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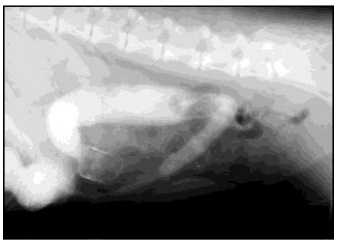
Gastrointestinal Surgery Mini Series

Session One: Gastrointestinal disease: Diagnostic tools; Medical stabilization; Surgical principles

Alison Moores BVSc(Hons) CertSAS DipECVS MRCVS
RCVS Specialist in Small Animal Surgery (Soft Tissue), European Specialist in Small Animal Surgery



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©Alison Moores BVSc(Hons) CertSAS DipECVS MRCVS
RCVS Recognised Specialist in Small Animal Surgery (Soft Tissue)
EBVS® European Specialist in Small Animal Surgery
Anderson Moores Veterinary Specialists, Hursley, Hampshire, UK
www.andersonmoores.com

Diagnostic approach

Dogs and cats with gastrointestinal disease may have a range of presenting owner complaints and physical examination findings, including (but not limited to):

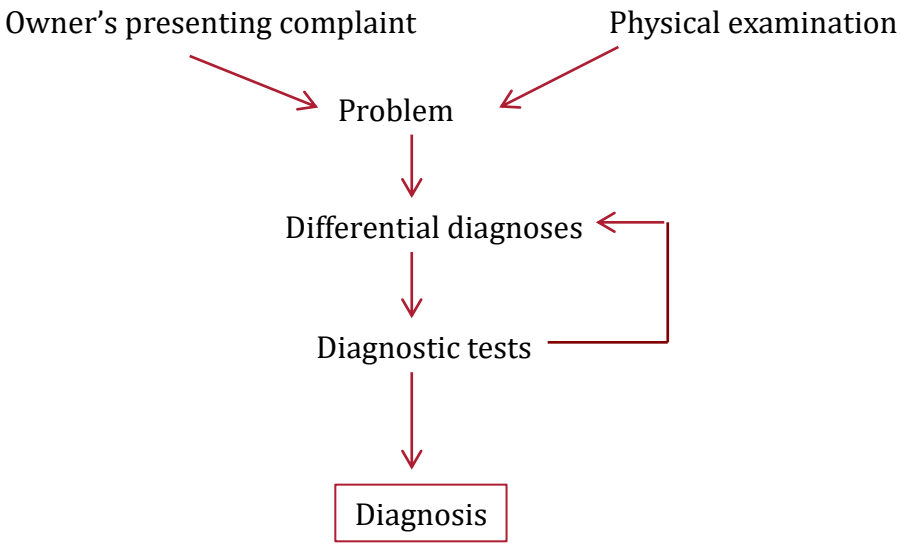
Owner's presenting complaint:

- Vomiting, regurgitation, nausea, hypersalivation, haematemesis
- Diarrhoea, tenesmus, haematochezia
- Depression, lethargy, collapse
- Anorexia
- Weight loss
- Abdominal pain, distension
- Reduced or increased thirst
- Icterus
- Known foreign body ingestion

Physical examination findings:

- May be normal
- Dehydration, hypoperfusion
- Abdominal distension – fluid, gas
- Abdominal pain
- Dilated intestines, plicated intestines
- Abdominal mass
- Organomegaly

It is important to approach these cases with a problem-oriented approach to avoid missing key differential diagnoses and to use the most effective and cost-efficient combination of diagnostic tests to reach the diagnosis. Although simple, many vets fail to consider a problem list and differential diagnosis list, especially when working within the tight time constraints of first opinion practice. There are also many cases in referral practice with a seemingly simple disease that haven't been diagnosed, either through lack of availability of diagnostic tools, or because the diagnosis hadn't been considered on a differentials diagnosis list.



Consider the example given in the lecture of the cat with rectal prolapse. Most cases are seen in young cats with gastrointestinal parasitism, and these animals respond well to rectal prolapse reduction, temporary purse-string suture placement and anti-parasitic mediation. In the example shown, creation of a problem list and differential diagnosis list leads to consideration of the urinary tract, and specific owner questioning led them to report inappropriate urination and straining in the litter tray that was not reported on presentation. It is easy to see that the cat would likely have re-prolapsed if purse-string suture alone were instituted.

Creation of a problem list can be relatively easy if there are only few clinical signs, and the differential diagnosis list may be relatively short, for example the dog with known foreign body ingestion and a palpable abdominal mass. The problem and differential diagnosis lists are very short and diagnostic tests are easy to choose. However, many dogs have more vague presenting complaints/physical examination findings, with some such as lethargy or anorexia leading to such a long differential diagnosis list as to be unhelpful, or there may be a number of problems. There are several ways to approach this type of case.

1. Consider each problem individually and create a differential diagnosis list for each, but this list is likely to be very long list with almost every disease imaginable on it (see the list for vomiting below).

Vomiting: Differential Diagnoses

- **Gastric Disease**

Gastritis, Parasites, FB, Obstruction, Ulceration, Neoplasia, GDV, *Helicobacter,* ulcer , Hiatal hernia, Motility disorders, Pyloric stenosis, Gastric antral mucosal hypertrophy

- **Small Intestinal Disease**

Parasites, IBD, FB, Bacterial overgrowth/enteritis, HGE, Neoplasia, Viral enteritis, Intussusception, Nonneoplastic infiltrative disease

- **Large Intestinal Disease**

Colitis, Obstipation, Parasites

- **Dietary**

Indiscretion, Intolerance, Allergy

- **Drugs**

Chemotherapeutic, Antibiotics, NSAIDs…

- **Extraalimentary Tract Disease**

Peritonitis, Pancreatitis, Hepatobiliary disease, Neoplasia, Uraemia, Diabetes mellitus/DKA, Hyperthyroidism, Hypoadrenocorticism, Hepatic encephalopathy, Septicemia/endotoxemia, Pyometra, Acid-base disorders, Electrolyte disorders, Hypertriglyceridemia, Gastrinoma, Mastocytosis

- **Intoxicants**
- **Neurologic Disease**

Epilepsy, tumor, meningitis, increased intracranial pressure, dysautonomia

2. Combine the problems and create a differential diagnosis list that encompasses all of them, but be mindful that some clinical signs are more important than others and that some differentials may be on one list only but must not be disregarded.
3. Create a broad differential diagnosis list by body system or disease type and use key diagnostic tests to narrow down the differentials list. For example, serum biochemistry will help rule out acute renal failure as a cause of acute vomiting (in most cases).

Vomiting: Differential Diagnoses (broad categories)

By body system

- Gastrointestinal – Oesophageal , Gastric, Small Intestinal, Large Intestinal
- Renal
- Hepatic
- Urogenital
- Endocrine
- Neurologic

By disease process

- D - Degenerative, Developmental
- A – Anomalous, Auto-immune
- M – Metabolic. Mechanical
- N – Neoplastic, Nutritional
- I – Inflammatory, Infection,
- T – Trauma, Toxins

Diagnostic tests

It is important to triage the patient to determine if any treatment is required prior to starting diagnostic testing. The most common example is the correction of fluid deficits (dehydration, hypoperfusion). This will be covered in a later section but it is important to remember that in the clinical scenario, diagnostic testing and therapeutic intervention often occur concurrently. The most common diagnostic tests for the problem lists and differential diagnosis lists created are blood test and diagnostic imaging tests.

Blood tests obtained will vary based on likelihood of differentials and will often depend on how sick the animal is. An otherwise quite healthy animal presenting with a short duration of vomiting and with no clinical abnormalities noted may have abdominal imaging prior to blood tests. Biochemistry and haematology may identify a different cause of clinical signs associated with the gastrointestinal system, e.g. renal failure causing vomiting and haematemesis, or concurrent diseases may be identified that must be considered in managing the patient. Obviously there is no set protocol that may cover all eventualities, so the blood tests selected will vary between cases. Potential blood tests may include:

- Haematology
- Serum biochemistry – will rule out many differentials e.g. acute renal failure; may identify changes related to gastrointestinal disease e.g. increased urea/creatinine/hepatic enzymes related to dehydration organ hypoperfusion
- Electrolytes (will be included in a full biochemistry profile but not in all in-house tests
- Acid-base
- Albumin/total protein – dehydration (high), protein loss (low)
- cPLI/fPLI if suspicious of pancreatitis

Electrolyte and acid-base abnormalities are not uncommon in upper gastrointestinal, and occasional lower intestinal disease. Vomiting due to disease oral to the major duodenal papilla results in a hypochloraemic metabolic alkalosis secondary to loss of chloride and hydrogen ions. Disease aboral to the major duodenal papilla that results in vomiting leads to a hypokalaemic, hyponatraemic metabolic acidosis. Acidosis occurs due to loss of duodenal bicarbonate as well as lactic acidosis secondary to poor tissue perfusion and dehydration. Electrolyte and fluid losses are more severe with duodenal vomiting than gastric vomiting.

Imaging studies have a high specificity and sensitivity in the diagnosis of gastrointestinal diseases. Radiography is often used in conjunction with abdominal ultrasound. Plain radiographs may identify radio-opaque foreign bodies, abnormal fluid and gas patterns, masses, and organ displacement or dilatation. Obstruction may be apparent on radiographs as ddilated loops of small intestine filled with gas, which may be very marked for complete obstruction but less obvious for very proximal or partial obstruction. Gastric dilation may be the only findings for a high intestinal obstruction. Definitive diagnosis of intestinal dilation is difficult; a study stated comparing small intestinal diameter to the height of the body of L5 at its narrowest point showed the upper limit for normal was 1.6x and that at >1.95 x there is a >80% chance of obstruction.

Radiographic findings of abdominal fluid include:

- Mottled appearance of organs
- Blurred borders between abdominal organs and intestinal loops
- Late: loss of abdominal detail, ‘ground-glass’ appearance
- Free peritoneal gas (normal after surgery)

Addition of positive contrast helps to delineate radiolucent foreign bodies, linear foreign bodies, intussusceptions and masses etc., but is typically only performed if ultrasound isn’t available as it takes longer to perform, may be difficult if animals are anorexic, and risk aspiration of contrast in a vomiting animal. Barium should not be given if there is any possibility of gastrointestinal rupture as barium is an adjuvant in peritonitis (i.e. it makes inflammation worse). Iodine solutions are safer than barium but have lower sensitivity for diagnosis. Positive contrast radiography may also be used to diagnose gastric outflow obstruction, identify mucosal lesions and demonstrate intestinal wall thickness.

Ultrasound is more useful in diagnosis of gastrointestinal disease than plain radiography and is easier to perform than contrast radiography, although it is operator and machine dependent. It will help to identify foreign bodies and masses, and is more helpful than radiography in identifying radiolucent foreign bodies. Partial obstruction may have intestinal changes similar to ileus or enteritis. Ultrasound is also useful for assessing motility, intestinal wall thickness and layering, and for assessing the extent of disease (how much intestine is involved, involvement of other organs etc.).

In a study of small and large intestinal adenocarcinomas, ultrasound showed poorly echogenic lesions with an irregular lumen, a thickened wall and loss of normal layering; most of the dogs had a lesion measuring 23 to 63 mm in length. Seventeen of 21 dogs had fluid accumulation proximal to the lesion, which was considered moderate to severe in 13. Many of these lesions would not have been apparent on radiography.

Abdominocentesis is indicted if there is abdominal fluid suspected from physical examination findings or confirmed with imaging. Abdominal fluid can be collected blind or with ultrasound guidance in patients with a high index of suspicion of haemoperitoneum, peritonitis, neoplasia etc. 5-6ml/kg fluid is needed to achieve a positive tap with a single blind tap having only 40% diagnostic accuracy and yielding fluid in only 20% dogs with fluid volume 3ml/kg up to 80% of dogs with 10ml/kg. Diagnostic yield can be improved with multiple taps or, more consistently, ultrasound guidance. Diagnostic peritoneal lavage was previously recommended frequently but has been largely superseded by ultrasound and I don't perform it. Fluid cytology should always be performed immediately in house and in cases of septic peritonitis will identify degenerate neutrophils that may contain intracellular bacteria. The presence of neutrophils in a post-operative abdomen can be difficult to interpret as they will always be present and often in large numbers. With septic peritonitis the neutrophils become more degenerate. Bacteria are not always present in animals that are on antibiotics. If it is not obvious if a pre- or post-operative patient has septic peritonitis, fluid biochemistry may be useful. Septic peritoneal effusions have high lactate, low glucose and low pH concentrations, especially when compared with serum concentrations (Lactate: fluid > serum; Glucose: fluid < serum). Further information can be obtained from the Tobias textbook on undertaking calculations.

↑ PCV	Blood
↑Bilirubin (>2 x serum) Golden-green granular pigment	Bile
↑Creatinine & potassium (> serum)	Urine
↑ Amylase & lipase (> serum)	Intestinal ischaemic injury Pancreatic inflammation

Endoscopy identifies lesions of the stomach, proximal small intestine and distal large intestine as long as the lesion is mucosal.

Stabilizing the Gastrointestinal Patient

Dehydration

Some owners present their pets after only one or two episodes of vomiting, or after known ingestion of a foreign body, in which case dehydration may not be present. However, if there is any history of vomiting, diarrhoea or reduced water intake, then some degree of dehydration is expected. Fluid losses into the gastrointestinal tract are due to increased secretions, reduced absorption and sequestration into dilated intestines, and these are permanently lost with vomiting/diarrhoea. Dehydration is the loss of fluid from all compartments in the body, with the largest component being extravascular (interstitial and intracellular), with physical examination findings including loss of skin turgor and dry mucous membranes. Poor pulse quality is not typically seen in early dehydration as there is not a large percentage reduction in vascular volume, but hypovolaemia becomes apparent in more severe dehydration. Clinical signs can be difficult to interpret, for example older animals may lose skin turgor and dry mucous membranes may becomes wet from hypersalivation secondary to nausea. Assessment of clinical signs is also subjective.

- History of losses but no clinical signs <5%
- 5% dry mucous membranes
- 7% + loss of skin turgor, mild tachycardia
- 10% + decreased pulse pressure
- 12% + hypoperfusion

Assessment of PCV and total protein is more objective – both are increase in the presence of dehydration, although a normal PCV and high total protein may be seen if there is anaemia and dehydration, but note that another differential for the latter is hyperglobulinaemia (relevant in cats, DDx FIP). Dehydration can be assessed by weighing an animal that has been weighed in the previous few days, or can be estimated based on volume of vomitus/diarrhoea and duration of reduced water intake.

In non-surgical patients, dehydration is usually collected over 24-48 hours. It is difficult to correct it more quickly as it takes time for increased vascular volume to redistribute into the extravascular space, and rapid expansion of intravascular fluid volume is excreted by the kidneys. Surgical patients require restoration of the intravascular volume prior to surgery (usually taking 2-4 hours), with the remainder of the dehydration corrected after surgery. Further information on correction of rehydration can be found in textbooks, but a brief summary is as follows:

Rehydration (% dehydration [expressed as /1.0] x weight/kg) + Maintenance (48ml/kg/24h) + Anticipated abnormal losses (fluid sequestration, V/D) (12-48ml/kg/24h)

e.g. 20kg dog 5% [0.05] dehydrated

(0.05 x 20) + (24 x 20) + (1 x 20) = 1.0 + 0.96 + 0.48 = 2.44l/ 24h = 100ml/h (over 24h)

Fluid choices:

Most dehydrated dogs are treated with isotonic fluids alone.

Gastric disease with outflow obstruction results in losses of water and hydrogen and chloride ions, leading to a hypochloraemic metabolic alkalosis. Normal saline (0.9% NaCl) is a good choice as it has high chloride and is acidifying. However it is too low in potassium so is usually supplemented. There is a maximum safe rate of potassium infusion of 0.5mEq/kg/h. The following chart shows the amount of potassium that should be added to a 1-litre bag of fluid depending upon serum potassium levels, and the maximum rate the fluid can be given at. Note that there is a lower safe rate for fluids with more potassium in. note that fluids with potassium supplementation should not be bloused or used for rapid intravascular expansion. It is better to have two fluid bags – one for potassium supplementation at a rate appropriate to correct serum hypokalaemia and the other with unsupplemented fluids used to correct dehydration or hypoperfusion.

Serum K = (mmol/l)	Total mEq KCL needed per 1litre 0.9% NaCl	Max rate (ml/kg/h) *
<2.0	80	6
2.0-2.5	60	8
2.5-3.0	40	12
3.0-3.5	28	18
3.5-5.5	20 (+ minimum needed for anorectic patients)	25

Small intestinal obstruction results in losses of water, potassium, sodium, hydrogen and chloride ions +/- pancreatic bicarbonate, resulting in a hypokalaemic, hyponatraemic, hypochloraemic metabolic acidosis. Due to the variations in acid-base and electrolyte derangements seen in different vomiting animals, the ideal fluid must be based on electrolyte analysis and cannot be stated in books. Typically Hartmann's (compound sodium lactate) is a good choice as it is the most physiologic fluid (containing sodium, chloride, calcium, and potassium) and it can correct metabolic acidosis, as lactate is a bicarbonate precursor. Lactated Ringer's is very similar and can be used as an alternative. Neither can be used with blood products as the calcium combines with citrate to form microthrombi.

Hypoperfusion

There are four categories/causes of hypoperfusion, all of which (except cardiogenic) can be caused by gastrointestinal disease:

- Hypovolaemia (decreased blood volume)

E.g.rapid fluid loss to another compartment e.g. GI tract (retained ingested fluids, upper GI secretions, failure of lower GI absorption, V/D), peritonitis (peritoneum)

E.g. blood loss

- Distributive abnormalities (decreased vascular tone)

E.g. sepsis, inflammation, infection

- Obstruction of venous return

E.g. GDV

- Cardiogenic (decreased cardiac output)

E.g. DCM, Ventricular tachycardia, etc

DOES NOT require fluid therapy

Hypoperfusion in individual causes can have more than one of the components above e.g. GDV can lead to hypovolaemic shock (sequestration of fluid into stomach, haemorrhage from avulsed short gastric veins), Distributive shock (inflammatory mediators) and obstructive shock (stomach compressing abdominal veins including caudal vena cava).

Hypoperfusion is not typical of animals with mild, uncomplicated gastrointestinal disease, but may be seen with marked vomiting, untreated dehydration, complete/proximal obstructions and septic peritonitis. Recognition and prompt treatment of hypoperfusion is important.

Clinical signs of hypoperfusion will vary depend upon the degree and timeframe. Early on the hypoperfusion is compensatory and the animal is able to compensate physiologically, later on there is decompensation.

	Early	Late
Mucous membranes	Injected	Pale
Pulse quality	Strong, short duration	Weak
CRT	Fast	Slow
Heart rate	Moderate tachycardia	Severe tachycardia Bradycardia
Temperature	Fever	Hypothermia

Cats are more likely than dogs to be bradycardic, hypothermic and depressed when they have hypoperfusion. Bradycardic cats should be investigated for signs of hypoperfusion, with measurement of temperature and blood pressure.

Fluid therapy is no longer a blanket treatment fits all (previously text books quoted a shock fluid rate of 90ml/kg/h dogs and 60ml/kg/h cats). It has been recognized that there is a spectrum of hypovolaemia and one size treatment doesn't fit all cases. Initial fluid boluses of 5-30ml/kg/h (based on physical examination findings) are given over 10 minutes and repeated until there is clinical response, usually up to 90ml/kg/h dogs and 60ml/kg/h cats. This is usually sufficient to establish normovolaemia, although very unstable patients, usually those with septic peritonitis, are hard to fully stabilise prior to surgery. Be careful to ensure that enough fluids have been given before assuming that the patient cannot be fully stablised, as survival is reduced in animals undergoing surgery in the face of hypoperfusion. Studies have shown that animals undergoing surgery for septic peritonitis can need very high fluid rates post-operatively (10-12ml/kg/h to maintain haemodynamic stability. Colloids can be added for animals that remain hypoperfused despite crystalloid fluid therapy (Dog 5-20ml/kg/d, cat 5-10ml/kg/d); other indications are development of oedema post-operatively. Blood products would be preferred, and are used in preference in people, but are unavailable in high enough quantities in companion animals, so we have to resort to colloid use. Plasma is indicated if there is coagulopathy. Although plasma is useful for treating hypoalbuminaemia (albumin concentrations below 15g/l, typically used at 10-15ml/kg), it requires high volumes not typically available to be effective, so human albumin can be used as an alternative. There is some evidence that blood transfusions can increase the risk of peritonitis and decrease intestinal healing, but the benefits of transfusion usually outweigh these risks.

Poor blood pressure is treated with drug therapy only when fluid volume is restored. Vasopressors are most effective when given with inotropes. Drug therapy is rarely needed in simple gastrointestinal surgery but may be needed in dogs with hypoperfusion due to complete obstructions for prolonged duration, GDV and septic peritonitis.

Drug class	Drug	Dose µg/ kg/ min
Positive inotropes	Dopamine	5-10
	Dobutamine	2-15
Vasopressors	Phenylephrine	1-3
	Noradrenaline	0.05 -1.0

Principles of Gastrointestinal Surgery

Antimicrobial Therapy

Definitions:

- Prophylactic antibiotics are administered *before* onset of infection or contamination. They are given if infection is likely to occur (clean-contaminated /contaminated surgery, any surgery >90 minutes) or if infection would be disastrous (typically if pre-existing implants e.g.pacemaker). They are not a substitute for aseptic technique/ good nursing.
- Therapeutic antibiotics are administered *after* infections established. Will be empiric (based on the most likely bacteria, pending culture results) or definitive (based on culture and sensitivity results).

Wound classification	Examples of GI surgery	Infection rates
Clean	None for GI surgery	5%
Clean -contaminated	GI surgery, no spillage, no infection	5%
Contaminated	GI surgery, with spillage Break in aseptic technique	12%
Dirty/infected	Infected or purulent tissues e.g. septic peritonitis	10%

A prophylactic antibiotic should be bactericidal, broad-spectrum and active against expected bacteria in the wound (typically Staphylococci and Streptococci spp [gram-positive aerobes] and Enterobacteriaceae [gram-negative, facultative anaerobes] from the gastrointestinal tract), and causing minimal side effects. Examples include the first- (or second-) cephalosprins or potentiated amoxicillin. Recent reports of allergic reactions to intravenous potentiated amoxicillin limit its current use. Note that these drugs are unlicensed.

Concentrations of antibiotic must be in tissues at the time of first incision. Tissue concentrations parallel serum concentrations due to high capillary permeability and reach their peak 30-60 minutes after intravenous administration. Non-intravenous administration is likely to take too long to reach minimum inhibitory concentration (MIC), or may never reach MIC, so will likely be ineffective. The role of the antibiotic is to kill any bacteria that contaminate the tissues as a result of the surgery. They are therefore stopped by the time the fibrin seal is formed (3-4 hours) although in most cases the last dose is given during surgery. Use of prophylactic antibiotics >24h after surgery will not reduce SSIs and may select for resistance. Repeat doses are given more often in surgery than when conscious, as the drug gets diluted by fluid and is important to keep time-dependent antibiotics above the MIC, and is typically repeated within 2 half lives – 2h for potentiated amoxicillin and 3-4h for cefuroxime,

Analgesia

Pre- & peri-operative multi-modal analgesia is advocated. Post-operatively analgesia drugs are given based on pain-scoring system (the short form of the Glasgow composite pain scale is popular, taking only a few minutes), often in conjunction with background analgesia at set times.

Simple cases typically are treated with opioids e.g. methadone, +/- fentanyl CRI if additional analgesia needed during surgery. Some anaesthetists recommend lower doses of methadone in recovery; others change to buprenorphine as the animal becomes more comfortable. Many anaesthetists and surgeons are reluctant to use pre- or peri-operative NSAIDs as they are contraindicated in hypovolaemic/ dehydrated patients, but they can be given on recovery. There has often been reluctance to use NSAIDs with any gastrointestinal surgery – they are contraindicated if there is gastrointestinal ulceration, but this is often not present and I usually have prescribed NSAIDs by the day after surgery. Note that each case must be assessed individually for NSAID suitability. Paracetamol can be used for peri- and post-operative use in dogs only (not in cats due to toxicity) without hepatic disease. Note that a licensed product (Pardale-V) is available and the ascade should be followed.

Lidocaine is not usually needed in uncomplicated cases, but is useful in more critical patients as a CRI, as it reduces the amount of gaseous anaesthetic needed, is very effective for visceral pain, improves gastrointestinal function (prokinetic) and can reduce arrhythmia formation. It can also be used in epidural analgesia and as local wound blocks. Ketamine can also be used as a CRI but is more effective with neurogenic than visceral pain.

Check lists

Check lists will reduce mistakes and complications, and are recommended prior to every procedure. A template is available from the AHT.

https://www.aht.org.uk/skins/Default/pdfs/theatre_checklist_june_09.pdf

Aseptic Technique

The patient, surgeon and atmosphere are potential sources of contamination that are most difficult to control. Contamination from instruments and equipment is unlikely if good sterilization and storage are undertaken. More information is available in surgical textbooks.

Patient preparation:

- Hair is the most common location of bacteria. Clipping is outside of theatre to avoid hair contaminating the theatre and must be very wide to avoid potential contamination. The clip should be at least 10cm (20cm if possible) cranial to the xiphoid and caudal to the pubis to allow a complete laparotomy if needed.
- Initial scrub in the prep room removes hair, debris, oil and transient bacteria.
- Final scrub in theatre.

Surgeon preparation:

- Appropriate theatre uniform
- Hair covered (large source of bacteria)
- Mask (to catch droplets from talking, sneezing etc.)

Draping:

- Fenestrated drape *or* 4-drapes
- Waterproof drapes *or* cotton drapes covered with impermeable drape

Useful instruments:

- Abdominal retractors
- Lavage fluids and suction
- Swabs with radio-opaque markers, including large laparotomy swabs
    - Check list – count swabs in and out

Avoiding contamination at surgery:

It is important to avoid spilling intestinal contents, as this will increase the risk of post-operative infection. Risks are higher following spillage of colonic contents and faeces.

- Exteriorise gastrointestinal site if possible e.g. jejunum can be operated on lateral to the abdominal wound outside the peritoneum. It is not possible to exteriorise the stomach, proximal duodenum or descending colon.
- Place multiple (3-4) layers of soaked laparotomy swabs deep to and around surgical site – remove and replace if contaminated during the procedure to decrease the risk of abdominal contamination.
- Where possible, stay sutures are placed in the stomach (full thickness cruciate pattern to avoid pullout) to allow mobilization, to increase exposure and reduce spillage during gastric surgery.
- Before making an incision, intestinal contents are milked away from the incision site.
- Use Doyen bowel clamps or an assistant's fingers on small and large intestine to avoid spillage. When clamping of the intestines is needed, an assistant can grasp the tissue between index and middle fingers. While it I the least traumatic technique, it may cause some leakage of intestinal contents after the incision is made, therefore it is more suitable to biopsy/enterotomy than enterectomy. When atraumatic intestinal forceps are applied the intestine is placed at the tip of the clamp and the clamps are closed to one 'click'. Crushing forceps are only placed on tissues that are to be resected.

- After surgery, gloves, drapes and instruments are changed before closure, to minimize contamination of other tissues. Local irrigation of the incision site and general abdominal lavage prior to abdominal closure will dilute contamination. It is important to utilise suction to remove all lavage fluids, as cells of the immune system cannot move across fluid. Fluid also dilutes immune cells and opsonins. Lavage should not be excessive as proteins are removed with the lavage fluid.

Tissue handling:

If intestines are manually retracted, they are first covered with a moistened swab. If instruments are used for tissue handling, they should be designed for use on abdominal organs e.g. DeBakey tissue forceps. Toothed forceps should never be used on gastrointestinal tissues.

Assessing Tissue Viability

Ischaemic necrosis may occur secondary to dilatation, obstruction or strangulation. It may be difficult at surgery to assess whether intestines will recover from ischaemic injury. Following a period of obstruction or dilatation, the gastrointestinal wall may be swollen and oedematous and have suffered intramural haemorrhage, which may make it appear non-viable. It is worth re-assessing the tissue 10-15 minutes after derotation of volvulus or removing foreign bodies. There may be obvious necrosis with a thin black-purple wall and a clear line of demarcation between viable and non-viable tissue, but signs of ischaemia are subtler. Assessments should be made of colour, thickness of tissue on palpation, texture, peristalsis, vessel pulsation or bleeding of the cut surface. It has been shown that clinical assessment of viability does not always correlate with histopathological evidence of ischaemia and necrosis. If in doubt, it is safer to assume tissue is necrotic and resect it, than leave necrotic tissue in situ, unless the entire intestinal tract is affected.

Objective measures of tissue necrosis, e.g. fluorescin and pulse oximetry, may not be more accurate than subjective assessments, are rarely available and have not been clinically assessed.

Sutures and Staples

Synthetic materials are broken down by hydrolysis and have a predictable initial tensile strength and loss of strength over time. There is no place for catgut in gastrointestinal surgery – breakdown by phagocytosis is unpredictable, especially in an inflammatory environment, and swelling when wet results in poor knot security. Monofilament sutures are preferred over multifilament sutures – they have less tissue drag, create less inflammation and potentiate infection less when used in contaminated tissues. Non-absorbable sutures are rarely indicated, and are avoided in full thickness or mucosal gastric sutures as they may result in ulcer formation.

The ideal suture material has a similar tensile strength to the tissue it is used in and loses tensile strength at the same rate that the tissue gains tensile strength. For gastrointestinal surgery, the suture needs to maintain adequate tensile strength for 20 days e.g. PDS. Suture should be 1.5 or 2 metric (3/0 or 4/0) – the smaller sutures are preferred.

Needles should be swaged on rather than eyed. Taper or tapercut needles are preferred for gastric sutures as they are easier to pass through the submucosa than round-bodied needles. Round bodied or tapercut needles are preferred for small and large intestines.

An appositional suture incorporating all stomach layers can be performed, starting and ending in normal tissue just beyond the incision. An alternative is to do a 2-layer closure (an appositional mucosa/submucosal suture then an appositional or inverting suture in the serosa/muscular layers) as the mucosa and submucosa are well differentiated from the other layers.

For small and large intestines, an appositional pattern is preferred as it causes less intestinal lumen narrowing than inverting patterns, and less adhesions than everting patterns. However, histological studies of appositional sutures showed that 2/3 of simple interrupted sutures were everted, and 1/3 of continuous sutures were inverted, everted or misaligned. Simple interrupted sutures cause less intestinal narrowing and are more secure than a continuous pattern, and it is easier to adjust tension and the distance between sutures. Continuous patterns are less strong than interrupted sutures, but they do provide enough strength for intestinal repair. They are quicker to place, provide a better watertight seal and leave less foreign material at the surgical site. Care must be taken to avoid excess tension, which may lead to inversion or eversion. If a continuous pattern is used in the intestine, 2 separate suture lines are used, beginning at the mesenteric and anti-mesenteric borders.

The mucosal layer is a barrier between the intestinal tract and the peritoneal cavity, and does not need to be included in the suture line, although it may be easier to include it to ensure that the submucosa, which provides mechanical strength, is included. The modified Gambee doesn't penetrate the mucosa and exits between the submucosa and mucosal layers of the intestine. The muscularis and serosa are included in the suture line as they ensure normal motility and a seal.

Staples can be used to perform a wide number of procedures in small animal surgery, particularly of the gastrointestinal tract, including vessel ligation, and resection and anastomosis. Staples are used to decrease surgical and anaesthesia time, blood loss, tissue manipulation and contamination of the peritoneal cavity. A stapled intestinal anastomosis has greater bursting pressures in the lag phase of healing and more tensile strength at 7 days than a sutured anastomosis. Healing is by primary intention with less inflammation, necrosis and oedema than suturing, so wound strength is greater in the first few weeks of healing. However, they have the disadvantage of limited availability and increased cost.

Suture Line Reinforcement

The omentum can provide surgery sites with a good blood supply, as well as promoting lymphatic draining and controlling infection. It adheres to surgical sites and areas of inflammation, but it is wise to wrap the surgical site in omentum, where it can be held in place with simple interrupted sutures as necessary. Experimental studies have shown that omentum can revascularise areas of intestinal ischaemia and prevent perforation.

Serosal patching is more secure then omental patching but is rarely needed. It may be used to reinforce intestinal suture lines and can even seal infected perforations. The anti-mesenteric borders of healthy jejunum are sutured either side of the suture line in question. Multiple patches may be necessary.

Post-Operative Care

Goals:

- Manage analgesia
- Correct persistent and ongoing fluid losses
- Support nutrition
- Medical treatment of underlying disease
- Prevent/manage complications

Most simple gastrointestinal cases have a good recovery. Animals with simple foreign body removal are expected to have normal fluid, electrolyte and acid-base status soon after surgery, eat voluntarily and can go home within 12-24 hours of surgery. Complication rates are low.

Animals with more complicated intestinal obstruction, GDV or peritonitis can remain critically ill overnight or for a number of days. Their management will vary based on clinical examination findings and cannot be easily summarized. Regular physical examinations should be performed and these patients should not be left alone for log periods as they can destabilize rapidly, therefore overnight monitoring is important.

Physical examination parameters to assess, at least twice daily but more often if the patient is more critical, include: temperature; pulse rate and quality, pulse deficits; respiratory rate and effort; mucous membrane colour and moistness, capillary refill time. Blood pressure, pulse oximetry and ECG can be monitored. A urinary catheter can be placed to assess urine output and urine specific gravity, to ensure fluid therapy is appropriate, and is helpful for nursing recumbent dogs. Electrolytes and albumin as a minimum database are measured daily in critical patients; other blood tests may be indicated. Further information about managing critical patients is outside the scope of this lecture – more information is available in textbooks.

Nutrition

Most animals undergoing simple gastrointestinal surgery have not had a period of anorexia and will eat normally. In these cases, feeding tubes are not needed, but oesophagostomy tubes can be placed later if an animal does not eat or deteriorates clinically. Most animals will eat normally post-operatively. It is important to encourage enteral nutrition to improve gastrointestinal healing.

For those animals where there has been a period in inappetance and there are concerns that the animal may not eat post-operatively, placement of an oesophagostomy tube is usually the easiest way to manage them. Gastrostomy tube is needed less often (if there is oesophageal disease) and jejunostomy tube rarely (if gastric feeding cannot be performed). MILA make an oesophagostomy tube that is easier to place, although the introducer is less stable than forceps and can be hard to place in fat dogs.

https://www.youtube.com/watch?v=qF14Jfajkhw&feature=youtu.be