Avian Anesthesia

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Anatomy and physiology

The high energy demands required for flight and the high aerobic rate of this activity create high demands for oxygen. For this reason, the respiratory apparatus of the bird is likely the most different from mammals. The trachea consists of complete cartilaginous rings which interdigitate. The sound-producing organ of birds is the syrinx. Unlike the mammalian larynx, birds do not have vocal cords. Instead they possess two vibrating syringeal membranes. Depending on the localization of the syrinx, this structure can be tracheal, bronchial, or the most common type: tracheobronchial.

Birds lack a diaphragm; therefore the thoracic and abdominal cavities are fused to form a single coelomic cavity or coelom. The avian lungs are located cranio-dorsally within the coelom. The primary bronchi are formed by the upper division of the trachea, usually just distal to the syrinx. Four series of secondary bronchi are named based on their anatomical location: medioventral, mediodorsal, lateroventral, and laterodorsal. Gas exchange occurs at the level of the parabronchi or tertiary bronchi, which originate from a division of the secondary bronchi. The avian lungs are approximately ten times more efficient at gas exchange or extracting oxygen when compared to mammals.

Both inhalation and exhalation are active actions, which require the assistance of respiratory muscles. In the avian respiratory cycle, inspired air passes through the trachea, passes through the lungs, and enters the air sacs. Expired air exits from the air sacs, passes again through the lungs, and is expelled from the trachea. Most birds have nine air sacs: paired cervical, cranial thoracic, caudal thoracic, and abdominal air sacs as well as a single clavicular air sac. Air sacs play no role in gas exchange. Instead they work like bellows, sucking in inspired air when expanding and eject air when they contract.

Functionally the avian lungs are divided into neopulmo and paleopulmo systems. The paleopulmo system is found in all bird species and makes up at least 75% of lung tissue. The neopulmo system, which is less efficient in gas exchange, is absent in penguins, and very reduced in Anseriformes and Psittaciformes. The neopulmo system is extremely developed in Galliformes, Columbiformes, and Passeriformes.

Injectable anesthesia

There are so few advantages to injectable anesthesia in birds. Probably, the only situation in which injectable anesthesia is the first choice, is a field setting, when a proper vaporizer is not available. Injectable drugs most commonly used in birds include benzodiazepenes (i.e. diazepam, midazolam), alpha-adrenergic agents (xylazine, medetomidine), opioids (butorphanol, buprenorphine), and the dissociative anesthetic agent, ketamine. Recently, there is an increasing interest in the use of Alfaxalone in birds, but there are only few publications about it.

Pre-anesthesia

Pre-anesthesia is routinely used in diurnal birds of prey, like falcons to limit stress during gas anesthesia induction, avoid damage to primary feathers, and to reduce the amount of inhalant anesthetic required for maintenance. A standard regimen used is medetomidine (50 μg/kg) and ketamine (12.5 mg/kg). Midazolam (2 mg/kg intranasal) is regularly used in psittacine birds.

Inhalation anesthesia

The minimum alveolar concentration (MAC) in birds has been defined as the minimum concentration of anesthetic needed to prevent that a bird reacts to a painful stimulus. Another way to evaluate the strength of an anesthetic, is to determine its ability to induce respiratory depression and apnea. For this purpose, the anesthetic index (AI) is used. The lower AI, the higher the chances of apnea.

The most commonly used inhalation agents are isoflurane and sevoflurane. For induction with isoflurane, the starting point is typically around 2 L/min oxygen and an isoflurane concentration about 4-5%. Compared to isoflurane, sevoflurane is less soluble and less powerful as an anesthetic, which leads to more rapid induction and recovery times. Sevoflurane is also not an irritant for the respiratory airways, and therefore this gas does not induce struggling during induction.

All open, non-rebreathing circuits, such as Magill, T Ayre, Mapleson, Jackson-Rees and Bain, can be safely used in birds. One of the major advantages of these open circuits, is that the response of the patient to the changes in anesthetic concentration are quite rapid. The oxygen flow rate should be two to three times the ventilation capacity of the patient or 150-200 ml/kg/minute.

Cole's tubes are the most commonly used endotracheal tubes in birds. They allow a good sealing of the trachea, and they limit the dispersion of air with no risk to the tracheal epithelium. Since the avian trachea has complete cartilaginous rings, cuffed tubes are not recommended. When forced to use a cuffed tube, the balloon should never be inflated. If the balloon is inflated, necrosis of tracheal mucosa can develop up to 15 days later.

Intermittent positive pressure ventilation is best provided with the use of pressure ventilators in the avian patient.

Monitoring the patient

Several parameters must be monitored during anesthesia, including respiration and tidal volume, carbon dioxide levels, heart rate, oxygen levels, and temperature. Birds are small patients and they cool down easily, therefore it is critical to monitor both the temperature of the environment and the temperature of the avian patient.

Intra-operative fluids

All birds should receive fluids during surgery. At the very least, it is wise to have vascular access ready for use in the case of an emergency. The most commonly used fluids are lactated Ringer's solution (LRS) and LRS with dextrose. The most popular routes to deliver fluids in birds are intravenous (IV) and intraosseous (IO).