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Implementation of the National Early Warning Score in patients with suspicion of sepsis:

evaluation of a system-wide quality improvement project

Abstract

Background

The National Early Warning Score (NEWS) was introduced to standardise early warning scores (EWS) in England. It has been recommended that NEWS should be used in pre-hospital care but there is no published evidence that this improves outcomes. In 2015, the West of England Academic Health Science Network region standardised to NEWS across all healthcare settings. Calculation of NEWS was recommended for acutely unwell patients at referral into secondary care.

Aim

To evaluate whether implementation of NEWS across a healthcare system affects outcomes, specifically addressing the effect on mortality in patients with suspicion of sepsis (SOS).

Design and setting

A quality improvement project undertaken across the West of England from March 2015 to March 2019, with the aim of standardising to NEWS in secondary care and introducing NEWS into community and primary care.

Method

Data from the national dashboard for SOS for the West of England were examined over time and compared to the rest of England. Quality improvement methodology and statistical process control charts were used to measure improvement.

Results

There was a reduction in mortality in the SOS cohort in the West of England, which was not seen in the rest of England over the time period of the project. Admissions did not increase. By March 2019, the West of England had the lowest mortality in the SOS cohort in England.

Conclusion

To the authors' knowledge, this is the first study demonstrating that use of NEWS in pre-hospital care is associated with improved outcomes in patients with SOS.

Keywords

mortality; national early warning score; prehospital care; sepsis; quality improvement; patient safety.

INTRODUCTION

The National Early Warning Score (NEWS) was introduced to standardise early warning scores (EWS) in England and is probably the best validated EWS for recognition of sepsis.^{1,2} Failure to recognise a deteriorating patient is a common cause of serious adverse events.^{3,4} EWS or physiological 'track and trigger' systems are designed to help healthcare professionals to identify and respond to patients at risk of clinical deterioration.⁵⁻¹⁴ In 2012, the Royal College of Physicians (RCP) developed a NEWS, but by 2015 this had not been adopted consistently by acute hospitals across the UK.¹⁵

Although the focus of the RCP report was using NEWS in hospital, it was suggested that it could be useful in pre-hospital settings. Since then, structured observations have been recommended by the National Institute for Health and Care Excellence (NICE),¹⁶ and NEWS has been recommended by the National Confidential Enquiry into Patient Outcome and Death,¹⁷ the Royal College of Emergency Medicine,¹⁸ and NHS England¹⁹ to aid identification of sepsis.^{1,2} NEWS2, an update of NEWS (see Supplementary Figure S1), was mandated by NHS England for adoption across all acute trusts and ambulance trusts in England at the end of

2018.¹⁴ A NEWS of ≥ 5 is the recommended trigger for sepsis screening.^{14,16-18}

The West of England covers a population of 2.4 million and includes five clinical commissioning groups, two mental health trusts, six acute trusts, seven community health services, and one ambulance trust. In 2015, two of six acute hospitals in the West of England region were using NEWS, two were using an adaptation of NEWS, and two were using an alternative EWS. NEWS was not being used in emergency departments (ED), out-of-hours services, primary care, or community mental health services. Some community services had started to use EWS but not NEWS. NEWS was not used in the ambulance service. As a consequence, NEWS was not used in handovers of care outside acute hospitals.

There are limited data on EWS, including NEWS, in pre-hospital settings. There have been some studies suggesting that EWS in out-of-hospital settings can predict short-term outcomes and some recent studies have demonstrated this for NEWS.²⁰⁻²⁴ To the authors' knowledge, there has been no published study where a standardised EWS has been used across a whole care pathway.²⁴ The aim of this project was to implement NEWS across the healthcare system for acutely unwell patients from the

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How this fits in

It has been recommended that the National Early Warning Score (NEWS) should be used in pre-hospital care but there is no published evidence that this improves outcomes. This was a quality improvement project undertaken across the West of England from March 2015 to March 2019 to evaluate whether implementation of NEWS across a healthcare system affects outcomes, specifically addressing the effect on mortality in patients with suspicion of sepsis (SOS). Implementation of NEWS at point of referral from community into acute care reduced mortality in patients with SOS. To the authors' knowledge, this is the first study to demonstrate that using the same early warning score across a healthcare system can improve outcomes.

community to hospital. The purpose was to standardise communication²⁵ and improve recognition and response to the deteriorating patient. As NEWS has not been validated outside of hospitals, the recommendation was a single NEWS at the point of referral into the acute system rather than using NEWS as a tool to continuously monitor a patient in the community. NEWS range from 0–20. The thresholds for action were aligned to those used in secondary care (≥ 3 = threat; ≥ 5 = refer; ≥ 7 = severe). The recommended threshold to consider review in secondary care was NEWS of ≥ 5 ; however, this did not mean that NEWS carried more weight than clinical judgement and did not override existing pathways of care, for example, chest pain or stroke. There was also guidance advising that a raised NEWS did not mandate referral if inappropriate, for example, in end-of-life care.

Over the past few years, NHS England has focused on raising awareness, recognition, and treatment of sepsis,^{26,27} and this has led to variability in the estimate of sepsis incidence depending on the coding set used. Changing coding practices over time makes comparisons between datasets difficult. Hospital Episodes Statistics (HES) data based on septicaemia codes have historically underestimated incidence of sepsis, as clinicians tend to document the underlying source of infection. Recent changes in coding guidance and raised awareness have led to a marked increase in reported sepsis numbers. This means that a proxy measure, identifying patients admitted to hospital with infection, is a more reproducible population to study for impact of improvement programmes. Suspicion of

sepsis (SOS) is a set of 250 International Statistical Classification of Diseases version 10 (ICD-10)²⁸ codes describing patients with bacterial infection requiring hospital admission, and is responsible for 25–38% of all hospital admissions. SOS data was used as the main outcome measure^{29,30} (for the coding set used to identify SOS see Supplementary Box S1).

This article describes an overview of a system-wide implementation of NEWS for assessment and communication of acutely unwell patients in one region, and presents evidence that the use of NEWS in pre-hospital care is associated with improved outcomes in patients with SOS.

METHOD

The Institute for Healthcare Improvement Breakthrough Collaborative Model³¹ was used to bring health professionals and patients together. Beginning in March 2015, teams from across the healthcare system met regularly to share and test ideas, define outcomes, identify learning, and develop educational material. Each individual organisation used quality improvement methodology to adopt NEWS and shared successes and barriers to implementation. Educational materials included two online toolkits for implementation of NEWS and adoption of structured communication, laminated NEWS cards for lanyards, and posters and presentations for local use. A whole system collaborative was complemented by ED and primary care collaboratives led by clinicians and supplemented by coaching in quality improvement methodologies. In total, there were five whole system events attended by 583 people (95–136 at each event), five ED collaborative events attended by approximately 100 people (20–25 at each event), three sepsis masterclasses attended by 186 people (32–85 at each event), and a primary care collaborative attended by 296 people (41–124 at each event). Whole system collaborative events were held every 6 months and teams also met in health community task groups aligning to clinical commissioning groups. The health community task groups were made up of the key leaders in each CCG. There were 8–15 people in each group. These groups engaged leaders from every acute trust, commissioner, mental health trust, community provider, out-of-hours GP services, and the ambulance service.

Organisational testing and implementation

Many interventions were tested and then implemented by different organisations to aid adoption of NEWS. These included acute trusts, community, digital enablers,

education and training, and patient and public involvement.

Acute trusts

- All six acute trusts standardised to using NEWS in the first year. Two trusts changed from the Bristol Early Warning Score to NEWS at the end of 2015.
- Two trusts changed from a modified NEWS to the nationally recommended NEWS.
- The regional neurosurgery centre developed a Neuro NEWS chart.
- An ED collaborative was set up in April 2016 to spread use of the ED safety checklist, which includes NEWS. Prior to this, no ED used NEWS. As a minimum, NEWS was recommended at triage into the department and at handover to in-patient wards. By July 2017 all hospitals had attained 80% of patients having NEWS documented on the ED checklist.
- NEWS was requested at point of GP referral into some acute trusts supporting triage and treatment escalation during transfer. Not all trusts captured this electronically, but for a large trust that did, 78% of referrals had a NEWS by the end of 2018.

Community

- In-patient mental health wards were already using NEWS and this was spread to prison services.
- NEWS was introduced to community mental health services, for example crisis teams, by one of two trusts by February 2016. The second trust introduced NEWS to community teams in 2019.
- All community health teams were using

NEWS by July 2016. Community teams started to use NEWS for routine visits not just for patients who were acutely unwell.

- A primary care collaborative was established to introduce quality improvement methodology and improve safety culture. This was used as a vehicle to promote NEWS.
- NEWS was introduced into some care homes.

Digital enablers

- The West of England Academic Health Science Network (WEAHSN) funded the introduction of NEWS into the electronic patient clinical record system in the South West Ambulance Service Foundation Trust (SWASFT), with a gradual roll-out over seven counties serving a population of 5.3 million up until February 2017.
- An electronic NEWS template was put into GP systems such as EMIS, Adatastra, and SystmOne, as well as the IT systems used by hospital call handlers accepting GP referrals.

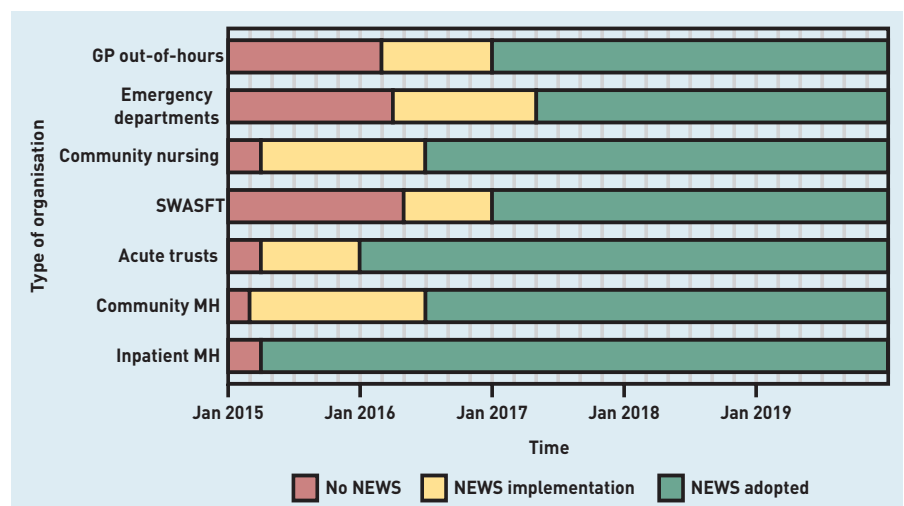
Education and training

- An online toolkit was developed to aid NEWS implementation.
- Human factors training was delivered to band four healthcare workers in the community focusing on SBAR (situation, background, assessment, recommendation) communication to facilitate escalation.
- Educational posters, badges, and prompt cards were developed.

Patient and public involvement

- Patients attended all events and board

Figure 1. Implementation of NEWS by organisation over time. NEWS adopted denotes when all organisations in a setting could evidence the use of NEWS in ≥80% of patients/referrals. MH = mental health. NEWS = National Early Warning Score. SWASFT = South Western Ambulance Service Foundation Trust.



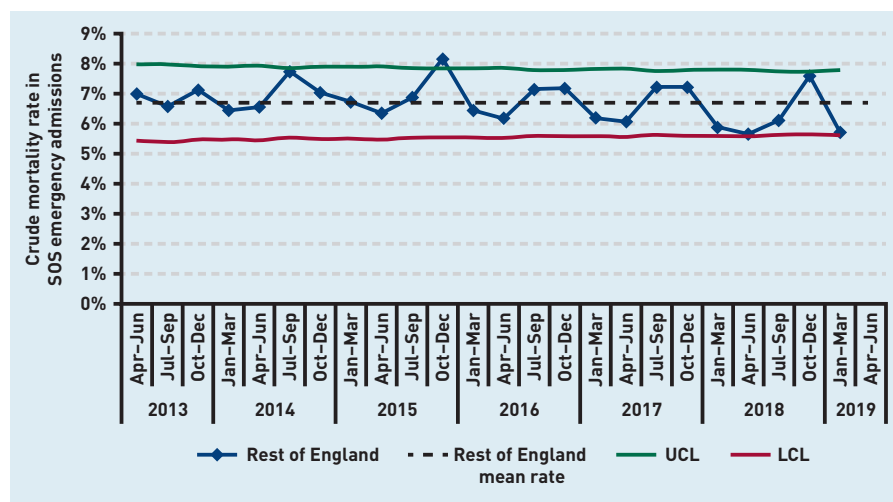


Figure 2. Statistical process control chart demonstrating mortality over time in patients with SOS in all 14 AHSN regions, excluding the West of England. AHSN = academic health science network. SOS = suspicion of sepsis. LCL = lower control limit. UCL = upper control limit.

meetings for the project.

- A patient story is used as a training video,³² and there is evidence that a patient with recurrent sepsis used NEWS as a way to self-manage.

Process and outcome measures

Organisations collected data electronically where possible using existing IT systems, and where this was not possible paper audits were undertaken. Each organisation undertook quantitative and qualitative audit recording whether NEWS was used but also whether the score was added up correctly and escalated appropriately. The timing of interventions for each healthcare provider is presented in Figure 1. Mortality rate for patients coded with SOS was used as the main outcome measure. This is a broader cohort than 'sepsis' (currently indicated in administrative data sets by 15 codes) and the cohort that is most likely to benefit from use of NEWS. This avoids an increase in

the denominator of patients with sepsis potentially leading to a false reduction in mortality as the cohort of SOS patients is more stable over time.

Crude mortality for discharges with an identified SOS code was measured in the WEAHSN using Statistical Process Control (SPC) methodologies in Microsoft Excel Charts to identify where special cause variation was evident.^{33,34} SPC charts are a means of robust statistical interpretation of measures presented over time and identification of the type of variation in the process over time. The centreline is calculated by the mean with an upper control limit (UCL) and a lower control limit (LCL) at a distance of ± 3 standard deviations from the mean. If the process has common cause variation, data points will lie inside the control limits. The control limits will remain fixed unless a fundamental change to the process has been made. This is known as 'special cause' variation, and if this occurs the control limits are recalculated.

A comparison was made to the rest of England. SOS data was used to measure admission numbers, mortality, length of stay (LOS), and intensive treatment unit (ITU) admissions. The data for these measures were obtained from Secondary Uses Service data and used in agreement with NHS England. As per guidelines in using National Commissioning Data Repository data, it has to be stated that this report is for NHS operational and management purposes, and is not to be used as official statistics for general public use.

RESULTS

Some process measures showing increased measurement of NEWS by sector are reported elsewhere.³⁵ Figure 1 illustrates the timings of NEWS implementation in different settings. By early 2017 the majority of services had introduced NEWS.

Figures 2 and 3 demonstrate mortality from SOS as SPC charts. Figure 2 shows mortality in the SOS cohort for the rest of England comprising 14 AHSN regions. As all data points lie between the upper and lower confidence limits, this is showing common cause variation with cyclical increases in mortality in winter months. Figure 3 shows the change in mortality over time in the WEAHSN and shows sustained special cause variation with a reduction in mortality from early 2017 onwards, corresponding to most providers having completed implementation of NEWS. Within the rules of SPC charts, seven or more data points below the mean suggest there has

Figure 3. Statistical process control chart showing crude mortality in patients with SOS in the West of England over time. LCL = lower control limit. SOS = suspicion of sepsis. UCL = upper control limit.

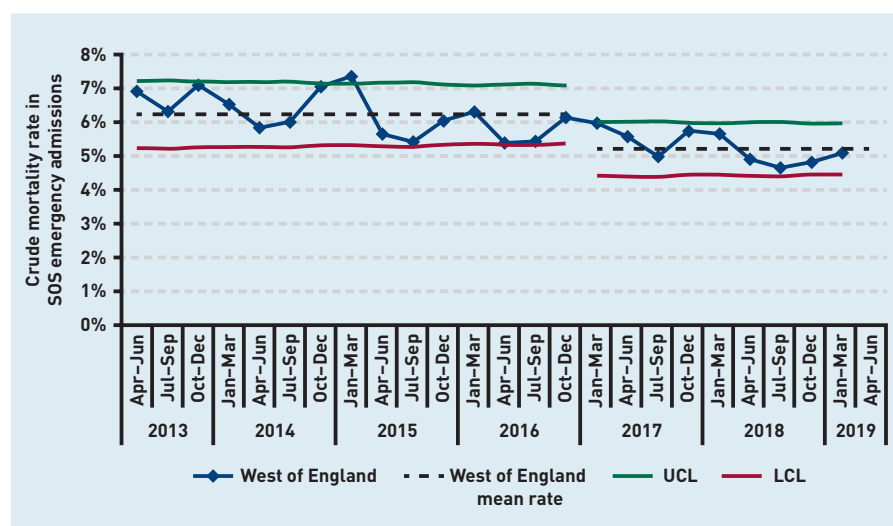
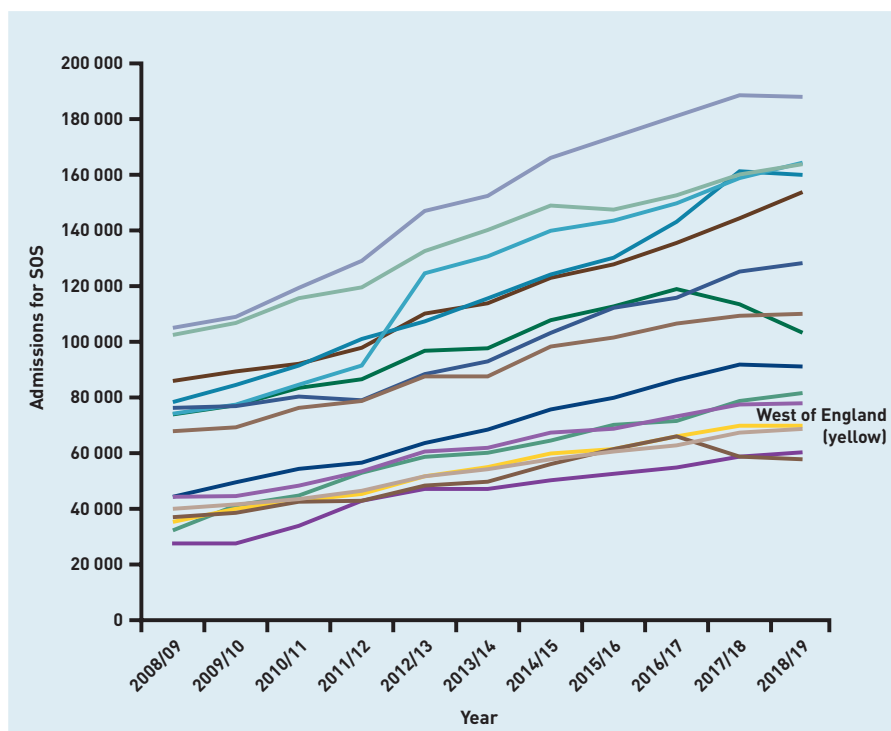


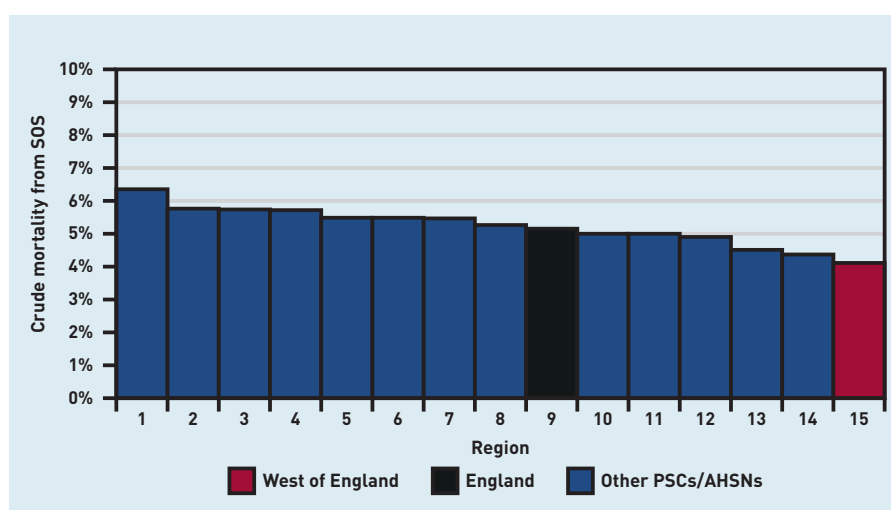
Figure 4. Number of admissions of patients with SOS over time by AHSN region. AHSN = academic health science network. SOS = suspicion of sepsis.



been a shift in data due to special cause variation. When this occurs, the upper and lower confidence limits are recalculated and this is what is shown in Figure 3. Using SPC chart methodology this is considered a significant shift in data demonstrating that there has been a change to the system. In addition, there is a suggestion that the winter peaks are less extreme since mortality has started to reduce, although this is not statistically significant and would require further analysis for confirmation of effect. In addition, the last four data points are lying below the new mean suggesting that there might be another shift in data

soon. The improvement was apparent for all individual trusts. Admissions with a diagnosis of SOS are increasing year on year and this was apparent in all trusts. The increase in admissions with SOS does not seem to have been driven by use of NEWS as the WEAHSN shows the same rate of increase of SOS admissions as other AHSN regions (Figure 4). The WEAHSN region now has the lowest mortality in the SOS cohort in England (Figure 5). Analysis of ITU admissions in the West of England compared to the rest of England show a slight but non-significant reduction. Prior to the introduction of NEWS in 2015 the West

Figure 5. Crude mortality from SOS by AHSN region from January 2019 to March 2019. AHSN = academic health science network. PSC = patient safety collaborative. SOS = suspicion of sepsis.



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Ethical approval

This study used retrospective, fully anonymised data from the participating NHS trusts and therefore did not require ethics review as detailed in the Health Research Authority toolkit.

Provenance

Freely submitted; externally peer reviewed.

Competing interests

The authors declare no competing interests.

Contributors

Further authors involved in the study were from 2gether NHS Foundation Trust: Rauli Worthington (Lead Resuscitation Officer), Louise Forrester (Lead Nurse), Margaret Trewin, (Resuscitation Training Officer), Kerry Dando (Resuscitation Training Officer), and Sally Ashton (Programme Lead and Clinical Continuous Improvement Lead). From Bristol Community Health: Sandra Akintola (Clinical Project and Dementia Lead), Karen Field (Clinical Lead Nurse for Urgent Care), Jamie Moore (Advanced Nurse Practitioner), Rachel Prodger (Clinical Lead), Abi Bartlett (Clinical Lead Nurse for Offender Health), and Luke MacCallum (Advanced Clinical Practitioner). From the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care West: Sabi Redwood (Deputy Director and Ethnography Team Lead), Niamh Redmond (Research Fellow), Jon Banks (Research Fellow), Lauren Scott (Senior Research Associate), and Penny Whiting (Epidemiology Team Lead). From Gloucestershire Hospitals NHS Foundation Trust: Andrew Seaton (Director of Safety), Kay Haughton (Deputy Director of Nursing), and Ben King (Lead for Acute Care Response, Resuscitation, Simulation and Clinical Skills). From Great Western Hospitals NHS Foundation Trust: Mark Juniper (Consultant in Respiratory and Intensive Care Medicine, Quality Lead), Dawn Oddie (Nurse Consultant in Outreach), Sarah Canfield (Matron ITU), Rachel Taylor (Team Lead Community Nursing Central), and Caroline Tandy (Clinical Lead for Electronic Observations).

of England had a higher LOS for patients with SOS than the rest of England. This has reduced by one day, and the LOS is now comparable with the rest of England.

DISCUSSION

Summary

Use of NEWS in pre-hospital care standardises communication and allows the track and trigger element of NEWS to start one step earlier, rather than on arrival in hospital, so that the patient is seen at the right time in the right place by the appropriate grade of clinician. This is achieved by pre-alerts to the ED for the sickest patients, safer management of ambulance queues, objective assessment and triage of ED attenders, and safe triage of selected admissions with NEWS of <3 to ambulatory care. NEWS also provides objective assessment of physical health in prisoners and patients with mental health problems.

The data in this study mainly pertains to NEWS rather than the updated NEWS2. It was a requirement from NHS England that all acute trusts changed to NEWS2 by the end of March 2019. As this dataset finished in March 2019 it is possible that some scores are NEWS2 rather than NEWS, but almost all of the data refer to the implementation and use of the original version of NEWS. The key changes to NEWS2 are a new section for scoring oxygen saturation in patients with hypercapnic (often termed 'type 2') respiratory failure, and changes to the consideration of new onset confusion alongside level of consciousness. While these changes would affect NEWS values in a subset of patients, it is not expected that these changes would alter the findings.

Over 4 years, the adoption of NEWS in primary and community care and communication of NEWS at handover of care has led to a reduction in mortality in patients with SOS compared to the rest of England without increasing admissions. While correlation cannot be proven as a certainty in a complex health system, the timing of the reduction aligns with the point at which most organisations had adopted NEWS and were communicating it consistently and effectively.

Comparison with existing literature

To the authors' knowledge, this is the first published study where a standardised EWS has been used across a healthcare system to improve outcomes.²⁴ National data from 2017 shows that the WEAHSN was one of only two regions where all acute trusts

were using NEWS; therefore, standardising a whole region to one EWS score in 2015 was uncommon in England.³⁶

Qualitative evaluation of healthcare professionals across all settings demonstrated that NEWS supported decision making, prioritisation of care, and improved communication across clinical settings and professional roles;³⁷ however, it raised concern that use of NEWS might conflict with clinical acumen. But in practice, patients with conditions that require time-critical treatment, such as myocardial infarction and stroke, were referred as usual according to defined pathways, and recommendations for referral did not replace clinical acumen for patients where admission was deemed inappropriate. There was also a perception that there might be a significant number of people in the community living with NEWS of ≥ 5 , which could increase admissions. This appears to be unfounded as SOS admissions in the West of England have not increased compared to the rest of England. This is because <20% of patients reached the referral threshold of NEWS of ≥ 5 ,³⁵ and also because NEWS was not the deciding factor for admission, it was merely an adjunct.

The West of England had a greater than average LOS for patients with SOS prior to this project. LOS has reduced and is now in line with the rest of England. While it is not possible to attribute a cause to this, it is expected that earlier recognition and treatment of sepsis could lead to a reduction in LOS. There has been no change in volume of ITU admissions.

Strengths and limitations

The limitations of the present study are that although mortality of patients with SOS has reduced in the WEAHSN footprint, locally and nationally there has been a lot of focus on recognition of sepsis, so not all improvement in outcomes can be attributed to the use of NEWS across the system. The West of England had a lower mortality than the rest of England before the beginning of the project. Despite national sepsis initiatives, such as the Sepsis CQUIN and the Sepsis 6,^{26,27} SOS mortality in the other regions in England is showing natural variation but no reduction, suggesting that something additional must have happened in the West of England. To the authors' knowledge, no novel treatments for sepsis have been implemented in this region that might have affected outcomes. Although two hospitals converted to NEWS, the authors do not think that this has significantly contributed to the mortality reduction as all hospitals showed a similar

From North Bristol NHS Foundation Trust: Seema Srivastava (Associate Medical Director), Lorraine Motuel (Patient Safety and Quality Lead), Kitt Waring (Lead Sepsis Nurse), Vardeep Deogan (Quality Improvement Practitioner), Nigel Lane (Acute Medicine Consultant), George Duffield (Clinical Matron, Medicine), and Alan Howe (Corporate programme, Clinical and Quality Education Manager). From North Somerset Community Partnership: Pauline Angell (Community Matron, Urgent Care) and Sofia Salim (Practice Education Facilitator). From Royal United Hospitals Bath NHS Foundation Trust: Lesley Jordan (Consultant Anaesthetist and Patient Safety Lead), Anne Plaskitt (Senior Nurse Quality Improvement), Rosie Corbett (Clinical Care Outreach Lead), and Lisa Morris (Quality Improvement Assistant). From South West Ambulance Service NHS Foundation Trust: Adrian South (Clinical Director), Sally Arnold-Jones (Senior Clinical Lead), David Partlow (Consultant Paramedic), and Joanna Garrett (Clinical Development Officer). From University Hospitals Bristol NHS Foundation Trust: Emma Redfern (Associate Clinical Director/Consultant), Anne Reader (Head of Quality, Patient Safety), Jeremy Bewley (Consultant in Intensive Care), and Caroline Horrobin (Patient Safety Audit and QI Nurse). From Weston Area Health NHS Foundation Trust: Natasha Goswell (Deputy Director Quality and Safety), James Merrell (Lead Nurse Deteriorating Patient and Sepsis), Claire Davies (Resuscitation Officer), Clare Grimes (Senior Sister), and Kate Rimmer (Senior Sister). From the WEAHSN: Ellie Wetz (Programme Manager), Kevin Hunter (Head of Patient Safety and Programme Delivery), and Nathalie Delaney (Programme Manager).

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reduction in mortality, suggesting that the pre-hospital intervention was more likely to be the reason.

The strength of the present study was that it was a system-wide project covering 2.4 million people, but it is extremely difficult to identify the exact timing of the interventions. Introducing NEWS to an organisation does not mean that it was immediately calculated or used properly. Embedding use of NEWS within each organisation took time. Key interventions were the ambulance service and GP out-of-hours service using NEWS. GPs were initially asked for a set of observations rather than NEWS, but as the system matured GPs provided a score. Not every GP is using NEWS, but data from one GP single point of access unit demonstrates NEWS on referral to be 70% by September 2017, which demonstrates the uptake by GPs.³⁷ The authors also have unpublished data from 13 000 GP referrals demonstrating that for patients transferred by ambulance, a higher NEWS was associated with faster conveyance to hospital. NEWS detects deterioration from any cause, not just sepsis. In this unpublished dataset it can also be demonstrated that NEWS calculated on referral from GPs correlates with mortality from any cause, not just sepsis. All-cause mortality at a regional level has not yet been looked at, but this could be a focus for further investigation.

Implications for practice

A system-wide implementation of NEWS has led to a reduction in mortality rates in patients with SOS. While correlation does not prove causation it is known that:

- NEWS supports clinical acumen, determines the system 'prioritisation' of a patient, and supports common language to describe 'acuity' and 'rate of deterioration';³⁸
- standardisation of acute hospitals to NEWS was rare at the time of this study³⁶ and implementation in pre-hospital care was unique;
- national initiatives, such as surviving sepsis and the Sepsis CQUIN,^{26,27} were implemented across the country and there was no other new initiative in this region other than implementation of NEWS across the system; and,
- the timing of the intervention aligns with the improvement in survival from SOS.

The WEAHSN is now a positive outlier for mortality from SOS with the lowest rate in England. This supports the recommendation that NEWS should be used in pre-hospital care for acutely unwell patients and, to the authors' knowledge, for the first time demonstrates that this leads to an improvement in outcomes.

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