Use of nebulisers in small animal practice

Abstract

Nebulisation offers a stress free method for the administration of medications in a form that, in the Flexineb neduliser, enables droplets of <5 µm in 67% of the total droplets produced (when using 0.9% sodium chloride) to enter into the lung tissue and deliver the active ingredient directly to the source of inflammation/constriction Nebulisation offers delivery of a number of different types of medication to all species. Nebulisation can be used to humidify air in cases of tracheostomy and aspiration pneumonia.

Key words: respiratory, inhalation, nebuliser, medications

Nebulisation in humans is an exceptionally common format in order to deliver specific medications to aid in the treatment of respiratory dysfunction. This format has been replicated and demonstrated to be highly advantageous in the veterinary field, although there are few studies on this subject. Asthma especially requires medication to be deposited at the site of inflammation, with species specific inhalers and nebulisers having greater enabled medication of this condition to be provided in cats, dogs and exotic species. Feline asthma is exceptionally difficult to treat in the stressed dyspnoeic case. Additional oxygenation for these animals is the normal route of treatment, alongside inhalers. Inhaled therapy has become increasingly popular and is now widely regarded as the treatment of choice in companion animal lower airway disease. While objective data on their efficacy are currently being collated, widespread anecdotal reports support their first line use. This paper serves to introduce the subject of inhalation therapy in small and exotic animals, and uses case studies to demonstrate effective use.

Inhalation therapy

In the human medical field it has been shown that the formulation of drugs, such as fluticasone propionate which is administered by aerosol inhalation, leads to very little systemic absorption allowing much higher concentrations to be used locally, where they are needed, in the respiratory tract (Fitzgerald et al, 1998). The low systemic absorption is in marked contrast to oral glucocorticoids, such as prednisolone, which can have serious side effects at the doses needed to control airway inflammation. These side effects include, but are not limited to, polydypsia/polyuria, diabetes mellitus, hepatic lipidosis, immunosuppression, skin and coat changes, muscle weakness and weight gain (which in itself can exacerbate dyspnoea) (Rohatagi et al, 1999).

Corticosteroids and bronchodilators have emerged as the most effective agents in the treatment of feline asthma (Adamama-Moraitou et al, 2004). A number of drawbacks, however, have been identified with these drugs when administered in the traditional manner, that is, either in tablet form or by injection. Frequent and extended corticosteroid therapy in cats, for example, is associated with an elevated risk for pancreatitis, diabetes and other conditions (Cornell University., 2015). Both corticosteroids and bronchodilator pills and injections are less efficient than inhaled medications because they circulate systemically rather than targeting the specific respiratory system tissues involved in asthma.

As systemic glucocorticoid administration may lead to serious adverse effects and may be contraindicated in certain patients (Cohn, 2006), inhaled glucocorticoids (iGC) appear to be advantageous, because of maximised local drug deposition and minimised systemic exposure (Allen et al, 2003). This means that a higher level of the drug gets to the lungs, without the systemic side effects. Inhaled corticosteroid (ICS) therapy is the preferred treatment for a wide range of respiratory diseases in human beings; for example, it is currently considered to be the most effective anti-inflammatory therapy for patients with asthma (Fitzgerald et al, 1998) and is also effective in people with other respiratory disorders such as chronic bronchitis and eosinophilic bronchitis (Joo et al, 2002; Mapel, 2004).

Leece and Cherubini (2015) described a case in which regurgitation occurred under general anaesthesia of a Pug with suspected masticatory muscle myositis. The dog's tongue was pulled from the mouth to enable suctioning, but could not be repositioned into the oral cavity as it was not possible to open the mouth. Swelling due to venous congestion and a bite wound were treated using nebulised adrenaline and resolved

Nicola Ackerman RVN BSc (Hons) in Equine Science Vet Technician specialist in Nutrition C-SQP A1 V1, Senior Medical Nurse at the Veterinary Hospital Group, Plymouth, UK

Table 1. Small animal nebuliser drug table

This chart is meant to be used as a guide for veterinary nurses and veterinary surgeons
Some of the medications listed are not available in all countries

Antibiotics				
Drug	**Trade name**	**Drug type**	**Drug format**	**Dilute with saline**
Cefquinome	Cobactan®	Cephalosporins	Cobactan® 4.5% Injectable Solution	No
Ceftiofur Sodium	Excenel®	Cephalosporins	Excenel® 4G Injectable Solution	No
Gentamicin	Gentaject	Aminoglycosides	Gentaject 10% Injectable Solution	Yes 1:1
Bronchodilators				
Drug	**Trade Name**	**Drug Type**	**Drug Format**	**Dilute with Saline**
Ipratropium	Atrovent®	Anticholinergic Agent	Atrovent® 250 UDVS Nebuliser solution	Yes 1:1
Salbutamol (Albuterol)	VentolinTM	B2-adrenergic receptor agonist	VentolinTM 2.5 Nebuliser Solution	Yes 1:1
Clenbuterol	Ventipulmin®	B2-adrenergic receptor agonist	Ventipulmin® 30 Injectable Solution	Yes 1:1
Corticosteroids				
Drug	**Trade Name**	**Drug Type**	**Drug Format**	**Dilute with Saline**
Dexamethasone	Dexameth	Corticosteroid	Dexameth 2mg/ml Injectable Solution	Yes 1:1
Fluticasone propionate	FlixotideTM	Corticosteroid	FlixotideTM 2mg/2ml Nebuliser Suspension	Yes 1:1
Budesonide	Pulmicort®	Corticosteroid	Pulmicort® 0.5 Nebuliser Solution	Yes 1:1
Mucolytics				
Drug	**Trade Name**	**Drug Type**	**Drug Format**	**Dilute with Saline**
Acetylcysteine	Parvolex®	Mucolytic	Parvolex® 2g Solution for infusion	Yes 1:1
0.9% Saline Solution	0.9% Saline Solution	Mucolytic	B.Braun NaCl 0.9%	No

Case Study 1

A 3-month-old Bulldog was referred to the emergency and critical care service at The Royal Veterinary College Queen Mother Hospital due to acute onset of respiratory distress following a period of regurgitation. Radiographs were suggestive of pneumonia. Events causing the inhalation of gastric contents can cause the development of aspiration pneumonia (Davis, 2015). Acidic irritation from the inhalation of these gastric contents within the lungs is thought to provide an ideal bed for the colonisation of bacteria, (Dear, 2014). The decision was made to mechanically ventilate the patient due to hypoxaemia and impending respiratory fatigue. The patient was anaesthetised and maintained with propofol, fentanyl and midazolam during ventilation. Multiple bacteria were identified following bacterial culture after bronchoalveolar lavage (BAL) was carried out.

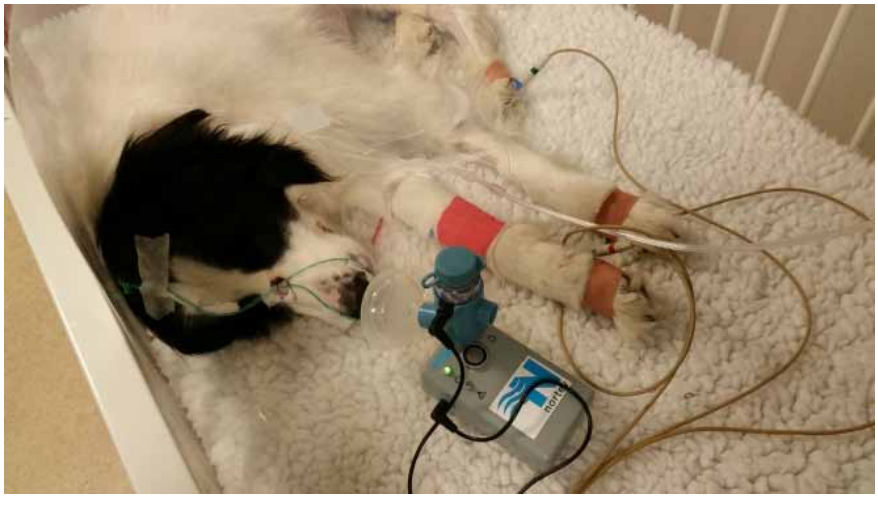
Cultured bacteria included *Bordatella bronchiseptica*, *Pseudomonas aeruginosa* and *Enterobacter* spp. Following several failed attempts, due to repeated occlusion of the airway with thick secretions, the patient was successfully weaned from the ventilator 3 days later. Appropriate antibiosis was continued using marbofloxacin as it was highlighted on the sensitivity panel that all the cultured bacteria were sensitive to this antibiotic. Supportive care was given, including oxygen therapy, nebulisation, administration of anti-emetics, gastroprotectants and intravenous fluid therapy. For this patient, the Flexineb small animal nebuliser was primed with saline and used every 4 hours for 15–20 minutes. The patient made a full recovery and was discharged from the hospital at a later date.

Louise Welsh

Case Study 2

A 7-year-old Doberman presented to the Royal Veterinary College Queen Mother Hospital with a history of lethargy, coughing, pyrexia and weight loss. Radiographs received from the referring veterinary surgeon were suggestive of pneumonia and partial pressure of oxygen (PaO2) on arterial blood sampled was 61.7 mmHg. Nasal cannulae were placed to facilitate oxygen supplementation. Despite this decrease in PaO2, only a mild increase in respiratory effort was noted. The patient's haematology results identified a neutrophilia. Investigative procedures were undertaken to try and identify a cause for the patient's ongoing weight loss. Computed tomography (CT) confirmed aspiration pneumonia, with the ventral lung fields affected bilaterally. The CT also showed ulcerative disease of the stomach and duodenum with free peritoneal gas present. A perforated gastric ulcer was suspected. While an ongoing treatment plan was discussed with the owners, nebulisation was started for the pneumonia. The Flexineb small animal nebuliser was used, primed with 0.9% sodium chloride. The Flexineb nebuliser works by creating small droplets of aerosolised medication or solution (Nortev, 2015). These droplets can be inhaled by the patient and enter the lower airways, helping secretion clearance (Dear, 2014). The Flexineb nebuliser is ideal for anxious patients as it is completely quiet when in use. Aerosolised droplets are delivered through a selection of three different sized silicone masks that fit over the patient's nose (Nortev, 2015). If the mask is poorly tolerated, it can be removed and the small nebuliser unit alone held near to the patient's nose. The medication cup at the top of the nebuliser can be filled with medications including antibiotics, mucolytics and steroids or solutions such as saline (Nortev, 2015). For this patient, a large silicone mask was used over the patient's nose and tolerated well.

Louise Welsh



Louise Welsh

Figure 1. An example of a patient receiving nebulisation, with use of a large silicone mask.

within 2 hours allowing retraction of the tongue. This highlights the wide variety of drug classes that can be effectively nebulised.

Administration of inhalation agents

There are currently two methods of the administration of medications for these cases: nebulisers and inhaler spacers. Both corticosteroids and bronchodilators are available as metered dose inhalers (MDIs) for use in humans with asthma (Padrid, 2004). The MDI is used in conjunction with a 'spacer' designed specifically for cats and dogs. The spacer is a plastic chamber the size of a cardboard inner role of toilet paper. The MDI fits into one end of the spacer; the other end of the spacer has an attachment for the silicon facemask. The end of the spacer that connects with the facemask has a purpose-designed one-way valve so that the medication within the spacer can only leave the spacer during an inhalation. In addition, an anti-static coating inside of the holding chamber ensures that the medication is held suspended until it is inhaled. The client first attaches the MDI and the facemask to the spacer, and then actuates (presses) the MDI twice to fill the spacer with medication. The client then places the facemask gently over the pet's mouth and nose. The pet is allowed to breathe in and out 7–10 times with the mask in place, and the treatment is completed (Padrid, 2004). Inhaler spacers like the AeroKat and AeroDawg are widely used in veterinary practice, though training the pet to accept these can prove to be difficult in some cases, although some adapt very quickly. Many dyspnoeic cases can panic when in respiratory distress, and the placement of the face mask over their face can cause further panic. Nebulisers are ideal in that the delivery pipe be placed next to the pet, or the pet placed inside of the nebulisation chamber (this will depend on the size of the pet).

Exotic species

Nebulisers are useful for the provision of some medications or saline, especially in cases of aspergillosis or other respiratory diseases in avians (Brown, 2010). A dyspnoeic bird can be difficult to examine and treat, as they are easily stressed when handled. Birds should not be held for more than 4 minutes at a time (Chitty, personal communication). Placement of the bird in an oxygen chamber or nebuliser chamber can enable observation of the animal alongside oxygen administration. The administration of medications can then be instigated without having to further stress the bird, as many medications can be given via nebulisation (*Table 1*). In birds droplet size of the medication must be below 5µm in diameter otherwise the droplet does not remain suspended in the air stream long enough to reach the target area (Coles, 2009). Vapourising the

medication does not work because most of the droplets are too big and condense in the upper respiratory tract. The drug needs to be nebulised into a chamber that the bird is housed in during the therapy (Coles, 2007).

Nebulisation in tracheostomy cases

In cases where a tracheostomy tube has been placed all efforts should be made to avoid the problems associated with under hydration. This is important to prevent airway secretions from drying and forming a plug, and also to maintain the health of the mucosa, hence the function of the mucociliary escalator (Nicholson and Baines, 2010). Humidification and warming of inspired air can be provided by nebulisation, either continuously in a specialised airtight enclosure or intermittently using a portable nebuliser unit, tubing and sterile saline. The ideal frequency and duration of nebulisation is not known, but should be maximised initially — over hydration is unlikely to be a problem. Nicholson and Baines (2010) recommend nebulisation for 5 to 10 minutes every 1 to 4 hours initially, reducing the frequency steadily over time while looking out for the formation of any dry crusts that would indicate under hydration of the airway.

Nebulisation in aspiration pneumonia

Aspiration pneumonia is unfortunately seen as a consequence of many medical conditions (megaoesphagus), or due to regurgitation. In all of these cases adequate antimicrobial therapy is required (Dear, 2014), and Dear (2014) suggests that adequate hydration is important in ensuring clearance of secretions produced in the airways. For these patients, the use of nebulisation, producing small particles which can enter the lower airways (Dear, 2014), helps to improve clearance by humidifying the secretions (Davis, 2015). Different types of nebulisers create particles of differing sizes. The Flexineb nebuliser uses a mesh design and produces droplets of <5 µm in 67% of the total droplets produced when using 0.9% sodium chloride (Nortev, 2015). For particles to enter the lower airways they must be <5 µm in size (Dear, 2014). Alongside physiotherapy techniques such as coupage removal of these secretions can aid in the recovery from aspiration pneumonia.

Conclusion

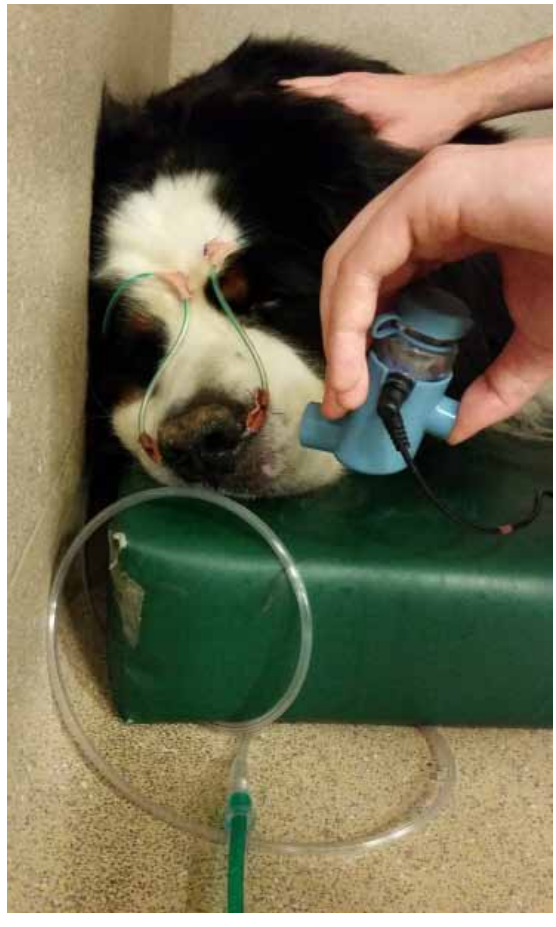
The methods of inhalers (with spacers) and nebulisation are effective, practical and very safe, and avoid the complications associated systemic

Key Points

- Nebulsation of medication can be a stress free experience for the animal, whilst deliver specific treatments to target areas.
- Nebulisers are cost effective, easy to maintain and clean.
- Compliance is key in the treatment of chronic cases, and ease of administration of medications is vital in this.
- Nebulisers allow a higher level of the drug to get into the lungs without the risk of systemic side effects.

Table 2. Dosages for inhalers for use with AeroDawg or AeroKat spacers (Nortev, 2015)

Brand name (generic name)	Classification	Supplied formulation	Pack sizes	Suggested starting dose
Clenill (Beclometasone diproprionate)	Corticosteroid	50 µg 100 µg 200mcg	200 dose MDI	200 µg q12h
Flixotide GlaxoSmithKline (Fluticasone proprionate)	Corticosteroid	50 µg 125 µg 250 µg	120 dose MDI	250 µg q12h
Salamol/Ventolin APS/GSK (Salbutamol)	Bronchodilator	100 µg	200 dose MDI	100 µg q6–12h (or as required)



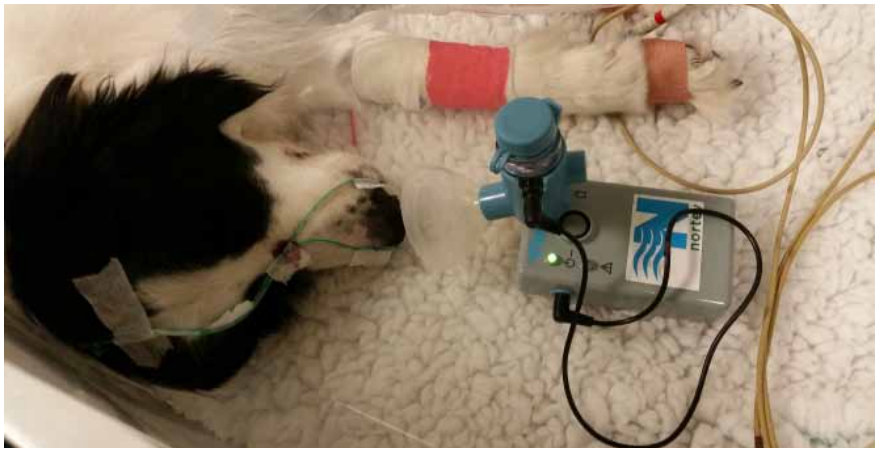
Louise Welsh

Figure 2. An example of a patient receiving nebulisation through the Flexineb Small Animal nebuliser.

Case Study 3

A 7-year-old Border Collie, presented at The Royal Veterinary College Queen Mother Hospital after a sudden onset of weakness, lethargy, pyrexia and inappetance. The patient also had a chronic history of vomiting after eating, with no cause having been previously identified. On presentation the patient was non-ambulatory. Arterial blood samples revealed a partial pressure of oxygen (PaO2) of 47.1 mmHg, which improved mildly with oxygen supplementation via nasal cannulae that were placed after admission. Guidelines for initiating mechanical ventilation in hypoxaemic patient's suggests patient's with a PaO2 <60 mmHg with no response to oxygen supplementation may require ventilation (Hopper and Powell, 2013). Despite only a small improvement in PaO2, the patient's respiration appeared to be stable with a normal respiratory rate. In liaison with the owners the decision was made not to ventilate and instead continue managing the patient with supportive care and oxygen therapy. Pulse oximetry (SpO2) readings were monitored continuously throughout oxygen supplementation to ensure hypoxaemia was not worsening. Extrapolation of SpO2 readings using the oxyhaemoglobin dissociation curve allow PaO2 levels to be estimated (Pachtinger, 2013). A SpO2 percentage of 90 equates roughly to a PaO2 of 60 mmHg (Pachtinger, 2013). Blood smears analysed in house showed a significant neutropaenia so barrier nursing was implemented. Reasons for a decreased neutrophil count in canines can include sepsis and pneumonia (Schnelle and Barger, 2012). Examination of fluid sampled from a bronchoalveolar lavage showed a large number of extracellular rods present in thick, purulent fluid. Bacterial pneumonia is confirmed by the presence of aseptic inflammation and positive bacterial culture from either bronchoalveolar lavage or tracheal wash (Dear, 2014). The confirmation of bacterial pneumonia suggests that sepsis is present in the lower respiratory tract (Dear, 2014). Dear (2014) explains that chronic pneumonias are far more difficult to recognise as signs, including exercise intolerance, coughing, anorexia and lethargy, can often be subtle. Due to the nature of the secretions examined, the patient was nebulised with 0.9% sodium chloride every 4 hours for 15–20 minutes using the Flexineb small animal nebuliser.

Louise Welsh



Louise Welsh

Figure 3. An example of a patient receiving nebulisation.

medications, especially those with chronic oral steroid use. Nebulisation is a method of administration of medications that should be actively sought in practice, and owners educated in its use for at home means of administration. **VN**

Conflict of interest: none.

The AeroKat, AeroDawg and Flexineb SA are available from BreathEazy. This article was supported by an educational grant from BreathEazy and Nortev.

Adamama-Moraitou KK, Patsikas MN, Koutinas AF (2004) Feline lower airway disease: a retrospective study of 22 naturally occurring cases from Greece. *J Feline Med Surg* **6**(4): 227–33

Allen DB, Bielory L, Derendorf H (2003) Inhaled corticosteroids: Past lessons and future issues. *J Allergy Clin Immunol* **112**(Suppl 3): 1–40

Brown D (2010) Kitting out an exotics practice. *In Practice* **32**: 263–6

Cohn LA (2006) Glucocorticoid therapy. In: Ettinger SJ and E. Feldman C, eds. *Textbook of Veterinary Internal Medicine 6th Edn.* WB Saunders, Philadelphia, PA, USA: 503–8

Coles BH (2007). *Essentials of Avian Medicine and Surgery.* Third Edition. Blackwell Publishing

Cornell University. (2015). Feline Asthma: A Risky Business for Many Cats. http://www.vet.cornell.edu/fhc/health_information/Asthma.cfm (accessed 17th October, 2015)

Davis H (2015) Nursing Care: Care of the Perioperative Patient. *Vet Clin North Am Small Anim Pract* **45**(5): 1029–48

Dear JD (2014) Bacterial Pneumonia in Dogs and Cats. *Vet Clin North Am Small Anim Pract* **44**(1): 143–59

Fitzgerald D, Asperen P, Mellis C, Honner M, Smith L, Ambler G (1998) Fluticasone propionate versus beclomethasone dipropionate: comparison of efficacy and adrenal function in paediatric asthma. *Thorax* **53**: 656–61

Hopper K, Powell LL (2013) Basics of Mechanical Ventilation for Dogs and Cats. *Vet Clin North Am Small Anim Pract* 43(4): 955–69

Joo JH, Park SJ, Park SW et al (2002) Clinical features of eosinophilic bronchitis. *Korean Journal of Internal Medicine* **17**: 31–7

Leece E, Cherubini G (2015) Nebulised adrenaline to manage a life-threatening complication in a pug with trismus. *J Small Anim Pract* **56**(7): 470–2

Mapel DW (2004) Treatment implications on morbidity and mortality in COPD. *Chest* **126**: 150S–8S

Nortev (2015) 'Flexineb SA', (Online), Available from: http://www.breatheazy.co.uk/brochures/Flexineb%20SA.pdf, (Accessed on: 11/10/2015).

Nicholson I, Baines S (2010). Indications, placement and management of tracheostomy tubes. *In Practice.* **32**: 104–13

Pachtinger . (2013) Monitoring of the Emergent Small Animal Patient. *Vet Clin North Am Small Anim Pract* **43**(4): 705–20

Padrid P (2004) Respiratory Medicine: June 2004. Accessed via http://www.breatheazy.co.uk/shop-home/shop-vets/further-reading/ (accessed 14th October, 2015)

Rohatagi S., Rhodes GR, Chaikin P (1999) Absolute oral versus inhaled bioavailability: significance for inhaled drugs with special reference to inhaled glucocorticoids. *J Clin Pharmacol* **39**: 661–3

Schnelle, A.N. & Barger, A. M. (2012). Neutropaenia in Dogs and Cats: Causes and Consequences. Veterinary Clinics of North America: Small Animal Practice. Vol.42, No. 1, pp. 111-122.