groupings.

	3 months pre implementation	Implementation month	9 months follow-up	P value	Kruskal-Wallis score
MTS 1 patients only					
Waiting time (mins) from triage to see a clinician (n = 92)	Median = 7.5 (n = 46)	Median = 11 (n = 22)	Median = 11 (n = 24)	0.116	4.3
Total time in department (min) (Triage to left ED) (n = 104)	Median = 498 (n = 47)	Median = 289 (n = 28)	Median = 396 (n = 29)	0.153	3.8
MTS 2 patients only					
Waiting time from triage to see a clinician (min) (n = 2301)	Median = 18 (n = 709)	Median = 19 (n = 767)	Median = 21 (n = 825)	0.034*	6.79
Total time (min) in ED (Triage to left department) (n = 2412)	Median = 387 (n = 745)	Median = 391 (n = 812)	Median = 475 (n = 855)	0.001*	48.7
MTS 3–5 patients only					
Waiting time from triage to see a clinician (min) (n = 6629)	Median = 88 (n = 2788)	Median = 136 (n = 1864)	Median = 147 (n = 1977)	< 0.001*	255.94
Total time (min) in ED (Triage to leaving) (n = 7511)	Median = 261 (n = 3148)	Median = 342 (n = 2137)	Median = 386 (n = 2226)	< 0.001*	399.27

* significant.

both groups waited significantly longer to see a clinician and overall spent a longer period of time in the ED. This overall increase in waiting times may be due to staff being more confident that patient monitoring using the EWS was effective in early detection of deterioration that required immediate intervention by a clinician versus those patients who remained stable but still required attention. Other possible reasons for the increased waiting time in this study are not immediately apparent although similar findings have been reported [16]. However this study focused on triage tools only and did not include a track and trigger system. Other studies report that the higher the EWS and triage score, the more likely patients are to be admitted [3] and with current ED crowding [17], in conjunction with reduced bed capacity in many acute care hospitals, particularly in the Irish Health Care services [18], this may have added to the overall increased waiting times in the ED as seen in this study.

There was little difference in how staff assigned patients MTS and EWS between the introduction month of the EWS and at nine-month follow up. This indicates that once introduced, staff were consistent in how they approached the allocation of MTS in conjunction with the EWS. It also suggests that their combined use in the ED may enhance accurate and consistent clinical decision-making and communication in acute care situations which is essential in supporting and sustaining quality improvement for quality of care in the ED [13,19]. This is reassuring given the overcrowding and increased waiting times for patients in EDs internationally, which is associated with poor patient outcomes and high mortality rates [20,21]. However, although positive, the effective and sustained combined use of the MTS and EWS in the ED requires resources in terms of increased bed capacity and experienced clinical staff in order to ensure that the increased ED journey time is reduced and ultimately eliminated [22].

5. Limitations

The increase in length of time patients waited to be seen by a clinician and remained in the ED following the introduction of the EWS warrants further investigation. The current study did not assess the impact of the introduction of the EWS on staff lines of communication or clinical decision-making. Such an examination may identify the reasons for increased wait times as well as areas of improvement required in terms of the combined use of the EWS and MTS.

The retrospective nature of this study was appropriate in that it permitted the large-scale analysis of patient care pathways. However, in using this approach, this study was limited to the retrospective analysis of patients attending ED as an entire group as analysis was confined to existing data available. Indeed, there is some evidence to indicate that the utility of the EWS in the ED is limited amongst certain cohorts such as patients with Chronic Obstructive Pulmonary Disease [23]. Subgroup analysis based on patient diagnosis would evaluate the efficacy of the EWS in conjunction with the MTS in ED at a more specific level. Similarly, an expanded study that incorporates analysis of staff skill mix and turnover during the period of investigation would have provided more detailed contextual findings relevant to any study concerning the implementation of new work practices in a hospital setting.

6. Conclusions

The findings indicate that the use of the EWS in conjunction with the MTS may lead to more risk-adverse approach regarding patients allocated mid-range scores. However, the accompanying increased length of time in the ED is of some concern given the already overcrowded ED's and lengthy waiting times. Thus, patient outcomes may improve and this is welcome but overall inefficiency due to ED crowding and limited bed capacity remains an issue, however this needs further investigation. The use of the EWS in conjunction with the MTS in the ED should be further examined on patients with specific presenting symptoms to assess its usefulness across patient groups. In addition, the role of the EWS in conjunction with the MTS on clinical practice in the ED (ie communication and decision-making) should also be examined to ascertain efficacy on a day to day basis and over time.

Conflicts of interest

None.

Ethical statement

The study was approved by research committee of the relevant hospital site – Approval number 2016 – 05 (6).

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