# Use of capnometry to determine the aetiology of persistent pneumothorax following thoracic drain placement in two dogs

Diagnosing pneumothorax using capnometry

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Thoracic drains are commonly placed in both human and veterinary medicine to treat conditions such as pleural effusion or pneumothorax (Valtolina & Adamantos 2009), and to facilitate chest drainage post-operatively (Tattersall & Welsh 2006; Moores et al. 2007). When there is a failure to achieve intrathoracic negative pressure with a persistent pneumothorax it can be difficult to diagnose the source of the air. The air could originate from damaged lung parenchyma or result from incomplete surgical closure leading to the entrainment of air.

In this letter, we describe the use of capnometry as a diagnostic tool to differentiate between causes of persistent pneumothorax in two dogs with thoracic drains. The partial pressure of carbon dioxide ($PCO_2$) was measured in a sample of intrapleural gas. This method has previously been described for use on human patients in ICU (Oparka & Walker 2014), however it has not been described in veterinary literature.

In both dogs, gas was sampled from the thoracic drains using a 20 mL plastic syringe (BD Plastipak, BD Switzerland Sarl, Switzerland), immediately sealed with a plastic cap (Combi-Stopper, B Braun Melsungen AG, Germany) and then introduced into a sidestream capnograph unit (Datex-Ohmeda S/5, GE Healthcare, Finland) via the sampling line. This unit is a self-contained module which samples gas at 200 mL $minute^{-1}$ and is self-calibrating using room air. The negative pressure generated was

insufficient to fully overcome the resistance of the rubber plunger seal from a plastic syringe, so gentle pressure on the plunger was required to introduce the gas.

Case one was a 5-year-old castrated male Border Collie that presented for exploratory median sternotomy following a stick injury with an associated pneumomediastinum and pyothorax. The foreign body was removed, a pleural abscess debrided and the thoracic cavity lavaged. Minor focal bruising of the lung parenchyma was noted, but not deemed sufficient to justify a lung lobectomy. At the end of surgery, a leak test was performed by filling the thoracic cavity with warm sterile saline and checking for gas bubbles during manual positive pressure ventilation. It was negative. Therefore, a 12-gauge x 30 cm MILA CT1210 thoracic drain (MILA International Inc, KY, USA) was placed, and the thoracic cavity closed. Then, a 20 mL plastic syringe was connected to the thoracic drain via a 3-way tap and gas extracted from the thoracic cavity. It was not possible to generate negative pressure. We hypothesised that damage to the lung resulted in continuous leakage of intrapulmonary gas into the thoracic cavity, and tested this gas as described previously. A peak $PCO_2$ of 40 mmHg (5.3 kPa) was present on the capnograph trace. The thoracic cavity was re-opened and a leaking area of lung identified. A lung lobectomy was performed and intrathoracic negative pressure was achieved by withdrawing gas following closure of the thoracic cavity. The dog recovered quietly and uneventfully, and physiological variables remained within acceptable limits. The dog was discharged 7 days later.

In case two, a 1-year-old intact female Cocker Spaniel presented with a pyothorax and underwent a median sternotomy and left caudal lung lobectomy. Prior to surgical closure, the lungs were submerged in sterile saline and inflated to a peak inspiratory

pressure of 20 $cmH_2O$ with manual positive pressure ventilation. No air leaks were identified, so a thoracic drain was placed, and the surgical site closed. A continuous negative pressure drain (Thopaz +, Medela UK Ltd, UK) was fitted to the thoracic drain during recovery in the ICU. After disconnection to allow the dog to walk outside, the machine was reconnected, but was unable to generate negative pressure. There were no reports of trauma; however, the animal had been noted to cough. A sample of gas was taken from the thoracic drain and tested as previously described. No $PCO_2$ was detected in the sample, which was consistent with atmospheric air. Upon further investigation a faulty needle-free valve was identified which allowed atmospheric air to enter the thoracic cavity. This was replaced and negative pressure was obtained. The dog was discharged to home 5 days later.

Capnometry has previously been used in human medicine for this purpose (Oparka & Walker 2014), however these are the first reports of its use in dogs. The technique we describe cannot determine the route by which atmospheric air enters the pleural space. However, systematic replacement of thoracic drain components such as one-way valves can quickly localise faulty mechanisms. In some cases, total replacement of the thoracic drain or further surgery to confirm a sealed closure of the thoracic cavity may still be required.

If a pneumothorax of uncertain aetiology occurs following thoracic drain placement, the authors recommend sampling pleural space gas and using capnometry to help determine the origin of the gas prior to commencing invasive procedures such as further surgical intervention. Provided that the sample syringe is sealed between collection and introduction into the capnometer's sampling line (the use of a 3-way stopcock and a

glass syringe is recommended), the authors believe that this could be both a sensitive and specific method of determining the aetiology of the pneumothorax.

These cases demonstrate how capnometry can be used to help determine the cause of pneumothorax quickly and effectively, therefore potentially reducing morbidity and improving veterinary patient care.

In conclusion, capnometry may provide a simple and reliable method of differentiating pulmonary parenchymal leaks from ingress of atmospheric gas as the cause of persistent pneumothorax.

## References


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