mysafety insight

TrueResp™ (Mindray PPG Based Respiratory Rate Measurement)

Clinical Information Leaflet

mindray
healthcare within reach

Respiratory rate measurement is critical in clinical practice

Vital sign monitoring provides healthcare practitioners important information on how the body is functioning and alerts them to possible medical conditions, many of which present without signs or symptoms [1].

Respiratory rate (RR) is an independent predictor of mortality, intensive care unit (ICU) admission, and cardiac arrest across a variety of conditions among hospitalized adults. It is also an integral component of many risk-prediction scores, such as early warning scores (EWS) and quick sequential organ failure assessment (qSOFA) and is one of the clinical criteria for determining the stability for discharge [2,3,4,5,6].

Manual count is still prevalent, which is labour-intensive and time-consuming

The gold standard for RR measurement is to visually observe or auscultate the chest to count breaths for 1 minute, or at a minimum, for 30 seconds, and then multiply the number of observed breaths by 2 to obtain breaths per minute. Counting the number of breaths is typically performed with the aid of watches or timers. However, even with these counting aids, measuring respiratory rate through visual observation requires focused concentration and can be challenging in a patient who may be moving or breathing rapidly [7].

Inaccurate or imprecise measurements can stem from various factors, including poor visibility of the start or the end of a breath, and difficulty counting or remembering the count. While other vital signs such as blood pressure (BP) and SpO_2 are measured objectively using automated technology, a manually counted RR is potentially subject to greater imprecision and error [8].

Studies show that the manual method may result in inaccurate recording of RR

In a large, diverse, multi-centre cohort of adults hospitalized for a broad range of medical conditions, it was found that the recorded RR was not normally distributed (Figure 1), and that there was little variation in the recorded RR, even among those with cardiopulmonary compromise or immediately prior to ICU transfer [9]. The clustering of values (18 and 20 bpm) suggests that the recorded respiratory rates represent an estimated measurement (Figure 1).

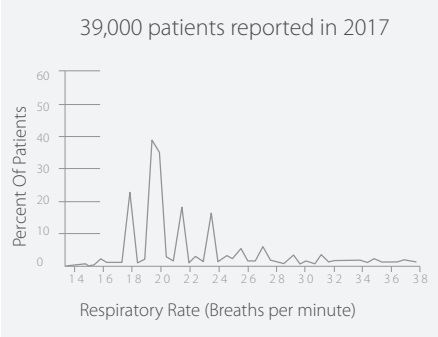

Figure 1. Distribution of maximum recorded respiratory rate on day of admission among hospitalized adults

The observed pattern suggests that respiratory rates are inaccurately recorded, which may lead to misclassification of disease severity and bias commonly used risk prediction scores such as EWS. This could potentially jeopardize patient safety, as early signs of respiratory failure may be missed due to the inaccurate measurement technique.

A simple and automatic method of measuring RR without additional resources and time

The photoplethysmography (PPG) signal for SpO_2 measurement contains components that are synchronous with respiratory and cardiac rhythms. By extracting respiratory-related components and applying a mathematical algorithm, Mindray TrueResp™ technology can calculate RR (Figure 2).

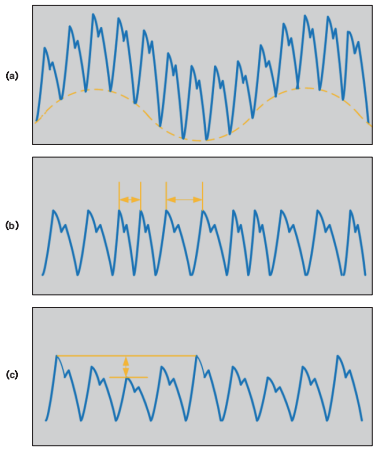

Figure 2. Signal processing is used to analyse baseline (a), frequency (b), and amplitude (c) changes to the PPG waveforms to calculate the respiratory rate

Relying on an SpO_2 sensor is simpler than the traditional manual count method. Its main clinical application is to spot check vital signs in outpatient service, ward rounds, or triage. The RR assessment could then be automatically performed concurrently while obtaining automated assessments for the remaining vital signs, without requiring any additional time or effort.

The performance of Mindray TrueResp™ has been verified by a large amount of clinical data. This clinical experiment was conducted in the emergency department of a Class A tertiary hospital in Shenzhen, involving 109 adults (58 males/51 females) ranging in age from 17 to 91 years old. The results showed that Mindray TrueResp™ could meet the clinical requirements in terms of efficiency and accuracy and were recognized by healthcare professionals.

▸ Efficiency

In clinical practice, fast value output not only saves time for medical staff, but also helps quickly analyse the physiological condition of a patient, especially when the patient has serious clinical conditions. Therefore, TrueResp™ value output duration (the time from putting on the SpO_2 sensor to generating the first reading) is one of the criteria to measure its performance. As shown in Figure 3, the results of clinical experiments showed that the fastest value output of Mindray TrueResp™ was 15 seconds and the slowest was 30 seconds, with an average time of 24.1 ± 4.6 seconds.

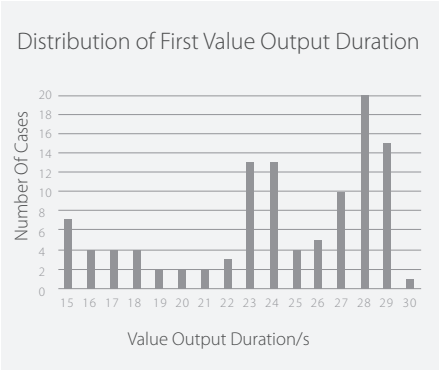

Figure 3. Distribution of the first value output duration for Mindray TrueResp™ measurement

▸ Accuracy

The accuracy of the RR measurement is also critical. In the clinical experiments, in order to test the accuracy of TrueResp™, the RR value measured by Mindray TrueResp™ was compared with the gold standard, capnography. The overall accuracy (Arms) of the respiratory rate value measured by Mindray TrueResp™ was 1.85, which met the clinical requirements. ARMS accuracy is a statistical calculation of the difference between TrueResp™ and reference measurements. Approximately two-thirds of the TrueResp™ measurements fell within ±ARMS of the reference measurements in a controlled study.

*Non-physiological and physiological factors that may affect TrueResp™ measurement and the recommended solutions

Impact Factor	Solution
Patient movement (autonomous or caused by a medical staff)	Keep the patient limb not moving during TrueResp™ measurement
Light disturbances such as sunlight, infrared warming lights, and phototherapy lights	Pay attention to possible light interference sources and ensure that the probe is properly positioned. It is recommended that the probe be shielded or wrapped with an opaque material in the presence of any strong light source
Low peripheral blood flow caused by physiological factors, such as peripheral vascular disease or low ambient temperature	Select the measured location with higher perfusion index
Tissue edema may cause light emitted from the probe to be scattered and affect the TrueResp™ measurement	Place the probe on the tissue without edema
TrueResp™ measurement may be inaccurate when the patient's pulse rate is less than three times the respiratory rate	It is recommended to use other measurements to measure respiratory rate

*Due to the limitation of its own measurement principle, the TrueResp™ technology is not applicable for neonates, detecting apnea, nor for patients with irregular breathing, arrhythmia, or motion interference.

TrueResp™ is a simple and automatic method of measuring respiration rate at the bedside, fully adapted to the nursing round or triage workflow, and clinically accurate. Relying solely on a SpO_2 sensor, it streamlines access to both oxygenation and respiration status without the need for additional resources and time.

References:

1. Rolfe, Sandy. (2019). The importance of respiratory rate monitoring. British Journal of Nursing (Mark Allen Publishing), 28(8), 504-508.

2. Fieselmann, J. F., Hendryx, M. S., Helms, C. M., & Wakefield, D. S. (1993). Respiratory rate predicts cardiopulmonary arrest for internal medicine inpatients. Journal of general internal medicine, 8(7), 354-360.

3. Seymour, C. W., Liu, V. X., Iwashyna, T. J., Brunkhorst, F. M., Rea, T. D., Scherag, A., ... & Angus, D. C. (2016). Assessment of clinical criteria for sepsis: for the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). Jama, 315(8), 762-774.

4. Fine, M. J., Auble, T. E., Yealy, D. M., Hanusa, B. H., Weissfeld, L. A., Singer, D. E., ... & Kapoor, W. N. (1997). A prediction rule to identify low-risk patients with community-acquired pneumonia. New England journal of medicine, 336(4), 243-250.

5. Escobar, G. J., LaGuardia, J. C., Turk, B. J., Ragins, A., Kipnis, P., & Draper, D. (2012). Early detection of impending physiologic deterioration among patients who are not in intensive care: development of predictive models using data from an automated electronic medical record. Journal of hospital medicine, 7(5), 388-395.

6. Morgan, R. J. M., Williams, F., & Wright, M. M. (1997). An early warning scoring system for detecting developing critical illness. Clin Intensive Care, 8(2), 100.

7. Ginsburg, Amy Sarah, Lenahan, Jennifer L, Izadnegahdar, Rasa, & Ansermino, J Mark. (2018). A Systematic Review of Tools to Measure Respiratory Rate in Order to Identify Childhood Pneumonia. American Journal of Respiratory and Critical Care Medicine, 197(9), 1116-1127.

8. Kallioinen, Noa, Hill, Andrew, Christofidis, Melany J, Horswill, Mark S, & Watson, Marcus O. (2021). Quantitative systematic review: Sources of inaccuracy in manually measured adult respiratory rate data. Journal of Advanced Nursing, 77(1), 98-124.

9. Badawy, Jack, Nguyen, Oanh Kieu, Clark, Christopher, Halm, Ethan A, & Makam, Anil N. (2017). Is everyone really breathing 20 times a minute? Assessing epidemiology and variation in recorded respiratory rate in hospitalised adults. BMJ Quality & Safety, 26(10), 832-836.

healthcare within reach

MINDRAY SOCIAL MEDIA CHANNELS

LinkedIn @Mindray

@Mindray Global

Wechat

www.mindray.com

P/N: ENG-TrueResp™ -210285X6P-20210406

mindray
healthcare within reach