



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

Bert Jan Reezigt, DVM 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..."

Hughes B. Acute diffuse peritonitis: a series of twenty-one consecutive cases. Br Med J 1919; 2(3064): 373–375

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Signalment and history

• Legolas is a 2-year-old, intact, mixed breed, male dog

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- 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





Postoperative clinical examination

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





| Venous blood work | | Ref range |
|-------------------|-------------|-----------|
| рН | 7.25 | 7.32-7.40 |
| HCO3 | 20 mmol/l | 18-26 |
| SBE | -3.3 mmol/l | - 5.0-1.0 |
| Anion gap | 8.3 mmol/l | 12.0-24.0 |
| Lactate | 4.3 mmol/l | 0.0-1.5 |
| pO2 | 31.5 mm Hg | 35.0-45.0 |
| pCO2 | 55.3 mm Hg | 39.8-46.2 |
| Na+ | 147 mmol/l | 140-150 |
| K+ | 3.7 mmol/l | 3.5-5.5 |
| CI- | 114 mmol/l | 105-115 |
| iCa | 1.18 mmol/l | 1.12-1.42 |
| Glucose | 5.5 mmol/l | 3.9-6.1 |
| Hct | 28,2 % | 43.3-59.3 |
| Hb | 77 g/L | 141-200 |



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



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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



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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)



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| Causes for secondary septic peritonitis | Leakage of gastrointestinal contents Perforating foreign body Perforating ulcers latrogenic (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 |
| From: Compendium on continuing education for veterinarians October 2011 | latrogenic Surgical peritoneal contamination Peritoneal dialysis |





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

T. Dayer*, J. Howard† and D. Spreng* 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
- latrogenic
 - anastomotic leakage of a GI surgical wound
 - leakage from a feeding tube



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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

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Risk factors for leakage following intestinal anastomosis in dogs and cats: 115 cases (1991–2000)

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

Risk factors for anastomotic leakage

- Sex (males > females)
- Malnutrition
- Preoperative peritonitis High BUN
- Foreign body
- Trauma
- Malignancies
- Preoperative tx corticosteroids
- Increased age
- Diabetes mellitus
 Ralphs CS JAVMA 2003;223;73
- NeutrophiliaLong operative times

concentration

• Low serum albumin

Hypertension

• Contaminated surgery

• Congestive heart failure

- Blood transfusions
- Hypovolemia and shock

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Risk factors for leakage following intestinal anastomosis in dogs and cats: 115 cases (1991–2000)

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

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

| ORIGINAL ARTICLE |
|---|
| 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. Demianiuk, DVM, DACVS-SA Jon Musser, DVM Maria Podsiedlik, DVM Joe Hauptman, 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 sta- bling may be preferred over hand-sewn anastomoses after enterectomies. |
| /eterinary Surgery. 2018;47:125–129. |



Risk Factors for Dehiscence of Stapled Functional End-to-End Intestinal Anastomoses in Dogs: 53 Cases (2001–2012)

Kyle A. Snowdon¹, Daniel D. Smeak², and Sharon Chiang³ Veterinary Surgery 45 (2016) 91–99

- Anastomotic leakage occured in 11% of cases
- Risk factors for anastomotic leakage:
 - preoperative IBD
 - intraoperative hypotension
 - surgery site large intestine



Original research

Does omental pedicle flap reduce an astomotic leak and septic complications after rectal cancer surgery? \star

Volkan Ozben^a, Erman Aytac^a, Xiaobo Liu^b, Gokhan Ozuner^{a,*}

International Journal of Surgery 27 (2016) 53-57

- Study on human patients who underwent rectal cancer surgery
- In this study blood transfusion was an independent risk faktor for anastomotic leakage



Blood Transfusion Impairs the Healing of Experimental Intestinal Anastomoses

TAMER TADROS, M.D., THEO WOBBES, M.D., PH.D., and THIJS HENDRIKS, PH.D. Ann. Surg. • March 1992

- 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

Ann Surg. 2009 Feb;249(2):181-5. doi: 10.1097/SLA.0b013e31818b73dc.

Impact of different crystalloid volume regimes on intestinal anastomotic stability. Marjanovic G¹, Villain C, Juettner E, zur Hausen A, Hoeppner J, Hopt UT, Drognitz O, Obermaier R.

<u>J Sura Res.</u> 2013 Aug;183(2):567-73. doi: 10.1016/j.jss.2013.03.030. Epub 2013 Mar 27. The effect of fluid overload in the presence of an epidural on the strength of colonic anastomoses.

Nessim C¹, Sidéris L, Turcotte S, Vafiadis P, Lapostole AC, Simard S, Koch P, Fortier LP, Dubé P.

- 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 anatomotic 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 endto-end anastomosis







Surgical technique is important

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

Nahai F Am Surg 1977;43:45



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

Jason R. Duell¹, Kelley M. Thieman Mankin², Mark C. Rochat¹, Penny J. Regier¹, Ameet Singh⁴, Jill K. Luther⁵, Michael B. Mison⁶, Jessica J. Leeman⁶, and Christine M. Budke³

¹Veterinary Clinical Sciences, Oklahoma State University, Stillwater, Oklahoma, ³Small Animal Clinical Sciences, ³Veterinary Integrative Biosciences, Texas A&M University, College Station, Texas, ³Department of Clinical Studies, Ontario Veterinary College, University of Quelph, Guelph, Ontario, ³Midvest Veterinary Referral Cartera, Chesterfield, Missouri and ⁵Seattle Veterinary Specialists, Kinland, Vashington

Veterinary Surgery 45 (2016) 100-103

- 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

Stapled functional end-to-end anastomosis



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
- absorbes fluids
- reduces infections





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Serosal patching

- Suturing the antimesenteric 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





Janet Grimes, DVM*, Chad Schmiedt, DVM, DACVS, Milan Milovancev, DVM, DACVS, MaryAnn Radlinsky, MS, DVM, DACVS, Karen Cornell, PhD, DVM, DACVS

JAAHA | 49:4 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



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* 2013;74:1138–1141)



Closed Suction Drainage for Treatment of Septic Peritonitis of Confirmed Gastrointestinal Origin in 20 Dogs

Robert J. Adams¹, BVM&S, Ronan S. Doyle¹, MVB CertSAS Diplomate ECVS, Jonathan P. Bray², MVScMANZCVSc CertSAS Diplomate ECVS, and Carolyn A. Burton¹, BVetMedPhD CertVA CertSAS Diplomate ECVS

Veterinary Surgery 43 (2014) 843-851

In this study closed suction drainage is an effective technique for treatment of septic peritonitis



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

T. Dayer*, J. Howard† and D. Spreng* Journal of Small Animal Practice (2013) **54**, 625–629

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



Other medical treatment

- Fluid therapy
- Pain management
- Inotropes and vasopressors
- Oxygen therapy
- Antimicrobials
- Enteral nutrition
- Lidocaine CRI





- 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



Retrospective Study

Journal of Veterinary Emergency and Critical Care 25(1) 2015, pp 152–15 doi: 10.1111/vec.1227

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

Amy E. Dickinson, DVM, DACVECC; Jennifer F. Summers, BVetMed, MSc; Jamie Wignal, BVetMed, DACVS; Amanda K. Boag, MA, VetMB, DACVIM, DACVECC, DECVECC and Iain Keir, BVMS, DACVECC

- 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)

Retrospective evaluation of recurrent secondary septic peritonitis in dogs (2000–2011): 41 cases

Dominic M. Barfield, BSc (Hons), BVSc (Hons), MVetMed, DACVECC, DECVECC; Michael S. Tivers, BVSc, PhD, DECVS; Matthew Holahan, DVM; Kristin Welch, DVM, DACVECC; Arthur House, BSc, BVMS (Hons), PhD, DECVS and Sophie E. Adamantos, BVSc DACVECC, DECVECC

J Vet Emerg Crit Care 2015

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

Journal of Veterinary Emergency and Critical Care 22(4) 2012, pp 453-459 doi: 10.1111/j.1476-4431.2012.00771.x

Early nutritional support is associated with decreased length of hospitalization in dogs with septic peritonitis: A retrospective study of 45 cases (2000–2009)

Debra T. Liu, DVM; Dorothy C. Brown, DVM, MSCE, DACVS and Deborah C. Silverstein, DVM, DACVECC

- 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)

RETROSPECTIVE STUDIES

Evaluation of the Safety of Early Compared to Late Enteral Nutrition in Canine Septic Peritonitis

Jamie Elizabeth Hoffberg, DVM, Amy Koenigshof, DVM, MS

This study indicates that it is safe to initiate Early Enteral Nutrition without risk of additional gastrointestinal complications

JAAHA 2017; 53: 90-95

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, VetMB

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



Risk factors for leakage following intestinal anastomosis in dogs and cats: 115 cases (1991–2000)

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

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

Risk Factors for Dehiscence of Stapled Functional End-to-End Intestinal Anastomoses in Dogs: 53 Cases (2001–2012)

Kyle A. Snowdon¹, Daniel D. Smeak², and Sharon Chiang³ Veterinary Surgery 45 (2016) 91–99

In this study the mortality rate for an astomotic leakage cases was 83%

Prognosis

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



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Retrospective evaluation of recurrent secondary septic peritonitis in dogs (2000–2011): 41 cases

Dominic M. Barfield, BSc (Hons), BVSc (Hons), MVetMed, DACVECC, DECVECC; Michael S. Tivers, BVSc; PhD, DECVS; Matthew Holahan, DVM; Kristin Welch, DVM, DACVECC; Arthur House, BSc, BVMS (Hons), PhD, DECVS and Sophie E. Adamantos, BVSc DACVECC, DECVECC

J Vet Emerg Crit Care 2015

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 bloodtransfusions 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