Updates on Pulmonary Function Testing in Small Animals

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KEYWORDS

• Pulmonary function testing • Spirometry • Tidal breathing flow-volume loops
• Plethysmography • Arterial blood gas • Capnography • Pulse oximetry

KEY POINTS

- Lung function tests can be divided broadly into those that measure lung mechanics and those that measure gas exchange capabilities.
- Pulmonary function tests do not identify specific diagnoses but instead are used to quantify the severity of respiratory system dysfunction.
- In some cases, these tests are used to determine the anatomic location of disease in the respiratory tract; for example, upper versus lower airway disease.
- The most widely available tool for assessment of pulmonary function is pulse oximetry; however, it provides only a crude assessment of oxygenation.

PULMONARY FUNCTION TESTING

Tests of pulmonary function are widely used in humans in respiratory medicine, sports medicine, and in occupational health. In human and veterinary medicine, pulmonary function testing is used to evaluate patients with known or suspected respiratory disease and is an invaluable tool for assessing the efficacy of therapeutic interventions and determining prognosis. It is also helpful during preanesthetic evaluation of patients and can help identify patients at greater risk for complications.

It is important to remember that pulmonary function tests (PFTs) do not identify specific diagnoses. Instead they are used to quantify the severity of respiratory system dysfunction, and in some cases to determine the anatomic location of the disease in the respiratory tract (eg, upper vs lower airway disease). Widespread use of PFTs is limited by the need for some expertise and specialized equipment to accurately perform and interpret these tests. The application of some PFTs used in humans to veterinary medicine is further hampered because many of these tests require patient

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cooperation and depend heavily on voluntary maneuvers. However, instruments such as blood gas analyzers and pulse oximeters are now readily available in most practices, and this type of PFT can easily be applied to small animal patients.

Tests of pulmonary function can be broadly divided into 2 major categories:

1. Tests of lung mechanics
2. Tests of pulmonary gas exchange

Tests of Lung Mechanics

Lung mechanics reflect the physical properties of the lung and evaluate the relationship between airway pressure, air flow, and lung volumes.

Spirometry

Spirometry is among the oldest and most well-known tests of pulmonary function. The spirometer measures the volume of air or rate of airflow in and out of the respiratory system (ie, volume is measured as a function of time). This method is the accepted standard for diagnosis of obstructive respiratory disease in human medicine,[1–3] and can be used to diagnose airway obstructions in veterinary patients with conditions such as laryngeal paralysis, tracheal collapse, or brachycephalic airway disease. Spirometry can also be used to evaluate ventilatory function in animals with neuromuscular disease, or after anesthesia. **Table 1** lists normal values for dogs and cats.

Spirometry can be performed using a handheld spirometer or a pneumotachograph, which is connected to an endotracheal tube in an anesthetized patient, or attached to a tight face mask fitted over the snout of an awake patient. The pneumotachograph is used to measure flow rates and duration of the various segments of a given breath, including inspiratory time, expiratory time, tidal volume, and peak inspiratory flow (PIF) and peak expiratory flow (PEF) rates.[2] Human patients undergoing spirometry are instructed to take a full inspiration and then exhale forcefully for as long as possible, thereby measuring the forced vital capacity (FVC). Achieving this in veterinary patients is challenging. Therefore, use of spirometry in veterinary medicine is largely confined to tests of spontaneous tidal volumes in anesthetized patients as a measure of neuromuscular function and respiratory drive.

Table 1
Normal reported values for respiratory parameters in dogs and cats

Parameter (Unit)	Dog	Cat
Tidal volume (mL/kg)	10–20	10–20
Minute ventilation (mL/min)	150–250	150–250
Respiratory rate (bpm)	32 ± 10	43 ± 7
Inspiratory time (ms)	920 ± 350	716.6 ± 139.5
Expiratory time (ms)	1170 ± 480	703.7 ± 133.0
Peak inspiratory flow (mL/s)	740 ± 240	110.0 ± 26.6
Peak expiratory flow (mL/s)	780 ± 230	113.7 ± 29.1
Dynamic compliance (mL/cm H_2O)	117 ± 46	19.8
Static compliance (mL/cm H_2O)	42.25 ± 32	NA
Lung resistance (cm H_2O/L/s)	0.8–4.2	28.9

Abbreviations: bpm, beats per minute; NA, not available.

Data from Rozanski EL, Hoffman AM. Pulmonary function testing in small animals. Clin Tech Small Anim Pract 1999;14(4):237–41.