Restraint And Anaesthesia Of Wild And Domestic Birds

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Summary

At present the information available on avian anaesthesia is often conflicting and confusing. Veterinarians, once having found a way to safely and successfully anaesthetise the feathered patient, will logically continue to use it. People find different ways, meet complications at different times thus resulting in literature with varying information. This essay looks at some of the methods used to restrain avians physically and chemically to allow observation, diagnostic procedures and surgery to be carried out.

Avian respiratory anatomy and physiology are the first topics discussed, so the response of birds to anaesthesia is understood. This is followed by: the factors that should be considered if the patient is to be anaesthetised, the different agents presently available, their advantages and disadvantages and patient monitoring. The different species have then been divided up into their respective orders with suggestions on how to restrain them and in some, how to anaesthetise them due to some of the special characteristics found within their order. The essay finishes by looking at what to do when if an anaesthetic emergency arises and post-anaesthetic care of the patient.

Introduction

There is no one way to anaesthetise birds just as there is no one way to anaesthetise mammals. Due to the different needs and requirements of each species, veterinarians find their own ways of dealing with the animals they work with. Logically, they adhere to the way that works best for them and their patients. However, it has resulted in a wide variety of sometimes confusing and conflicting literature becoming available to the practitioner, who is wanting to learn more about this field. No one way is right and each technique has it's own advantages and disadvantages. This paper provides an overview of the techniques of restraint used by veterinarians in the

1 **Veterinary Science V, University of Queensland, 1995**

field, and some of the ways in which practitioners, over the years, have found to anaesthetise their feathered patients successfully. However, the basic fact of anaesthesia is unchanging - always go back to the patient and work to their requirements.

Avian Respiratory Anatomy And Physiology

Birds present a special problem to the anaesthetist due to their anatomical, physiological and metabolic differences from mammals. Anatomically the avian trachea, which can be palpated on the right side of the neck, is composed of tightly stacked, cartilaginous rings. In certain long necked species, the trachea is longer than the neck and so it forms a loop at the thoracic inlet. This is accommodated in an excavation of the sternum (Dyce *et al*. 1987). The trachea bifurcates, dorsal to the base of the heart, into two mesobronchi. These in turn divide into secondary bronchi. One group, the ventrobronchi, communicates with the cranial air sacs (cervical and interclavicular) . The dorsal and lateral secondary bronchi arise from the mesobronchus before these terminate in the caudal air sacs (abdominal and posterior thoracic air sacs). The dorsal and ventral bronchi are joined by narrow tubes, the parabronchi, which form the analogue to the mammalian lungs and are where gaseous exchange takes place between the air and the blood (Hall *et al*. 1991).

Inspiration in birds is normally passive whilst expiration is an active process. Air flow through the parabronchi is unidirectional during both these phases of respiration. Blood flows in the direction of the gas flow allowing gas exchange to occur during inspiration and expiration. The efficiency of this system is dependant on an uninterrupted flow of air through the lungs. Tidal exchange is generated through the air sacs and fluid such as blood or injected solutions in these sacs will interfere with ventilation (Hall *et al*. 1991). If apnoea occurs even for short periods, marked hypoxia can occur.

The observed suddenness with which birds go under and come out of gaseous anaesthesia, can explained by solubility of anaesthetic gases in avian blood. Gases are readily absorbed into the blood stream resulting in rapid induction and recovery when inhalation anaesthesia is used. Most inhalation anaesthetics are less soluble in avian than mammalian blood therefore brain tensions equilibrate more rapidly with lung tensions causing induction and recovery to be sometimes disconcertingly abrupt.

Anaesthetic And Surgical Considerations

Whilst preparing for the bird for surgery it is important to remember that it's most sensitive areas are it's beak and head, feet and feather follicles. Plucking one or two feathers, to expose a site for incision, may elicit a violent reaction whilst suturing a cutaneous wound or cutting skin may not. It is often possible to handle the viscera without provoking a pain response from a conscious bird.

Other important factors to take into consideration include:

(a) Birds have a higher metabolic rate than mammals and the glycogen stores in the liver readily deplete if the bird is fasted. This decreases hepatic detoxification and therefore fasted birds seem less tolerant of anaesthesia. If considering crop surgery, this aspect cannot be avoided.

(b) During anaesthesia, all homeostatic mechanisms are depressed to some extent. This includes thermoregulation, resulting in a loss of body heat which can be fatal if not attended to quickly. The length of the procedure, the body size of the bird and the amount of tissue exposed, are directly proportional to the amount of heat lost. Paper, cloth or preferably a warm-water circulating blanket at 40.5°C can be used to maintain body temperature. Warm water bottles can be used for smaller birds.

(c) Steiner *et al*. (1981) recommends that fluid therapy be administered for procedures taking longer than half an hour. The longer the procedure the more prone birds are to vascular collapse and circulatory failure. Dehydration occurs through the respiratory tract during inhalation anaesthesia. Warm Lactated Ringers solution can be given as a bolus IM injection every 10-15 minutes to remedy this (Steiner *et al*. 1981).

Birds ideally should be placed onto an IV drip, but complications can arise due the fragility of their veins leading to haematoma formation and blood loss. A parakeet can be given 0.1ml of fluid IM every 10 minutes, using alternate sites with each administration. (Steiner *et al*. 1981).

(d) During surgery, it is often hard to monitor birds as they can be lost under large opaque drapes. Replacing standard drapes with plastic transparent ones will allow visualisation of the rate and depth of the patient's respiration. An oesophageal stethoscope is an excellent tool for monitoring heart rate.

(e) Prior to surgery a PCV should be done to determine hydration status along with a blood glucose determination. A PCV above 55 indicates that the bird should be rehydrated prior to surgery. A PCV of 20 or below indicates severe anaemia and the surgical procedure should be postponed or a blood transfusion given with homologous blood. Steiner *et al*. (1981) recommends that if this is not available, pigeon blood is a satisfactory substitute. These authors also state that they have had no experience with multiple transfusions, so the incompatibility of blood types was not been addressed. Blood glucose levels below 200 mg/100ml require supplementation with 5% dextrose IV prior to any surgery.

(f) Atropine, at a dose rate of 0.04 to 0.1 mg/kg may reduce the flow of respiratory secretions but there is still discussion on the value of it's use.

(g) If possible, intubate every bird no matter what the procedure or type of anaesthetic is used. If respiratory arrest does occur, then it can be dealt with quickly and effectively (Steiner *et al*. 1981). Also, some anaesthetised birds relax their tongues to such an extent that is can fall back over the glottis. Tracheal intubation will prevent this or the tongue of smaller birds may be pulled forward and fixed to the lower beak with a paper clip.

Contraindications To Anaesthesia

Birds that are in shock, have ascites, severe anaemia, respiratory distress, a fluid filled crop, are severely emaciated, dehydrated or are suffering from acidosis should not be anaesthetised (Muir *et al*. 1989). Harrison *et al*. (1986) also recommends that the following be avoided:

(a) Methoxyflurane (and other volatile anaesthetics) when administered by open drop or nose/mouth
(b) Barbiturates (use recommended only in convulsions in otherwise healthy bird)
(c) Chlorohydrate combinations (extremely long reaction and recovery times)
(d) Thiamylal sodium; sodium pentobarbital
(e) Intraperitoneal administration
(f) Local anaesthetics (safety is dose related; however errors are common)
(g) Xylazine alone
(h) Ether (due to explosiveness only)

Methods Of Anaesthesia And Anaesthetic Agents

Local Analgesia

Local analgesia is a very useful agent in the larger bird species, however smaller birds such as budgies can easily be given gross overdoses. It is still wise to closely monitor the doses given to larger birds as there has been some evidence that birds are more sensitive to local analgesia than mammals of the same body weight. Hall *et al*. (1991) advises dilute solutions such as 0.25-0.5% lignocaine to be used. There have been some workers that suggest local analgesia has no place in avian anaesthesia as capture and restraint places undue stress on the bird. It is true that in many species this would be very unbeneficial. However for those larger species of birds which require minor surgical procedures and are located in the field situation where there is no anaesthetic equipment, local analgesia may be a useful alternative. The bird can get up straight away after the procedure and does not have to be restrained as it would have to be if placed under a general anaesthetic.

General Anaesthesia

(a) Injectable Anaesthetics

Birds, like all other animals, should be weighed before any drug is given. Intramuscular injections are given into the pectoral muscles 1 to 2cm lateral to the sternum or into the quadriceps muscles. Large vessels run near the sternum and must be avoided. If possible avoid using the leg muscles due to the possibility of nerve damage and the first pass effect due to the renal portal system (Muir *et al*. 1986). However, Hartsfield *et al*. (1986) suggests that blood from the legs may first reach the liver thus enhancing biotransformation with a resultant decrease in anaesthetic effect. Intraperitoneal injections should be avoided due to the variable absorption rates.

Intravenous injections are made into the brachial vein as it passes over the medial surface of the elbow. After the bird has been given an injectable anaesthetic, they should be confined to a warm, dark place. Anaesthetic depth can be assessed by noting the response to pinching the wattle or the skin of the neck.

Agents found to be most useful in avian medicine include:

1. **Ketamine Hydrochloride** - a dissociative anaesthetic, the patient retains their body tone and musculoskeletal coordination but is seemingly oblivious to the environment. The heart rate increases and the laryngeal and pharyngeal reflexes remain intact. There is also increased salivation.

   The site of this drug's action is thought be at the frontal cortex. The extrapyramidal and reticular activating systems may be variously affected also, resulting in muscular tension, myoclonic seizures or convulsions (Sedgwick 1986). When a patient is in this state, it is difficult to know whether the movement is due to pain or is from CNS stimulation. Giving more of the agent only serves to increase muscle tension and "titrating" the anaesthetic to a state where muscle relaxation occurs has resulted in many an animal's death. If such seizures occur then it is best to induce anaesthesia by using gaseous anaesthetics via a face mask, then intubating once the animal is unconscious. Hyperactive muscular activity using a cyclohexylamine anaesthetic has sometimes been observed. Therefore the temperature needs to monitored if such an event occurs.

Ketamine's wide safety margin allows doses of up to 25 mg/kg to given safely to all species of birds, although recovery may be prolonged (Hall *et al*. 1986). It is contraindicated in patients with liver/kidney disease.

Advantages	has a wide safety margin, is relatively potent and readily available
Disadvantages	anaesthesia cannot be lightened once administered, effects vary between members of the same species and recovery is often violent

2. **Ketamine/Xylazine combination** - G. Harrison *et al*. (1986) has had consistently good results using ketamine (100 mg/ml) with an equal volume of xylazine (20 mg/ml). By using this combination, muscular relaxation is improved along with analgesia. Diazapam is less commonly used in combination with ketamine by some practitioners. This mixture has been found by Harrison to be the most useful anaesthetic in all but the most critically ill birds. The route and dose is dependant on the degree of immobilisation and speed of recovery required. The two drugs can be combined in a syringe, but draw up the xylazine first, especially if small birds are to be dosed. Pure solutions of xylazine can otherwise remain in the needle bulb, resulting in adverse reactions. A dose rate of 10-30 mg/kg of ketamine combined with an equal volume of xylazine and given IM produces adequate anaesthesia to allow minor surgical procedures to be carried out. If the procedure is to be brief then the volume of anaesthetic can be reduced by 30 to 50% and given IV, to increase the speed of recovery. The dose rate per kilogram of body weight is lower for birds weighing over 250 grams than those less than 250 grams. Harrison *et al*. (1986) states that the calculated volume for the initial injection may be one eighth to one fourth of the full dose and may be repeated if the plane of immobilisation is not sufficient. Within 5 to 10 minutes after an IM injection and 1 minute after an IV injection the anaesthetist will be able to tell if the dose needs to be repeated. Small increments rather than the full dose all at once will increase control over the plane of anaesthesia. After using this combination birds can be back on their perch in 15 to 20 minutes. If the procedure will take longer, then inhalation anaesthesia can be used. Only oxygen should be given first.

Once movement occurs, the inhalation anaesthetic can be turned on (Harrison *et al*. 1986).

Advantages: good analgesic, rapid induction and recovery if used IV.

Disadvantages: prolonged recovery with IM administration, hypothermia and high doses (3x) leads to CVS and respiratory disturbances.

3. **Tiletamine and Zolazepam** (Zoletil) - Blyde (1992) has found Zoletil to be a useful induction agent especially for those birds which can hold their breath for long periods (ie. ducks, swans, geese and waterbirds). Also, it has been used in the larger birds such as pelicans, ostriches and emus. It can be administered IV or IM. Dose rates for IV range from 2.5 mg/kg in large birds (Ostriches, Emus etc.), up to 10 mg/kg in birds such as cockatoos, galahs and ducks. Up to 25 mg/kg IV has been given without any untoward effects except for an extended period of recovery. Dose rates for IM injection range from 10 mg/kg in large birds to 20 mg/kg in small birds. Recovery from an intramuscular dose was found to be prolonged and erratic and birds had to be properly restrained during recovery.

Advantages - good muscle relaxation and analgesia produced.

(b) **Inhalation Anaesthetics**

Induction and maintenance of anaesthesia can be carried out using gaseous anaesthetics alone and should be used whenever possible. The gas can be introduced by restraining the bird and using an Ayre's T-piece and face mask or by confining the bird to a box made of transparent material while the anaesthetic gas or vapours are filtered into the box. Hall *et al*. (1991) suggests that the best method is to pass halothane and oxygen into the box and then maintain anaesthesia with the same combination via an endotracheal tube or by a face mask.

It is not difficult to intubate birds and tubes can be constructed from silicone rubber or PCV tubing. Urinary catheters are useful in small birds. The tube should be made long enough to reach the syrinx and the bevel cut to facilitate passage into the trachea. Dead space must be kept to a minimum as the tidal volumes are small. It is essential to have suction available as secretions can build up in both intubated and non-intubated birds. A 60 ml syringe fitted with a fine catheter is a useful tool.

The total flow rate of gas should be two to three times the estimated minute volume of the bird's respiration. As a guide, suggested by Klide (1973) a domestic chickens has a minute volume of 770 ml, a pigeon, 250 ml and a budgerigar, 25 ml. Once the bird is successfully anaesthetised the air sacs should be flushed at 5 minute intervals to prevent overdistention. This is done by occluding the long arm of the Ayre's T-piece and allowing the escape of gas from around the loose fitting endotracheal tube or by partially lifting the face mask. After the procedure, recovery speed can be increased by administering oxygen and flushing the air sacs at regular intervals until the bird is conscious and able to right itself. If this is not done, then the anaesthetic remaining in the air sacs will be cleared more slowly due to the suppressive effects of the gas on the respiratory system. The parabronchial capillary blood takes up the anaesthetic left in the lungs and air sacs again, extending the recovery period.

1. **Halothane** - a poor analgesic, it has depressant effects on the myocardium and sensitises it to catecholamines. However, as it is relatively insoluble in tissues and not well metabolised (15-20%), induction is rapid and the plane of anaesthesia can be changed. Halothane is also a respiratory depressant and its use is contraindicated in those patients with renal or hepatic damage.

   Patients may be induced at concentrations of up to 3-4% along with 2-3 litres/min of oxygen. Maintenance levels of 1.5-2% with 0.5-1 litres of oxygen is sufficient.

2. **Methoxyflurane** - is a relatively good analgesic and provides excellent muscle relaxation. However, it is a potent myocardial depressant. It is metabolised by the body and releases a fluoride ion which is toxic to the renal tubules. Nonflammable and very soluble in tissues. Has a slow induction and recovery time thus the level of anaesthesia is slow to change.

3. **Nitrous Oxide** - provides good analgesia at concentrations higher than 50%, but should never be used at concentrations higher than 75%. Because of its analgesic properties it can be combined with halothane. In doing so the second gas effect occurs, speeding up induction. A rule of thumb is that the amount of methoxyflurane or halothane can be reduced by one third when nitrous oxide is used (Paddleford 1986). Since it does not support metabolism, it cannot be used at concentrations greater than those required to provide oxygen at physiological safe levels (21%) (Hall *et al*. 1991). It is insoluble, not metabolised and readily moves into compliant spaces which is relevant especially to birds (ie. aquatic birds). It is a combustible gas.

4. **Isoflurane** - This gas does not biodegrade nor is it metabolised by the body. This attribute reduces the incidence of organ toxicity and studies have shown there is little effect on the liver and kidneys. Harrison *et al*. (1986) conducted clinical trials using isoflurane to anaesthetise pigeons and cockatiels. It was delivered safely under extreme conditions of patient dehydration, deliberate multiple overdoses, collection of up to 10% of blood volume, and multiple organ biopsies. This gas was also used in critical cases where the patients required immobilisation for treatment purposes, several times a day.

   A face mask can be used to induce and maintain patients. Initial induction concentrations can be as high as 5% with 2-3 litres of oxygen. Once the patient noticeably relaxes, the bird may be maintained at a concentration of 2-3% with 0.5-1 litres/min of oxygen (Harrison *et al*. 1986). Larger birds may require slightly higher flow rates. Isoflurane at these recommended levels, can cause respiratory depression in some birds such as Blue and Gold Macaws. These birds should therefore be maintained at 0.5 to 2% following induction. Harrison *et al*. (1986) attempts to maintain anaesthesia at the lowest level required. As birds respond rapidly to changes in isoflurane concentration the levels of anaesthetic will need to be readjusted throughout the procedure, if maintained on the lowest dose possible. This technique is not tolerated with other inhalation anaesthetics. Isoflurane also produces excellent muscle relaxation. Disadvantages are its cost, its pungent odour which may increase induction, and that it is a respiratory depressant (although not as much as halothane).

(c) **Combining Gaseous And Injectable Anaesthetics**

This method of anaesthesia produces satisfactory results. Using ketamine as an induction agent, at a dose rate of 10-15 mg/kg, then maintaining the patient on halothane/oxygen or isoflurane/oxygen, is probably the simplest and safest method. Deciding on dose rates for ketamine in very small birds like budgerigars and canaries is difficult but Hall *et al*. (1991) suggests that 1-2 mg per bird be used. Solutions of ketamine usually contain 100 mg/ml, so if 0.1 ml is diluted to 1 ml, birds can be given 0.1-0.2 ml IM. The solution of 0.2 ml (diluted) will produce light anaesthesia for 2-3 minutes from the time of the injection. The aim is to give just enough injectable anaesthetic is to produce unconsciousness until the bird can be hooked up to the gaseous anaesthetic.

Monitoring Anaesthesia

General signs such as response to pain and the corneal and palpebral reflexes are subjective evaluations of anaesthetic depth. However, response to a stimulus, such as pinching the comb, wattles, cere or interdigital web of the feet with forceps, is a fairly reliable indicator (Hartsfield *et al*. 1986). Objective measurements such as rate, depth and pattern of respiration, heart rate and mucous membranes allow the most accurate assessment of the patient's condition.

During light anaesthesia, birds retain their reflexes and will respond to the pinch test; respiration is deep and rapid; and there is no voluntary movement nor response to vibration or posture change (Steiner *et al*. 1981). Corneal and pedal reflexes become sluggish during medium anaesthesia, whilst palpebral and cere reflexes become absent. Respiration becomes slow, deep and regular and voluntary movement is absent. This is the plane of anaesthesia at which most surgery is performed.

At deep anaesthesia all reflexes are abolished and there is no voluntary movement. Respiration becomes shallow, regular and slow. Cardiac arrest will occur if any more anaesthetic is given at this stage (Steiner *et al*. 1981).

Any sudden changes in respiratory rate, depth or rhythm needs to be immediately assessed. The signs seen with each stage of anaesthesia is sometimes variable between species and even individuals. These are general guidelines only.

Methods Of Restraint And Anaesthesia

Psittacines and Passeriformes

Psittacines (six subfamilies)

Strigopinae owlparrots; *Nestorinae*, keas; *Loriidae*, lories; *Micropsittidae*, pygmy-parrots; *Kakatoemae*, cockatoos; and *Psittacinae*, true parrots.

Passeriforme (comprises 4800 species and 72 families): includes broadbills, lyrebirds, larks, crows, jays, thrushes, swallows, bowerbirds, shrikes, sparrows, finches and canaries, There are four suborders: broadbills (*Desmodactylae*), noisemakers (*Clamatores*), lyrebirds (*Suboscines*) and songbirds (*Oscines*).

Restraint Small birds such as budgies and small parrots may either be in an aviary or single cage. In the aviary situation, netting the birds is the easiest method of capture. Once trapped, they can be grasped from the back of the head using the thumb and forefinger on either side of the mandible, whilst being careful not to crush the bird. Small birds such as budgies can be retrieved by placing the hand beneath the net and trapping the head between the forefinger and second finger. The thumb and remaining fingers are then wrapped around the body. Be careful not to hold the bird too tightly as it needs to be able to move it's sternum freely.

With larger birds such as cockatiels, lovebirds and lorikeets, a towel or gloves may be required. In a cage, obstructions such as perches, toys, ladders etc. should be removed so the bird can be cornered and the head immobilised using the technique described above. Large psitticines are best captured using a towel instead of a glove. Corner the bird against the cage wall or floor and approach it from behind. Restrain the head firmly, being careful not to crush it (Fowler 1986).

Anaesthesia - A table from Harrison *et al*. (1986).

Recommended dose rates for xylazine-ketamine combination

SPECIES	IM	IV
Budgerigars	0.01	0. 005
Cockatiels	0.02	0.01
Lories, rosellas	0.07	0. 035
Amazons, miniature macaws	0.05-0.1	0. 025-0.05
African Greys	0.08-0.1	0.04-0.05
Conure s	0.05	0.025
Cockatoos	0.12-0.15	0.06-0.07
Macaws	0.15-0.20	0.075-0.10

Otherwise anaesthetise as recommended in **Methods of Anaesthesia.**

Galliformes

This order consists of seven families, those of which are listed below:

Megapodiidae	Brush turkeys, incubator birds, and mound builders
Cracidae	Curassows, guans, and chachalacas
Tetraonidae	Grouse, ptarmigan, capercaillie, and prairie chickens
Pharianidae	Quail, pheasants, peacocks, partridges, francolins, tragopans, and domestic chickens
Numididae	Guinea fowl
Meleagrididae	Turkeys
Opisthocomidae	Hoatzin

Restraint Many of the birds in this order are docile and can be easily handled. However they all have claws and, when excited can scratch the handler. The males usually have large tarsal spurs which are normally used for fighting other males and may also be used as a defence against capture. In the breeding season, some pheasant species can occasionally become aggressive and will try to attack intruders by flying at them with their feet outstretched, using their tarsal claws and wings to inflict damage. Avoid grasping these birds by their tail feathers as pheasants, crown pigeons and turacos readily release them if they are captured in this manner. Nets are normally used and the bird can be immobilised by holding the wings against the bird's body and controlling the legs. Beaks are seldom used as a defence but be cautious until the individual's nature is known. Chickens can be quietened by immobilising their wings against their bodies, turning them on their back and stroking their abdomen.

Anaesthesia see Methods of Anaesthesia

Anseriformes

- Ducks, geese, swans, screamers

Restraint Waterfowl can be captured with a hand net or a small group of birds can be driven into a corner to allow individuals to be picked up. Do not do this with large numbers of birds as they can all pile up and many can be injured or suffocated. Avoid carrying captured birds by the wings or feet alone as the heavier members of this species especially, can suffer a temporary or permanent brachial paralysis. These birds are best carried under one arm which controls the body whilst the other hand controls the head and neck. Be wary of sharp claws and large birds can inflict painful blows with their wings. Snow geese have been known to inflict painful bites.

Anaesthesia Chemical restraint is rarely required for these types of birds. However, ketamine hydrochloride can be used if minor surgical procedures need to be carried out, or as a preanaesthetic agent to gaseous anaesthesia. Xylocaine hydrochloride is one of the safest local anaesthetics for waterfowl (Humphreys 1986).

Columbiformes

Pigeons and doves

Restraint These birds are inoffensive and easy to handle and nets can be used to capture those in large aviaries.

Anaesthesia see Methods of Anaesthesia

Coraciiformes and Piciformes

The Coraciiformes order contains 190 species of kingfishers, todies, motmots, hornbills, rollers, hoopoes and bee-eaters. Those birds found in Piciformes order include 383 species of toucans, wood peckers, barbets, honey guides, puffbirds and jacamars.

Restraint Many of the bird species in the *Coraciiformes* order have large heavy beaks. Initially they can be captured using a net, but once this has been achieved, their beaks should be controlled to prevent serious injury. Piciformes can also be captured with a small hoop net, extracted and hand held, keeping the head under constant control (Fowler 1986).

Anaesthesia see Methods of Anaesthesia

Gruiformes

Cranes are long-legged and long-necked birds with strong flight capabilities (Carpenter 1986). The characteristic anatomical feature of the adults is their convoluted trachea that penetrates and is enclosed within the bones of the sternum.

Restraint Cranes are prone to leg and wing damage if allowed to throw themselves around their enclosure during capture or are handled roughly when restrained. The best method is to herd them into a corner or confined space. Once the crane's head is in the corner, the secondary and tertiary wing feathers can be held with one hand to keep the wings in the closed position. The free arm can then be placed over the crane' s body and wings, directing the head and neck behind the handler. Once this has been accomplished the hand holding the wing feathers is then released and used to grasp the hocks of both legs. The bird can be picked up, and the legs extended parallel to the ground. (Carpenter 1986). If the bird is facing the handler during capture, the neck can be grasped and the bird manipulated into the position required.

Anaesthesia A mixture of 10 to 15 mg/kg of ketamine and 1 mg/kg xylazine hydrochloride, or 1 mg/kg of diazapam is useful as a preanaesthetic or for use as an anaesthetic for surgery of short duration. Diazapam alone at 1 mg/kg IV provides useful short term sedation. If the surgical procedure will be longer, then the crane should be intubated and maintained under gaseous anaesthesia. If there are no facilities available for this, or it is not indicated, then ketamine at 20 to 30 mg/kg and xylazine at 1 mg/kg can be used instead.

Ciconiiformes and Phoenicopteriformes

Birds in the *Ciconiiformes* order include herons, egrets, bitterns, hammerheads, storks, ibises and spoonbills. The order *Phoenicopteriformes* encompasses the flamingoes.

Restraint Caution has to be exercised when dealing with these birds due to the presence of their sharp beaks which can inflict serious wounds to the eyes, face and body of the handler. It is therefore advised that a protective shield be worn over the face. If the birds are only to be restrained for a short period of time or are going to be transported in a cage, then the bill can be taped shut and cork or rubber tubing placed over the tip. Note: these birds, when excited, can still jump over fences and gates even if they have been properly pinioned.

Flamingoes should not be captured with a net as their legs can be easily damaged. Instead, herd them into smaller pens using panels or solid gates. Their head should be grasped first to control the bill, then their body. The smaller members of these orders can be caught with a hand net.

Anaesthesia Ketamine hydrochloride IM at 20 mg/kg is effective at immobilising these birds and they can be placed onto gaseous anaesthesia for maintenance. The main problem that occurs with these birds is at recovery, where their long legs get them into trouble. They will try to stand before being ready and can in jure themselves badly when they fall over. After surgery, place the bird in a burlap sac so the head extends out the opening. Be careful not to cramp the legs as this will lead to a necrotising myopathy.

Ratites

Orders:	*Struthionformes*	- ostriches
	Casuariiformes	- cassowaries, emus
	Rheiformes	- rhea
	Tinamiformes	- tinamou
	Apterygiformes	- kiwi

Restraint These birds are potentially dangerous and can injure both themselves and their handlers. Quick to react when frightened, they will use their powerful legs and clawed feet to defend themselves. The immature members of this order can be captured by grasping the legs and picking the bird off the ground. As with storks and flamingoes, the adult ostriches, emus and rheas should be caught by the head. Once this is accomplished, pull the head forward and down until the vision is blocked. Other handlers can then grasp the wings from the sides and place pressure in a downward direction to prevent the bird from jumping up. Continual, steady pressure will cause the bird to gradually sit down. Four experienced handlers are the minimum number that should be used to capture an adult. Complications arise when the bird is allowed to jump or fall sideways. Hooding the will help to settle them and makes them easier to handle.

Cassowaries are very aggressive and need to be handled carefully. Large padded sheets of plywood allows the handlers to herd the bird into a smaller yard or crates (Bruning .et a1.1986). Handlers must be instructed to brace themselves for blows.

The smaller tinamous can be captured with a net and held by hand to allow inspection. Observe them carefully, as they seem to readily develop syncope during handling and can go into irreversible shock.

Anaesthesia

Bruning *et al*. (1986) states that ketamine hydrochloride at a dose rate of 25 to 50 mg/kg and a combination of tiletamine hydrochloride and zolazepam hydrochloride at 2 to 5 mg/kg IM, has been used in ratites.

When the lower dose ranges are used, the birds will in general, be calmer, whilst at higher dose rates, they will be recumbent. It was found when tiletamine hydrochloride and zolazepam was used, the birds were immobilised and there was little excitement. On recovery however, the birds struggled and their legs and head had to be controlled to prevent serious injury. The use of this particular form of chemical restraint perhaps is best confined to sedating ratites to move them from pen to pen.

Ketamine hydrochloride given at a dose rate of 5 to 10 mg/kg IV after previous immobilisation with ketamine at a dose rate of 25 mg/kg IM can produce suitable anaesthesia. Additional ketamine given at a dose rate of 5 mg/kg is usually required at 10-15 minute intervals to maintain a suitable depth of anaesthesia.

Volatile anaesthetics such as halothane are useful in producing general anaesthesia in ratites. Problems can occur during induction and recovery as the birds may thrash around and need to be restrained to prevent injuries. During induction the birds must be carefully observed as their rapid respiration can result in rapid depression. Once induced, an endotracheal tube can be passed and anaesthesia maintained. Methoxyflurane is difficult to use effectively with small animal vaporisers as the depth of anaesthesia produced is usually not sufficient to allow major surgery to be performed.

Raptors

Orders:	*Strigiformes*	comprises the owls of which there are two families, 131 living species, and 33 extinct species
	Falconiformes	the diurnal birds of prey and is composed of four or six families(depending on the classification) of 271 living and 99 extinct species

Restraint Trained birds are naturally easier to handle and permit close inspection. If they are hooded, this will further pacify them. If they are unaccustomed to wearing a hood, a darkened room works on the same principle and birds can be captured this way. To hold the bird, first approach it the rear with a piece of cloth over the hands. When the bird's wings are folded in a normal position, it can be grasped and the wings pinned against the body. The feet can then be pulled back by applying pressure to the feet or jesses (Halliwell 1986). Once the bird is completely controlled, wrap in a cloth and expose the injured portion for examination.

Nylon stockings to elaborate vests are available to use as a restraints. However, Vetrap tape is a cheaper and just as effective method and it can be used to tape the wings to the body and the talons into a closed fist. It is readily available in most vet surgeries and does not adhere to the bird.

Anaesthesia Raptors are difficult animals to anaesthetise. They easily go into shock if not handled properly and regurgitate during anaesthesia, thus requiring preanaesthetic fasting, especially in the smaller species. Several anaesthetic agents such as local anaesthetics, ultrashort barbiturates, pentobarbital and phenthiazine tranquilisers have been shown to be either ineffective or cause toxicity problems. Increased susceptibility to hypothermia and blood loss make raptorial birds poor anaesthetic risks.

Two injectable anaesthetics that have are recommended for raptorial birds (Paddleford 1986); chloral hydrate and ketamine hydrochloride.

Chloral hydrate administered IM at 2.5 ml/kg, takes roughly 10 minutes to take effect and produces 30 minutes to an hour's anaesthesia. If a second dose needs to be given, the it should be halved. For birds that are sick or debilitated, an initial dose of 1.0 to 1.5 ml/kg should be utilised.

Ketamine hydrochloride at a dose rate of 5 to 10 mg/kg IM provides sufficient sedation to allow physical inspection and diagnostic procedures to be carried out. Doses of 15 to 30 mg/kg IM will permit minor surgical procedures and intubation. Anaesthesia occurs 2 to 5 minutes after injection and lasts 20 minutes to six hours depending on the dosage given. If large or repeated doses are administered, birds may remain groggy for up to 12 to 24 hours. Paddleford (1986) has found a combination of ketamine hydrochloride and diazapam to be a satisfactory intravenous anaesthetic for raptorial birds. The recommended dosage for diurnal raptors is 30 to 40 mg/kg of ketamine hydrochloride and 1.0 to 1.5 mg/kg of diazapam. Owls require less anaesthetic so the dose of ketamine can be reduced to 25 mg/kg and diazapam to 1-1.5 mg.

Keep recovering birds in a quiet warm place and disturb as little as possible. Due to ketamine' s hallucinogenic effects, some birds may become agitated or excited during recovery.

With regard to inhalation anaesthetics, methoxyflurane, halothane and nitrous oxide have been used with varying degrees of success by Paddleford (1986). Halothane alone or in combination with nitrous oxide appears to be the safest and easiest to. use. A concentration of 3 to 4% is used for induction, after which an endotracheal tube is passed. For small raptors a 2.5 to 4 mm Cole endotracheal tube may be used. The larger species require 3.5 to 6.5 mm cuffed tubes. By having cuffed tubes the possibility of aspiration pneumonia occurring if the bird regurgitates is reduced.

Paddleford also suggests that because of the small size of some raptors, a nonrebreathing system be used. If used, the oxygen flow rate should be at least 800 ml/min. After completion of the surgical procedure, the bird should be put onto 100% oxygen.

Aquatic Birds

Orders: *Sphenisciformes*, *Gaviiformes*, *Podicipediformes*, *Procellariiformes*, *Pelecaniformes* and *Charadriiformes*

Restraint A hoop net, the appropriate size for the bird in question, is a valuable tool in capturing aquatic birds. Shorebirds need to be handled carefully due to their thin, long legs. When restraining those species with long bills, control the bill first by holding it at the end so as not to block the nostrils. As with all birds, keep the wings firmly against the body and protect yourself from the often well clawed feet.

Penguins once captured can efficiently pummel their captors with their flippers, which is quite painful. To avoid this, one technique advised by Stoskopf *et al*. (1986) is to grasp them suddenly by the neck and hoist them in to the air at arm' s length. The feet can then be controlled with the other hand, and a light stretch applied. The handler should not be too concerned at choking the bird as they have muscular necks and rigid tracheas and a good restraint will reduce struggling. The penguin can then be supported on the handler's lap. Larger penguins require two handlers - one to restrain the head and the other, the limbs.

Anaesthesia As very few occasions have arisen where these birds have had to be anaesthetised, little research has been carried out on the subject. Inhalation of halothane is a one technique suggested and has been used successfully for over two hours in Adelie penguins and California murres (Stoskopf et a1.1986). Many species in this order are diving birds which can complicate anaesthesia due to their capacity to hold their breath for long periods of time. Induction time is thus increased and the birds are more susceptible to acidosis. It is therefore very important to monitor the cardiovascular system with an ECG monitor. The placement of leads is standardised for penguins, and adaptations of this system are suitable for other birds of similar build (Stoskopf *et al*. 1986). The heart rate of a medium sized penguin ranges between 85 to 120 beats per minute. Stoskopf *et al*. (1986) states that the height and axis of the T wave be monitored closely as an indicator of oxygenation status. A persistent increase in amplitude should be viewed with alarm and increased effort be expended towards ventilating the patient.

A single dose of pentobarbital sodium at 33 mg/kg, administered into the peritoneal cavity, has been successful in producing profound anaesthesia in penguins. However, because of the various rates of absorption, this technique may not always be indicated.

Pelicans are the most commonly anaesthetised water birds in this group and ketamine hydrochloride at a dose rate of 7 mg/kg IM immobilised white penguins after an induction period of 10 minutes (Stoskopf et a1.1986). Saffan, at a dose rate of 0.45 ml/kg IV is an alternative induction agent. When used, a further three doses of 0.18 ml/kg were required for a 30 minute surgical procedure with recovery occurring 9 minutes after the final injection. (Stoskopf et a1.1986)

Miscellaneous Orders

Caprimulgiformes - frogmouths, nightjars and goatsuckers
Apodiformes - swifts and hummingbirds
Cuculiformes - cuckoos and turacos
Coliiformes - colies or mousebirds
Trogoniformes - trogons

Restraint Many of these birds can be readily restrained by hand. However stress-induced death can occur in some species so they should be observed closely during handling. All of these birds really only pinch when they bite, except hummingbirds which are passive. Therefore, cloths to wrap the birds in is all that is required. A hole can be cut in the centre of a cloth through which the bird' s head can fit allowing the rest of the material to be secured around the bird's wings and body. It can be tied off below the legs or pinned above the wings. Hummingbirds should have artificial nectar within reach at all times or should be offered food every hour or so. (Ingram, 1986).

Anaesthesia Inhalation anaesthesia is suitable for these birds. Intramuscular injections of ketamine hydrochloride at a dose rate of 20 to 30 mg/kg is recommended. As specific dose rates are not available, extrapolation of data from other birds is necessary. Note: In turacos behavioural regurgitation can occur, therefore they should be intubated. Atropine may help prevent this (Ingrain 1986).

Post Anaesthetic Considerations

It is vital that birds be keep warm and propped up in sternal recumbency after being anaesthetised. In recovering from anaesthetics some birds may flap vigorously, so to prevent trauma to the wings the bird should be wrapped in a towel. The sternum should be able to move freely within the restraint so the bird can breathe easily.

Anaesthetic Emergencies

A decrease in heart, respiratory rate or body temperature may be the first sign of an impending emergency. If the heart rate drops below 120 beats/min or the respiratory rate drops below 25-35 resp/min in large birds and below 35-50 in small birds, or there is loss of all reflexes, then the surgical procedure should be put on hold until the bird has been restabilised. If the bird goes into respiratory or cardiac arrest, then the following procedures should be carried out (Harrison *et al*. 1986; Murril *et al*.

1989).

1. The bird should be immediately removed from the attachment to the machine
2. Pulmonary resuscitation, using gentle rhythmic finger pressure at 40-60 cycles/rain on the sternal carina must be carried out while the residual gas is removed from the endotracheal tube or mask by suction
3. Turn off the flow of anaesthesia
4. Flush the machine and hose with pure oxygen
5. Reattach the bird to the hose to administer pure oxygen
6. Continue resuscitation until unaided respiration reaches a safe rate (30/min).
7. Antishock and antiacidosis therapy should be carried out if the patient is reviving, but at a slow rate.

If cardiac arrest occurs, it is usually irreversible. Muir *et al*. (1989) suggests that 5-10 micrograms of epinephrine be injected to try to resuscitate the bird. Harrison *et al*. (1986) managed to successfully rescue one patient, which was under isoflurane anaesthesia, by stimulating the heart with a saline soaked cotton tipped applicator introduced via the thoracic air sac. If respiration ceases, doxepram at a dose rate of 5-10 mg/kg may be administered IV or IM to stimulate the patient.

Just as in mammalian anaesthesia, IV fluids are an essential component in patient maintenance and in emergency situations. Have the bird already attached to a fluid line or have fluids readily available in case of emergency.

As prevention is the best cure, providing adequate ventilation and oxygenation, monitoring and adjusting anaesthetic depth, and by maintaining blood volume and haemodynamic stability, the chances of cardiac arrest occurring will be significantly reduced.

Conclusion

This overview of the field of avian anaesthesia is brief and is only a conglomeration of the ideas of just a few veterinarians. There is a wealth of varying information available on the subject. However, the way in which the patient is handled to ensure as little stress as possible, the considerations that should be taken into account prior to anaesthesia, during treatment and after anaesthesia, essentially remains the same. As long as the primary objectives of anaesthesia, which are:

(1) to accomplish diagnostic, therapeutic, and surgical procedures as safely and as quickly as possible;
(2) to minimise the level of pain and stress and potential side effects in the animal; and
(3) to minimise recovery time and degree of post anaesthetic monitoring, are achieved, the goal has been accomplished.

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