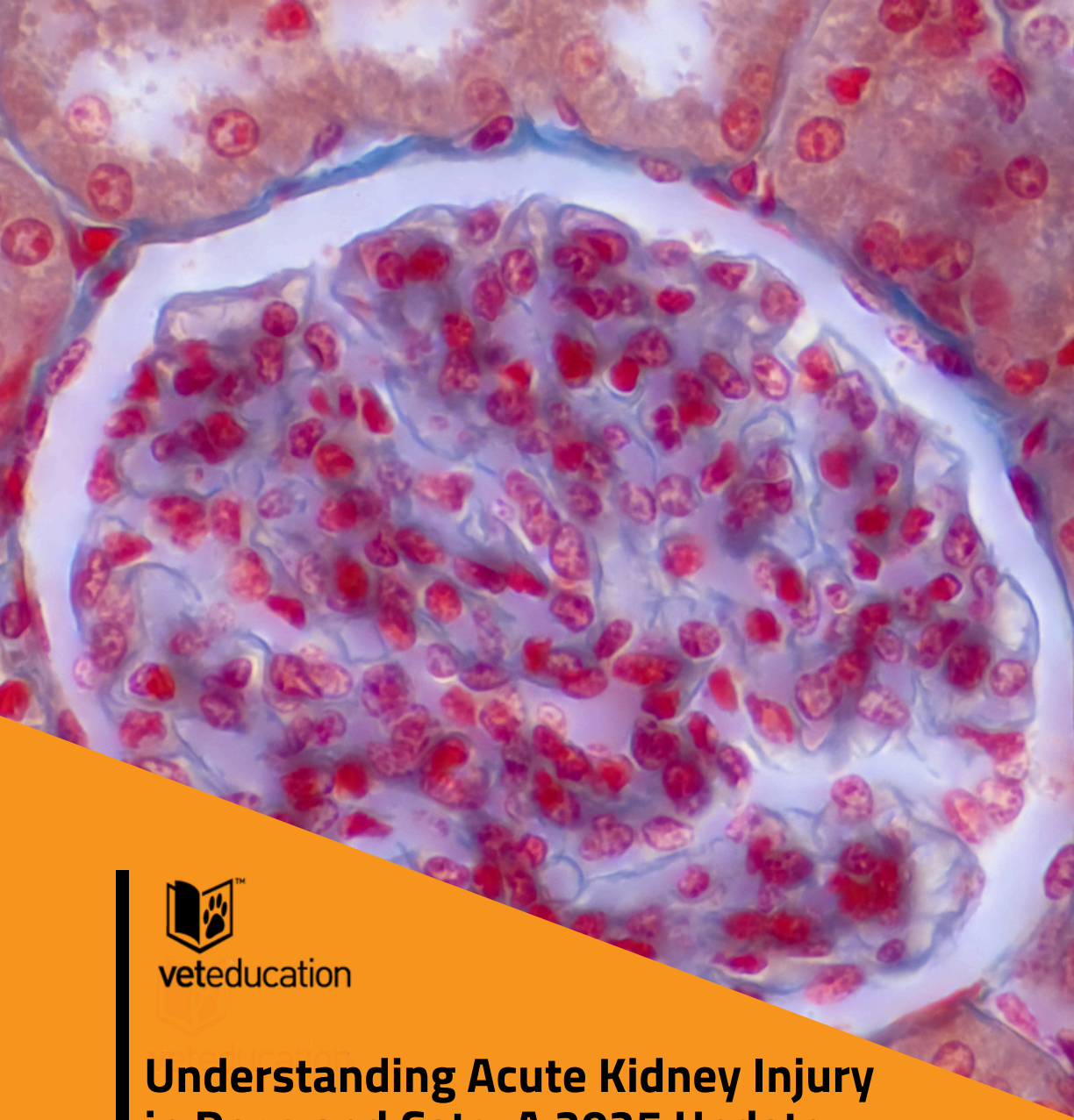


veteducation

Understanding Acute Kidney Injury in Dogs and Cats: A 2025 Update

Dr Philip Judge

BVSC MVS PG Cert Vet Stud MACVSc (Vet. Emergency and Critical Care; Medicine of Dogs)

Understanding Acute Kidney Injury in Dogs and Cats: A 2025 Update

Dr. Philip Judge BVSc MVS PG Cert Vet stud MACVSc (Vet. Emergency and Critical Care, Medicine of Dogs)

Acute Kidney Injury (AKI) is a critical condition characterised by a sudden decline in glomerular filtration rate (GFR), leading to the accumulation of waste products and dysregulation of fluid, electrolyte, and acid-base balance. Despite advances in care, mortality remains high, especially for patients requiring dialysis. The key to improving outcomes lies not just in better treatment, but in a paradigm shift towards early risk identification, detection of subclinical disease, and tailored supportive care. This update summarizes crucial advances from peer-reviewed literature from the past 8 years, providing a modern framework for managing AKI in our canine and feline patients.

Why the Kidney is Sensitive to Injury

Understanding why the kidneys are so susceptible to damage is the first step in prevention. Despite the kidneys receiving approximately12% of cardiac output – most of which is directed to the glomeruli - the renal medulla is very sensitive to variations in blood flow. Its high oxygen consumption, driven by active solute transport combined with relatively low blood flow compared to the cortex, creates a vulnerability to minor variations in oxygen delivery.
Any event that reduces oxygen delivery, including hypotension, hypovolemia, sepsis, or vasoconstriction, can leading to decreased in tubular cell ATP production, and the release of adenosine, a potent renal vasoconstrictor. This creates a cycle of reduced glomerular pressure and medullary hypoxia, culminating in Acute Tubular Necrosis (ATN) if uncorrected. This explains why tubular damage is one of the main features of AKI.

Identifying the At-Risk Patient

Identification of patients susceptible to AKI is arguably the most impactful intervention to be made in AKI – because early recognition of kidney injury allows earlier treatment, and potentially, better recovery as a result. A thorough patient history, physical examination, and diagnostic evaluation are essential. Common risk factors include

- Dehydration/Hypovolaemia: This can increase AKI risk tenfold by reducing renal blood flow, decreasing the volume of distribution for nephrotoxins, and increasing tubular reabsorption of toxicants.
- Nephrotoxins: A wide range of toxins may adversely affect kidney tissue and function e.g. NSAIDs, antibiotics, ethylene glycol etc. A thorough toxicological history should be obtained during patient evaluation to identify potentially toxic insults.
- Conditions Causing Renal Hypoperfusion: Cardiac disease, hypoalbuminaemia, hypovolaemia, and hyperviscosity syndromes e.g., severe dehydration, polycythaemia, etc., among other conditions, reduce blood flow and oxygen delivery to the kidneys, resulting in decreased kidney tubular flow rates and increased sensitivity to toxins.
- Systemic Illness: including sepsis, heat stroke, and trauma, results in decreased kidney perfusion, increased kidney interstitial fluid volume and vascular compression, and intra-renal haemorrhage from DIC (in heat stress or sepsis) or concussive kidney injury (following trauma).

In patients with known risk factors, collection of baseline data - including PCV/TP, serum biochemistry, electrolytes, blood gas, and urinalysis - provides a crucial benchmark for early detection and monitoring.

Evolving Diagnostics in AKI

Traditional AKI diagnosis, based on serum creatinine and urine output, are neither sensitive nor specific for AKI. Creatinine is insensitive, requiring up to a 50% loss of GFR before it rises, and is influenced by muscle mass – with lean patients having lower creatinine as a result. Urine output is influenced by non-renal factors, including blood volume and hydration status.

The International Renal Interest Society (IRIS) has developed a grading system for AKI (Grades I-V) based on creatinine and clinical description, with sub-grades, depending on the presence of oliguria and the need for renal replacement therapy.

Current research is focused on more specific biomarkers of kidney tubular damage, which will allow identification of kidney injury before functional declines.

Promising Biomarkers in Veterinary Medicine:

- Symmetric Dimethylarginine (SDMA): Is a surrogate marker of GFR that is less influenced by muscle mass. It increases earlier in kidney disease than creatinine (decreased GFR of 40% vs. 60-75% with creatinine). Studies show it has high sensitivity (100% in cats, 90% in dogs) and specificity (91% in cats, and 83% in dogs) for kidney injury, and even mild increases can herald significant disease, allowing for earlier intervention.
- Urine Neutrophil Gelatinase-Associated Lipocalin (NGAL): is an emerging urine biomarker for in-clinic detection of glomerular and tubulointerstitial injury. In healthy animals, NGAL passes freely through the glomerular membrane and is almost completely reabsorbed by the proximal tubules. Tubular damage, therefore, can result in increased urine NGAL. Studies in dogs show NGAL can increase days before creatinine in models like gentamicin-induced AKI. It is an emerging powerful tool for monitoring tubular injury, although it can be elevated with pyuria, and should be interpreted with caution in these patients.
- Kidney Injury Molecule-1 (KIM-1): is a tubular protein, whose expression is markedly upregulated in tubular damage. KIM-1 has been shown to be a highly sensitive and specific marker of kidney injury in several animal models of kidney disease, including models of injury due to ischemia and nephrotoxic AKI.
- Other Biomarkers: including cystatin B (released by kidney tubular cells in response to injury), cystatin-C (released by kidney tubular cells in response to injury), and α1-Microglobulin (a glycoprotein completely absorbed by the proximal kidney tubules) all indicate kidney tubular dysfunction). Urine GGT (a brush border enzyme released with tubular damage) is found in increased levels in acute kidney injury. These biomarkers are all being validated for clinical use.

The clinical utility of these biomarkers is clear: they allow improved detection of AKI – even in the subclinical phase, potentially enabling therapeutic intervention before irreversible damage occurs.
In dogs and cats, the use of SDMA, urine protein-creatinine ratio, GGT and cystatin-B may increase sensitivity of detection of acute kidney injury, before increases in serum creatinine and urea are detectable, allowing earlier supportive care to be commenced in patients at risk of more severe kidney injury.

Updates in Treatment Recommendations

Fluid therapy has long been recommended in the management of acute kidney injury. However, excess use of fluid therapy can lead to volume overload, which can exacerbate kidney injury, as well as overwhelm the circulatory system, especially in oliguric or anuric patients.
While essential for correcting hypovolemia and dehydration, fluid therapy can be harmful in other contexts

Key Principles of Fluid Therapy in AKI:

- Indication: Use for acute hypovolemia and dehydration. Avoid in patients who are already volume-replete.
- Fluid Choice: Balanced crystalloid solutions (e.g., LRS) are generally preferred over normal saline and certainly over synthetic colloids, which are associated with an increased AKI risk in patients with sepsis and systemic inflammation.
- End-Points: A target of mean arterial blood pressure of 80 mm Hg is associated with less kidney damage than lower pressures. However, fluid overload (an increase in body weight >10%) is strongly associated with worse outcomes, and should be avoided.

The Role of Diuretics and Vasodilators:

- Furosemide: Loop diuretics can help convert oliguric to non-oliguric AKI, simplifying fluid management, but do not improve survival or reduce the need for dialysis. Their primary utility is in managing fluid overload.
- Vasoactive Drugs: Drugs like dopamine and fenoldopam have been studied for renal vasodilation, but there is no evidence supporting their use to improve survival or disease progression in AKI.

The Role of Dialysis

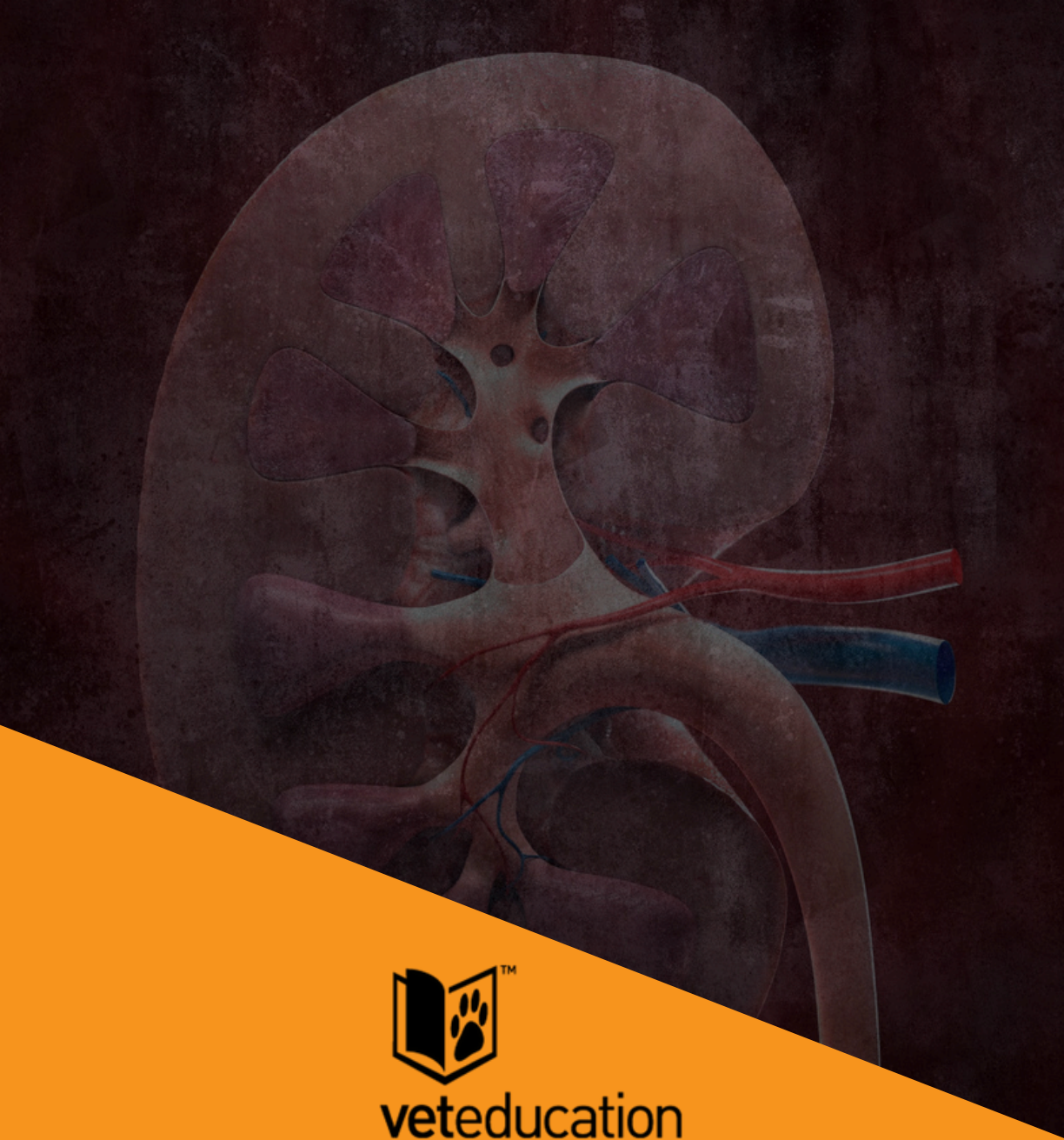
Renal Replacement Therapy (RRT or dialysis) is a life-saving treatment for patients unresponsive to medical management. Indications include anuria/oliguria, severe electrolyte/acid-base disturbances, and volume overload. Dialysis should be considered early in the disease course. Studies show survival rates of 41% in dogs and 44% in cats with AKI after failing medical management, with rates as high as 86% for specific diseases like leptospirosis. It is also the treatment of choice for many toxicoses, including ethylene glycol, NSAIDs, and baclofen.

Conclusion

The management of AKI is evolving from a reactive to a proactive and precision-based model. By understanding renal risk and vulnerability, identifying at-risk patients, using novel biomarkers for early detection, and applying fluid therapy judiciously, we can significantly impact patient outcomes. When medical management fails, timely dialysis provides a useful tool for improving survival.

References:

1. Zuk A, Bonventre JV. Acute kidney injury. Annual review of medicine. 2016 Jan 14;67(1):293-307.
2. Wen, Y., & Parikh, C. R. (2021). Current concepts and advances in biomarkers of acute kidney injury. Critical Reviews in Clinical Laboratory Sciences, 58(5), 354–368.
3. Hughes PJ. Classification systems for acute kidney injury. Medscape, Drug & Diseases April. 2017;27.
4. Kellum, J.A., Romagnani, P., Ashuntantang, G. et al. Acute kidney injury. Nat Rev Dis Primers 7, 52 (2021)
5. Villa G, Ricci Z, Ronco C. How Do I Rapidly and Correctly Identify Acute Kidney Injury?. Evidence-Based Practice of Critical Care. 2019 Aug 29:389.
6. Scholz, H., Boivin, F.J., Schmidt-Ott, K.M. et al. Kidney physiology and susceptibility to acute kidney injury: implications for renoprotection. Nat Rev Nephrol 17, 335–349 (2021).
7. James MT, Bhatt M, Pannu N, Tonelli M. Long-term outcomes of acute kidney injury and strategies for improved care. Nature Reviews Nephrology. 2020 Apr;16(4):193-205.
8. Dahlem DP, Neiger R, Schweighauser A, Francey T, Yerramilli M, Obare E, Steinbach SM. Plasma symmetric dimethylarginine concentration in dogs with acute kidney injury and chronic kidney disease. Journal of Veterinary Internal Medicine. 2017 May;31(3):799-804.
9. Loane SC, Thomson JM, Williams TL, McCallum KE. Evaluation of symmetric dimethylarginine in cats with acute kidney injury and chronic kidney disease. Journal of veterinary internal medicine. 2022 Sep;36(5):1669-76.
10. Chen H, Avital Y, Segev G. Biomarkers of acute kidney injury. Isr J Vet Med. 2017 Mar 1;72(1):3-12.
11. Mack RM, Hegarty E, McCrann DJ, Michael HT, Grauer GF. Longitudinal evaluation of symmetric dimethylarginine and concordance of kidney biomarkers in cats and dogs. The Veterinary Journal. 2021 Oct 1; 276:105732.
12. McKenna M, Pelligand L, Elliott J, Cotter D, Jepson R. Relationship between serum iohexol clearance, serum SDMA concentration, and serum creatinine concentration in non-azotemic dogs. Journal of veterinary internal medicine. 2020 Jan;34(1):186-94.
13. Sargent HJ, Elliot J, Jepson RE. The new age of renal biomarkers: does SDMA solve all of our problems?. Journal of Small Animal Practice. 2021 Feb;62(t 2):71-81.
14. Harris AN, Brown E. Clinical Application of Renal Biomarkers. Internal Medicine. Today's Veterinary Practice. 2022 P 67-72.
15. De Loor J, Daminet S, Smets P, Maddens B, Meyer E. Urinary biomarkers for acute kidney injury in dogs. Journal of veterinary internal medicine. 2013 Sep;27(5):998-1010.
16. Cowgill L. Grading of acute kidney injury. International Renal Interest Society. 2016:1-9.
17. Nivy R, Chaim N, Hanael E, Sutton GA, Bruchim Y, Aroch I, Segev G. Prospective evaluation of 5 urinary biomarkers as predictors of acute kidney injury in nonazotemic, hospitalized dogs. Journal of Veterinary Internal Medicine. 2021 Nov;35(6):2812-20.
18. DuU' S, Murray PT. What Is the Value of Non-Dialytic Therapy in Acute Kidney Injury?. Evidence-Based Practice of Critical Care. 2019 Aug 29:402.



veteducation

www.veteducation.com