The abdomen as a source of sepsis in the critically ill patient

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Swedish specialist in small animal diseases
May 2018

“...the treatment for peritonitis included: removal of the cause, drainage of the peritoneal cavity, abolition of the distension, control of emesis, saline administration, and suitable nourishment...”


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Signalment and history

• Legolas is a 2-year-old, intact, mixed breed, male dog
• Previously healthy
• Presenting with a three-day history of decreased activity, inappetence and vomiting
• Dog is prone to ingesting foreign objects

Clinical examination

• Mentally depressed
• Body temperature 38.6 deg C
• Pulse frequency 80/min, regular, good quality
• Heart and lung auscultation wnl
• Pain on abdominal palpation
• Dry, pink mucous membranes
• 8% dehydrated

Treatment

• Rehydration with Ringers-acetate
• Intestinal surgery
  – exploratory celiotomy
  – removal of a jejunal intestinal foreign body
  – functional end-to-end anastomosis using a GIA stapler
  – occurrence of som intra-abdominal contamination
Postoperative clinical examination

- Lateral recumbency
- Mentally depressed
- Pulse frequency 180/min, regular, poor quality
- Distended abdomen
- Pale mucous membranes

Venous blood work

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Ref range</th>
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<tbody>
<tr>
<td>pH</td>
<td>7.25</td>
<td>7.32-7.40</td>
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<tr>
<td>HCO₃</td>
<td>20 mmol/l</td>
<td>18-26</td>
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<tr>
<td>SBE</td>
<td>-3.3 mmol/l</td>
<td>-5.0-1.0</td>
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<tr>
<td>Anion gap</td>
<td>8.3 mmol/l</td>
<td>12.0-24.0</td>
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<tr>
<td>Lactate</td>
<td>4.3 mmol/l</td>
<td>0.0-1.5</td>
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<tr>
<td>pO₂</td>
<td>31.5 mm Hg</td>
<td>35.0-45.0</td>
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<tr>
<td>pCO₂</td>
<td>55.3 mm Hg</td>
<td>39.8-46.2</td>
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<td>Na⁺</td>
<td>147 mmol/l</td>
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<td>K⁺</td>
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<td>3.5-5.5</td>
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<td>Cl⁻</td>
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<tr>
<td>iCa²⁺</td>
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<td>1.12-1.42</td>
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<tr>
<td>Glucose</td>
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<td>3.9-6.1</td>
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<td>Hct</td>
<td>28.2 %</td>
<td>43.3-59.3</td>
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<td>Hb</td>
<td>77 g/L</td>
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Shock treatment

- Oxygen
- Fluid treatment
  - Ringers-acetate 1000 ml iv
  - Hetastarch 500 ml iv
  - pRBC 2 units iv
  - FFP 2 units iv
Follow-up surgery

• Explorative celiotomy
• Presence of 700 ml free abdominal blood and bloodclots
• Bleeding mesenteric artery in the vicinity of the anastomosis, promptly ligated by the surgeon

Two days postsurgically

• Patient develops a fever and distended abdomen
• Extremely painful on abdominal palpation
• On abdominal ultrasound free abdominal fluid was detected and aspirated
Abdominal fluid analysis

• Serohemorrhagic exudate
• High total nuclear cell count
• Biochemical analysis:
  fluid-lactate 12,3 mmol/l
  fluid-glucose 0,9 mmol/l
• Cytology: intracellular bacterial organisms

Septic peritonitis

• Definition: an inflammatory condition of the peritoneum secondary to microbial contamination
• Causes many clinical signs and can have a high mortality (20-68%)
• Septic peritonitis can be:
  – localized or diffuse
  – primary, secondary or tertiary
• Primary septic peritonitis is a spontaneous infection of the peritoneal cavity with no identifiable source

Secondary septic peritonitis

• Consequence of an underlying primary abdominal disease process
• Most common cause is loss of integrity of the GI tract (53-75 % of cases)
Causes for secondary septic peritonitis

- Leakage of gastrointestinal contents
  - Perforating foreign body
  - Perforating ulcers
  - Intrinsic (e.g., dehiscence of intestinal surgical wound, perforation, feeding tube leakage)
  - Gastric rupture in gastric dilatation-volvulus
  - Ischemic intestinal injury
- Blunt abdominal trauma, penetrating abdominal wounds, bite wounds
- Urogenital
  - Ruptured pyometra
  - Ruptured prostatic abscess
  - Ruptured urinary tract with urinary tract infection
- Pancreatitis and pancreatic abscess
- Liver abscess or hepatitis, ruptured infected gallbladder
- Splenic abscess or splenitis, splenic torsion
- Mesenteric/lymph node abscess
- Umbilical abscess
- Intrinsic
  - Surgical/peri toneal contamination
  - Peritoneal dialysis

Loss of integrity of the GI tract

- Perforating foreign bodies
- Perforating ulcers
- Perforating neoplasia
- Gastric rupture in GDV
- Ischemic intestinal injury

Conclusion:
Administration of NSAIDs is a significant risk factor for pyloric perforation in this group of patients with septic peritonitis.

Septic peritonitis from pyloric and non- pyloric gastrointestinal perforation: prognostic factors in 44 dogs and 11 cats

T. Davis*, J. Howard† and D. Stone*  
Journal of Small Animal Practice (2013) 54, 625-629

Conclusion:
Administration of NSAIDs is a significant risk factor for pyloric perforation in this group of patients with septic peritonitis.
Loss of integrity of the GI tract

- Perforating foreign bodies
- Perforating ulcers
- Gastric rupture in GDV
- Ischemic intestinal injury
  - Iatrogenic
    - Anastomotic leakage of a GI surgical wound
    - Leakage from a feeding tube

Tertiary septic peritonitis

- Patients that have failed treatment for secondary septic peritonitis following a perceived successful surgical source control
- Relaparotomy is the treatment of choice for recurrent secondary septic peritonitis (RSSP)

Anastomotic leakage

- Important complication to gastrointestinal surgery
- In several studies the anastomotic leakage rate after intestinal surgery ranges from 2.0-15.7 %
- In one study median time from surgery to identification of anastomotic leakage was 5 days (range 3-10 days)
  Ralphs CS JAVMA 2003;223:73

S. Christopher Ralphs, DVM, MS; Carl R. Jessen, DVM, PhD, DACVR; Alan J. Lipowitz, DVM, MS, DACVS

JAVMA, Vol 223, No. 1, July 1, 2003

• Retrospective study on 90 dogs and 25 cats
• Anastomotic leakage was identified in 14% of dogs

Dogs with two or more of the following factors were predicted to develop anastomotic leakage

-- preoperative peritonitis
-- intestinal foreign body
-- serum albumin concentration < 25 g/l

Risk factors for anastomotic leakage

• Sex (males > females)
• Malnutrition
• Preoperative peritonitis
• Foreign body
• Trauma
• Malignancies
• Preoperative tx corticosteroids
• Increased age
• Diabetes mellitus
• Hypertension
• Congestive heart failure
• High BUN
• Low serum albumin concentration
• Neutrophilia
• Long operative times
• Contaminated surgery
• Blood transfusions
• Hypovolemia and shock

Ralphs CS JAVMA 2003;223:73

Influence of preoperative septic peritonitis and anastomotic technique on the dehiscence of enterectomy sites in dogs: A retrospective review of 210 anastomoses

Daniel J. Davis, DVM | Ryan M. Dominick, DVM, DACVS-SA | Jon Munson, DVM | Maria Pughedlik, DVM | Joe Hampman, DVM, DACVS-SA

Conclusion: Our results confirmed that PSP is a risk factor for dehiscence of IRA and suggest that patients with PSP may be a unique surgical population, in which stapling may be preferred over hand-sewn anastomoses after enterectomies.

Veterinary Surgery, 2018;47:125–129.
Anastomotic leakage occurred in 11% of cases

Risk factors for anastomotic leakage:
- preoperative IBD
- intraoperative hypotension
- surgery site large intestine

Experimental study in rats on the effect of blood transfusions on anastomotic strength

Blood transfusions affect quantity and quality of anastomotic collagen

Blood transfusions impair the cell-mediated immune response causing a reduction in anastomotic strength
- negative changes in macrophage migration and function
- negative changes in T-lymfocyte function

Study on human patients who underwent rectal cancer surgery

In this study blood transfusion was an independent risk factor for anastomotic leakage

Several studies in the human field conclude that volume overload may have deleterious effects on anastomotic healing

This may cause marked bowel wall edema and increase the risk of anastomotic leakage
**Hypoalbuminemia as a risk factor**

- Experimental study demonstrated impaired intestinal wound healing in malnourished human patients with extremely low serum albumin levels
  
  *Irvin TT* Surg, Gyn and Obs 1978; 146: 33

- Several canine and human studies on intestinal surgery found otherwise no increased risk of postoperative wound leakage in hypoalbuminemic patients
  
  *Harvey HJ* Vet Surg 1990; 19: 289
  
  *Pickleman* JACC 1999;188: 473
  
  *Shales CJ* JSAP 2005; 46: 317

**Early detection of leakage**

- It is important to detect anastomotic leakage as early as possible

- Anastomotic leakage can be clinically silent

- One could recommend screening patients post surgically for anatomic leakage on day 4-5 and day 8-9 with:
  
  - C-reactive protein levels
  
  - aFAST3 ultrasoundtracking

**Abdominal surgery triggers**

- Pneumoperitoneum

- Exudative abdominal fluid showing toxic/degenerate neutrophils with
  
  - foreign debris
  
  - intracellular bacteria

- Exudative abdominal fluid with high lactate and low glucose compared to the blood
Surgical treatment

Surgical goals

– identification and correction of the underlying cause
– debridement of infected or necrotic tissue
– lavage of the peritoneal cavity
– possible closed drainage
– nutritional support with a feeding tube

Surgical techniques

• Primary closure through a sutured anastomosis
• Stapled functional end-to-end anastomosis
Surgical technique is important

- Provide adequate apposition
- Ensure adequate blood supply
- Reduce tension

Nahal F Am Surg 1977;43:45

Stapled functional end-to-end anastomosis

No difference in frequency of anastomotic leakage between hand-sutured and stapled anastomoses in dogs

Surgery duration is reduced by the use of staples for intestinal closure

Frequency of Dehiscence in Hand-Sutured and Stapled Intestinal Anastomoses in Dogs

Strategies to prevent leakage

- Keep surgery time short
- Use an experienced surgeon
- Prevent contamination
- Place omentum over the intestinal sutureline
- Apply serosal patching

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Omental wrapping

- Placement of omentum around the intestinal suture line
- Omentum
  - improves healing of tissues
  - absorbs fluids
  - reduces infections

Serosal patching

- Suturing the anti-mesenteric border of a loop of small intestine over an intestinal suture line
- Patching could provide:
  - support
  - a fibrin seal
  - increased resistance to leakage
  - improved blood supply
  - reduced risk of intussusception

Efficacy of Serosal Patching in Dogs with Septic Peritonitis

Jenell Dinnes, DVM, Cheil Schmidt, DVM, DACVS, Mark Moonsen, DVM, DACVS, MaryAnn Padilha, MS, DVM, DACVS, Karen Cornell, PhD, DVM, DACVS

JAVMA | 48:4 Jul/Aug 2013

- Retrospective evaluation of 82 intestinal surgeries
- 18 Dogs received a serosal patch during surgery
- The serosal patch did not protect patients from:
  - postoperative septic peritonitis
  - failure to survive

Evaluation of serosal patch supplementation of surgical anastomoses in intestinal segments from canine cadavers

Lane A. Hansen, DVM, MS, and Eric L. Monnet, DVM, PhD

Conclusions and Clinical Relevance—Serosal patch-supplemented anastomoses were able to sustain a significantly higher pressure before leakage than were nonsupplemented anastomoses in intestinal specimens from canine cadavers. The serosal patch supplementation may protect against leakage immediately after enterectomy in dogs. (Am J Vet Res 2012;73:1138-1143)
In this study closed suction drainage is an effective technique for treatment of septic peritonitis.

Conclusion:
Placement of a closed suction drain compared to primary closure did not improve outcome.

Other medical treatment
- Fluid therapy
- Pain management
- Inotropes and vasopressors
- Oxygen therapy
- Antimicrobials
- Enteral nutrition
- Lidocaine CRI
Antimicrobial therapy

- Choice of antibiotics is often empirical while waiting on results of culture and sensitivity testing
- Should cover a broad spectrum because bacteria are often a combination of aerobic and anaerobic organisms
- Single-drug versus combination therapy
  - amoxycillin TID combined with enrofloxacin SID
  - third generation cephalosporin TID combined with metronidazole BID

Antimicrobial therapy in Sweden

- Empirical: ampicillin/enrofloxacine/metronidazole
- Pyometra: E coli TMPS or enrofloxacine
- Gastroenteral leakage: TMPS + metronidazole
- Septic shock: ampicillin/enrofloxacine/metronidazole

In this study improved survival was not demonstrated in patients receiving appropriate empirical antimicrobial therapy

Surgical treatment with copious lavage and the removal of contamination is important

Always avoid recently used antimicrobials (prior 30 days)

Impact of appropriate empirical antimicrobial therapy on outcome of dogs with septic peritonitis

In this study the initial use of appropriate antimicrobials was not statistically related to survival in patients with recurrent secondary septic peritonitis
Early enteral nutrition

- Preserves or increases gastrointestinal tract blood flow
- Prevents ulceration
- Increases IgA concentrations
- Stimulates immune defenses
- Stimulates wound repair

Khalili TM, Am J Surg 2001;182:621

Retrospective Study

Early nutritional support is associated with decreased length of hospitalization in dogs with septic peritonitis: A retrospective study of 45 cases (2000–2009)
Debro T. Lisa, DVM; Dorothy C. Brown, DVM, MSCE, DACVS and Deborah C. Silverstein, DVM, DACVIMCC

- Early nutritional support is defined as consistent calorie intake initiated within 24 hours postoperatively
- Dogs that received early nutritional support had significantly shorter hospitalisation length (1.6 days)
This study indicates that it is safe to initiate Early Enteral Nutrition without risk of additional gastrointestinal complications.

**Prognosis**

Based on several studies the mortality rate for dogs with bacterial peritonitis secondary to gastrointestinal perforation ranges from 29-63%.

**Effect of Intraoperative Constant Rate Infusion of Lidocaine on Short-Term Survival of Dogs with Septic Peritonitis: 75 Cases (2007-2011)**

*Luca Bellini, DVM, PhD*

Christopher J. Seymour, MA, VCEMBA

*J Am Vet Med Assoc 2016;248:422-429*

- IV infusion with lidocaine might improve short-term survival of dogs with septic peritonitis
- Lidocaine has analgesic, anti-inflammatory and anti-endotoxin effects


S. Christopher Ralph, DVM, MS; Carl E. Jensen, DVM, MS; Joshua R. Layne, DVM, MS; Alan J. Lipowitz, DVM, MS; and Michael J. Kraemer, DVM, DABVP

*J Am Vet Med Assoc 223, No. 1, July 1, 2003*

In this study the mortality rate for dogs with anastomotic leakage cases was 85%


Kate A. Soubak,* Daniel D. Sprick,* and Sharon Chiang

*Veterinary Surgery 45 (2016) 91-99*

In this study the mortality rate for anastomotic leakage cases was 83%
In this study the mortality rate for anastomotic leakage cases was 56.1%.

Risk factors for leakage in this patient:

- Presurgical peritonitis
- Intestinal foreign body
- Intra-operative abdominal contamination
- Low serum albumin concentration
- Hemorrhagic shock
- Treatment with blood transfusions

Conclusions:

- In case of gastrointestinal surgery discuss prognosis and the risk of complications and accurately estimate costs to the owner.
- Apply strict surgical and sterile technique when performing end-to-end anastomosis.
- No difference in frequency of anastomotic leakage is seen between hand-sutured and stapled anastomoses.
- Serosal patching does probably reduce the risk of anastomotic leakage.
- Avoid blood transfusions and fluid overload in dogs going through GI surgery.
Conclusions

• Giving early enteral nutrition through a feeding tube to dogs that underwent an end-to-end anastomosis reduces the length of hospitalization
• Try to identify dogs at high risk for anastomotic leakage at an early stage
• Expect signs of septic peritonitis to start within 5 days postoperatively
  – screen patients with aFAST3 ultrasound and CRP levels
• Perform early, aggressive treatment in case of RSSP
• The mortality rate for dogs having more than one surgery for septic peritonitis can, in some cases, be similar to dogs having a single surgery for septic peritonitis