Maximising Anaesthetic Outcomes in Geriatric Patients

Worth it.

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Age-related Physiological Changes in Geriatric Patients, Their Consequences and Impact on Anaesthesia

Dogs and cats are living longer than ever before, largely due to improved availability and options for veterinary care. Approximately **30% of the pet population** are now considered to be **geriatric**.[1-3]

The age at which an animal becomes geriatric is generally defined as *'when the animal reaches 75-80% of its expected lifespan'*.[1-8] For cats, this is usually from 12-14 years of age.[6,8] Dogs differ significantly in size, weight and likely lifespan. Giant breeds such as Great Danes age more quickly than smaller breeds and could be considered geriatric at only six years, whilst toy and small breeds such as Chihuahuas or toy Poodles may not be considered to be geriatric until they are 12 or more years of age.[1,6,8]

Whilst age itself is not a disease, as animals age, they undergo progressive and irreversible physiological changes, leading to a reduction in their bodies' overall organ function and physiological reserve capacity.[1-8]

There can be a lack of correlation between physiologic and chronologic age, with many older animals remaining remarkably fit, whereas others seem to age faster than expected. Often this may be due to co-morbidities, diagnosed or undiagnosed.

Evaluate and manage each animal as an individual, remembering that the changes in physiological reserve superimposed with the effect of any concurrent diseases – not just the patient age – will affect anaesthesia.[1-7] Be particularly wary of animals which look 'old for their years'.[7] A **thorough pre-anaesthetic assessment** of geriatric patients is of paramount importance.[6]

A large scale study into perioperative small animal fatalities in the UK estimated that the **risk of anaesthetic death** increased with age as much as **seven times for patients over 12 years of age.**[9]

The key reason for this **increased anaesthetic morbidity** is the **decline in organ function** and in **functional reserve** in geriatric patients.[1,3,6]

Under routine non-stressful conditions, when the geriatric pet is in its 'normal' home environment, the physiological decline in its body – brain, kidneys, liver, heart, lungs, muscles, bones and fat, – produces no or only minimal functional impairment for the animal.

However, with **acute stress** such as **anaesthesia** and surgery (or disease), the **diminished reserve capacity impairs** the **pet's body's ability** to **respond** to the increased 'demand' placed upon it.[6]

By understanding the changes that occur in geriatric patients and planning appropriately, anaesthesia may be performed with greater confidence. Developing a **suitable anaesthetic plan** for a geriatric patient involves a **thorough assessment** of each animal, **appropriate perianaesthetic management, careful drug selection, and vigilant, responsive monitoring.**[1-8]

Age-related Physiological Changes in Geriatric Patients, Their Consequences and Impact on Anaesthesia (continued)

Central Nervous System (CNS)

- Reduced cerebral perfusion and oxygen consumption leads to loss of neurons, reduced brain mass and increase in cerebrospinal fluid volume.
- Increased blood-brain barrier permeability:
  - Increased **sensitivity to sedatives** and **general anaesthetics.**
  - **Minimum alveolar concentration** (MAC) for inhalant anaesthetics **decreases** linearly with age; requirement for local anaesthetics, opioids, barbiturates, benzodiazepines, and other **intravenous anaesthetic drugs** is likely similarly **reduced** and **the duration of effect prolonged.**[1-8]
- Myelin degeneration, reduced neurotransmitters and reduced receptor affinity lead to a reduction in neuronal plasticity.
- Accumulation of metabolic products within the brain (e.g. beta-amyloid plaques).
- Decreased visual and auditory acuity:
  - Sensory impairment makes geriatric pets **anxious** in unfamiliar environments and situations.
  - Metabolic product deposition worsens sensory impairment; can lead to **cognitive dysfunction.**[5,6]
  - **Dysphoria** and **delirium** during perioperative period are more likely, causing stress and increasing detrimental **sympathetic stimulation**; can **precipitate cardiovascular failure.**[1-6]
- Reduced thermoregulatory centre function:
  - The risk of **hypothermia** increases, which:
    - Reduces coagulation and reduces MAC during anaesthesia.
    - Post-anaesthesia, delays recoveries, increases oxygen consumption by 200-300%, potentially precipitating arrythmias.
    - Increases the likelihood of infection and reduces wound healing.[1-3,5,6,8]

- ✓ Titrating anaesthetic agents to effect is crucial in geriatrics as doses required may be significantly lower than those required in younger adult animals.[1-8]
- ✓ Management of anxiety is essential to ensure a smooth anaesthetic and avoid the dangerous effects of excessive stress on geriatric patients.
- ✓ Careful temperature monitoring throughout the anaesthetic and active efforts to rewarm geriatric animals are crucial.

Musculoskeletal System

- Reduction in muscle mass and total body water lead to a reduction in basal metabolic rate:
  - Geriatrics are more susceptible to **hypothermia** (see CNS section).[1]
- Increases in fat composition, with (relative) obesity more common in aged pets:
  - An **increase** in the **relative proportion of fat** in some older animals can **prolong the effect of drugs** normally redistributed to fat, as their **elimination** from the body is **delayed.**[1]
- Osteoarthritis and/or spondylosis are common:
  - **Painful joint** conditions can make positioning geriatrics for surgery or radiography **uncomfortable**; reduced 'padding' due to muscle atrophy exacerbates this: good analgesia is essential.[6,7]

- ✓ Avoid pulling limbs into abnormal positions or over-extending joints and provide adequate cushioning and good analgesia before, during and after anaesthetic procedures.[6,7]

Age-related Physiological Changes in Geriatric Patients, Their Consequences and Impact on Anaesthesia (continued)

Cardiovascular System

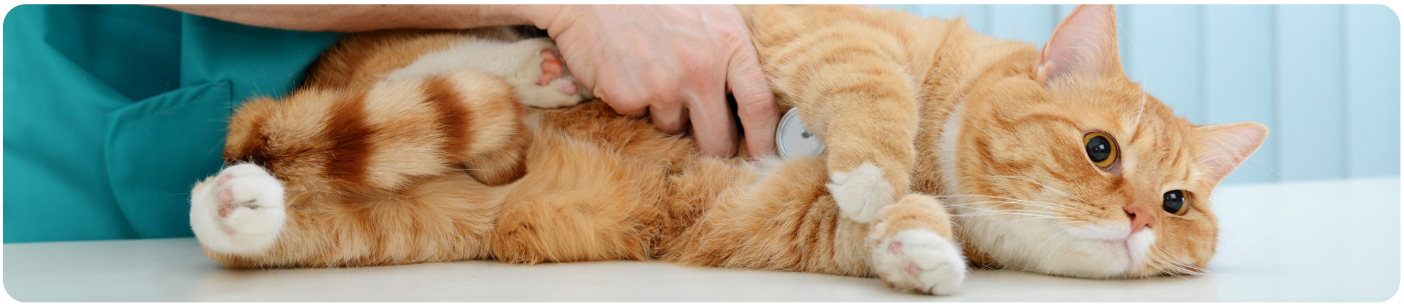
- Reduced cardiac reserve due to decreased cardiac output because of decreases in both blood volume and pressure.
- Reduced myocardial and vascular compliance due to atrophy and fibrosis:
  - **Decreased pump efficiency** and a reduced ability to respond to haemodynamic changes.
  - With age, **cardiac output becomes preload-dependent** with more reliance on **increasing stroke volume to increase cardiac output** and less ability to elevate the heart rate.[1-8]
- Increased vagal tone.
- Reduced baroreceptor sensitivity:
  - This, combined with reduced cardiac reserve, means **volume depletion** is **poorly tolerated**; **intravenous fluids** should be provided judiciously during the perianaesthetic period to replace fluid losses and counteract the vasodilatory and hypotensive effects of anaesthetic agents.
  - However, **fluid overloading may precipitate congestive heart failure and pulmonary oedema**, so inadvertent **over-administration of fluids must be avoided**.[2-4,6]
- Increased circulation time:
  - It will take **longer than expected to induce anaesthesia** via the **intravenous** route.[6]
- Increased likelihood of arrhythmias due to conduction changes in the heart:
  - Increases in cardiac workload (e.g. during stress) result in higher myocardial oxygen requirements; if not met, cardiac muscle may fail, causing **life-threatening arrhythmias.**[1-4]

- ✓ Any evidence of heart disease should be thoroughly investigated before anaesthesia.
- ✓ Take a basal arterial blood pressure reading prior to administration of any medications.
- ✓ Fluid rates must be calculated accurately for each patient.
- ✓ Intravenous anaesthetic agents must be administered slowly and titrated to effect, to avoid overdosing.
- ✓ Carefully monitor the cardiovascular system during anaesthesia; avoid dramatic changes in heart rate and blood pressure: a geriatric animal's cardiac reserve may not cope with these.[1-4,6]

Hepatic System

- Reduced functional reserve with decreased liver mass and reduced metabolic capacity.
- Reduction in cardiac output leads to reduction in hepatic blood flow:
  - **Metabolism** and **excretion** of **drugs** are **reduced.**[3]
- Reduction in protein synthesis, clotting factor production and poor glucose regulation:
  - The proportion of **'free' (active) drug** can be **increased**, if hypoproteinaemia is present.[3]
  - **Decreased blood clotting** requires diligent haemostasis.[2,4,6]
  - Increased propensity for **hypoglycaemia following fasting.**[2,4,6]

- ✓ Prolonged and/or increased effects of some drugs and a slower patient recovery.[3]
- ✓ Serum biochemistry is essential to assess for changes in liver enzymes prior to anaesthesia, with supplementary coagulation testing also recommended.



Age-related Physiological Changes in Geriatric Patients, Their Consequences and Impact on Anaesthesia (continued)

Respiratory System

- Reduced ventilatory reserve due to decreased functional residual capacity and closing capacity.
- Loss of compliance in thoracic wall and lung parenchyma:
  - Decreased lung elasticity, thoracic compliance, high closing volume, easily fatigued ventilatory muscles and less responsive metabolic system makes geriatrics prone to **ventilation-perfusion mismatching, hypoxaemia** and **hypercapnia** during anaesthesia.[1-8]
- Increased airway dead space.
- Reduced gas diffusion capacity, so reduced resting haemoglobin-oxygen saturation (SpO_2).
- Slower ventilatory response to respiratory depression due to reduced chemoreceptor sensitivity:
  - If adequate oxygen is not delivered to body tissues, cells die, which is catastrophic if the tissues involved do not have ample reserve; can be the precipitating factor for the animal declining into renal or cardiac failure post-anaesthesia.[6]
- Reduced laryngeal and pharyngeal protective reflexes (e.g. cough):
  - Increased risk of aspiration in the perioperative period.[4]

✓ Diligent respiratory monitoring, pre-oxygenation, intubation, warming and readiness to provide additional ventilatory support are crucial for successful anaesthesia of geriatric patients.

Urinary System

- Reduced renal functional reserve due to reductions in renal blood flow, number of functional nephrons and glomerular filtration rate.
- Disturbances to sodium and water homeostasis due to tubular resistance to anti-diuretic hormone.
- Reduced responsiveness of the renin-angiotensin-aldosterone system:
  - A geriatric kidneys' ability to cope with decreased perfusion, correct electrolyte imbalances or excrete excess fluid is impaired, even in the absence of overt renal disease.
  - If anaesthesia and surgery increase sympathetic stimulation, causing vasoconstriction, this will further reduce renal blood flow. A **poorly managed anaesthetic can hasten the development of renal deterioration or even failure.**[6]
  - The plasma half-life of drugs dependent on renal excretion may also be **prolonged** in geriatric patients.[4]
- Often, co-existence of primary renal disease.[1-8]

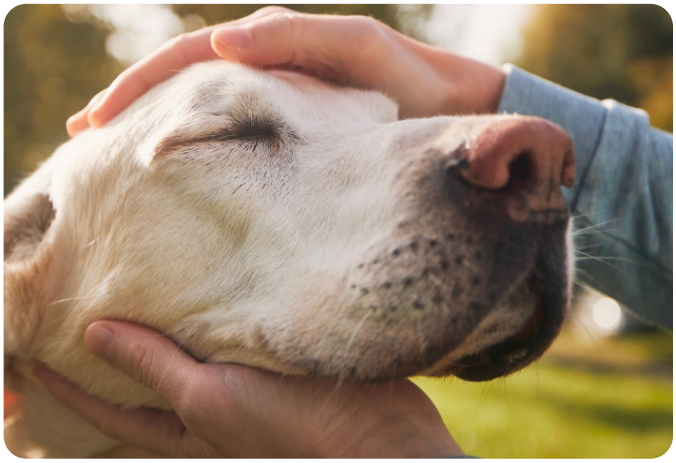
✓ Serum biochemistry and urinalysis should be performed prior to anaesthesia to identify renal insufficiency, which has been estimated to occur in 15-20% of geriatric dogs and cats.[5]

✓ Baseline blood pressure testing prior to, and appropriate fluid therapy during anaesthesia is also important for geriatric patients for renal preservation (see Cardiovascular section).[2,3,5,6]

Gastrointestinal System

- Reduced lower oesophageal sphincter tone.
- Increased gastric acidity / lower gastric pH:
  - increased risk of reflux and regurgitation.[7,8]

✓ The likelihood of aspiration pneumonia is increased, necessitating careful protection of the geriatric patient's airways during anaesthesia and efforts to mitigate the occurrence of reflux or regurgitation.[7,8]



Anaesthetic Considerations in Geriatric Patients

With increasing age, there is often an increased requirement for anaesthesia of pets. To maximise success, thorough pre-anaesthetic evaluation of geriatric patients is essential to identify any co-morbidities that may require management or could change the anaesthetic plan for that patient. Veterinary teams should aim to stabilise the patient prior to anaesthesia and choose multimodal anaesthesia. Where possible, select drugs with a short duration of action and with reversal agents available, using the lowest effective dose of all agents. Pre-oxygenation, provision of IV fluids, patient warming and vigilant monitoring is essential for geriatric patients undergoing anaesthesia.[1-8]

Pre-anaesthetic Patient Assessment

A thorough **history** should be obtained, including previous or concurrent diseases, ongoing medications and any previous anaesthetic experience. Exercise tolerance is an important predictor of perioperative outcome, so question the pet owner on this in detail.[1,4,6]

A complete **physical examination** should be conducted on the patient, with **careful auscultation of the heart** and **lungs**. Thoracic **radiographs**, an **echocardiogram** and **electrocardiogram** should be performed if any abnormalities are detected.[1-4]

Pre-anaesthetic diagnostic testing is essential for geriatric patients to maximise anaesthetic success. This should include a **complete blood count** and full **biochemistry** panel, **thyroid testing** (in cats especially), a **urinalysis** and baseline **blood pressure** measurement. Coagulation testing may also be included.[1-4,6]

For elective procedures, collect blood and urine a few days in advance of the planned anaesthetic to determine the presence and extent of any systemic disease. This will give time to stabilise the patient and **correct any major abnormalities prior to anaesthesia**.[6]

A pre-anaesthetic blood testing study was conducted in 101 dogs over seven years of age. 30% had new conditions diagnosed and 14% of anaesthetics were delayed or cancelled as a result of the new diagnosis.[10]

This baseline of information will enable determination of the patient's **ASA Physical Status Classification Score** to help guide a risk assessment and formulate an appropriate anaesthetic plan for that patient.[11]

Patient Preparation

Fast geriatric patients for **at least six hours** prior to presentation to the clinic, but only **remove water** at the time of **premedication** (to reduce dehydration).[6,7] In geriatric patients, consider the use of **anxiolytics** prior to presentation to the clinic, to reduce patient stress and anxiety.

Due to the increased risk of aspiration pneumonia in geriatrics, consider the use of **anti-emetics** such as **maropitant (e.g. Cerenia®)** either prior to presentation to the clinic or during preparation of these patients for sedation and anaesthesia, to reduce the likelihood of vomiting.

If required, **stabilise the patient prior to anaesthesia**. Correcting hydration, electrolyte and acid-base disturbances will help to prevent issues during anaesthesia. Use extreme care **not to overhydrate** the patient.[6]

An **IV cannula** should be routinely placed prior to anaesthesia to allow delivery of medications, fluids and in case of emergencies, to allow venous access.[6]

Calm and gentle handing of these patients and "TLC" at all times is imperative to reduce stress.[8]

Premedication

Aim to maintain a quiet, comfortable, stress-free animal prior to induction, rather than a deeply sedated patient.[6]

Multi-modal anaesthesia for geriatric patients will commence with their premedication. Ideally, choose **agents with minimal impact on the cardiovascular and respiratory systems** and those which can be **reversed**.[8]

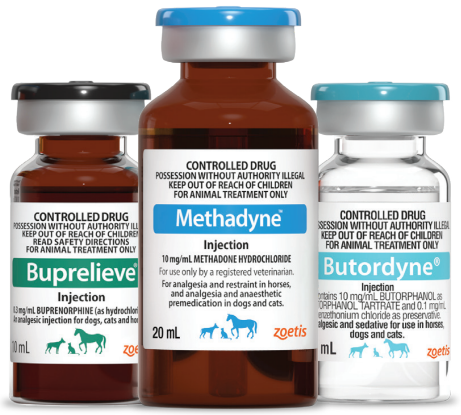
Anaesthetic Considerations in Geriatric Patients (continued)

Opioids will often form the foundation of premedication due to their potent (pre-emptive) analgesia, mild sedation and options for reversal if cardiopulmonary depression occurs.[1-8]

Methadone (e.g. Methadyne™) is a pure μ- agonist, a highly effective analgesic and an appropriate choice for animals undergoing **major surgery**; it is also a good sedative, but can cause more respiratory depression than the partial or agonist-antagonist opioids.

Buprenorphine (e.g. Buprelieve®), a partial agonist, has the longest duration of action, is also a good sedative with minimal impact on organ function and is suitable for **moderate pain relief**, particularly in **cats**.

Butorphanol (e.g. Butordyne®) is an agonist-antagonist. It is short acting and a comparatively less effective analgesic, but an **excellent sedative** causing minimal cardiovascular or respiratory depression. It can be useful in geriatric patients being anaesthetised for **non-painful procedures**.[1-3,6]



As with all agents used in geriatric anaesthesia, the **doses** of opioids may need to be **reduced**.[1,7]

There is often less need for substantial sedation or tranquilisation as patients age and an opioid alone may be sufficient as premedication for many geriatric patients.[4] The most commonly selected agents to use in conjunction with these are **benzodiazepines**, which provide **anxiolysis** and **more consistent sedation** in **geriatric** animals than younger adults, but their **effects may be prolonged** with liver dysfunction. Remember that **sole use** of **benzodiazepines** can **predispose patients to emergence delirium** upon recovery from anaesthesia.[3-5,8]

Very **low doses of acepromazine** may, in some cases be appropriate for sedation, and less commonly, **very low doses of α-2 agonists** in healthy geriatrics, but their profound cardiovascular effects may make them an inappropriate choice for many geriatric patients.[1-8]

The **addition of local or regional anaesthetic techniques** to anaesthetic protocols is often appropriate for geriatric patients and enables lowering of doses of more cardiovascular or respiratory depressant agents.[1,3] These have the added benefit of blocking the stress response induced by the surgical intervention.[5]

Induction

Pre-oxygenation for three minutes immediately prior to induction, ideally by facemask, will increase the respiratory reserve of geriatric animals.[4,12]

Alfaxalone (e.g. Alfaxan® Multidose) is a suitable choice for induction of geriatric patients and may be used in patients of all ASA Classifications.[13-15]

Alfaxalone has a **wide safety margin, a short duration of action**, and is **rapidly metabolised**. Patients induced with alfaxalone at recommended dose rates, slowly to effect over 60 seconds, have been shown to maintain clinically acceptable blood pressures, heart and respiratory rates and breathe spontaneously.[14-19]

Propofol is an alternate intravenous induction agent which may be used in geriatric animals, but can cause both **cardiovascular and respiratory depression**.[1-6] One study observed that geriatric dogs were more sensitive to the effects of propofol than younger adults and required **lower doses**.[5]

Co-induction with benzodiazepines has been suggested by some veterinary anaesthetists.[6]

It is crucial to **induce slowly to effect** in geriatric animals, as they **often require lower induction doses** than younger animals and their blood circulation time may be prolonged, which can **slow the onset of effect of intravenous anaesthetics**.[6]

Geriatric patients should be **intubated** immediately after induction and provided with **supplemental oxygen**.[3,4,8]

Anaesthetic Considerations in Geriatric Patients (continued)

Maintenance and Monitoring

Isoflurane (e.g. IsoFlo®) has become well established in veterinary anaesthesia for use as a maintenance agent in higher risk patients, including relatively compromised geriatric patients.[4] Isoflurane depresses respiration in a dose-related fashion and causes hypotension, producing a transitory decrease in renal blood flow, glomerular filtration rate, and urine flow, although no direct renal toxicity has been reported.[1,2,4] It is eliminated by ventilation, requiring virtually no hepatic metabolism.[3,4] Remember the MAC is lower in geriatric animals than younger adults, so lowering the vaporiser setting is advisable.[1,8]

Judicious use of **intravenous fluids** (usually Hartmann's solution or Lactated Ringer's solution) is recommended during anaesthesia of geriatric patients rates should be reduced in patients with cardiac disease to avoid over-hydrating.[2-4,6,8] Fluid therapy should be continued until patients are eating and drinking adequately post-anesthesia.[6]

Geriatric patients should be **monitored diligently by a dedicated anaesthetist** throughout the **entire anaesthetic period, including recovery**, including as many of the following parameters as possible:

- Anaesthetic depth
- Heart rate and rhythm and pulse rate
  - (Oesophageal) stethoscope
  - Blood pressure monitor
  - Continuous ECG
- Respiratory rate and depth
  - Capnography
- Mucous membrane colour and capillary refill time
  - Pulse oximetry
- Temperature
- Urine output.[1,8]

Recovery

Recovery can be a dangerous time for geriatric patients. **Careful, vigilant monitoring during the recovery period** is essential to detect and correct alterations in homeostasis that may develop during the perianesthetic period. Monitoring and support must continue **until the patient has regained full control of all physiologic functions**.[1,3,6] Hypothermia, hypoventilation and cardiovascular disturbances are all highly possible during this period.[1,3,6]

Fluid therapy, oxygen supplementation (including post-extubation) and **patient warming** are all likely to be required during the post-anaesthetic period.[1-3,5,6,8]

Care should be taken to **avoid pain, stress and overstimulation** during the recovery period, with the provision of appropriate **analgesia, warm, comfortable bedding** and a **quiet environment** to assist with a smooth recovery and reduce the likelihood of emergence delerium.[2,3,5,6,8]

Summary

Age-related physiologic changes and their potential impact on the process of anaesthesia in geriatric patients can be significant. With appropriate preanaesthetic screening, informed choices, judicious dosing and the use of multimodal anaesthesia, along with careful monitoring and supportive care, the risk of anaesthesia in geriatric animals can be greatly reduced, to improve patient outcomes.[1-8]

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