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Everything You Need to Know about Birds (Not Chickens!) Mini Series

Session Two: Critical Care, Anaesthesia and Diagnostics of Birds

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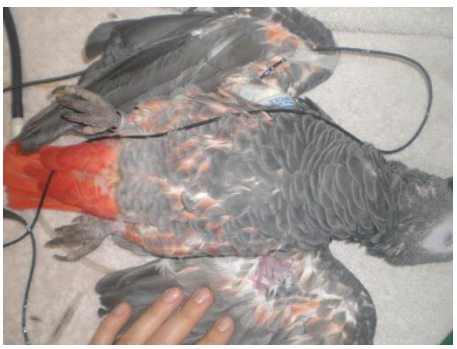

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Session two

Critical care and emergency treatment of birds

Avian patients are challenging because have a high metabolic rate and hide disease well so there must be an emphasis on obtaining a definitive diagnosis quickly and thus 'emergency treatment' in many cases is in fact geared around obtaining an 'emergency diagnosis'. A sick bird that is detected by the owner is so ill it can no longer pretend to be normal. At the time of presentation even handling can be fatal and physical restraint of such a bird is contraindicated. Traumatic injuries can occur and these may be the main focus of attention or a more thorough evaluation of the bird is indicated. This is the case for wildlife casualties and a bird with a suboptimal diet and husbandry.

There is little point in diagnosing by trial treatment in avian medicine. As a result the majority of birds undergo a full diagnostic work up on the same day as they are presented. Thus a specific diagnosis is achieved first and then appropriate therapy is instigated. Only in the critically ill (those that will die under GA) should diagnostics be avoided. It may be necessary to stabilise ill birds before a full clinical assessment can be made of their condition. Only experience will allow the veterinary surgeon to assess how far to go with an individual case. Before handling and stressing the bird a full diagnostic and therapeutic plan should be formulated as you may be able to complete a number of procedures whilst handling the bird. In some cases a complete physical examination may only be possible under anaesthesia. These should be stabilised for 24 – 48 hours only, then diagnostics should be performed. If they are still not stable enough for a GA then they will probably die anyway as your supportive care has not stabilised the patient. In these circumstances pursing a diagnosis will assist the case in reaching its ultimate conclusion. It may be that euthanasia is recommended on the basis of severity of pathology identified during the work up, or the bird may decide for us.

The bird should be weighed prior to transferring it into hospital accommodation so that you can assess its response to therapy, compare this to species records and use it to accurately calculate drug dosages and the volumes of supportive fluid and nutrition required.

Birds should be kept quiet and warm in a small, darkened cage to reduce stress. This is also advisable in the case of fractured bones. If appropriate, and the exotic animal will tolerate immobilising of the affected bone, it may be helpful to do so. However if attempts to do this cause panic and possible further negative consequences then it may be better to leave the animal alone, to be calm and quiet until it can be anaesthetised.

Many birds presenting will be 'fluffed up' this is a method by which the bird aims to conserve body heat and supplying warmth is a vital first step for many cases. The use of an easily cleaned hospitable cage which can provide both heat and humidity is vital for small species. Commercial intensive care cages are expensive but often have the advantage of including nebulisation ports. A cheaper alternative is garden propagators. The cage should be heated to 25-30 degrees Celsius with a high humidity (50-80%).

In order to assess birds properly they must be able to relax and covering the cage or monitoring the bird by CCTV will allow a 'stress free examination'. Once again practising barrier nursing is important. Ventilation is important and air purifiers, such as ionisers can be helpful. UV-b lighting is an important aspect of treatment for some conditions but it also stimulates natural behaviours and will be beneficial. Perching should be just high enough so the tail clears the floor to limit damage. A quiet ward away from predator species should be used. Try and maintain a 12 hour light cycle. The ability to supply pure oxygen is required in many cases of severe respiratory disease, prior to handling or diagnostics. Raptors should be housed separately from other birds in a different room. Most will tolerate being in with cats and dogs in their travel box for short time periods.

Collapsed birds will need to be placed on a padded base, such as a towel, to prevent keel injuries. It is also important to keep their heads slightly raised and facing forward to maintain a good airway. This can be achieved by positioning another towel, which has been rolled up, around the front of the bird in a horseshoe shape with the birds' head resting on the inside of the "toe" part, with the sides of the towel supporting the body.

Thermal therapy

Supplemental heat can be an essential life saver to many critically ill birds, in particular passerines which have a high metabolic rate. This allows the bird to expend less energy in maintaining temperature, therefore helping to maintain body condition and allowing more energy to be channelled to healing.

Birds are frequently small in size and therefore have a large surface area to volume ratio. For avian species there is an even greater surface area due to their internal air sac structures.

So they are therefore predisposed to heat loss. This can be further exacerbated in avian species by a rapid metabolism. To combat hypothermia appropriate heat sources need to be provided.

Plant propagators offer a cheap and easy method of providing a heated chamber. Care must be taken to monitor temperatures as many do not have a thermostat, or if present it may be unreliable. It is also important to observe the patient for signs of discomfort or overheating as these chambers are heated across the whole surface of the base and do not have a cool area to retreat to if necessary. Other methods of providing heat include; water bottles, heat lamps, heat mats and, microwaveable bean bags. Many heating methods can be utilised but the nature of the animal needs to be considered, for example parrots must not have easy access to electric cables.

Oxygen therapy

Critically ill patients can commonly be suffering from hypoxia due to such things as lung disease, hypovolaemia and anaemia. Whilst the cause of a lack of oxygen in the blood stream is investigated, and hopefully rectified, a supply of at least 40% oxygen should be provided to the patient to avoid a critical situation from occurring. Flow rates of 200 – 300 ml/hour are sufficient for a small cage.

Purpose made chambers are available that provide comfortable housing, heat and oxygen and are ideal for smaller patients. If they are not available or are not appropriate for a particular patient then there are other options. Plant propagators can be easily converted into oxygen chambers by connecting a suitable circuit. This makes them ideal intensive care units for all manner of exotics.

Many birds will tolerate oxygen delivery by facemask, especially if they are weak and dramatic recoveries can be made by avian patients if given pure oxygen by mask following an acute respiratory episode. If a face mask or the use of a plant propagator is likely to cause additional stress to a bird in respiratory distress other means of providing oxygen will need to be considered. Using the patients own transport carrier as an oxygen tent may be the least traumatic method and is advised for birds unaccustomed to handling, for example aviary birds. Carriers may need to be wrapped in plastic or towels to provide an air space to oxygenate. The darkened covered area will also help in calming down a stressed individual. It is worth mentioning that the methods applied to provide oxygen can also be used to nebulise a patient with medication if necessary.

To prevent drying of respiratory mucous membranes the oxygen should ideally be fed via a water chamber or high levels of humidity maintained.

Fluid therapy

Birds have a high metabolic rate and can become rapidly dehydrated. Although there may not be specific clinical or pathological data available for the bird certain assumptions can be made just based on appearance. For example a bird which has been sat on the floor of a cage for over 24 hours is likely to be both hypothermic and dehydrated, compared with a normally perched individual.

The degree of dehydration can be assessed by assessing the eyes (dull) and skin (discoloured and withered) of the face. A bird with 5% dehydration will demonstrate some brief tenting of the skin between the shoulders and dry, dull eyes. If the basillic vein has a delayed filling time (over 1 – 2 seconds) then the bird is 7% dehydrated .Once dehydration reaches 10%, the patient's skin tenting will be permanent, the eyes sunken and the bird will be hypothermic. More severe degrees of dehydration will lead to a collapsed bird with tachycardia. Any dehydrated bird should be considered to be acidotic unless they have been regurgitating when alkalosis might be involved. It is probably best to assume an ill bird is 10% dehydrated even when there are no obvious clinical signs.

There are a variety of options when considering fluid therapy for ill birds.

Providing water, presented in the appropriate manner in a low stress environment will be required and is often overlooked. It is important to appreciate that some birds will be used to fountain drinkers and others to a water bowl. Given the high metabolic rate of birds, it is likely they may still be feeding and drinking when presented and will continue to do so whilst in your care.

However it is highly likely that additional support will be required as well to top up voluntary intake. It is best to assume all critically ill birds are dehydrated and acidotic. Assessment of the PCV, electrolyte and protein levels can be helpful, but this usually requires an anaesthetic and this may be contraindicated in the initial phase of supportive care. All fluids should be warmed prior to administration. Baby bottle warming devices are to be preferred or using warm water or microwaving as they maintain a constant heat source.

In mild cases fluids can simply be given by crop tubing, which promotes normal gastrointestinal function. Avian species can be fed directly into the crop or proventriculus via a feeding tube. Rigid metal tubes are preferred when used gently. Giving fluids by using a crop tube is a very easy way and can be performed by vet nurses and in some cases owners of the birds concerned.

Psittacines have a very muscular tongue which they use to great affect to prevent you placing a crop needle in their oesophagous. Lorikeets have very well developed rake like lingual papillae that serve to lap up their nectar diet. The beak is very mobile due to a craniofacial hinge. For parrots, the feeding tube must be made of stainless steel to avoid breakage and possible ingestion of the tube. Given the size of commercially available crop tubes it is impossible (never say never though) to accidentally intubate small birds of less than 100 grams. Over this weight you should visualise the glottis prior to passing the tube. A metal mouth gag can be used if a red rubber tube is being used. In large waterfowl long calf stomach tubes can be used.

To place a crop tube the bird needs to be held in a towel in one hand, or by another handler if it is a large parrot or a bird of prey. For birds of prey a thumb can be used in the corner of the birds' mouth, between the upper and lower beaks, as a gag. For parrots a metal mouth gag can be used. The head and neck are extended. The crop tube is then advanced into the mouth, from the patients left side and passed back over the tongue and to the right.

It needs to be advanced over the base of the tongue, where the glottis and opening to the trachea lie, and down into the oesophagus. The tube can be palpated to ensure correct placement. Slight movement can help to differentiate this from the trachea. Fluids can then be given. A bolus of liquid can then be given directly into the crop or proventriculus. Care needs to be taken not to apply pressure to the crop during feeding and subsequent release to avoid causing regurgitation. Generally the crop is considered to hold 5% of the bodyweight in adults and up to 10% in neonatal birds. Small birds such as budgerigars may only tolerate 1 – 2 ml but larger birds can take volumes up to 20ml at a sitting. There are a number of commercially available electrolyte solutions that are suitable for use and these are diluted as for mammals. Very sick birds may regurgitate fluids given leading to the risk of aspiration pneumonia. In these cases a maximum of 2% bodyweight should be considered. If reflux occurs remove the needle and return to cage (do not tip the bird upside down).

Birds with gastrointestinal disease, impaction, foreign bodies, crop trauma or facial trauma will likely require an alternative route. Thus many cases will be given parenteral fluids initially with or without oral fluids as well. Leur fitting syringes are to be preferred as some bird can pull off the crop tube leading to complications. It is also possible to injure the crop and lead to crop atony if the crop is overfilled.

Subcutaneous fluids are generally reserved for mildly dehydrated patients, but are easy to provide. They are best given in the inguinal skin fold between the leg of the bird and the abdomen, but note that due to the poor skin circulation seen in birds, large volumes cannot be absorbed quickly. The axillary region or the interscapular region can also be used. Up to 1% of the bodyweight can be given at each site. The author uses lactated ringers and gives this on both sides of the bird. Budgies will tolerate 0.5ml per side larger birds can take up to 10ml. Temporary lameness can result with large volumes. The use of hyaluronidase ‘Hyalase’ (75 – 150 IU/L of fluids) can be used to speed up absorption. Maintenance therapy generally necessitates fluids to be given six times a day by this route. This is a simple route and can be performed by an individual in a collapsed bird with assistance being required for physical restraint with more lively birds and birds that can do significant damage such as parrots and raptors. This is a very useful route for supplying fluid therapy during routine anaesthetic procedures.

Avian patients should NOT be given intracoelomic fluids due to the absence of a diaphragm and the presence of an air sac system, which occupies and links all the body systems, including the lungs. It is thus easy to flood the air sacs with fluid.

Intraosseous therapy is a highly effective technique and can be a very practical alternative route for fluid therapy in parrots, using either the tibiotarsus or proximal or distal ulna. This method of fluid administration can only be carried out on the anaesthetised patient (which may already be collapsed) as this procedure is considered painful. They usually remain in place for 2 – 3 days only or whilst under anaesthesia. The distal ulnar is the best site for longer term placement. Care needs to be taken to avoid infection, as this could lead to an osteomyelitis.

Antibiosis is advisable to prevent this. However, for very small patients requiring rapid venous support, intraosseous administration of fluids may be the only option available. Spinal needles with a central stylet or hypodermic needles can be used. Boluses of fluids can be slowly administered and repeated at intervals, or a giving set or syringe driver can be attached. Boluses are considered painful and 1% of body weight as a maximum should be administered. Generally initial boluses are given under anaesthesia when the needle is being placed. The needles can be left in situ so that repeated bolus volumes can be given throughout the treatment period including drugs. This saves the veins for serial blood monitoring. Intraosseous fluids have a lag time of about five minutes compared to intravenous fluids that have a lag time of two minutes. Thus if an IO needle can be placed quickly the actual time of fluids entering the circulation may well be quicker. Most bird species can be given intraosseous fluids but care needs to be taken with regard to sites of administration. In avian patients it is common for the femur and the humerus to be pneumatized (contain air) and are involved in respiration. These should never be used for fluid administration.

Technique: -

1. Pluck feathers over site and prep for aseptic procedure.
2. Use an 18 - 25g needle or a 21 – 23g spinal needle with a stylet (preferred) depending on size of bird. A smaller gauge needle or piece of sterile wire can be used to clear bone fragments from the needle lumen.
3. Flex the carpus and insert through the dorsal condyle of the ulna into the medullary cavity or flex the stifle and insert in proximal tibiotarsus via the cnemial crest or “tibial plateau” of the bone, which is readily palpated just distal to the stifle joint and the needle can be simply advanced into the medullary cavity. These sites also used for bone marrow aspiration.
4. Aspirate bone marrow to assure correct placement or test inject (there should be no subcutaneous swelling when fluids are administered). Alternatively radiography can ensure correct placement.
5. Attach tape to hub and suture/glue to skin.
6. Fluid type- crystalloids/colloids (warm fluids first).

With practice intravenous fluid therapy can be given to birds as small as 30g (particularly short term) and this nullifies the IO route in most cases.

Intravenous fluid therapy is the preferred route for many cases, particularly more severely dehydrated birds. The site used depends on species and in many cases general anaesthesia will be required for correct placement. Intravenous routes may be difficult to access, and veins are often very small and fragile. Added to this, many birds will not tolerate being attached to a giving set. Therefore, it is common for a one off bolus of fluids to be given directly by needle. Crystalloids, colloids, oxyglobin or blood can be given via this route. The author also provides a multivitamin solution, such as ‘Duphalyte’, via this route in many cases.

The medial metatarsal vein is the first choice in waterfowl but rarely used in other species. Intravenous catheters can be placed without anaesthesia in these birds. 20g to 24g catheters can be used depending on the size of the bird. These can be attached to IV giving sets in Swans and geese or simply have an injection port available for fluid boluses to be given. 10 - 15ml/kg is given initially followed by a maximum rate of 10ml/kg/hour (during anaesthesia). Fluid is given based on the requirements of the case and the practicality of repeat boluses being given by staff.

The Jugular veins are used as a first line for all psittacine birds and birds of prey. Jugular veins can be hard to find in waterfowl due to the density of feathers overlying them, however, it is possible to use this route. A variety of catheters can be used and placed in either jugular vein. The right vein is larger and would typically be used. The vein is mobile and fragile and can easily lead to haematoma formation. Catheters are placed by parting the feathers with spirit to find the apterium over the neck. The catheter is then sutured in place and a light conforming bandage collar can be wrapped around the bird's neck. The catheter has an injection port attached and fluids can be given by a bolus as above. The catheter once in place is very stable, difficult for psittacines to remove, is well tolerated and enables one individual to provide fluid therapy. The author has used this technique in birds as small as 30g, using a 24g catheter.

Although the basilic vein is easy to access for blood sampling it is very fragile and not recommended for permanent catheter placement. However, it can be used for single bolus injections of fluid. The basillic veins are therefore second choice in most species, but are tolerated well by birds of prey and waterfowl. Psittacines will remove these quickly and can bleed out from the placement site. This route is probably the best during anaesthesia as the wing can be easily accessed with minimal interference with the surgeon and reducing the risk of dislodging an endotracheal tube or other items towards the head of the bird. Plucking a few feathers may be required to gain access. Size may limit the availavbility of this vessel in passerines. The vessel passes over the proximal ulna in the medial side of the wing. Here a catheter can be placed (generally smaller than a jugular catheter). The catheter is sutured in place and an additional loop of suture material is passed around the secondary feathers at their base to prevent kinking. Generally birds of over 100g can be catheterised by this route. An injection port can be screwed to the catheter. Fluids are given by bolus injection.

Nebulisation in small birds providing warmed humidified air that can be inhaled can provide an easy stress free way of fluid therapy. The nebuliser provides a small droplet size (3 nanometers) that can penetrate even the smallest of airways. In birds with respiratory compromise using oxygen at 6 litres/minute can help to stabilise a bird that was too dyspnoeic for a clinical examination Therapeutic agents could also be given via this route.

Fluid therapy is required both to provide for maintenance, deficits and ongoing anticipated losses. Maintenance fluids requirement is 50ml/kg/day for birds. In ill birds it is assumed they are fluid deficient. This is taken as 10% for the typical sick bird. The volume of fluid required is calculated by multiplying the estimated percentage deficit by the bodyweight in kilograms.

50% of this deficit should be replaced in the first 24 hours with 25% replaced on day 2 and day 3 alongside maintenance requirements. Ideally fluid therapy should be spaced out over the 24 hour period. An example is given below.

A sick 400g Silver African Grey Parrot

The bird is assumed 10% dehydrated and maintenance requirement: 50 ml/kg/day

Fluid deficit: 400g x 0.10 = 40ml

Maintenance requirement 50 x 400/1000 = 20ml

Day 1 50% deficit + maintenance 40/2 + 20 = 40ml
5ml eight times a day

Day 2 & 3 25% deficit + maintenance 40/4 + 20 = 30ml
5ml six times a day

Day 4 maintenance = 20ml
5ml four times a day

Fluid options for birds

There are a number of oral preparations marketed for veterinary use and include ‘lectade’ and ‘Vetark critical care formula’. A number of probiotic products marketed contain electrolytes and can be made up to isotonic fluids for oral administration.

Crystalloids will cause haemodilution. Both glucose saline and lactated ringers are ideal for birds. Glucose saline provides fluid to temporarily replace the lost circulatory volume but perhaps more importantly provides an immediate energy source in the form of glucose. Therefore, it is the fluid of choice for an initial intravenous or intraosseous bolus. Lactated ringers or hartmanns are useful to correct acidosis as the lactate is converted to bicarbonate in the liver to correct the acidosis. It is the routine maintenance fluid in birds. A simple regime to follow is to use lactated ringers subcutaneously prior to an anaesthetic and then an IV or IO line can be placed for further fluid therapy.

Colloids are used to expand plasma volume containing large molecules, which do not easily pass out of the vasculature. They are used in cases with prolonged illness, starvation, burns and hypoproteinaemia. They are essential for cases of hypovolaemic shock and in cases with a PCV below 20%. The ultimate colloid is whole blood but carries the risks of transfusion reactions, spread of infectious disease and low availability. Donors should ideally be from the same species although pigeons have been used to transfuse psittacine birds. Heterologous transfusions are short lived.

The blood should be taken into acid citrate dextrose and approximately 1% of the bird's body weight can be safely obtained from a healthy donor. For a grey parrot this equates to 5 mls. There are also synthetic colloids (Haemaccel) available, which don't carry oxygen to the tissues but expand plasma volume. These have the advantage of economics and are freely available. Finally there are haemoglobin-based oxygen carriers (Oxyglobin®), which potentially do carry oxygen although there have been no clinical studies to assess their effectiveness at the present time. They are also expensive and only come in large pack sizes designed for a 20-kilogram dog. Colloids are generally given at a rate of 10 – 15ml/kg as a bolus and many authors use a 50:50 mixture with crystalloids as an alternative.

Supportive nutrition

Nutritional support is vital. The owner needs to be asked to bring in some of the birds normal diet and particularly favourite foods to stimulate feeding. Although the birds diet may be inappropriate or lead to it's current problem, the diet must not be changed until the bird is better. Once again knowing how the food is usually presented is vital. In any case providing easy access bowls or scatter feeding on the floor of the cage will encourage feeding in most individuals. In raptors assist feeding is possible, you can soak mice or chicks in water or electrolyte solution or inject solutions into a prey item (e.g. mouse). If the mouse is large it can be cut into pieces. Place your thumb in the bird's mouth at the commissure and force down with fingers while allowing time to swallow between pieces.

In clinical situations there are two main methods of nutritional support that can be practically given.

Crop tubing with foods can be performed readily but may be contraindicated in the initial period but should be instigated as soon as possible. Although young birds can be fed up to 10% of their body weight in one feed great care must be taken with ill adults. The crop is less elastic so no more than 5% of the body weight should be fed in one meal and the birds are more likely to regurgitate in any event and debilitated birds will require much lower volumes. Make sure any fluid or food is fine enough to pass through the crop needle.

Crop feeding is contraindicated in cases of ileus and birds should be rehydrated prior to feeding. With practice the feeding tube can be placed directly into the proventriculus bypassing the crop and the food can be immediately digested as a result. This is of particular importance for falcons with gastrointestinal stasis as a sour crop can develop (as the crop is not turned over) and proventricular feeding allows nutritional support while the bird is being stabilised.

It is also possible to place a proventricular feeding tube. This is useful for cases where head or beak trauma prevents feeding. The bird will require general anaesthesia. The tube can be measured so that its tip reaches to the distal part of the keel in most birds. A nasogastric catheter, giving set or any length of sterilised tubing can be used. There are two ways to place the tubing. Birds have minimal tissue surrounding the proximal oesophagus and the tube can be palpated easily. The tube can be threaded orally and palpated as it passes down the neck.

It can be difficult to get the tube through the thoracic inlet. Placing the bird in dorsal recumbency can help correct placement. The tube can be felt in the distal oesophagus or crop – curling round if placement is not correct. Once through the thoracic inlet the tube can be fed easily into the proventriculus. Once placement is correct the tube can be palpated and elevated in the proximal oesophagus and an incision made directly through the tissue to reveal the catheter. It can then be cut, the proximal section removed and the distal segment sutured to the skin just proximal to the incision site. Alternatively a pair of haemostats can be used to enable placement similar to the method used for oesophagostomy tubes in reptiles.

A proventricular feeding tube reduces stress and can enable both nutritional and fluid support to be given at home by the owner until lesions heal (such as beak trauma). The bird's normal diet can be blended through larger gauge tubes or energy dense foods such as Critical Care Formula® (Vetark) can be given. If critical care formula is not available a simple sugar solution can me made using commercially available fructose and malt dextran. Raptors may need initial assisted feeds to be of a high energy, easily digestible fluid. Seriously ill birds can suffer from a slowing or shut down of the digestive process. Solid foods may then sit in the crop and cause the additional problem of sour crop. Unless gut motility is normal an electrolyte such as Vetark Critical Care should be tube fed. When the bird is able to tolerate solid foods, Hills AD diet or Oxbow Carnivore Critical Care, can be diluted with warm water and used. Oxbow critical care for carnivores is superior as it has a lower purine component. Hand rearing foods are also useful and Harrisons produce a Recovery Formula® which is often used following on from critical care formula®.

Analgesia of birds

Pain relief is important in birds and should not be over looked. Signs of pain may be hidden or go unrecognised. Close observation of patients is required but may need to be done discreetly for many species as they will by nature be reluctant to display any signs of pain or weakness. Anorexia can commonly occur in exotic animals in pain, other signs, such as reluctance to move or depression, are usually more difficult to recognise.

Many birds will self traumatise painful areas and analgesia should not be overlooked. Butorphanol or meloxicam are options to consider for routine use. Pigeons have been shown to have a high concentration of kappa receptors and butorphanol has been shown to provide analgesic effects .However butorphanol does have the disadvantage of causing respiratory depression. Dosages reported range from 0.05 – 4mg/kg IM. I would consider butorphanol in the immediate post operative period when a bird has recovered sufficiently from anaesthesia. Tramadol is also effective and can be given orally at a dose of 10mg/kg twice a day.

Non steroidals such as meloxicam should be provided routinely to birds. It is also available as a liquid that can be given orally after anaesthesia and at home. A dose of 0.2 - 1mg/kg is given. Ketoprofen (5mg/kg) and carprofen (1mg/kg) are other well used alternatives. Steroids have a minimal role in avian medicine and are only used in specific cases.

These are generally administered by intramuscular injection. The standard site due to its large mass is the pectoral muscles. Find the keel of the sternum and inject into the muscles on either side. Give the injection at a 45° angle and not perpendicular to the muscle. Inject small volumes only. The exact amount is dependant on the size of the bird and the bird's pectoral muscle mass. Use alternative sites within the muscle if multiple injections are to be given. If the solution is a known muscle irritant (e.g. enrofloxacin) then consider dilution before administration. If the bird is wild, and is to be released, multiple injections in the pectoral muscles may affect its flight performance. The hind limb musculature can be used as an alternative.

Local anaesthetics have been used but birds are more sensitive and toxic effects have been seen. Lidocaine at 1mg/kg and bupivacaine at 1mg/kg have been used in a premixed syringe to good effect in birds. This combination has the advantage of being quick acting and longer lasting.

Clinical techniques in the avian patient

Presumptive drug therapy is generally not indicated unless based on a sound diagnosis or presumptive diagnosis.

Birds are quite fractious and the range of clinical techniques that can be performed in the conscious patient is limited. However the analysis of samples *from* the bird is possible. Historically clinicians placed too much emphasis on obtaining samples from the conscious patient and drawing conclusions from them avoiding more invasive techniques. However diagnostic plans must be formulated for each case and appropriate tests undertaken with a critical evaluation of the results obtained to link these findings into the whole clinical picture.

Faecal analysis is a good place to start. Chlamydophilla PCR testing has already been mentioned and some practitioners routinely collect faecal samples from any psittacine admitted. It is important to note that this will detect faecal shedding and prior treatment with certain antibiotic classes may stop shedding and lead to a false negative result. Examples of these include the tetracyclines and the fluoroquinolones. Bornavirus PCR can also be performed. Faecal parasitology can also yield useful results, although the incidence of parasites in psittacines is rare, apart from parakeets housed in aviaries with a particulate substrate. It is always worth analysing a 'mute' sample from raptors as many get exposed to wild quarry and infections such as caryospora are common in small falcons. Wildlife casualties, waterfowl and game birds have a higher incidence of faecal parasites and should also be screened whenever possible. Faecal samples collected for parasitology should be as fresh as possible. Specimens that cannot be examined immediately should be fridged and a portion added to equal part of 10% Formalin. (Histology fixative strength). A fresh sample is needed due to the fact that eggs, oocysts and other life cycle variation may alter due to development. The owner may collect the faecal sample immediately after defecation and place into a plastic bag, clean jar or suitable container to keep it moist. Pooled samples may be used if a number of animals are housed together. These samples are used to give a general idea of the degree of parasitic load.

Or you can collect the sample directly from the animal using a cotton swab, although this only gives a tiny sample. Many birds may void during examination (or in transit) and this should be collected if available.

Faecal samples must be handled with care as they may contain parasites, bacteria or viruses that are zoonotic (i.e. hazardous to people). A visual assessment of the faecal sample should be made and noted prior to analysis. A direct smear and a flotation are typically performed with additional tests based on the specific case.

The following notes detail the standard protocol used for faecal analysis in our clinic to be used for your reference.

Direct Smear

Materials required: Microscope slide and cover slip. Applicator stick or loop/sterile saline or water.

Procedure

1) Place a drop of warmed saline or water on the slide with an equal amount of faeces. A drop of stain may be added at this time.

2) Mix thoroughly with the applicator stick to form a homogeneous solution.

3) Remove any large pieces of faecal material.

4) Note: Smear should be thin enough to read print through add more diluent if required.

5) Cover with cover slip.

6) Examine under x10 objective for eggs and larvae and then under x40 for motile protozoa and cysts.

Top tip: If you feel something should be motile and it's not moving, heat a penny or any coin through a flame and rest the slide on it to warm, alternatively heat gently with a lighter or match flame.

Flotation Method

Salt Flotation

Most commonly used but in fact the least desirable. It corrodes laboratory equipment, forms crystals and severely distorts parasite eggs. The maximum specific gravity obtainable is only 1:200, which allows heavier eggs to remain submerged. It also needs TIME for the parasites to rise to the surface.

Flotation Solutions

Saturated Sodium Chloride

Add table salt to water until the salt no longer dissolves but tends to settle to the bottom of the container. Specific gravity cannot go higher than 1:200.

Standard Flotation Technique

Materials required: Flotation solution (saturated sodium chloride), waxed paper cups, tea strainer, tongue depressor and universal.

Procedure

1) Take about 2 grams faeces (1/2 teaspoon) and place in a paper cup.

2) Add approximately 20mls of flotation solutions and gently mix thoroughly to form a thin ‘soup’.

3) Pour this mixture through the tea strainer or alternative and discard large faecal lumps.

4) Pour filtered liquid into a test tube or a universal to the top to form a meniscus. If there is not enough fluid, top up with flotation solution.

5) Gently place a cover slip on top of the tube.

6) Allow the tube to remain UNDISTURBED for a minimum of 20/30 minutes but not longer than 1 hour. If the preparation is not allowed to sit this long, some eggs will not have time to float to the surface and if left longer than 1 hour, eggs may become waterlogged and sink and are also prone to distortion.

7) Carefully remove the cover slip by picking it STRAIGHT UP (don’t slide it off) and place on a slide with the wet side adjacent to the slide.

8) Examine under the microscope at x10 and x40 objectives.

Common faecal parasites

There are a vast number of parasites seen, however only a few are seen commonly. Many can be carried causing no clinical signs and subclinical carriers are the main route of introduction of infections into a collection. Thus diagnostic testing to prevent the introduction of agents into a collection is wise.

Ascarids are a problem in smaller parakeets. Problems are typically witnessed in grass parakeets (*Neophema sp*) and budgerigars (*Melopsittacus undulatus*). These typically have direct life cycles. The most commonly seen is *Ascardia sp*. Backyard poultry, wild passerines and pigeons can also carry ascarids. Heavy burdens can cause fatal intestinal impaction. Heterakis can be transmitted via an intermediate host or directly infective and is common in poultry. It chief significance is in the transmission of *Histomonas meleagridis*.

Capillaria is frequently seen in Tawny owls (*Strix aluco*) and other species. The worms can sometimes be seen at the back of the oropharynx. The eggs are bipolar and can be found on faecal floatation. These require an intermediate host and any animal in contact with wild invertebrates is at risk. Pigeons and wild passerines can also harbour capillaria. Differing species can burrow into the mucosa of the crop, oesophagus or intestine.

Birds of prey can have higher levels of parasitic infections, which they can acquire from their aviary floor (usually these are shingle or soil based) or prey items. These can include *Syngamus* (particularly in wildlife casualties) which are found in the trachea and bronchi. These worms are unusual that the male remains in permanent copulation with the larger female and these can be visualised on endoscopic examination of the respiratory tract or on post mortem examination. The eggs are double operculated can be seen in respiratory secretions or faecal examination. *Syngamus* is also very common in corvids and passerines.

Filarial nematodes are possible and can be found subcutaneously in the tissues and are usually diagnosed by the identification of microfilaria on blood smears.

Tapeworms are unusual although Hymenolepis can be a problem in wild birds. Praziquantal has been reported to be toxic in finches.

Caryospora, Isospora and *Eimeria* can be seen. *Caryospora* has one sporocyst containing eight sporozoites and looks like a fried egg, *Isospora* has two sporocysts containing two sporozoites each and *Eimeria* have four sporocytes with two sporozoites in each. *Caryospora i*s a frequent problem in certain species of falcon (Merlins especially, *Falco columbarius*). Waterfowl and backyard chickens can have heavy burdens with coccidiosis (*Eimeria sp*). Wild passerines and pigeons frequently harbour *Eimeria*. *Isospora* can also be commonly found in birds. Backyard poultry commonly harbour *Eimeria* burdens. *Cryptosporidium* is a pathogen in birds and can cause upper gastrointestinal tract disease or adhere to the respiratory or urinary system. These are usually self limiting.

Cockatiels (*Nymphicus hollandicus*) are predisposed to G*iardia* in their faeces which has been reported to be a cause for feather plucking. *Hexamita* is commonly seen in pigeons, gamebirds and poultry faecal samples. They cause foamy yellow diarrhoea. These parasites are short lived in the environment and a faecal analysis should be performed quickly. *Cochlosoma* can also be found in passerine faecal samples, most typically in juvenile birds.

Atoxoplasma can also be a problem in certain passerine species (canaries and mynahs). This is a systemic infection that replicates in multiple tissues, however sexual stages replicate in the intestine and oocysts can be detected in a faecal examination. Tapeworms can present as pathogens in wild species. *Hymenolepis* is commonly identified in wild passerines.

Cytology

Cytology preparations can be taken from any lesions present on clinical examination and cytological examination of faeces may also yield useful results. Cytology can also be used to augment any culture and sensitivity results confirming the presence of a potential pathogen and an inflammatory response to it. Presumptive therapy can be started while waiting for culture results, or in the event of the culture failing to grow organisms. Cytology can also identify organisms that may be difficult to culture. Slides should be made by gently rolling or dabbing material onto the slide. Faecal gram staining has also been commonly used to identify the quantity of gram positive & negative bacteria and yeasts. Psittacines should have a high percentage of gram positive bacteria. A high level of gram negative rods can imply a poor diet and this has been historically performed to assess the health of captive parrots. Typically a healthy gram stain has less than 30% gram negatives. Generally seed fed birds have far more gram negative bacteria and fewer yeasts and gram positive bacteria compared to pellet fed psittacines, some clinicans have used this as an owner 'incentive' to convert the birds diet. Gram staining may also reveal *Macrorhabdus ornithogaster*. There is little point performing routine cultures unless indicated clinically.

Apart from faecal samples crop washes are commonly performed in birds. To perform a crop flush the bird should be firmly restrained with the neck extended. A speculum or metal sterilised crop tube may be required in psittacines to prevent trauma to the tube. 5% of the bird's bodyweight of warmed saline is passed into the bird's crop. The crop is manipulated and fluid aspirated. Aspirated material should be examined microscopically (immediately as a wet preparation), gram stained and submitted for aerobic, anaerobic and fungal culture. Common pathogens seen include *Trichomonas, Macrorhabdus* and *Candida*. *Trichomonas gallinae* is highly motile in wet preparations (these should be kept warm and examined within 30 minutes. This causes sour crop in psittacines (budgerigars especially) and frounce in raptors. It is an emerging wildlife disease of passerines and also commonly affects columbiforms. *Macrorhabdus ornithogaster* (Avian Gastric Yeast) is a common cause of weight loss in small psittacines, notably budgerigars and passerines, notably canaries. A gram stained preparation reveals multiple gram variable hyphae. *Candidiasis* is very common in juvenile parrots (Blue and gold macaws particularly), leading to gastrointestinal stasis. Many macaw breeders presumptively treat their hand reared chicks during the rearing process. In older parrots it is usually secondary to some other disease process. Typical cottage loaf budding yeasts can be identified on wet prep or gram stained preparations. Candida stains gram positive.

Skin cytology may be undertaken in feather plucking parrots or birds with skin lesions. Confirming these pathogens as primary agents can be difficult. Bacteria and malassezia may be identified in such samples. *Cnemodicoptes pilae* is commonly seen on psittacines and passerines, notably budgerigars as a cause of scaly face. Other *Cnemidocoptes sp* are found in fowl. Red mites (*Dermanyssus gallinae*) can be found on canaries, budgerigars and fowl. Northern mites (*Ornithonyssus sylvarium*) can also be occasionally found on fowl. Lice are also commonly found on wildlife casualty birds or those in contact with wild birds (birds from outside aviaries). In captive birds lice are a particular problem in canaries (*Serinus canarius*).

Feather pulp analysis (cytology and culture) is also frequently performed as bacterial folliculitis and follicle mites (*Syringophilus*) can be seen as potential causes of feather plucking in captive parrots. A recently grown feather is plucked and the contents of the quill squeezed onto a microscope slide. This can be examined as a wet preparation and the stained to assess for inflammatory cells. Diff quick suits this purpose very well. Feathers can also be used for PCR tests to determine certain viral infections (PBFD) or to identify the sex of a bird. PBFD can also be tested on blood and bone marrow aspirates. Hippoboscids ('flat flies') are commonly found on wild birds.

Post mortem cytology of the gastrointestinal lumen is also commonly performed to look for parasites or Macrorhabus.

Urinanalysis is generally not performed in birds. Should collection be attempted (for example in a polyuric bird) then the urine must be aspirated from around the faecal material to minimise contamination. Measurements of specific gravity, glucose, ketones and protein can all give meaningful results. In birds the gross examination can give an indication of polyuria and biliverdin staining (if liver pathology is present). In many birds polyurea can be an indication of renal disease.

Cytological or culture samples can also be taken directly from any other lesions or any site based on clinical presentation. These include ocular, nasal, choanal, aural, oral, cloacal or skin swabs. It is important to obtain a suitable sample. Thus where there is obvious purulent material sampling from the edge of lesions is more likely to lead to a positive culture result. The thick consistency of pus in birds means that in many cases surgery is the treatment of choice with the physical removal of all infected tissue including the abscess capsule is of paramount importance.

Antibacterial therapy based on culture is used to prevent a recurrence from contamination of the surgical wound during surgery or to 'mop up' residual infection where complete excision is not possible (for example bumblefoot in raptors). The centre of many abscesses is biologically sterile. Faecal samples should be minimally contaminated and freshly voided faeces should be used for culture. Swabs taken from the choana, nasal passages or from tracheal washes should be minimally contaminated with oral flora as this may confuse potential treatment and guarded swabs may be required to avoid touching the oral mucosa. This is also true with culture from oral discharges as these may have significant contamination from oral flora and may not reveal the true pathogens. Starving the animal prior to sampling will reduce the level of bacterial flora and food in the oral cavity.

Historically a ‘combi’ culture was considered to be useful in the assessment of avian disease. A culture swab of the choana and cloaca was performed and conclusions drawn on the results generally with antibacterial therapy based on the sensitivity result. This is sadly typical of the approach taken in many exotic animals. However the resistance pattern of commensals may be useful given the high levels of plasmid mediated resistance between gram negative bacteria. Selecting an antibiotic based on this sensitivity where genuine infection is present may be a prudent short term solution pending the results of culture or cytology. It is important to confirm that all pathogens present are receiving appropriate therapy.

If possible the material collected should be placed immediately onto culture media to maximise the growth of fastidious organisms. This is only possible if a laboratory is within walking distance of the practice or the practice has their own. This usually means that samples will need to be placed into a medium prior to transport. Charcoal medium is ideal and this should be held at room temperature for one hour (to allow the bacteria to colonise the medium) and then be kept cool or posted immediately (to reduce the chances of overgrowing the medium). This is fine for aerobic bacteria. Cooling swabs with kill off the more fastidious anaerobes. Samples should be submitted for aerobic, anaerobic and fungal culture. Anaerobic infections can be significant in all species and are typically cultured from deep infections. Avian cultures will typically grow gram negative bacteria with multiple resistance patterns. Agents commonly identified include *Actinobacter, Aeromonas, Campylobacter, Citrobacter, Klebsiella, Moraxella, Pastuerella*, *Prevotella, Proteus, Pseudomonas, Salmonella, Serratia* and *Yersinia*. *Pasteurella* infection is typical after cat bites in many species. It is generally considered that anaerobes are easily eliminated with a 7 – 14 day treatment course. Species typically cultured include *Bacteroides, Clostridium, Fusobacterium* and *Peptostreptococcus*. Sensitivity testing can lead to false sensitivities due to the protracted time required for anaerobic bacteria to grow when using disc diffusion methods.

Many isolates are likely to be pathogenic, but they may not be the primary cause or agent or have any significance whatsoever. Their growth in a culture should always be questioned, as all bacteria isolated from birds have been cultured from healthy individuals. Mixed cultures may indicate that there is no specific agent identified and some laboratories (thankfully) are not performing sensitivities where mixed normal flora has been cultured. A pure culture of a gram negative organism may be due to an overgrowth of one organism and this may lead to inappropriate treatment. This is more likely if previous antibiotic therapy has been utilised and the growth of a resistant organism may be encouraged. However this organism may well not be pathogenic and a change in antibiotic therapy may not be indicated, particularly if the patient is clinically responding. If the patient is not responding then further diagnostics to support the pathogenic role of the bacteria is indicated.

It should be noted that other atypical bacterial pathogens may be involved such as *Mycoplasma, Chlamydophilla* and *Mycobacteria* and antibiotic cover for these may need to be included and this may alter the selection of antimicrobial agents considered. *Mycoplasma spp* are common in respiratory problems in all avian species.

Chlamydophila is a common pathogen in birds leading to respiratory signs. *Mycobacteria* typically lead to chronic abscessation and fibrosis and should be considered a differential in all species.

Selection of an appropriate antimicrobial requires careful thought and clinical parameters and likely pathogens are far more important in the selection process than the cascade. A good exotic animal formulary should be utilised to identify the most suitable regime based ideally on pharmacokinetic studies in the same or similar species. These can be highly variable between species and a blanket dose for all birds is inappropriate.

Antibiotic class selection

Aminoglycosides are bactericidal and act on bacterial ribosomes preventing protein production. They are much less active in purulent material. Side effects include nephrotoxicity and ototoxicity. They are effective against gram negative aerobic infections only and are not absorbed from the gastrointestinal tract. The risk of nephrotoxicity, in humans, is based on the antibiotic remaining above a certain threshold in the serum. This level may well be below the MIC for many pathogens. Less frequent dosing may need to be considered where pharmacokinetic studies have not been performed to reduce the risk of nephrotoxicity. The use of these agents with cephalosporins or penicillins leads to synergism due to increased cell permeability to the aminoglycosides and may help to maintain effectiveness in this situation. To improve effectiveness further a concentration of 3 – 5 times the MIC of the organism at the site of infection is recommended for the aminoglycosides. I only utilise them where a culture result shows resistance to all other therapies. Amikacin is safer than gentamicin and is a second generation aminoglycoside. Generally amikacin has greater activity than gentamicin.

Second generation cephalosporins, such as cephalexin, are stable to gram negative beta lactamases and have greater activity against enterobacteria. They are bactericidal and kills aerobes and anaerobic bacteria by inhibiting mucopeptide synthesis in bacterial cell walls. Ceftazidime is a third generation cephalosporin with excellent anti-pseudomonal activity. Anaerobic bacterial resistance to cephalosporins is low. They are useful as a primary agent or alongside aminoglycosides or fluoroquinolones to extend the spectrum of cover. They are widely distributed both into bone and the CNS if meningitis is present. Ceftazidime is available as an injection only. Once re constituted it only maintains potency for 24 hours at room temperature. Refrigerated injections last for 7 days. Frozen injections remain potent for 3 – 4 months.

Chloramphenicol is bacteriostatic in low doses and bactericidal at higher doses. It is effective against aerobes and anaerobes. It works by inhibiting protein synthesis. It is highly effective against a number of aerobic, anaerobic pathogens and *Mycoplasma*. Human health concerns (bone marrow aplasia) have limited the widespread use of chloramphenicol.

Enrofloxacin is the only licensed antibiotic for use in exotic species. This is bactericidal and effective against aerobic bacteria (particularly *Pseudomonas)* and *Mycoplasma* only.

It acts by inhibiting DNA gyrase and resistance is currently less likely compared to other antibiotic classes and occurs via mutation of the bacteria. Fluoroquinolones are metabolised by hepatic biotransformation and oral administration leads to a first pass effect. Thankfully the hepatic extraction ratio is low. Side effects include cartilage damage in growing animals and CNS signs in humans. Muscle damage due to the alkaline pH (11) of the injectable enrofloxacin is well known. Dilution of samples in saline has been suggested to avoid these local tissue effects. Slow intravenous use is also possible. Sadly abuse of this agent is leading to increasing resistance and reduced efficacy in birds with *Mycoplasma* has been reported. Ciprofloxacin has greater anti-pseudomonal activity and many isolates resistant to enrofloxacin prove sensitive to ciprofloxacin. This is available as an oral preparation and as eye drops (which can be given intranasally). Sadly the bioavailability of ciprofloxacin is less than enrofloxacin when given orally. Marbofloxacin is increasingly used in preference and resistance is lower. The injection has an acidic pH and there are reduced gastrointestinal effects (regurgitation).

Pulse therapy works well and efficacy is determined by obtaining a plasma level eight times or more than the MIC. There is a significant post antibiotic effect (PAE) that acts to inhibit bacteria even when levels drop below the MIC. This effect can last up to 8 hours and depends on bacterial species, drug concentration and effective time above the MIC. Essentially the PAE allows for more infrequent dosing compared to the regime calculated from pharmacokinetic studies.

Macrolides and lincosamides have activity against both aerobic and anaerobic bacteria, but also *Mycoplasma*. Their effectiveness against gram negative pathogens is much reduced compared to other agents. They are bacteriostatic but high doses can become bactericidal. They are metabolised by the liver and cleared by the kidneys. Clarithromycin and azithromycin are newer derivatives with fewer side effects and are becoming increasingly popular choices.

Nitroimidazoles are believed to inhibit DNA synthesis. Over 50% of oral medication is absorbed. Toxic effects effect primarily the liver, CNS and gastrointestinal tract. Metronidazole is commonly used but only has anaerobic activity. Aerobes are naturally inherently resistant. Metronidazole has limited clinical use in birds as macrolides or lincosamides are typically employed for anaerobic cover.

Penicillins act by inhibiting bacterial cell wall synthesis but beta lactamase resistance is possible. These require steady state pharmacokinetics and maintaining the serum level above the MIC for an extended time period is important in their effectiveness. Broad spectrum penillcillins in combination with clavulanic acid, such as amoxicillin (Synulox®, Augmentin®) or ticarcillin (Timentin®) are commonly used in birds. Antipseudomonal penicillins are commonly used in exotic animal medicine where bacterial resistance is likely. These include ticarcillin, carbenicillin and piperacillin. Ticarcillin is the most readily available and can be frozen in a similar fashion to ceftazidime. It also has the best activity against *Pseudomonas*. Ticarcillin is bactericidal and is available with clavulanic acid.

Sulphonamides are underutilized and are effective against a wide range of both aerobic and anaerobic pathogens. They have minimal activity against *Pseudomonas* and many enterobacteria can be resistant. When combined with trimethoprim they are bactericidal and there is synergism between the agents.

Tetracyclines are bacteriostatic only but do have the advantage of being truly broad spectrum covering aerobic and anaerobic pathogens and both *Mycoplasma sp* and *Chlamydophila sp*. They act by binding to the ribosomes and inhibiting protein synthesis. They undergo enterohepatic recirculation in some mammalian species and can have a long duration of activity. This is exploited in avian medicine when doxycycilne is given parenterally for *Chlamydophila* infections. Their action is time dependant and a steady state above the MIC is required. Local irritation leads to slow release of the drugs from the injection site. They are excreted by glomerular filtration. Doxycycline is considered the treatment of choice for Chlamydophila and can be given orally or by injection.

To progress any further with the diagnostic plan birds will generally require anaesthesia. Although venipucture is possible conscious in many species it can lead to considerable stress. The exception to this rule is medial metatarsal sampling in waterfowl.

Anaesthesia of birds

Anaesthesia needs to be as short as possible. A quiet location and all the required equipment must be ready for use. The anaesthetic and surgery can be improved and made safer by paying attention to the main risk areas of anaesthetising a small patient.

Hypothermia can be an issue if the avian patient is anaesthetised for some time. The high surface area to body mass ratio of avian patients causes a rapid loss of heat, this coupled with the flow of drying anaesthetic gases through the respiratory system, the removal of feathers and surgical skin preparation mean that the need to provide a heat source is essential. Minimal plucking, warming fluids used for scrubbing the patient (baby bottle warmer) and minimal use of surgical spirit is the norm. There are a variety of methods available, water circulating heat mats are perhaps the most suitable as they will provide a constant supply of heat at a constant temperature. Other heat sources used include; hot water bottles, heat lamps, warm-air blankets or warmed towels. Switch off any air conditioning and elevate the room temperature whenever possible (room heater on a thermostat for example). To reduce heat loss, clear plastic drapes, silver foil and bubble wrap can be used. Plastic clear drapes act to insulate the patient better than cloth drapes and enable a clearer view of the patient. Great care has to be taken to ensure that at no point do they cause harm. Indeed if using hot water bottles they should not come into direct contact with the patient as they can scald, but conversely they should be removed and replaced as soon as they cool as they will actually withdraw heat from the body if left in contact when cold. Warm-air blankets can dry the eyes and heat lamps can cause a hyperthermia. It is good practice to monitor the body temperature; this can be done with an oesophageal or cloacal thermometer. Oesophageal readings are more reliable indications of core body temperature. Hyperthermia is also a risk if you do your job too well.

Also attention should be made to the birds temperature from admission if sick, through to sedation and premedication and during anaesthesia and recovery.

As with any anaesthetised patient the provision of fluids during an anaesthetic can improve recovery rates and return to normal function. For healthy patients undergoing routine procedures replacement fluids can be administered at a rate of 10ml/kg for the first 2 hours and then 5-8ml/kg thereafter. Replacement fluids should be warmed to 39-40^{o}. Routes of administration include subcutaneous, intravenous and intraosseus. For routine fluid replacement subcutaneous is sufficient. If blood loss has occurred then fluid replacement is of greater value and crystalloids should be given at a rate of 3 times the blood volume lost, if 30% volume has been lost then a blood transfusion should be considered.

Small patients have a small chest volume. The surgeon can prove to be the patient's worst enemy. Ergonomics play a role. A fatigued surgeon is more likely to suffer hand tremor or rest their elbows or hands. Any of these can prove fatal to a small exotic patient. The author prefers to sit and rest his elbows on the side of the anaesthetic table to reduce tremor, the build up of fatigue and the tendency to lean on the patient.

Anaesthesia is required to facilitate handling and diagnostic sampling and is indicated in all birds presented for non routine procedures. It should be thought of as a management technique as opposed to a risky invasive procedure. The aim is to allow sufficient restraint of the patient for the procedure to be performed quickly and safely, to provide analgesia, muscle relaxation and a reduction in stress levels. Traditionally the risk of avian anaesthesia was considered high due to the risk of apnoea or hypoventilation, but the arrival of safer volatile anaesthetic agents together with better monitoring techniques and the ability to ventilate birds, has dramatically improved success rates. This has lead to increased confidence in anaesthetic techniques which result in them becoming a routine procedure for avian patients.

All sick birds require anaesthesia early in their diagnostic work up unless deemed to be too sick to survive an anaesthetic. However, one will be required to achieve a diagnosis and this will need to be staged after a period of supportive care. For example a bird with severe respiratory disease may show minimal clinical signs when in the usual surroundings, but can worsen markedly on handling increasing your concerns regarding anaesthesia and pre-oxygenating this patient will be helpful. A specific diagnosis is required and these cases should rapidly progress to anaesthesia and if a syringeal blockage is suspected then anaesthesia is indicated as an emergency procedure to place an air sac tube.

Many texts stipulate that the birds PCV is an important parameter to assess prior to anaesthesia as fluid therapy or a blood transfusion may be indicated. Placement of an IV or IO catheter will require anaesthesia as will sampling for a blood profile in most species of birds. Prolonged physical restraint can prove fatal in a debilitated bird. In many cases stabilisation for a period in oxygen and giving subcutaneous fluids for 1 – 2 hours is ideal followed by a short anaesthetic to obtain IV access.

In some emaciated birds providing nutritional support by crop tube first for 24 – 48 hours may be wise prior to diagnostics. Clinical assessment of the bird is important as many caged birds can be obese. Atheroma and arteriosclerosis can be found and can cause cardiac arrest during anaesthesia. A coelomic ascites will put pressure on the air sacs and this should be borne in mind. Try to place these birds in lateral recumbency if possible.

Withholding food is generally not performed. Due to their high metabolic rate (particularly passerines) and poor glycogen storage it can be detrimental to withhold food from birds. Some advocate starvation for small birds (canaries/budgies) of 30 minutes and 1-3 hours for increasing sizes of bird. Starvation will mean that the crop, which is the first part of the digestive system, has emptied and will greatly reduce the chance of reflux once anaesthetised. Larger parrots should only be anaesthetised if the crop is empty, unless it is an emergency procedure. Some parties believe that the realities of avian anaesthesia mean that, providing intubation is practised as routine, the need to starve for an extended period of time is all but removed. Regurgitation is a particular problem with juvenile psittacines and intubation is mandatory for these cases. A bird of prey or waterfowl may need 4-8 hours starvation. It is worth checking if the raptor has cast following feeding the night before as it is possible for a bird to try to cast upon recovery from anaesthesia which can lead to complications.

Pre-anaesthetic medications

The administration of parasympathetic antagonists as premedicants is not routinely practised in birds. They do not have the same benefit in avian patients as they do in mammals, in fact they often have a negative effect, causing unacceptable levels of tachycardia and myocardial oxygen demand and thickening oral and respiratory secretions.

Occasionally diazepam or midazolam are used in waterfowl to reduce to breath- holding or the dive-reflex as it is erroneously known. This is a trigeminal receptor initiated response whereby the breath is held and the blood flow diverted to the brain, kidneys and heart.

Most birds we are dealing with have nine air sacs. These are comprised of the paired cervical, single clavicular, paired cranial thoracic, paired caudal thoracic and paired abdominal. These air sacs are split into a cranial (cervical, clavicular, cranial thoracic) and caudal (caudal thoracic and abdominal) groups. These act as bellows and provide airflow to the rigid lung. They are poorly vascularised and are minimally involved in gaseous exchange. However, they account for some 80% of the respiratory volume. Gas exchange occurs in the lungs mainly in the paleopulmonic Para bronchi. The inspired air travels in one direction from the caudal air sacs to the lungs, then to the cranial air sacs before expiration. This produces a unidirectional flow and there is oxygen absorption at all phases of the cycle. The lungs are thin walled and fixed to the roof of the thorax and do not expand or contract. This stability means that they can have thinner respiratory membranes and thus a far greater gas perfusion rates. The blood and gas flow is in a counter current manner allowing a highly efficient oxygen gradient to be established over the respiratory membranes.

This highly efficient method of gas exchange together with the potential of the air sacs to act as gas reservoirs means that anaesthetic overdose is a potential hazard and there is a lag phase prior to the gaseous anaesthetic reaching the lung fields.

Isoflurane and sevoflurane both provide rapid inductions and recoveries due to low blood gas coefficients. This means that they have a low solubility in blood, so less is distributed to the tissues & nearly all is exhaled. They therefore require little to no organ metabolism meaning depth of anaesthesia is more easily controlled. Respiratory arrest occurs prior to cardiac arrest giving opportunity for intervention and recovery times are markedly reduced. However should mechanical ventilation be employed then relying on this fact is usurped by good nursing skill and other monitoring methods. These do not sensitise the myocardium to catecholamines as much as halothane which is important when a bird may have been stressed in catching.

Sevoflurane has the advantage of quicker induction and recovery times due to its higher lipid solubility. However due to the inhibiting cost factor associated with sevoflurane, isoflurane tends to be the anaesthetic of choice for most practitioners.

However, it should be remembered that although analgesia during the operation is good, no analgesia is afforded once the anaesthetic is over. Nitrous Oxide is not recommended as it can severely suppress ventilation rates and has been associated with respiratory acidosis.

Most birds (non diving species) are induced by mask within 1 - 5 minutes. If the bird fails to become anaesthetised it can be associated with respiratory disease such as air sac abscessation which effects the normal movement of air through the bird.

For mask induction you need a well fitting mask and isoflurane concentrations of 5% and oxygen flow rates of 1 – 2 litres/minute using an Ayres mini T-piece. Take care not to hold too tightly at this stage and restrict sternal movements. Although masks are available commercially with rubber caps, psittacine birds will quickly destroy these. For these we prefer to use syringe cases and plastic bottles modified with cohesive bandage and elastoplast. They can be disposable if you wish (to reduce the risk of disease transmission such as PBFD) and any frayed material replaced. For raptors flexible rubber masks are utilised. Induction chambers can also be used although the anaesthetist clearly has less control over the procedure.

Non volatile agents may be useful in certain circumstances. Obviously weighing the bird beforehand is vital in these cases and the larger the bird the lower the dose rate tends to be. In waterfowl which undergo a degree of breath holding during induction then an injectable combination to allow intubation is most helpful. IV induction can be used in waterfowl and dosages used in mute swans are well established. I use a pre-filled syringe with medetomidine 0.1mg and ketamine 90mg and to effect. Xylazine or dexmedetomidine are alternatives to medetomidine. Generally half to three quarter of this mixture is given to an adult healthy swan IV and this allows intubation.

Venous access is best obtained from the medial metatarsal vein which runs over the caudomedial aspect of the tarsometarsus. Propofol has been used at 10mg/kg. This can cause significant respiratory depression. Medetomidine and ketamine can also be given intramuscularly (Medetomidine (150-350ug/kg) and ketamine (4-10mg/kg IM) is the most useful combination and has been used in a wide variety of species. the most common site used is the pectoral muscle, which is often highly developed as it is a flight muscle.. Combinations and doses vary depending on the patient involved. The advantage of an IM combination induction agent is that it can usually be administered with minimal handling. The induction time is variable, usually 5-10 minutes, however recovery time is prolonged; 2-4 hours and the drugs involved require organ metabolism to be excreted from the body. These combinations are most commonly used in waterfowl and ratites. Alfaxalone has also been used intravenously and intramuscularly in birds.

When at a suitable plane of anaesthesia, the bird should be intubated. If at all possible all birds should be intubated but there are a few exceptions to this rule outlined below. Birds have no epiglottis and in most species no complex laryngeal structures, just a simple glottis that lies closed at rest. These factors mean that E.T. tube placement is relatively easy when compared with mammals. Uncuffed latex tubes should be used and ones under 2mm in diameter have stylets to aid intubation. The size of tube should reflect the size of the bird aiming to completely fill the trachea so an almost air tight seal is created, vital for artificial ventilation. Birds have complete tracheal rings and cuffing a tube is not indicated in most cases.

In parrots the tongue should be pulled forwards with atraumatic forceps to facilitate intubation due to the muscular nature of the tongue. The rima glottis will be seen at the back of the tongue and will open during inspiration, at which time the tube can be placed. The tube is inserted and can be tied in place behind the head. Birds have complete tracheal rings and cuffing a tube is not indicated in most cases. The use of a self cuffing E.T. tube can be invaluable especially if a mechanical ventilator is to be used. The bird can then be placed on an Ayres T-piece circuit with an oxygen flow rate of 1 – 2 litres. It is very important to avoid damaging the trachea during intubation, especially in Blue and Gold Macaws (*Ara araruana*), as this can lead to tracheal stricture several days following the procedure. This can be caused by a non-secure tube move slightly backwards and forwards in the trachea as the bird is moved. In these species an airsac cannula should be placed for longer procedures. It is important that the E.T. tubes are cleaned with a non-chlorhexadine based cleaner. This is because chlorhexadine is an epithelial tissue irritant.

Once placed the tube should be secured, in most species of bird this can be achieved relatively easily by taping around the tube and the beak. In psittacines this can be slightly more difficult due to the size of the beak. String can be used with caution, ensuring the eyes are avoided and it is not tied too tight.

Blockage of endotracheal tubes with mucus is also a real risk during long procedures given the small size of the endotracheal tubes, but the risk is reduced by using mechanical ventilators. Raptors can have their feet padded and dressed at this stage to prevent injury to staff. These should be removed prior to recovery.

If work is being done around the head or if there is a blockage (a syringeal aspergilloma for example) then placing an air sac tube can be used to maintain anaesthesia. In many birds in acute respiratory compromise this will be an emergency procedure.

Air sac tube placement

In cases of upper respiratory distress the nares, pharynx, trachea and syrinx can be bypassed by placing an air sac tube. In cases of syrngeal aspergilloma or tracheal obstruction, birds present gasping for breath, neck extended and a characteristic squeak with each inspiration. The air sac tube can be inserted to buy time before any obstruction alleviated. Air sac tubes will not assist conditions where the respiratory disease is below the level of the syrinx (pneumonia) and is contraindicated in birds with lower respiratory disease (affecting the air sacs).

This is a relatively commonly performed emergency procedure. For entry into the coelomic cavity minimal instrumentation is required. Ophthalmic instruments are best. For entry the skin is incised and the muscles penetrated by either a pair of round ended scissors or artery forceps. The entry site can be either between the last two ribs or behind the last rib, usually at the midpoint on the left hand side. From a practical point of view the ideal entry point is the caudal thoracic air sac as this has a direct communication with the lung fields. In order to increase the chances of entering the caudal thoracic air sac I would suggest an entry point between the last two ribs. The ribs also provide some support to the entry site and less pressure is required to enter the body cavity and the body wall at this point is not so compressive. Bird position is important to facilitate entry into the body cavity. The bird is positioned in right lateral recumbency with both wings brought dorsally and held in place with a sandbag. This places the bird in a true lateral position. The left (upper) leg is retracted caudally and held in place (usually by the nurse). Feathers over the caudal ribcage are plucked and the area can then be examined. The borders of the entry site are the lumbar vertebrae, the iliotibialis (thigh musculature) and the rib cage. With the leg retracted the ribs can be easily palpated and the entry location identified. It is important to miss vital structures that lie inside the body cavity. Placing the leg cranially (the Taylor hold) is an alternative and if the tube is required to be in place for a few days, typically the birds tolerate this position better. The actual entry point into the body cavity is identical except that instruments are directed cranially.

Ventrally there is the liver and proventriculus, dorsally the kidney, gonad and adrenal gland and cranially the lung field sits under the rib cage. The entry therefore is halfway up the ribs of the bird. This provides and entry site just above the proventriculus.

The skin is incised using scissors and any subcutaneous tissue bluntly dissected away. It is important to reflect any thigh musculature caudally. This facilitates entry into the body cavity and less force is required. Round ended scissors or fine curved artery forceps can then be used to enter the body cavity. Gentle steady pressure is required until there is a sudden advancement of the instrument. This may be accompanied by an audible pop as the air sac is entered.

The instrument can then be opened to bluntly dissect the muscle fibres apart and it is then removed (still open) such that no tissue is incised or crushed. An air sac tube can be made out of a shortened endotracheal tube (usually a 4mm portex tube for most birds) - lateral holes in the end of the tube can help prevent blockage. This can be inserted and sutured to the skin and muscle of the body wall. In many cases placement of the air sac tube leads to immediate relief as oxygenation or anaesthetising the bird via the air sac tube is now the preferred option. It may be that some diagnostics could be performed while you are there and tracheal endoscopy is high on the list of requirements. Removal of the air sac tube is indicated when the pathology has been identified and dealt with successfully. Air sac tubes can remain in place for up to a week. Closure of the surgical wound is not required.

Air sac tubes are also indicated in those species where tracheal stricture is a complication of intubation. Species such as blue and gold macaws, scarlet macaws and owls have been reported to suffer from this condition. In these species mask induction can be followed by maintenance for brief periods or an air sac tube can be placed for longer procedures.

However this is the normal anatomy and there are some considerations when dealing with birds where pathology may be evident (that's all of them). Birds with hepatomegaly, Proventricular dilatation, ascites, severe respiratory pathology, or any other space occupying lesion (egg, big ovary or a tumour) may well require a more cautious approach and so a careful clinical examination is important to minimise the chances that the dysponea is due to ascites or a space occupying lesion within the coelomic cavity. Radiography may be worthwhile prior to placing an air sac tube for confirmation but this would usually delay the procedure risking respiratory arrest.

In waterfowl an extra laryngeal cartilage, the crista ventrailis, can prove a minor hindrance to intubation as this is a vertical laryngeal cartilage centrally located within the glottis. This limits the tube size and needs to be displaced slightly by a smaller tube. Some authors have considered lightly cuffing tubes in ducks as a result. Many sea birds also have this feature.

Without airflow over the lungs no gaseous exchange can occur so apnoea is a life threatening condition in an anaesthetised bird. Once anaesthetised the bird's normal ventilatory performance is altered due to the relaxed abdominal viscera compressing the air sacs, and reducing the effective respiratory volume. The respiratory rate is also depressed. This is more dramatic in a bird placed in ventral rather than dorsal recumbency, and consideration should always be given to providing IPPV. This is indicated in all animals that are intubated and will markedly improve the patient's chance of survival. PO_2 is increased and $ETCO_2$ decreased by ventilation and with the addition of capnography and pulse oximetry can be monitored throughout the procedure. IPPV ensures there is no apnoea and allows the anaesthetist to concentrate on monitoring.

If mechanical ventilators are not available then it is important to closely monitor spontaneous breathing and manually ventilate the bird if required. This can be difficult to assess especially if a bird is draped up, and the use of a side stream capnograph to measure end tidal CO_2 and respiration rate.

The use of commercial mechanical ventilators adapted to fit the Ayres T-piece circuit removes the concern relating to apnoea, and allows the assistant to concentrate on other factors. We routinely monitor the brachial pulse and corneal reflex by digital pressure together with mechanical IPPV and capnography.

Relying on a nurse to provide consistent ventilation is difficult as the slightest of touches on the bag is usually sufficient to inflate the airsacs appropriately, however there are many distractions and the rate and level of ventilation is likely to be highly variable. Mechanical ventilators that are able to cope with the smallest birds are now available and of great value, not only will they allow for a much better control over rate and depth of anaesthesia, but they also eliminate the reliance on the anaesthetist and free them up to monitor the anaesthetic more closely. We use the small animal ventilator MA03® (Vetronic services). This is a pressure cycling system which is measured at the end of the endotracheal tube. There are two variables to consider. First is the pressure setting and the second the expiration time. The ventilator relies on the animal's inherent elastic recoil for expiration to occur after a set time lag (set by the operator) a valve shuts causing the animal to fill with oxygen (and hence inspire) until the set pressure is reached and then the valve is opened. This is a simple system to use and the pressure setting is gauged by observing the animal's chest movements. It is good practice to assess the amount of respiratory movement that the conscious patient generates and try to mimic that. The trigger pressure required for most patients is around 8mm H_2O in the majority of species irrespective of size. The frequency should also be set to the normal anticipated respiratory rate. This ventilator overrides the normal respiratory pattern. There are other larger, more costly, ventilators on the market which augment normal respiration. These units detect a breath and insufflate the animal to a required volume or pressure. A set time lag occurs until the ventilator instigates a breath or it augments the animals own breath and re sets the timer.

One potential problem exists when ventilating small patients. The pressure is monitored at the junction between the circuit and the endotracheal tube. If there is a marked decrease in volume then the pressure will build up with high flow rates deactivating the ventilator. This means there is poor insufflation of the patient and the typical response is to elevate the flow rate worsening the problem. Then increasing the pressure setting is used in a further attempt to ventilate the patient. DO NOT DO THIS. The problem is the high flow rate used. Firstly lower the pressure setting right down and then lower the flow rate. Then the pressure can be increased for effective ventilation. DOING THIS THE OTHER WAY AROUND OVERINFLATES THE PATIENT. If this happens quickly switch off the IPPV (there is a flip switch) to open the valve. Then sort out your pressure and flow rate and switch the IPPV back on.

The flow rate and the finite size of space that has to be filled influences the inspiration time. This should be minimised (ideally 1 – 2 seconds) by getting the flow rate right for each patient. Birds have large air sacs which means higher flow rates are required.

In birds mechanical ventilation through an air sac tube works equally as well. During abdominal operations the ventilator is still functional if the thoracic air sacs are intact. If the air sacs are opened there will still be anaesthetic laden gas being passed over the paleopulmonic lung fields. Arguably most gas exchange would occur over the neopulmonic tissue which will be poorly ventilated during abdominal surgery. In these cases covering the surgical field in an attempt to seal it and compressing the abdomen may allow some ventilation of the neopulmonic parabronchial tissue. There is obviously surgeon exposure to anaesthetic gasses. During endoscopy procedures occasionally ventilation will cease, depending on which air sac is entered. This usually is regained with the insertion of the endoscope and by placing the surgeons hand around it to manipulate it. Artificial ventilation has been shown to reduce the mortality rate in avian patients under anaesthesia. In one practice the level fell from 4.65% to 0.75%.

Monitoring a bird during anaesthesia is a skilled and critical role. The eye of a bird remains fixed in position. During induction there is usually a short excitement phase, where the respiratory rate is erratic and shallow. As anaesthesia progresses voluntary movement will cease, but CNS reflexes remain. These reflexes include, palpebral, corneal and pedal. As stage 3 of anaesthesia is reached the palpebral reflex is lost, but the pedal and corneal reflexes remain. The most useful reflex is the corneal reflex. Touching the eye should make the third eyelid move across it. This reflex should remain through the whole anaesthetic procedure, but it slows with depth. If the bird is too deep the reflex can stop, as it lightens it speeds up. This reflex can be extremely useful but requires an experienced anaesthetist to evaluate it. The reflex can become extinct to frequent prodding by the inexperienced, and ocular lubricants should be applied to prevent damage. Many people prefer to use a dampened cotton bud to assess this reflex. This is the level required for non-invasive procedures.

For a surgical plane of anaesthesia to be attained the patient is allowed to become slightly deeper, whereby the pedal reflex is lost and the corneal reflex is slower. If the corneal reflex is lost then the patient is too deep and efforts should be made to lighten the bird immediately.

Heart and pulse rate should also be monitored closely and be constant (approx. 700 for small budgies to 400 for African greys to 60 for large birds of prey). Turn the bird down if the rate slows to about 100 as this can indicate that it is getting too deep. The pulse can be felt over the brachial vessels that cross the ulna near to the elbow joint. When palpating the vessel care should be taken not to occlude it by applying too much pressure, especially in small birds. The heart can be auscultated ventrally over the keel and dorsally over the back. The rate is variable depending on the size of the patient. The sounds often become clearer when the bird is anaesthetised as muscular sounds are eliminated. If at any point the rate, rhythm or heart sounds vary then the anaesthetist and veterinary surgeon should be made aware and appropriate action taken.

Capnography

Ventilatory failure is the primary cause of morbidity and mortality under anaesthesia. The principle of capnography is based on the rapid exchange of gases between the lungs and the circulation. This means the $ETCO_2$ correlates well with the $PaCO_2$ of the animal and because of the rapid rate of exchange capnography is very sensitive and immediate. Capnography has superseded pulse oximetry as the must have anaesthetic monitoring device.

In African grey parrots $ETCO_2$ was compared to $PaCO_2$ and produced good correlation but consistently over estimated the $PaCO_2$ by 5mmHg. Despite this, it still provides a reasonable continuous assessment of ventilation. In human medicine a difference of 5 – 10mm Hg is expected. Further studies have been performed in raptors with similar findings.

Pulse oximetry

Pulse oximetry has been used on a variety of animals and PaO_2 has been shown to correlate with SaO_2 in a number of species. Many units come with a set range of probes and this can prove difficult to adapt to the patients. Units are based on human oxygen haemoglobin dissociation curves. In pigeons and parrots the PaO_2 from two commercial pulse oximeters correlated poorly with SaO_2 values. Pulse oximetry however does not give any information on blood flow or oxygen deliverance to tissues and has fallen out of favour given the increased sensitivity of capnography. Pulse oximetry does enable the heart rate to be monitored on a continuous basis and this has been shown to be consistent in birds. Most pulse oximeters can measure up to 350BPM. This may be exceeded in small patients. Probes on the tongue, ear, or via the mouth or anus/cloaca can be used and there are oesophageal probes that can fit into rats readily available. An oesophageal stethoscope can be used as an alternative.

Blood pressure monitoring.

Although the volume and filling of the basillic vein is a useful parameter to monitor during anaesthesia. Indirect blood pressure monitoring has been shown to be a useful technique in birds. Validity of the results is influenced by cuff size, the birds blood pressure, the monitor itself and the site of placement. In birds the best results are obtained using a cuff width of 40 – 50% of the diameter. This is placed either over the humerus (with some concerns regarding the pytagium) or the tibiotarsus. Use a Doppler probe to identify vessel flow. Blow up cuff until sound lost = Systolic Arterial Pressure and first pulse sound after let down = Diastolic Arterial Pressure. As bird require physical restraint for blood pressure monitoring it is difficult to obtain reference ranges and monitoring trends is suggested as the ideal method. Under anaesthetic blood pressure drops due to reduction in vascular resistance or decrease in the cardiac output. Sevoflurane provides worse values than isoflurane according to some papers. IPPV does not increase arterial pressure and is likely due to a lack of a diaphragm and increased air sac compliance (so less pressure).

Recovery

Recovery is usually rapid once the inhaled anaesthetic agent has been turned off. Ventilation with 100% oxygen should continue until the presence of the E.T. tube is resented and a response to noxious stimuli has returned. Many birds die at this stage rather than induction and it is vital to leave the bird on the mechanical ventilator until the very last minute. At this time the E.T. tube should be removed and the patient should be gently restrained with continued monitoring. Some birds will allow oxygen to be delivered by mask at this time.

This stage of recovery is the most important as although the patient will appear to have recovered from the anaesthetic it is at this point that agitated responses i.e. wing flapping and excessive bending of the neck can occur. If left alone at this time the bird can bend its neck in such a fashion that the trachea becomes occluded and they can suffocate.

Support its head in a towel as a floppy head can obstruct the airway and check for any mucous at the glottis if possible. Hold the bird continually until it is able to perch. Care must be taken not to cause hyperthermia within the towel.

Should the bird arrest at this point or during anaesthesia doxapram at 5 – 10 mg/kg can be given by any parenteral route. Adrenalin and atropine can be given at 0.1 mg/kg. Reversal agents, oxygenation and IPPV should be provided.

Once the bird has become aware of its surroundings and can stand properly, it can be returned to its hospital area. Again remote monitoring for some time is good practice as the patient may still be sleepier than it appears.

The bird should be placed in a warm but dark hospital cage, and observed constantly until the operator is satisfied a full recovery has been made. Watch that the bird is eating soon after recovery; if not then it may need crop tubing. It is useful to provide heated surroundings for the first few hours after anaesthesia. Many patients will need to be kept in overnight so further analgesics, fluids and antibiotics can be given.

More invasive diagnostic procedures that typically require anaesthesia

Blood sampling

Birds have a large heart with four chambers. The lungs are dorsal to the heart & the liver lobes cover the heart base. The cardiac output is large due to a high heart rate and large stroke volume combined with thick walled arteries necessary to accommodate high blood pressures. Blood volume is approximately 10% of body weight. Erythrocytes are short lived compared to mammals, so anaemia can develop rapidly as can recovery from significant blood loss.

The right jugular is larger than the left. A rule of thumb for blood sampling in birds is take no more than 1% of body weight **in a healthy bird** (halve this in a bird that is ill). Persistent anaemias need to be investigated as birds will usually quickly regenerate their circulating blood volume after an episode of blood loss.

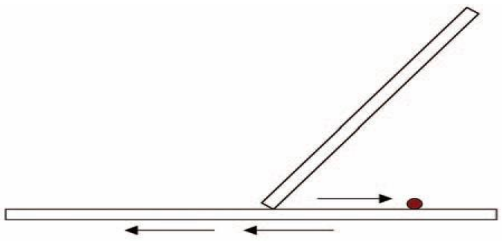
Common sites used for blood collection are similar to those used for intravenous fluid therapy and include the ulnar/basilic/radial/cutaneus/wing (same vein but will have different names in various texts). This is found coursing over the proximal ulna on the ventral aspect of the wing. This vein is fragile and quite mobile. Haematoma formation can easily occur and 27 gauge needles are recommended. This is typically used in psittacines, falconiformes, strigiformes, passeriformes, galliformes and anseriformes and columbiformes. The right jugular vein is large and is useful if large volumes are required, provided the bird has apteriae over the vein but venepuncture is possible, blind in waterfowl and penguins. The left jugular can be used as second choice. The jugular veins are mobile and need to be stabilised prior to sampling. The medial metatarsal is good for most waterfowl, domestic chickens and penguins. This vessel courses on the medial aspect of the tarsometatarsus and anaesthesia is usually not required. Haematoma formation is usually minimal, but only small blood volumes can be obtained in smaller birds via this vessel.

Too large a syringe and over enthusiasm will cause excessive negative pressure when drawing back on the plunger leading to the collapse or spasm of the vein. Some practitioners will flush the needle and syringe with heparinised sterile saline. This can facilitate blood flow and will not affect clinical pathology values if the heparin only coats the syringe. Positioning is the most important key to success with avian venipuncture. Birds do not have a panniculus so their skin is very mobile and needs to be held taut in the direction the needle is pointing. The angle the needle penetrates the vein is also important. Some practitioners will bend a needle to obtain a better angle of entry to the vein. Haemostasis is vital after withdrawal of the needle. 25 (orange) or ideally 27 gauge (grey) needles should be used. NEVER squirt blood out of the needle. If an insulin syringe is used. Re cap the tube, draw the plunger back and cut off the needle with canine nail clippers, then gently push the blood into the appropriate sample containers. Apply pressure to the venipuncture site for at least two minutes as haematoma formation is common. Lastly, consider the stress on the bird and whether venipuncture is best accomplished under anaesthesia or conscious. Heparin is typically used in birds as it can be both utilised for haematology and biochemistry. However if sufficient blood is available then EDTA should be used for haematology.

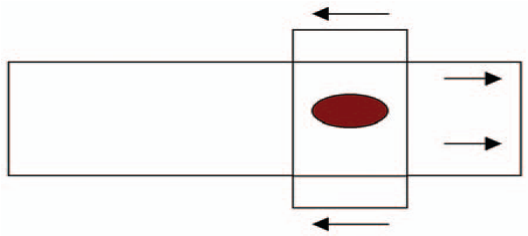
Making a blood smear can be very hard and some commercial laboratories just bin them when sent. However they can be of use ‘in house. It is best to place all blood into the appropriate sampling containers and use what is left for blood smearing. The objective is to produce a cell monolayer with an even distribution of leucocytes.

The slide on slide wedge technique is commonly used. This technique can cause greater cell damage than other techniques and more margination of granulocytes. A bevelled edge to the spreader can minimize this. *Use clean slides*. Place a small drop of blood on one end of the slide.

A spreader is placed at approximately 30º angle to the slide (the greater the angle the thicker the film). It is drawn back until it touches the blood drop. After the blood spreads across the edge of the spreader move forward with a firm and clean motion. Air dry.



A slide and cover slip technique employs a 22mm x 60mm cover slip. Place a small drop of blood near the end of the slide. Place the cover slip over the blood and allow the blood to radiate out between the slide and cover slip. Horizontally pull the slide and cover slip apart without lifting (this can take practice as the biggest mistake is pulling, rather than sliding the cover slip off the slide).



Stain with Romanowsky's stains (e.g. Wrights/Giemsa) which stain granulocytes better than Diff-Quick or Rapid diff stains.

Avian haematology

If performing haematology yourself then the simplest way is to do a PCV, a blood smear and an indirect white cell count.

PCV values fall between 35 and 55% with a rough negative correlation between PCV and body size. PCV can be affected by age, sex, season, time of day, reproductive cycle and photoperiod. For example PCVs are generally lower (20-30%) in nestlings still to fledge. Generally decreases in PCV indicate an anaemia and increases (often with increased serum protein) indicate dehydration. Changes in serum/plasma colour should also be noted (lipaemia, haemolysis, carotenoid pigmentation).

Birds have nucleated red blood cells and they are larger than mammalian cells. Erythropoiesis only occurs in the bone marrow, thus mitoses on the blood film are abnormal. In general terms the changes in morphology of the red cell and indices follow the mammalian pattern. Of particular interest in avian films is the level of polychromasia and anisocytosis of the cells which, if elevated, indicates a regenerative response. This is due to the relatively short lifespan of avian erythrocytes meaning there will be more reticulocytes and other precursor cells within the circulation. Avian red cells survive for about 30 – 45 days only.

Regenerative anaemias can result from trauma, ectoparasitism, coagulopathies, endoparasitism or ulcerated neoplasms. Haemolytic anaemias can be associated with bacterial septicaemias, toxaemias, aflatoxins and toxic chemicals (petroleum in oil spill affected waterbirds).

Ballooned or misshapen erythrocytes with an increased amount of chromatin and hypochromasia may be seen in liver disease, lead poisoning, and erythaemic myelosis. Basophilic stippling is not seen in avian lead poisoning

Non regenerative anaemias typically appear as a normocytic, normochromic anaemia and are typical of chronic infectious diseases such as tuberculosis, chlamydophylosis, aspergillosis and chronic liver disease. Other causes include nutritional deficiencies (e.g. iron) and starvation (withholding food from birds will result in the absence of reticulocytes within 48 hours), chronic renal disease, viral infections and toxicities (chloramphenicol, carbamates, organochlorine pesticides).

Avian leukocytes differ from the mammalian classification. The first cell of concern is the heterophil. This is a granulocyte with similar functions to the mammalian neutrophil and is the most abundant leukocyte. It responds in acute infections, most typically to bacteria including *Chlamydophila,* but elevations can occur in response to viral, fungal and parasitic infections as well as traumatic injuries, toxicities (zinc, organophosphates) and stress can cause a leucocytosis with heterophilia. Severe heterophilias may contain cells demonstrating toxic changes, which usually indicates a poor prognosis. Toxic activity can be assessed by darkening granules (increasing basophilia) and intracellular bacteria can be identified. Typically numbers are elevated and toxic when an infection is evident.

Stressors usually elevate the number of heterophils and depress the number of lymphocytes and thus the heterophil/lymphocyte ratio can be a useful indicator of stress in birds. While most domestic avian species have lymphocytes as the predominant circulating leucocyte, psittacines, raptors and ratites have higher levels of heterophils, and thus demonstrate less dramatic changes in the stress leucogram. A heterophilia associated with a monocytosis is often seen in chronic infections such as mycobacteriosis, mycotic infections and Chlamydophilosis.

Heteropaenia is seen in severe inflammatory disease when the rate of utilization outstrips the rate of production. This is often accompanied by a left shift and toxic changes. Overwhelming viral infections, such as Pacheco's disease, may lead to a heteropaenia without a left shift. A heteropaenia with a non regenerative anaemia and thrombocytopaenia is indicative of a chronic bone marrow injury or PBFD infection.

Eosinophils and basophils are much less common and tend to be smaller and more eosinophillic or basophilic respectively. The nucleus can be obscured from view due the number of intracytoplasmic granules evident. An eosinophillia is interpreted as a response to parasitism or foreign antigen (hypersensitivity reaction). Basophils produce, store and release histamine and may function in hypersensitivity reactions. Basophilia is rare in birds.

Lymphocytes resemble the mammalian cells and respond similarly. Monocytes are the largest leukocyte present and once again resemble the mammalian cell. These agranulocytes respond in chronic diseases and can be elevated with avian tuberculosis, aspergillus and chlamydophila infections. Lymphoid leukaemia can also lead to elevations. Foreign body reactions, neoplasia and zinc deficiency can also cause a monocytosis. Viral infections (PBFD), cortociosteroids, stress, or toxicity (fenbendazole) can lead to a plummeting white cell count to the extent it can be difficult to find any on the blood films.

Birds also have nucleated thrombocytes and these are the second most numerous cells after the erythrocytes. These are small round to oval basophilic cells with no granules. They are usually clumped on blood films. The main function of thrombocytes, like the mammalian platelet, is haemostasis. Thrombocytes are capable of phagocytosis and may play a role in removing foreign material, including bacteria, from the blood and pseudopodia can be seen on the films.

White cell counts are either counted directly or estimated based on the blood smear.

Technique:

1. Scan the slide on 10x objective to ensure a monolayer of cells (technique will only be accurate if counting in a monolayer)

2. Using high dry power (40X) count all the leucocytes in 10 evenly distributed fields and divide by 10

3. Multiply this by 2 and this is the number of cells x 10^9/L

4. If the PCV is outside the normal range (40-55%) then correct the count by using the following formulae:

5. $\frac{\text{Estimated WBCC x actual PCV}}{\text{Normal PCV}}$

6. Take normal PCV to be 47.7 in an adult bird or look up reference values for that species

White cell reference ranges are large for many avian species blurring the margins between disease and a physiological leucocytosis, therefore caution should be used during interpretation. Stress, captivity, age and season can all affect the leucocyte response. Causes of a leucocytosis include infectious and non infectious inflammatory reactions, toxicities, leukaemia and rapidly growing neoplasms.

Abnormal finding	Differential diagnosis
Regenerative (blood loss) anaemia	Trauma, parasites, coagulopathy, organic disease
Haemolytic anaemia	Red blood cell parasites, bacterial septicaemia, toxicity, immune mediated
Non-regenerative anaemia	Chronic disease, hypothyroidism, toxicity, nutritional deficiencies, leukaemia
Leucocytosis	Infection, trauma, toxicity, haemorrhage, neoplasm, leukaemia
Heterophillia	Inflammation, stress response
Leucocytosis and heterophillia	Chlamydiosis, avian TB, aspergillosis
Immature heterophils	Severe inflammatory response
Toxic heterophils	Septicaemia, toxaemia
Leukopaenia and heteropaenia	Viral disease, overwhelming bacterial disease
Lymphocytosis	Infections
Monocytosis	Chlamydiosis, granulomas (bacterial, fungal), massive tissue necrosis
Thrombocytopaenia	Severe septicaemia's, rebound from blood loss

Avian Biochemistry

Selecting the correct biochemical profile is important. Uric acid is the main method of protein excretion in birds. Uric acid is elevated only when two thirds of renal function has been compromised. Mild elevations can reflect folliculogenesis or high protein meals in omnivores or carnivores (it can be elevated four fold for 48 hours after feeding).

Total protein and albumin can elevate in dehydration and in reproductive activity. Reduced values can be due to anorexia, gastrointestinal tract disease, liver disease or blood loss.

Total calcium consists of protein bound calcium, complexed calcium and free or ionised calcium. There is no physiological control of total calcium levels and to values are primarily influenced by protein binding. Ionised calcium can be directly measured now and should be included on all avian profiles. This is the regulated ion and it is decreased when there is an acute demand leading to tetany, most notably in grey parrots. This can also occur in reproductively active females laying eggs. Many juveniles can have normal levels despite having marked NSHP.

Glucose can be performed on a heparin sample or a glucometer. There is marked physiological variation. High levels can reflect diabetes or pancreatic disease. Hypoglycaemia can occur in liver disease, starvation, malnutrition and septicaemia.

AST and CK are useful in combination. AST is found in liver and muscle tissue. CK is only present in muscles. Thus an AST elevation alone can reflect hepatic damage. If in concert with CK it can be disregarded. LDH and ALT have wide tissue distribution and there is no point measuring them. Bile acids are the most important liver test. 80% of birds with hepatic disease have elevated bile acids. Chronic liver cases may have levels within reference ranges. Many clinicians consider values lower than 60 - 80µmol/l to be acceptable.

Total cholesterol has also been measured and high and low density lipoproteins may prove useful in the prognosis/diagnosis/staging of fatty liver or arteriosclerosis in the future.

A standard biochemical profile for a sick bird should include, total protein, albumin, AST, CK, Bile acids, uric acid, ionised and total calcium. Further testing to be considered in specific cases can include cholesterol and phosphorous.

Sinus flushing

Sinus flushing is indicated in birds with upper respiratory tract disease. Birds have large infraorbital/paranasal sinuses and these encircle the eye and drain via the choana. Flushes can be performed to obtain samples for culture and cytology. Sinus flushing may also be performed therapeutically with F10 disinfectant, antifungals or antibacterials. There is a soft tissue space between the birds eye and external nares below the zygomatic arch and a fine gauge needle can be placed here. Fluid can be instilled and aspirated.

Conscious sinus flushing is also performed from the nares. In this situation the fluid drains via the choana and the head should be down over a sink or bowl to reduce the risk of aspiration. Up to 5% of body weight can be used in the flush.

Tracheal washes

This requires anaesthesia and sterile technique. 0.5 – 1% of bodyweight is instilled via a sterile catheter and then aspirated for cytology and culture. Tracheal swabs can also be taken. This is possible conscious using metal mouth gags from the proximal trachea.

These are used less now given appropriately sized endoscopes which can be used to visualise the respiratory tract. This enables targeted sampling using instrument or insufflation channels to collect samples.

Radiology

The same principles apply to avian radiology as are used with mammals. However, grids are rarely required except if the structure radiographed is thicker than 10 cm (usually swan gizzard radiography). A general anaesthetic is usually required and recommended.

The high avian respiratory rate requires very short exposure times usually between 0.01-0.05 seconds. For the fine detail often required with small avian patients, high speed or mammography film is recommended. Scatter radiation affects detail more on high speed films so close collimation is required as well as higher exposure settings than double screen (standard) films. Contrast is usually good on avian radiographs due to the air sacs surrounding soft tissue.

Positioning

Correct positioning is vital for easy interpretation. Two views perpendicular to each other are required, most often a lateral and ventrodorsal. The anaesthetised bird can be taped to the cassette or a thin, but rigid perspex (plexiglass) board. The latter is very useful as you can position the bird while developing film without having to reposition if the film needs to be repeated. Some clinicians take two exposures one for evaluation of the skeleton and one for soft tissue.

Ventrodorsal view

1. Birds are placed on their back.
2. Wings level and extended laterally, either fully or partially on both sides.
3. Femurs parallel.
4. Keel should be superimposed over vertebral column for its entire length. This is critical so that the thoracic girdles can be assessed and so that the coelomic contents can be critically assessed (for example liver size).
5. If examining digits make left foot placement a mirror image of right.

Dorsoventral view

Used for gizzard radiography in large waterfowl.

1. Bird is restriained in a swan bag.
2. Beam is centred in the midline at the point of the distal humerus.

Lateral view

Be careful as this can be an awkward position for the bird to be in and may cause the bird to become light under general anaesthetic if the positioning is painful.

1. Femoral heads overlie each other.
2. Legs pulled caudally but NOT overlying each other.*
3. Wings stretched dorsally but NOT overlying each other.*
4. Use same side down for consistency.
5. Sternum parallel to the film cassette.

6. If examining digits make left foot placement a mirror image of right.

* This is actually personal preference. If examining the coelomic cavity pulling both legs, together, as caudal as possible is indicated so there is minimal superimposition of the limbs over the coelomic tissues. Pulling the wings together facilitates better positioning. It should be noted that this view does not give a suitable anterioposterior view of the wings.

Anterioproximal view of the wing

Used to detect minor fractures, particularly in the distal wing.

1. Suspend the bird vertically by its limbs from the tube head ('fly the bird into the plate').
2. Pull the required wing out into extension.
3. Secure using tape on the feathers.
4. Extubate the bird and gently tip the head to one side.
5. Once taken intubate and reposition the bird.

Contrast studies

Barium sulphate 25 ml/kg diluted 1:1 with tap water by crop tube- transit time in large psittacines: barium: 3 hr and Iohexol 1 hr but this can vary. Barium films are made at 5, 30, 60, 90, 120 and 180 min or longer.

Iohexol (240 mg iodine/ml) given intravenously. Will outline vessels and the heart as well as give an intravenous pyelogram. Iohexol- films are made at 1, 3, 15, 30, 60 and possibly 120 minutes. Rarely utilised.

CARE to avoid aspiration in anaesthetised patients (can try conscious with bird on a perch with the x ray head positioned horizontally or specially designed restraint boxes have been described).

A direct positive contract proventriculogram can be used to outline the proventriculus. A crop tube is passed under anaesthesia through the thoracic inlet into the distal oesophagus or proventriculus. 10mls per kilo of barium sulphate is administed and both lateral and ventrodorsal radiographic views taken immediately with the crop tube in place.

Contrast studies of the infraorbital sinus are also possible with iohexol being injected directly into the sinus.

Interpretation

- ☐ Musculoskeletal system- check skeletal density (e.g. African grey parrots on all seed diets), fractures (shoulder region for coracoid or furcula fractures especially in wild birds), soft tissue swellings, increased joint space (dislocations) and articular gout.

- ☐ Cardiovascular system - the normal position of the heart is between the second to fifth rib. The lateral margins of the normal heart and liver in psittacine birds create an hourglass shape on the ventrodorsal view. The heart size at its base equals about 50% the width of the coelomic cavity at the fifth thoracic vertebra. Brachiocephalic trunks can be seen end on in the ventrodorsal view. Atherosclerosis is common in aged psittacines on an all seed diet. If the vessels have become calcified this can be most clearly seen on a lateral projection.

- ☐ Respiratory system – The trachea can easily be seen and narrows as it enters the thoracic inlet. In waterfowl the trachea may be convoluted at the thoracic inlet. The syrinx can be visualised as a gas filled out pouching in waterfowl. The parabronchi can be seen as a reticular (netlike) pattern on a good lateral x ray. Pneumonic changes are best appreciated at the caudal edge of the lungs on the ventrodorsal view. Air sacs- usually not visible unless inflamed when fine lines may be seen delineating them on the lateral view. Air sac compression or abscessation can be clearly seen. Birds with coelomic ascites, hepatomegaly, proventricular dilatation or severe obesitiy can have minimal visible air sac space. Raptors that have just been fed may also have a distended proventriculus. Waterfowl with reduced gastrointestinal motility, due to lead poisoning for example, may also have reduced air sac space.

- ☐ Gastrointestinal system - The crop is on the right side of the distal neck but may appear to extend across the neck, depending upon species and contents. The ingestion of foreign bodies may be seen. The gastrointestinal tract is best appreciated with barium contrast. Gas is considered abnormal in the avian GIT. The proventricular outline can normally be seen and enlargement noted.

- ☐ Liver – This should not extend beyond the sternum on the lateral view. An enlarged liver leads to loss of the ‘waist’ of the hourglass shape formed with the heart. Enlargement can indicate iron storage disease in those predisposed species.

- ☐ Spleen – may be identified best on the lateral view sitting dorsal to the junction between the proventriculus and ventriculus. May also be seen as a rounded object located slightly right of midline at the junction of the ventriculus and proventriculus on the ventrodorsal view.

- Gentiourinary system – Kidneys are normally made visible by the presence of air around them and located ventral to synsacrum. The ovary can rarely, when active, appear as a bunch of grapes cranial to the kidneys. Testes when active are large and just cranial to the kidney and can be misinterpreted as renal enlargement.

Endoscopic examination

Many diagnostic options have already been covered but, sadly, may fail to obtain an accurate diagnosis. In many species direct visualisation of internal organs and tissue biopsy for cytology, histopathology or culture is required. This is only possible by a surgical approach. Birds, however, are uniquely designed for laparoscopy which reduces the need for exploratory surgery.

Anaesthesia is required for laparoscopic examination. There are many indications for endoscopic examination.

- Ill birds require endoscopy to obtain a definitive diagnosis.
- Endoscopic examination may be required to rule out other underlying diseases even if a diagnosis is already obtained.
- Wildlife casualties require endoscopy to assess their suitability for rehabilitation.
- It may be used as a screening tool prior to entering a collection.
- An endoscopic examination should be performed in birds with a poor athletic or reproductive performance.
- Surgical sexing for the purposes of identifying sex alone (as opposed to likely reproductive performance) is considered a mutilation in the UK and has been replaced by DNA sexing.

Respiratory anatomy is important as the air sac system is used when performing coelioscopy. Most birds we are dealing with have nine air sacs. These are comprised of the paired cervical, single clavicular, paired cranial thoracic, paired caudal thoracic and paired abdominal. These air sacs are split into a cranial (cervical, clavicular, cranial thoracic) and caudal (caudal thoracic and abdominal) groups. These act as bellows and provide airflow to the rigid lung. They are poorly vascularised and are minimally involved in gaseous exchange.

The caudal group of air sacs are utilised when performing coelioscopy and provide an inflated body cavity. Entry into the birds' abdomen is thus aimed at entering either the caudal thoracic or abdominal air sac. Traditionally the left side has been utilised as (with the exception of the kiwi and some hawks) female birds only have one gonad – the left! Endoscopy was initially used for surgical sexing for owners wishing to breed their birds.

Equipment required

Originally 4mm 0^0 endoscopes were used for sex determination. These consisted of biconvex lenses with large air spaces between. Light transmission was poor and only objects directly in front of the endoscope were visualised.

More recently rod lens telescopes have been produced by Storz®. It is this system which has become regularly used in exotic animal medicine. These telescopes allow far greater light transmission and so smaller diameter instruments can be used. They also can have an angled end. Most usually a 30^0 angle is utilised and this allows a greater field of view by rotation of the telescope within the bird.

The standard equipment we use is as follows: -

Telescope 2.7mm, 30^0, 19 cm long cat number 64019 BA
Protective sheath with a port for insufflation 64018 US

To perform biopsies then a larger sheath with a biopsy port and an insufflation port are required.
67065 CV
5 french endoscopic biopsy 67161 Z

However smaller units are now available for use in small birds. A 30^0, 1.9mm endoscope with a biopsy sheath is now available.

For larger birds, such as swans, the light transmission is insufficient and a larger telescope should be used (4 – 6mm ideal).

Storz® produce a Telepack™ unit for documentation which incorporates a xenon light source. This unit saves a lot of space. This comes with a lightweight camera supplied. However any medical grade monitor will do. A DVD recorder allows for storage and retrieval of images for client education.

For tracheoscopy a 0^0 endoscope allows visualisation directly in front and endoscopes available range from 0.9mm to 1.9mm in diameter. The 2.7mm 30^0 endoscope can be used to visualise the trachea in larger birds. In our practice we use a 30^0, 1.9mm endoscope with a biopsy sheath. This allows instruments to be brought into the centre of the field of view for syringeal surgery. Care has to be taken as the tracheal narrows by 30% as it enters the thoracic inlet.

Flexible endoscopy is used in avian practice but is typically limited to the upper gastrointestinal tract of larger birds when the oesophagus is too long for rigid scopes. Image quality is poorer based on endoscope diameter. It is commonly employed for foreign body removal from the oesophagus and proventriculus.

Coelioscopy

For entry into the coelomic cavity minimal instrumentation is required. Ophthalmic instruments are best. For entry the skin is incised and the muscles penetrated by either a pair of round ended scissors or artery forceps. The entry site can be either between the last two ribs or behind the last rib. From a practical point of view the ideal entry point is the caudal thoracic air sac as it is practically easier to enter the abdominal air sac by puncturing through the reflected air sacs (there are two layers in apposition) by simply advancing the endoscope. In many cases this connection will be broken by the surgical entry and you will already have made your hole. However there is nothing wrong with entering the abdominal air sac directly. It just is slightly more difficult to enter the caudal thoracic air sac as you need to direct the endoscope cranially to puncture it. In order to increase the chances of entering the caudal thoracic air sac I would suggest an entry point between the last two ribs. The ribs also provide some support to the entry site and less pressure is required to enter the body cavity and the body wall at this point is not so compressive.

Bird position is important to facilitate entry into the body cavity. The bird is positioned in right lateral recumbency with both wings brought dorsally and held in place with a sandbag. This places the bird in a true lateral position. The left (upper) leg is retracted caudally and held in place by taping securely to the operating table.

Feathers over the caudal ribcage are plucked and the area can then be examined. The borders of the entry site are: -

The lumbar vertebrae, the iliotibialis (thigh musculature) and the rib cage. With the leg retracted the ribs can be easily palpated and the entry location identified. It is important to miss vital structures that lie inside the body cavity. Ventrally there is the liver and proventriculus, dorsally the kidney, gonad and adrenal gland and cranially the lung field sits under the rib cage. The entry therefore is halfway up the ribs of the bird. This provides and entry site just above the proventriculus.

However this is the normal anatomy and there are some considerations when dealing with birds where pathology may be evident (that's all of them). Birds with hepatomegaly, Proventricular dilatation, ascites, severe respiratory pathology, or any other space occupying lesion (egg, big ovary or a tumour) may well require a more cautious approach or even aborting the endoscopic examination completely. Given this all bird undergoing endoscopic examination at our practice firstly have lateral and ventrodorsal radiographs taken and these are assessed *prior* to endoscopic examination.

The area is then prepared surgically. Ideally the endoscope and light cable should be autoclaved with a sterile camera sheath used. If the system is not autoclavable then cold sterilisation using Medis® disinfect is possible for the endoscope and light cable. Clear plastic drapes are best.

The skin is incised using scissors and any subcutaneous tissue bluntly dissected away. It is important to reflect any thigh musculature caudally. This facilitates entry into the body cavity and less force is required. Round ended scissors or fine curved artery forceps can then be used to enter the body cavity. Gentle steady pressure is required until there is a sudden advancement of the instrument. It is best to hold the shaft of the instrument to avoid excessive pressure and your fingers will also limit the advancement of the instrument into the body cavity. Entry may be accompanied by an audible pop as the air sac is entered. The instrument can then be opened to bluntly dissect the muscle fibres apart and it is then removed (still open) such that no tissue is incised or crushed.

The endoscope can then be inserted in its protective sheath. Both ends should be stabilised as it is still fragile. The 30^0 angle on the Storz® telescope facilitates entry by pushing the muscle fibres apart. Once in the body cavity general illumination should be reduced to facilitate visual acuity of the monitor. A single handed grip can be used where the shaft of the telescope is supported by the hand, rather like a pencil grip, should your other hand be required for taking images or biopsies.

An alternative technique involves bringing the left leg cranially. This is called the ‘Taylor hold’ as is popular in America. The bird position is the same as before but the leg is taped as far forward as possible. This enables the last rib to be palpated behind the limb. The point of entry is just behind the last rib. In this case the abdominal air sac is entered and should the caudal thoracic air sac require assessment then the endoscope is advanced cranially under the ribs.

Closure of the surgical wound is not required and in many cases can increase the trauma to the area.

Complications of coelioscopic examination

Puncture of abdominal viscera. This is most likely to occur if there is pathology within the bird. Radiographic assessment prior to endoscopic can help to avoid this.

Subcutaneous emphysema. This is not an uncommon complication. Air has the potential to leak through the abdominal wall and collect under the skin. Usually the body wall seals without incident. If this should occur the draining the subcutaneous space with a needle is indicated. In severe cases a small surgical wound may need to be created. This is most common where a large abdominal wound has been created and a large endoscope has been used.

Air sac granulomas. These have been reported when the sterile technique has failed. It is important to treat each case as a surgical procedure and to sterilise equipment between each use. Cold sterilisation is most commonly used and there are a number of disinfectants that can be used to clean an endoscope prior to its use. The Telescope in use in the wet lab can be autoclaved but this does reduce the lifespan.

Normal endoscopic anatomy

From the left sided approach described here the following organs should be visible.

Assuming we have entered the caudal thoracic air sac you will see the proventriculus ventrally and the lung/ostium cranially. The endoscope can be advanced over the lung and ostium to obtain a detailed view. Transillumination through the cranial thoracic air sac will allow the heart and major vessels to be visualised. It is possible to enter this air sac with caution. Passing the endoscope ventrally down the side of the proventriculus will allow the left side of the liver to be visualised within the left hepatic cavity. Transillumination through the reflected caudal thoracic and abdominal air sac walls will allow visualisation of the contents of the abdominal air sac. However it is most usual to advance the endoscope over the back of the proventriculus until both layers of air sac have been penetrated. Directly in front should be the cranial pole of the left kidney. This lies dorsally and can be traced down. Over the surface the ureter can be seen and urates can be visualised passing down to the cloaca. Cranially the gonad and adrenal gland can be seen and it is important be able to distinguish between a testis and an adrenal gland. The ovary is supported by a suspensory ligament and the oviduct can be seen coursing over the kidney to the cloaca. Ventrally the spleen can be visualised. Occasionally you need to use the endoscope to displace the small intestine which may overly the spleen. Intestines can be visualised caudal this and it is important to assess motility. Anatomical differences between species may be noted and probably the first one to appreciate is that some species have pigmented gonads (cockatoos for example). Changing the sheath can allow endoscopic biopsies to be taken of the lung, liver, spleen, kidney, testis or granulomas.

A ventral approach is possible and allows better visualisation of the liver and the option of endoscopic biopsy of this organ. The cavity is entered just behind the keel in the ventral midline. A small incision via the linea alba gains entry into the ventral hepatic cavities. Care must be taken in this approach not to puncture the liver or the duodenum.

A right sided approach should be considered and is of potential use if there is any indication of pathology on the right side of the bird, based on radiography. It is generally assumed (probably wrongly) that a left sided approach is sufficient for internal examination.

Other diagnostic endoscopic procedures

Tracheoscopy is also commonly performed and should be in all cases where there are concerns regarding upper respiratory tract disease or a change in voice of the patient. A 0^0 endoscope allows the syrinx and bronchi to be directly evaluated. It is important to have the head and neck extended. In many cases this is performed prior to intubation. The trachea narrows more distally and this should be noted when selecting endoscope size. This technique is limited by the small size in passerines and the long trachea in waterfowl.

In cases where there is severe upper respiratory compromise, then mask induction can be followed by maintenance for brief periods or an air sac tube can be placed for longer procedures. Air sac tube placement follows the identical surgical approach for coelioscopy. In many cases placement of the air sac tube leads to immediate relief as oxygenation or anaesthetising the bird via the air sac tube is now the preferred option. It may be that some diagnostics could be performed while you are there and tracheal endoscopy is high on the list of requirements. The bird can be ventilated via this route to allow more extensive endoscopic examination or surgery of the trachea. It also allows for free access to the structures of the head for other procedures. . Removal of the air sac tube is indicated when the pathology has been identified and dealt with successfully. Air sac tubes can remain in place for up to a week. Closure of the surgical wound is not required. The endoscope can be used to examine the nares and choana. Detecting abnormal choanal papillae and recording the data is helpful to confirm hypovitaminosis A. The caudal nasal passages and chonchae are also visible.

Examination of the upper alimentary tract is possible and is primarily used in cases of sour crop, head flicking, regurgitation, foreign body ingestion or gastrointestinal slow down. Ideally the crop should be empty and starvation may be indicated. Air insufflation is usually required and can be achieved by attaching a 20ml syringe to a port on the examination sheath. Cloacal endoscopy is also possible. The cloaca is divided into three sections: the coprodeum (where the rectum empties), the urodeum (communicates with the ureters and reproductive tracts) and the proctodeum (houses the bursa of fabricius-the site of B lymphocyte production and in waterfowl also contains the protrusible phallus). The external opening of the cloaca is the vent. Saline insufflation is ideal for cloacal examination as the mucosa is not flattened and maintains its 3D effect. The oviduct can be examined in breeding birds.

The external auditory canal can also be examined endoscopically.

Ultrasound examination

Ultrasound is less frequently used in avian practice due to the air sac system. It can be performed with a 7.5 MHz curved probe in birds greater than 200 grams. The probe is placed caudal to the keel. Usually only a minimal amount of feathers need be removed. The liver, intestines, kidneys and heart can be scanned. Ultrasound is also useful to scan tendon injuries in birds of prey to assess inflammation or thickening of the tendon sheaths.