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Septic peritonitis can develop from numerous and diverse aetiologies, and the best way to deal with this problem is to prevent its occurrence. Although we cannot prevent all septic peritonitides, we can certainly minimize risk when performing gastrointestinal surgery. Adequately preparing your patient for surgery, adhering to the principles of intestinal surgery, and recognizing the high-risk patient beforehand can prevent many potential complications such as peritonitis.

**Adequate preparation of the patient:**

**Timing.** Complete intestinal obstruction, organ displacement, intestinal perforation, strangulation, penetrating abdominal wounds, and a septic exudate or evidence of marked contamination on abdominocentesis require immediate surgical intervention with aggressive stabilization. Partial obstructions generally benefit with hydration, electrolyte and acid-base correction for several hours before surgery.

**Fluid therapy.** Most patients requiring gastrointestinal surgery are dehydrated and often have acid-base and electrolyte disorders. This should be addressed before surgery as much as possible, and surgery delayed for several hours (unless it’s an acute abdomen) until the animal has been partially corrected. The hypotension associated with anesthesia, as well as evaporation from the open abdomen and the anesthesia circuit will compound the fluid deficit, so aggressive fluid therapy is generally continued throughout surgery and into the post-operative period. As a rule, 10 ml/kg/hour of an appropriate crystalloid should be administered during surgery (unless cardiac failure or renal failure is evident). Oncotic support or blood products may be indicated in critical cases.

**Fasting.** Fasting the patient before surgery is recommended - it will decrease the incidence of gastroesophageal reflux, decrease ingesta volume in the intestinal tract, and will also decrease bacterial numbers. A 12-hour fast is normal for adult patients, and a 6-hour fast for paediatric patients (measuring blood glucose before anesthesia).

**Anesthesia and monitoring.** Most careful anesthetic protocols are suitable for small intestinal surgery. Some anesthetists will premedicate with atropine or glycopyrrolate to counter vagal effects of handling the bowel. If there is evidence of gas-filled loops of bowel, or free gas in the abdomen, then nitrous oxide should be avoided. Critical cases will require more intensive monitoring under anesthesia and post-operatively, with a urinary catheter, central line, and possibly an arterial line.

**Principles of intestinal surgery**

**Keeping patient warm.** Hypothermia is a huge concern with any open cavity surgery. All lavage fluids must be warm. Circulating water heating blankets should be *routinely* used, and other safe forms of warming (e.g., warm air huggers, warmed intravenous fluids) are warranted in smaller dogs and cats. It is desirable to keep core temperatures above 35 degrees Celsius.

**Antibiotic prophylaxis / antibiotic therapy.** In most cases of abdominal surgery where a hollow organ is entered, prophylactic antibiotics are indicated. A first-generation
cephalosporin or ampicillin is commonly used for gastric and small intestinal surgery, administered as a slow intravenous bolus around induction. The dose is repeated every 2 hours until the end of surgery. If infection is present, this broad-spectrum therapy should be continued into the post-operative period, until the results of culture and sensitivity provide an effective choice of antibiotic. A second-generation cephalosporin (such as cefoxitin) is preferred for the colon or rectal procedures.

**Instrumentation.** Appropriate instrumentation greatly facilitates surgery of the gastrointestinal tract:

- Self-retaining abdominal retractors (such as Balfours, Gossets, or Nelsons) are essential.
- Hand-held retractors for deeper structures (e.g., malleable, Faraboeufs, Army-Navy).
- Doyen non-crushing intestinal forceps are useful for occluding the lumen of the bowel without compromising perfusion of the bowel wall.
- Suction connected to continuous suction device. A Poole suction tip is preferred for general peritoneal cavity suction, Yankaeur suction for voiding hollow organs, and a Frazier tip for fine haemorrhage.
- Metzenbaum scissors and Babcock forceps, should be included in all surgery packs.
- Fine, multitoothed forceps such as Debakey or Cooley are the least traumatic for handling bowel edges - avoid large toothed forceps.
- Intestinal stapling equipment, automatic ligating staplers are quick and secure, although moderately expensive.
- A ceiling mounted, two light system is invaluable. Fully mobile, double articulated arms are preferred.

**Assistance.** Surgical assistance facilitates many gastrointestinal procedures. Having a sterile assistant will enable enhanced exposure due to accurate retraction, improved apposition of bowel ends, decreased contamination and shorter surgical times.

**Sponges.** The use of large laparotomy sponges is highly recommended, rather than the traditional small gauze squares. If used, smaller sponges should be counted in and counted out of the abdomen, and should contain a radio-opaque stripe.

**Surgical technique.** Always handle bowel gently. Excessive handling and drying of the intestines will irritate serosal surfaces and may result in a vagal response leading to postoperative ileus. The abdominal contents should be kept moistened with warm, sterile saline at all times, as they have a tendency to dry out in the operating room. Hands are excellent for examining the intestines and occluding the bowel lumen. Correctly placed Doyen forceps can also be used to occlude lumen. Electrocautery should not be used on the bowel wall – haemorrhage from transected or incised bowel will soon clot with gentle pressure from moistened gauze. Likewise, bleeding from vasa recti or arcuate vessels should be attenuated with fine ligatures of 5-0 monofilament suture, not electrocautery. Harmonic scalpels appear to cause Minimal tension should be imposed on any suture line.

**Assessment of intestinal viability.** A decision to resect bowel requires an accurate assessment of its viability. The standard subjective criteria for viable intestine are, colour, arterial pulsations, peristalsis and bleeding from a cut edge. The bowel should be moistened and warm when assessing these characteristics. These are not all completely accurate, but the error is made in favor of resecting too much, rather than leaving non-viable bowel behind. Other tests of perfusion used clinically include intravenous fluorescein dye injection, Doppler ultrasonic flow probes and pulse oximetry. If viability is questionable, resection is the prudent choice. Around 75 - 80% of the small intestines can be resected before permanent short bowel syndrome is seen.
“Packing off”. Following initial exploration of the abdomen, the affected area of bowel should be isolated and packed off from the remaining abdominal contents. Four or more large laparotomy sponges moistened with warmed sterile saline are placed around the affected area. These sponges act to protect the packed off abdomen from contamination in case of inadvertent leakage from an enterotomy or enterectomy site; they will also keep abdominal contents moistened and decrease heat loss. By using a double top layer of exclusion draping, the top sponge can be whisked away if spillage occurs, minimizing further contamination.

Stay sutures. Stay sutures are just loops of suture material passed through the bowel wall, and held with a hemostat. They are atraumatic and can be used to provide traction and reposition the bowel as needed. Stay sutures are removed by snipping one end of the suture close to the bowel, so that drag through the tissues is minimized.

Suture material. A monofilament, absorbable suture material with a consistent, known rate of absorption and minimal reactivity is suitable for use in the small intestine. Polydioxanone, poliglecaprone 25, and polyglyconate are most commonly used. Non-absorbable monofilament sutures such as nylon, polypropylene and polybutester are also suitable choices. Braided sutures tend to harbour bacteria and cause more trauma as they pass through the tissue and are not generally recommended. Chromic gut is not indicated due to its unpredictable rate of absorption, especially in the presence of inflammation. Gut will also incite a significant inflammatory response. A fine suture material is always indicated, usually 4-0 or 5-0, and occasionally 3-0 in size.

Suture patterns. Single layer, direct apposition of the bowel is preferred for rapid healing, rather than an inverting, evertong or two-layered suture pattern. This is true for small and large bowel, but stomach wall is usually sutured in two layers – a simple continuous full thickness layer, followed by an inverting layer in the seromuscular layer. Gastrointestinal sutures need to be tied snugly. Accurate apposition is difficult to obtain, due to the tendency for the redundant mucosa evert from the lumen. Mucosal eversion can be minimized by mucosal trimming with Metzenbaum scissors, using a modified Gambee bite, and using a simple continuous suture pattern.

Abdominal lavage and suction. Copious quantities of warm, sterile saline followed by suctioning before closure is essential following GI surgery. Thorough abdominal lavage will reduce contaminating bacteria and debris, removes residual blood, warms the abdomen, moistens all organs and enables a final check of the cavity. (Water impermeable barrier draping should be consistently used as part of the draping protocol). The addition of antibiotics or antiseptics to the final lavage solution has no proven benefit, and can be irritating to serosal surfaces.

Recognizing the high-risk patient
Although complications of gastrointestinal surgery can occur in any patient, there are some patients at increased risk of dehiscence, or other complications. Patients with pre-existing peritonitis, hypoproteinemia, uremia, hyperadrenocorticism or other immunosuppressed state, advanced liver disease, negative nitrogen balance, coagulopathies, sepsis will not heal as quickly or effectively. These patients should be identified before surgery and aggressively nursed into the critical post-operative period. Intestinal suture lines should be augmented with serosal overlay or omental wrap, thus bringing in blood supply, a source of macrophages and mesothelial cells to the sutured area. A serosal overlay pexies two sections of healthy bowel over the suture line, carefully avoiding kinking of the jejunal
festoons. An omental wrap covers the suture line with a ‘wrap’ of omentum, held in place with several tacking sutures. Both these techniques effectively reinforce the suture line.

Septic peritonitis

Septic peritonitis is a serious, emergent condition with high mortalities reported. It can be caused by the breakdown of an intestinal suture line, penetrating injury the intestinal tract, neoplastic perforations, abdominal foreign bodies, bacterial prostatic abscessation, infected bile peritonitis, infected uroabdomen and ruptured pyometras. Most intestinal dehiscences will occur within 3 – 5 days of surgery - an initially improved post-operative patient will become lethargic, and anorexic. With colonic dehiscence, marked deterioration will occur within 6 hours. Heart rate increases, temperature may rise, and vomiting, abdominal pain and distention can (but will not always) develop. Hypotension and failure to respond to fluid loading is common.

Diagnostics should include haematology, biochemistries, blood gas, abdominal radiography, and abdominocentesis. Ultrasonography can be useful to determine presence of early abdominal effusion, and underlying aetiology. If a tap is not diagnostic, diagnostic peritoneal lavage is indicated. (Air can be present in the abdominal cavity for up to a week following abdominal surgery, as well as mature neutrophils and a few extracellular bacteria). Haematology values can show an increase in the WBC and percent bands, and decrease in platelets. Peritoneal fluid cytology is not always diagnostic due to prior antibiotic administration, but a high nucleated cell count is a fairly consistent finding. Diagnosis is more reliable when blood and peritoneal fluid glucose levels are compared (> 20mg/dL).

Treatment is aimed at surgical intervention to attenuate the underlying cause of peritonitis, with aggressive supportive therapy, including fluids (colloids and crystalloids), antibiotics, blood products and any further drugs (pressors) to maintain cardiovascular function and adequate renal perfusion. A central line (triple lumen), arterial catheter and urine catheter should be placed. A complete abdominal exploration, incising from xiphoid to pubis is performed and all abdominal contents should be thoroughly inspected. Cases of intestinal dehiscence will require re-resection and anastomosis, with an omental wrap or serosal overlay. Large volume lavage and suction, exit culture, placement of closed-suction abdominal drains, feeding and gastric decompression tubes are indicated. The occasional case of sclerosing peritonitis may benefit from heparin or streptokinase in the lavage solutions. In severely contaminated cases, open abdominal drainage, or a planned second look surgery is warranted. Vacuum-assisted closure may prove to be useful in these cases.

It is very common to get behind on fluids in peritonitis, especially with prolonged surgical time, and then fail to catch up in the post-operative period. In most cases, renal perfusion can be gauged by measuring urine production through a urethral catheter (more than 2 ml/kg/hour). In more critical cases, a central line (and sometimes arterial line) should be placed and central venous pressure measurements will provide feedback on vascular volume. A triple lumen catheter will allow concurrent administration of blood products and total parenteral nutrition with intravenous fluids. If a patient’s urine production falls in the face of previously normal cardiac and renal evaluations, or arterial pressures cannot be maintained, crystalloid fluids can be administrated as a bolus, usually as 500 or 1000 mls. Colloids such as hetastarch will also pull volume into the vascular space. Persistent hypoperfusion may require frusemide therapy, or a pressor agent (dobutamine, dopamine). These agents should only be used when adequate vascular volume is assured. If systemic blood pressure stays below a mean of 60mmHg for more than 4 – 6 hours, permanent renal failure may ensue.
Intensive post-operative monitoring and support is continued until signs of improvement are seen – cardiorespiratory signs, urine output, cytology of peritoneal fluid, haematology. Most animals will become hypoalbuminemic in the post-operative period and develop dependent edema. This improves with ambulation and as nutritional balance improves.