Cornell University Veterinary Specialists

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CUVS CLINICAL BRIEF

MECHANICAL VENTILATION: When and Why

Mechanical ventilation (MV, or positive pressure ventilation) is a potentially life-saving intervention that can be used to manage a variety of disease conditions. Advanced MV is a highly specialized intervention that, performed well, requires a team with advanced training and sophisticated equipment. As such, it is offered at very few institutions and so many veterinarians are not familiar with its applications, and do not always think of it as an option in their patients. This brief is intended to provide the practitioner with an overview of the indications and potential benefits of MV in dogs and cats.

Indications

Broadly speaking, indications to consider mechanical ventilation include:

- *Hypoxemia that is not responsive to oxygen supplementation*. This refers to a sustained decrease in arterial oxygen levels due to ineffective oxygen transport from alveoli into pulmonary capillaries. Objectively, this would mean arterial oxygen concentrations (PaO_2) <60 mmHg despite oxygen supplementation. (Normal PaO_2 on room air is 80-100 mmHg.) Causes include severe primary pulmonary parenchymal disease such as pneumonia (aspiration or infectious), pulmonary edema (cardiogenic or non-cardiogenic), pulmonary thromboembolism, acute respiratory distress syndrome (ARDS), pulmonary hemorrhage, or pulmonary contusions.
- *Hypoventilation*. This refers to a decreased ability to clear CO_2 from the blood through alveolar ventilation. Hypoventilation can be caused by a wide variety of conditions including CNS depression (sedation/anesthesia, post-cardiac arrest, seizure activity, brain tumors, traumatic brain injury, intracranial bleeding), cervical spinal disease (intervertebral disc disease, spinal fracture, spinal neoplasia, FCE), chest wall disease (rib fractures/flail chest), neuromuscular disorders (myasthenia gravis, tetanus, botulism, tick paralysis), toxicities (ivermectin, 5-FU), pleural space disease (pneumothorax, pleural effusion, diaphragmatic hernia), phrenic nerve disease, or advanced pulmonary parenchymal disease. Objectively, this can be evaluated by measuring CO_2 levels in venous or arterial blood. A sustained pCO_2 (venous or arterial) > 60 mmHg is an indication for MV.
- *Increased work of breathing*. This is perhaps the most subjective assessment of patient respiratory effort that may indicate a need for MV. Respiratory fatigue is caused by excessive respiratory effort, relative to the strength and endurance of respiratory muscles (intercostals, diaphragm). Primary pulmonary disease that causes hypoxemia, or a secondary disease process causing hypoventilation may significantly increase the work of breathing, and consequently the energy requirement for respiration. Clinically, this can be manifested as sustained signs of excessive respiratory effort (nostril flaring, orthopnea, recruitment of abdominal muscles). As fatigue is impending, notably weaker chest wall excursions may be observed. Blood gas analysis may show an increasing pCO_2 (in arterial or venous blood), pointing to decreasing ventilatory efficiency and impending respiratory fatigue. If not addressed by immediate intubation and ventilation, respiratory arrest usually ensues.

Prognosis

The prognosis for a mechanically ventilated patient depends entirely on the underlying disease process. In general, animals ventilated for reasons other than pulmonary parenchymal disease will have a better prognosis for weaning from ventilation and survival to discharge, than animals with severe primary lung disease. MV is best considered relatively early in the case of severe disease, rather than delaying this intervention until the patient is unstable and the disease has progressed significantly.

Case Examples

Case 1. An 11-year old MC domestic shorthair cat was presented for evaluation of lethargy and vomiting up "coffee-grounds" vomit. An abdominal ultrasound revealed marked gastric distension with fluid and a possible duodenal foreign body. Prior to anesthetic induction for a gastrotomy, the patient vomited a massive quantity of fluid, acutely aspirated

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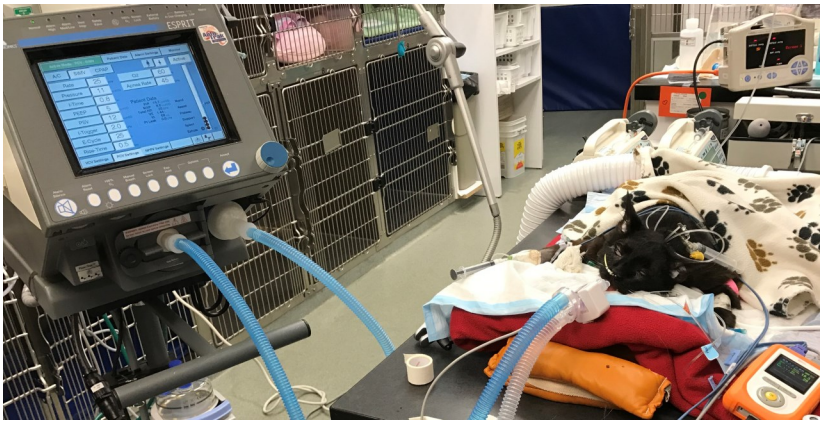
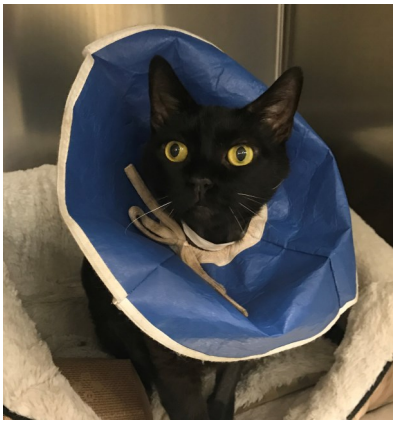
and experienced cardiopulmonary arrest. CPR was initiated and return of spontaneous circulation was achieved within 3-5 minutes. The patient arrested again shortly thereafter and was again resuscitated. A gastrotomy was performed to remove a trichobezoar from the duodenum. MV was initiated post-operatively due to concerns for severe pulmonary parenchymal disease (aspiration pneumonitis, and possible pulmonary contusions from CPR) and concern for hypoxic brain injury (following two bouts of cardiac arrest). The patient was ventilated for ~24 hours and weaned successfully. He remained mentally dull for 12-24 hours following extubation, following which his neurologic status rapidly improved. He was discharged home 48 hours after weaning from MV.



Patient on mechanical ventilation



Patient following mechanical ventilation

Case 2. A 3-month old MI French Bulldog puppy presented for evaluation of a possible esophageal foreign body after he was noted to be choking on a bone. Thoracic radiographs revealed severe bilateral alveolar infiltrates in the caudodorsal lung fields, most consistent with severe non-cardiogenic pulmonary edema. The patient was markedly hypoxemic on presentation with a PaO_2 of 55 mmHg and a $PaCO_2$ of 49.3 mmHg, with markedly increased respiratory effort (RR >80 bpm, nostril flaring, orthopnea). This patient was ventilated due to a combination of unresponsive hypoxemia and concerns for impending respiratory fatigue. After 3 days of MV, the patient's oxygenation status gradually improved and he was successfully weaned from the ventilator. He was discharged home 24 hours thereafter.

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Mechanical ventilation, while an invasive and advanced intervention, can save lives when initiated in a timely manner and in the appropriate patient. While ventilation is NOT a cure, it does enable us to sustain life such that appropriate treatment can be employed and have a chance for success. The highest rates of success occur when ventilation is instituted earlier rather than later in the course of the disease process. Early identification of these patients, and timely referral for ventilation, can potentially reverse the course of disease in many patients that would otherwise succumb.

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If you have questions about mechanical ventilation, or have a patient you think may be a candidate, please do not hesitate to call one of our critical care specialists.

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