Digital NEWS? How to amplify the benefits of NEWS in a digital healthcare system

Authors: Christian P Subbe[A] and Rhidian Bramley[B]

ABSTRACT

With the transition of documentation systems, the National Early Warning Score (NEWS) is moving into a digital environment as a part of electronic health records. This paper aims to explore the opportunities and challenges of the digital environment for delivery of NEWS and the impact on safety of deteriorating patients. We make five recommendations to maximise the impact of a change to digital systems for patients, clinicians and healthcare organisations.

Background

Rapid response systems (RRS) are designed for early identification of patients at risk of catastrophic deterioration and timely response to such a detection. RRS have an afferent limb (an algorithm usually based on vital signs) with threshold levels used to trigger the efferent system (a specialist responder, such as a critical care outreach team, that will assist with the care of a patient at risk). The National Early Warning Score (NEWS) is part of the afferent limb of RRS. Early warning scores (EWS) have been used since the early 2000s and NEWS was developed through a consensus process by a group of experts hosted by the Royal College of Physicians in 2012, with an updated version published in 2017.[1–3] It has been adopted in many countries and its use has been mandated in all NHS England acute and ambulance trusts since 2019.[4]

NEWS provides a standardised approach to monitoring the risk of clinical deterioration and recovery by applying a score to vital signs used in quantifying the risk. It was designed to optimise the sensitivity and specificity for the detection of deterioration, and provide clinical decision support as to when to refer a patient for specialist clinical review. Nevertheless, there is significant evidence in the literature to suggest that many patients with abnormal vital signs are not escalated appropriately.[5,6] Inappropriate escalation can overwhelm responders and lead to 'alert fatigue'. Failure to escalate is a common cause of 'failure to rescue' patients who are developing complications, including sepsis, acute kidney injury and cardiorespiratory arrest.

Standardisation of NEWS has brought about a 'common language' in the way that vital signs are measured, evaluated and escalated, as well as standardisation in the training for detection of deterioration. In a digital environment, the elements of this chain of escalation still hold true but they present in a different form. The transition from paper-based to digital NEWS creates a real opportunity to address current challenges but might also add new risks to the reliable delivery of safe patient care across the NHS and other national healthcare systems.

A framework to capture the impact of NEWS

As a framework for this paper, we used a model developed by Subbe and Welch that describes the elements of a monitoring system aimed at preventing patient harm as a loop with five elements (record, recognise, report, respond and repeat), also called the five 'R's of RRS (Fig 1).[7]

> **Recording** of physiological observations or other safety-critical information at the bedside.
> **Recognition** of the degree of abnormality and the associated clinical risk.
> **Reporting** to a healthcare professional with the skill to identify and treat the underlying disease.
> **Responding** with the correct treatment.
> **Repetition** of the previous four functions as a feedback loop in order to identify failure to improve.

Record

Recording of vital signs has been traditionally undertaken at the bedside by registered nurses and allied health professionals (AHPs). The manual process of recording on a standard paper NEWS chart is a four-step process: capturing each of the observed values used in the NEWS assessment; plotting each value within the range of values specified on the chart; reading across to determine the risk score for each observation; and summing-up each observation risk score to record an overall NEWS. Each step in the process is prone to human error that may result in an incorrect NEWS record. Studies have shown that over 30% of EWS records may contain incomplete observation sets and calculation errors

Authors: [A]consultant in acute, respiratory and critical care medicine, Ysbyty Gwynedd, Bangor, UK and senior clinical lecturer, Bangor University, Bangor, UK; [B]clinical lead for diagnostics, digital and innovation, Greater Manchester Cancer Alliance, Manchester, UK and consultant radiologist, The Christie NHS Foundation Trust, Manchester, UK

Fig 1. The five 'R's of rapid response systems. Reliable care requires recording of vital signs, recognition of abnormalities, reporting in good time, competent response and repeated assessment.
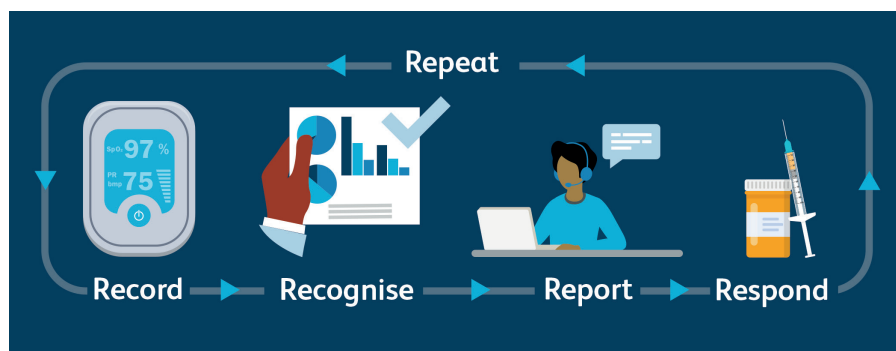
are common.[8] Digital NEWS systems are designed to minimise human error by enabling the healthcare professional to record the actual observation values at the bedside, and having the system automate the process of plotting the values on the chart bands and calculating the risk and overall NEWS.

Digital systems might increase the efficiency of manual vital signs recording: Wong *et al* reported a 30% time saving (average 65 seconds) to complete a set of physiological observations.[9] The National Institute for Health and Care Excellence (NICE) published an expert commentary suggesting that technology might save approximately 1 minute per patient, per set of observations, releasing up to 140 hours per day of staff time across their NHS trust (90 wards).[10] Implementation of digital NEWS can increase compliance with recording observations, increasing the average number of recorded vital sign sets from three to four per day.[11] The NICE commentary suggested that staff saving would be difficult to achieve in practice.[10]

Digitisation opens the possibility of capturing vital signs directly through connected or wireless device monitoring. Sensors can monitor respiratory rate, heart rate, oxygen saturations, blood pressure and surface temperature continuously or on demand. Increasingly, this ability to record vital signs is available on consumer grade devices such as a the Apple Watch or Samsung Galaxy Watch, which have been licensed for medical usage by the US Food and Drug Administration. Automated monitoring can have a significant impact on the possible frequency with which vital signs can be recorded and pick up catastrophic deterioration, including cardiorespiratory arrest and arrythmias within seconds (albeit with currently high rates of 'false' alarms). Standard NEWS recording aimed at detecting the deteriorating patient can be supplemented with real-time telemetry previously only available in specialist units.

Traditionally, vital signs recording is done with patients at rest and often in a supine position. Wearables allow the monitoring of mobile patients during a broad range of activities. As expected, the range of measured parameters in a mobile active person is different from that of someone resting and this might require re-calibration of scores to account for the level of physical activity at the time of measurement.[12]

More research is being undertaken to establish 'normal' ranges for groups of patients or individual patients during cancer treatments.[13] More frequent recording allows a different level of trend analysis and might aid to detect significant shifts in physiological measurements. Advances in these areas have been used in the prehabilitation of patients before major surgery and offer an opportunity for personalisation and scaling of the prehabilitation remote monitoring of patients receiving chemotherapy to detect early signs of sepsis.[13–15]

Recognise

Once vital signs have been entered into an electronic record, a key benefit of the automation can provide 'clinical decision support' by displaying the appropriate NEWS guidance for the patient based on their individual risk scores and overall NEWS. This increases the reliability of escalation, resulting in fewer unplanned admissions to the intensive care unit (ICU) and lower numbers of cardiac arrests.[10,11,16]

There are potential downsides of digital automation. In clinical practice, abnormal vital signs are often validated by the staff present at the bedside. Experienced nurses might wait and repeat vital signs abnormalities if they believe that they are transient and not clinically relevant (ie if vital signs have been measured after a patient with severe chronic obstructive pulmonary disease returns from the bathroom, respiratory and heart rate are likely to be out of the normal range but will settle within an expected time frame). In automated systems, this level of clinical validation of physiological abnormalities is less easy and automated systems might, therefore, increase the rate of non-actionable alerts or 'nuisance alarms'.

An experienced observer may also recognise that a patient is deteriorating irrespective of NEWS. The Royal College of Physicians emphasises that NEWS should be used as an aid to clinical assessment, it is not a substitute for competent clinical judgement. Any concern about a patient's clinical condition should prompt an urgent clinical review, irrespective of NEWS.[2] Digital NEWS should, therefore, make it possible for the observer to flag their concern, and for that to be visible in the system and trigger the appropriate escalations.

Algorithms generated by machine learning algorithms and artificial intelligence (AI) have been shown to assist with the identification of deterioration in large interventional studies.[17–19] These algorithms can include vital signs and other available parameters, such as laboratory values, previous diagnostic codes, intensive care admissions, or markers of frailty or dependency. AI algorithms have the potential to enhance the sensitivity or specificity for identification of deterioration beyond the standard NEWS, should these reach the threshold for regulatory approval. Digital NEWS may be seen as a pre-requisite for this AI research and development, as machine learning typically requires large datasets and will validate across representative populations.

Report

NEWS provides a standard table for clinical guidance to the NEWS thresholds that should trigger a response through escalation to the appropriate team. The normal mechanism is for the nurse to call or message the relevant team.

Digital NEWS systems supplement this process by providing a tailored decision support to ensure the appropriate team are notified, for example, a NEWS value of 5 may prompt referral to the local team, and a NEWS value of 7 to the critical care outreach team. The system can be designed to automatically send a message to the relevant team. In addition, the system can provide 'safety netting', creating work lists and dashboards to notify outreach staff of patients at most risk, facilitating early advice and intervention if there is a concern. An example is where an outreach team can conduct a 'safety huddle' or virtual ward round and handover using a system-generated list of patients with NEWS approaching and above the threshold.[20] The system should make it clear which patients have been escalated, and which patients are awaiting review following escalation.

Digital NEWS should also support 'personalised care' decision support. Some patients will require adjustment of the thresholds for escalation based on their clinical needs and whether they have already been escalated and are under review. This may necessitate adjusting the individual alert levels for the patient, or temporarily suspending alerts where they do not add value and it is safe to do so. Any decision to suspend or change the thresholds should be restricted to those in the escalation team, while ensuring it is always possible for a member of staff to override this and alert a member of the team if they are concerned.

Respond

The response to abnormal vital signs will be down to clinicians but the rise in the availability of digital systems means that NEWS can be viewed both at the bedside and remotely by outreach teams, enabling teams to respond more quickly and to monitor the response to any intervention. The integration of NEWS with electronic patient records provides direct access to blood results and other investigations, treatments and patient history that may help determine the appropriate course of action.

NEWS includes a standard NEWS chart to support responders assessing the baseline observations and rate of deterioration, as well as any oxygen therapy given and the subsequent response. The adoption of a standard national chart for this purpose was a key safety feature to help pattern recognition and staff moving between different organisations. It is important that this consistency is maintained in adopting digital NEWS and, at a minimum, the system must be capable of displaying the standard chart and printing the chart if required for transfer of care between digital and non-digital settings.

Digital NEWS provides an opportunity to innovate and supplement the standard display with additional views that can assist in managing the response. It should be possible for outreach teams to record specific actions and be able to monitor the effect on the individual vital signs and NEWS.

Repeat

NEWS provides decision support guidance on how often observations should be repeated based on the current NEWS.

In practice, compliance with guidance on the frequency of observation can be patchy, particularly at night.[21] Compliance with repeating observations is dependent on a number of factors, including staffing levels and training.

Digital NEWS systems have been shown to improve compliance with the guidance and the frequency of observations performed.[11] Ward dashboards and notifications support direct care, helping to remind staff when the next set of observations are due. Longitudinal performance monitoring might be able to identify trends and variation across different wards and settings. Clinical managers can monitor compliance remotely and help set appropriate staffing levels and support and training for staff where required.

Other considerations

Digital NEWS has similar general considerations to other digital healthcare records. The clinical benefits of wider remote access to the clinical information are balanced against the risk of data security, inappropriate access and consent to share data. Organisations should have data protection impact assessments and operating policies to cover these risks. UK legislation requires all digital clinical system have a clinical hazard assessment and safety report and it is the responsibility of both the system supplier and the implementing organisation clinical safety officers to review and assess any clinical risks. The local implementation and training should take into account general information technology systems' clinical risks (eg ensuring the correct patient is selected and displayed) and risks specific to the NEWS system (such as those mentioned in the review). The supplier is required to include any clinical hazards related to their application.

One of the underlying design principles of NEWS was the emphasis on a shared model that would apply in all settings of healthcare, including nursing homes, primary care, ambulances, and hospital wards with medical or surgical patients. While the original validation was undertaken in medical emergency admissions, NEWS has proved to be remarkably robust in its assessment of patients in a broad range of settings and with a broad range of conditions.[22–25] Modification of algorithms might improve sensitivity and specificity for subgroups of patients of specific settings but might challenge the interoperability of systems and the 'shared mental model' within the multi-professional team. NHS Digital have published interoperability standards through InterOpen for the integration and transfer of NEWS recording through Health Level-7 (HL7) fast healthcare interoperability resources (FHIR) interfaces.[26] Suppliers meeting these standards should be able to transfer records between connected systems across care settings. In order to maintain the 'common language' of NEWS, it is imperative that the scoring algorithm is implemented unabridged to retain the integrity of the assessment and score. Systems may then personalise the escalation and response based on individual patient needs.

NEWS was published with a vital sign chart that supported easy charting and recognition. One of the challenges of electronic health records has been to replicate the design, colour scheme and functionality of the chart in a uniform fashion. Different electronic health records currently use different charts and colour schemes to display vital signs to document NEWS. Suppliers introducing NEWS have sought to implement the algorithm to calculate the score to the agreed standard, but there has been wide variation

in how the data are charted and presented. NEWS was designed to standardise how data are presented by using a standard chart. The risk is that variation in presentation can hinder the ability to monitor progress especially for staff that move between organisations using different suppliers. Engagement with some suppliers has determined that this is a limitation of the software as opposed to any evidence base that deviating from the standard format offers any clinical benefit. There is a risk that non-standard implementation in electronic health records can impair cognitive pattern recognition and, therefore, error rates in documentation and reading of safety-critical information. The implementation of a standard should not stifle innovation, but suppliers should, at a minimum, provide the standard view to comply with national guidance.

Digital data capture and NEWS can facilitate standardised audit against locally agreed standards for quality improvement and benchmarking of performance across the organisation and over time.[27]

Conclusion

Based on the evidence underpinning NEWS and principles of patient safety, we believe that implementations of NEWS in electronic health records should include the following five quality standards.

> Electronic health records should maintain the 'common language' of NEWS unless another system is introduced nationally: the common language should include the parameters included in the score, their weighting of the parameters and the visualisation of results and trends as per the standard NEWS chart. The NEWS algorithm and its visual representation on electronic charts should be characterised by familiarity for clinical users. The risk is that variation in presentation can hinder the ability to monitor progress especially for staff that move between organisations using different suppliers. Workflow considerations might mean that it is reasonable to record additional parameters at the same time as NEWS (eg pain scores) but these should not alter the score until another system is introduced nationally or evaluated alongside the current standard.

> Electronic health records might enable senior authorised users to override the default threshold levels for escalation reporting and the frequency of repeating NEWS observations, tailored to the individual patient's care. It should be clear for all involved in monitoring the patient that the default settings have been overridden, and the reason why. To ensure a common language, the NEWS must not be changed, with any changes applied only to the individual thresholds for reporting and repeat, based on the standard NEWS.

> Digital NEWS should enhance patient-centred care and shared decision making between clinicians and patients. As part of this principle, it is expected that any electronic recording of NEWS will be accessible by patients who would like to view their own data through dedicated portals or applications. Patients should have the option to share their digital NEWS with trusted friends and family members. This should include information about clinical overrides.

> Electronic health records should include easily accessible audit functions and real-time dashboards to assess the compliance with nationally recommended or locally agreed monitoring

standards and quality improvement initiatives. These should take into account any tailored override of the default standard thresholds and intervals, and also enable identification and audit of this subset of patients to determine the reasons and appropriateness of the override decisions. Recording of interventions (at a minimum, coded oxygen delivery) and significant events is encouraged to facilitate audit of treatment decisions and clinical outcomes.

> Electronic health record providers should support real-time remote monitoring of patients including virtual ward rounds of at-risk patients by a rapid response or critical care outreach team. All recorded information available at the bedside should be visible remotely to provide a safety net and ensure physiological abnormalities are being escalated and the appropriate response measures have been implemented. ∎

Conflicts of interest

Chris Subbe was member of the original working part of the Royal College of Physicians that launched the National Early Warning Score. He has received grants from Philips Healthcare to support research into electronic monitoring systems and has acted as an advisor and speaker for Philips Healthcare. Chris Subbe is member of the advisory board of the International Society for Rapid Response Systems.

Rhidian Bramley has been involved in the development of a digital NEWS systems for The Christie NHS Foundation Trust, Manchester.

References

1 Subbe CP, Kruger M, Rutherford P, Gemmel L. Validation of a modified early warning score in medical admissions. *QJM* 2001;94: 521–6.

2 Royal College of Physicians. *National Early Warning Score (NEWS): Standardising the assessment of acute-illness severity in the NHS.* RCP, 2012.

3 Royal College of Physicians. *National Early Warning Score (NEWS) 2: Standardising the assessment of acute-illness severity in the NHS.* RCP, 2017.

4 NHS Improvement. *Resources to support the safe adoption of the revised National Early Warning Score (NEWS2).* NHS, 2018.

5 Johnston MJ, Arora S, King D *et al.* A systematic review to identify the factors that affect failure to rescue and escalation of care in surgery. *Surgery* 2015;157:752–63.

6 Subbe CP, Barach P. Failure to rescue and failure to perceive patients in crisis. In: Sanchez JA, Barach P, Johnson JK, Jacobs JP (eds). *Surgical patient care.* Springer, 2017:635–48.

7 Subbe CP, Welch JR. Failure to rescue: using rapid response systems to improve care of the deteriorating patient in hospital. *Clin Risk.* 2013;19:6–11.

8 Prytherch DR, Smith GB, Schmidt P *et al.* Calculating early warning scores-A classroom comparison of pen and paper and hand-held computer methods. *Resuscitation* 2006;70:173–8.

9 Wong D, Bonnici T, Knight J, Gerry S, Turton J, Watkinson P. A ward-based time study of paper and electronic documentation for recording vital sign observations. *J Am Med Inform Assoc* 2017;24:717–21.

10 National Institute for Health and Care Excellence. *National Early Warning Score systems that alert to deteriorating adult patients in hospital: Medtech innovation briefing [MIB205].* NICE, 2020.

11 Lang A, Simmonds M, Pinchin J *et al.* The impact of an electronic patient bedside observation and handover system on clinical practice:

mixed-methods evaluation. *JMIR Med Inform* 2019;7:e11678.

12 Subbe CP, Duller B. Continuous monitoring of respiratory rate on general wards what might the implications be for clinical practice? *Acute Med* 2018;17:5–9.

13 Waller E, Sutton P, Rahman S, Allen J, Saxton J, Aziz O. Prehabilitation with wearables versus standard of care before major abdominal cancer surgery: a randomised controlled pilot study (trial registration: NCT04047524). *Surg Endosc* 2022;36:1008–17.

14 Durrand JW, Moore J, Danjoux G. Prehabilitation and preparation for surgery: has the digital revolution arrived? *Anaesthesia* 2022;77:635–9.

15 Maguire R, Fox PA, McCann L *et al*. The eSMART study protocol: a randomised controlled trial to evaluate electronic symptom management using the advanced symptom management system (ASyMS) remote technology for patients with cancer. *BMJ Open* 2017;7:e015016.

16 Subbe CP, Duller B, Bellomo R. Effect of an automated notification system for deteriorating ward patients on clinical outcomes. *Crit Care* 2017;21:52.

17 Churpek MM, Yuen TC, Winslow C *et al*. Multicenter comparison of machine learning methods and conventional regression for predicting clinical deterioration on the wards. *Crit Care Med* 2016;44:368–74.

18 Malycha J, Redfern OC, Ludbrook G, Young D, Watkinson PJ. Testing a digital system that ranks the risk of unplanned intensive care unit admission in all ward patients: protocol for a prospective observational cohort study. *BMJ Open* 2019;9:e032429.

19 Escobar GJ, Liu VX, Schuler A *et al*. Automated Identification of Adults at Risk for In-Hospital Clinical Deterioration. *N Engl J Med* 2020;383:1951–60.

20 Moore J, Merchant Z, Rowlinson K *et al*. Implementing a system-wide cancer prehabilitation programme: The journey of Greater Manchester's 'Prehab4cancer'. *Eur J Surg Oncol* 2021;47:524–32.

21 Hands C, Reid E, Meredith P *et al*. Patterns in the recording of vital signs and early warning scores: compliance with a clinical escalation protocol. *BMJ Qual Saf* 2013;22:719–26.

22 Prytherch DR, Smith GB, Schmidt PE, Featherstone PI. ViEWS-Towards a national early warning score for detecting adult inpatient deterioration. *Resuscitation* 2010;81:932–7.

23 Neary PM, Regan M, Joyce MJ, McAnena OJ, Callanan I. National early warning score (NEWS) - evaluation in surgery. *Int J Heal Care Qual Assur* 2015;28:245–52.

24 Kostakis I, Smith GB, Prytherch D *et al*. The performance of the National Early Warning Score and National Early Warning Score 2 in hospitalised patients infected by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). *Resuscitation* 2021;159:150–7.

25 Nabayigga B, Kellett J, Brabrand M, Opio MO. The mortality of acutely ill medical patients for up to 60days after admission to a resource poor hospital in sub-Saharan Africa compared with patients of similar illness severity admitted to a Danish regional teaching hospital — An exploratory observational study. *Eur J Intern Med* 2016;27:24–30.

26 NHS Digital. *Interoperable medicines standards*. NHS. https://digital.nhs.uk/services/interoperable-medicines/standards [Accessed 21 July 2022].

27 Patchett A. *Improving the completeness and accuracy of NEWS2 observation recording*. NHS. www.gloshospitals.nhs.uk/work-for-us/training-staff/gsqia/quality-improvements/Improving-the-Completeness-and-Accuracy-of-NEWS2-Observation-Recording [Accessed 21 July 2022].

Address for correspondence: Dr Christian P Subbe, Bangor University, Bangor, Gwynedd LL57 2AS, UK.
Email: c.subbe@bangor.ac.uk