THE SEPTIC ABDOMEN: DIAGNOSIS AND PRESURGICAL STABILIZATION

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Introduction
Septic peritonitis is life-threatening and requires prompt recognition and aggressive cardiovascular (CV) stabilization prior to anesthesia or surgery to improve outcome.

Etiology
Gastrointestinal rupture is the most common cause (secondary to previous intestinal surgery, gastric dilatation and volvulus, gastrointestinal ulceration, gastrointestinal neoplasia, blunt abdominal trauma, penetrating abdominal trauma, intestinal intussusception, or intestinal infarction). Other causes include bladder, biliary or uterine rupture, prostatic, hepatic, pancreatic, lymphatic and splenic abscesses, and bacterial translocation.

History and physical examination findings
Clinical findings can be non-specific and vary with the underlying cause. Abdominal pain is a frequent occurrence in many patients with septic peritonitis but is not always present, even in patients with advanced disease.

Although newer classification systems for evaluation of sepsis are being developed, the classic criteria of SIRS, because they are sensitive, are worth evaluating; if an animal presents with criteria of SIRS, and historical and clinical findings supportive of abdominal disease, an aggressive search for a source of infection should be undertaken. Because of its fatal nature and need for early intervention, failure to consider sepsis is likely to result in a negative outcome.

As surgical dehiscence is a common cause of septic peritonitis, it should be considered in any animal that displays relevant clinical signs following abdominal surgery.

Cardiovascular signs can vary with the stage of sepsis; early phases in dogs often present with hyperdynamic signs (tachycardia, brick red mucous membranes, rapid capillary refill time (< 1 second) bounding pulses, and hyperthermia) and later progress to hypodynamic signs (tachycardia, pale mucous membranes, prolonged capillary refill time (>2 seconds), weak pulses and hypothermia). Cats tend not to show a hyperdynamic phase and the hypodynamic phase is more commonly present, often with bradycardia.

Diagnosis
Abdominoceintesis and Diagnostic peritoneal lavage The accuracy of abdominocentesis depends on the amount of fluid present in the abdomen (4-6ml/kg to obtain consistent positive results) but is generally around 50%. A 4 quadrant tap may improve chances of collecting fluid samples.

Sonography increases the chance of detecting fluid and collecting a sample by localizing areas of fluid accumulation, which can then be tapped with ultrasound-guided abdominocentesis. Serial FAST exams of the abdomen may also improve the chances of detecting fluid.

Cytological, microbiologic and biochemical analysis should be performed on the abdominal fluid obtained.
Cytological evaluation: Studies in veterinary patients suggest that fluid cytology is only 57-87% accurate in the diagnosis of septic peritonitis (1).

The presence of intracellular or extracellular bacteria and degenerative neutrophils is the most rapid test at definitively confirming the presence of septic peritonitis. Even a single intracellular bacterium is significant and diagnostic. If multiple bacterial species and or plant/digestive material are present in the abdominal fluid, it is suggestive of GI rupture, although this must be differentiated from accidental GI aspiration. Ultrasound guided centesis helps ensure accuracy of fluid collection.

Degenerative neutrophils are suggestive of a septic peritonitis (although they may also occur with non-septic conditions of pancreatitis and bile peritonitis), and their presence warrants a thorough examination of all areas of multiple slides to look for the presence of micro-organisms: fluid samples can also be centrifuged to concentrate cells if necessary - be thorough in the search!

It should be remembered that some animals, especially those on antibiotics, may not show typical degenerative neutrophils or the presence of bacteria.

Abdominal fluid biochemical analysis: An abdominal fluid glucose concentration of less than 2 mmol/l (50 mg/dL) has been shown to correlate with septic peritonitis and a peripheral blood glucose to abdominal fluid glucose difference of > 1.1 mmol/L (20 mg/dl) is highly suggestive of septic effusion in both dogs and cats (100% and 92% accurate respectively). A lactate concentration difference of > 2mmol/L between abdominal and peripheral blood lactate concentrations is also suggestive of septic effusion in dogs (100% accurate for 7 cases), but further studies on a larger group of patients is required to confirm these results. Furthermore, these findings cannot be used in postsurgical cases where abdominal fluid is collected via surgical drains.

Culture and sensitivity testing: Aerobic and anaerobic cultures should be performed on all cases of suspected abdominal sepsis prior to starting antibiotics. Urine and blood cultures should be considered if the abdomen is the suspected source of infection but an abdominal fluid sample cannot be obtained. When bacteria are identified, a gram stain helps direct empirical antibiotic therapy until culture and sensitivity results are available.

Radiography: Abdominal radiographs may detect foreign bodies or masses and should be examined carefully for evidence of free gas, frequently noted between the liver and diaphragm. In the absence of recent surgery (within one week), free gas in the abdomen is compatible with gastrointestinal perforation or free gas-forming organisms and is an indication for immediate stabilization and exploratory laparotomy. Contrast studies can be helpful but the agent used must be carefully considered, particularly if gastrointestinal perforation is suspected or if surgery is inevitable.

Ultrasonography: In the emergency setting it has a dual purpose in the evaluation of patients with septic peritonitis; 1) rapid (< than 5 minute) localization of free abdominal fluid for sample collection and cytolo/biochemical analysis to confirm septic peritonitis (it is very sensitive at detecting free abdominal fluid with minimal ultrasound training and should be considered a first line diagnostic test in unstable patients to rapidly search for the presence of free abdominal fluid which may be indicative of peritonitis), and 2) a more extensive evaluation to identify possible underlying causes (more dependent on operator experience): masses, foreign bodies, pyometra, free gas, splenic, hepatic, pancreatic, lymphatic or prostatic abscesses.

The sonographic detection of free gas with appropriate historical and clinical signs suggests GI perforation and the need for surgery. The combination of localized bright fat and local fluid accumulations often determines the site of GI perforation. All of these factors, which may influence the prognosis and the owner’s willingness to proceed with surgery, make ultrasonography a useful ancillary test in the evaluation of patients with septic abdomen.
CBC and biochemistry, urinalysis and coagulation testing: Although not specific to patients with septic abdomen, these tests are important to evaluate as septic patients often show abnormalities that require management prior to surgery to improve successful outcomes (see treatment section).

Treating the septic abdomen

There are 6 keys points important in any septic patient, including those with septic peritonitis:

1. Early recognition of patients that are septic or at high risk of becoming septic (see above)
2. Intravenous fluids for volume resuscitation to improve systemic perfusion
3. Early use of inotropes and vasopressor agents
4. Starting intravenous antibiotic therapy early
5. Identifying and controlling the sources of infection as soon as possible.
6. Close regular monitoring with tailored goals to the individual patient.

Establishing vascular access and initiating early fluid resuscitation in the CV unstable patient is the first priority in patients with septic peritonitis. Waiting for a diagnosis prior to stabilization could result in deterioration or even death of the patient in advanced cases. With recent human suggesting a potential harm of overly aggressive fluid therapy the individual needs of the patient must be considered and the balance of under-resuscitation vs. over-resuscitation considered.

Although the evidence is unclear in dogs and cats with sepsis, there is a strong association of acute kidney injury (AKI) in septic human patients that receive synthetic colloids. It may therefore be prudent to start initial fluid therapy in dogs and cats using isotonic crystalloids until further evidence is available regarding the association between synthetic colloids and AKI in cats and dogs with sepsis.

The author currently administers repeated intravenous isotonic crystalloids boluses at 20 ml/kg to dogs and 10-15 ml/kg to cats, while evaluating the response (see end points below) and tolerance/responsiveness (see notes on fluid response) of the patient. Based on the response and tolerance, the bolus is repeated intravenously every 5-10 minutes while continually monitoring the patients until end points of resuscitation are achieved or the animal displays evidence of maximal intravascular volume (see notes on predicting fluid response). If the animal fails to show a response to a fluid challenge, vasopressors or positive inotropes in the form of dobutamine, dopamine, norepinephrine or possibly vasopressin are indicated, and should be considered earlier than later in patients with sepsis. A focused evaluation of cardiac function is helpful in deciding on the initiation of pressors vs. inotropes. If patients fail to reach hemodynamic stability following fluids and ino-pressor therapy, relative adrenal insufficiency should be considered: Consider glucocorticosteroids if relative adrenal insufficiency is suspected OR if the patient shows signs of lethal infection and is unstable despite increasing doses of catecholamines and vasopressin. Hydrocortisone 0.4 mg/kg followed immediately by 0.4 mg/kg/hour (lean body weight) CRI or dexamethasone sodium phosphate at 0.01 mg/kg IV followed immediately by 0.01 mg/kg/hour (lean body weight) CRI should be considered.

When CV stability is achieved patients should be induced and taken to surgery as soon as possible, as the chance of recurrent CV instability is high if the underlying cause is not promptly identified and corrected. Occasionally an animal will fail to reach end points of stabilization despite adequate fluid resuscitation and the administration of vasopressors. The prognosis in these patients is extremely poor and surgery should be considered when all efforts of resuscitation have been exhausted.

End points of resuscitation are controversial. However, currently, clinical exam findings are often used (although proven not to be accurate at predicting fluid status and response), along with static, dynamic and sonographic assessment, depending on resources available (see notes on predicting fluid volume and response).

Broad spectrum intravenous antibiotic therapy should be started within the first hour of arrival, after appropriate cultures have been obtained. Subcutaneous, intramuscular and oral antibiotics should be avoided. The antimicrobial regimen should be reassessed after 48-72 hours based on culture and sensitivity results. Once a causative pathogen is identified, there is no evidence that combination

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therapy is more effective than monotherapy and the goal should be to narrow the administered antibiotics to prevent development of resistance, to reduce toxicity and reduce costs. Duration of therapy is typically 7-14 days and guided by clinical response.

Blood glucose levels vary in patients with sepsis. The presence of hypoglycemia should be treated with dextrose containing fluids to maintain glucose concentrations in the normal range. Hyperglycemia should be avoided as it is associated with worse outcomes. Insufficient data exists to determine if a CRI of insulin should be used in septic veterinary patients, however, iatrogenic hyperglycemia should be avoided and glucose administration only administered when indicated and at a rate to correct hypoglycemia and prevent hyperglycemia.

As coagulation abnormalities are common in septic patients, the coagulation status and the presence of DIC should be determined and appropriate therapy instituted as required.

**Clinical parameters as surrogates to achieve end points of resuscitation:**

*Electrocardiography (ECG):* An ECG is recommended to detect the presence of arrhythmias, which are common in patients with septic peritonitis, and is a very helpful in evaluating the patient’s response to therapy.

*Lactate:* Normal blood lactate is < 2.5 mmol/L in cats and dogs. In many cases the lactate should decrease following initial fluid resuscitation and continue to trend downward if therapy is adequate. Conditions other than hypoperfusion that could influence lactate levels should be considered (catecholamine administration, stress, hepatic or renal disease, certain drugs, ongoing sepsis). In these cases fluid therapy should be continued in conjunction with the clinical picture and other end points of resuscitation, and the lactate followed until it returns to normal.

*Central venous pressure (CVP):* The CVP is an easily applicable tool that has been used to estimate the intravascular volume status of patients. Although it may still have some value, recent studies have questioned its role in predicting fluid volume status and other methodologies (dynamic variables and ultrasound) have begun to replace CVP measurement (see notes on predicting fluid volume status).

*Arterial blood pressure:* Evaluation of the arterial blood pressure (direct or indirect) is valuable in assessing the severity of shock and is useful in achieving desired end points of resuscitation.

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<th>Findings suggestive of SIRS in cats and dogs: any two of the following</th>
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<td>Parameter</td>
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<td>Heart rate : beats per minute</td>
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<tr>
<td>Respiratory rate : breaths per minute</td>
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<td>Temperature</td>
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<td>WBC count</td>
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<th>Potential end points for treating hypoperfusion associated with septic peritonitis</th>
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| Heart rate | < 120-140 bpm in dogs  
< 225 or > 140 bpm in cats |
| Peripheral pulses | Strong and regular |
| Mucous membrane color | Pink |
| Capillary refill time | 1-2 seconds |
| Blood pressure | > 90 mmHg systolic or > 70 mmHg mean |
| Lactate level | Significantly decreasing (it can take several minutes to hours to achieve normal values in patients with sepsis – recheck until normal) |
| Urine output | > 1-2ml/kg hour |
Mental status | Alert and responsive or improving
---|---
Hematocrit | Varies depending on inciting cause
Central venous pressure | 8-12 cm H2O (normal value is 0-5 cm H2O)

**References**