Original Article

Implementing a Digital Deteriorating Patient Pathway to improve the safety and effectiveness of care of the adult deteriorating patient

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Abstract

Identification, escalation and clinical review of the deteriorating patient is essential for a safe and effective hospital. We present a deteriorating patient pathway developed within our electronic patient record, including implementation of a digital escalation and senior review process, triggered from a logic algorithm and vital signs. The pathway is activated by an average 43 patients per day with median mortality of 13.3%. Our Trust has seen a significant improvement in escalation and senior review and increased use of treatment escalation plans. The pathway has facilitated a cultural shift in the Trust towards the deteriorating patient. The new pathway is transferrable to both other digital Trusts as well as maternity and paediatric practice.

Keywords

Electronic Health Records, Vital Signs, Algorithms, Early warning score, Adults

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Introduction

Care of the deteriorating patient is fundamental to the safety and effectiveness of an acute hospital. The NHS England PIER (Prevention, Identification, Escalation, Response) framework provides an approach to agree common pathways and processes, language and responses within healthcare systems.[1] Human factors methodology describes how the most effective way to engineer patient safety is through system design.[2]

Identification of deteriorating patients commonly use structured observation tools which generate an early warning score. The National Early Warning Score (NEWS) version 2 (NEWS2) is used in adults alongside professional intuition.[3] Physiological parameters are weighted and aggregated to derive the NEWS. The NEWS should be recorded throughout a patient's stay in hospital to guide the clinical response, frequency of monitoring and whether an escalation of care is required. Additional NEWS2 guidelines in 2020 defined the urgency of clinical response, the seniority and clinical competencies of the responder and frequency of subsequent monitoring required for an elevated NEWS 5-6 or ≥7 that is new for the patient.[4] NEWS2 guidelines state a structured clinical assessment should be documented that includes: time of escalation to the medical team; time and grade of clinical response; clinical assessment and plan, including treatment plan and the individualised trigger score (threshold) for further response. Screening for sepsis should also be initiated when the NEWS is elevated.[5] These key performance indicators are the subject of a Commissioning for Quality and Innovation (CQUIN) scheme for 2023/24.[6]

The Dudley Group NHS Foundation Trust has a single acute site with 629 core inpatient beds. It uses a digital observation chart within an Altera® Sunrise™ electronic patient record (EPR) (Altera Healthcare UK Ltd, London) to record vital signs and calculate NEWS2. Historically, the ward digital tracking boards would display the latest NEWS for each patient with green/amber/red colour dependent on the magnitude of the score and consequent level of clinical concern. There was however no notification message or alerting functionality when new deterioration occurred. Nursing clinical documentation was paper-based; medical documentation was electronic on a range of different document templates. A lot of emphasis and resource had been directed to improve sepsis care in the Trust and the sepsis pathway was well embedded. However, there was no Trustwide deteriorating patient pathway addressing the non-septic patient. There were also various difficulties in the process of care: there was no differentiation of a new patient deterioration as identified by the electronic NEWS2 versus an established/ongoing one, creating a lack of clarity for individual staff as to the onset and whether they should escalate, re-escalate or ignore; a lack of clarity around time zero from which the timeliness of actions and

interventions are measured; the action of escalation, the urgency, to whom and when was inconsistent and poorly documented in the paper nursing notes; senior clinical reviews were unstructured and recorded on a variety of electronic documents lacking categorical fields making digital reporting and audit impossible; no mechanism to avoid alert fatigue in patients with a persistent high NEWS; a cultural unfamiliarity with the syntax of the 'deteriorating patient'.

This made providing assurance of care of the deteriorating patient challenging as it required manual audit of health records, and the quantity and distribution of new deteriorating patients difficult to establish. Understanding the burden of deteriorating patients and having strong assurance of their care was a Trust priority as it sought to improve the Summary Hospital-level Mortality Indicator (SHMI)[7] and provide evidence against the key lines of enquiry to the healthcare regulator.[8]

The use of an automated predictive model to identify high-risk patients for intervention by rapid-response teams has been associated with decreased mortality.[9] Automated vital signs monitoring and notification systems signalling clinical deterioration have been associated with significant improvement in clinical outcomes.[10]

After commissioning a new Trust Patient Safety Strategy, we sought to implement a digital Deteriorating Patient Pathway (DPP) within our EPR to implement NEWS2 guidelines following the PIER approach. The aims were to provide objective identification of new patient deterioration, to support timely escalation and senior review, and design the digital process such that detailed informatics could be established to facilitate local quality improvement cycles.

Methods

A multidisciplinary project team was established including medics, nurses, data analysts and software developers. Project governance was through the Trust Deteriorating Patient Group (DPG). We designed a logo to attach to all DPP material to give the project and pathway a visible profile. A key principle was to objectively identify when a patient deterioration began. Firstly, enhancements were made to the digital observation chart: once the physiological parameters were entered by the healthcare practitioner, the NEWS2 would calculate. Logic rules would then assess if the threshold for DPP activation had been met (NEWS ≥5), if this was a new deterioration and the clinical risk associated (NEWS 5-6 = medium risk; NEWS ≥7 = high risk). If applicable, a 'DPP activated' notification message to the user would then appear directing them to escalate and get a senior clinical review (Figure 1). The time the triggering set of vital signs were recorded would define time zero against which the timeliness of subsequent interventions could be measured. Observation frequency would be automatically adjusted according to the most recent NEWS.

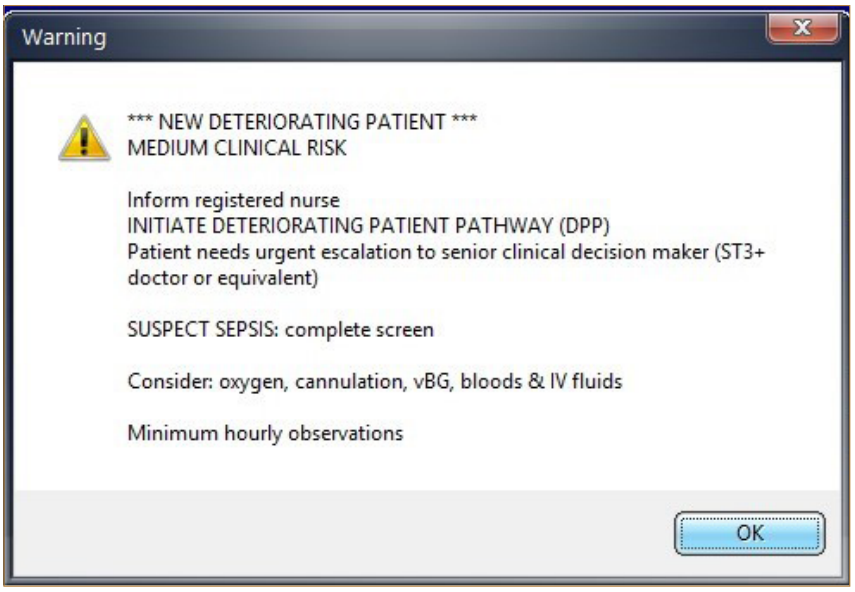

Figure 1. Example Sunrise® EPR alert pop-up after a new set of observations with a NEWS2=5, triggering the DPP.

To further support the required clinical response, once a patient activated the DPP, icons would appear against their name on the digital tracking board to signify escalation and senior clinical review is outstanding. The time zero would also be displayed and the patient's name would be highlighted in amber or red according to the level of clinical risk (Figure 2). These prompting icons would only redact upon completion of these tasks, after which the patient's name would revert to a grey highlight to reflect recent DPP activation.

Capturing the timing and completion of escalation and senior clinical review was fundamental. New EPR document templates were designed for this purpose.

Patient Name	Age / Gender	Consultant	Location DGFT	LOS..	Patient Alerts	RAD	LABS	Flag	EWS	Deteriorating Patient	Time since deterioration	Vital Signs Due
ZZCAT, DPPSEPSIS-PEWS	5y /F		East B3 - RM 10 - Bed 03	0w 0d 00h								
DETERIORATING, ICONS 2	22y /F		East B3 - RM 07 - Bed 03	0w 0d 00h					5	☎ + S	00:59	00:27

Figure 2. Sample of the Sunrise® tracking board layout highlighting a deteriorating patient with a new NEWS2=5, with icons in the deteriorating patient column indicating escalation, senior clinical review and sepsis are outstanding. The time since the deterioration event is displayed and the current Early Warning Score (EWS).

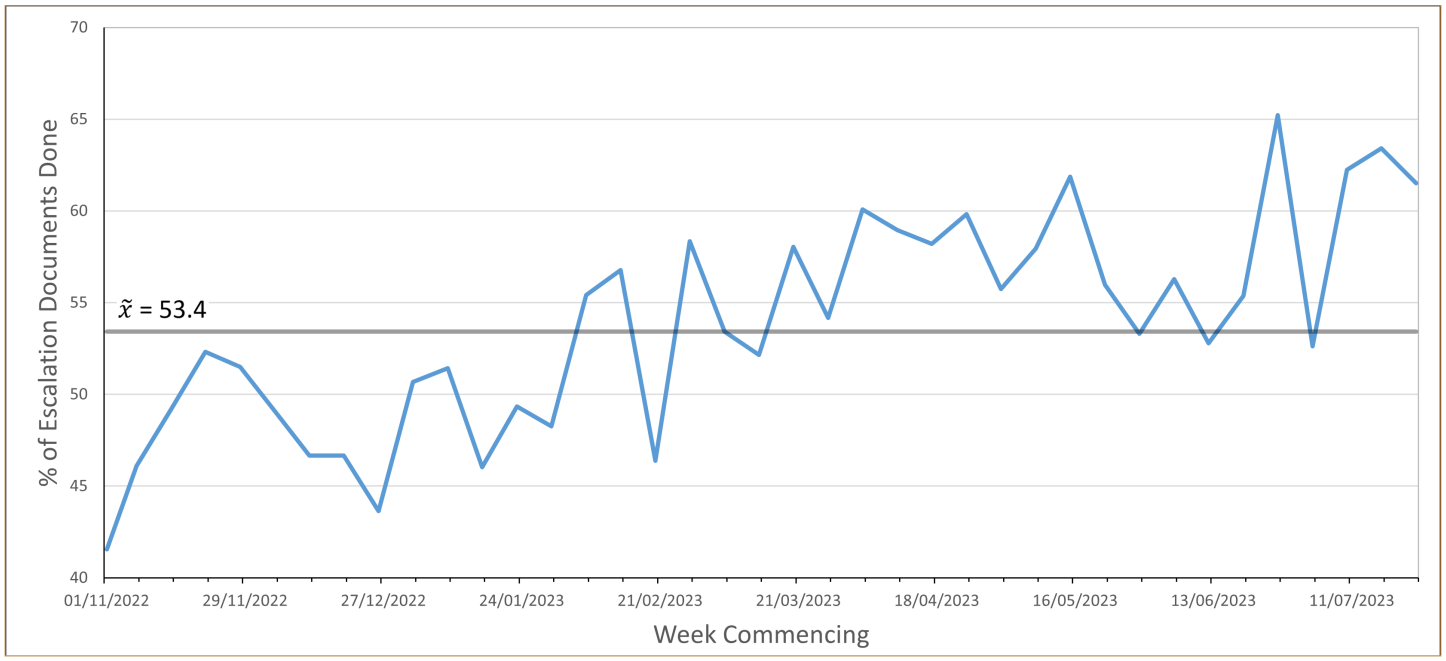

Figure 3. Runchart of completion of an escalation document within 4 hours of the time zero versus time ($\tilde{x}$ = median).

The escalation document, principally to be used by nursing staff, would mandate recording of when and to whom the patient was escalated, and the SBAR (situation, background, assessment, recommendation). The senior clinical review document would record the time of review, grade of the practitioner and the treatment plan. Categorical and mandatory fields within these new documents would ensure informatics reporting would be unambiguous. Escalation would follow existing Trust processes: NEWS 5-6 to the responsible clinical team ST3+; NEWS ≥7 requiring a Medical Emergency Team (MET) response (unless within the Emergency Department). The MET team are supported by the Critical care Outreach Team, Hospital@Night Team (nighttime), and the Deteriorating Patient Team (daytime).

In order to avoid alert fatigue in patients who had already activated the DPP and NEWS2 remained elevated, relative and absolute lockout rules were written: following DPP activation, no repeat activation could occur within 1 hour; between 1 and 18 hours, DPP re-activation would only occur if the NEWS2 was raised by a further two points. These rules would be overridden if ongoing professional concern was recorded by nursing staff at any point, thus triggering repeated escalation and senior clinical review.

A live EPR patient list was designed showing all patients triggering the DPP within the preceding 24 hours and whether their escalation and senior review had occurred. Finally, a new digital order was created allowing senior clinicians to set an individualised trigger score (threshold) for further response to be used when a patient has a persistently elevated NEWS2 that was normal for them. The same order could also be used for patients with Treatment Escalation Plans (TEPs) to suppress triggering from persisting abnormality as appropriate. These revised thresholds would be considered within the DPP activation logic when subsequent vital signs were recorded. End of life patients can have their electronic vital signs deactivated within our EPR and this would avoid these patients triggering the DPP.

All EPR changes were thoroughly tested and refined based on feedback from clinical reviewers prior to a Trustwide launch. Pre-emptive data reports were designed in Microsoft® Power BI™ to allow visualisation of DPP key performance indicators and trends and to support iterative quality improvement. Comprehensive Trust communications and an IT training package supported the launch alongside clinical support from IT support staff and our Deteriorating Patient Team.

Following launch, DPP performance was reported through the local DPG. DPP performance was added to departmental and divisional governance templates. DPP education was added to Trust induction and a Deteriorating Patient Human Factors module to mandatory training. Local departments were encouraged to perform their own DPP PDSA cycles, supported by the DPG and Trust Deteriorating Patient Team. Data and run charts were regularly circulated to ward teams, alongside access to the informatics dashboard. Several papers were presented to the Trust executive committee.

The DPP was launched 1st November 2022. Data is presented from 1/11/22 – 31/7/23.

Results

There were 11987 DPP activations across the 9 month period. In the first week after launch, there were 302 DPP activations (average 43/day). Activity peaked week commencing 26th December, in line with winter pressures, at 83/day and has fallen since with median 37.0 activations/day (mean 38.9 [SD 12.0]). The distribution of DPP activations shows the busiest areas to be the Emergency Department (44%), Acute Medical Unit (16%), respiratory ward (8%) and elderly care ward (4%). Surgical inpatient areas represent 10% of activations; medical areas 46%. The NEWS2 triggering the DPP was 5-6 in 74% of patients; NEWS ≥7 in 26%. Deteriorating patients are largely responded to by the responsible medical team. NEWS ≥7, outside of ED requiring a MET response, occurred an average of 5.7 times per 24 hours.

DPP performance was compared between November 2022 and July 2023. There was a reduction in the number of DPP activations from 1630 to 842. Initial compliance with patient escalation was 40.6% within 1 hour of time zero; 7.4% within 1-4 hours and 52.1% not done or done >4 hours from the time zero. Quality improvement initiatives improved this to 54.4% within 1 hour of time zero; 5.5% within 1-4 hours and 40.1% not done or done >4 hours in July 2023 (Figure 3). Across the implementation period, Emergency Department compliance with escalation has been 54.9% within 1 hour of time zero compared to 38.2% in other areas. Improvement has been seen in both areas.

Senior clinical review compliance in November 2022 was 29.8% within 1 hour of time zero; 21.5% within 1-4 hours and 48.7% not done or done >4 hours from the time zero. Quality improvement initiatives improved this to 40.3% within 1 hour of time zero; 23.8% within 1-4 hours and 36.0% not done or done >4 hours in July 2023 (Figure 4). Across the implementation period, Emergency Department compliance with senior clinical review has been 39.0% within 1 hour of time zero compared to 27.6% in other areas. Improvement has been seen in both areas.

While not an objective of the project, completion of TEPs increased from DPP launch.[11] Excluding the Emergency Department, in November 2023, 45.3% (226/499) who triggered the DPP had a TEP completed during their admission. This rose to 62.8% (172/274) in July 2023. Of TEPs completed, 97.0% had 'Do Not Resuscitate' within their plan.

In terms of clinical outcome, patients who trigger the DPP have a 13.3% in hospital mortality (if first trigger NEWS 5-6 6.2%; NEWS ≥7 26.5%). 6.1% patients are admitted to critical care (if first trigger NEWS 5-6 3.7%; NEWS ≥7 10.6%; Emergency Department 6.2%; other wards 6.0%) and we have not observed any significant change in this. The median length of stay for DPP patients is 141 hours (if first trigger NEWS 5-6 129 hours; NEWS ≥7 157 hours). We have not observed any reduction in overall Trust crude mortality rate since the DPP launched. The quarterly cardiac arrest incidence per 1000 hospital admissions has fallen from 1.17 (Q1/2 2022/23) to 1.0 (Q3/4 2022/23 and Q1 2023/24).

The individualised trigger score order allowing revised acceptable lower and/or upper physiological parameter thresholds has been used an average of 69

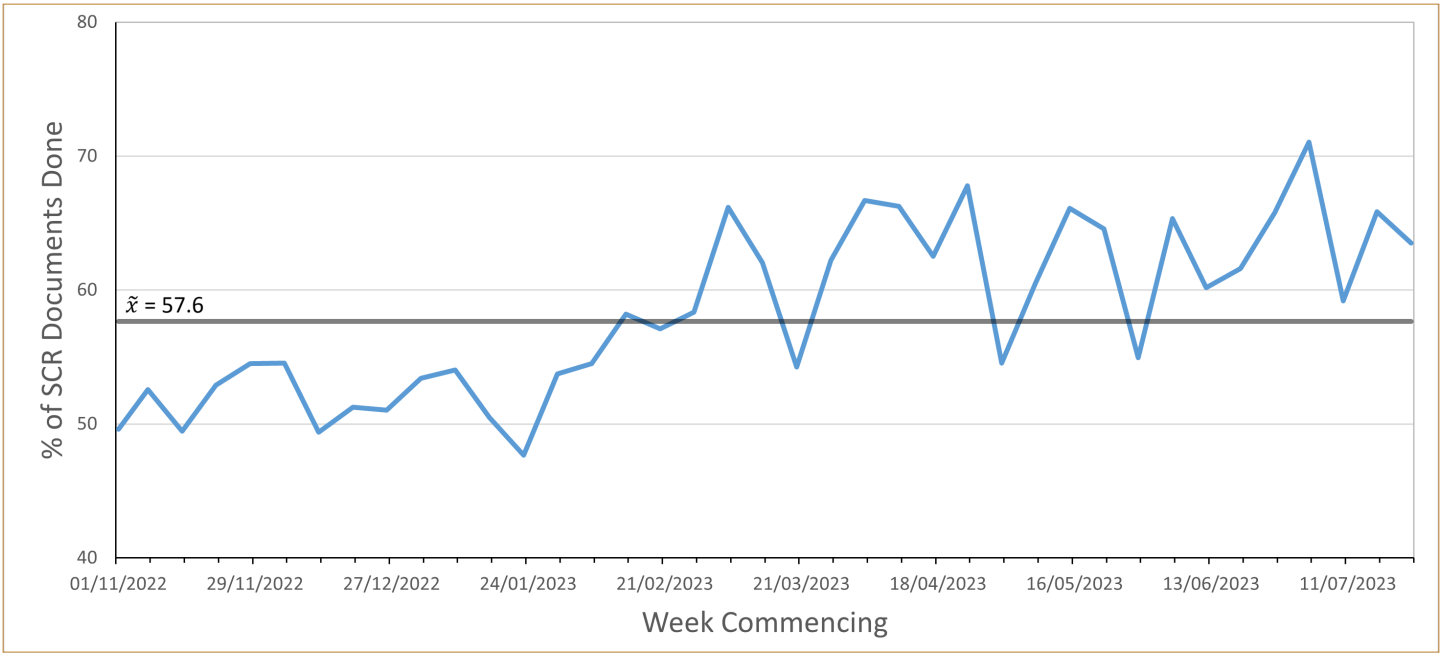

Figure 4. Runchart of completion of a senior clinical review (SCR) document within 4 hours of the time zero versus time ($\tilde{x}$ = median).

times per month since launch and has have reduced the burden of patients who would otherwise have recurrently triggered on their NEWS in the absence of clinical concern.

Discussion

The deteriorating patient project has successfully embedded a DPP following the PIER approach within our EPR. We have seen a gradual improvement in the key metrics of escalation and senior clinical review. Objectively defining the time of deterioration and pathway interventions has allowed evaluation of workload, timeliness and reliability of deteriorating patient care. The quantity of deteriorating patients triggering per day is significant, although the majority occur in front door assessment areas. Timely escalation and senior review are superior in the Emergency Department reflecting the availability of staff and the familiarity with deteriorating patient management. Outside of these areas, more variation in care is to be expected as individual staff would encounter a deteriorating patient rarely and maintaining skills and competence is challenging. In these areas, the model of using a central Deteriorating Patient Team to provide a clinical response is achievable as the triggers are fewer than 20 per day.

There have been many tangible benefits: quantification of the Trust deteriorating patient burden, the distribution by time of day and ward location, and acuity allows better staff resource allocation and strategic planning; overt highlighting of deteriorating patients on the ward tracking boards enables clinical prioritisation and reinforces the necessary actions; early, objective deteriorating patient recognition has enabled earlier discussion with patients regarding TEPs and end of life care; the Trustwide deteriorating patient EPR list provides strategic clinical oversight for critical care outreach and on-call teams; handover of deteriorating patients has been facilitated. A highly effective and filterable informatic dashboard has given ward teams data to benchmark and facilitate quality improvement through local plan-do-study-act cycles. Executive support has ensured deteriorating patients are prioritised above other clinical and operational priorities.

There has been a cultural shift within the organisation towards a common 'deteriorating patient' syntax and the behaviours that follow. Observing the high mortality of patients triggering the DPP has enabled engagement. Feedback has been overwhelmingly positive. Nursing staff report feeling more empowered to escalate patients. Clinical staff have welcomed the assurance that deteriorating patients are not overlooked amongst the burden of clinical workload, and that they are prioritised. Prior to launch, there was concern that the DPP would increase workload for staff. However, feedback is the DPP promotes earlier senior involvement, management plans, TEPs and reduction of unanticipated out-of-hours deterioration. The latter helps reduce workload on on-call teams. The Trust board reviews the DPP data on the deteriorating patient dashboard and the healthcare regulator has been positive of its value during a recent visit.

The individualised trigger score order has been welcomed by senior staff who can use their clinical judgement to revise DPP scoring thresholds and remove the alert fatigue and workload for patients in whom the raised NEWS is normal for them. This has had most utility for chronic respiratory patients on long term oxygen, with tachypnoea and low oxygen saturations who tend to maintain a NEWS ≥5.

There will be circumstances when a healthcare professional judges that the NEWS underestimates their concern for the patient's clinical condition. We have included professional concern as an override trigger for our DPP to manage this circumstance. We have defined absolute and relative lockout periods for DPP activation by a raised NEWS to avoid recurrent alerting whilst a management plan is being enacted. However, this is always overruled if ongoing professional concern is recorded. If a patient is on a steep deterioration trajectory, they could otherwise be missed within the DPP logic rules. It is important that the decision logic built into our DPP is seen to support care, but not override clinical judgement.

The 2023/24 CQUIN07 incentivises adherence to evidence-based steps in the identification, recording and timely response to deterioration identified with NEWS2. The CQUIN requires accurate recording of NEWS2, escalation and senior clinical review. Local data collection and adherence to this CQUIN has been facilitated by the DPP and is an approach transferrable to other NHS organisations with EPR systems.

The main challenges during the project have been educating the clinical workforce on the DPP and ensuring the correct template documents are used within the EPR to record escalation and senior review. Our EPR has multiple different document templates and if the wrong document template is used, the EPR will continue to show escalation and senior review as incomplete. It is essential to have bespoke documents as otherwise escalation and senior review are not identifiable amongst the wealth of other documents in the digital record and data analysis is compromised. We have since added pop-up warnings if the wrong document templates are opened to redirect staff. We also now recognise there is insufficient functionality to modify the DPP for patients with TEPs and we have since added functionality to permanently deactivate the DPP if appropriate for these patients.

Accurate, realtime data is key to inform understanding of how the pathway is working and what interventions might help further compliance. We have not yet reached >90% compliance with the pathway and quality improvement in ongoing. It is essential to have clinical champions driving this process, engaging staff and agreeing specific, measurable, achievable, realistic and timely (SMART) local objectives. Our Trust remains on this quality improvement journey.

The DPP is generalisable to paediatric and maternity practice although national Early Warning Scores are still in development.[1,12] We have now implemented the same DPP framework for our Modified Early Obstetric Warning Score (MEOWS) and Paediatric Early Warning Score (PEWS). This has further advantages as the DPP now provides a common approach to patient deterioration, escalation and response across all patient subgroups. This is particularly valuable in the ED where there is a mixed economy of patients and having different pathways has previously caused confusion.

In summary, a DPP promoting identification, escalation and senior clinical review can be successfully implemented within an EPR and can support a culture that prioritises the deteriorating patient. Informatics are vital to understanding local context and to facilitate quality improvement. All digital tools must allow for overriding professional concern and the ability to individualise triggering thresholds to avoid alert fatigue. A digital DPP can improve adherence to best practice.

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Declaration of interest

The authors declare no competing interests.

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