Clinical Practice
Review
Respiratory

In this article...
● A case study of a patient with community-acquired pneumonia and sepsis
● How respiratory assessment helps to detect early signs of patient deterioration
● The importance of monitoring trends in vital signs

Respiratory rate 5: using this vital sign to detect deterioration

Key points

Respiratory rate is a vital sign and should be monitored regularly

It is uncommon for significant changes to occur in a single physiological parameter

It is important to assess multiple parameters and monitor trends

A respiratory rate of 21-24 breaths per minute is an early clinical sign of deterioration (amber on NEWS2)

Those with a respiratory rate of 25 or more are at high risk of deterioration (red on NEWS2)

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Abstract This article is the fifth in a six-part series highlighting the importance of respiratory rate (RR) assessment. It uses a case study to build on the information in the previous parts, demonstrating the links between the anatomy and physiology of respiration and changes in RR, rhythm and chest movement in an acute illness.

The respiratory system adapts readily to demands placed on it and early identification of changes in observations can facilitate early treatment. It is uncommon for a significant disturbance to occur in isolation in a single physiological parameter, so it is important to assess multiple parameters and monitor trends (Royal College of Physicians, 2017). The National Early Warning Score 2 (NEWS2) uses six physiological parameters: respiratory rate, oxygen saturations, systolic blood pressure, pulse rate, level of consciousness (AVPU – alert, voice, pain, unconscious) and temperature (RCP, 2017). A case study highlights why respiratory rate (RR) measurement is a primary indicator of patient deterioration and a fundamental part of the NEWS2 system (RCP, 2017).

Patient case study
Ernest Carbury is 80 years old and presented in primary care with a five-day history of a productive cough, dyspnoea (shortness of breath), tachypnoea (rapid breathing) with some chest discomfort on deep breathing and fever. He has a past medical history of hypertension treated with antihypertensives, arthritis and is an ex-smoker. He lives with his wife in a bungalow and has had no recent travel abroad.

Mr Carbury's signs and symptoms suggested that he had community-acquired pneumonia (CAP). The definition of CAP varies in the literature but includes signs and symptoms related to the respiratory tract and the patient's general health (British Thoracic Society, 2009). The very young and older people are more susceptible to CAP and the average length of stay in hospital is six days with mortality at 30 days being approximately 18% (Lim and Woodhead, 2011).

The CRB65 tool can help primary care clinicians determine whether a patient with CAP should be treated in the community or referred to hospital (National Institute for Health and Care Excellence, 2016a) (Box 1).

Baseline vital signs
Mr Carbury's baseline vital signs were recorded as part of a holistic assessment; his RR was at the upper end of normal – 20 breaths per minute (bpm) measured over a full 60 seconds, the depth of his breaths was shallow and the rhythm was regular, and his oxygen saturation (SpO2) was 93% (Table 1). He was sitting on a chair but leaning slightly forwards, with his hands on his knees and reported chest discomfort on the right side. However, his chest movement appeared symmetrical and there was no paradoxical movement observed: in normal breathing

the chest and abdomen should move in the same direction, while paradoxical breathing occurs when the chest and abdomen move in opposite directions (see part 4).

It is difficult to distinguish pneumonia from other chest infections without a chest X-ray, however a simple C-reactive protein (CRP) blood test – which detects inflammation in the body – can be carried out in a GP surgery and can help with diagnosis and treatment.

Assessment after four hours
After four hours, Mr Carbury's vital signs (Table 1) showed an increase in RR to 28bpm; although the rhythm was regular, the depth of chest movement remained shallow. The increase in RR and heart rate was largely due to metabolic demand for oxygen delivery and removal of lactic acid (a by-product of anaerobic cellular respiration). Anaerobic respiration occurs when there is an inadequate oxygen supply to the tissues. Mr Carbury's SpO_2 had decreased to 91% on room air, indicating that insufficient oxygen was diffusing into the blood due to inflammation, fluid and/or pus in one lobe of the right lung.

Mr Carbury's chest movement was asymmetrical, with reduced movement on the right side of the chest and he answered questions in short sentences. He was using his accessory muscles to help relieve his

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Box 1. The CRB65 tool

One point is awarded for each of the following:
- **C**onfusion – recent
- **R**R ≥30bpm
- **B**lood pressure – systolic ≤90mmHg or diastolic ≤60mmHg
- **65** years of age or older

Scores
- **0:** Treat in the community
- **1:** May require hospital
- **2:** Refer to hospital
- **≥3:** Urgent referral to hospital

Source: NICE (2016a)

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respiratory muscles and increase inspiratory capacity. These changes in vital signs indicated that Mr Carbury met the high-risk criteria (NEWS2 score 8) for deterioration and suspected sepsis (NICE, 2016b). The treatment options included antibiotics and oxygen to maintain SpO_2 >92% as well as admission to hospital (NICE, 2016b).

Sepsis is an overreaction by the body's immune system in response to infection or injury (sepsistrust.org), which causes damage to its own vital organs and tissues. NICE's (2016b) risk stratification for adults with suspected sepsis identifies that patients with a RR of 21-24bpm are at

moderate risk of sepsis and those with a rate of ≥25bpm are at high risk. In addition, patients requiring oxygen (40% FiO_2 – fraction of inspired oxygen – or more) to maintain an SPO_2 >92% (or >88% in patients with known type 2 hypercapnic respiratory failure) also meet the high-risk criteria.

Admission to hospital
On arrival in hospital, Mr Carbury's vital signs were rechecked (Table 1) and he had a RR of 30bpm, which indicated that he was having to work hard to meet the metabolic demand caused by his septic state. His chest movement showed that his left side was moving more than his right. The associated reduction in SpO2 and a need for supplementary oxygen indicated hypoxaemia and impaired tissue oxygen use. A chest X-ray showed radiological shadowing at the right lower section. Mr Carbury responded to voice but with one-word answers, and was clearly fatigued. The vital signs show a marked deterioration (NEWS2 = 15). This score required an immediate response, including contacting the emergency assessment team and transfer to a higher level of care with monitoring facilities (RCP, 2017).

Conclusion
This case study illustrates how RR is an early predictor of deterioration. It remains one of the vital signs that is often poorly assessed and intermittent measurement of RR means that vital changes may be missed. **NT**

References
British Thoracic Society (2009) *Guidelines for the Management of Community-acquired Pneumonia in Adults. A Quick Reference Guide (Update).* Bit.ly/BTSCAP
Lim WS, Woodhead M (2011) British Thoracic Society adult community-acquired pneumonia audit 2009/10. *Thorax;* 66: 548-549.
National Institute for Health and Care Excellence (2016a) *Pneumonia in Adults. Quality Standard.* Nice.org.uk/QS110
National Institute for Health and Care Excellence (2016b) *Sepsis: Recognition, Diagnosis and Early Management.* Nice.org.uk/NG51
Royal College of Physicians (2017) *National Early Warning Score (NEWS) 2.* Bit.ly/NEWS2RCP

Table 1. Trend in Mr Carbury's vital signs

Observation	Normal values*	Initial assessment	After 4 hours	Admission to hospital
Respiratory rate	12-20	20	28	30
SpO$_2$	**Scale 1**** >96% **Scale 2***** 88-92% >93% on air	93% on air	91% on air	92% on 40% oxygen
Blood pressure	Systolic 111-219	140/70	130/80	98/60
Pulse rate	51-90	104	112	130
AVPU	Alert	Alert	Alert	Responding to voice
Temperature	36.1-38.0	37.8	38	38.8
NEWS2	0	3	8 (urgent or emergency response	15 (urgent or emergency response
CRB65	0	1	1	3

* Normal values taken from NEWS2 (RCP, 2017) excluding CRB65

** Use with patients who do not have hypercapnic respiratory failure

*** Use in patients with hypercapnic respiratory failure who have recommended oxygen saturation of 88–92%, for example, patients with COPD

CRB65 = confusion, respiratory rate, blood pressure, 65 years of age and older

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CLINICAL SERIES **Respiratory rate series**

Part 1: Why measurement and recording are crucial **Bit.ly/RespiratoryR1**
Part 2: Anatomy and physiology of breathing **Bit.ly/RespiratoryR2**
Part 3: How to take an accurate measurement **Bit.lyRespiratoryR3**
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Part 5: Respiratory rate and the deteriorating patient
Part 6: Technology in respiratory assessment