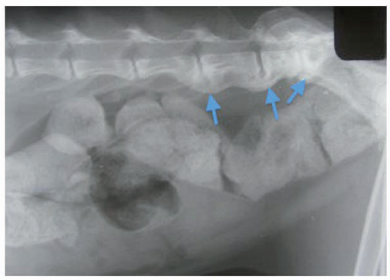
VETERINARY focus

Special edition

The worldwide journal for the companion animal veterinarian



Constipation in the Cat: Thinking Outside the Gut

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USA / CANADA

ROYAL CANIN

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Foreword

Cats are among the world's most popular pets. They are affectionate, playful, entertaining and self-cleaning, making them well-suited for indoor living as companion animals. One of the greatest achievements in the history of pets has to be the invention of the litter box. Outdoor, feral cats tend to use multiple large areas of sand, dirt or grass to eliminate, but indoor cats are mostly comfortable with small litter trays kept in the same spot.

Because owners have daily knowledge of their cat's litter box habits, they are often quick to notice when problems arise. Straining or vocalizing in the litter box, reduced size or number of stools or associated conditions such as lethargy and reduced appetite will lead owners to seek veterinary advice.

Information about the etiology, pathophysiology, clinical signs and complications, diagnostic testing, differentials, treatment options, expected outcomes and prognosis of feline constipation has been scattered throughout veterinary textbooks and investigational literature. Because of the importance of this condition, which can result in significant morbidity and mortality, Royal Canin decided to bring together a team of experienced veterinary specialists who are passionate about cats and their unique problems. The authors have diverse backgrounds in fields such as gastroenterology, soft tissue surgery, pharmacology, nutrition, behavior and feline practice and have collaborated to provide a comprehensive overview of the topic of constipation, including the most up-to-date results from research and clinical studies.

This special edition of Veterinary Focus is intended for veterinarians who share our commitment to promoting the best possible healthcare for feline patients who depend on us. We hope you will find the information useful and clinically applicable, and we welcome your questions and comments.

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Section One/ Feline constipation in context

1. The constipated cat: An overview

> SUMMARY

- Constipation is a clinical sign that has numerous contributing factors, including dehydration, which plays a key role in etiology and effective therapy.
- Constipation can be a result of pain associated with defecation, a behavioral disinclination to defecate, mechanical or functional obstruction and some metabolic diseases.
- The occasional bout of constipation is not a problem, but chronic constipation may progress to colonic dysfunction (obstipation) and potentially megacolon.

Introduction

The frequency of defecation and the consistency of feces are determined in the colon. Constipation is an acute or chronic condition in which the frequency of bowel movements decreases, relative to normal for the individual cat, and hard, dry, small stools are passed with difficulty and discomfort. Like other clinical signs, such as vomiting or diarrhea, the underlying cause(s) and concurrent medical, behavioral and environmental problems should be addressed with the presenting complaint.

The occasional bout of constipation, although uncomfortable, does not necessarily progress and does not imply a loss of colonic function. Prolonged and intractable constipation results in the impaction of stool, referred to as obstipation, which is refractory to cure because a permanent loss of colonic neuromuscular function has developed. Recurring episodes of constipation or obstipation may result in distension of the colon, or megacolon. The absence of an identifiable cause is referred to as idiopathic megacolon, which is characterized by the lack of normal neuromuscular function despite normal ganglionic innervation.

Potential progression from constipation to megacolon

1/ What causes constipation?

Constipation is common in cats. Although concrete data are lacking, elderly and dehydrated cats appear to be especially predisposed. Most frequently, constipation is a sign of inadequate cellular water. Water is obtained by drinking, from water in food and as a product of metabolism. Additionally, water is resorbed by the renal tubules in response to dehydration. Once that ability has been maximized, water is reclaimed from colonic contents resulting in constipation.

There are, however, other causes for constipation **(Table 1)**. Pain associated with the act of defecation can result in

Table 1. Causes of constipation/obstipation.

Mechanism or process	Causes
Dehydration: Increased water loss	Polyuria (chronic kidney disease [CKD], diabetes mellitus, hyperthyroidism) Vomiting, diarrhea Drugs (diuretics)
Dehydration: Decreased water intake	Inadequate access to fresh water, behavioral (anxiety due to social stress, hospitalization, change in environment) Painful drinking/eating: oral pain, abdominal pain Impaired ability to reach water (degenerative joint disease [DJD], neoplasia, trauma, etc.)
Behavioral disinclination	Soiled litter box, change in litter substrate, litter box ambush, social stress, hospitalization, inadequate number or placement of boxes, inadequate size of litter box
Painful defecation	Proctitis, anal sac disease, prostatic disease, degenerative joint disease, orthopedic disease
Physical obstruction	
• Intraluminal	Neoplasia, polyp, stricture, foreign body (bones, hair, cat litter, plants)
• Mural	Intussusception, rectal diverticulum, perineal hernia, thickened colonic wall (neoplasia, inflammation)
• Extra-intestinal	Compressive mass, pelvic fracture, congenital anorectal disorders (e.g., atresia ani), prostatic disease (hypertrophy, cyst, abscess), anal gland disease
Functional obstruction	Idiopathic megacolon Inflammation-induced ileus
• Neuromuscular disease	Manx sacrocaudal deformity, dysautonomia
• Spinal cord disease	Neoplasia, feline infectious peritonitis (FIP), sacrocaudal spinal trauma (e.g., tail-pull injury)
• Electrolyte imbalance	Hypercalcemia, hypocalcemia, hypomagnesemia
• Drugs	Opioids, barium, phenothiazines, anticholinergics, antihistamines, antacids, iron, sucralfate, vincristine
Metabolic disease	Obesity, hypothyroidism

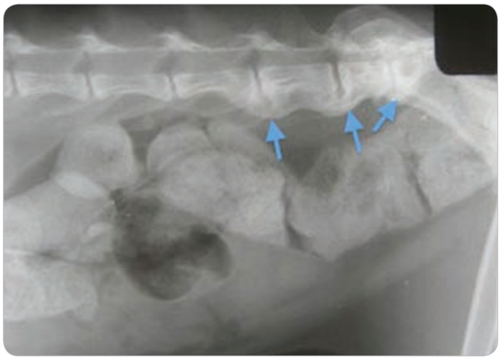

Figure 1. Spondylosis of the caudal lumbar vertebrae and degeneration of the lumbosacral joint may contribute to stiffness and painful defecation resulting in obstipation. Arrowheads indicate boney lesions on L5-6, L6-7 and L7-S1.

less frequent bowel movements. Getting to the litter box may be painful if mobility is restricted by muscle, joint or lumbosacral discomfort **(Figure 1)**. Abdominal pain or pain in another area may interfere with a cat's desire to move or may directly interfere with the passage of feces. This may be due to mechanical or functional factors that are (1) within the lumen or wall of the bowel, (2) external to the bowel or (3) associated with inflammation causing spasm or ileus. Pain from headache as well as pain associated with the urinary tract (including kidneys and ureters), rectum or anal glands should be considered.

Age-related senescence causing a decrease in normal intestinal motility is recognized in humans; whether this occurs in cats is unknown. At any age, a dirty litter box, a box that is too small or environmental and social stress may result in constipation caused by decreased desirability or accessibility of the litter box.

Given this spectrum of causes and contributing factors, it is clear that we need to be ready to ask appropriate questions, look for constipation and then think beyond laxatives and dietary fiber as the only therapies. The purpose of this issue of *Veterinary Focus* is to highlight all aspects of addressing this clinical problem. Contents include the following:

- Pathophysiologic mechanisms and etiologies to consider
- Pertinent history questions to ask and physical examination findings to look for
- Appropriate diagnostic procedures to consider
- Supportive therapy based on clinical complaint
- Targeted therapy based on diagnostic findings
- Household management checklist for the client
- Answers to frequently asked questions (FAQs)

There is a limited amount of validated information at this time regarding constipation, specifically in cats. This issue covers what is known and extrapolated between species when feline data are not available.

2. Obtaining the medical history

> SUMMARY

- Information regarding overall history should include signalment, body and muscle condition, percentage change in weight since previous visit, previous medical problems, concurrent problems and dietary history.
- Clients may misinterpret straining as constipation when the problem is in the lower urinary tract. Similarly, their concern may be vomiting that occurs secondary to constipation.
- The duration of constipation and character of the stool, the cat's posture and location of bowel movements are important.
- Specific questions regarding constipation focus on the patient, the household, toileting, diet and water intake.

Introduction

Beyond the basic signalment (age, breed, sex), it is helpful to know whether the cat is housed strictly indoors, outdoors or has access to both. Clients may misinterpret straining as constipation when the problem is in the lower urinary tract. Similarly, their concern may be vomiting that occurs secondary to constipation. Listening closely to the client's description and coaxing more details regarding timing and posture are very important.

The duration of constipation, as well as the stool consistency **(Figure 1)**, color, frequency and odor, and whether the problem has been intermittent or persistent must be determined. If this is not the first episode, the effect of previously used therapies (e.g., medications, supplements, homeopathic remedies, fluids, etc.) needs to be known. Additionally, a dietary history (what diets the cat has been offered and been willing to eat, as well as other food that he/she has had access to, treats and supplements) should be obtained. Other diets that have been offered but refused by the cat should be noted. The checklist on page 13 includes questions suitable for the general history, and those questions specific for constipation are listed in the following box.

Previous medical history should be reviewed for causative

Text continued on page 16

Fecal scoring system for cats

DIRECTIONS FOR USE

Score the stools of each cat individually from 1 (liquid) to 5 (formed and dry).

When the consistency of the stools of one cat is not homogeneous, record the lowest score.

Figure 1. Fecal consistency scoring tool.

General history checklist

- Current age?
- How old was she/he at adoption?
- Breed?
- Intact M (male), NM (neutered male), F (female), SF (spayed female)?
- Housing: Indoors only? Indoors with access to other animals? Indoors and outdoors? Outdoors only?
- Weight?
- Body condition score (1-5 or 1-9)?
- Muscle condition (well muscled, adequate, wasting)?
- Percentage weight change from last visit?
  $\frac{\text{(previous weight – current weight)}}{\text{previous weight}} \times 100$
- Blood pressure?
- Previous medical history (any traumatic injury that could affect pelvic integrity or neurologic function)?
- Ongoing concurrent problems other than constipation?
  - o Vomiting? Frequency, timing relative to eating?
  - o Changes in appetite, frequency or manner of eating?
  - o Intermittent passage of small amounts of semi-formed stool?
  - o Muscle weakness or incoordination?
  - o Documented electrolyte abnormalities (hyperglycemia or hypoglycemia, hypercalcemia, hypokalemia or hypomagnesemia)?
  - o Increased volume or frequency of urine?
  - o Any difficulties climbing up or down? Jumping up or down?
  - o Increased or decreased activity and/or energy level?
- Duration of constipation?
- Frequency of constipation: persistent or intermittent?
- Previous management methods and the effect of the following:
  - o Diet?
  - o Fluid therapy?
  - o Supplements?
  - o Medications (doses, durations)?
- Diet and duration on diet; treats, supplements; frequency of feeding, amount?
- Appetite (severely decreased, mildly decreased, normal, mildly increased, severely increased)?
- Home environment: Multiple cats, when was each one adopted, apparent relationship, other pets?
  - o Any stress between cat and other household members?
  - o Location and number of resources (water, food bowls, litter boxes)?
  - o Has there been a change in the location or type of each resource (bowl, fountain, covered vs. open litter box, litter type, etc.)?

Questions Relevant to Constipation

Patient

- How many bowel movements does the cat have per day?
- Would you describe the feces as hard pellets, moist logs, cow-pie or colored water?
- Does the stool have an abnormal odor?
- Is the color of the feces unusual?
- Are the bowel movements ever outside of the litter box (i.e., in inappropriate locations)?
- Is the cat declawed?
- Does the cat show hesitation when climbing or jumping up? Climbing or jumping down?
- Have you noticed any change in how the cat positions himself/herself in the box? Is his/her back arched when he/she has a bowel movement? (See **Figures 2** and **3**.)
- Does the cat cry when using the box?
- Is there anything that makes you think your cat might dislike using the litter box or is fearful of the litter box (e.g., stand on the rim of the box rather than get inside and dig in the litter)?
- Does he/she exit the box casually or in a hurry?
- Is there a possibility for a loud and startling noise to occur (such as from a washing machine or heater) unexpectedly?
- Does the cat cover the urine/feces after going to the bathroom?

Figure 2. Normal posture of a defecating cat. Note the curved spine.

Figure 3. Posture of a cat with pain in the lower spine or coxofemoral region or one that is voiding. Note the flatter spine.

Household

- Does anyone (another cat, a dog or child) stalk or ambush the patient when he/she is using the litter box?
- Are there other pets in the household? How many cats? Other pets?
- Does the cat seem intimidated by the other cats about its use of the litter box?
- How do the cats seem to get along?
- Do other pets/animals come into the house?
- Are you aware of any stress between this cat and other household members?

Litter box

- Is the litter box open or hooded?
- Where is the box located?
- How often is the litter box scooped?
- How many litter boxes does the cat have access to?
- Has any other cat in your family had diarrhea or urinary tract disease recently?
- Has the type of litter been changed?

Diet

- What diet is the cat eating?
- Do you feed the cat raw food? A bones and raw food (BARF) diet? A high-fiber diet?
- Do you give the cat any treats?
- Do you give the cat any supplements?

Water

- How many water bowls does this cat have access to?
- Do the cat's whiskers touch the edges of the water bowls **(Figure 4)** or are the bowls wide **(Figure 5)**?
- How often are the bowls washed and how often is the water changed?

Figure 4. The cat's whiskers have to be held away from the edges of a bowl that is too narrow.

Figure 5. The cat's whiskers are not touching the edges of the vessel.

or complicating factors (e.g., traumatic injury that could have affected pelvic structure or neurologic function, arthritis, hypokalemia, diabetes or hyperthyroidism resulting in weakness). Ascertaining the frequency and volume of urination will help rule out concurrent lower genitourinary disease.

Since it has become apparent how common degenerative joint disease (DJD) is in cats and as mobility and flexibility may play roles in constipation, questions regarding movement should be asked. Decreased range of movement and pain in the shoulders or elbows may be indicated by hesitation in climbing or jumping down, whereas restricted upward jumping/climbing suggests problems in the stifles, hips and hocks. A cat may still achieve his/her goal, but it may require multiple attempts or an intermediary step part way up or down. Changes in posturing, such as hesitant sitting or a less flexible spine (either more or less curved), may be a result of vertebral spondylosis deformans (see Figure 1 in Chapter 1, page 9). This may manifest itself in cats defecating or urinating adjacent to the litter box despite standing inside it.

What is often interpreted as "normal" age-related "slowing down" may be reversible or treatable pain or weakness caused by dehydration, hypokalemia or arthritic or other pain (see Figure 3 on page 14).

Questions regarding the household environment may be key to understanding the cause of the problem. The number and locations of resources (litter boxes, food and water bowls, perches and beds) are especially important when the possibility of social stress (as perceived by the cat) exists.

Information regarding toileting (i.e., the use, type and cleanliness of litter boxes/latrines) provides essential information because constipation may be a result of a lack of willingness to use a dirty, smelly litter box or one in which the cat has experienced pain or fear. A cat balancing on the rim of the box **(Figure 6)** or failing to cover feces may be a sign of dislike of the type of litter or of paw pain (e.g., after being declawed or from nail bed infection).

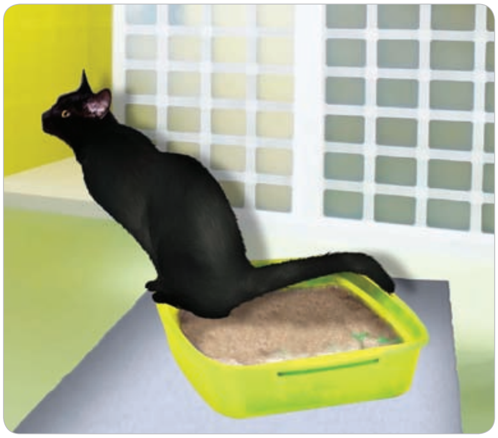

Figure 6. A cat may balance on the rim of the litter box rather than stand on litter if the litter substrate is unpleasant or if he/she associates pain (e.g., onychectomy) or fear (e.g., sound of baking soda in litter) with it.

3. Physical examination

> SUMMARY

- Beyond abdominal palpation of a firm tubular mass, assessment of hydration, neurologic status and anorectal abnormalities must be performed.
- Orthopedic discomfort may result in constipation, thus the musculoskeletal system should be evaluated.

Introduction

Physical examination of the constipated cat should initially focus on assessing the hydration status and the severity of colonic distension and impaction. More focused examination to determine the underlying etiology should center on neurologic, orthopedic, perineal and rectal examination. Assessment of patient hydration is subjective and should be combined with objective indicators, such as packed cell volume/total solids (PCV/TS), to optimize accuracy. It is important to recognize that interstitial dehydration may be present in the absence of physical examination abnormalities. Dehydration may not be recognized on physical examination until approximately 5% of the normal interstitial fluid is lost, at which point a minimal loss of skin elasticity and somewhat dry mucous membranes may be noted **(Table 1)**. A complete physical examination may give clues to common underlying causes of dehydration in cats. Examples include small or irregular kidneys with chronic kidney disease (CKD), a dull or greasy coat with diabetes mellitus or a palpable thyroid nodule with hyperthyroidism.

Table 1. Assessment of hydration deficit.

Degree of deficit*	Physical examination findings
Mild: ~5%	Slightly tacky mucous membranes, minimal loss of skin turgor, normal eye position
Moderate: ~8%	Dry mucous membranes, moderate loss of skin turgor, mildly sunken eyes
Severe: >10%	Extremely dry mucous membranes, skin does not return to original position when tented, severely sunken eyes, weak thready pulses, tachycardia, hypotension, altered level of consciousness

*Degree of dehydration is an estimate of the deficit relative to euhydration. From AAHA/AAFP Fluid therapy guidelines for dogs and cats.

Other components of a general comprehensive physical examination that should be included in evaluating a constipated cat include the following:

- Body weight
- Body condition score (1-5 or 1-9)
- Muscle condition (well-muscled, adequate, wasting)
- Percentage weight change from last visit

  $$\frac{(\text{previous weight} - \text{current weight}) \times 100}{\text{previous weight}}$$
- Blood pressure

The presence and severity of colonic impaction can be subjectively assessed by abdominal palpation in most patients, although it may not be possible in obese patients. The degree of colonic distension and the characteristics of the stool (soft vs. firm vs. rock-hard) will help guide strategies for evacuation of fecal matter. Abdominal palpation may also reveal lesions causing mechanical obstruction cranial to the pelvic inlet such as a mass or foreign body.

Orthopedic pain may prevent a cat from defecating normally, thereby leading to constipation. Cats with degenerative joint disease (DJD), particularly those with affected hind limb joints, and those with intervertebral disk disease (notably lumbar and lumbosacral, including but not restricted to spondylosis deformans) may be hesitant to defecate due to pain associated with their orthopedic condition. The veterinarian should be cognizant of these conditions during the orthopedic examination **(Figure 1)**. The most commonly described orthopedic disease leading to megacolon is pelvic fracture causing a narrowed pelvic canal. Orthopedic examination findings in cats with pelvic fracture may include pain on palpation of the hips and pelvis. Many cats with pelvic fractures have concurrent abnormalities due to the force of trauma required to fracture the pelvis, such as sacral fracture, coxofemoral luxation or femoral fracture (Bookbinder, 1992). Other signs of trauma, such as contusions, are often absent because they have resolved by the time the cat is presented for constipation.

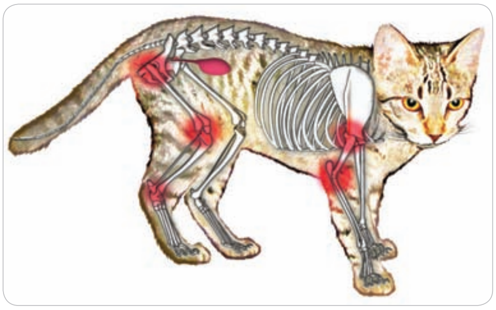

Figure 1. The appendicular joints most affected by degenerative changes resulting in pain are shown in red.

A complete neurologic examination should be performed in all constipated cats. The neurologic control of defecation is described in Chapter 4. Spinal cord lesions in the sacral segments (and possibly caudal lumbar) may lead to fecal retention and progressive constipation. Manx cats with sacrocaudal dysgenesis have been reported to develop megacolon (Deforest, 1979; Washabau, 1997). Cats with this syndrome may show paraparesis, pelvic limb ataxia with hyporeflexia, urinary incontinence, decreased anal sphincter tone and reflexes or altered nociceptive responses in the perineal area and possibly pelvic limbs (Westworth, 2010). Similar neurologic examination findings are present in cats with other etiologies of sacral spinal cord disease. Various disturbances in the autonomic nervous system may be present in cats with dysautonomia. These can include urinary retention, regurgitation (secondary to megaesophagus), decreased tear production, protrusion of the nictitating membrane, mydriasis and bradycardia (Dickinson, 2004).

Any cat with recurrent constipation or obstipation should have perineal and digital rectal examination performed. Rectal examination should be performed under sedation or anesthesia, although assessment of anal tone should be performed prior to sedation. Perineal examination allows evaluation of perineal reflexes, external masses, wounds or fistulae. Rectal examination should focus on finding causes of mechanical obstruction such as intraluminal or extraluminal masses, strictures, rectal diverticulum, narrowed pelvic canal secondary to previous fracture or prostatic enlargement. Anal sacs may be evaluated for masses or abscesses. Gentle pressure applied to the epaxial muscles allows for the assessment of lumbosacral pain in the lightly sedated animal. Perineal hernias may be a cause of constipation, although these are more likely to be the result of chronic tenesmus.

4. Anatomy, physiology and function of the colon

> SUMMARY

- The main functions of the colon are to absorb water and electrolytes and to control defecation.
- These functions require complex and coordinated neuromuscular function resulting in appropriate motility.
- In addition, the colon is a source of short-chain fatty acids (SCFAs) that are important for providing energy to the colonocytes, promoting a healthy microbiota and supporting the main functions of the colon.

1/ Anatomy of the colon

The feline large intestine includes the cecum, colon, rectum and anal canal. The colon is divided into the following: ascending colon on the right side of the body from the ileocecocolic junction to the right colic flexure, the transverse colon coursing cranial to the root of the mesentery at about the level of the twelfth thoracic vertebra from the right colic flexure to the left colic flexure and the descending colon from the left colic flexure to the pelvic inlet.

The wall of the colon is composed of a luminal mucosal layer, submucosa, muscularis and serosa **(Figure 1)**. The colonic mucosa differs from the small intestinal mucosa in that it lacks villi, has fewer microvilli and endocrine cells, contains more goblet cells and has slower crypt to epithelial cellular turnover than small intestinal mucosa (Washabau, 2013a, 2013b). The submucosa contains many blood vessels and lymphatic vessels, in addition to the nerves and ganglia of the submucosal plexus (Meissner's plexus). The muscularis is composed of an inner circular smooth muscle layer and an outer longitudinal smooth muscle layer. The nerves and ganglia of the myenteric plexus (Auerbach's plexus) lie between the circular and longitudinal muscle layers.

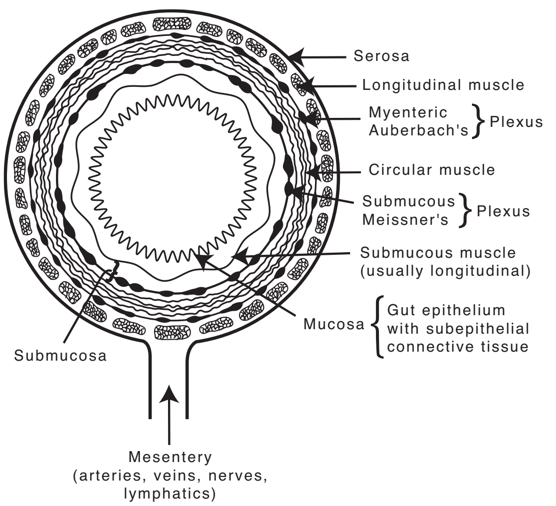

Figure 1. The wall of the colon.

A) Normal physiology: Innervation

The gastrointestinal tract (GIT) is innervated by an autonomic nervous system that controls contractility, secretion and endocrine functions. The extrinsic component responds to neurohumoral endocrine signals, the intrinsic component to both the extrinsic system and internal signals. Integrated responses to internal and external signals involve more than 10 different receptor types or subtypes located on smooth muscle, epithelial, endocrine or other cells and their respective inhibitory or stimulatory chemical signals. Receptors commonly are targets of drugs intended to alter GIT motility and secretion **(Table 1)**.

B) Normal physiology: Motility

Motility in the normal colon relies more heavily on extrinsic rather than intrinsic activity. Water is removed in the proximal colon; segmentation mixes luminal contents, exposing them to the absorptive mucosa.

Motility patterns in the normal colon consist of four main types of contractile responses: tone, rhythmic phasic contractions (RPCs), retrograde giant contractions (RGCs) and giant migrating contractions (GMCs). These contractile responses are mediated by two types of electrical activity: slow wave activity, which is undulating change in the resting membrane potential mediated by pacemaker cells, and migrating spike bursts, which are action potentials that initiate strong muscle contractions. Different motility patterns occur in different parts of the colon, which aid in their respective functions.

- In the proximal colon, electrical slow wave frequency is slower and RPCs are less frequent. RPCs allow mixing and slow distal propulsion of digesta to allow increased time for absorption. RGCs also occur in the proximal colon to propel digesta cranially, resulting in additional mixing and time for absorption.
- Motility in the distal colon consists primarily of migrating spike bursts, which create GMCs. GMCs are strong contractions that move fecal matter toward the rectum to evacuate the colon. These are also referred to as mass movements (Washabau, 2013a, 2013b).

The normal act of defecation involves interactions between peripheral pressure receptors, the enteric and extrinsic nervous system, spinal cord, brainstem and muscles of the large intestine and anal sphincter. The colon responds to two reflexes: (1) the gastroduodenal

Table 1. Innervation of the colon.

Component	Composed of	Role
Intrinsic = "enteric nervous system"	Submucosal and myenteric plexus	Controls blood flow, secretion and motility
Extrinsic = "autonomic nervous system"	• Parasympathetic to cranial colon = vagus; transverse, descending colon and rectum = pelvic nerves (sacral spinal segments) • Sympathetic = paravertebral sympathetic trunk **(Figure 2)** via abdominal ganglia	• Contract colon smooth muscle and relax internal anal sphincter • Relax colon smooth muscle and contract internal anal sphincter
Somatic	Pudendal nerve (sacral spinal segments)	External anal sphincter, reflex and voluntary control

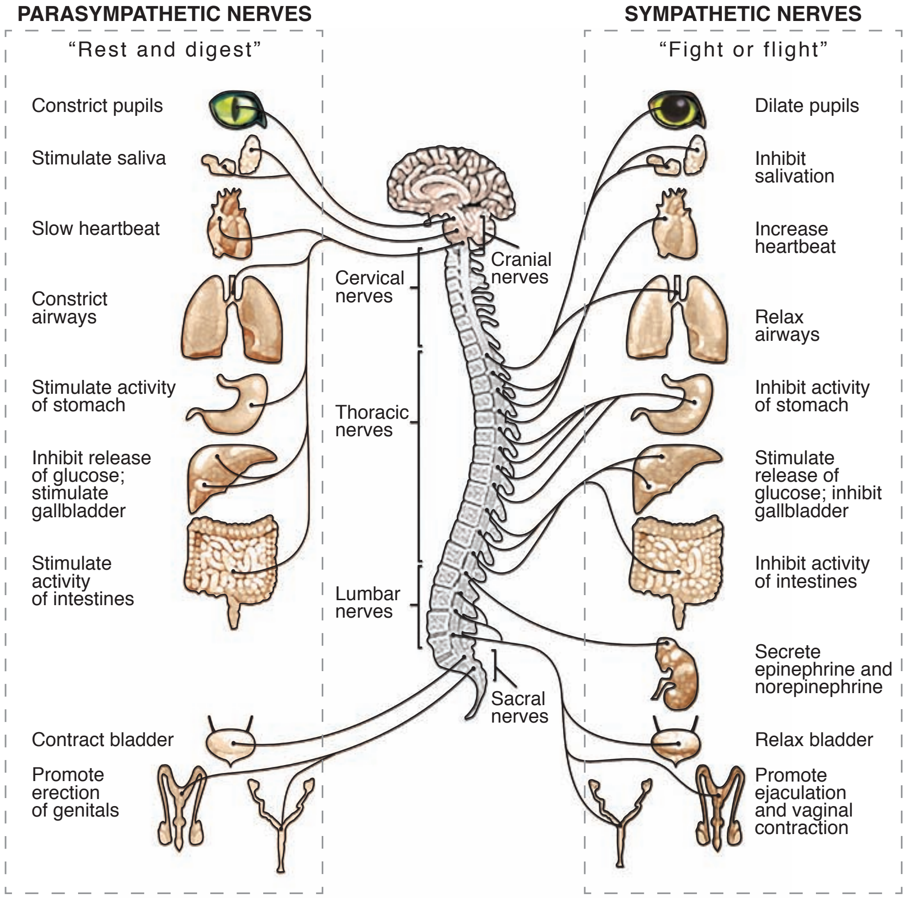

Figure 2. Autonomic innervation of the colon.

reflex, which is stimulated by duodenal distension, and (2) the rectosphincteric reflex, which is a result of colonic-rectal distension. As the rectum fills with feces, the increased intraluminal pressure signals for reflex relaxation of the internal anal sphincter and contraction of the external anal sphincter, allowing for gradual filling of the rectum with feces. When the pressure becomes high enough, parasympathetic efferents in the pelvic nerves stimulate contractions of the descending colon (mass movements), which propel feces caudally. Voluntary control of posture, increased intra-abdominal pressure and relaxation of the external anal sphincter allow for defecation (Guilford, 1996a, 1996b).

2/ Normal function of the colon

The main functions of the colon are absorption of water and electrolytes and control of defecation. In the normal cat, the ascending and transverse colon absorbs up to 90% of the fluid presented to it. Two major influences of fecal consistency are luminal water and electrolyte movement and colonic microbiota. The colon determines fecal consistency by regulating electrolyte and water composition. Sodium is resorbed by both active and passive processes, water follows sodium passively and potassium and bicarbonate are actively secreted (Washabau, 2013a, 2013b).

A commonly overlooked aspect of normal colonic function is the interaction of colonic bacteria with fiber. Fermentation of fiber results in production of the short-chain fatty acids (SCFAs), acetate, propionate and butyrate. SCFAs have many beneficial effects, including serving as an energy source for colonocytes, helping maintain electrolyte and fluid balance, stimulating colonic motility, helping prevent overgrowth of pathogenic bacteria, maintaining colonic morphology, and ameliorating intestinal inflammation (Sanderson, 2013). These beneficial effects of SCFAs provide one basis for the use of soluble fiber in the treatment of cats with constipation. Microbiota are discussed on page 41 in the section on dietary modification.

5. Pathophysiology of constipation and megacolon

> SUMMARY

- Mechanical obstruction may be luminal, mural or extra-intestinal in origin.
- Mild constipation can become moderate or recurrent constipation, which can result in obstipation or megacolon.
- Megacolon occurs via two mechanisms: hypertrophy and dilation.
- Hypertrophic megacolon is a result of obstruction and may be reversible if treated early.
- Dilated megacolon is the end stage of colonic dysfunction and reflects an irreversible loss of function.

Introduction

Constipation occurs as the result of partial obstruction (mechanical or functional) or voluntary lack of defecation (such as secondary to anxiety or pain). Although most descriptions of feline constipation in the veterinary literature focus on recurrent severe constipation or obstipation, many cats will have one or two isolated bouts of constipation without recurrence. In many cases, this is the result of dehydration leading to dry feces as the body attempts to absorb water via the colon. Accounts of dehydration leading to constipation in the veterinary literature are purely anecdotal; however, even mild dehydration has been shown to cause constipation in humans. Once fecal water content falls below 75%, further small decreases in water content result in relatively large increases in stool viscosity (Arnaud, 2003). The dry feces become difficult to pass because of partial mechanical obstruction and associated discomfort. Appropriate assessment of hydration status and treatment of dehydration are essential first steps in the management of any constipated cat.

As discussed in Chapter 1, there are many reasons for constipation to develop secondarily in cats, the majority of which are unrelated to the gastrointestinal tract (GIT). (See Table 1 in Chapter 1, page 8.)

It is widely believed that chronic constipation in some cats will lead to megacolon (Guilford 1996; Washabau, 2013a, 2013b). Megacolon describes the colonic dilation that occurs via two pathologic mechanisms: Hypertrophy and dilation. Hypertrophic megacolon occurs secondary to complete or partial mechanical obstruction and results in a dilated colon with a thickened wall. Dilated megacolon, on the other hand, is the end stage of colonic dysfunction, which results in diffuse colonic dilation and loss of function (Washabau, 1997). Naturally occurring conditions, which cause colonic obstruction and resultant megacolon, include pelvic canal stenosis secondary to fracture in cats (Matthiesen, 1991; Schrader, 1992). Delay in surgical correction of pelvic canal stenosis results in failure of return to normal colonic function (Schrader, 1992). This progressive decline in function over time implies that early intervention may prevent the development of dilated megacolon secondary to obstruction. However, it is not know whether early intervention and aggressive management in cats with constipation due to other causes can prevent megacolon from developing **(Figure 1)**. Not all cats with constipation will develop megacolon, but the reason that megacolon does occur in some cats remains unknown.

Idiopathic dilated megacolon is the most common cause of obstipation in cats (Washabau, 1997). In vivo studies to elucidate the pathophysiology of this condition in affected animals have not been performed. In vitro studies have shown the disorder to be associated with an impairment of colonic smooth muscle function. Specifically, longitudinal and circular smooth muscle from both the proximal and distal colon of affected cats develops less isometric stress than normal controls in response to (1) neurotransmitters including acetylcholine, substance P and cholecystokinin, (2) membrane depolarization with potassium chloride and (3) electrical field stimulation (Washabau, 1996). Histologic evaluation revealed no abnormalities of smooth muscle cells or enteric neurons of affected cats. The biochemical mechanism underlying this smooth muscle dysfunction remains unknown. It is also unclear whether the dysfunction is the cause of megacolon or the result of chronic constipation and colonic dilation leading to myofilament disruption. The findings from the aforementioned study suggest that smooth muscle dysfunction may be the primary problem in cats with idiopathic dilated megacolon rather than being a result of chronic colonic dilation.

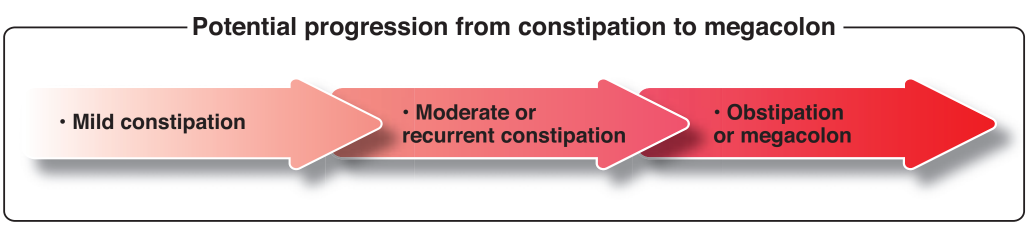

Figure 1. Progression to obstipation may occur if instigating factors are not corrected.

6. Diagnostics

> SUMMARY

- General diagnostics required for any constipated cat include a rectal examination, complete blood count (CBC), serum biochemistries, urinalysis, T4 and abdominal radiographs.
- Depending on the findings of the general diagnostics, abdominal ultrasound with or without fine needle biopsy, colonic contrast imaging, colonoscopy, magnetic resonance imaging (MRI) or computed tomography (CT) may be warranted.

Introduction

The diagnostic work-up **(Figure 1)** for the constipated cat should be divided into those tests that are required for any constipated cat and those tests that are individually indicated. A thorough history, physical examination and neurologic examination are important steps in the diagnosis (see Chapters 2 and 3). Rectal examination is vital in evaluating for foreign material, pelvic fracture, anal sac impaction, stricture or mass lesion.

1/ General diagnostics

Clinical pathology, including a complete blood count (CBC), serum biochemistries, urinalysis and T4, should be performed to assess the patient's metabolic status and level of dehydration (Washabau, 2000; Davenport DJ, 2010). These tests will rule out conditions that may be the primary or contributing underlying causes of the constipation. These include chronic kidney disease (CKD), hypercalcemia and hypokalemia. If hypokalemia

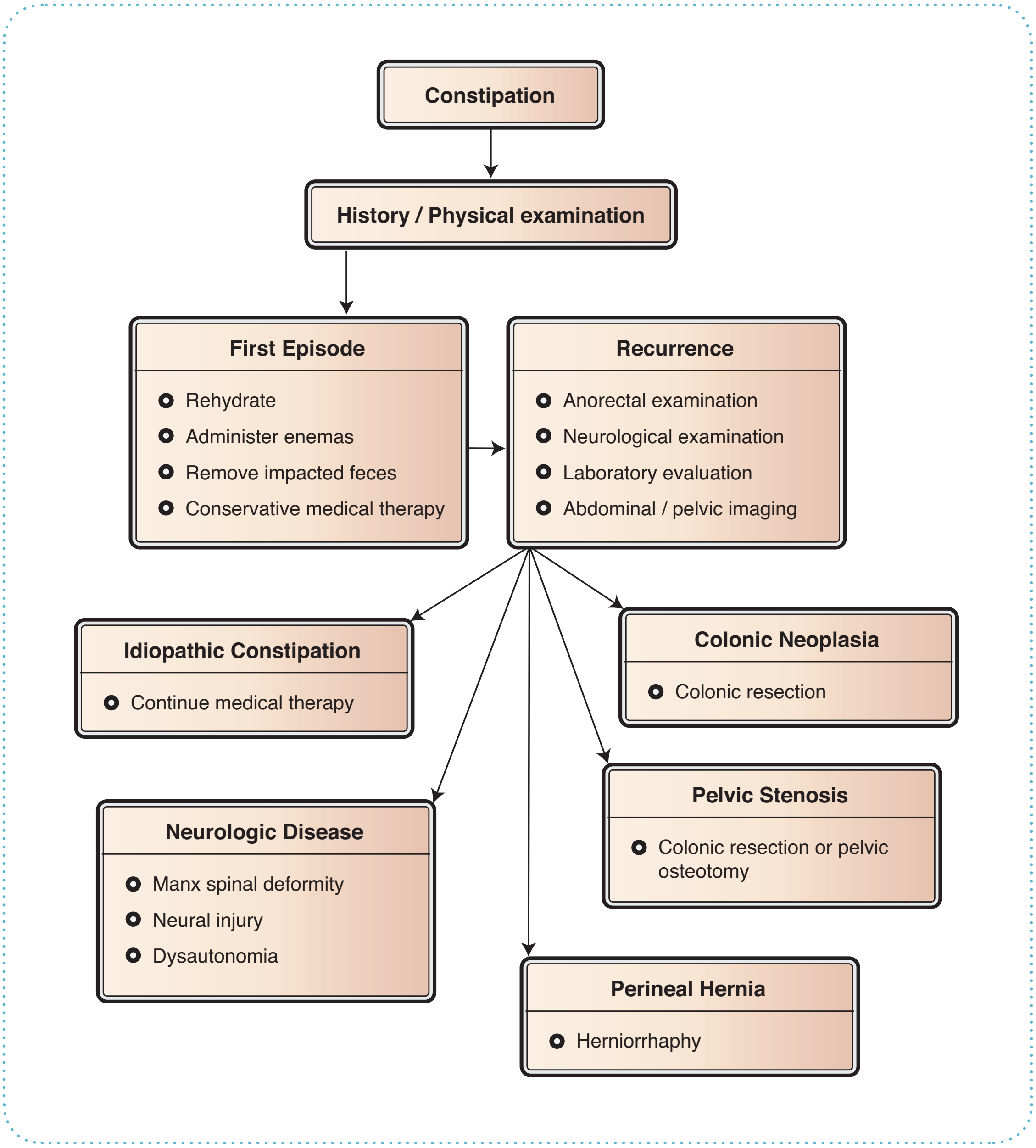

Figure 1. Systematic work-up for a cat presenting with constipation.

is refractory to therapy, serum magnesium levels should be measured to look for hypomagnesemia **(Figure 2)**. Congenital hypothyroidism causes constipation in kittens, as can acquired and iatrogenic hypothyroidism

Abdominal radiography is recommended in all constipated cats. In addition to verifying that the hard tubular mass palpated is a feces-filled colon, it allows for assessment of the severity of the colonic impaction, identification of foreign material in the colon, pelvic fractures **(Figure 3)**, spinal abnormalities (e.g., Manx sacral spinal cord deformity) and mass lesions. In a recent study, Trevail (2011) suggested that a ratio of colon diameter to L5 length greater than 1.48 is an indicator of megacolon. Unfortunately, consensus regarding the categorization of constipation based on imaging and other diagnostic tools is lacking, leaving communication about constipation subjective.

Figure 2. Venipuncture in a cat.

Figure 3. Ventrodorsal view of a cat with a fractured pelvis (arrows identify fractures).

A) Additional diagnostics

If physical examination and/or radiographic findings are suggestive of a mass lesion, abdominal ultrasonography helps confirm and obtain fine needle biopsies **(Figure 4)**. Ultrasound may also help evaluate colonic wall thickness, lymphadenopathy and other relevant abdominal changes **(Figure 5)**. A barium enema or a pneumocolonogram may be useful for the identification of luminal, intramural or extra-intestinal lesions and strictures **(Figure 6)**. These contrast studies require colonic evacuation and sedation or anesthesia.

Colonoscopy is useful when luminal or mural lesions are suspected **(Figure 7)**. The mucosa can be evaluated for evidence of inflammation and ulceration. Mass lesions, such as neoplasia and polyps, can be identified, biopsied or removed. If strictures are found, attempts may be made to repair them. As noted regarding contrast studies, colon cleansing and general anesthesia are required.

Computed tomography (CT) or magnetic resonance imaging (MRI) studies are indicated, if neurologic deficits or an intrapelvic lesion are present **(Figure 8)**.

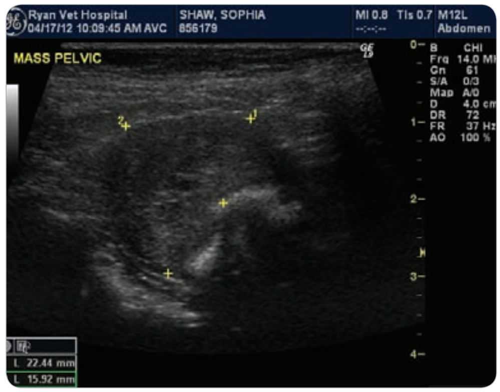

Figure 4. Ultrasound of a mass within the lumen of the colon (boundaries are outlined by the yellow + symbols).

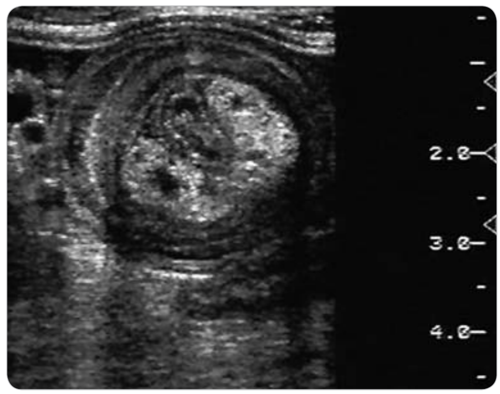

Figure 5. Ultrasonic image of ileocolic intussusception. Note the concentric circles alternating increased and decreased echogenicity within grossly extended intestines. Courtesy Dr. Karon Hoffman, University of Sydney. *(From Baral DM. Diseases of the intestines. In: Little SE, ed.* The cat: clinical medicine and management. *St Louis: Saunders/Elsevier, 2012. With permission.)*

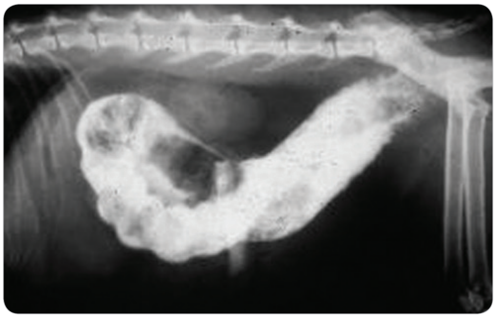

Figure 6. Lateral view of barium enema contrast study of a cat with megacolon. Note the increased diameter of the transverse and descending colon.

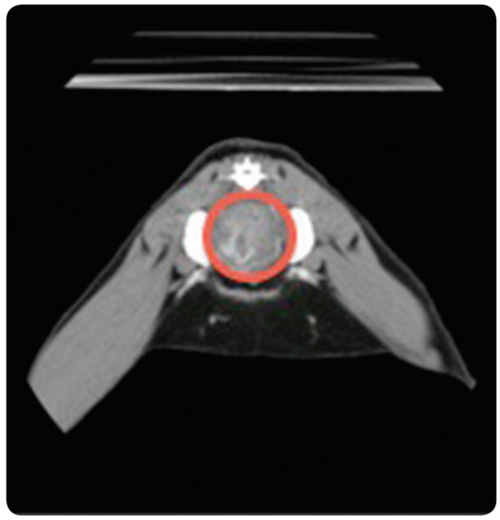

Figure 8. Computed tomography (CT) of an intrapelvic colonic mass shown outlined.

Figure 7. Endoscopy: A circumferential colonic stricture is shown between the arrows.

Section Two/ General therapeutics

7. General management of feline constipation

Introduction

The general approach to the treatment and management of feline constipation **(Figure 1)** may consist of some or all of the following:

1. Hydration management
2. Evacuation of feces
3. Dietary modification
4. Behavioral and environmental management
5. Pharmaceutical therapy
6. Surgical correction

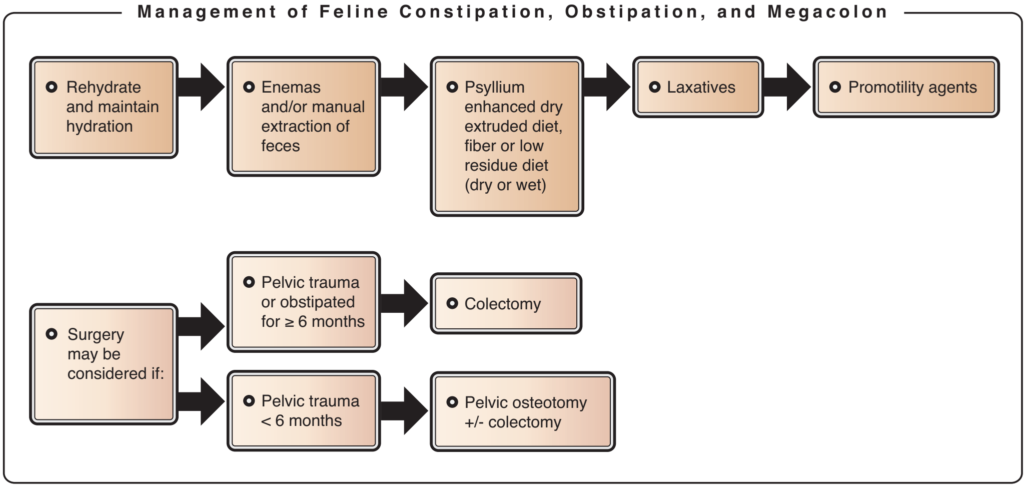

Figure 1. Step-by-step management of feline constipation.

8. Correcting dehydration

> SUMMARY

- Appropriate fluid therapy is important in order to correct dehydration and maintain euhydration.
- Degree of deficit is related to normal, hydrated state rather than existing state.
- Feeding canned diets can reduce the amount of maintenance fluids required.

1/ Assessing and correcting dehydration

In the dehydrated individual, compensatory mechanisms engage to correct intracellular and extracellular fluid volume and to alter its composition in order to regain a state of homeostasis. These include secretion of vasopressin, stimulation of the renin-angiotensin-aldosterone system, activation of the sympathetic system and reduction of renal solute and water excretion. Osmoreceptors in the hypothalamus initiate the experience of thirst, which cats appear to be less sensitive to, reflected by their ability to achieve highly concentrated urine, a result of having evolved in the deserts of northern Africa. When inadequate fluid is drunk, water is resorbed by the renal tubules in response to dehydration. When water needs exceed this capacity, it is reclaimed from colonic contents resulting in constipation.

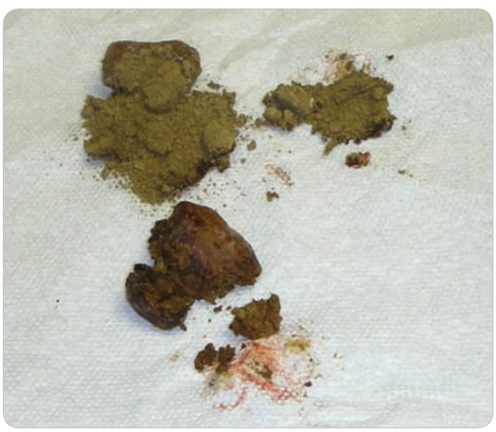

Figure 1. Lack of adequate hydration can result in extremely dry feces.

In addition to the traditionally used parameters used to assess hydration, stool character is one that can be readily monitored in the home **(Figure 1)** and reported by the client. In the clinic, coat character, skin elasticity, mucous membrane moisture and eye position can be evaluated. However, factors other than hydration can also affect these parameters, making them non-specific indicators of dehydration. Packed cell volume/total solids (PCV/TS) or hematocrit with albumin are useful laboratory parameters for estimating dehydration.

Based on a rough approximation of dehydration, we can calculate fluid volume to correct this problem. Mild (~5%) deficit is suggested by a minimal decrease in skin elasticity and semi-dry mucous membranes with normal eye position (Davis, 2013). With more severe dehydration, the mucous membranes become noticeably dry and tacky (most easily identified on the gingival surface) and a definite decrease in skin turgor can be appreciated as a slow return to normal position of tented skin. Pulses may become rapid and weak, and enophthalmos may develop. These changes occur at levels of dehydration of approximately 8%. Extreme dehydration (>10%) is marked by severe loss of mucous membrane moisture and skin turgor combined with pronounced enophthalmos caused by dehydration of retrobulbar fat. Signs of hypovolemic shock, such as tachycardia, weak pulses and an altered level of consciousness, may develop (Davis 2013).

Accurate assessment of patient hydration will help direct rehydration strategies (see Table 1 in Chapter 3 page 13).

It is important to recognize that estimation of the deficit is based on the weight of the hydrated individual (see example in box below). Once corrected, maintenance of hydration requires approximately 2-3 ml/kg/hour or 48-72 ml/kg/day (Davis, 2013), some of which is accrued through drinking and from liquid in the diet.

Ideally, the deficit + maintenance (in the example: 605 ml) should be restored within 24 hours. Once rehydrated, only the daily maintenance volume (330 ml) is needed, some of which can come from canned food and water added to diet. Canned food has 70%-85% water by weight, whereas dry food has 8%-12% water by weight. As such, once deficit needs have been met, the volume of fluids required is less for cats being fed solely canned food than those eating strictly dry food.

Increased voluntary water intake is unlikely to be sufficient since the water drunk by a patient who is polyuric/polydipsic is lost through increased urine volume.

Regardless of route (intravenous [IV], subcutaneous [SQ], parenteral, per os [PO] or by feeding tube), the volume of replacement fluids is the same. IV fluids may be preferable to SQ therapy when a patient is severely obstipated or prior to anesthesia if this is being considered for the evacuation of feces.

Rehydration should be achieved using an isotonic polyionic fluid such as lactated Ringer's solution (LRS). A different type of fluid should be used for ongoing maintenance of euhydration (see box below) because ongoing use of replacement solutions predisposes to hypernatremia and hypokalemia.

Successful rehydration is indicated by an increase in energy and appetite and passage of one or more bowel movements daily consisting of elongated, log-shaped stools. The presence of unabsorbed SQ fluids in the paws or axillary region indicates that the dose administered (rather than the frequency) should be reduced. When a cat is euvolemic and eating, stools that are a normal consistency will be passed within 1-2 days.

Assessment of fluid volume required to correct dehydration

Example: An 11 lb (5 kg) dehydrated cat, with an ~5% deficit whose normal, hydrated weight was 12.2 lb (5.5 kg)

Deficit = 5% × 5.5 kg hydrated weight = 275 ml*
+ Maintenance = 60 ml/kg/day* × 5.5 kg = 330 ml

Total: 605 ml in first 24 hours

After rehydration, for maintenance: This rehydrated 12.2 lb (5.5 kg) cat needs 330 ml. If the cat eats canned food (5.5 oz/156 g with 80% water = 124 ml water), only an additional 206 ml of fluids are needed.

Maintenance crystalloid solutions options

- Commercial maintenance solutions
- Equal volumes of replacement solution (e.g., LRS) and D5W + 13-20 mEq KCl/L of fluids
- 0.45% saline + 13-20 mEq KCl/L of fluids

From 2013 AAHA/AAFP fluid therapy guidelines for dogs and cats.

9. Evacuation of feces: Laxatives, cathartics and enemas

> SUMMARY

- After hydration has been optimized, fecal evacuation should be performed using laxatives, enemas or manual retrieval because obstipation has negative consequences on bowel health.
- Laxatives from different classes have different mechanisms of actions
- Gentle administration of multiple, small volume enemas is more effective than using large volume enemas.

Introduction

Often, rehydration alone (or along with stool softeners) is adequate to allow the patient to pass the stool without assistance. Chronic, unrelieved constipation may progress to obstipation and megacolon, and prompt treatment is required. Once treated, progress reports and/or rechecks are indicated to determine whether further treatment is needed. At the extreme end of the clinical spectrum, severe untreated chronic colonic distension with feces, as seen in megacolon, can rarely result in systemic toxicity in humans. The pathophysiologic mechanisms leading to "toxic megacolon" are incompletely understood but include colonic inflammation, which is a result of colitis or obstipation (Kobayasi, 1992; Gan, 2003; Autenrieth, 2012) Therefore, in addition to relieving discomfort and improving mucosal circulation, removal of impacted feces is recommended when other supportive care fails.

Laxatives and cathartics increase the volume and frequency of defecation and improve consistency (Washabau, 2013). Laxatives (or aperients) promote elimination of a soft-formed stool, whereas cathartics (or purgatives) tend to produce a more fluid evacuation. The difference between the two may be a matter of dose for some drugs. Any laxative or cathartic will be effective only if the patient is well hydrated. These products are summarized in **Table 1** essentially in the order of their efficacy. Laxatives are modestly effective, although caution should be exercised because they may have adverse effects when overused. A number of deleterious effects may occur with excessive or constant use of cathartics as well. Overdosing may cause severe, continuous diarrhea and abdominal colic, leading to dehydration and even shock.

Many of the products are given orally, although introduction of solutions or suppositories into the rectum to initiate the defecation reflex is a useful and simple method to correct or prevent constipation. Numerous preparations have successfully served as enemas, including soapy water (soft anionic soap), isotonic or hypertonic sodium chloride solutions, sorbitol, glycerol, surfactants such as sodium lauryl sulfoacetate, mineral oil and olive oil. Human pediatric rectal suppositories may be useful to help cats with mild constipation. These include docusate sodium (e.g., Colace™), glycerin or bisacodyl (e.g., Dulcolax™). Doses are listed in **Table 2**.

Alternately, after appropriate pre-anesthetic measures (including rehydration) have been taken, the patient should be anesthetized (rather than sedated) so that

Table 1. Types and effects of laxatives and cathartics.

Category	Agent	Mechanism of action	Risks and comments	Efficacy
Laxatives		Stimulate fluid or electrolyte transport	Patient should be well hydrated prior to use	
Lubricating laxatives	Mineral oil, white petrolatum, soft paraffins (e.g., hairball remedies)	Impair water absorption → improve fecal passage	1. With chronic use, impaired absorption of fat-soluble vitamins, other nutrients and co-administered therapies. 2. Aspiration pneumonia with orally administered mineral oil; only use rectally. 3. Decreased mucosal irritability can result paradoxically in constipation.	Mild
Emollient laxatives	Anionic detergents (e.g., docusate sodium) Available in oral form, suppositories and enemas	Enhance absorption of lipid but impair water absorption from ingesta	1. Docusate may be absorbed, metabolized and excreted in bile. 2. It should not be given with any product whose absorption should be avoided (e.g., mineral oil). 3. Docusate may be more useful in acute rather than chronic constipation.	Not reliable
Bulk-forming laxatives	Hydrophilic, poorly digestible polysaccharides (e.g., cereal grains) or cellulose fiber	Increase fecal bulk, viscosity and fermentation	1. Used in excess quantity, may decrease fecal water content and dietary digestibility. 2. Flatulence, abdominal cramping. 3. May be detrimental in obstipation or megacolon.	Mild; use in combination with other agents
Cathartics/ Purgatives		Increase motility of colon	Patient should be well hydrated prior to use.	
Saline purgative (hyperosmolar laxative)	Saline with magnesium (e.g., Epsom salts), sodium (e.g., Glauber's salt) or phosphate salts	Increase peristaltic activity	1. Not recommended. 2. Magnesium absorption may result in toxicity especially with CKD. 3. Sodium phosphate enemas (any brand, not just Fleet) are contraindicated due to lethal hyperphosphatemia and hypocalcemia.	Moderate; often combined with polyethylene glycol for bowel evacuation prior to procedures in humans
Polysaccharide hyperosmotic laxatives	Lactulose, lactose, lactitol, mannitol, sorbitol,	Sugar fermentation by saccharolytic bacteria stimulates fluid secretion and motility	1. Lactulose may cause flatulence. 2. Lactitol is less sweet than lactulose.	PEG > lactitol > lactulose > lactose; effect seen within 3-12 hours
Polyethylene glycols (hyperosmolar laxative)	Polyethylene glycol (PEG/PEG 3350)	Osmotically draw water into colon	PEG may be mixed with food or given by enema.	PEG is more effective than lactitol; effect seen within 3-12 hours
Stimulant/ irritant cathartics	Sennoside (e.g., senna), bland vegetable oils (e.g., castor oil, linseed oil, olive oil, cascara), diphenylmethane (e.g., bisacodyl), glycerin, sodium stearate	Activate secretion or stimulate mucosal lining, resulting in propulsion	1. Irritation results in mucosal damage, with altered mucosal integrity and possible hemorrhage. 2. Bisacodyl is given orally or by enema. 3. Long-term bisacodyl use damages myenteric neurons.	Bisacodyl is very effective; effect seen within 4-8 hours

Table 2. Dosing regimens for oral or rectal laxative use in the cat.

Active ingredient/ trade name	Mechanism	Dose	Route	Frequency
Bisacodyl (Dulcolax™)	Stimulant	5 mg	PO or PRS	q24h short-term only
Commercial diets	Bulk	—	—	—
Docusate calcium (Surfak™)	Emollient	50 mg	PO	q12-24h PRN
Docusate sodium (Colace™)	Emollient	50 mg	PO or PRS	q12h
Docusate sodium (Colace™ enema)	Emollient	5-10 ml/cat	Enema	—
Glycerin	Lubricant, hyperosmotic	—	Enema	—
Lactulose	Hyperosmotic	0.5 ml/kg	PO	q8-12h
Lactulose	Hyperosmotic	5-10 ml/cat	Enema	—
Mineral oil	Lubricant	5-10 ml/cat	Enema	—
Petrolatum	Lubricant	1 to 5 ml	PO	q24h
Polyethylene glycol	Hyperosmotic	25 ml/kg	PO	q24h PRN
Polyethylene glycol	Hyperosmotic	—	Enema	PRN
Psyllium	Bulk	1-4 tsp	With food	q12-24h
Pumpkin, canned	Bulk	1-4 tbsp	With food	q12-24h
Warm saline	Softener	5-10 ml/kg	Enema	PRN
Warm tap water	Softener	5-10 ml/kg	Enema	PRN
Wheat bran	Bulk	1-4 tsp	With food	q12-24h

PO = oral; PRN = as needed; PRS = pediatric rectal suppository; tsp = teaspoon = 5 ml; tbsp = tablespoon = 15 ml.

the airways can be protected from aspiration of vomit. A cuffed endotracheal tube should be used. Rectal examination is performed to evaluate anal glands, the rectum and prostate as well as the pelvic canal for diverticula, masses, abscesses or strictures. Using an aqueous-based lubricant, feces is removed digitally with concurrent massage of the abdomen to break down and move the feces into the rectum for retrieval. Use of instruments is not recommended.

Solutions that may be used include warm tap water, docusate sodium (DSS): 5-10 ml per cat, mineral oil: 5-10 ml per cat or lactulose: 5-10 ml per cat. Enemas should be administered slowly through a well-lubricated 10-12 French rubber catheter. Mineral oil and DSS should not be given together because the latter promotes mucosal absorption of the mineral oil. Sodium phosphate–containing enemas are contraindicated because they predispose to life-threatening electrolyte imbalances (hypernatremia, hyperphosphatemia, hypocalcemia) in cats. Hexachlorophene-containing soaps should be avoided because of potential neurotoxicity. Finally, giving enemas too rapidly may cause vomiting, pose a risk for colonic perforation and may not allow the fecal mass to be softened. If enemas are used, as with manual manipulation, a cuffed endotracheal tube should be in place in the anesthetized patient because stretching often induces vomiting. In general, multiple small volume doses may be preferable. For example, in a 10 lb (4 kg) cat, three enemas consisting of 35 ml of warm soapy water may be given to a compliant conscious cat over a 24-hour period.

Polyethylene glycol (PEG 3350) is a large molecular weight water-soluble polymer used as an osmotic laxative that bulks and softens stool. It is minimally absorbed in the gut and is not absorbed by intestinal bacteria. By binding water, it prevents absorption of water out of the intestinal lumen into the body. It is more effective than lactulose and many other oral laxatives. In the only study in cats to date (Tam, 2011), PEG has been shown to be effective in healthy cats when mixed with food. Stool consistency varied with the dose administered in each individual and neither food intake nor body weight was significantly changed by PEG 3350. Traditionally recognized side effects include bloating, nausea and diarrhea; in this study, hyperkalemia was noted but was not clinically or statistically significant.

10. Dietary modification

> SUMMARY

- Dietary alterations with adjustments to fiber content and the health of the microbiota should be considered.
- An extruded psyllium-enhanced dry diet has been shown to be of benefit.
- Consider including canned diets in therapeutic regime for their higher water content and increasing the number of water sources available.

Introduction

Constipation can occur as the result of excessive dehydration of the luminal contents and/or impaired motility. The most important nutrients that can be modified in the treatment of constipation are the moisture and fiber content of the food. The role of prebiotics, probiotics and synbiotics is unclear at this time.

1/ Water

Before initiating a dietary change, the hydration status of the patient should be assessed and corrected. As already discussed, constipated cats are often dehydrated, therefore increasing moisture in the diet and the amount drunk can help correct and maintain appropriate hydration, which results in softer stool. This may be accomplished in a number of ways, including the following:

- Place multiple water bowls in safe and accessible locations.
- Have a running water source (e.g., fountain) to possibly increase drinking.
- Feed the cat canned foods since they contain 70%-85% water; dry diets contain 8%-12% water.
- Dry-only feeders: float a few pieces of dry food on top of water at a time.
- Feed smaller meals more often because this has been shown to result in an increased amount of water being drunk (Kirschvink, 2005).

2/ Dietary fiber

The simple bulk laxatives (fiber) are hydrophilic, poorly digested polysaccharides (e.g., from cereal grains) or cellulose fiber that impact fecal bulk, viscosity and fermentation. As a class, they adsorb water, swell and form an emollient gel. Increased volume or bulk causes colonic distension and reflex contraction, leading to peristaltic activity. Most bulk laxatives also are fermented to some degree by colonic bacteria, producing volatile short-chain fatty acids (SCFAs) and other osmotically active products.

Fiber can be supplemented in commercial diets or added to an existing diet. Bulk laxatives are most effective if hydration is well maintained. When fiber is ingested, the resulting feces remain soft and hydrated, transit time decreases and defecation frequency increases. At excessive concentrations, fecal water content and digestibility of dietary constituents may be decreased. Highly fermentable fibers, such as pectin and guar gum, may produce excessive gas (carbon dioxide, hydrogen or methane) and may contribute to cramping. (Pectin is an example of a soluble fiber characterized by high fermentability.) On occasion, bulk laxatives are not sufficiently effective by themselves for the treatment of constipation and are useful when combined with other non-dietary treatments.

The ideal fiber balances solubility and fermentability.

1. *Solubility* refers to the capacity of the fiber to hold water.

- By acting as a gel, soluble fiber has a higher capacity to retain water compared with insoluble fiber, thereby increasing the moisture content of feces. Examples of soluble fiber include pectin, gums and oligosaccharides **(Table 1)**.
- Insoluble fiber increases fecal bulk and colonic distension, resulting in increased motility and frequency of defecation in normal individuals. Using insoluble fiber in cats with impaired colonic motility is controversial, however, because it will increase fecal bulk with minimal increase in water, possibly exacerbating constipation (Chandler, 1999; Sunvold, 1995a). Insoluble fibers include cellulose, brans (such as rice and wheat), oat fiber and peanut hulls.
- No fiber is exclusively soluble or insoluble and the degree of one or the other is very variable between fiber sources.

2. Fibers are also classified based on their *fermentability*. The fermentability of a fiber refers to the degree to which it is broken down by GI flora to produce SCFAs and gas. SCFAs provide energy to colonocytes and stimulate longitudinal colonic smooth muscle contractions (Rondeau, 2003; Sunvold, 1995b). Highly fermentable fibers, such as pectin and guar gum, may produce excessive gas (carbon dioxide, hydrogen or methane) and may contribute to cramping (see Table 1). Moderately fermentable fibers, such as beet pulp, provide the benefits of SCFAs without the undesirable effects of excessive gas formation. Non-fermentable fiber is preferred when fecal bulking and increased peristalsis is needed.

A) Therapeutic benefits of fiber

For managing constipation in cats, a diet providing a combination of soluble and insoluble fiber sources (i.e., a mixed fiber) is ideal. Soluble fiber increases stool moisture, while the insoluble fiber provides fecal bulk and stimulates motility. Mixed fibers include beet pulp, soy fiber, pea fiber and psyllium. Psyllium has a great capacity to hold water and to increase the viscosity of the ingesta by forming a viscous gel. Due to its low fermentability, psyllium increases bulk (Davenport, 2010). In a recent paper, cats with chronic constipation that were fed a dry psyllium-enriched diet showed major improvement in their clinical signs (Freiche, 2011). The diet was well tolerated and in most cats, the need for cisapride and lactulose significantly decreased.

Although a mixed-fiber source is preferable for the treatment of constipation, individualization is important for a successful diet change. Some cats may respond better to a greater proportion of insoluble fiber, whereas others will benefit from a more soluble fiber.

Table 1. Effects of dietary fiber on physiologic function.

Function	Soluble fiber	Insoluble fiber
Gastric emptying	Decrease	+/- or increased
Pancreatic secretion	+/- or no effect	No effect
Nutrient absorption	+/- or no effect	+/- or no effect
Small intestinal transit	Decrease	Increased
Large intestinal transit	Decrease	Increased
Intestinal mucosal mass	Increased	No effect
Microbial growth	Increased	No effect
SCFA production	Increased	Increased but less than soluble fiber effect
Toxin binding	No effect	Increased
Luminal pH	Lowered	No effect
Pathogen growth	Decreased	No effect
Dilution potential	Reduced	Increased
Absorption of luminal toxins	No effect	Increased
Fecal weight	Decreased	Increased
Warm saline	Softener	5-10 ml/kg
Warm tap water	Softener	5-10 ml/kg
Wheat bran	Bulk	1-4 tsp

Commercial diets usually contain several sources of fiber. Pet food manufacturers must report the "crude fiber" as a maximum on the guaranteed analysis. Crude fiber represents the organic residue that remains after plant material has been treated and the mineral component has been extracted. It usually underestimates the level of true dietary fiber within a diet. The solubility and fermentability cannot be ascertained from the label since amounts of each type of fiber are not listed. Reading the ingredient list can, however, be helpful in evaluating the fiber sources **(Table 2)**. Contact the manufacturer for more information regarding the amount of total dietary fiber (TDF).

When a patient cannot be transitioned to a diet that contains the necessary fiber, it is possible to add fiber to the current diet. Fiber supplementation will be tolerated best when added to moist foods. It is important to make sure that the food will still be palatable and nutritionally balanced.

Psyllium (Metamucil®), 1-4 teaspoons mixed with food per day, is a good source of mixed fiber. Wheat bran, 1-4 teaspoons per day, can be used as a source of insoluble fiber and wheat dextrin (Benefiber™), ½-2 teaspoons per day, as a source of soluble fiber. It is recommended to start with a low dose and titrate the dose upward to effect. The patient should be given at least 7 days to adjust to the fiber change before evaluating the response to therapy.

Table 2. Characteristics of selected fibers.

Fiber ingredient	Solubility in water	Fermentability
Citrus pulp	Soluble	High
Guar gum	Soluble	High
Pectin	Soluble	High
Soy fiber	Soluble	High
Inulin	Solublve	Moderate
Gum arabic	Soluble	Moderate
Xanthan gum	Soluble	Moderate
Methylcellulose	Soluble	Low
Psyllium	Mixed	Moderate
Cabbage fiber	Insoluble	High
Beet pulp	Insoluble	Moderate
Corn bran	Insoluble	Moderate
Pea fiber	Insoluble	Moderate
Rice bran	Insoluble	Moderate
Wheat bran	Insoluble	Moderate
Cellulose	Insoluble	Low
Wheat bran	Bulk	1-4 tsp

Canned pumpkin can increase the moisture and add some fiber to the diet. The amount of fiber provided by canned pumpkin, however, is small compared to psyllium (one tablespoon of canned pumpkin has 0.3 g of fiber vs. 6.6 g in one tablespoon of psyllium husk powder). A considerable amount of canned pumpkin is needed for a substantial change in the amount of fiber, which can affect the nutritional balance. These properties make canned pumpkin a good treat or supplement, rather than relying on it for relieving constipation.

3/ Targeting the microbiota

Based on the importance of SCFAs (and other compounds that have yet to be described), changes in the colonic microbiota might be a reasonable approach in treating chronic constipation. Ways to accomplish this include making changes in the cat's diet, thereby modifying the substrates available for microbial use, by administering antibiotics or by treating with a prebiotic, probiotic or synbiotic (Schrezenmeir, 2001; de Vrese, 2008).

The colonic microbiota are of great benefit to the host, contributing substantially to whole body and local health (Twedt, 2013; Washabau, 2013). Based on molecular discrimination, over 450 organisms are represented, but only approximately 10% have been identified. Although the colonic microbiota are similar at the phylogenetic level within a given species, each individual animal has a unique profile, with only a 5%-20% overlap. Such diversity has been described in the GI microbiota of normal cats as well (Desai, 2009). Many factors influence the microbiota in the normal colon including, but not limited to location within the intestine, age, diet and environment.

Marked diversity in the microbiota of normal animals complicates identification of changes that accompany disease and thus approaches for therapeutic interventions. The major bacterial groups of the colon include *Bacteroides, Clostridium* (5 different clusters), *Lactobacillus, Bifidobacterium* and *Enterobacteriaceae*; *Actinobacteri*, *Fusobacteri* and *Erysipelotrichales* spp. are the other major categories. In normal adult cats, *Actinobacteri* (primarily bifidobacteria) and *Firmicutes* (primarily lactobacilli) are the predominant fecal organisms, with marked animal-to-animal variability (Desai, 2009).

The microbiota are particularly important to the production of SCFAs (Twedt, 2013; Syring, 2013; Boothe, 2012). These molecules are formed particularly in the proximal colon from fermentation of non-absorbable carbohydrates such as celluloses, pectin and other sugars. Major SCFAs produced by the microbiota include acetate, butyrate and propionate. *Bacteroides* spp., in particular, contribute to SCFA production. Un-ionized SCFAs are rapidly absorbed, providing up to 8% (less in the cat) of energy sources for the host. In contrast, ionized SCFAs remain in the lumen, providing energy to the colonic epithelium (Chandler, 2013). They also inhibit growth of pathogenic bacteria, either directly or indirectly through increasing environmental pH. Absorption of sodium, chloride and water facilitated by SCFAs may account for the majority, if not all, of the osmotically absorbed water in the colon. Colonocyte differentiation and proliferation are promoted by SCFAs.

Finally, SCFAs directly impact colonic motility. The effects of three SCFAs (acetate, butyrate and propionate) were compared to acetylcholine (ACh) on circular and longitudinal proximal and distal colonic smooth muscle of adult cats and kittens. Butyrate caused the most (29% of ACh response) and acetate the least increase in activity (Rondeau, 2003).

The impact of antimicrobial therapy on the GI microbiota can be profound, causing disruptions for weeks to months (Aly, 2012). It is reasonable that these effects can impact colonic motility and for this reason, indiscriminant use of antimicrobials should be avoided in the cat at risk for chronic constipation.

A) Prebiotics, probiotics and synbiotics

Prebiotics are generally composed of complex carbohydrates or other materials intended to enhance growth of the microbiota (e.g., *Bifidobacterium*). Prebiotics are resistant to destruction by gastric acidity, are fermentable by colonic bacteria and selectively stimulate either the growth or activity of beneficial microbes. Characteristics of prebiotics that influence colonic health include those discussed for fiber (solubility in water and fermentability)—a balance of both is prudent. Among the most common examples of prebiotics are the fructooligosaccharides (fructose is the predominant sugar), psyllium, soy hulls (after processing), beet pulp and chicory. These products are discussed in the previous section on bulk laxatives and **Table 2**.

In contrast to prebiotics, *probiotics* consist of living beneficial bacteria, which, when administered orally in sufficient number and in a preparation able to resist gastric acid, colonize host GI epithelium, subsequently exerting beneficial effects. Identifying the proper microbial population to make up a probiotic is complicated by the factors that impact diversity under normal conditions and the lack of information regarding disease conditions.

Synbiotics are a mixture of prebiotics and probiotics that beneficially affect the host. The synbiotic may improve survival of the probiotic and promote its retention.

The microbiota are resilient to change, rapidly returning to normal conditions. Neither bacterial counts nor diversity are conducive to permanent changes, with successful change requiring higher doses and longer periods of exposure. Further, changes in one microbe may be limited by changes in others. The efficacy of clinical trials will be impacted by this resistance to change.

Ultimately, despite these challenges, manipulation of GI (not simply colonic) microbiota is likely to offer a reasonable therapeutic option for treatment or prevention of constipation. A plethora of non-scientific information is available on the Internet regarding the use of probiotics to treat feline constipation, none of which appears to be based on scientific evidence. Well-designed clinical trials demonstrating efficacy will be challenging to design, and caution is recommended when interpreting the results of a study that fails to detect a significant difference. This failure is not equivalent to a “no treatment effect”; rather, it is more likely that a type II error (a false negative result) has occurred and the study has insufficient power to detect a significant difference. The most common cause for this is that the sample size is too small given the variability in population data. In addition to the challenges previously described, the well-designed clinical trial must begin by demonstrating the quality of the product itself. Weese (2011) demonstrated that only 2/25 probiotic products marketed for animals had acceptable labels, let alone that they contained the organisms listed.

Clinical trials supporting treatment of constipation with probiotics are slowly emerging. For example, a systematic review (Chmielewska, 2010) found probiotics containing *Bifidobacterium lactis* DN-173 010, *Lactobacillus casei* Shirota and *Escherichia coli* Nissle 1917 had favorable effects on defecation frequency and stool consistency. However, the review encouraged that the status of probiotics in the treatment of constipation remain investigational.

11. Behavioral and environmental management

> SUMMARY

- Behavioral and environmental modifications need to be addressed to reduce stress and improve overall well being.
- The type of litter box, litter, number and placement, as well as cleanliness, are of crucial importance.

Introduction

A decrease in defecation resulting in constipation (and potentially obstipation) may have a psychological, emotional or behavioral basis (see Table 1 in Chapter 1 page 8). For this reason, as well as for basic well being, questions should be asked that address social stress and distress. Research into feline environmental needs and enrichment is still in its infancy and only a few evidence-based studies are available (Ellis, 2009). At least two of the Five Freedoms for Animal Welfare (see box) apply, in particular, the freedom from fear and distress (Webster, 2001). If using the litter box/latrine is unpleasant due to an aversive texture or off-putting odors (e.g., soiled or from smells associated with illness of another cat), the cat may choose to not defecate, rather than use an alternate location.

Five freedoms for animal welfare

1. **Freedom from Hunger and Thirst** by ready access to fresh water and a diet to maintain full health and vigor.
2. **Freedom from Discomfort** by providing an appropriate environment including shelter and a comfortable resting area.
3. **Freedom from Pain, Injury or Disease** by prevention or rapid diagnosis and treatment.
4. **Freedom to Express Normal Behavior** by providing sufficient space, proper facilities and company of the animal's own kind.
5. **Freedom from Fear and Distress** by ensuring conditions and treatment which avoid mental suffering.

From Farm Animal Welfare Council: http://www.fawc.org.uk/freedoms.htm.

Social stress may also result in not defecating (or in eliminating in alternate locations). Hooded litter boxes may be a deterrent for the cat that is afraid of being ambushed by another cat, a dog or a human. Latrines in locations in which noises may occur unexpectedly (e.g., a furnace or an appliance starting up) may likewise cause fear. There must be enough litter boxes in *different parts of the house* in order to avoid cats encroaching on the territory of housemates.

The height of the rim of the litter box and difficulty getting to the boxes (e.g., stairs) should also be taken into consideration because they may pose a problem for older cats with muscle weakness, degenerative joint disease (DJD) or pain from other causes. In these situations, providing a greater number of and more readily accessible boxes may help reduce the predisposition to retention of feces.

Boarding or being hospitalized offers numerous reasons for a cat to not choose to defecate. In these situations, litter boxes are generally too small, a cat may be fearful in a strange place with strange people and unfamiliar cats, there may be "potential" predators and unpleasant experiences may have occurred. Lack of movement/ exercise, dehydration, inappetence and pain will add to the risk of constipation.

Distress may also be present due to inadequate or inappropriate environmental opportunities. The second of the Five Freedoms is to be able to express normal behaviors. For cats, this includes the ability to play, to hunt, to observe from a safe place (perch) and to hide. This does not require a plethora of expensive, commercially marketed toys and structures. Opportunities for safety, privacy and imaginative exercise can be created in almost any home environment.

Additionally, environmental needs are recognized. These include those relating to the indoor and outdoor physical environment, as well as a cat's social interactions, human and otherwise. In the AAFP and ISFM Feline Environmental Needs Guidelines, five pillars are described that form the basis of a healthy feline environment (Ellis, 2013). These pillars provide the following:

1. A safe space
2. Multiple and separated resource stations (food, water, toileting areas, scratching areas, play areas, resting and sleeping areas)
3. Opportunity for play and expression of predatory behaviors
4. Positive, consistent and predictable interactions with humans
5. An environment that respects the importance of a cat's sense of smell

Once these basic needs are met, the goals of environmental *enrichment* include the following:

- Increasing behavioral diversity
- Reducing the frequency of abnormal behavior
- Increasing the range or number of species typical behavior patterns
- Increasing positive utilization of the environment
- Increasing the ability to cope with challenges in a more "normal" way

12. Pharmaceutical therapy

> SUMMARY

- Pharmaceutical therapy may be considered in addition to other therapies and consists of the use of prokinetic agents.
- Drugs that should be avoided because of the potential to exacerbate constipation are discussed.
- All therapeutic agents depend on effective hydration, thus rehydration must be addressed first or concurrently.

1/ Drugs targeting the chronically constipated cat

Among the advantages of treatment or prevention of constipation are options regarding drug delivery. Medications intended to reach the colon might be supplemented in the diet, given orally or given topically either as an enema or a suppository (see Table 2 page 50). Care must be taken with the topical route as a fair proportion of active drug may be absorbed from the colonic mucosa, depending on the agent. Transdermal gels as a method of delivery are discussed for cisapride.

2/ Drugs targeting the chronically constipated cat

Prokinetics enhance the transit of intraluminal contents by stimulating GI smooth muscle contractions.The mechanisms of action of these drugs are varied and not all are well understood. Their effects on intestinal functions generally reflect either promotion of an agonist, such as ACh, using drugs that act at or modulate muscarinic receptors or inhibition of an inhibitory signal such as dopamine (in some regions) (Reynolds, 1989) **(Figure 1)**. **Table 1** lists feline doses of prokinetic agents.

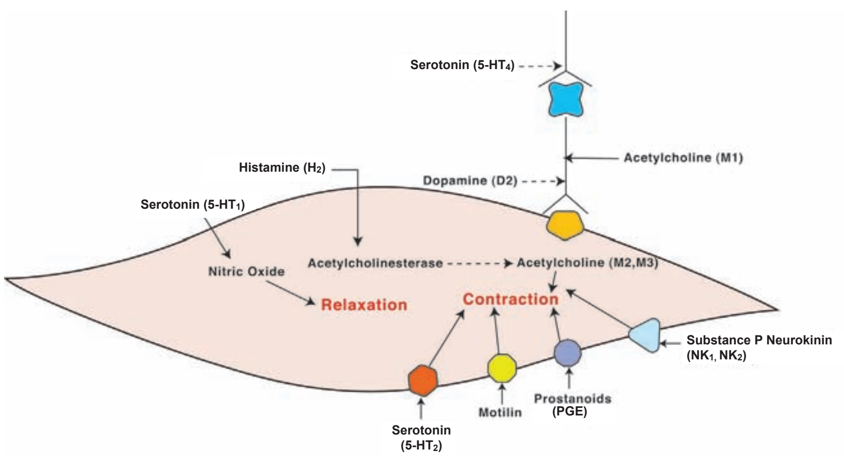

Figure 1. Depiction of a gastrointestinal smooth muscle showing the sites of action of neurotransmitters affecting motility. Drugs that either stimulate *(solid arrow)* or inhibit *(dotted arrow)* the signal are indicated.

Table 1. Dosing regimens for prokinetic agents intended to prevent or treat constipation in the cat.

Active ingredient	Mechanism: Neurotransmitter receptor	Dose	Route	Frequency
Cisapride	Serotonin: 5-HT_4	0.5-1.5 mg/kg	PO	q8-12h
Misoprostol*	Prostanoid: PGE_1	Dog: 2-5 mcg/kg	PO	q6-8h
Mosapride	Serotonin: 5-HT_4	0.25-1.0 mg/kg	PO	q12h
Nizatidine	Histaminergic: H_2 Anticholinesterase	2.5-5.0 mg/kg	PO	q12h
Prucalopride†	Serotonin: 5-HT_4	0.01-0.20 mg/kg	PO	q12h
Ranitidine	Histaminergic: H_2 Anticholinesterase	1-2 mg/kg	PO	q8-12h
Tegaserod‡	Serotonin: 5-HT_4	0.05-1.0 mg/kg	PO, IV	q12h

5-HT_4 = 5-Hydroxytryptamine receptor 4; IV = intravenous; PGE_1 = prostaglandin E_1; PO = oral.

*Misoprostol has been used in other species; however, its efficacy and dose have not been established in cats (see text).

†This anecdotal dose for Prucalopride differs from the dose that demonstrated efficacy in experimental study (see text).

‡Tegaserod is promoted as a prokinetic, although its potentially paradoxical effects in the colon should be taken into account (see text).

A) Cholinergics

Clinically, the use of cholinergics is limited by undesirable systemic effects. Bethanechol enhances the amplitude of contractions throughout the GIT (Reynolds, 1989; Demol, 1989). However, common adverse events reflect generalized direct enhancement of parasympathomimetic stimulation, including abdominal cramps, diarrhea, salivation and bradycardia (Reynolds, 1989).

B) Serotonergic agonists

A number of serotonergic 5-hydroxytryptamine receptor 4 (5-HT_4) agonists have been developed for clinical use. Several prokinetic drugs that target the 5-HT_4 receptor are not effective in the colon. For example, metoclopramide's prokinetic effects are limited to the upper GIT.

Cisapride has the broadest spectrum of action of the serotonergic prokinetic drugs (McCallum, 1988). Activity increases in a dose-dependent manner at all locations in the GIT, including the colon (Reynolds, 1989). The prokinetic actions of cisapride appear to reflect indirect stimulation of cholinergic nerves and interaction with 5-HT_4 receptors. Limited studies have described the effects of cisapride in the cat. In colonic muscle of healthy cats, cisapride causes a calcium-dependent contraction that is partially dependent on enteric cholinergic innervation. Cisapride has similar effects on smooth muscle of cats with idiopathic megacolon, particularly in the ascending colon (Hasler, 1997).

The disposition of the human-approved cisapride preparation has been evaluated for cats. Oral bioavailability was shown to be 30%, a parameter that may vary between compounded preparations (LaGrange, 1997). The elimination half-life is approximately 5 hours. Elimination may be prolonged in the presence of liver disease (McCallum, 1988). In contrast to metoclopramide, extrapyramidal side effects do not occur because cisapride does not interact with central dopamine receptors. However, stimulation of 5-HT_4 receptors by cisapride (and other drugs) causes blockade of selected potassium channels in the heart, resulting in prolongation of the QT interval (*torsades de pointes*) and the potential for sudden cardiac death. In vitro studies have demonstrated a similar effect in the canine myocardium (Di Diego, 2003). The risk is increased when cisapride is combined with other drugs that inhibit the cytochrome P450 enzyme responsible for cisapride metabolism in humans (e.g., clarithromycin, itraconazole).

This risk of cardiotoxicity in humans led to its withdrawal from most international markets. In the United States and Canada, cisapride prescriptions can be filled only as a compounded preparation. This raises several safety and efficacy concerns. The active pharmaceutical ingredient must be obtained as a pure bulk drug substrate, which is not approved by the Food and Drug Administration (FDA). As such, the risk of contamination and lack of potency presents a greater risk than with approved products. The United States Pharmacopeia (USP) is a non-regulatory agency that sets standards for drug ingredients. It has published a standard monograph for cisapride and is preparing a cisapride monograph for compounding as a 10 mg/ml aqueous oral suspension or a 3 mg/ml sterile injection solution (personal communication, Gigi Davidson, Chair, USP Expert Committee on Compounding, April 5, 2013). Once available, this monograph should be the template on which all cisapride is compounded. Finally, increased confidence in compounded preparations can be achieved if prescriptions are limited to pharmacies that are accredited by the Professional Compounding Accreditation Board (PCAB; www.pcab.org). Accreditation involves a robust, rigorous application process through which successful pharmacies demonstrate their adherence to good principles of pharmaceutical compounding. Pharmacies that are accredited by the PCAB can be found on the PCAB website.

Some compounding pharmacies offer cisapride as a transdermal gel. In addition to the previously described risk, therapeutic failure should be anticipated due to failed drug delivery. A number of investigators have demonstrated that, in general (an exception being methimazole), transdermal gel systems do not effectively deliver drug to cats after single or multiple dosing. A signed informed consent that delineates the risks associated with using transdermal cisapride, including therapeutic failure, is recommended to empower the client while protecting the patient and clinician.

At least two other drugs exert prokinetic effects in the colon due to potent partial agonistic activity at 5-HT_4 receptors. Prucalopride is a partial benzamide that has no effect at other serotonin receptors. At a dose of 0.64 mg/kg, a dose-dependent increase in giant migrating contractions and defecation was seen (Briejer, 1997; 2001). However, fecal consistency does not appear to be affected.

Tegaserod is a non-benzamide that also acts as a weak agonist at 5-HT_{1D} receptors. Direct serotonergic effects have not been described in the cat, but in other species, including the normal dog, prokinesis occurs in the colon within 1 hour of an intravenous dose (0.03-0.3 mg/kg) (Anonymous, Tegaserod, 2001 Advisory Committee Briefing Document). However, Tegaserod has been shown to decrease sensitivity to bowel distention in cats (Coffin, 2003), reducing distension-induced reflex colonic peristalsis and making its use questionable in constipated cats.

C) Miscellaneous prokinetic drugs

Erythromycin stimulates GI motility at low doses; its effects appear to mimic those of motilin. However, neither appears to be effective in dogs or cats (Smith, 2000).

Selected antihistaminergic drugs acting at H_2 receptors have mild prokinetic effects in vitro. Ranitidine and nizatidine (but not cimetidine or famotidine) inhibit anticholinesterase activity and thus are prokinetic at antisecretory doses (Ueki, 1993; Pouderoux, 1995).

Misoprostol is a prostaglandin E_1 (PGE_1) analogue that stimulates giant migrating complex patterns in the colon, facilitating propulsion. In vitro, misoprostol has demonstrated prokinetic properties in the colon of dogs (Botella, 1995) and cats; side effects include abdominal cramping. Misoprostol also stimulates intestinal secretion.

D) Miscellaneous products

Other products used in humans for chronic constipation include prostones (e.g., lubiprostone) and colchicine. They have not been studied in cats.

3/ Summary of therapeutic management

Although a number of drugs or other medications may be used to prevent or treat chronic constipation and megacolon in the cat, all are dependent on effective hydration. As such, the importance of maintaining hydration in the at-risk cat cannot be overemphasized. Most if not all drugs that target fecal consistency are effective only in the sufficiently hydrated cat. Initial medical management of megacolon associated with mild constipation should include bulk laxatives and more active laxatives, such as bisacodyl or DSS suppositories. As constipation progresses to obstipation, enemas and evacuation under general anesthesia are implemented. In severe cases, antimicrobials that target coliforms may be indicated to decrease the potential for bacterial translocation across the damaged mucosa. Ideally, the anaerobic population will be less affected than the aerobic one. Long-term medical management should be accompanied by dietary management. Laxatives and periodic enemas are indicated as needed. Prokinetics, such as cisapride, have had variable success. Antisecretory drugs with anticholinesterase activity (e.g., ranitidine, nizatidine) might also be considered. Earlier use is more likely to prevent progression from constipation to obstipation in cats. Surgery is a last resort but may provide a comfortable, good quality life for cats requiring it.

4/ Drugs to avoid in the constipated cat

A number of drugs or supplements induce or contribute to constipation and thus should be avoided in cats at risk for constipation **(Table 2)**. These drugs generally act as antagonists or inhibitors of cholinergic function or are agonists of sympathetic or dopaminergic function.

Opioids should be avoided. If they need to be used for analgesia when other agents are contraindicated, their effects on motility should be taken into consideration. Their widely accepted mechanism is presynaptic modulation of ACh release such that circular smooth muscle is stimulated and longitudinal smooth muscle is inhibited (Holzer, 2004). Opioids also stimulate (by delta receptors) the net absorption of water and electrolytes in enterocytes of both the small and large intestine. The risk of constipation may vary with the specific opioid. In humans, transdermal fentanyl was associated with the lowest risk of constipation compared to oxycodone or morphine continuous rate infusion (CRI). Epidural morphine was associated with urinary and bowel dysfunction in a cat (Song, 2011).

The role of various prostaglandins in intestinal motility, as well as in absorption and secretory processes, is complex, and the inhibition of prostaglandin synthesis will not consistently influence secretory diarrheal states. The non-steroidal anti-inflammatory drugs (NSAIDs) may, however, be therapeutically beneficial in some acute and chronic diarrheal syndromes and, accordingly, can be expected to decrease colonic emptying.

Table 2. Drugs that may exacerbate constipation.

Prescription drugs	Non-prescription drugs
Anticholinergics: atropine, glycopyrrolate	Antacids (especially calcium containing)
Antihistamines (H1): diphenhydramine, dimenhydrinate	Calcium supplements
Antiparkinsonians	Iron
Antipsychotics: chlorpromazine	Antidiarrheals
Barium	Non-steroidal anti-inflammatory drugs (NSAIDs) (?)
Calcium channel blockers: nifedipine, verapamil, diltiazem (?)	
Diuretics	
Dopamine antagonists*: bromocriptine	
Opioids: fentanyl, morphine	
Sympathomimetics: ephedrine, terbutaline, others	
Tricyclic antidepressants (adrenergic): clomipramine, amitriptyline > nortriptyline	

*In the colon, dopamine acts as an agonist.

13. Surgical management

> SUMMARY

- Surgery may be required early if pelvic fracture or malunion exists or as a last resort when intractable megacolon has developed.
- Preservation of the ileocolic junction is recommended, thus subtotal colectomy is preferable in most cases.
- Colectomy should be performed by a board-certified small animal surgeon or by a veterinarian with advanced skills in soft tissue surgery and intestinal resection and anastomosis.

Introduction

Surgical management of cats with chronic constipation involves colectomy. Removal of the colon in patients with obstipation and megacolon is a last-case resort and should be reserved for those patients that are refractory to medical management and for chronic cases of megacolon that are secondary to pelvic canal obstruction. In all cases of pelvic canal obstruction, the underlying cause of the obstruction should be corrected if possible.

The causes of pelvic canal obstruction or disruption in cats may include pelvic fracture malunion; colonic, rectal or anal stricture or tumor; intrapelvic extraluminal mass; colonic foreign body; anal or rectal atresia; or perineal hernia. Pelvic fracture malunion is the most common cause of pelvic canal obstruction resulting in megacolon (Bertoy, 2002). Diagnostic tests should be performed to assess the integrity of the pelvic canal and rule-out obstruction (see Chapter 6).

Pelvic fracture malunion should be treated with partial pelvectomy or pelvic reconstruction if the pelvic canal diameter is narrowed by at least 50% (as measured on the ventrodorsal radiographic projection of the pelvis; **(Figure 1)** and if constipation or secondary colonic distension is noted. It has been suggested that in cats with pelvic fracture malunion, clinical signs of obstruction and megacolon may be reversible if the obstruction is

Figure 1. Ventrodorsal radiographic projection of a cat with megacolon secondary to pelvic stenosis from malunion of an ileal fracture. The pelvic canal width at the level of the malunion is reduced by approximately 50%. (*From Radlinsky MA. Surgery of the digestive system. In: Fossum TW, ed.* Small animal surgery, *4th ed. St. Louis: Mosby/Elsevier, 2013. With permission.*)

corrected within 6 months of the onset of clinical signs of constipation (Schrader, 1992). Although specific criteria for performing colectomy remains ill-defined, it has been suggested that in cases of chronic (>6 months) obstipation secondary to pelvic canal obstruction, correction of the obstruction plus colectomy may be warranted (Bertoy, 2002).

1/ Total vs. subtotal colectomy

Surgical treatment of idiopathic megacolon involves removal of the majority of the cat's colon, with or without preservation of the ileocolic junction **(Figure 2)**.

The importance of the ileocolic junction is debatable. In cats, removal of the ileocolic junction may predispose the patient to reflux of colonic bacteria into the small intestine, resulting in bacterial overgrowth and severe postoperative diarrhea. On the other hand, although preservation of the ileocolic junction reduces the risk of postoperative diarrhea, it could predispose to recurrence of megacolon in the remaining colonic segment. Recent literature suggests that cats are at greater risk of developing problems when the ileocolic junction is removed than they are when the ileocolic junction is preserved, therefore preservation of the ileocolic junction is recommended (Bright, 1991; Sweet, 1994; Gregory, 1990; Rosin, 1988; White, 2002).

Colectomy is an advanced (complicated) surgical procedure, and this procedure should be performed by a board-certified small animal surgeon or by a veterinarian with advanced skills in soft tissue surgery and intestinal resection and anastomosis.

2/ Pre-operative considerations

The patient should be rehydrated pre-operatively if indicated (see Chapter 3 to assess hydration status). Enema administration pre-operatively to loosen the stool is contraindicated and increases the risk of spillage intra-operatively. Prophylactic antimicrobials against gram-negative and gram-positive organisms (e.g., cefoxitin) should be administered intravenously starting at the time

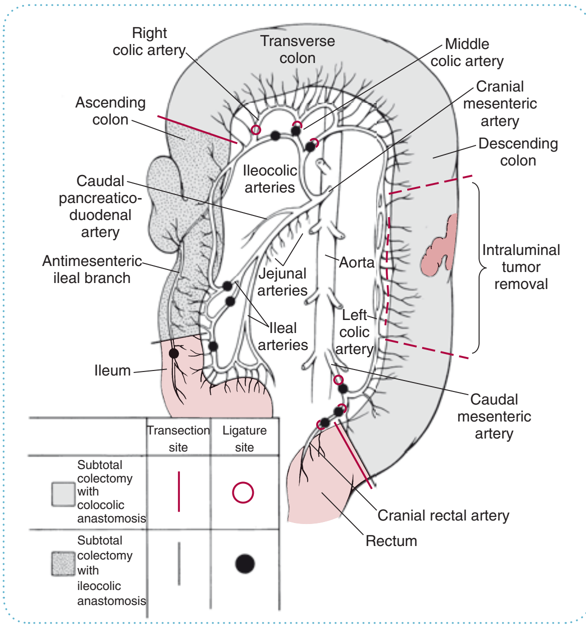

Figure 2. Sites of ligation and transection for subtotal colectomy for ileocolic vs. colocolic anastomosis techniques. (*From Radlinsky MA. Surgery of the digestive system. In: Fossum TW, ed.* Small animal surgery, *4th ed. St. Louis: Mosby/Elsevier, 2013. With permission.*)

of anesthetic induction and continuing every 90 minutes until skin closure has been achieved. Postoperative dosing is then used, as detailed in **Table 1**.

3/ Surgical technique

For a detailed description of colectomy, refer to a detailed small animal surgery textbook such as Fossum's *Small Animal Surgery 4th Edition* (Fossum TW, 2013). Unlike the small intestine, the colon is a region of very high bacterial concentration that may be difficult to mobilize and expose during surgery, and anastomosis may afford a significant luminal discrepancy. For these reasons, experience and competency in small animal intestinal resection and anastomosis is highly recommended prior to performing a colectomy or subtotal colectomy. As with other intestinal surgeries, note that adherence to strict asepsis, accurate mucosal apposition and achieving a tension-free anastomosis are of utmost importance in minimizing postoperative complications (Radlinsky, 2013).

4/ Postoperative management

Following subtotal colectomy, intravenous fluids, opioid analgesics (e.g., butorphanol tartrate or buprenorphine or oral tramadol) and antimicrobials should be administered (see Table 1). If gross spillage occurred or may have occurred intra-operatively, postoperative use of antimicrobials (e.g., amoxicillin, ampicillin or amoxicillin-clavulanic acid) should be continued for 7 days.

Early spontaneous eating is encouraged, and food should be offered as soon as the patient appears interested at the latest within 12 hours of surgery. However, it is not uncommon for a cat to show little or no interest in food while hospitalized. If the patient is otherwise bright and alert, normothermic and comfortable or only mildly tense on abdominal palpation, then it is reasonable to discharge the cat 2 days after surgery and have its owner monitor its food intake. Often, they will resume eating once they are home.

5/ Complications and expected outcome

Reported complications of total or subtotal colectomy in cats include leakage or dehiscence of the anastomosis site, abscessation and peritonitis, intestinal ischemia and necrosis, transient or persistent diarrhea, constipation, recurrence of megacolon (White, 2002; Fossum, 2013). Life-threatening postoperative complications (dehiscence, stricture) following colectomy are uncommon and can be minimized using excellent technique and attentive postoperative care.

The risk of leakage, dehiscence and stricture formation at the anastomosis site may be minimized via fastidious tissue handling, minimizing intra-operative spillage, avoiding a luminal disparity and creating a tension-free anastomosis. Clinical signs of breakdown of the anastomosis site most commonly occur within 2 to 7 days postoperatively and include some or all of the following: lethargy, anorexia, vomiting, pyrexia and discomfort

Table 1. Drugs for use in the peri-operative period for colectomy.

Drug	Dose and route	Duration	Indication
Cefoxitin	22 mg/kg IV	q90 minutes	Starting at time of anesthetic induction and continued until skin is closed
		q8h × 24 hours	Immediately postoperative
Amoxicillin-clavulanic acid	13.25 mg/kg PO	q8-12h × 7 days	Postoperative, if gross spillage occurred during surgery
Amoxicillin	22 mg/kg PO	q8h × 7 days	Postoperative, if gross spillage occurred during surgery
Ampicillin	22 mg/kg IV	q90 minutes	Starting at time of anesthetic induction and continued until skin is closed
		q6h	Immediately postoperative
Buprenorphine	0.015-0.03 mg/kg IV	q6h × 3-5 days	Postoperative
Butorphanol tartrate	0.1-0.4 mg/kg IV or IM	q4h × 3-5 days	Postoperative
Tramadol	2-4 mg/kg PO	q8-12h × 3-5 days	Postoperative

IV = intravenous, IM = intramuscular, PO = oral.

on abdominal palpation **(Table 2)**. A hemogram may reflect a neutrophilia with a left shift, and an abdominal ultrasound may reveal a fluid pocket adjacent to the anastomosis site, free fluid in the abdomen and/or may indicate inflammation of the mesenteric fat adjacent to the anastomosis site. Any free fluid in the peritoneal space should be aspirated using a fine needle and evaluated cytologically for neutrophils +/- intracellular bacteria, all of which suggest dehiscence. Within 7 to 10 days postoperatively, the origin of any free gas in the abdomen may be difficult to differentiate between intestinal surgical site dehiscence and residual air from the recent laparotomy. Free gas in this case should be interpreted in light of other clinical signs suggesting dehiscence.

Postoperative diarrhea is common and may result from peri-operative antimicrobial administration and/or resection of the water-absorbing colon. The remaining intestinal villi usually hypertrophy and assume a water-absorbing function within 2 to 3 months postoperatively, resulting in a gradual improvement in diarrhea in most cats. A small population of cats may have life-long loose stools (Rosin, 1988, Rosin, 1993). Clients should be reassured that incontinence is unlikely since the anal sphincter is not affected by surgery. Postoperative constipation may be treated conservatively as described earlier in this issue; however, failure to respond to medical management for constipation after colectomy may result in euthanasia.

Although colectomy is a last resort, the long-term clinical outcome of subtotal colectomy in cats for management of refractory chronic constipation with megacolon is good to excellent and should be recommended to owners when medical management of their cat's obstipation has not been successful.

Table 2. Clinical and diagnostic signs suggestive of intestinal dehiscence

Clinical signs	Diagnostic findings
• Lethargy • Inappetence or anorexia • Vomiting • Tense or painful abdomen on palpatation • Pyrexia	• Ultrasound: Fluid pocket around anastomosis site or free fluid in the abdomen. • Free gas in the abdominal cavity may support dehiscence or may be residual from the recent laparotomy • Cytology (from fine-needle aspiration [FNA] of fluid): Suppurative inflammation with or without intracellular and extracellular bacteria.

14. Frequently Asked Questions (FAQs)

Q: *What is one of the most commonly overlooked causes of constipation in cats?*
A: Pain (from a musculoskeletal, neurologic, gastrointestinal or urogenital condition). This results in a decreased ability for the patient to ambulate to and into the litter box and/or pain when attempting to defecate.

Q: *What is the most common underlying cause of constipation in cats?*
A: Inadequate cellular water content. When evaluating a cat for constipation, it is critical that the patient's hydration status be assessed and normalized.

Q: *Can a cat be constipated without showing signs of tenesmus?*
A: Yes. Tenesmus refers to difficulty during the act of defecation. If the cat has too much pain or is otherwise uncomfortable assuming the position of defecation, constipation may develop without overt signs of tenesmus.

Q: *Do I need to do a rectal examination on every constipated cat?*
A: A rectal examination is essential for any cat with recurrent bouts of constipation, although not necessarily required for a first bout of constipation. Rectal examination allows the clinician to evaluate for causes of distal mechanical obstruction such as intraluminal or extraluminal masses, strictures, rectal diverticulum, narrowed pelvic canal secondary to previous fracture or prostatic enlargement.

Q: *Can dehydration be the cause of constipation if a cat has a normal physical examination with no evidence of dehydration?*
A: Yes. Dehydration is not detectable on physical examination until an interstitial fluid deficit of at least 5% occurs. Lower levels of dehydration can lead to constipation but will not be appreciated on physical examination.

Q: *Will early, aggressive treatment of constipation prevent the eventual development of megacolon?*
A: This is unknown. If there is a mechanical obstruction (such as pelvic fracture), early intervention will prevent the development of megacolon. However, for cats that develop idiopathic megacolon after chronic constipation, the underlying cause is unknown.

Q: *Does the product label provide comprehensive information regarding fiber?*
A: It is mandatory that pet food manufacturers report the percentage of crude fiber in the diet, however, this represents only the organic residue remaining after plant material has been treated and the mineral component has been extracted. In general, it underestimates the level of true dietary fiber in a diet.

Q: *Is a dry psyllium-enriched diet helpful in the management of constipation in cats?*
A: Yes. Although canned foods can contribute to hydration, it has been shown that cats fed a dry psyllium-enriched diet showed major improvement in their clinical signs. The diet was well tolerated and in most of the cats the

need for cisapride and lactulose significantly decreased. Cats being fed this (or any other dry diet) should be rehydrated by other means before relying on diet alone.

Q: *If an owner does not have the time to pursue medical management for their cat with chronic constipation, is colectomy a valid treatment option?*

A: No. Colectomy is not with out significant expense and potential morbidity and/or complications. It is recommended only as a last resort in cats who are refractory to the medical management options described. Fortunately, there are many effective conservative treatment options for constipation in cats.

Q: *If a cat presents with a healing pelvic fracture and the pelvic canal diameter is reduced by over 50%, should owners be warned of the risk of obstipation and megacolon?*

A: Yes. Development of obstipation and megacolon is reportedly common when the pelvic canal is compressed by 50% or greater. If callus has already formed, then resetting the pelvic bone segments would be challenging. Instead, this cat should be observed for early signs of constipation and may require pelvectomy if obstipation develops.

Q: *I have performed numerous gastrotomies and enterotomies for foreign body retrieval in small animals and I am comfortable with those procedures. Is performing a colectomy appropriate for my level of experience?*

A: Probably not. Colectomy is a complicated surgical procedure with a high risk of complications from bacterial spillage, luminal diameter discrepancy and incisional tension. It is advised that a colectomy only be performed by a surgeon who is experienced and comfortable with intestinal anastomoses and has advanced soft tissue handling skills.

Q: *When treating a cat for constipation, is it appropriate to start with a laxative as a therapy of choice?*

A: No. A laxative is only effective in treating constipation if the patient is well hydrated. As cellular dehydration is a very common underlying cause of constipation, the patient's hydration status should first be carefully assessed and normalized prior to administering a laxative.

Q: *Are all high-fiber diets good for managing a cat with chronic constipation?*

A: The ideal diet for treating chronic constipation in cats is one composed of both soluble (to hydrate the stool) and insoluble (to bulk up the stool) fiber sources.

Q: *When recommending a dietary fiber supplementation to an owner, is canned pumpkin as good as psyllium (Metamucil®)?*

A: No. Psyllium is a much greater concentrated source of fiber than is canned pumpkin and is therefore a better choice if the cat will ingest it.

Q: *Will lactulose affect the blood glucose levels of a diabetic cat?*

A: No. The synthetic disaccharide lactulose is not digested in the small intestine, therefore, it will not affect glycemic control in diabetic patients.

Appendix

Abbreviations

ACh = acetylcholine
CBC = complete blood count
CKD = chronic kidney disease
CRI = constant rate infusion
CT = computed tomography
DJD = degenerative joint disease
FDA = Federal Drug Administration
GI = gastrointestinal
GIT = gastrointestinal tract
IV = intravenous
IM = intramuscular
LRS = lactated Ringer's solution
Microbiota = microbial flora
MRI = magnetic resonance imaging
PCAB = Professional Compounding Accreditation Board
PCV/TS = packed cell volume/total solids
PEG = polyethylene glycol
PO = oral
PRS = pediatric rectal suppository
q4h, q6h, q8h, q12h, q24h = every 4 hours, every 6 hours, etc.
SCFAs = short-chain fatty acids
SQ = subcutaneous
TDF = total dietary fiber
Tbsp = tablespoon = 15 ml
Tsp = teaspoon = 5 ml
USP = United States Pharmacopeia

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This book has been prepared with the greatest care, taking into account the latest research and scientific discoveries. It is recommended that you refer to drug and food prescriptions and instructions, since they are likely to change. In view of the diversity and complexity of clinical cases for dogs, it is imperative to realize that any supplementary tests and therapeutic treatment described in this book are non-exhaustive. The treatments and solutions proposed can under no circumstances replace examination by a qualified veterinarian. The publisher and authors can in no way be held responsible for any failure of the suggested treatments and solutions.

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