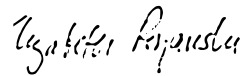


**Association Between Early Postoperative Intravenous Fluid Administration and Organ Dysfunction in Canine Septic Peritonitis.**

Emma Kelleher, 2028 DVM Candidate  
Cummings School of Veterinary Medicine at Tufts University

Under the supervision and guidance of:  
Dr. Elizabeth Rozanski, DVM, DACVIM, DACVECC  
Associate Professor, Department of Small Animal Clinical Sciences



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Signature of Mentor

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## **Abstract**

Septic peritonitis is a life-threatening condition in dogs which is characterized by bacterial contamination of the peritoneal cavity with subsequent systemic inflammation and organ dysfunction. This retrospective study aimed to assess whether intravenous fluid administration during the first 24 hours following surgical intervention of septic peritonitis was associated with acute kidney injury (AKI), need for supplemental oxygen (OS) or both. Furthermore, the study assessed the impact of these complications on patient survival. Electronic medical records of client-owned dogs treated surgically for septic peritonitis at a veterinary teaching hospital were reviewed. Total intravenous fluid volume (mL/kg) administered intraoperative and the first 24 hours following anesthetic recovery was recorded. Dogs were grouped based on development of AKI, OS, both, or neither of the complications. Survival to discharge was significantly higher in dogs that did not develop AKI or OS (90%) compared to dogs that developed one or both complications (56%;  $p = 0.02$ ). Dogs that developed both AKI and OS received significantly higher volumes of intravenous fluid in hospital during their first 24 hours postoperative compared to dogs that did not develop organ dysfunction ( $p = 0.03$ ). These findings suggest an association between postoperative fluid administration, development of organ dysfunction, and decreased survivability in dogs with septic peritonitis. This study further highlights the importance of careful and individualized fluid therapy in the postoperative management of canine septic peritonitis.

## **Introduction**

Sepsis is defined by a host's dysregulated response to an infection that leads to organ dysfunction.<sup>1</sup> In veterinary medicine, sepsis has historically been identified using the criteria of systemic inflammatory response syndrome (SIRS) in the presence of confirmed or suspected infection. However, this approach to diagnosing sepsis lacks specificity and does not consistently correlate with patient outcome.<sup>2,3</sup> More modern veterinary approaches are similar to human sepsis frameworks which emphasize organ dysfunction due to the underlying infection, rather than the infection itself.<sup>1</sup> In dogs, sepsis is commonly associated with gastrointestinal disease, specifically septic peritonitis. Septic peritonitis carries a high risk of progression to multiple

organ dysfunction syndrome (MODS), which is a known major determinate of mortality ranging from 25% to 70% depending on disease severity.<sup>2</sup> These complications may arise from inflammatory injury, altered perfusion, and iatrogenic factors during perioperative management.

The association between sepsis-induced organ dysfunction and survivability in dogs has been previously well established. In a study conducted by Kenney et al, dogs with a dysfunction of two or more organ systems had a mortality rate of 70%, compared with a 25% in dogs with fewer affected systems.<sup>2</sup> Overall, mortality increases significantly with each additional dysfunctional organ system. Specifically, renal and respiratory dysfunction are commonly seen postoperatively, and have a significant impact on mortality.<sup>2</sup> Despite the recognized importance of MODS as a prognostic indicator in canine sepsis, limited data exists evaluating which postoperative variables may influence the development of this condition.

Intravenous fluid therapy is a fundamental part of sepsis treatment. Early fluid resuscitation is essential to restore intravascular volume, maintain tissue perfusion, and support oxygen delivery to tissues.<sup>3</sup> However, excessive or poorly managed fluid administered can lead to the development of interstitial edema and impaired oxygen delivery. This can result in severe organ injury, particularly to the kidneys and lungs. While early antimicrobial administration has been shown to improve outcomes in dogs with septic peritonitis<sup>4</sup> the impact of fluid administration strategies on organ function and survivability remain partially understood. Dogs with septic peritonitis commonly receive higher volumes of intravenous fluid to mitigate surgical losses, vasodilation, hypotension, and prevent organ damage. However, there is a concern that over-resuscitation with high fluid rates may contribute to organ dysfunction, rather than mitigate it.

The objective of this retrospective study was to evaluate whether the volume of intravenous fluid administered intraoperatively and within the first 24 hours following surgical correction of septic peritonitis was associated with the development of AKI, need for supplemental oxygen, or both. Moreover, we evaluated how the development of these postoperative complications impact survival.

## **Materials and Methods**

**Case Selection** - Client-owned dogs treated surgically for septic peritonitis at the Cummings School of Veterinary Medicine Foster Hospital in Grafton were selected. Electronic medical records (EMR) were manually reviewed to identify these cases. The diagnosis of septic peritonitis was based on evidence of gastrointestinal leakage, positive bacterial culture of peritoneal fluid, cytologic evidence of intracellular bacteria or a combination of these findings as documented in the EMR. Cases were included if the patient survived initial surgical correction at least 24 hours after anesthesia recovery and had sufficient postoperative data including intravenous fluid therapy and the development of any complications. Cases were excluded if perioperative or postoperative records were incomplete or if they did not survive 24 hours postoperatively.

**Data collection** - For each included case of septic peritonitis, demographic information, surgical details, and postoperative clinical data were manually extracted from the EMR. Intravenous fluid administration was retrieved for the intraoperative period and for the first 24 hours following anesthesia recovery. Fluid volumes were calculated on a mL/kg basis and included all crystalloids, colloids, blood products, and constant rate infusions. If there was variability in documentation, fluid totals were confirmed and calculated using recorded nursing notes, infusion rates, transfusion volumes, and anesthesia records.

**Defining Organ Dysfunction** - Postoperative organ dysfunction was evaluated with a focus on respiratory and renal systems. Respiratory dysfunction was defined as the need or benefit from supplemental oxygen (OS) beyond anesthetic recovery, as documented in the EMR. Acute kidney injury (AKI) was defined as an increase in serum creatinine concentration of  $\geq 0.3$  mg/dL during hospitalization. Dogs were categorized based on if they developed AKI, needed oxygen supplementation (OS), developed both, or neither complication during hospitalization.

**Measuring Outcome** - Other than evaluating postoperative organ dysfunction, survival in hospital to discharge was also evaluated. Survival was defined as discharge from the hospital

alive. Nonsurvival included death or euthanasia during hospitalization after surgical correction or treatment of septic peritonitis.

**Statistical Analysis** - The significance of survival outcomes were compared between dogs that developed AKI and/or OS and dogs that did not develop either condition using a Fisher's exact test. Intravenous fluid volumes administered intraoperatively and during the first 24 hours postoperative were compared between complication groups using Mann-Whitney U tests. Mann-Whitney U tests were used due to the large variability in data with a nonnormal data distribution. Statistical significance was defined as  $p < 0.05$ . Statistical analyses were performed using commercially available software.

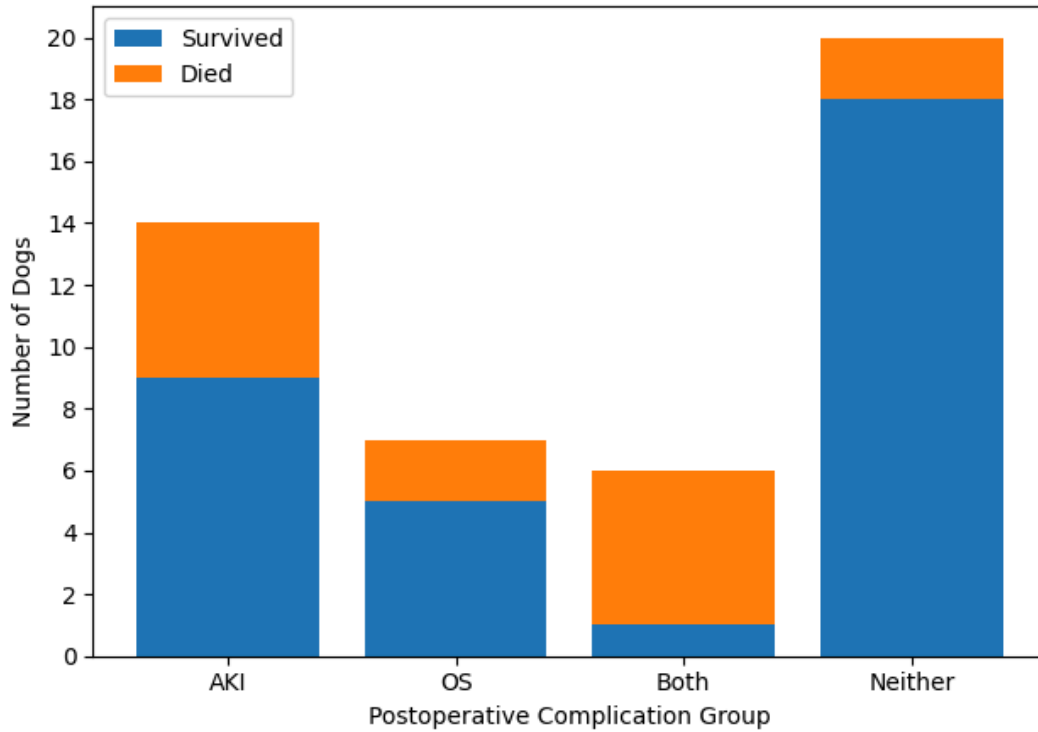
## **Results**

A total of 47 canine septic peritonitis cases were included in this study, with 33 surviving to hospital discharge. The survival rate in dogs that did not develop either postoperative condition was significantly higher at 90% compared to dogs that developed AKI, OS, or both had a significantly lower survival rate of 56% ( $p = 0.02$ ; Figure 1). Survival decreased with the presence of postoperative organ dysfunction, especially with multiple present complications.

Median intravenous fluid volumes administered during surgical correction of septic peritonitis and during the first 24 hours postoperatively were calculated on a mL/kg basis (Table 1). When dogs were grouped by postoperative complications, no statistically significant differences in intraoperative fluid volumes were identified between the groups.

Dogs that developed both AKI and OS received significantly higher volumes of intravenous fluids during the first 24 hours postoperatively compared with dogs that did not develop either complication ( $p = 0.03$ ; Table 2). No statistically significant differences in postoperative fluid volumes were identified when dogs developed either condition alone compared with dogs that did not develop organ dysfunction.

### Survival Outcomes in Dogs With Septic Peritonitis by Postoperative Organ Dysfunction



**Figure 1.** Survival outcomes in dogs treated surgically for septic peritonitis organized by postoperative organ dysfunction. Dogs were grouped based on the development of acute kidney injury (AKI), need for supplemental oxygen (OS), both, or neither of the complications. Survival to hospital discharge was significantly lower in dogs that developed postoperative organ dysfunction compared with dogs that developed neither complication.

**Table 1:** Median intravenous fluid volumes administered intraoperatively and during the first 24 hours postoperatively in dogs treated surgically for septic peritonitis.

Postoperative Group	Intraoperative fluids (mL/kg)	Fluids in first 24 h post-op (mL/kg)
Normal (no AKI or OS)	18	74
MODS	22	90
AKI only	22	83
OS only	23	81
AKI and OS	26	120

**Table 2:** Mann-Whitney U analysis comparing intravenous fluid volumes between dogs with no organ dysfunction postoperatively and dogs with postoperative organ dysfunction. Patients who developed both AKI and OS received a statistically significant ( $p = 0.03$ ) higher quantity of fluids compared to dogs who did not develop organ dysfunction during hospitalization for septic peritonitis.

<u>Intraoperative</u>		<u>24 hours Postoperative</u>	
<b>Comparison group</b>	<b>P value</b>	<b>Comparison group</b>	<b>P value</b>
Normal vs. MODS	0.07	Normal vs. MODS	0.25
Normal vs. AKI	0.11	Normal vs. AKI	0.68
Normal vs. OS	0.33	Normal vs. OS	0.76
Normal vs. AKI + OS	0.21	Normal vs. AKI + OS	<b>0.03*</b>

## Discussion

This retrospective study identified an association between early postoperative intravenous fluid administration and postoperative organ dysfunction in dogs treated surgically for septic peritonitis. Dogs that developed acute kidney injury (AKI), required supplemental oxygen (OS), or experienced both complications had significantly lower survival to discharge compared to dogs that did not develop postoperative organ dysfunction. Dogs that developed both AKI and OS received significantly higher volumes of intravenous fluid within the first 24 hours postoperatively, suggesting a relationship between early fluid administration, multiple organ dysfunction, and survival outcome.

Intravenous fluid therapy is essential in the management of sepsis; however, excessive or prolonged fluid administration may exacerbate organ dysfunction rather than mediate it. The early postoperative period may represent a critical window during which fluid management strategies influence subsequent complications. Clinically, the results support a balanced approach to postoperative fluid management in dogs with septic peritonitis, incorporating careful

monitoring of organ function, and respiratory status to minimize the risk of iatrogenic organ injury.

Several limitations warrant consideration in this study. Variability in documentation in the EMR made precise calculation of fluid volumes over a 24 hour time frame challenging. Additionally, identifying septic peritonitis cases with consistent AKI and OS monitoring was inconsistent due to clinician-dependent decisions and documentation variability.

Future prospective studies evaluating intravenous fluid therapy in dogs with septic peritonitis are needed to clarify optimal postoperative management. Inclusion of a larger, multicenter case population would strengthen the external validity and generalizability of these findings. Incorporation of standardized volume assessment and documentation could give more insight into the best management strategy. Moreover, evaluation of additional outcomes such as duration of hospitalization and long-term renal function could further inform best practices.

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