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Acute monitoring of patients with chronic respiratory disease during hospital admission

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The traditional bedside monitoring of temperature, pulse rate and respiratory rate (TPR) chart was established during the 19th century. The measurement of blood pressure (BP) was added in the early 20th century and pulse oximetry monitoring as the fifth vital sign in the 1980s and 1990s.[1] This led to a temporary decline in the documentation of respiratory rate in the early 21st century, although it has been shown to be more valuable than heart rate or BP in distinguishing between stable patients and those at risk of cardiac arrest and admission to the intensive care unit (ICU).[2,3]

Observation rounds were traditionally undertaken by qualified nurses, but are increasingly delegated to more junior healthcare assistants. In the past, the doctor's attendance would be requested if the bedside nurse expressed concerns about the TPR measurements or the patient's general clinical condition. This led to a highly subjective system of medical call-outs, the mainstay of in-hospital clinical monitoring and management of acute medical and surgical patients outside of critical care until the introduction of physiological 'track and trigger' systems in the late 1990s.[4]

These systems, such as the standardised early warning score (EWS) or modified EWS (mEWS) have become a standard assessment tool in UK hospitals and internationally. The National Institute for Health and Clinical Excellence recommends that systems of this nature should be used to monitor all adult patients in acute hospital settings to facilitate the recognition of patient deterioration and a need for timely escalation of care.[5]

Reliability and clinical effectiveness of mEWS systems

There is strong evidence that mEWS systems can detect deterioration in the clinical status of patients.[3–9] However, there is limited published evidence that these systems affect clinical outcomes such as cardiac arrest rate, admissions to ICUs and mortality, in part because it is difficult to undertake randomised controlled clinical trials (RCTs) in this area of clinical practice. A recent Cochrane review found either no evidence of the effectiveness of EWS systems combined with outreach teams or a reduction in overall mortality.[10] This was based on data from a negative outcome cluster-randomised study in 23 Australian hospitals incorporating a track and trigger system and a medical emergency team,[11] and a smaller controlled UK trial which reported reduced in-hospital mortality (adjusted odds ratio 0.52, 95% CI 0.32–0.85).[12]

The difficulty in demonstrating benefits in prospective controlled studies could reflect lack of effectiveness in everyday clinical settings, but could also be due to:

- inherent difficulties in trial design in this area
- the heterogeneous nature of the EWS systems in different hospitals, and/or
- the differences in level of training and expertise amongst those responding to alert calls.

The heterogeneity amongst EWS systems has been addressed recently with the development of a new system called ViEWS. This was found to be superior to 33 other track and trigger systems in predicting mortality within 24 hours.[13] It is anticipated that the increased use of new mEWS systems will lead to more appropriate call-outs and fewer false alarms.

Clinical effectiveness of a critical care outreach team

Although many hospitals introduced a critical care outreach team, either a medical emergency team (MET) or a rapid response team (RRT) at the same time as the introduction of mEWS systems, these two approaches should be considered separately. It is self-evident that the introduction of either an inefficient mEWS system or an efficient mEWS system and MET or RRT without adequate staff training could lead to ineffective use of scarce senior medical expertise without improving outcomes. This may reflect the less than positive conclusions of the Cochrane review which analysed MET and EWS systems as a unified concept.[10] A systematic review and meta-analysis of RRTs by Chan and colleagues found a 34% reduction in cardiopulmonary arrests outside the ICU, but no associated reduction in hospital mortality.[14] They concluded that robust evidence to support the effectiveness of RRTs was lacking. Subsequently, Shah *et al* showed no difference in the number of cardiac and/or respiratory arrests during over 70,000 patient days of observation in a large academic centre in a period of 27 months after implementation of an RRT system.[15]

An additional problem, which must be acknowledged in the light of the current financial constraints affecting all healthcare organisations, is the inappropriate medical call-outs and clinical reviews that occur with the introduction of a MET or RRT. In a cluster RCT by Hillman *et al* investigating the effect of the MET service, there was no difference between the intervention and control groups in the composite primary outcome of cardiac arrest, unexpected death or ICU admission (5.9 *v* 5.3 per 1,000 admissions), but the medical call-out incidence for MET increased from 3.1 to 8.7 per 1,000 admissions (p=0.0001).[11]

Clinicians are aware of this issue in the UK: the critical care outreach teams frequently receive medical call-outs for patients with high scoring mEWS arising as a consequence of easily identifiable causes, such as atrial fibrillation with an

uncontrolled ventricular rate, which should be easily dealt with by the attending ward medical team.

There is a significant risk that our junior doctors in emergency medicine and general internal medicine working in the emergency room, acute admissions unit and general wards will be excluded from important educational experiences that are a central component of core medical training and acute care common stem training. This will result in clinicians less competent to manage common medical emergencies. Patient care and medical education would be best served by training doctors in these specialties in the combined use of EWS systems and management of the common causes of elevated EWS scores. This would include instruction as to the most appropriate time to call the critical care outreach team.

Practical difficulties for patients with chronic respiratory disease

Patients with chronic respiratory disease, such as chronic obstruction pulmonary disease (COPD) and interstitial lung disease, not infrequently have an elevated resting baseline respiratory rate and heart rate, with further rises during acute exacerbations of the disease. This adds a specific complexity to interpretation of mEWS which are based on absolute values rather than proportional changes from baseline. Although scores could be adjusted to accommodate for baseline abnormality, there are no published data to guide any adjustments in the mEWS parameters. In clinical practice, nurses and doctors providing acute care should adjust either the criteria for a patient's baseline score or the threshold for triggering a medical call-out.

An audit of 199 admissions to the respiratory and cardiology wards at the university hospital where the authors work was carried out soon after the introduction of mEWS. It was found that 61% of patients with COPD and 78% of patients with pneumonia had scores of 3 or above (the predetermined trigger threshold for medical call-out) at some time during their hospital admission, but a medical call-out was requested in only 38% of instances. Most of these patients had chronic respiratory disease with a baseline mEWS of 2 or more. All the patients with a mEWS of 3 or above who did not receive a medical call-out request did not experience any adverse outcomes, suggesting that the nurses used appropriate discretion in these cases. This audit included a survey of 15 junior doctors and 37 junior and senior nurses. Both groups reported favourably on their experience of the new mEWS, which was preferred to the previous system, although the junior doctors recognised that it generated some unnecessary medical call-out requests. This new system builds and extends the clinical expertise of the nurses and junior doctors.

Addition of oxygen saturation measurements to mEWS systems in patients with chronic respiratory disease

The recently developed ViEWS system[13] allocates three EWS points to patients requiring supplementary oxygen, with additional points if the oxygen saturation (SpO_2) measurement falls below 96% (one point), 94% (two points) or 92% (three points). This is reasonable for patients with many disease states such as pneumonia, but it would subject COPD patients to potential risk as an SpO_2 above the target range of 88–92% is associated with increased risk of death in COPD.[16,17] For this reason, it will be necessary to modify the scoring system to protect vulnerable COPD patients and other patients with long-term conditions at risk of hypercapnic respiratory failure.[16]

Future direction

There is recent evidence that stroke patients, critically ill patients and survivors of cardiac arrest may be harmed by hyperoxaemia.[18–20] For this reason, it will be necessary to adjust the track and trigger scoring systems to ensure that staff are alerted to the risks of hyperoxaemia as well as of hypoxaemia. Systems are being trialled in which patients are allocated three EWS points if the SpO_2 is above or below the predefined target

Key points

Modified early warning scoring systems (mEWS) have been shown to identify critical illness at an early stage. This allows early intervention prior to the onset of significant clinical deterioration, but there is limited controlled trial evidence that this reduces hospital mortality

Patients with chronic respiratory illness can have elevated background mEWS scores due to high resting respiratory rate and pulse rate as a consequence of advanced respiratory disease and use of inhaled beta-2 agonist therapies. Further increases are observed during acute illness. The clinician must be able to fully interpret abnormal scores in these patients and respond appropriately

The addition of a score for oxygen saturation (SpO_2) may be of considerable clinical value, but uncontrolled oxygen therapy without targeted SpO_2 can pose a significant risk to patients with chronic respiratory disease, in particular, those with acute-on-chronic respiratory failure

The introduction of a mEWS system, as part of a package of care for acutely unwell patients, has shown benefit with reduced rates of cardiac arrest and lower standardised hospital mortality in single centre cohorts but not in multicentre randomised controlled trials

The addition of separate stand-alone mEWS could result in deskilling of front-line medical staff

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range for their medical condition, as defined by the recent British Thoracic Society guideline[16] on the emergency use of oxygen:

- 88–92% if there is a risk of hypercapnic respiratory failure
- 94–98% if there is no history of chronic respiratory disease.

It will be important to identify the most effective method of managing the clinical response to elevated EWS, but the precise clinical usefulness of METs and RRTs have yet to be proven. Furthermore, a standard consensus is required in order to adjust cardiorespiratory parameters for patients with significantly elevated baseline scores.

The key to enhancing care and safety for hospital patients will be the education and training of medical and nursing staff, combined with an agreed hospital-wide alerting and response system within an integrated and structured system for the care of acutely unwell patients. Recent data suggest that an approach of up-skilling the ward staff rather than the introduction of an RRT may result in a fall in both the cardiac arrest and hospital standardised mortality rates (PM Turkington, P Murphy; personal communication), This may be more effective than the development of critical care response teams which may compromise the experience and training of junior doctors in other areas of the hospital.

Finally, advanced respiratory monitoring systems that measure neural respiratory drive non-invasively have been shown in pilot studies to predict clinical deterioration and readmission in patients with chronic respiratory disease. These may be clinically useful in the future as an automated strategy to monitor patients during acute illness.[21]

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