The Use of the PneumoWave DC Mobile as part of a COPD Respiratory Monitoring System: *In vitro* Validation

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BACKGROUND

COPD is one of the most common causes of death worldwide (1) and the World Health Organization (WHO) estimates that 64 million people have COPD worldwide (2). An acute exacerbation of COPD, marked by worsening respiratory symptoms that are often triggered by infections, environmental factors, or air pollution, can result in hospitalisation, a higher risk of mortality, and long-term deterioration of health (3). It has been observed that the respiratory rate changes before and during an exacerbation (4). Monitoring subtle changes in respiratory rate to identify early signs of clinical deterioration in COPD patients may allow timely community interventions and reduce disease burden. PneumoWave DC Mobile is a monitoring device intended to capture and store chest motion data continuously over a period of time for retrospective analysis and is registered with UKCA as a Class 1 device (5). The aim of the study was to validate the ability of the PneumoWave DC Mobile device to accurately detect a range of physiological-relevant respiratory rates in an *in vitro* adult manikin model.

MATERIALS & METHODS

A PneumoWave DC Biosensor was placed on the upper left side of an adult manikin chest, approximately 6cm down from the centre of the left collarbone (SimMan ALS, Laerdal, UK operated via Laerdal patient software). Respiratory rates ranging from 10 to 30 breaths per minute (BPM) were captured for 3 mins at each setting (n=5) and exported as a CSV file to MATLAB (version R2023a, MathWorks Inc., USA) for visualisation and analysis. Additional experiments exploring sensor(s) chest location and manikin body posture (45°, 90° or 180°) were undertaken.

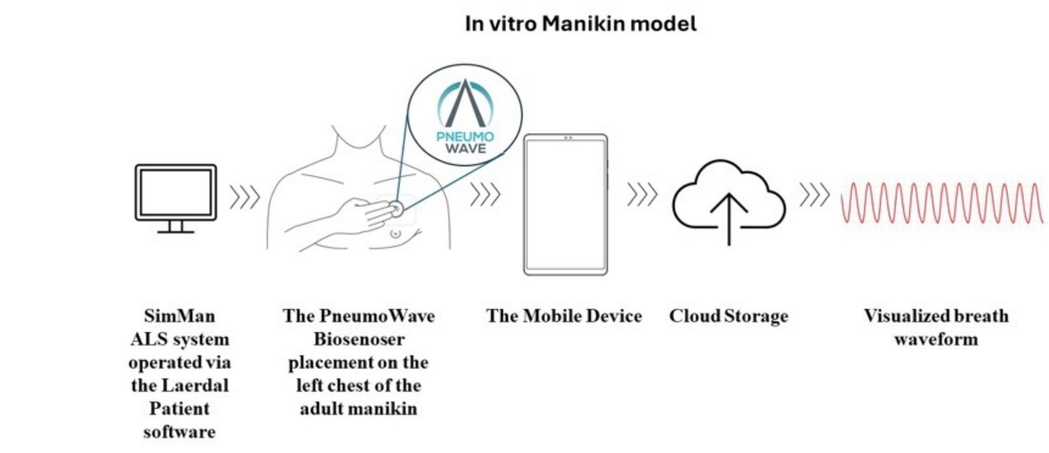


Figure 1. *In vitro* manikin model to evaluate the performance of a PneumoWave DC Mobile device.

RESULTS

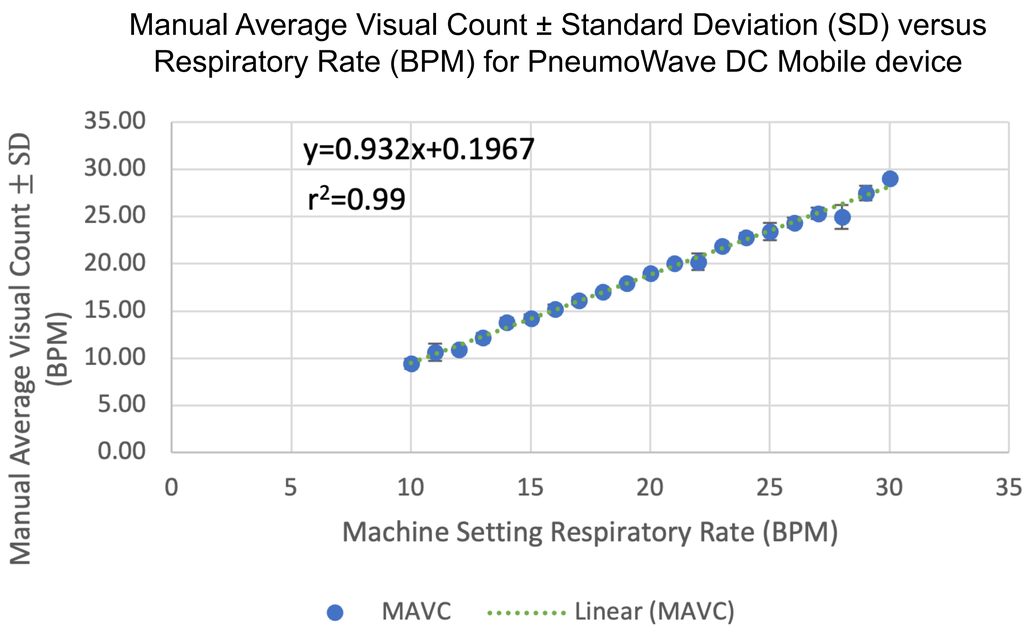
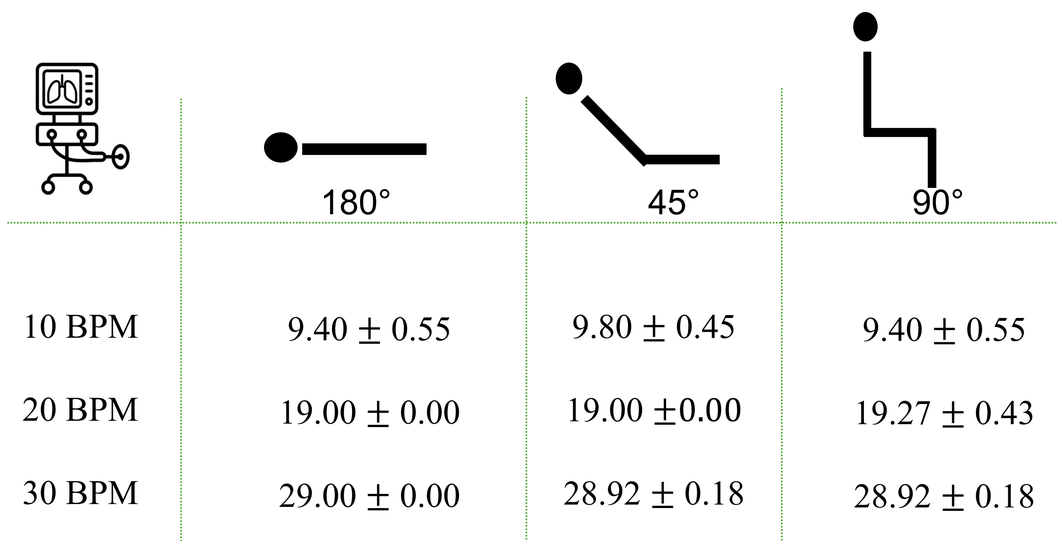


Figure 2. Manual Average Visual Count from PneumoWave DC Mobile biosensor versus ventilator respiratory rate setting (range 10 – 30BPM) with manikin posture of 180°.



	180°	45°	90°
10 BPM	9.40 ± 0.55	9.80 ± 0.45	9.40 ± 0.55
20 BPM	19.00 ± 0.00	19.00 ±0.00	19.27 ± 0.43
30 BPM	29.00 ± 0.00	28.92 ± 0.18	28.92 ± 0.18

Figure 3. Manual Average Visual Count from PneumoWave DC Mobile biosensor versus ventilator respiratory rate setting with manikin posture of 45°, 90° or 180°.

RESULTS

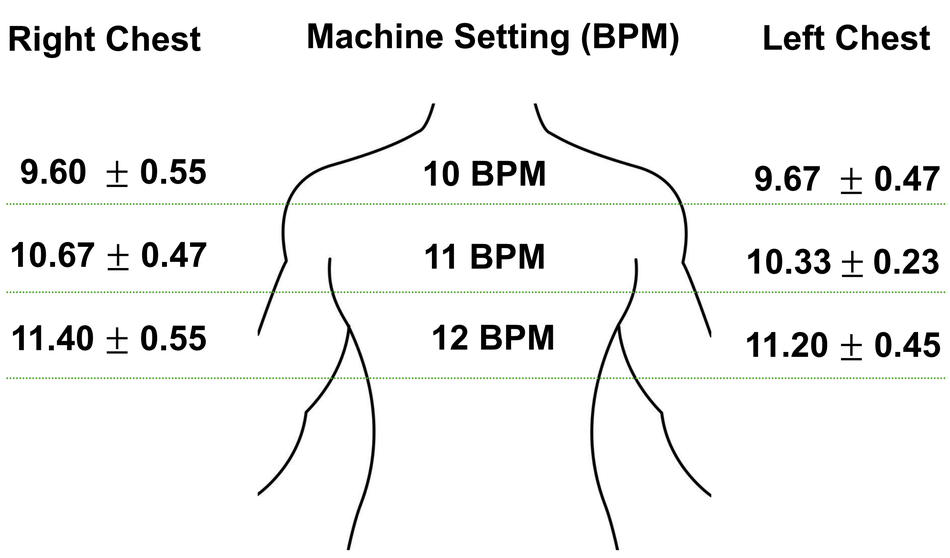


Figure 4. Manual Average Visual Count from PneumoWave DC Mobile biosensor versus ventilator respiratory rate setting for a manikin wearing two sensors on the left and right side of the chest.

CONCLUSION and FUTURE WORK

The study validate the suitability of the PneumoWave DC Mobile device for monitoring simulated chest movement in an *in vitro* manikin, with an accurate estimation of respiratory rates over a physiologically relevant range (10-30 bpm). The device exhibited commendable accuracy regardless of sensor chest location and/or the posture of the manikin. Only counting whole respiratory waves during the manual measurement process was recognised to introduce small artifacts into the results (see Figures 2 – 4). Software that allows continual measurements would have further improved the accuracy of the results. Future research will recruit human volunteers to further evaluate device performance and usability. This study positively highlights the potential of PneumoWave DC Mobile as an effective and low-cost option for COPD monitoring and to aid clinical decision-making processes.

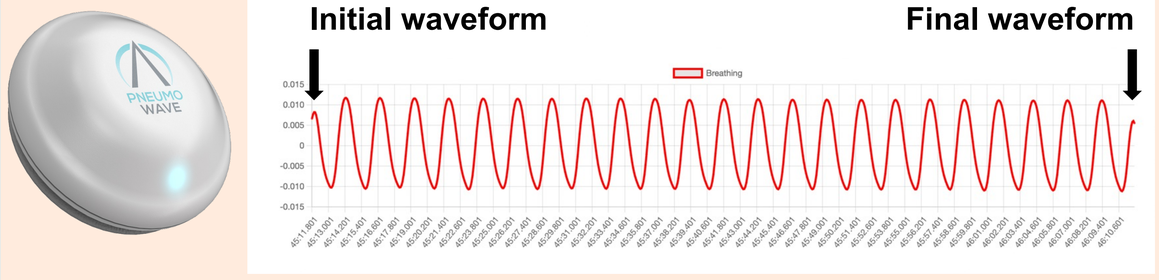


Figure 5. Typical breathing waveform captured by Pneumowave biosensor

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