NEWS2, patient safety and hypercapnic respiratory failure

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ABSTRACT

The National Early Warning Score (NEWS) has been widely adopted for use in clinical practice in the UK since its introduction in 2012. It is designed to improve patient safety. The original score was adapted in 2017 to improve patient safety further by introducing a separate score for oxygen saturation to be used in selected patients with respiratory diseases. In this article, evidence for the effectiveness of the improved score is reviewed.

Introduction

Patients with hypercapnic respiratory failure are commonly encountered by the general physician on the acute medical take. The most common cause is chronic obstructive pulmonary disease (COPD). Hypercapnia is found, in particular, in patients with previous respiratory failure or on long-term oxygen therapy. COPD is currently the second most common reason for hospital admission in the UK, resulting in more than 130,000 hospital admissions per year.[1] Other patient groups are also at risk of hypercapnic respiratory failure, in particular, those with other advanced lung diseases, severe obesity and neuromuscular disease. When oxygen treatment is used for these patients, over-oxygenation can precipitate life-threatening respiratory failure. Careful control of oxygen levels is required to avoid this complication and to improve patient safety. In spontaneously breathing patients, the safest way of ensuring that a controlled concentration of oxygen is given, to achieve a target saturation, is by using a Venturi mask.

The National Early Warning Score (NEWS), introduced in 2012, was designed to provide a structured approach to the interpretation of patients' physiological parameters.[2] The purpose of this was to improve patient safety by using the score alongside protocols that trigger increased frequency of vital signs monitoring, patient review and escalation of care. A key principle of the original NEWS scoring system was standardisation: improving safety by using a common language to communicate abnormal physiology. NEWS allocates a higher score the further physiological measurements are above or below a defined normal range. For oxygen levels, the 'normal' oxygen saturation value, which was allocated no points in NEWS, was 96%–100%. An unintended consequence of targeting this value was that it either encouraged excessive oxygen administration to the group of

patients who usually had lower oxygen saturations when well or, without the ability to reset the score to different thresholds, an elevated NEWS would persist in this group of patients. Excess oxygen administration in this context had the potential to worsen rather than improve patient safety. An updated NEWS, NEWS2, was therefore introduced to address this risk.

Understanding the background to the updated NEWS2 model, how to apply the new oxygen saturation scores and the evidence supporting its use is important for all clinical staff who supervise the care of acutely ill patients in hospital.

Oxygen therapy and hypercapnic respiratory failure

The pathophysiology of respiratory failure, particularly in COPD, is complex. This has been reviewed in detail elsewhere.[3,4] Hypercapnic respiratory failure due to oxygen toxicity is caused by a combination of ventilation-perfusion mismatch and alveolar hypoventilation. It is important to understand that the relationship between carbon dioxide levels and ventilation is not linear; once carbon dioxide levels start to rise, even small

> **Key points**
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> The National Early Warning Score 2 target oxygen saturation of 88%–92% is safer for patients with hypercapnic respiratory failure.
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> The presence of hypercapnic respiratory failure identifies a patient group with an increased risk of death.
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> All patients at risk of hypercapnic respiratory failure require blood gas analysis to identify the need for controlled oxygen therapy.
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> Use of controlled oxygen, continuous oximetry and repeat blood gas analysis will all improve safety in this group of patients.
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> An enhanced care environment, such as a respiratory support unit, should be considered for these patients.
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reductions in ventilation lead to a rapid rise in carbon dioxide levels and acidosis. Severe respiratory acidosis can lead to drowsiness, loss of consciousness and, eventually, death. This means that both aiming for oxygen saturations that are too high and the administration of uncontrolled concentrations of oxygen are particularly dangerous to at-risk patients.

Hypercapnic respiratory failure is commonly encountered in clinical practice. National audit data in the UK has shown that of 9,716 patients admitted with COPD exacerbation, 20% had respiratory acidosis at presentation.[5] More recent UK-based observational studies have shown that over-oxygenation occurs in up to three-quarters of patients on blood gas analysis.[6,7] Even in hospital patients with known hypercapnic respiratory failure and given a target saturation of 88%–92%, more than three-quarters of patients have at least one oxygen saturation recording above the target range.[8] For patients requiring acute non-invasive ventilation for acute decompensated hypercapnic respiratory failure (the most common reason being for COPD), oxygen toxicity contributes to just over a quarter of all episodes of acute hypercapnic respiratory failure.[7]

Hypercapnic respiratory failure is associated with poor outcomes. In the pre-hospital setting, using controlled oxygen to a target saturation of 88%–92% has been shown to improve mortality rates in patients with COPD, with or without hypercapnia.[9] Correct oxygen administration as part of an admission care bundle for COPD has also been shown to improve outcome (odds ratio for death 0.22; 95% confidence interval 0.05–0.88).[10]

The current British Thoracic Society guidelines for oxygen use in adults in healthcare settings were published in 2017, the same year as the updated NEWS2.[3] These state that critically ill patients should be administered high concentrations of oxygen, and blood gas analysis should be used to guide further treatment once the patient has stabilised. For those that are not critically ill, all patients at risk of hypercapnic respiratory failure should have a target saturation of 88%–92% while awaiting blood gas analysis. If the blood gas reveals normal or low carbon dioxide levels, these guidelines suggest revising the target saturation to 94%–98%.

The main risk factor for hypercapnic respiratory failure is moderate or severe COPD (in particular, those with previous respiratory failure or on long-term oxygen therapy).[3] Other at-risk groups include those with severe chest wall or spinal disease, neuromuscular disease, severe obesity, cystic fibrosis or bronchiectasis.[3] The NEWS2 protocol supports the use of the same 88%–92% target oxygen saturation range.[11] It suggests that this should only be used in those patients with confirmed hypercapnic respiratory failure. Blood gas analysis, therefore, needs to be prioritised in this group of patients. While awaiting blood gas results, it is safer to use the lower 88%–92% oxygen saturation target.

Concerns about patient safety: improving NEWS

Prior to the introduction of NEWS in 2012, a development group assessed the effectiveness of a variety of early warning scores, concluding that NEWS outperformed other scores in predicting death, unplanned critical care admission and cardiac arrest in the subsequent 24 hours.[12] After its introduction, the effectiveness of NEWS in clinical practice was demonstrated including in predicting outcomes of patients with COPD exacerbation.[13]

It was recognised from the outset that NEWS would over-score patients with chronically abnormal physiology, such as

those who normally ran low oxygen saturations and had chronic hypercapnic respiratory failure. Concerns were also raised that a high NEWS might trigger oxygen administration when this was actually inappropriate. This had the potential to cause acute decompensation of hypercapnic respiratory failure and worsen outcomes.[14]

To address this patient safety issue, the updated NEWS2, introduced in 2017, included a second scale for oxygen saturation.[11] This was intended for use only in those patients with documented hypercapnic respiratory failure. NEWS2 was introduced without the same testing of its effectiveness.[11,15] Some concerns were raised that the revised oxygen saturation score in NEWS2 would result in a lower score for the same severity of illness in patients with hypercapnic respiratory failure and, therefore, a lower likelihood of escalation.[15] However, any concerns about the potential for fewer escalations related to hypoxaemia using NEWS2 needed to be balanced against the reduced chance of hypercapnic respiratory failure in these patients when using the new, lower target oxygen saturation. The new scale also promoted best practice by triggering appropriate escalation for hypercapnic patients with inappropriately high oxygen saturations, further enhancing patient safety.

Is NEWS2 effective?

There is no specific evidence for the use of NEWS2 in respiratory diseases that cause hypercapnic respiratory failure other than COPD. The studies that have evaluated NEWS2 have looked at the ability of the score to predict outcomes. A true measure of the impact of NEWS2 on patient safety would need to evaluate the escalation process in response to a trigger score, and the outcome of any interventions. Controlling for all such variables makes such an evaluation challenging, if not impossible. As a result, studies that have evaluated the use of NEWS have looked at the ability of the score to predict outcomes, the most reliable measure, and the one that was used in the original validation studies.

When interpreting published studies, it is important to keep in mind that NEWS2 is one part of a wider system designed to improve safety. NEWS2 identifies patients at risk of deterioration or death. Patient safety is improved not just by a trigger score, but by the response to that score that might involve more frequent vital signs monitoring or a review of the patient by an appropriately skilled clinician. It is the outcome of this review that has the potential to improve outcomes. The potential of the scoring system itself to cause harm is, however, of great importance. Published studies that have explored the effectiveness of NEWS2 are discussed later.

Data from more than 50,000 patients with acute exacerbation of COPD entered into the UK national COPD audit have been analysed.[16] Using the area under the receiver operating characteristic curve (AUROC) showed that admission NEWS2 has an acceptable utility in predicting inpatient mortality (AUROC 0.72) and also the need for treatment for hypercapnic respiratory failure with non-invasive ventilation (AUROC 0.70). For each 1-point increase in NEWS2, the odds of inpatient death increased by 20%.

A further study compared NEWS, NEWS2 and another risk prediction score (DECAF) to predict mortality in 2,645 patients admitted with COPD exacerbation to six UK hospitals.[17] This study showed that NEWS and NEWS2 score on admission

delivered equivalent performance in identifying in-hospital mortality risk (NEWS2 AUROC 0.72; NEWS AUROC 0.65). The authors noted that the inclusion of new confusion as a parameter in NEWS2 also improved performance of the score. They also noted that NEWS2 resulted in a lower percentage of patients with a score of 5 or more (classified as needing urgent clinical review), without reducing the percentage of patients at risk of death. They suggested that this might result in improved patient safety by targeting urgent medical reviews more effectively to patients that needed them.

Analysis of a large database containing the vital signs measurements from 251,226 acute admissions to five hospitals attempted to compare the performance of NEWS and NEWS2 for the identification of mortality risk, cardiac arrest and unplanned intensive care admission within 24 hours of a set of observations.[8] In that study, calculation of the score for NEWS2 was incomplete as it did not include points for new onset confusion. The study, therefore, effectively compared use of the different oxygen saturation scales, rather than of NEWS and NEWS2. A combination of diagnostic coding and oxygen prescription was used to identify patients with or at risk of hypercapnic respiratory failure. Importantly, there were only 1,394 patients (0.6% of the cohort) with hypercapnic respiratory failure. There were, however, 48,898 (19.5%) patients who were considered to be at risk. This study showed that both scores performed similarly (NEWS AUROC 0.86; modified NEWS2 AUROC 0.84) in identifying patients with hypercapnic respiratory failure or risk of death. When patients not at risk of hypercapnic respiratory failure were included in the analysis, NEWS2 did not perform quite as well as NEWS in identifying patients at risk of death in the next 24 hours. This suggested that the oxygen scale of NEWS2 is appropriate for patients with documented hypercapnic respiratory failure but is less effective when applied inappropriately (to patients without hypercapnia), emphasising the importance of blood gas analysis to confirm hypercapnia in at-risk patients.

Although some criticisms were made about the last of these studies, including that it did not truly look at NEWS2, it did provide data that both quantifies the frequency of hypercapnic respiratory failure in a large dataset from several UK hospitals and confirms that both early warning scores are effective for identifying risk of deterioration and death.[18]

Finally, a review of 886 patients (of whom, 104 had hypercapnic respiratory failure) in Finland who required rapid response team assessment concluded that the use of the new oxygen saturation scale for patients with confirmed hypercapnic respiratory failure did not improve discriminatory ability of NEWS for immediate outcomes: intensive care transfer or limitation of treatment (AUROC 0.73) or hospital outcome (death, limitation of treatment or poor neurological outcome; AUROC 0.68).[19]

Evidence published since NEWS2 was introduced has, therefore, confirmed its effectiveness in recognising patients with hypercapnic respiratory failure at risk of deterioration.

The question posed by reviews so far has been whether NEWS2 provides greater discriminatory value than NEWS in order to justify the change to a new score. This is the wrong question and misses the point that NEWS2 was introduced to improve patient safety. The new score can be justified if NEWS2 is equivalent to the original NEWS. The added value comes from reducing harm to vulnerable patients with respiratory disease. The challenge now is to find a measure of that harm reduction.

Patient safety beyond NEWS2

As outlined earlier, the presence of hypercapnic respiratory failure identifies a group of patients for whom there is a significant risk of a poor outcome. Non-invasive ventilation support may be required if blood gas analysis shows acute decompensation, and reliable achievement of target saturation using controlled oxygen is often challenging.

Once these patients have been identified, safe care requires close monitoring of oxygen saturation, access to repeat blood gas analysis and may require escalation to non-invasive support and/or escalation to critical care if clinically appropriate. The models of care proposed in the recently published guidance on development and implementation of respiratory support units help to describe how care can best be provided for these patients.[20] This environment associated with enhanced staffing levels and escalation protocols has the potential to improve patient safety further when combined with routine use of NEWS2.

Summary

NEWS2 is one part of a system designed to improve patient safety. An individual's NEWS2 can help to identify patients at risk of deterioration. The separate oxygen saturation scale for patients with hypercapnic respiratory failure was introduced to address the potential of the original scale to drive inappropriate oxygen administration. Treatment with controlled oxygen to a target saturation of 88%–92% follows published guidelines and improves the safe care of patients with respiratory disease while a full patient assessment, including blood gas analysis, is carried out. Current evidence suggests that combining safe oxygen administration with the ability of NEWS2 to identify patients at risk is likely to contribute to improved outcomes. This needs to be combined with other aspects of care that have the potential to improve outcomes. For patients with hypercapnic respiratory failure, this includes the use of the enhanced care environment of a respiratory support unit to provide access to appropriate monitoring, clinical decision making and respiratory support. ■

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