Veterinary nursing of a dyspnoeic juvenile Humboldt penguin *Spheniscus humboldti*

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ABSTRACT: A Humboldt penguin chick presented with dyspnoea. Radiographs showed opacities on the lungs and radio-opaque material within the ventriculus. A ventriculotomy was performed to remove the opacities (which were pebbles) and nutritional, medical and supportive nursing care was provided. Despite recovering well, the chick presented dyspnoeic again a few weeks later. With diagnostic testing indicative of chronic aspergillosis, the chick was given a poor prognosis, and the decision was made to euthanise. This case study highlights the nursing steps taken and the possible mitigations that could be applied in the future to improve outcomes.

Keywords: Penguin; aspergillosis; foreign body

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Introduction

Humboldt penguins are native to the coasts of Peru and Chile, near the Humboldt cold water current. They are listed as Vulnerable on the IUCN red list (IUCNredlist, 2017) but are a commonly kept captive penguin species across zoological institutions in the UK (Blay & Côté, 2001).

The success of a captive breeding population is often hindered initially due to lack of coherence, as a coherent colony can take some time to be established. Marshall et al. (2016) found that the breeding success was most affected by group composition variables. Immediately after hatching, chicks are reliant upon their parents to regurgitate food to feed them. Although they can be offered small fish by hand from about 3 weeks old, they aren't fully independent until they are 70–90 days old (AZA Penguin Taxon Advisory Group, 2005).

There is a correlation between young, inexperienced parents and infertile or inadequately incubated eggs (Cheney, 1990). Inexperienced parents have also been known to feed abnormal objects to their chicks, e.g. enclosure substrate and plant material, which may cause foreign bodies.

Penguin chicks are also, like other birds, susceptible to a variety of diseases, including fungal, bacterial and viral infections. Sick penguins, from a variety of causes, commonly exhibit lethargy, inappetence, regurgitation, dehydration, respiratory symptoms and weight loss or poor weight gain (Lovering et al., 2014).

Case study

Presentation

A 38-day-old Humboldt penguin chick presented with unsettled behaviour and walking around the enclosure with no obvious parental care. The chick was dyspnoeic and open mouth breathing, with the cervical air sac visibly inflating. On auscultation wheezing was audible, particularly over the dorsal aspect of the lungs. On clinical exam, the chick had suspected multiple foreign bodies, palpable in the caudal coelom, weighed 929 g and was in thin body condition (3/9 BCS). The expected body weight for a chick of this age, based on internal ZSL reference charts for previous parent-reared Humboldt penguin chicks, was 1200 g.

Diagnostic work up

An anaesthetic was considered too high risk in this individual, so conscious radiographs were taken (Figure 1). They showed lots of small, round, soft-tissue opacities in areas of the lungs. There were also many small radio-opaque objects visible on the radiograph, thought to be sitting in the cloaca, consistent with pebbles from the enclosure substrate.

Differential diagnosis

Differential diagnosis included aspergillosis, a common fungal illness in captive penguins (Miller & Fowler, 2015), ± bacterial pneumonia and poor parenting (feeding of pebbles) with subsequent parental neglect/abandonment. The outside temperature was unusually warm for May, so this could have contributed to and exacerbated the respiratory symptoms, as penguin chicks can suffer from heat stress (AZA Penguin Taxon Advisory Group, 2014).

Treatment

A critical care patient assessment was completed to establish the vulnerabilities of the chick and a nursing care plan created. Treatments, behavioural observations and physiological parameters were documented throughout. This documented information was essential in ensuring continuity of care between the veterinary staff responsible for the management of the case.

The chick was given supplemental oxygen therapy and housed in a temperature-controlled environment in the intensive care unit. Recommended environmental temperatures for rearing *Spheniscus* penguins is 18.3–21.1 °C; the room was maintained at 20 °C (AZA Penguin Taxon Advisory Group, 2014).

Figure 1. Radiograph showing opacities in lungs and pebbles in cloaca.

Although a full diagnosis had not been made, the veterinary surgeon initiated the following treatments: 40 ml of subcutaneous fluid Hartmann's Solution (Aqupharm, Animal Care) once daily, Marbofloxacin (Marbocare®, Animal Care) 5 mg/kg I/M Q24 hours and Itraconazole (Fungitraxx®, Petlife International Ltd) 20 mg/kg PO q24 hours. Hand-reared chicks by this age would be consuming pieces of fish, but as this individual was a parent-reared chick until this point, gavage feeding was required.

After stabilisation over 48 hours, respiratory rate and effort had improved while the chick was at rest. However, oxygen supplementation was continued as the chick was still tachypnoeic after being fed. A conscious enema was attempted by the veterinary surgeon, due to the risk associated with anaesthesia at this time, but with no success. The following day a subsequent GA and enema also proved unsuccessful. Anaesthesia was induced incrementally with Isoflurane (Isocare, Animal Care) 1–5%, the chick was intubated and maintained on 2–3% isoflurane for the duration of the procedure (11 minutes). The chick was positioned with his cranial body raised at a 45° angle to reduce the pressure on his respiratory system, oxygen saturation stayed within normal limits (measured using a pulse oximeter attached to the chick's foot), despite an increased respiratory effort.

It is normal for a small amount of grit and stones to be present within the muscular ventriculus in many bird species including penguins; in penguins they are believed to have a role during foraging and/or aid in digestion (AZA Penguin Taxon Advisory Group, 2014). The absence of these pebbles in zoo/aquarium exhibits does not appear to affect digestion; however, the increased number seen in this case was likely to have a negative impact. It is not uncommon to find gastrointestinal foreign bodies, with young birds and nesting females more likely to investigate small and novel items and ingest them (Miller & Fowler, 2015). Due to a penguin's large gizzard size, when interpreting radiographs, foreign bodies can appear to be located very far caudally in the coloemic cavity giving the false appearance that they may be in the intestines or the cloaca. They are, however, more likely to still be within the ventriculus (as was this case). Although penguins can regurgitate easily, foreign bodies usually require endoscopic or surgical removal (AZA Penguin Taxon Advisory Group, 2005; Miller & Fowler, 2015).

Ventriculotomy

A decision was made to surgically remove the pebbles as they were unlikely to pass on their own and in the number present could cause further problems, including putting pressure on the air sacs and compromising respiration. The chick was anaesthetised as above with incremental increases in isoflurane. A small, rigid endoscope was placed down the trachea and bronchi to ensure no obvious signs of *Aspergillus*. The trachea and bronchi were clear with no discharge, mucous, redness or fungal growth visible. A biochemistry panel run on a blood sample obtained from the right jugular vein was also within normal limits, so the surgery went ahead.

The chick was intubated with a 3.5-mm endotracheal tube and maintained on a ventilator (SAV03 Small animal ventilator, Vetronic Services Ltd) throughout the procedure. This achieved a smoother plane of anaesthesia for this longer procedure and counteracted the profound respiratory alteration commonly seen in diving birds when placed in dorsal recumbency. It also prevented breath-holding (dive reflex), another common anaesthesia difficulty in these species (Mulcahy, 2007; Miller et al., 2019). Meloxicam (Metacam®, Boehringer Ingelheim), Butorphanol (Torphasol®, Animal Care) and Marbofloxacin (Marbocare®, Animal Care) were administered alongside a bolus of warm subcutaneous fluid.

After routine surgical preparation, a ventriculotomy was performed to remove most of the pebbles. A total of 29 g of pebbles was removed, leaving only a small number which were located too cranially within the proventriculus to reach without creating a further incision. The chick was monitored throughout the procedure with respiratory rate ranging from 12 to 44 bpm, heart rate 160–280 bpm and temperature 37.4–36.8 °C, which was considered to be within normal parameters based on previous penguin anaesthetic data from the ZSL collection, but no published reference ranges could be found as a comparison.

The chick's recovery was slow but uneventful and within 2 hours it was active and vocal. The chick was restricted to a small kennel within the ICU still on supplemental oxygen therapy with the surgical wound assessed and cleaned with dilute hibiscrub three times a day. Five very small feeds were administered to the chick over the first 24 hours with 1 ml of Sulcralfate 1 g/5 ml (Antepsin, Chugai Pharma UK Ltd), an anti-ulcerative drug, administered 1 hour before each feed

to prevent ulceration of the ventriculus post-surgery. It was given on an empty stomach to allow the prescribed amount to coat the stomach without being interfered with by food. Pain relief was continued, and a course of antibiotics initiated.

Nutrition

Gavage feeding (Figure 2) was initiated three times a day giving no more than 10% of the chick's morning body weight; this calculation helps prevent overfeeding, which can be a common problem when hand-rearing penguins (AZA Penguin Taxon Advisory Group, 2005). The food offered could be described as a fish gruel, a blend of the ingredients outlined in Table 1. This is the food used at the institution when hand-rearing penguin chicks, but there are commercial veterinary liquid diets available which could have been considered, e.g. Emeriad Piscivore® (Lafeber).

At day 8, the chick was started on tiny pieces of fish to encourage independent feeding and eventually whole-prey feeding. This helped enable the high calorie requirement of a chick to be met without overfeeding (AZA Penguin Taxon Advisory Group, 2005). By day 16 the chick was taking large pieces of fish independently and by day 18 whole fish. The chick's growth rate and the food taken is shown in Figure 3. In healthy hand-reared or parent-reared chicks a steady daily increase in weight is seen, with doubling in size every 2 weeks.

Aspergillus

Aspergillosis is the primary fungal illness in penguins and the most common cause of mortality and morbidity in captive penguins (Bunting et al., 2009; Miller & Fowler, 2015). Among infective *Aspergillus* spp., *A. fumigatus* is the most common causative agent of disease in birds. It may not cause problems at low levels in healthy individuals; however, disease frequently occurs in debilitated or stressed animals (Miller & Fowler, 2015). Young birds also have an immature immune system which increases the susceptibility to aspergillosis (Xavier et al., 2007). Early detection is vital for successful treatment (Diebold et al., 1999); however, clinical signs are often non-specific and typically include dyspnoea, coughing, lethargy, weakness, inappetence, weight loss and self-isolation (Friend et al., 1999; Miller & Fowler, 2015). Disease may be acute and rapidly fatal, or chronic with the lungs and air sacs infected resulting in a decrease in respiratory function over time (Friend et al., 1999).

Definitive diagnosis is difficult, particularly in the early stages, but radiographs, tracheal and air-sac cultures and scoping as well as haematology may be useful diagnostic indicators. Tracheal scoping and swabs taken at the time of the ventriculotomy were negative and early blood samples did not show the expected elevated white blood cell count and associated monocytosis documented in aspergillosis cases (Beernaert et al., 2010; AZA Penguin Taxon Advisory Group, 2014). However, due to other clinical signs and radiographs, aspergillosis was suspected.

Supportive care including a heated environment, fluids and nutritional support are essential when treating fungal pneumonia. Oxygen supplementation was provided for 24 hours initially with a gradual reduction over time, to 1 hour post feeding only, and then stopped. A combination of systemic and topical treatments were used. Itraconazole (Fungitraxx®, Petlife International Ltd) was given orally at a dose rate of 20 mg/kg once daily, reducing to 15 mg/kg during treatment, as it can cause inappetence. Itraconazole is one of the most widely used antifungal agents in birds (Harrison & Lightfoot, 2006) and a primary choice of treatment in avian aspergillus due to its broad spectrum of efficacy (Miller et al., 2019). Aerosolisation alongside systemic treatment is usually recommended and can enhance treatment by delivering drugs directly to the respiratory tract (Harrison & Lightfoot, 2006). The chick was nebulised twice daily for 15 min with F10®SC (Meadows Animal Healthcare Ltd) initially which was then changed to Clotrimazole 1% w/v (Canesten®, Bayer plc). Oral Terbinafine (Medreich PLC) was added in alongside Itraconazole after 2 weeks at 22 mg/kg orally once daily. It was added in at this time as there had

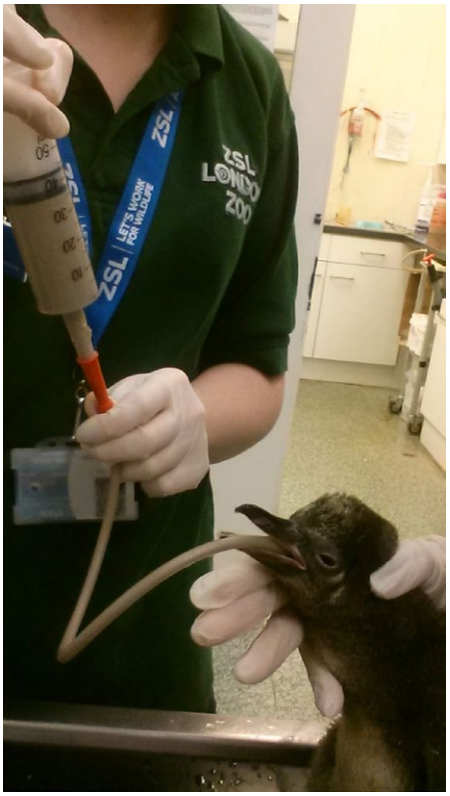

Figure 2. Gavage feeding.

Table 1. Ingredients blended to create fish gruel for feeding.

Ingredient	Quantity
Sprat *Sprattus sprattus*	280 g
Saline	200 ml
Aquaminivit (IZVG ZooVet)	¼ tablet
Avipro (Vetark)	2 pinches
Nutrobal (Vetark)	1 pinch

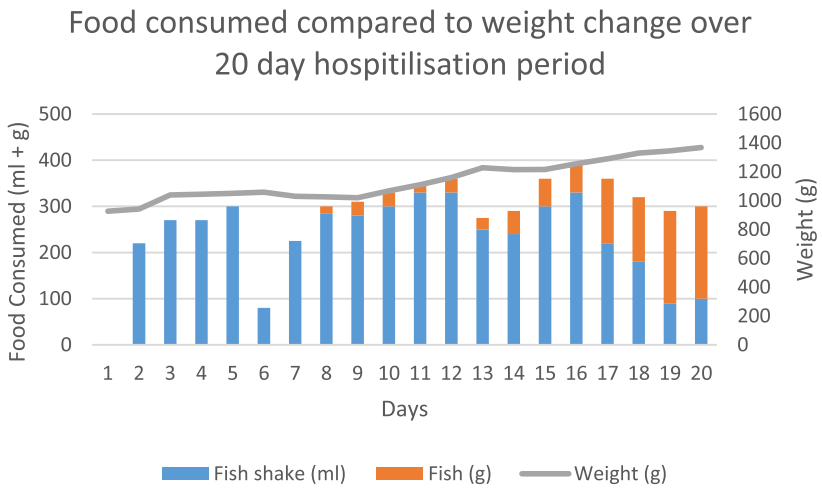

Figure 3. A graph to show growth rate and feeding log.

been limited improvement of clinical signs and this would give more comprehensive cover.

Outcome

The chick made a good recovery post-surgery and respiratory clinical signs reduced, it was active and gaining weight. It was decided to transfer the chick to the incubation unit to be cared for by the keepers, with daily checks from veterinary staff. However, 6.5 weeks after initial presentation, 4 weeks after the transfer, the chick deteriorated with a lack of appetite, weight loss, increased respiratory rate and effort. Haematology showed a severely elevated white blood cell count with a monocytosis and mild anaemia indicative of chronic disease. Radiographs (Figure 4) revealed the chick's entire right side (lungs and air sac) to be obscured by soft-tissue density and/or fluid. Given the grave prognosis the decision was made to euthanise.

Figure 4. Radiograph showing obscured right lung and air sac.

On post mortem examination the most significant finding was grossly thickened right cranial and caudal thoracic air sacs lined with a thick caseous cream-coloured mat (Figure 5). The right lung was also completely consolidated. *Aspergillus fumigatus* was cultured from the air sacs, with sensitivity testing showing it was resistant to Itraconazole and Terbinafine, but sensitive to Co-trimazole and Voriconazole.

Discussion

The supportive and nutritional nursing care for a dyspnoeic penguin is a fine balance to ensure clinical improvement while preventing exacerbation of clinical signs from frequent interference (handling, treatment and feeding).

Definitive diagnosis of aspergillosis was difficult without invasive endoscopic examination. As this was not performed, and with the risk of a bacterial lung infection and ventriculotomy surgery, antibiosis was decided upon and provided for a total of 22 days. Antibiotic use, however, is often contraindicated in fungal infections as it is known to increase the proliferation of the infection by disrupting the natural microbiological flora (De Pauw, 2011) which helps keeps fungal spores at a reduced level. This was a clinical decision made by the veterinary surgeon at the time, based upon the diagnostic results and clinical assessment.

Itraconazole is traditionally a primary choice of treatment in avian aspergillosis (Miller & Fowler, 2015). With human aspergillosis it is used only in chronic and allergic cases (Kosmidis, 2018). Voriconazole is the treatment of choice for human aspergillosis (British National Formulary, not dated). Historic post-mortem *Aspergillus* culture on ZSL London Zoo Humboldt penguins has since, however, confirmed sensitivity to Voriconazole and Terbinafine and resistance to Itraconazole. This is a recent internal, unpublished study and was not available for our decision-making process.

It is unknown what caused the reoccurrence of clinical signs. It was likely to be multifactorial. The use then cessation of antibiotics, the use of an ineffective antifungal, the change in environment from the veterinary department care unit to the section care unit (differing temperatures, humidity, etc.) and the chick's young age with the huge demand on its resources for growth were all likely contributing factors. This case highlights the difficulties faced when treating a young bird with multiple medical conditions.

As a result of this case the use of both antibiotics (if indicated) and concurrent Voriconazole alongside supportive nursing care will be considered in future cases when treating lung disease of unknown aetiology in Humboldt penguins.

The nursing care was patient-focused and documented throughout, taking into account the vulnerability of the young chick and its multiple medical conditions, as well as the equipment, medicines and knowledge available at the time. The nursing care plan provided for all the chick's needs, but going forward nursing care plans for young debilitated birds will continue to be adapted on a case-by-case basis.

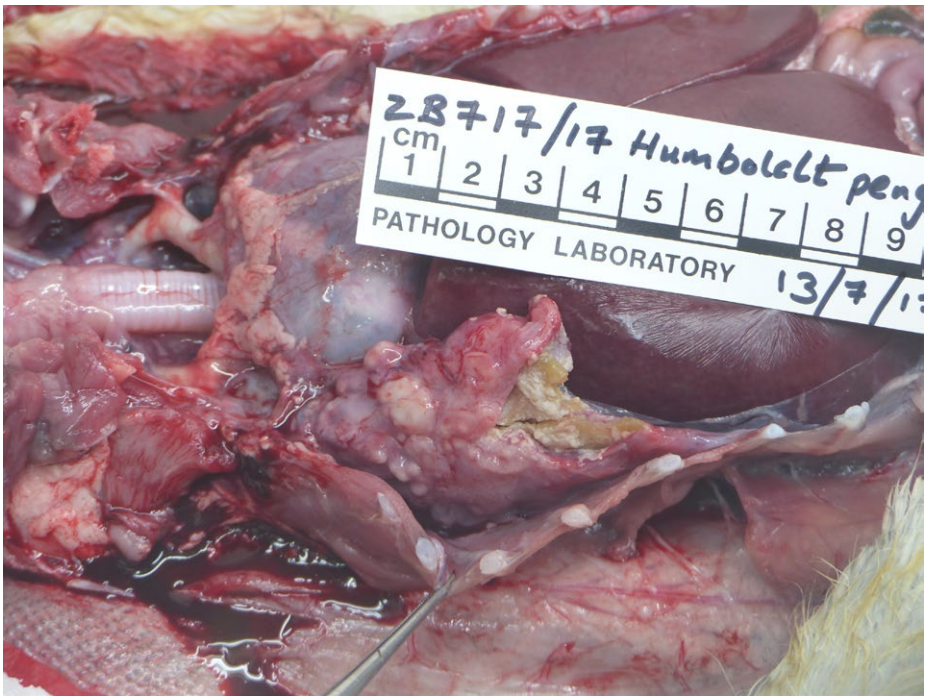

Figure 5. Air sac on PME.

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Disclosure statement

No potential conflict of interest was reported by the author.

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