

## Respiratory function monitoring in ventilated newborns

Respiratory failure is a common problem in premature newborn infants due to the immaturity. In newborns with sufficient spontaneous breathing efforts, non-invasive ventilation support is commonly used, but intubation and mechanical ventilation are often unavoidable. Although intubation and mechanical ventilation can be life-saving, these methods can be associated with long-term morbidities.

During the last few decades, many new ventilation modalities and strategies have been developed to reduce these side effects and improve patient outcome. Independent which ventilation mode is used, a careful monitoring of respiratory function during mechanical ventilation remains an essential prerequisite for lung protective ventilation. In conjunction with clinical, radiological, and blood gas monitoring it is currently an essential tool for the adjustment of ventilator parameters to achieve optimal ventilation and oxygenation and for assessment of patient status and therapeutic interventions.

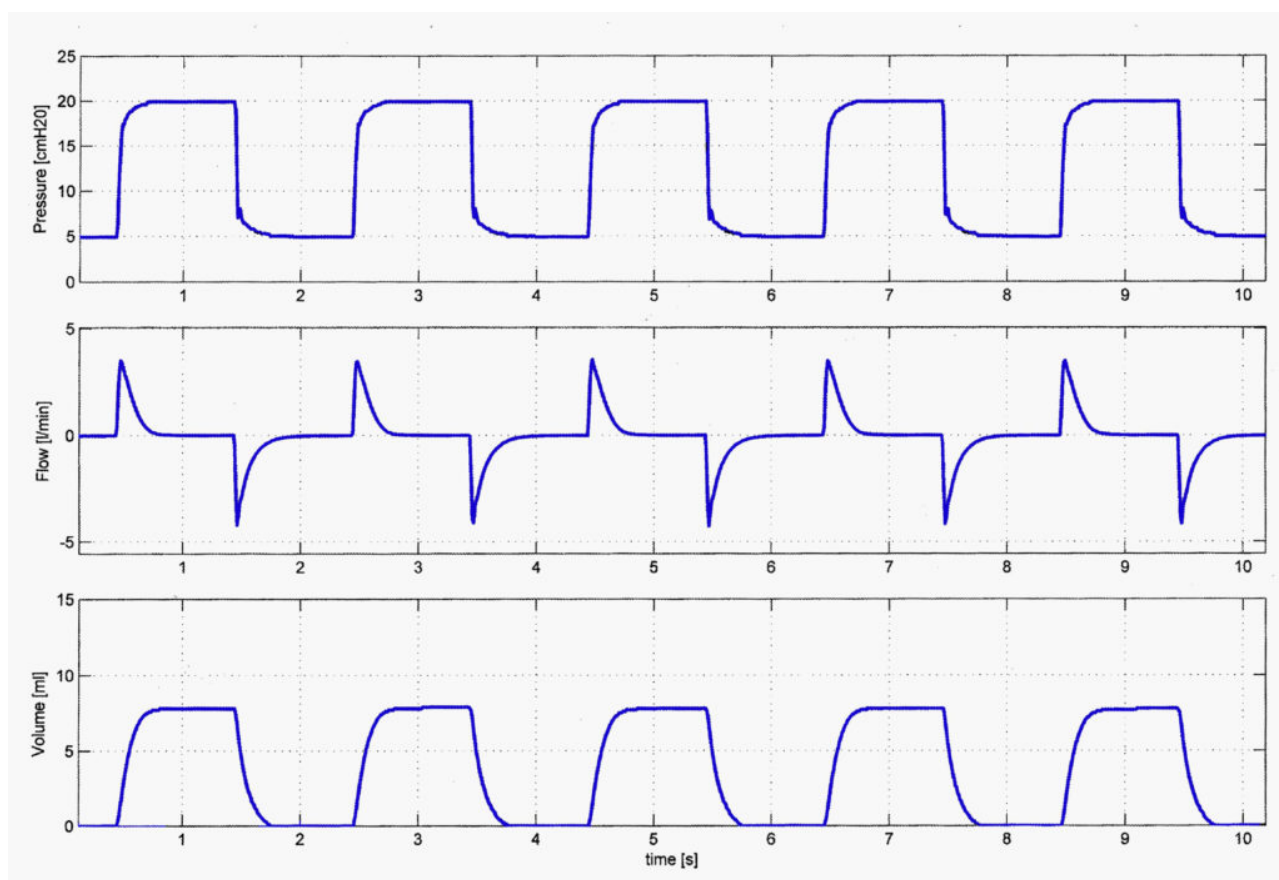


Fig. 1. The three basic parameters of respiratory function monitoring during mechanical ventilation: airway pressure (top), air flow (middle) and volume (bottom).

Respiratory function monitoring in newborns means primarily the direct on-line visualization of the three fundamental signals of the respiratory system namely driving pressure  $P(t)$ , airflow  $V'(t)$  through the endotracheal tube (ET) and the delivered volume  $V(t)$  as shown in the Figure 1. Most mechanical ventilators incorporate an airflow sensor positioned between the T-piece of the ventilator circuit and the ET. This arrangement allows the most accurate air flow measurement, however, it increases the apparatus dead space of the ventilator. This can be an important clinical problem in preterm infants with tidal volumes less than 10mL. An alternative to in-line flow measurements is dead space free differential pneumotachography, in which flow is measured in both the inspiratory and expiratory limbs of the ventilator circuit and patient airflow is represented by the difference between these flow measurements (Fig. 2). This technique, however, is not easy to perform and at present, this measuring principle is not commercially available.

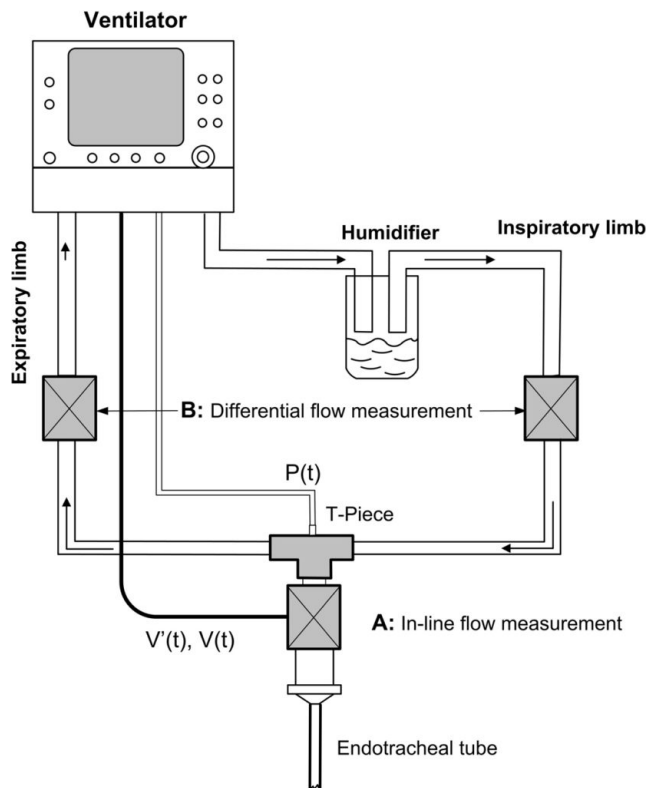


Fig. 2. Two methods of measuring ventilation during mechanical ventilation. (A) Conventional in-line flow measurement, (B) differential flow measurement, with one flow sensor each sited in the inspiratory and expiratory limbs.

The current technologies to measure airflow and driving pressure signals are standardized, sufficiently accurate and reliable. The measurement of the total lung volume and the homogeneity of the air distribution within the lungs is possible without disconnection and interruption of the

mechanical ventilation by using tracer gas wash-in and wash-out techniques. However, several technical problems are to be solved before it can be used in routine clinical practice. The clinical benefit of the continuous measurement of the exhaled carbon dioxide (capnography) during mechanical ventilation is well documented in adults and older infants; however, the high respiratory rate and low tidal volume in newborns, especially those with stiff lungs, hamper the measurement. Furthermore, capnography will not be embraced by neonatologists as long as it is not integrated in the neonatal ventilator without increase of the apparatus dead space by the gas analyzer.

From the recorded signals a lot number of clinically important parameter can be measured and calculated automatically. While the ventilatory parameters are well defined, the calculation of physiological parameters (e.g., parameter of the respiratory mechanics, lung volume und indices of the homogeneity of the alveolar ventilation or airway dead spaces) is based upon specific assumptions which are difficult to verify. It is critical that the user understand the theoretical background of these calculations to prevent possible pitfalls in data interpretation with clinical consequences. The use of faulty monitoring data for clinical decisions may increase the risks of the infants rather than improving their condition. Therefore, the aim of this review is the description of the basic principles and the underlying assumptions of current clinically used methods of respiratory function monitoring in ventilated newborns.

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## **Publication**

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