Anaesthesia for compromised patients

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Introduction

From time to time we are faced with anaesthetising a very old, young, sick, or emergency patient for surgery, diagnostic procedures or stabilisation. While fit and healthy patients may have significant reserves in organ function and are usually able to handle the stress of general anaesthesia and surgery, compromised patients have markedly less reserves and impaired ability to cope with these stresses. In a recent study, the risk of an anaesthetic related death in a dog and cat with a normal health status was reported to be low (0.05% and 0.11% respectively), however the risk of an anaesthetic related death increases markedly if the patient was considered compromised and “sick” to 1.33% in dogs and 1.4% in cats (Brodbelt et al. 2008).

Being in charge of a “compromised” patient’s anaesthesia can be intensely scary and not to mention a stressful time for many nurses and technicians. A systematic approach and an anaesthesia plan is often required to help reduce the risks associated with premedication, induction, maintenance and recovery from anaesthesia, and reduce the chances of morbidity (or even mortality) for our patient.

Pre anaesthetic assessment and physical examination

A pre anaesthetic assessment and physical examination is the first step in our plan, and required to accurately determine a patient’s overall health status. This should be performed prior to the intention of anaesthesia. It may be difficult to perform a complete physical examination in some of our patients (for example, a recumbent patient with blunt trauma from a road traffic accident); therefore the focus should be on the organ systems that will be most affected or influenced under general anaesthesia, that is, the cardiopulmonary systems.

The heart should be auscultated to provide an evaluation of heart rate, rhythm (regular, regularly irregular, or irregularly irregular) and whether any murmurs are present. Cardiac arrhythmias may range from mild and incidental through to severe and compromising. Because of this, if arrhythmias are suspected an electrocardiogram (ECG) should be performed (if possible) to determine their extent and allow appropriate treatment (e.g. intravenous lignocaine to treat ventricular tachycardia) prior to the beginning of anaesthesia. A peripheral pulse should also be palpated to provide an assessment of vascular tone and to check synchronicity with the heartbeat (Posner 2011).

A respiration rate and pattern should be observed while the patient is at rest before both lungs are auscultated, dividing the lung fields into quadrants. Pay particular attention to the pattern of breathing. Dyspnoea warrants immediate attention and oxygen support even from the preliminary anaesthetic work up. Oxygen should be provided via whichever means is tolerated, and the patient handled in the least stressful manner possible throughout their examination.

A quick assessment of mucous membrane colour and capillary refill time should be made. Valuable information can be obtained quickly by doing so. Compromised patients may have pale or white mucous membranes if they have experienced significant blood loss (either externally or internally). Cyanotic mucous membranes are a strong indicator of severe hypoxaemia and respiratory compromise (Pascoe 2011).
A rectal temperature is vital. Hypothermia associated with anaesthesia is common and treatable, but remains a significant complication. Thermoregulation is depressed under anaesthesia and abnormal vasoconstriction occurs. This can lead to alterations in hepatic function (including coagulation), cardiac function, renal function, and delays in wound healing (Armstrong et al. 2005).

It is extremely sensible to collect blood for a complete blood count and serum biochemistry before anaesthetising compromised patients, but as a bare minimum a packed cell volume (PCV) and total plasma protein (TPP) should be collected as they deliver vast information quickly to aid our decision process. A PCV gives extra information on hydration status and oxygen carrying capacity. The TPP value allows appropriate fluid therapy to be selected (crystalloids versus colloids) and aids anaesthetic drug selection (Dupre 2010).

In addition to the physical examination an assessment of pain levels must be made at this time and the most appropriate form of analgesia delivered. Painful animals may display aggressive or fearful behaviours when guarding an injury, making it harder for us to perform simple tasks such as placing an intravenous (IV) catheter, or even moving the patient. Animals in pain may also be displaying respiratory abnormalities such as hypoventilation, which leads to hypercapnia and hypoaxemia (McAlees 2009).

The compromised patient, how do we determine the risk?

Determining to what extent a patient is “compromised” before anaesthetising them is extremely important in the overall management of an individual patient’s anaesthetic plan.

The American Society of Anesthesiologists (ASA) developed a set of categories which classifies a patient’s health status and operative risk (Appendix 1). The categories are graded one to five (I-V). One (I) is a fit healthy patient, while five (V) is a moribund patient that is not expected to survive the next 24 hours. The addition of an “E” denotes an emergency and can be added to any classification. The ASA scale can be used to not only identify a truly compromised patient, but may also serve as a prediction of anaesthetic mortality and morbidity. For example; a patient with an ASA score of III or higher is four times more likely to experience serious complications or death under anaesthesia than a patient with an ASA score of I - II (Machon 2011, Posner 2011).

Truly compromised patients will fit the ASA guidelines for categories III – V including emergencies. Compromised patients have a significant risk of anaesthetic-related mortality but some factors increase this risk further. These include: patients of increased age (geriatric patients), with extremes in weight (cachexia or obesity), increased procedural urgency and increased procedural complexity (Machon 2011).

Initial stabilisation

There are hardly any cases that truly require the patient to be immediately anaesthetised and taken straight to theatre. It is vital to perform whatever stabilisation is possible under the given circumstances. Stabilisation is aimed towards improving patient well-being and reducing the overall anaesthetic risk. It can include: oxygen support, decompression of the stomach, placement of an intravenous catheter and appropriate IV fluid therapy, appropriate analgesia, correction of electrolyte imbalances, arrhythmia treatment, re-warming or cooling techniques, plasma or red blood cell transfusion or the placement of a thoracic drain to evacuate air or blood from the chest.

Preparation for the anaesthetic period.

We should consider the preparation phase as being time to prepare ourselves for managing the anaesthetic that is about to take place, and preparing the anaesthetic equipment and drugs that are required for the patient.

Listing some “concerns and considerations” for this individual patient before they are anaesthetised allows a preemptive thought process about what may go wrong, and also helps us think about how we would respond to and correct a given problem if things did go wrong. This is a “fore warned is fore armed” approach to managing any species, age related, disease process, trauma related or procedural considerations. Or in other words; if you prepare for the worst, the worst won’t happen... or if it does, you’re prepared.
Check the anaesthetic machine is set up correctly with no leaks in the patient breathing circuit. Ensure there is enough oxygen in the cylinder to last the procedure, and likewise ensure there is enough inhalational agent in the vaporiser. Some patients are harder to intubate (brachycephalic patients) therefore it is a must to have (and use) a laryngoscope. Check the cuffs for leaks on a selection of appropriately sized endotracheal tubes. Calculate and draw up pre-medication and induction agents using the patient’s lean body weight. If the patient is unable to be weighed due to state of emergency then a conservative estimate of body weight can be made, with induction agents being “dosed to effect” carefully. Compromised patients should have a selection of emergency drugs calculated at this time also.

Prepare the patient

The patient should be fasted for an appropriate time prior to their intended anaesthesia induction (8 - 12 hours for adult small animals). If the patient is not able to be appropriately fasted then they should be treated as though they have a “full stomach” and care taken to prevent regurgitation and aspiration during the induction and maintenance periods by using a rapid induction technique, maintaining a “head up” position during induction, intubating the trachea with a cuffed endotracheal tube and inflating the cuff while the patient is still in the “head up” position, and maintaining anaesthesia with the nose slightly lower than the pharynx to allow drainage if regurgitation does occur (Machon 2011). Anaesthesia time can be shortened considerably by clipping as much of the surgical site as possible and performing an initial skin prep prior to induction of anaesthesia with the nose slightly lower than the pharynx to allow drainage if regurgitation does occur (Machon 2011). Anaesthesia time can be shortened considerably by clipping as much of the surgical site as possible and performing an initial skin prep prior to induction, but care must be taken to not unduly stress the patient. A large bore IV catheter should be placed if it hasn’t already been done so, and IV fluids therapy should be started. If significant haemorrhage is expected (or has already occurred) it is beneficial to place more than one IV catheter, allowing faster delivery of emergency drugs or shock rates of crystalloids, while also providing another readily available port to administer blood products (if so required).

Pre oxygenation

I was always taught: “Oxygen is never a bad idea”. In general, anything old, young, sick or compromised should be pre oxygenated. Patients we consider compromised will have significantly less respiratory reserve and a higher chance of desaturating and becoming hypoxic than fit healthy patients. Compromised patients should therefore be pre oxygenated for around five minutes with a mask and tight-fitting diaphragm immediately prior to induction of anaesthesia, to increase the partial pressure of oxygen within arterial blood (PaO₂), and help reduce the chance of hypoxia and desaturation during the induction period (Pascoe 2011). If the mask diaphragm is not tolerated then it can be removed, as increased stress will not help overall ventilation.

Minimum alveoli concentration (MAC) requirement

It is important to remember that anything sick or compromised will usually require a lower vaporiser setting than a fit healthy patient. After induction, assess the patients depth by looking at their eye position and whether they have a palpebral reflex or not, and assess their cardiovascular function by feeling a pulse and listening to their heart prior to turning the vaporiser on. If the patient appears light, put them onto a vaporiser setting that would be similar to, but lower than a fit healthy patient. If they appear deep, do not turn the vaporiser on, and instead ventilate the patient with 100% oxygen until they come back to a recognisable plane of anaesthesia. If a compromised patient goes deeper than expected from the IV induction agent and the vaporiser is turned on without an initial assessment of depth it just might be “the straw that broke the camel’s back” and send a deep patient into cardiopulmonary arrest.

Monitoring and essential monitoring equipment

A trained vet nurse or technician closely monitoring a compromised patient will lower that patient’s chance of death during the anaesthesia (Dyson et al. 1998). Using anaesthetic monitoring equipment (that a vet nurse is interpreting and responding to) may significantly lower this chance further. Even if there is limited monitoring equipment or all you have is an oesophageal stethoscope there are still multiple parameters that can be assessed to monitor depth, including: heart rate and rhythm, respiration rate, depth and rhythm, and the five facial signs (eye position, presence/absence of palpebral reflex, jaw tone, mucous membrane colour and capillary refill time).
Monitoring should be performed *continuously*, with parameters recorded every five minutes on an anaesthetic record.

**Blood pressure**

It is important to remember that some compromised patients will warrant blood pressure monitoring not just while under anaesthesia, but right from the initial stabilisation period, and well into the recovery period. Blood pressure should be monitored non-invasively via oscillometry or the Ultrasonic Doppler, or if available, invasively by a direct arterial catheter. Direct arterial catheterisation is the most accurate form of blood pressure monitoring, and has many advantages in critical and compromised patients such as allowing access to collect an arterial blood gas sample, and being able to monitor continuous changes in blood pressure on a second-by-second basis. Hypotension is one of the most common complications occurring in veterinary patients under inhalational anaesthesia (Gaynor *et al.* 1999), and is defined as a lower than normal blood pressure i.e., a systolic arterial pressure (SAP) or a mean arterial pressure (MAP) less than 90mmHg, and, 60mmHg respectively. A MAP of 60mmHg is the minimum pressure required to adequately perfuse vital peripheral organs, most importantly the kidneys, liver and spleen (Wagner and Brodbelt 1997).

There are three (main) ways we can treat hypotension:

1. If the patient is under anaesthesia, turn down the inhalational agent.
2. Give an IV fluid bolus: The type of fluid required will depend on the underlying reasons for hypotension. 10ml/kg of crystalloids (Hartmanns or 0.9% saline), shock rates of crystalloids (90ml/kg for dogs and 60ml/kg for cats), 5-20ml/kg of synthetic colloids (either gelatin or starch based) or a blood product transfusion may be indicated.
3. Use positive inotropes: Dopamine at 5-10µg/kg/min or dobutamine at 2-10µg/kg/min delivered as a constant rate infusion.

It is important to point out that compromised patients are more likely to be hypotensive due to compounding factors other than just the anaesthetic agents used, and may not respond to the simple “fixes” such as decreasing the vaporiser setting or giving a fluid bolus. Cardiac arrhythmias, bradycardia, hypovolaemia, hypoproteinaemia and vasodilation may all decrease blood pressure, warranting further investigation and prompt correction where possible.

**Pulse oximetry**

Pulse oximetry is useful to pick up hypoxic episodes (before the patient displays cyanosis) as well as monitor heart rate. A recent study has shown that cats that were monitored with a pulse oximeter (in combination with assessing the pulse) were 3-4 times less likely to die under anaesthesia compared to cats that were not monitored in this way (Brodbelt *et al.* 2007). The percentage of haemoglobin that has oxygen bound to it (SpO2) should be maintained above 94% and an oxygen saturation of <90% indicates severe hypoxia. SpO2 changes are to be expected with many compromised patients, including thoracic trauma, head trauma, heart failure, late stage pregnancy, geriatric patients and gastric dilation volvulus (GDV).

**Electrocardiograph (ECG)**

If you have an ECG they are helpful to use in compromised patients where ECG changes are expected (hit by car patients, GDV, hyperkalaemic patients). By monitoring for cardiac arrhythmias we can not only just “pick up” on their occurrence, but respond to them, and where necessary administer the appropriate anti arrhythmic agent.

**Capnography**

Capnography is an extremely useful tool in anaesthetic monitoring, and provides information about the patient’s circulation, metabolism and ventilation. A normal end tidal carbon dioxide (ETCO₂) should be between 35-45mmHg. An ETCO₂ greater than 55mmHg can contribute significantly to a respiratory acidosis, while an ETCO₂ lower than 20mmHg will decrease cerebral perfusion and is associated with a respiratory alkalosis. If respiration
remains constant, an increase in ETCO$_2$ represents an increased cardiac output (or an increased metabolic rate). Likewise, a decreased ETCO$_2$ can be seen with a decreased cardiac output. An embolism caused by air, fat or bone marrow is identifiable by a sudden decrease in ETCO$_2$, (usually at the same time as the pulse would cease on the Doppler). A rapidly falling ETCO$_2$ may indicate low cardiac output or impending cardiac arrest, particularly in the presence exaggerated respiratory efforts (Fletcher 2011).

**Recovering the compromised patient**

The highest risk phase of anaesthesia is now considered the recovery phase. Postoperative fatalities (mostly occurring in the first three hours of recovery) account for 47% of deaths in dogs and 61% of deaths in cats (Brodbelt 2008). It is therefore absolutely necessary to continue monitoring into the recovery period for all patients undergoing heavy sedation or anaesthesia, and some compromised patients would also warrant the continued use of monitoring equipment (such as blood pressure monitoring and pulse oximetry).

Recovery starts when we turn off the anaesthetic agent and concludes when the patient is back at a level of consciousness that we would consider to be “awake”; i.e. responsive and alert. Compromised patients will be slower to recover, most likely hypothermic to some degree and often painful if they have had surgery. Pay particular attention to rectal temperature, heart rate, respiration rate and pattern, mucous membrane colour and capillary refill time and how comfortable the patient seems. Blood pressure, oxygen saturation and, if required, arrhythmia analysis via and ECG, can continue into the recovery period in severely compromised patients. Monitoring should be performed continuously until vital parameters are close to normal limits and can be recorded every 5-15 minutes. If the patient appears painful it is important to supplement analgesia. Shivering and rewarming is “metabolically expensive”, with oxygen demand increasing by up to 800% to perform this task (Machon 2011), highlighting the necessity for active warming techniques and thermal support (such as circulating warm water blankets) during the anaesthesia maintenance phase as well as recovery. Oxygen support may still be required well into the recovery period for some patients. This can be provided by an oxygen hood, nasal oxygen, mask or oxygen cage.

**Conclusion**

Compromised patients represent a significant challenge to the anaesthetist, and require a rigorous plan to help decrease the chance of morbidity and mortality whilst caring for and anaesthetising them. A plan for the management of a compromised patient should include:

- A pre anaesthetic physical exam.
- ASA classification to determine the anaesthetic risk.
- Stabilisation of the patient.
- Listing the concerns and considerations appropriate for each individual patient.
- Setting up the machine and equipment.
- Premedication, induction and emergency drug calculations.
- Allowing fasting time if possible.
- Limiting anaesthesia “down time”.
- Pre oxygenation.
- Careful vaporiser setting selection.
- Continuous monitoring while anaesthetised.
- Continued monitoring for the entire recovery period while providing analgesia and thermal support.
References


McAlees T. Assessment and management of thoracic trauma. In: *Australian College of Veterinary Scientists (annual conference proceedings)*, Anaesthesia Emergency and Critical care chapter, pp 16-18, 2009


## Appendix A

<table>
<thead>
<tr>
<th>Category (ASA)</th>
<th>Physical Status</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Fit healthy normal patient undergoing an elective procedure with no evident disease.</td>
<td>Castration, cat spey.</td>
</tr>
<tr>
<td>II</td>
<td>Mild pre-existing disease or systemic disturbances but they do not limit function.</td>
<td>Healthy geriatric or paediatric patient, skin tumour removal, cruciate repair.</td>
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<tr>
<td>III</td>
<td>Moderate to severe pre-existing disease that limits function but is usually a compensated disease.</td>
<td>Chronic renal failure, dehydration, mild liver disease, significant blood loss.</td>
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<tr>
<td>IV</td>
<td>Severe systemic pre-existing disease that is a threat to life and unable to be compensated for.</td>
<td>Uncompensated heart disease, endocrine disease or acute renal failure, emaciation.</td>
</tr>
<tr>
<td>V</td>
<td>Moribund patient that is not expected to survive the next 24 hours with or without surgical intervention.</td>
<td>Severe trauma, uncompensated hypovolaemic shock,</td>
</tr>
<tr>
<td>E (emergency)</td>
<td>An emergency procedure. The “E” can be added to any category above.</td>
<td>Non-elective caesarean, Gastric dilation +/- volvulus, Equine colic surgery.</td>
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