Tips for Improving Anaesthetic Safety for the Small Animal Patient with Kidney Disease

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Introduction

Kidney disease is relatively common in small animals. Frequently, patients with kidney dysfunction or compromise require anaesthesia for procedures including dental therapy, removal of neoplastic lesions, and emergency surgery following trauma. Because anaesthesia carries with it the risk of hypotension, it can potentially add significant risk to a patient with pre-existing renal compromise. The following provides a short description of the major considerations in patients with kidney disease facing anaesthesia.

The Problems in Patients with Renal Disease

1. Altered drug distribution and excretion – the kidney is responsible for removing the metabolites of many anaesthetic drugs. In addition, the kidney also metabolizes some drugs. The presence of kidney disease reduces excretion rates of many drug metabolites – some of which still have anaesthetic pharmacological activity. Additionally, kidney disease also reduces the rate of metabolism of anesthetic drugs such as ketamine. However, this does not necessarily mean that we should not use these drugs (except for known nephrotoxic drugs like non-steroid anti-inflammatory medications, which should be avoided) in patients with kidney disease, but it DOES mean we may need to use lower doses, or extend the interval between administering certain drugs such as antibiotics, and opiate analgesics. Examples of drugs that should have dose reductions in patients with renal disease are
    1. Ketamine
    2. Thiopentone
    3. Benzodiazepines (diazepam, midazolam)
    4. Opioids – morphine, fentanyl, buprenorphine, hydromorphone, butorphanol, meperidine (pethidine)
    5. Beta-lactam antibiotics – cephalosporin and penicillin antibiotics
    6. Isoflurane, (halothane)

Patients with chronic kidney failure often have altered body mass, which affects drug distribution. Additionally, fluid and electrolyte imbalances can alter physiological responses to anaesthetic drug administration.

1. Reduced renal mass – the kidneys rely on a constant blood flow to excrete body wastes, and to maintain normal electrolyte and acid-base status. Patients with kidney disease generally have reduced renal mass, and changes in arterial blood pressure, blood loss, changes in body temperature etc., caused by anaesthetic drugs can damage remaining nephrons, resulting in patient decompensation and uraemia. The harmful renal effects of anaesthesia are generally related to the doses of anaesthetic agents used. Use of the lowest possible concentrations and doses of drugs to achieve desired anaesthetic depth during the anaesthetic period is recommended. Furthermore, avoiding drugs with undesirable impacts on kidney blood flow is recommended e.g. acepromazine, alpha-2 agonists, high concentrations of isoflurane etc.
2. Electrolyte disturbances – In addition to abnormal drug metabolism, reduced renal mass produces alterations in serum electrolyte and acid-base status, which result in abnormal cell function throughout the body. Pre-anaesthetic normalization of serum electrolytes – particularly sodium, potassium, calcium and hydrogen are important in ensuring normal body cell function during anaesthesia.
3. Fluid balance – Patient with kidney disease are frequently dehydrated, hypovolaemic, or both. Every attempt should be made to correct volume and hydration deficits prior to anaesthesia in the kidney disease patient, as failure to do so increases risk of further kidney injuryElectrolyte disturbances – In addition to abnormal drug metabolism, reduced renal mass produces alterations in serum electrolyte and acid-base status, which result in abnormal cell function throughout the body. Pre-anaesthetic normalization of serum electrolytes – particularly sodium, potassium, calcium and hydrogen are important in ensuring normal body cell function during anaesthesia.

Anaesthetic Management of the Patient with Renal Disease

Having identified the problems facing a patient with renal disease, appropriate steps should be taken to remedy or solve these problems both prior to and during (and following) anaesthesia.

1. Fluid therapy – the aims of fluid therapy during anaesthesia are to maintain proper blood volume, and ensure the kidneys have the optimum perfusion before, during AND after the anaesthetic, so that remaining kidney tissue is not compromised or lost due to hypotension, and/or reduced blood volume.
    1. Prior to anaesthesia, the patient with kidney disease should be rehydrated over about 6-24 hours, using a balanced electrolyte solution such as lactated Ringer’s solution. This should enable correction of pre-renal azotemia, and increased excretion or uremic toxins.

    2. During the anaesthetic, lactated Ringer's solution may also be used, but the rate of fluid administration should increase from rehydration rates to surgical rates of approximately 5 ml/kg/hr (cat), to 8 ml/kg/hr (dog) to begin with. During anaesthesia, the rate of fluid therapy may be adjusted, depending on the status of the patient – using such indices as heart rate, blood pressure, and urine output.
    3. Post anaesthesia, patients should continue to receive intravenous fluid therapy support in most instances for a period of 12-24-hours, and until the patient is ambulatory, has good appetite and is urinating well.

2. Transfusion therapy – patients with chronic renal failure are not uncommonly anaemic. Transfusion to achieve a PCV of 28-30% may be required in some patients.
3. Normalise bleeding time – patients that are azotaemic frequently have prolonged bleeding times. Azotemia interferes with platelet function, and this can increase the risk of surgical bleeding. Desmopressin acetate (Minirin) given at 1 microgram/kg SC may be beneficial in reducing the risk of bleeding in uremic animals. Fresh frozen plasma is rarely required to manage coagulopathy in uraemic patients unless co-morbidities exist such as sepsis, DIC or rodenticide toxicity etc.
4. Electrolyte levels – sodium and potassium levels should be normalized prior to anaesthesia. Some animals with acute urinary tract obstruction, or acute renal failure, or urinary tract leakage may have elevated potassium levels, which can produce life-threatening cardiac arrhythmias and death if not treated. These patients should be treated to reduce serum potassium levels prior to induction of anesthesia.
5. Drugs to avoid in renal disease patients – include…
    1. Non-steroid anti-inflammatory medications (including COX-2 selective or specific)
    2. Alpha-2 adrenergic receptor agonists such as medetomidine, dexmedetomidine and xylazine
    3. Mask-down gas anaesthesia techniques (due to stress-induced reduction in kidney perfusion, and isoflurane-mediated reductions in blood pressure and cardiac output)

Suggested Anaesthetic Protocols for Patients with Kidney Disease

Suggested anaesthetic regimes for patients with renal disease include a combination of opioid premedication, injectable intravenous induction agents, and total or partial intravenous anaesthesia protocols for maintenance of anaesthesia, with minimal use of isoflurane (to avoid potential for hypotension). Regardless of the drugs chosen, care should be taken during administration to avoid potential toxic side effects resulting from altered drug distribution or metabolism. For this reason, it is recommended to dose drugs at lower dose rates than standard references suggest for healthy patients, and to titrate the drug dose to effect.

Suggested Protocol A

1. Premedication: Fentanyl 2-4 micrograms/kg given IV
2. Induction: Alfaxalone IV
3. Maintenance: Fentanyl 2-6 micrograms/kg/hr CRI +/- midazolam 0.1-0.25 mg/kg/hr CRI plus isoflurane to effect.

Suggested Protocol B

1. Premedication: Fentanyl 2-4 micrograms/kg given IV
2. Induction: diazepam 0.25-0.5mg/kg IV combined with ketamine 1.0-3.0 mg/kg IV
3. Maintenance – Fentanyl CRI @ 2-6 micrograms/kg/hr plus isoflurane to effect

There are many other possible anaesthetic protocols that may be suitable for patients with kidney failure in addition to those suggested above. Ultimately, the choice of medication for a patient is made by the clinician in charge of the case, with consideration given to familiarity with the drugs selected, assessment of risk to the patient, and the extent to which patient abnormalities can be corrected or stabilised prior to anaesthetic induction.

References and Suggested Reading:

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