Clinical Practice
Review
Respiratory

In this article...
● Developing technology to continously monitor respiratory rate
● Case study of how this development could inform care

Respiratory rate 6: the benefits of continuous monitoring

Key points

Abnormal respiratory rate (RR) is the single strongest predictor for a severe adverse event, yet it is the most neglected vital sign

The continuous monitoring of vital signs on general wards has resulted in earlier identification of deterioration and a decreased need for patient rescue

Continuous RR monitoring has the potential to improve detection of deterioration, but technological limitations have held back its adoption on acute wards

The latest devices allow nurses to continuously monitor RR in patients on acute wards and identify trends that might be missed by intermittent monitoring

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Abstract Changes in respiratory rate often occur in advance of other vital sign changes, such as heart rate or blood pressure. Recent technological advances in sensor technology can empower nurses to continuously and accurately monitor the respiratory rate of patients on acute wards and could lead to earlier detection and intervention compared with current care.

There is an ever-changing case mix on general wards with increasing numbers of older, comorbid and acutely ill patients needing more complex care and procedures. This requires a more proactive and standardised approach to the early detection of patient deterioration and monitoring of vital signs (Prgomet et al, 2016). Poor monitoring is still a concern and, of the six vital signs, respiratory rate (RR) has been shown to be the most neglected in clinical practice (Elliott, 2016). Lack of automation has been cited as one possible reason why nurses do not always prioritise RR monitoring (Elliott, 2016).

Continuous monitoring of vital signs has been recognised by clinicians as a way of identifying trends that might otherwise be missed by intermittent monitoring: a patient's condition can markedly change between routine sets of observations and these 'gaps' pose a potential to miss signs of deterioration (Prgomet, 2016). While the time constraints may not allow more frequent manual observation, automated devices can continuously monitor vital signs.

Two studies assessing the impact of continuous monitoring of vital signs in general wards showed the use of this technology was associated with earlier identification of deterioration, increased rapid response activation and a decreased need for patient rescue (Brown et al, 2014; Taenzer et al, 2010). Similar benefits have also been associated with intermittent monitoring strategies, such as early warning scoring systems, but this relies on accurate and timely monitoring (Prgomet, 2016). The interpretation of continuous monitoring data still requires expert nurses and clinicians to inform patient care.

Technological limitations have held back the adoption of continuous RR monitoring on acute wards. However, recent advances in sensor technology have led to devices that are non-invasive, wireless and motion-tolerant, and deliver high-quality measurement (Subbe, 2018; Lee, 2015). These devices can potentially allow clinicians to detect the earliest signs of patient deterioration and develop more accurate early warning scores to improve clinical outcomes.

For example, Danish researchers at South West Hospital, Jutland are investigating continuous RR monitoring of patients with suspected sepsis and looking at whether RR can indicate deterioration earlier compared with other vital signs, particularly oxygen saturation (SpO_2). During early stages of deterioration,

Box 1. **Case study**

Admission

Jean Everitt*, aged 73, was admitted to an acute medical admission unit at 11am with a pyrexia. She had a history of hypertension, hypercholesterolemia, atrial fibrillation and transient ischaemic attacks, and had been taking oral penicillin for a skin infection for the past two days. Doctors prescribed intravenous broad-spectrum antibiotics; blood tests confirmed highly elevated C-reactive protein and white cell count indicating infection and dehydration. Staff measured vital signs on arrival, then at 3pm and 9pm, and 6am the next morning. Ms Everitt was given intravenous fluid for dehydration, administered from arrival until 7am the next day.

Day 2

At 6am, Ms Everitt's RR was manually counted and it was normal (16bpm) but she had a low SpO_2 (89%), so an arterial blood gas test was ordered. She quickly deteriorated and her SpO_2 decreased to 81%. Oxygen therapy restored normal oxygen saturations. Pulmonary oedema was diagnosed and treated and her condition was stabilised, but she required high-flow oxygen (>10/L/min).

Day 3

At 4am Ms Everitt deteriorated again. Prior to deterioration, her vital signs were acceptable, although her respiratory rate was elevated (Fig 1). At deterioration, her respiratory rate peaked and SpO_2 fell. Again, acute pulmonary oedema was suspected and she was stabilised after receiving oxygen therapy and appropriate drug treatment.

Continuous monitoring

Ms Everitt had been enrolled in a study to see whether continuous monitoring of RR could help clinicians predict and identify patients' deterioration earlier than usual care. This involved wearing a RespiraSense device, which constantly monitors respiratory rate and calculates a mean every 15 minutes. Data was available retrospectively and did not inform care. Before each deterioration, continuous monitoring showed an upward trend in RR, at six and 12 hours respectively. Manual counting identified a rise before the second incident, but in the first incident deterioration was only noticed when the patient had overt clinical evidence of severe dyspnoea.

Had the study data been available to clinicians, they could have used it to predict or identify the patient's clinical deterioration sooner, allowing for more timely assessment and intervention.

*The patient's name has been changed
The manufacturer of RespiraSense (PMD), has been awarded a fellowship by NHS Innovation Accelerator to accelerate the adoption of this innovation in the NHS.

patients' SpO_2 may appear normal, while RR increases in response to inadequate gaseous exchange. Patients with sepsis can deteriorate precipitously once SpO_2 breaches the current 90% thresholds for intervention. Continuous monitoring of changes in RR could allow earlier detection and intervention than current care standards, potentially reducing complications, such as organ failure and need for transfer to an intensive care unit.

In a case study from this research, continuous monitoring identified an upward trend in RR 6-12 hours before deterioration in a patient with pulmonary oedema (Box 1). This helps build a case for the value of continuous monitoring, which intuitively will reduce the risk of missing the 'golden period' for intervention.
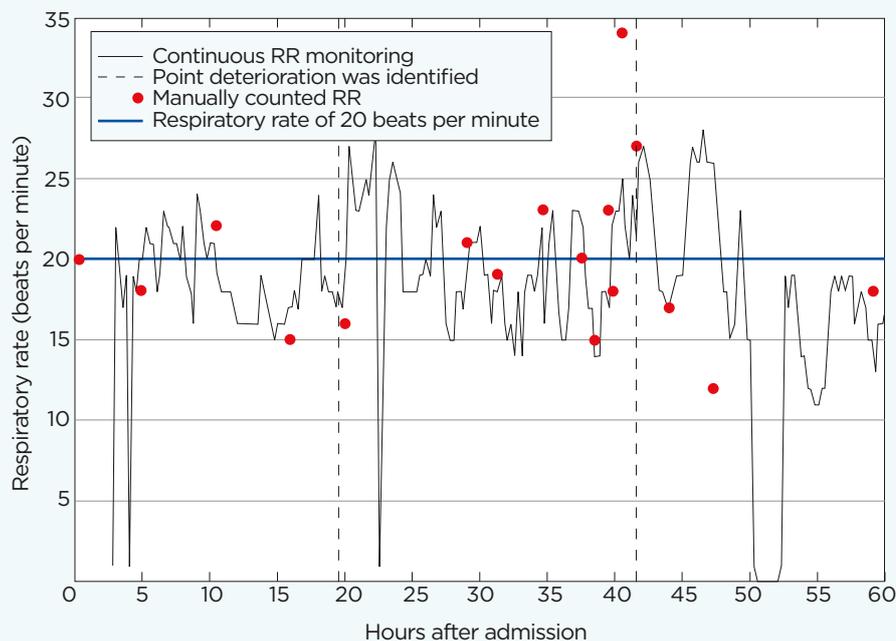
Conclusion

Continuous monitoring of vital signs offers a more proactive approach to early detection of patient deterioration. Advances in sensor technology mean there are now devices to support nurses in continuous RR monitoring of general ward patients at high risk of adverse events. **NT**

References

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Fig 1. **Continuous RR monitoring and manually counted RR**

- Continuous RR monitoring
- Point deterioration was identified
- Manually counted RR
- Respiratory rate of 20 beats per minute

(Y-axis: Respiratory rate (beats per minute); X-axis: Hours after admission)