CRRT专业文献【摘要】译文参考

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连续性肾脏替代疗法在犬猫急慢性急性肾衰竭治疗中的应用：33例（2002-2006）

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摘要

目的：描述连续性肾脏替代治疗(CRRT)在17只病例犬和16只病例猫中应用的适应症、临床特征、结果和并发症，这些犬猫均患有经积极的药物治疗无效的急性或急性慢性肾衰竭。

系列简介：29%的犬和44%的猫有慢性肾病(CKD)的证据。犬CRRT的中位持续时间为16.3小时(范围0.3-83.0小时)，猫为11.5小时(范围1.0-35.5小时)。犬血尿素氮(BUN)由41.0mmol/L (115.0mg/dL)改善至11.8 mmol/L (33.0mg/dL)，肌酐由636.5 mmol/L (7.2 mg/dL)改善至274 mmol/L (3.1 mg/dL)。猫尿素氮中位数从46.4mmol/L (130 mg/dL)改善至13.9mmol/L (39.0 mg/dL)，肌酐从1069.6mmol/L (12.1 mg/dL)改善至2917mmol/L (3.3 mg/dL)。80%的患犬和71%的患猫的代谢性酸中毒得到缓解。100%的患犬和88%患猫的高钾血症得到缓解。CRRT的并发症包括医源性低钾血症、医源性代谢性碱中毒、临床低钙血症、总高钙血症、滤器凝血、贫血、低体温和神经系统并发症。41%的狗和44%的猫存活出院。没有狗、仅1只猫新诊断为CKD。

提供的新的/独特信息：CRRT可以作为一种可行的选择，用于治疗狗和猫的急性或急性慢性肾功能衰竭，这些肾衰对积极的医疗管理是难治性的。本研究中与CRRT相关的并发症的频率证明在推荐其广泛应用之前需要进一步的经验。

关键词：氮血症，血液透析，肾脏

Retrospective Study

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Use of continuous renal replacement therapy for treatment of dogs and cats with acute or acute-on-chronic renal failure: 33 cases (2002–2006)

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Abstract

Objective: To describe the indications, clinical features, outcomes and complications associated with use of continuous renal replacement therapy (CRRT) in 17 client-owned dogs and 16 client-owned cats with acute or acute-on-chronic renal failure refractory to aggressive medical management.
Series summary: Twenty-nine percent of dogs and 44% of cats had evidence of pre-existing chronic kidney disease (CKD). Median duration of CRRT was 16.3 hours (range 0.3–83.0 hours) in dogs and 11.5 hours (range 1.0–35.5 hours) in cats. Median canine blood urea nitrogen (BUN) improved from 41.0 mmol/L (115.0 mg/dL) to 11.8 mmol/L (33.0 mg/dL) and creatinine from 636.5 mmol/L (7.2 mg/dL) to 274 mmol/L (3.1 mg/dL). Median feline BUN improved from 46.4 mmol/L (130 mg/dL) to 13.9 mmol/L (39.0 mg/dL) and creatinine from 1069.6 mmol/L (12.1 mg/dL) to 291.7 mmol/L (3.3 mg/dL). Metabolic acidosis resolved in 80% of affected dogs and 71% of affected cats. Hyperkalemia resolved in 100% of affected dogs and 88% of affected cats. Complications noted with CRRT included iatrogenic hypokalemia, iatrogenic metabolic alkalosis, clinical hypocalcemia, total hypercalcemia, filter clotting, anemia, hypothermia, and neurologic complications. Forty-one percent of dogs and 44% of cats survived to discharge. No dogs and only 1 cat developed newly diagnosed CKD.
New or unique information provided: CRRT can be a viable option for the management of acute or acute-on-chronic renal failure in dogs and cats that are refractory to aggressive medical management. The frequency of complications associated with CRRT in this study warrants further experience with this modality before its widespread use can be recommended.

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Keywords: azotemia, hemodialysis, kidney

Introduction

Acute renal failure (ARF) is a potentially life-threatening disease in dogs and cats. ARF-induced changes in metabolic state and fluid balance may cause life-threatening arrhythmias, hypertension, vasculitis, hypervolemia, interstitial fluid retention, gastrointestinal bleeding, oliguria, and anuria. These abnormalities may lead to respiratory and circulatory collapse and damage to other organ systems. Standard ARF management includes removal of the inciting cause, IV fluid therapy, use of osmotic and chemical diuretic agents, medical management of acid–base and electrolyte abnormalities, correction of fluid volume irregularities and uremic signs, and nutritional and cardiovascular support.[1] Despite aggressive intervention, many ARF patients remain refractory to medical management and succumb to the consequences of uremia before renal recovery can occur.[1] It is well recognized that replacement of renal function can be performed via dialysis while awaiting renal recovery or transplantation. Peritoneal dialysis (PD) and intermittent hemodialysis (IHD) have been successfully used to manage severe uremia due to various disease processes in dogs and cats.[2,3] PD is readily available and less expensive when compared with other modalities. IHD is becoming more readily available but the distance to dialysis centers may render this modality unfeasible for many pet owners. Additionally, many veterinary patients requiring dialytic therapy have concurrent critical illness requiring care within an intensive care setting that may not be equipped with IHD.

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CRRT专业文献【摘要】译文参考

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连续性肾脏替代疗法对健康犬血液动力学影响的评价

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摘要：

我们对临床健康犬进行持续肾替代治疗(CRRT)，以评估CRRT对血液动力学的影响。在全身麻醉下，记录6只犬的心率、动脉血压、中心静脉压。在整个CRRT中，心率和动脉血压都是稳定的。CRRT终止后中心静脉压升高，但在30分钟内恢复到基础水平。本研究中，CRRT期间未观察到血液动力学改变，包括低血压、高血压和心律失常。这些观察结果表明，本研究中使用的CRRT方案可以安全地应用于急性肾功能衰竭的临床病例。

关键词：犬，连续性肾脏替代疗法，血液透析，血流动力学

NOTE *Clinical Pathology*

Evaluation of the Hemodynamic Impact of Continuous Renal Replacement Therapy in Healthy Dogs

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ABSTRACT. We performed continuous renal replacement therapy (CRRT) on clinically healthy dogs to evaluate the effects of CRRT on hemodynamics. Heart rate, arterial blood pressure, and central venous pressure of the dogs (n=6) were recorded during the procedure, which was performed under general anesthesia. Throughout the CRRT, heart rate and arterial blood pressure were stable. Central venous pressure increased after CRRT termination but returned to the basal level within 30 min. In this study, hemodynamic alterations, including hypotension, hypertension, and arrhythmias, were not observed during CRRT. These observations suggest that the CRRT protocol used in the present study can be safely applied to clinical cases with acute renal failure.

KEY WORDS: canine, continuous renal replacement therapy, hemodialysis, hemodynamics.

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Acute renal failure (ARF) is a common complication of critical illnesses and is frequently life-threatening in dogs [2, 19]. If ARF proves refractory to conventional management such as intravenous fluid therapy, administration of diuretics, or vasopressor agents, some form of renal replacement therapy will be required. In human medicine, continuous renal replacement therapy (CRRT) has become the technique of choice in the treatment of ARF. In contrast, in veterinary medicine, intermittent hemodialysis is the standard extracorporeal therapy for ARF and CRRT is an emerging modality; although it has been recently investigated, animal CRRT is used in only a few veterinary facilities [1, 7, 14]. Therefore, information regarding CRRT in veterinary medicine is fairly limited.

CRRT is a noninterrupted extracorporeal procedure using hemofiltration/hemodialysis for fluid and solute removal [13]. It is continuously administered 24 hr/day rather than on an intermittent basis. Therefore, it allows continuous and gradual fluid and solute removal with better hemodynamic tolerability than either intermittent hemodialysis or peritoneal dialysis [10, 11, 15]. Furthermore, control of acidosis and electrolyte balance has also been reported to be superior in patients receiving CRRT [3, 5, 18]. Therefore, CRRT has become an essential modality in the intensive care unit (ICU) settings for patients with profound clinical and hemodynamic instability [4, 6, 10]. Although CRRT offers better hemodynamic tolerability than peritoneal dialysis and conventional hemodialysis, hypotension observed at the beginning of CRRT is still the most common complication in humans [17]. However, there have been no studies analyzing the initial hemodynamic impact of CRRT in dogs. Therefore, the purpose of this study was to evaluate the effects of CRRT on hemodynamics in clinically healthy dogs.

Six adult beagles (all females), weighing 7.5–12.3 kg (mean ± SD, 10.7 ± 1.7) were used. The dogs were maintained for experimental purposes, housed individually in cages, fed commercial dry food, and given free access to water. The study was conducted in accordance with the guidelines outlined by the Experimental Animal Committee of Yamaguchi University, Japan. Before each experiment, all dogs underwent complete blood count analysis, serum blood chemistry, radiography, and ultrasonography and were determined to be clinically healthy.

After induction of general anesthesia with propofol (7.0 mg/kg), the dogs were endotracheally intubated, and anesthesia was maintained with isoflurane. A 12-Fr dual-lumen catheter (GentleCath; Nippon Sherwood, Tokyo, Japan) was inserted into the right external jugular vein for CRRT. The distal tip of the catheter was advanced to the level of the right atrium. A central venous catheter (LG DX143SS; Terumo, Tokyo, Japan) was then inserted into the left external jugular vein for measuring central venous pressure (CVP). The distal tip of this catheter was advanced to the level of the cranial vena cava. Thoracic radiography was used to confirm the correct placement of the catheter tips in order to ensure that the distal tips were at least 2 cm apart from each other. A peripheral arterial catheter was inserted into the dorsalis pedis artery or femoral artery for continuous blood pressure monitoring and for blood gas analysis. After placing all the catheters, breathing movements were arrested using vecronium bromide (continuous rate infusion at 0.1–0.4 mg/kg/hr) and were changed to mechanical ventilation at a frequency of 10–14 breaths/min to achieve an end-tidal partial pressure of carbon dioxide ($ETCO_2$) of 35–45 mmHg. The end-tidal isoflurane concentration was adjusted

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犬猫的连续性肾脏替代治疗

Mark j. Acierno, MBA, DVM

关键词：连续性肾脏替代治疗 CRRT 急性肾损伤 透析

20世纪初，约翰霍普金斯大学医学院的一位年轻药理学家进行了一系列实验，为随后100年发展起来的体外血液净化技术奠定了基础。Abel和他的同事们将动物患者的动脉血与抗凝剂混合，通过一个装置将血液分成悬浮在液体中的吸管状半透膜，然后将血液引导回患者体内(图1)。Abel证明，通过改变液体的成分可以改变受试者的血液。这一过程被称为活体扩散法，它依赖于扩散的特性，并成为间歇性血液透析(IHD)的基础。

连续性肾脏替代治疗(CRRT)是最近发展起来的一种血液净化疗法。顾名思义，CRRT是一个持续的过程，一旦开始治疗，治疗将继续，直到肾功能恢复或患者过渡到间歇性透析。CRRT与IHD相似，因为患者的血液被分成含有在透析器内的数千个吸管状半透膜，然而，IHD主要是一种弥漫性治疗，CRRT则是扩散、对流和较小程度的吸附。

与IHD相比，CRRT有几个显著的优势。该技术的缓慢和渐进性质能够更好地控制电解质和酸碱平衡。连续的操作更接近于正常肾脏的功能。与扩散相比，在CRRT中使用对流在去除大分子方面具有显著的优势。这些大分子的大小比通常由肾脏过滤的分子要小。IHD的目标是通过扩散在短时间内显著改变患者的尿毒症、酸碱和液体状态，因此，必须在现场生产大量的纯透析液。这种技术需要在购买和维护专门的水处理设施方面进行相当大的投资。相比之下，CRRT中扩散和对流的有效使用允许使用预先包装的无菌液体，并使CRRT设备几乎无需在处理之间进行维护。

Continuous Renal Replacement Therapy in Dogs and Cats

Mark J. Acierno, MBA, DVM

KEYWORDS
- Continuous renal replacement therapy • CRRT
- Acute kidney injury • Dialysis

In the early 1900s, a young pharmacologist at the Johns Hopkins University School of Medicine performed a series of experiments that would lay the foundation for all extracorporeal blood purification technologies developed during the next 100 years. Abel and colleagues[1] directed arterial blood from animal patients, mixed it with an anticoagulant, passed it through a device that divided the blood into strawlike semipermeable membranes that were suspended in fluid, and then directed the blood back to the patient (**Fig. 1**). Abel demonstrated that the subject's blood could be altered by changing the composition of the fluid. This process, referred to as vividiffusion, relied on the properties of diffusion and became the basis for intermittent hemodialysis (IHD).

Continuous renal replacement therapy (CRRT) is a more recently developed blood purification modality. As the name implies, CRRT is a continuous process, and once treatment begins, therapy continues until renal function returns or the patient is transitioned to intermittent dialysis. CRRT is similar to IHD because patient blood is divided into thousands of strawlike semipermeable membranes contained within a dialyzer; however, whereas IHD is primarily a diffusive therapy, CRRT uses diffusion, convection, and, to a lesser extent, adhesion.

CRRT has several significant advantages compared with IHD. The slow and gradual nature of the technique provides better control of electrolytes and acid-base balance.[2] The continuous operation more closely approximates the functioning of a normal kidney.[3] Use of convection in CRRT provides a significant advantage in the removal of larger molecules than can be achieved with diffusion. These larger molecules are closer in size to those that are normally filtered by the kidney. The goal of IHD is to make dramatic changes in a patient's uremic, acid-base, and fluid status over short periods using diffusion; therefore, significant quantities of pure dialysate must be produced onsite. This technique requires a sizeable investment in the purchase and

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血液透析治疗犬肾病的实用方法

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要点

- 现代技术意味着血液透析现在不仅可行而且是安全、有效的，对于危及生命的尿毒症动物来说，是必不可少的。
- 血液透析可作为间歇或连续治疗。在这两种情况下，氮质血都要通过透析器泵入，在此过程中，溶质和水发生交换，然后干净的血液才会回到患者体内。
- 分子在透析膜上的运动主要由两种力量驱动：扩散和对流。
- 为每个患者选择透析方案时，必须考虑各种因素。
- 确保透析过程中不发生凝血是至关重要的；可以采用各种方法来防止这种情况的发生。

A practical approach to hemodialysis for canine renal disease

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Dr. Lippi graduated with first-class honors from the University of Pisa in 2006 and was the recipient of the SCIVAC-Pfizer Animal Health award the following year; this allowed her to spend some time with the Feline Internal Medicine Service at Bristol University in the UK before moving to UC Davis in 2010 for hemodialysis training. She was awarded her PhD in 2011 for a research project on early diagnostic and prognostic markers of CKD in cats and dogs. Dr. Lippi currently works in the Hemodialysis and Blood Purification Service (CEPEV) of the Department of Veterinary Sciences at Pisa University. Her main areas of interest are nephrology, urology and hemodialysis.

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Dr. Guidi graduated with first-class honors in 1978 and is currently Full Professor of Clinical Pathology at the Department of Veterinary Sciences of the University of Pisa, where she also performs clinical duties with a particular interest in feline medicine and small animal nephrology and urology. Her research focuses primarily on upper and lower urinary tract diseases, looking at early diagnostic and prognostic markers of CKD in both canine and feline patients, and she has authored several national and international publications on the subject. Professor Guidi serves as a clinician in the departments of both Internal Medicine and Intensive Care and is Director of CEPEV.

KEY POINTS

- **Modern technology means that hemodialysis is now not only feasible but is safe, efficacious, and indispensable for the management of animals with life-threatening uremia.**
- **Hemodialysis may be provided either as intermittent or continuous therapy. In both situations azotemic blood is pumped through a dialyzer, where solute and water exchange occurs, before clean blood is returned to the patient.**
- **The movement of molecules across the dialysis membrane is primarily driven by two forces: diffusion and convection.**
- **Various factors must be considered when selecting a dialysis protocol for each patient.**
- **It is essential to ensure blood coagulation does not occur during dialysis; various methods may be employed to prevent this from happening.**

Introduction

Although considered the standard of care in human medicine, hemodialysis (HD) as a management option for animals with significant kidney disease continues to have limited availability. Only within the last decade has hemodialysis become increasingly available and it is now offered in many countries. Traditionally, intracorporeal dialytic therapies (*i.e.* peritoneal dialysis) have been used to manage patients with severe acute kidney disease. However, where available, extracorporeal renal replacement therapies (ERRT) are now preferred due to improved patient outcomes as well as logistical factors (1,2). Although patient size may be a limiting factor, as it employs equipment designed for humans ***(Figure 1)***, ERRT hemodialysis is now a successful therapy within veterinary medicine (2).

ERRT may be provided as intermittent hemodialysis (IHD) or continuous renal replacement therapy (CRRT) ***(Figure 2)***. Although they differ in execution, both methods rely on the same physiologic principles. Once vascular access has been established, typically via a jugular catheter, the patient is connected to the extracorporeal circuit. The dialysis machine regulates the flow of blood

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猫急性肾损伤的连续性静脉-静脉血液透析滤过（CVVHDF）治疗

Glacoma Stanzani, Rosanne E Jepson and Daniel L Chan

摘要

连续性肾脏替代疗法是治疗急性肾损伤(AKI)的新兴技术。关于它在猫身上使用的数据有限。本报告描述了使用一种新型的连续肾替代治疗(CRRT)系统治疗一只猫的AKI。一只1.3岁的猫在接受非甾体抗炎药治疗后出现了尿毒症的症状。CRRT采用连续静脉-静脉血液透析过滤模式，AN-69表面处理膜，合成胶体引物和肝素抗凝。两个治疗周期共51h CRRT。该治疗有效地控制了尿毒症的症状，没有发现重大并发症。由于经济上的限制，主人拒绝接受进一步的CRRT治疗，在住院的第8天，由于没有明显的临床改善，实施了人道的安乐死。本报告中详细介绍的设置为猫的AKI初始治疗提供了一种可行的选择。

Case Report

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Management of acute kidney injury with continuous veno-venous haemodiafiltration in a cat

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Abstract

Continuous renal replacement therapy is an emerging technique for the treatment of acute kidney injury (AKI). Data regarding its use in cats are limited. This report describes the use of a novel continuous renal replacement therapy (CRRT) system for the treatment of AKI in a cat. A 1.3-year-old cat developed uraemic signs following the administration of a non-steroidal anti-inflammatory agent for the treatment of a suspect traumatic episode. CRRT was provided with a Prismaflex Gambro machine used in continuous veno-venous haemodiafiltration mode, with an AN-69 surface-treated membrane, synthetic colloid priming and heparin anticoagulation. Two treatment cycles were performed totalling 51 h of CRRT. The treatment was effective in controlling uraemic signs, and no major complications were noted. Owing to financial constrains the owners declined further CRRT treatments, and on day 8 of hospitalisation, owing to the lack of significant clinical improvement, humane euthanasia was performed. The set-up detailed in this report provides a viable option for the initial treatment of cats with AKI.

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Acute kidney injury (AKI) refers to a rapid decrease in renal function, usually within 48 h.[1] AKI is a commonly encountered emergency presentation in veterinary patients and is associated with a poor prognosis.[2–4] Renal replacement therapy (RRT) is indicated when medical management fails and AKI results in intractable uraemic signs, and life-threatening acid–base, electrolyte and fluid disturbances.[5] Continuous RRT (CRRT) describes a spectrum of blood purification techniques that have been recently reported for the treatment of AKI in both dogs and cats.[6–8] While intermittent haemodialysis (IHD) is mainly a diffusive modality, CRRT can combine convection and diffusion to achieve solute clearance, allowing for removal of larger molecules.[9] Moreover, CRRT allows a gradual correction of electrolyte, acid–base and body fluid imbalances, promoting the maintenance of haemodynamic stability. Despite these theoretical advantages, current human literature failed to identify a clear superiority in outcome when comparing the two techniques.[10] In feline patients, CRRT has been associated with a number of complications, and experience with this technique is limited.[6,7] This report describes the use of veno-venous haemodiafiltration in a feline patient with AKI.

A 1.3-year-old, 5 kg, male neutered domestic shorthair cat presented to the referring veterinarian following a possible traumatic episode. Earlier in the day the owners found the cat to be very lethargic and noted the presence of several superficial excoriations. The cat had access outdoors, but no other previous medical history or access to toxins was reported. Physical examination revealed no abnormalities other than the superficial lesions. The cat was treated with a long-acting antimicrobial, cefovecin 10 mg/kg (Convenia; Zoetis) and a single dose of a non-steroidal anti-inflammatory drug, meloxicam 0.2 mg/kg (Metacam; Boehringer Ingelheim), both administered subcutaneously (SC). In the days following discharge the cat began vomiting and, 5 days from initial presentation, developed ataxia. The cat represented to the referring veterinarian where physical examination revealed obtundation, bradycardia, renomegaly and abdominal pain. Serum biochemistry showed marked hyperkalaemia (9.4 mmol/l; reference interval [RI] 3.5–5.8 mmol/l) and azotaemia (urea >46.4 mmol/l;

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CRRT专业文献【摘要】译文参考

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肾脏疾病中液体和电解质紊乱的处理

Cathy Langston, DVM

关键词：急性肾脏损伤 慢性肾脏疾病 肾功能衰竭

要点：

- 一个个性化的、精心构建的、经常评估并根据需要修改的液体计划，是治疗肾病住院患者的重要组成部分。
- 准确评估水合作用和水平衡是输液疗法的关键。
- 肾脏疾病液体治疗的目标是：
  (1) 急性复苏以恢复有效的血管内容积、器官灌注和组织氧合；
  (2) 维持血管内容积平衡，不存在过多的积液；
  (3) 恢复期排液，消除血流动力学不必要的容积。
- 增加尿流量的利尿剂并不能改善肾功能。

Managing Fluid and Electrolyte Disorders in Kidney Disease

Cathy Langston, DVM

KEYWORDS

• Acute kidney injury • Chronic kidney disease • Renal failure

KEY POINTS

- A personalized, carefully constructed fluid plan that is frequently assessed and revised as needed is an important component of treating patients hospitalized for kidney disease.
- Accurate assessment of hydration and water balance is critical for successful fluid therapy.
- The goals of fluid therapy in kidney disease are (1) acute resuscitation to restore effective intravascular volume, organ perfusion and tissue oxygenation; (2) maintenance of intravascular volume homeostasis without excessive fluid accumulation; and (3) fluid removal during convalescence to remove hemodynamically unnecessary volume.
- Diuretics to increase urine flow do not improve renal function.

Because of the role of the kidneys in maintaining homeostasis, kidney failure may lead to derangements of fluid, electrolyte, and acid-base balance. Reversing these derangements is the goal of treatment.

Kidney disease is classically compartmentalized into acute and chronic disease. Decompensation of chronic disease presents as an acute crisis, and the principles of therapy are similar, although clinical manifestations of acute kidney injury (AKI) or decompensated chronic kidney disease (CKD) may be quite different. Many patients with AKI require hospitalization for optimal management. Patients with CKD may need hospitalization or their fluid and electrolyte management may occur on an outpatient basis.

When blood flow to the kidney is diminished, as may occur with hypovolemia, hypotension, decreased cardiac output, or increased renal vascular resistance, azotemia may develop. This hemodynamic azotemia is typically rapidly reversible when the underlying cause is corrected. Intrinsic kidney injury occurs when damage to the renal

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连续性肾脏替代治疗（CRRT）是犬急性肾损伤初期治疗的一种安全有效的方法

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目的：描述通过连续肾脏替代疗法 （CRRT） 对患有急性肾损伤 （AKI） 的狗的管理，并研究规定的 CRRT 剂量、每小时尿素减少率 （URR） 和总体疗效之间的关系。

动物：45 只被诊断患有严重 AKI 的客户拥有的狗，在兽医教学医院接受了 48 次 CRRT 治疗。

程序：回顾性研究。检索由CRRT管理的患有AKI的狗的医疗记录。

结果：CRRT 开始时的中位血清尿素和肌酐分别为 252 mg/dL [四分位数间范围 （IQR），148 mg/dL;范围，64 至 603 mg/dL]，以及 9.0 mg/dL（IQR，7 mg/dL;范围，4.3 至 42.2 mg/dL）。中位治疗持续时间为21小时（IQR，8.8小时;范围为3至32小时）。全身肝素化和局部柠檬酸盐抗凝治疗各24例（50%）。整个治疗的处方中位CRRT剂量为1 mL/kg/min（IQR，0.4 mL/kg/min;范围，0.3-2.5 mL/kg/min）。中位每小时URR为4%（IQR，1%;范围，2%至12%），总体URR为76%（IQR，30%;范围，11%至92%），中位数Kt/V为2.34（IQR，1.9;范围，0.24至7.02）。CRRT 剂量从 0.9 mL/kg/min 逐渐增加到 1.4 mL/kg/min （P < .001），每小时 URR 从 6.5% 降至 5.5% （P = .05）。主要并发症是体外回路的凝血，发生在 6/48 的治疗中 （13%）。24只狗（53%）存活出院。

临床相关性：如果处方是基于目前的逐步减少尿素的兽医指南，CRRT是安全的。根据实际URR逐步增加剂量，可使治疗效果最大化。

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Continuous renal replacement therapy is a safe and effective modality for the initial management of dogs with acute kidney injury

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OBJECTIVE
To describe the management of dogs with acute kidney injury (AKI) by continuous renal replacement therapy (CRRT), and to investigate the relationship between a prescribed CRRT dose, the hourly urea reduction ratio (URR), and the overall efficacy.

ANIMALS
45 client-owned dogs diagnosed with severe AKI, receiving 48 CRRT treatments at a veterinary teaching hospital.

PROCEDURES
Retrospective study. Search of medical records of dogs with AKI managed by CRRT.

RESULTS
Median serum urea and creatinine at CRRT initiation were 252 mg/dL [Inter quartile range (IQR), 148 mg/dL; range, 64 to 603 mg/dL] and 9.0 mg/dL (IQR, 7 mg/dL; range, 4.3 to 42.2 mg/dL), respectively. Median treatment duration was 21 hours (IQR, 8.8 hours; range, 3 to 32 hours). Systemic heparinization and regional citrate anticoagulation were used in 24 treatments each (50%). The prescribed median CRRT dose for the entire treatment was 1 mL/kg/min (IQR, 0.4 mL/kg/min; range, 0.3 to 2.5 mL/kg/min). The median hourly URR was 4% (IQR, 1%; range, 2% to 12%), overall URR was 76% (IQR, 30%; range, 11% to 92%) and median Kt/V was 2.34 (IQR, 1.9; range, 0.24 to 7.02). The CRRT dose was increased gradually from 0.9 mL/kg/min to 1.4 mL/kg/min ($P < .001$) and the hourly URR decreased from 6.5% to 5.5% ($P = .05$). The main complication was clotting of the extra-corporeal circuit, occurring in 6/48 treatments (13%). Twenty-four dogs (53%) survived to discharge.

CLINICAL RELEVANCE
CRRT is safe when the prescription is based on the current veterinary guidelines for gradual urea reduction. Treatment efficacy can be maximized by gradually increasing the dose according to the actual URR.

Acute kidney injury (AKI) is a debilitating condition, associated with high morbidity and mortality in both veterinary and human patients.[1,2] Metabolic disturbances, fluid imbalance, electrolyte abnormalities, hypertension, and involvement of multiple organ systems are commonly present in dogs with severe AKI.[3] Diagnostic investigation is aimed to identify the inciting cause and to eliminate it when possible as well as addressing complications.

Severe renal dysfunction leads to accumulation of uremic toxins affecting all body organs, thus providing only a narrow window of opportunity for therapeutic intervention. Conventional management is limited and often insufficient, and animals might succumb to the consequences of AKI before kidney function has improved. In such cases, dialytic intervention is indicated, extending the window of opportunity for renal recovery.

There are several modalities for delivering renal replacement therapy, including, continuous renal replacement therapy (CRRT), intermittent hemodialysis (IHD) and peritoneal dialysis.[4] IHD is a very effective renal replacement modality, in which solutes are removed mostly by diffusion and excess fluids are removed by ultrafiltration, typically over 4 to 5 hours.[5] However, IHD is currently available at a limited number of specialty centers equipped with an IHD unit, and requires expensive equipment and maintenance (eg, water purification system) as well as high level of expertise.

As implied by its name, CRRT is delivered continuously, resulting in a slow and gradual removal of uremic toxins. This modality enables the utilization of both diffusive and convective principles and allows several treatment modalities: slow continuous ultrafiltration (SCUF; used primarily for removing excess