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DIAGNOSTIC IMAGING

Radiology Hacks: Simple Tips to Increase Diagnostic Yield

GI Foreign Bodies

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In the vomiting patient, especially a young animal or one with a tendency for dietary indiscretion, ruling out mechanical obstruction secondary to a gastrointestinal foreign body is a common reason for performing survey abdominal radiographs. The first step is a careful search of the length of the gastrointestinal tract for evidence of abnormal luminal contents. Of course, some foreign objects (e.g., of mineral or metal opacity) will be easier to identify than others (e.g., soft tissue opacity or lucent foreign bodies). When foreign material is identified, or at least suspected, determining the location of this material (gastric, small intestinal, or colonic) is the next important step. Due to inherent superimposition of structures encountered in abdominal radiography, this determination can be challenging, even for experienced practitioners. Identification of concurrent imaging features suggestive of small intestinal mechanical ileus, such as two populations of bowel (with normal bowel

PHYSICAL REHABILITATION

Continued Physical Rehabilitation at Home for Post-Cranial Cruciate Ligament Repair

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During the initial phases of rehabilitation for canine cranial cruciate ligament repair surgery, the primary goal, especially for osteotomy procedures, is healthy bone healing. Now that the dog has completed his initial course of physical rehabilitation and he is healing well after surgery, what happens next?

Your client owner is most likely very eager to know when their dog can get back to his normal level of exercise and play. The answer is NOW, but the truth is that his rehabilitation isn't over, and the back-to-normal exercise protocol is a SLOW, CONTROLLED process! It is important that owners understand that they will need to continue physical rehabilitation at home for continued proper healing.

Progression from the initial phase of physical rehabilitation to the return to normal exercise will vary from patient to patient. Although each dog is

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FIGURE 1

↘ Right lateral (**A**) and VD (**B**) abdominal radiographs of a patient with a foreign body within the pyloric outflow tract. On the left lateral projection (**C**), the foreign material is outlined by gas and is seen crossing the pyloroduodenal junction.

FIGURE 2

↘ Right lateral radiograph (**A**) and VD (**B**) radiograph of a patient with a soft tissue opaque, striated foreign body in the right cranial abdomen (textile). Following pneumocolonogram, it is clear that foreign body is within the small intestine (**C**).

segments measuring less than 1.6x the height of L5 in the dog and less than 12mm in the cat)[1], supports a small intestinal localization of the foreign body, and exploratory laparotomy may be pursued. However, in cases where the patient has presented soon after ingestion, has been intractably vomiting, has a foreign body that is only partially obstructive, or has received medical management for an apparently nonobstructive foreign body, determining the location of the material may be more difficult. Accurate localization is imperative, as it will drastically change the patient's treatment plan. Following are three tips for additional radiographs that are easy to perform in the general practice setting and may increase diagnostic yield of a study when a foreign body is suspected.

Tip #1 The Left Lateral View

As a general standard, many practices obtain a two-view study of the abdomen, including right lateral and ventrodorsal (VD) images. Though a recent study suggested that obtaining three views of the abdomen instead of two did not have a statistically significant effect on diagnostic accuracy or confidence in evaluation of studies from patients presented with acute abdominal signs,[2] obtaining a left lateral view can still provide diagnostic benefit. On a left lateral projection, the gastric fundus will be dependent and the pylorus will be nondependent; as a result, gas within the gastric lumen will redistribute into the pylorus, potentially into the pyloroduodenal outflow tract, and even into the proximal duodenum. Obtaining a left lateral view as the

first image in a three-view abdominal series is more likely to highlight the pylorus and proximal duodenum with gas compared to obtaining it as the second or third view in the series.[3] Therefore, if clinical suspicion of an outflow tract obstruction or a linear foreign body is high, planning to obtain the left lateral view first may be beneficial. The presence of an outflow tract foreign body may appear as a distinct object highlighted by surrounding gas or as the lack of gas within the pyloric outflow tract (Figure 1). Because linear foreign bodies must have a proximal anchor point in order to produce their characteristic intestinal plication, the pyloric outflow tract is a very common location for these foreign bodies to lodge; one study reported up to 85% of dogs with linear foreign bodies as having material anchored in the pyloric outflow tract.[4]

DIAGNOSTIC IMAGING

FIGURE 3

↘ Right lateral radiograph (**A**) and VD (**B**) radiograph of a patient with a mineral opaque midabdominal foreign body (rock). Following pneumocolonogram, the location of the rock in the proximal descending colon is confirmed (**C**).
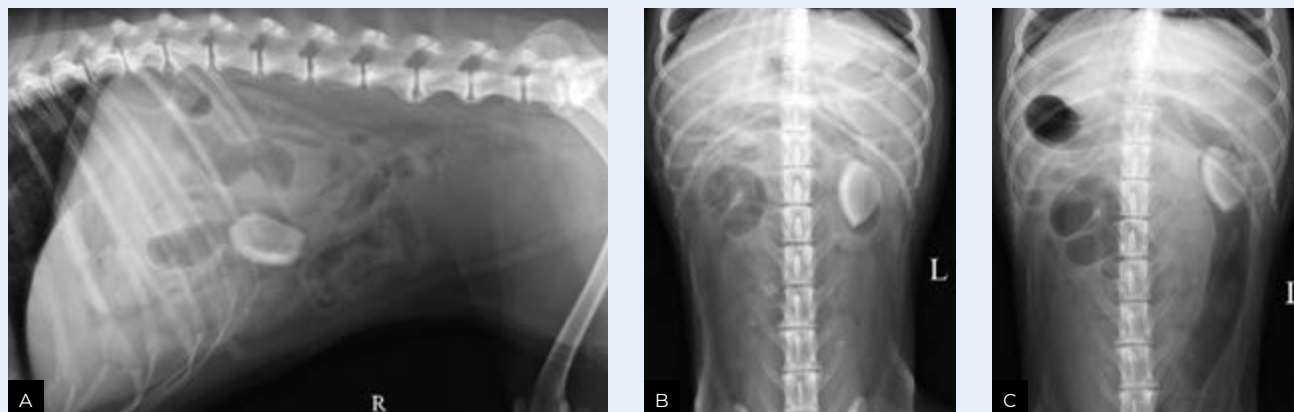

FIGURE 4

↘ Right lateral (**A**) and VD (**B**) radiographs of a patient with suspected pneumoperitoneum found on thoracic radiographs; there are linear lucencies between the serosal margin of the stomach and the diaphragm on these images. A horizontal beam VD radiograph (**C**) with the patient in left lateral recumbency demonstrates collection of free gas immediately adjacent to the body wall. The right side of the patient is marked (R).
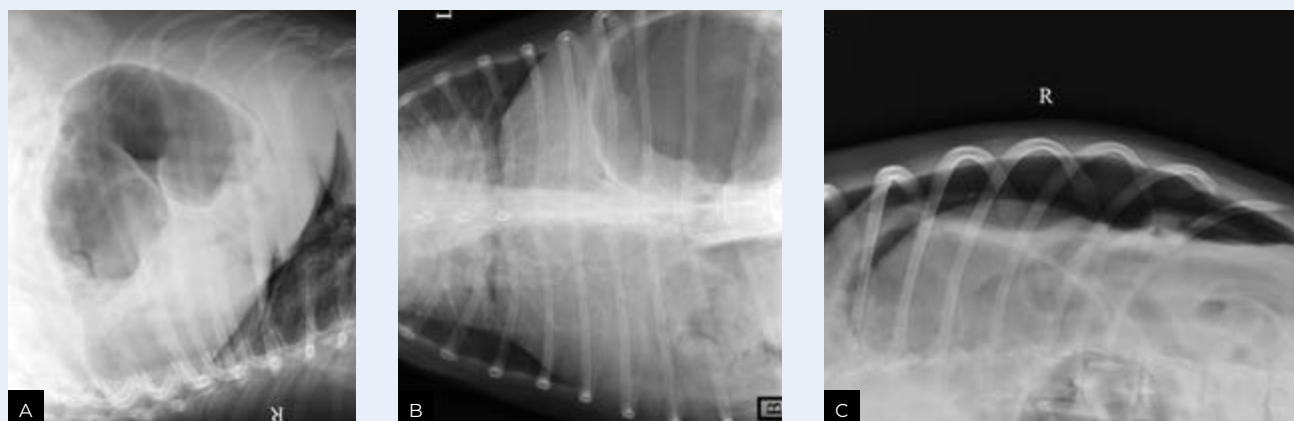
Tip #2 The Pneumocolonogram

The use of contrast media in diagnostic imaging is very common. The most recognizable contrast media, such as barium and iodinated compounds, are designated as "positive" contrast media due to their highly opaque appearance on radiographs. Alternatively, gas is designated as a "negative" contrast medium. Similar to our previous tip, where native gas was used to better visualize a particular anatomical region +/- highlight a foreign object, gas can also be infused into a hollow viscous as a negative contrast agent for the same purpose. A pneumocolonogram is an efficient and simple study that can better define the course and luminal contents of the colon. A red rubber or Foley catheter can be used. A red rubber catheter should be advanced into the distal descending colon. The Foley catheter can be positioned more caudally, even within the rectum, as partial inflation of the balloon will reduce retrograde leakage of gas. In either case, the catheter should be left in place following administration of gas. Room air is gently infused, ideally until the entire length of the colon up to the ileocecocolic junction is gas-filled. Published doses range from 1-8mL/kg[5, 6] for a dog to 20-30mL total for a cat.[7] The patient may be more comfortable and less likely to expel administered air if sedated. Additional lateral and VD radiographs are then obtained for comparison to survey radiographs (Figures 2-3). The presence of fecal material within the colon does not preclude performance of a pneumocolonogram, though it may make administration of gas slightly more difficult; when the colon contains a large volume of fecal material, it should be easily identified and a pneumocolonogram is unlikely to add diagnostic information.

Tip #3 The Horizontal Beam

The presence of free peritoneal gas in a patient with a suspected or known GI foreign body is suggestive of GI perforation and an indication for emergency surgery. In larger volumes, free gas may appear as conspicuous angular gas lucencies that highlight the serosal surface of abdominal organs; smaller volumes can appear as multifocal, round, or irregularly shaped gas lucencies not superimposed with a viscous; scant gas may be evidenced only by a subtle, stippled

PHYSICAL REHABILITATION

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unique, it is imperative to ensure that, at minimum, the return to normal exercise phase includes the following:

1. Radiographic proof of bone healing (TPLO, TTA)

2. Proof of normal stifle range of motion

3. Return of appropriate muscle mass at the surgical limb

Bone repair is typically radiographically present between eight and 12 weeks, and confirmation of appropriate bone healing is recommended before moderate impact exercises are performed.

Normal stifle range of motion[1]:

Flexion	30-45 degrees
Extension	155-170 degrees

A dog working through a formal physical rehabilitation process will typically regain appropriate muscle mass at the thigh of his surgical limb at six weeks after surgical repair.[2] The goal for quadriceps muscle mass gain at eight weeks post-surgery is equal to 80% of the girth of the contralateral limb.[3]

The most important part of transitioning a dog from his initial rehabilitation program to his normal exercise routine is to communicate the slow back-to-normal exercise routine with the dog's owner. Setting realistic goals is imperative to

the continued success of physical rehabilitation! You must take into consideration the dog's personality, his job, his home environment, and the level of at-home participation that the owner is able to offer.

Based on your discussion with the dog's owner about continuing the dog's rehabilitation at home, it is best to provide a written list of attainable exercises, demonstrate the proper exercise format, and talk through the feasibility of each exercise with the resources that the owner has at home. In human medicine, we follow the SAID (Specific Adaptations to Imposed Demands) Principle. This concept is based on the notion that the body will respond to exercises targeted to build specific muscles required to meet the demand of the activities for return to normal function. Therefore, think about the dog's job at home and assign exercises accordingly.

Remind the owner that they will most likely have to advocate for their dog to make sure that he does not overdo physical movement, which could result in high-level pain, lameness, and possible injury. Just like going to the gym after a two- to three-month break, it makes sense to GO SLOW!

Examples

ONCE BONE HEALING IS CONFIRMED

• Increase controlled leash walking to 20-30 minutes two or three times per day.

• Integrate hill walking (slow, gradual inclines).

• Assist dog with proper navigation up/down stairs once or twice per day (use harness support and proper four-beat gait).

• Assuming you do not observe any lameness, increase the walk time by five minutes per week and stair work by doubling the volume weekly.

ONCE DOG APPEARS CONFIDENT AND NONPAINFUL WITH MULTIPLE LEASH WALKS, HILLS, AND STAIRS

• Begin short periods of off-leash activity.

– Off-leash activity should be in a tightly controlled and supervised environment such as a small, fenced-in, flat-surfaced yard with no other dogs present.

– Start with very short periods of time, depending on the dog's normal energy output (one to five minutes). If the dog has high energy off-leash, then one minute may be enough, whereas if the dog typically meanders around to sniff the flowers, five minutes may work well.

– Slowly increase off-leash time over a period of two to three weeks until the dog appears confident in his movements.

– Once the dog appears confident, and if he enjoyed playing with other dogs in the past, introduce another, familiar dog into the controlled environment. Scale this new play time back to one to five minutes, based on your dog's energy with play. Always maintain control over both dogs to ensure no rough play.

ONCE DOG APPEARS COMFORTABLE WITH 15 MINUTES OF OFF-LEASH PLAY WITH ANOTHER DOG IN A CONTROLLED SETTING

• Continue the same concept with play at the park.

– Try to find quieter times at the park (early morning) when there are fewer other animals present, and begin with five minutes of off-leash play. Slowly increase this type of play until both the owner and the dog are confident in his movements.

Remind owners that keeping their dog's weight at a proper level is imperative to keeping his joints healthy by reducing joint load. It is also recommended that you instruct owners to avoid explosive and high-impact, side-to-side, "cutting" activities such as fetch, as these types of activities place a very high level of stress on
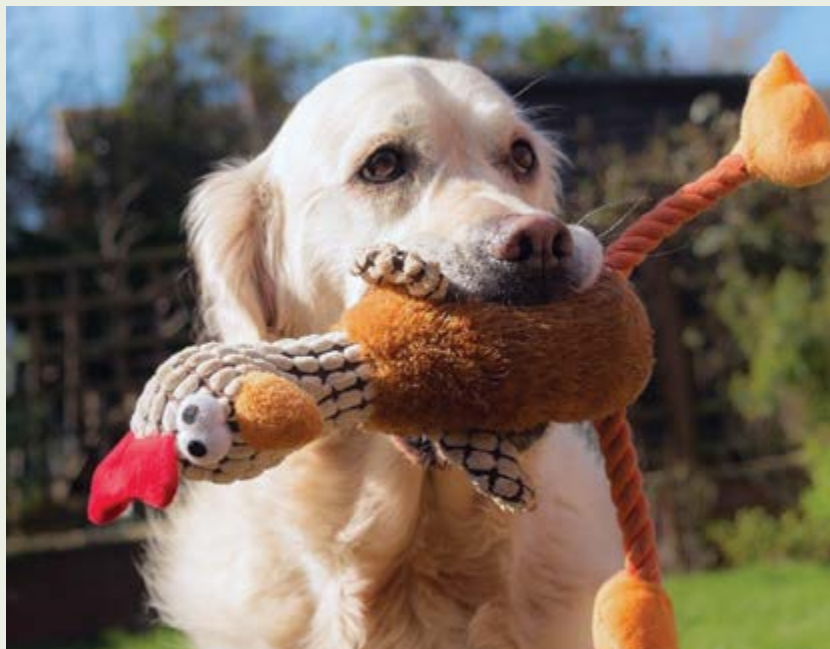
the stifle joints. Swimming is an excellent low-impact exercise that owners may offer their dog as an alternative form of exercise.

If, at any time during this back-to-normal exercise process, the dog becomes slightly lame or painful (increased limping), have the dog rest for a few days and return to the previous level of rehabilitation. There are no strict numbers on how much activity is adequate for your dog; the most important part is to avoid multiple setbacks.

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What Causes Drug Shortages?

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In recent times, drug shortages have affected most veterinarians both in private practice and academia throughout the United States. Although it seems these shortages are new, they have been occurring often over the last decade (Figure 1).[1] These shortages have not only affected veterinary medicine but also have caused major crises in human medicine, from the emergency room to the oncology wards. The causes of drug shortages are multifaceted and at this point very difficult to remedy. Currently, the U.S. is experiencing increasing frequency of drug shortages, and this is causing difficulties for hospitals, physicians, veterinarians, and patients. Patient care is adversely affected both in human and veterinary medicine due to the need to substitute safe and effective drugs with less familiar or efficacious drugs. This article will discuss the factors causing drug shortages and the ways in which supply and demand play a role in the current situation (Figure 2).[1]

The first and one of the most significant reasons for drug shortages in this country is manufacturing difficulties. There is no simple solution to this problem, as many underlying factors contribute to the difficulties in the manufacturing of drugs, including outdated equipment, a shift in the company's focus and resources from manufacturing the drug to research and development, loss of personnel, and many other factors.[1] Manufacturing plants are often antiquated, leading to faulty equipment and shutdown of certain parts of the plant. When this happens, it brings production on that particular equipment to a standstill, and since the FDA approves only a specific manufacturing line to produce a specific drug, the company cannot use other parts of the plant to produce the drug. When this occurs, the manufacturing plant needs to spend large amounts of money to repair the broken parts or on buying new equipment, which is expensive and takes time. Another cause of delay in manufacturing drugs is antitrust laws that prevent companies from sharing information. These reasons and others can lead to lags in production of drugs and shortages in supply of those drugs.

Shortages in raw materials needed to produce a drug also lead to a disruption in the supply of that particular drug. This becomes particularly problematic when the drug is produced from a single source of raw material or when the supplier discontinues production of the raw material needed.[1] Even if the drug is produced by several
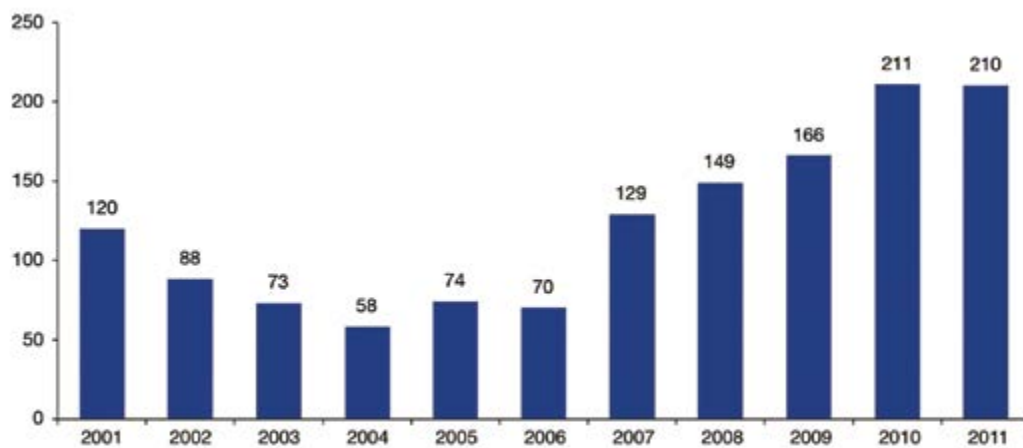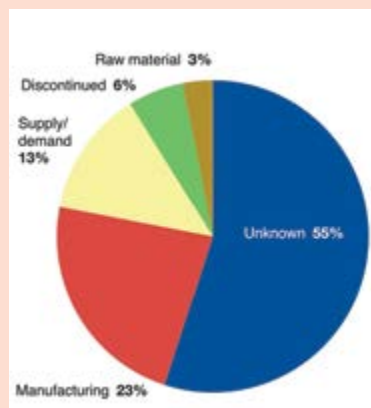
↘ Drug shortages

Figure 1 National drug shortages from January 2001 to September 15, 2011. Each column represents the number of new shortages identified during that year. (From Fox ER. University of Utah Drug Information Service.[7])

FIGURE 2

↘ Causes of drug shortages in the U.S.

different manufacturers, the absence of the raw material needed will halt production of that drug completely. The U.S. has become dependent on other countries to supply much of the raw materials needed for several drugs, and if these foreign companies have supply problems, it leads to disruption of the drug supply in the United States. Companies in places such as China, India, or Europe may have to deal with issues such as conflicts, animal diseases, contamination during export, or decreased crop yield that affect the supply of the needed raw materials.[1]

Drug recalls can lead to a disruption in the supply of a product, especially if it is only produced by one manufacturer. These recalls are usually caused by minor issues at a manufacturing plant and do not usually lead to major lags in medication supplies, but they can lead to short-term shortages. In addition to recalls, there are periods of time in which demand of a drug increases exponentially, leading to the inability of the supply of that drug to keep up. Demand for certain drugs may increase suddenly due to an outbreak in disease, such as a terrible flu season, or a change in vaccination recommendations.

One of the most frustrating reasons for a drug shortage for clinicians is a manufacturing company's business decisions. These decisions are oftentimes based on finances or profits, the

introduction of a generic version of a drug, patent expiration, expenses of manufacturing issues, or company mergers.[2] Unfortunately, generic drugs often seem to be affected; because they do not bring large profits to a company, they are not a focus of that company's manufacturing supply. Generic drugs are very important to healthcare systems and hospitals, and the lack of production of them leads to rapidly rising costs with which these hospitals cannot cope.

The FDA's regulatory oversight is often blamed for the drug shortages, but this viewpoint is not shared by the FDA. FDA officials blame manufacturing problems, and their claims are backed by data. The FDA does need to pay close attention to quality control of injectable drugs and make sure manufacturing companies are complying for safety reasons.[3] The FDA only has limited staff and at times cannot inspect a manufacturing plant in a timely manner, thereby leading to a lag in the production of a certain drug.[1]

There are other causes of drug shortages, such as issues with wholesalers or distributors, delays in transportation, poor ordering practices at healthcare facilities, or if too many facilities are using the same distributor in one region. A break in one area of the supply chain will lead to a drug shortage, whether short- or long-term. Natural disasters can lead to major drug shortages. An example of this occurred in Puerto Rico when a hurricane destroyed a major manufacturing plant, leading to shortages in mainstays in treatment such as morphine, norepinephrine, and saline. The saline shortage caused a huge problem in the treatment of patients because saline is used as flush, a diluent, and as a replacement and maintenance fluid. Although it seems simple to manufacture or compound saline since it is literally salt water, when this occurs outside of manufacturing plants, the chance of contaminants is very high.[4]

As veterinarians, we make up such a small percentage of the total demand for drugs and other manufactured products that we always fall victim to whatever is occurring in human medicine. There is a chance that the manufacturing of a veterinary-specific product could be affected, and in this case, a shortage

would most likely occur due to the lack of additional manufacturing plants available to make that product. It is important that veterinarians and their staff keep a close eye on the stock of their drugs and give themselves ample time to search for alternative sources if they are running low on a particular item. It is also important to familiarize yourself with alternative treatments for specific diseases and become comfortable using unfamiliar drugs. With more and more companies merging with each other, the chances of continued drug shortages continues to rise, and this will most likely be a topic we will be dealing with into the unforeseeable future.

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Approach to Hypertension

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One of the biggest challenges facing veterinary practitioners attempting to manage hypertension in dogs and cats is accuracy of the measurement. Unless addressing a crisis in which target organ damage is believed to have been caused by hypertension, it is often best to take repeated blood pressure measurements over time, prior to instituting therapy. Currently, there is no device for indirect blood pressure measurement that has been validated for use in conscious dogs and cats. Additionally, given the known presence of "white coat" hypertension in many of our patients, this adds to the challenge of an accurate diagnosis.

Developing a standard approach to recording the blood pressure is important, keeping a few key concepts in mind. If at all possible, the patient should be in a quiet, calm environment. In an ideal situation, the patient either has the blood pressure obtained after being in a quiet room for 5 to 10 minutes prior to an exam or has a visit dedicated solely to checking the blood pressure. In most cases, it is best if the client is present to help keep the patient relaxed. The cuff should be as close to the heart base as possible with respect to vertical distance, so the patient is often best kept in sternal or lateral recumbency. The tail can be a useful appendage since it is close to the heart base and many patients are resistant to manipulation of their feet and forelegs. In our hospital, we find the Doppler technique to be most reliable, and less affected by mild motion than the oscillometric methods such as the Petmap. However, it is important that the person operating the machine is comfortable with whatever technology they choose. When choosing a cuff size, the width should be 30-40% of the circumference of the site being used. We attempt to get at least three reliable readings during a single session, and average these to determine the value that is recorded in the record. The ACVIM consensus statement from 2018 recommends five to seven readings, throwing out the first reading of the session. The average of the readings or all readings is recorded, as well as the machine used, the site of the measurement, and the cuff size. This is crucial so that subsequent measurements are consistent. If the animal is particularly agitated, this is also recorded in the patient record. For patients in which anxiety precludes getting an accurate reading but for whom we have significant concerns, we will often recommend trying to have a house-call vet come to the client's home to see if a more meaningful result can be obtained.

Hypertension is defined as a sustained increase in systolic blood pressure. Once it has been established that a patient is hypertensive, the type of hypertension must then be determined:

1. Situational, or "white coat," hypertension

2. Secondary; associated with a disease, drug side effect, or toxin exposure

3. Idiopathic, or essential, hypertension

↘ The following algorithm has been set forth by the ACVIM for monitoring at-risk patients.
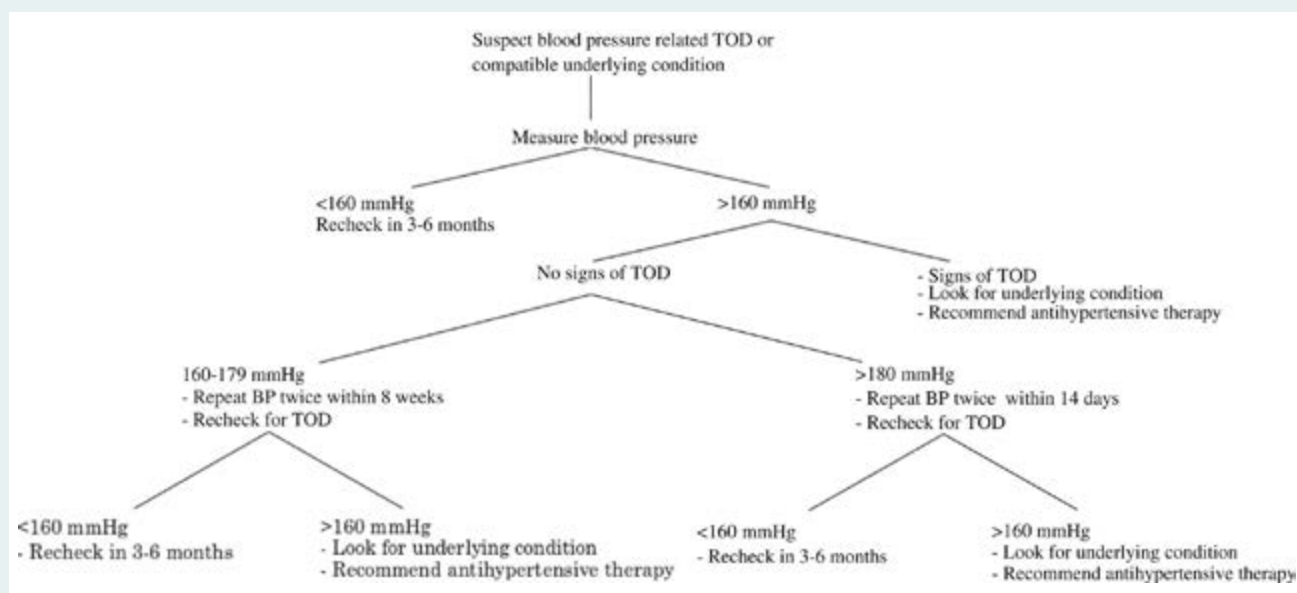
The diseases most commonly associated with hypertension in dogs include chronic kidney disease, protein-losing nephropathy, hyperadrenocorticism (naturally occurring and iatrogenic), obesity, and pheochromocytoma. Less commonly, we see primary hyperaldosteronism, diabetes mellitus, and hypothyroidism as causes.

In cats, the common causes of hypertension are chronic kidney disease, hyperthyroidism, hyperaldosteronism, obesity, and diabetes mellitus.

Drugs that are commonly associated with secondary hypertension include glucocorticoids, erythropoietic agents, phenylpropanolamine, and phenylephrine.

Hypertension can result in damage to organs, referred to as target organ damage (TOD). The specific tissues most at risk include the kidneys, brain, heart and vasculature, and eyes. Unfortunately, many of our patients don't present for treatment until they have already sustained target organ damage. Patients that present with signs of target organ damage and patients that have diseases associated with secondary hypertension or are on medications associated with hypertension all fall into the population of patients in which blood pressure should be monitored.

Because of the difficulty in obtaining accurate measurements and the low known incidence of hypertension in young, healthy animals, the ACVIM consensus statement does not recommend routine monitoring of blood pressure in healthy young patients. However, due to the possibility of occult diseases in the geriatric population, it is reasonable to institute routine screening in dogs and cats at age nine and above. At this time, in our hospital, we routinely measure blood pressure in hospitalized patients, but most of the outpatients only routinely have blood pressure monitored if there is underlying disease or suspected TOD.

Treatment

Once hypertension has been identified and the decision has been made to move forward with treatment, there are a number of drug classes that can be used. Renin-angiotensin-aldosterone system (RAAS) inhibitors are often the first-choice antihypertensive agents in dogs. Within this category, the ACE inhibitors have been used most frequently (see chart for dosing). An alternative choice would be an angiotensin receptor blocker (ARB) such as telmisartan, and we sometimes use these drugs concurrently, particularly in dogs with significant proteinuria that is not responsive to single-agent therapy.

Calcium channel blockers (amlodipine) are also effective antihypertensive agents, but their use

The chart following is adapted from the ACVIM consensus statement as an easy reference guide for commonly used oral antihypertensive agents for both dogs and cats.

Class	Drug	Usual Oral Dosage
Angiotensin-converting enzyme inhibitor	Benazepril	D: 0.5 mg/kg q12-24h
		C: 0.5 mg/kg q12h
	Enalapril	D: 0.5 mg/kg q12-24h
		C: 0.5 mg/kg q24h
Angiotensin receptor blocker	Telmisartan	C: 1 mg/kg q24h
		D: 1 mg/kg q24h
Calcium channel blocker	Amlodipine	D/C: 0.1-0.25 mg/kg q24h
		(up to 0.5 mg/kg in cats and dogs)
		C: 0.625-1.25 mg per cat q24h
α1 blocker	Phenoxybenzamine	D: 0.25 mg/kg q8-12h or 0.5 mg/kg q24h
		C: 2.5 mg per cat q8-12h or 0.5 mg/cat q24h
Aldosterone antagonist	Spironolactone	D/C: 1.0-2.0 mg/kg q12h
β blocker	Propranolol	D: 0.2-1.0 mg/kg q8h
		(titrate to effect)
		C: 2.5-5 mg/cat q8h
	Atenolol	D: 0.25-1.0 mg/kg q12h
		C: 6.25-12.5 mg/cat q12h

as sole agents in dogs is not recommended due to the fact that they cause preferential dilation of the afferent arterioles in the kidney, which may result in increased glomerular capillary pressure and subsequent glomerular damage. The initial use of amlodipine in conjunction with an ACE inhibitor or ARB is often instituted if hypertension is severe (SBP > 200 mmHg).

Due to dilation of the efferent arterioles caused by the RAAS inhibitors, we recommend checking a renal panel one week after instituting therapy or after a dose increase, due to the possibility of reduced GFR and progressive azotemia, especially since many of these patients have renal disease.

For dogs (and cats) in which pheochromocytoma is the known or suspected cause of hypertension, an alpha blockade with phenoxybenzamine is the treatment of choice.

The use of amlodipine in cats as a first-line antihypertensive agent is recommended based on known efficacy. The ACVIM recommends

a starting daily dose of 0.625mg for cats with systolic blood pressure < 200 mmHg, and 1.25mg for cats with BP > 200 mmHG, irrespective of size.

Recently, the FDA approved telmisartan, marketed as Semintra, for treating hypertension in cats. A double-blinded placebo-controlled trial in Europe showed a statistically significant reduction in blood pressure in the telmisartan treated group compared to placebo in cats with naturally occurring hypertension. Telmisartan has not been used enough clinically in the U.S. yet to know if it will become the favored antihypertensive agent for cats.

Diuretics are often used for treatment of hypertension in human medicine, but are not recommended as first-line drugs for cats and dogs, especially since many of our patients have renal disease and are often already dehydrated.

In cats with known or suspected hyperaldosteronism, treatment with an

Differentiating Gastrointestinal Stasis from Gastrointestinal Obstruction in Domestic Rabbits *(Oryctolagus cuniculus)*

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The most common presentation for rabbits through our busy emergency service is change in appetite. Most owners are aware that rabbits should be steadily eating and defecating throughout the day. When these habits change, either acutely or over several days, evaluation by a veterinarian is warranted. Early differentiation between gastrointestinal stasis and gastrointestinal (GI) obstruction is crucial and changes the treatment plan and prognosis. A systematic approach to an anorexic rabbit allows for an earlier diagnosis and appropriate case management.

Rabbits are monogastric hind-gut fermenters that have specific dietary requirements for normal dental and gastrointestinal health. Wild rabbits are considered browsers, as they are selective in what they ingest. Their digestive anatomy and physiology allow for efficient digestion and nutrient extraction from a high-fiber diet with low gut fill compared to grazers like cattle. This is in part due to the expulsion of high-fiber fecal content and packaging of nutrient-dense cecotropes for reingestion.

Gastrointestinal stasis acts as an umbrella term for decreased appetite or fecal production. This syndrome can also be described as ileus, since gastrointestinal contractions have slowed or diminished. Owners will report that fecal pellets are smaller, dryer, or fewer in number over several days. Appetite may also be diminished, and some patients will only accept treats or their favorite food items. A variety of underlying causes can contribute to the symptoms displayed, and these different etiologies will alter the treatment plan implemented. Diet, underlying health condition, pain, or stress can all contribute to the onset of gastrointestinal stasis. A thorough history of the signs displayed prior to presentation as well as the husbandry provided at home will offer clues.

Diet is often one of the largest contributing factors to gastrointestinal stasis. Rabbits provided with unlimited hay, making up more than 50% of their diet, will consume an appropriate amount of indigestible fiber. This fiber plays an important role in gut motility and transit time by stimulating peristalsis throughout the GI tract. Rabbits unintentionally consume hair through grooming, but unlike other animals, they lack the ability to vomit hairballs back up. This is inability to vomit is due to a narrow cardiac sphincter in the stomach. As a result, the movement of hair through the gastrointestinal tract relies on continuous peristaltic contractions. A diet lacking fiber allows for excessive hair to build up in the stomach, which results in anorexia. Dehydration of the gastric contents develops, followed by eventual discomfort that further contributes to hypomotility. Indigestible fiber also plays an important role in the sorting and transfer of soluble (digestible) fiber at the ileocecocolic junction. Diets low in fiber can also result in cecal dysbiosis, or the disruption of the delicate balance of organisms within the rabbit's digestive tract. The cecum acts as a large fermentation vat composed of many types of anaerobic organisms, such as *Bacteroides* species, gram-negative oval and fusiform rods, amoeba, and protozoa. The cecum also harbors a species of Sarcomyces yeast (*Cyniclomyces guttulatus*) in low numbers under normal circumstances. One of the most common ways that owners unknowingly contribute to cecal dysbiosis is by feeding rabbits food items that are too high in simple sugars and starches. These diets typically also have reduced fiber content, which results in cecocolic hypomotility. When the normal flora population is exposed to carbohydrates for long periods of time, excessive fermentation occurs, and the populations of organisms shift. Yeast proliferate, and the typically low numbers of *Escherichia coli* and *Clostridium* species begin to multiply, resulting in soft stool or in severe cases, true diarrhea. The excess glucose allows *Clostridium* to create iota-toxin, which can result in enterotoxemia and death.

FIGURE 1

↘ GI stasis
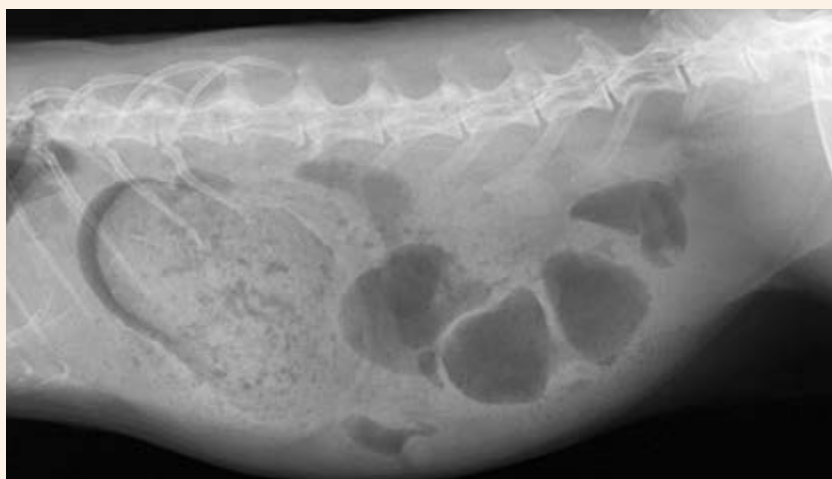
Gastrointestinal stasis can also be triggered by episodes of excessive stress. As a prey species, rabbits have the potential to be susceptible to changes in the patient's home or normal routine. This can be something as simple as a visitor to the household, addition of a new pet or family member, a sudden change in food, loud noises or other environmental changes, or travel (such a car ride). Each individual may to respond to these events differently. Any underlying health issues can also contribute to the onset of anorexia that may result in gastrointestinal stasis. Health issues such as dental disease, respiratory infection, *Encephalitozoon cuniculi*, urinary tract disease, or liver lobe torsion all have the potential to result in gastrointestinal stasis.

A thorough physical exam and diagnostic plan will allow a clinician to determine the underlying issue and provide appropriate treatment. However, an underlying cause is often not determined, yet patients will still respond to proper supportive care. Full-body radiographs, a complete blood count, and a chemistry panel are always recommended as a baseline workup for these patients. Radiographs often show granular material within the stomach and a gas halo outlining the ingesta (Figure 1). A variable amount of gas may accumulate throughout the intestines and cecum as fermentation continues in the absence of peristalsis. Mainstays of treatment include subcutaneous fluid therapy, analgesia, assisted feeding, and prokinetic medications. Deciding whether these patients are treated on an outpatient basis varies with the severity of clinical signs and lab results.

Gastrointestinal obstruction often has a more acute presentation than GI stasis. Owners report that their rabbit was normal earlier in the day but now seems uncomfortable and refuses to eat. The rabbit may also abruptly stop defecating. The most common site of obstruction is within the proximal duodenum due to a sharp turn of the pyloric outflow tract at the cranial duodenal flexure and subsequent narrowing of the duodenum. Another common site of obstruction is the ileocecocolic junction, where the fiber sorting occurs. The intestinal lumen narrows here as well. The most common cause of obstruction is a felted matt of rabbit fur that has been ingested from grooming. Carpet fibers, towels, and plastic can also cause obstruction. Similar to other species that have gastrointestinal obstruction, profound electrolyte abnormalities can occur, so rabbits may present as dull or obtunded. Acute gastric rupture is possible, which can result in sudden death.

When a rabbit is triaged by the emergency service for decreased appetite, one of the most important early vital signs is body temperature. All hypothermic rabbits are provided with immediate heat support using heated blankets, heated discs, incubators, or forced-air blankets. Patients presenting with gastrointestinal stasis have a normal core temperature or mild hypothermia (98-101°F). Rabbits suffering from GI obstruction may be in hypovolemic or decompensatory shock, and are often profoundly hypothermic (<98°F). Aggressive heat support is provided prior to any further diagnostics, as stress can result in cardiopulmonary arrest. Once normothermic, a brief physical exam usually reveals a distended, turgid stomach. These patients are typically painful during palpation. Analgesia is provided and radiographs obtained. In the case of proximal duodenal obstruction, the stomach will be moderately to severely enlarged with fluid and have a central gas bubble of varying size (Figure 2). If the obstruction is farther downstream or at the ileocecocolic junction, then loops of intestines upstream of the obstruction will be distended with fluid and gas. These patients need aggressive intravenous fluid support starting with a shock bolus of fluids to correct blood pressure, followed by twice maintenance fluids if the patient can support it (e.g., no known heart condition, etc.). A complete blood count and chemistry panel should always be submitted, as electrolyte abnormalities may need to be addressed. Confirming hyperglycemia, often greater than 400mg/dl, further supports a diagnosis of obstruction, as glucose is often normal to mildly elevated in cases of GI stasis. Rehydrating the gastrointestinal tract will sometimes allow for the obstruction to pass. If the stomach is severely distended, decompression with an orogastric tube can relieve some pressure on the outflow obstruction and improve the comfort of the patient. Patients are provided access to food and water, but no oral treatments are administered. Resolution of the obstruction is sometimes obvious, as the patient will no longer require heat support, will start eating, and will begin producing feces again. Repeating radiographs is recommended if improvement is ambiguous. Surgical treatment is reserved as a last resort for patients who fail medical management. Surgical prognosis is guarded, but varies from case to case.

While rabbits presenting with gastrointestinal stasis or gastrointestinal obstruction can present with similar histories and clinical signs, prompt differentiation is important so that the most appropriate treatment plan can be implemented.
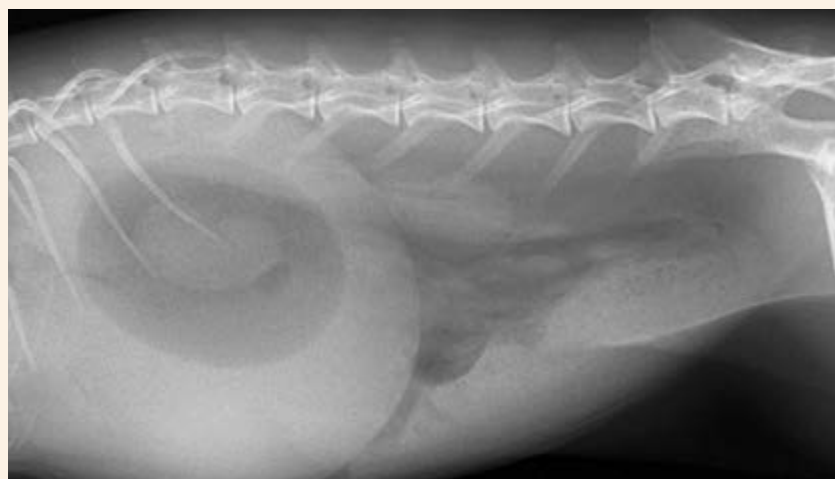
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FIGURE 2

↘ GI obstruction

Immune-Mediated Thrombocytopenia (ITP) in Dogs

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*NOTE: The abbreviation ITP is from the name for the analogous human condition, idiopathic thrombocytopenic purpura. This is the abbreviation that is used most commonly for the canine form of immune-mediated thrombocytopenia and will be used throughout this article.

Immune-mediated thrombocytopenia (ITP) is an important cause of severe thrombocytopenia in dogs. In patients with ITP, platelet autoantibodies are made and attach to the surface of platelets, targeting them for destruction by macrophages. This results in profound thrombocytopenia, with platelet counts commonly below the threshold of 30,000-50,000 platelets/uL that is considered high risk for spontaneous bleeding. ITP is a major differential to consider in any patient presenting with unexplained hemorrhage, bruising, or petechiae.

ITP can be primary, in which no underlying trigger for the immune response against platelets is discovered, or it can be secondary to another disease process or medication administration. Sulfa-based medications are commonly reported triggers for ITP, and secondary ITP should be suspected in any patient using a sulfa drug for longer than five to seven days who has unexplained thrombocytopenia, bleeding, or bruising. Other antibiotics such as penicillins and cephalosporins have also been implicated in ITP cases. Although vaccination has been associated with transient thrombocytopenia, there has been no established link between ITP and vaccination in dogs.[1] Infectious diseases, particularly tickborne infections, are frequent causes of secondary ITP. Platelet autoantibodies have been found in thrombocytopenic dogs positive for Babesia, Ehrlichia, anaplasma, leishmania, leptospirosis, heartworm, and Rocky Mountain spotted fever, indicating that immune-mediated platelet destruction is present.[2, 3] Neoplasia can also be associated with ITP, with lymphoma implicated most commonly. Treatment of secondary ITP should always include treatment of the underlying disease process or discontinuation of the triggering medication.

Although ITP can occur in any age or breed of dog, middle-aged female dogs appear to be at greatest risk, and cocker spaniels are the most commonly cited breed predisposition.[4] Patients with ITP may present with unexplained bruising, petechiae (capillary hemorrhages), bleeding, or more vague signs such as lethargy and decreased appetite. In one study, 81% of dogs presented with signs of bleeding, the most common of which was petechiae or ecchymoses (present in 66% of total ITP cases on presentation). Hematemesis, melena, and gingival bleeding were each reported in approximately 20% of cases, while less common signs of bleeding included epistaxis, hematuria, and hyphema.[4] Cavitary bleeding (such as hemoabdomen or hemothorax) is rare in patients with ITP and is more commonly noted in patients with coagulopathy. Fever is common, noted in about one third of patients in one study.[4]

Dogs with ITP typically have very low platelet counts (<50,000 platelets/uL), which puts them at risk of spontaneous bleeding. Most studies of ITP in dogs report median platelet counts on presentation in the range of 1000-5000 platelets/uL,[1, 4, 5] and another study found that dogs with ITP had lower platelet counts and a higher incidence of anemia than dogs with thrombocytopenia from any other cause.[6] ITP dogs are commonly anemic on presentation and may have other changes on a complete blood count indicative of an inflammatory response, including leukocytosis, increased numbers of band neutrophils, and toxic change. It is important to note that the presence of these changes does not necessarily indicate infection, but rather can be seen simply due to the marked systemic inflammation that occurs with ITP.

Although platelet-bound antibodies can be detected using flow cytometry, this is not commonly done, so diagnosis of ITP is typically presumptive based on the presence of severe thrombocytopenia without another explanation. Recommended diagnostic workup for possible causes of secondary ITP includes testing for tickborne diseases, as well as chest x-rays and abdominal ultrasound to look for evidence of neoplasia. While point-of-care testing such as 4dx is a useful first step in evaluation for tickborne diseases, a broader tick screening can be useful to look for other diseases such as

↘ The shaved ventral abdomen of a patient with ITP secondary to administration of trimethoprim-sulfamethoxazole, displaying petechiae and ecchymoses.

Rocky Mountain spotted fever and Babesiosis. Screening for *Babesia* infection should be considered particularly in overrepresented breeds, such as greyhounds and pit bull terriers. Due to the high prevalence of tickborne disease in New England, it is also common practice to administer doxycycline as a part of initial therapy for ITP to cover for the majority of tickborne diseases.

The mainstay of treatment for ITP is immunosuppressive corticosteroid therapy, usually given as prednisone starting at 2 mg/kg/day (or 30 mg/m^2 for larger-breed dogs). This

dose is gradually reduced once the platelet count has returned to normal, typically with dose reductions of 25% every two to four weeks. Platelet count should be monitored after each dose reduction to make sure there is no sign of relapse. Adjunctive immunosuppressive medications, including cyclosporine, mycophenolate, and azathioprine, are also frequently used in an attempt to better control the disease or reduce the corticosteroid requirement. However, there is no concrete evidence that use of these medications in addition to steroids provides a significant survival benefit when compared to steroids alone.[7] There is also no consensus on which secondary immunosuppressive drug is best; in one study, there was no difference in outcome in dogs treated with mycophenolate when compared to cyclosporine when each was used in combination with steroids.[8]

There are several other adjunctive therapies that have more tangible benefits in ITP patients. A single dose of human intravenous immunoglobulin (hIVIG) has been shown to reduce the time to platelet recovery above 40,000 platelets/uL and to reduce the required hospitalization time in ITP patients. hIVIG's beneficial effect is thought to be due to its ability to block Fc receptors on phagocytic cells, thereby reducing their ability to destroy platelets that are tagged with autoantibodies.[5] Administration of a single dose of vincristine has also been shown to speed platelet recovery, and in one study, it was found to be equivalent to hIVIG in its effect on reducing platelet recovery time and hospitalization time.[9] Since vincristine is less expensive and easier to administer than hIVIG, it is often the first choice for adjunctive therapy in ITP cases. A more novel but promising option in the treatment of ITP is the use of Romiplostim, a thrombopoietin-receptor agonist that is used to stimulate platelet production in human patients with ITP. In a small pilot study of five dogs with ITP, platelet count increased after a single dose of Romiplostim was given in four of the dogs, and the fifth dog ultimately had an increase in platelet count after repeated and increased dosing.[10] While the cost of this medication currently makes its use impractical for canine patients, it may become more widely utilized in the future.

Although ITP is a serious disease that can result in fatal hemorrhage in some cases, the prognosis is generally good, with approximately 75-90% of patients surviving to discharge from the hospital and 63-80% surviving long-term.[4, 11] Melena and elevated BUN have both been found to be negative prognostic indicators. In one study, only about 60% of patients with melena or elevated BUN survived to discharge, versus 85-90% of dogs without these changes.[4] Both melena and elevated BUN may be indicators of more severe gastrointestinal bleeding, leading to a greater transfusion requirement and worse prognosis. Reported rates of ITP relapse vary widely in recent studies, ranging from 9 to 39%.[4, 7, 11] Time to relapse of ITP also varies greatly between individuals and can occur years after initial diagnosis. Therefore, dogs with a history of ITP should still have complete blood counts monitored routinely, even when they have been in remission and off immunosuppressive medications for years.

While ITP patients often require intensive care and monitoring at the time of diagnosis, they can do very well with appropriate immunosuppressive therapy. Most patients will survive to discharge from the hospital, and many attain long-term survival.

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TECH TIP
5 Top Triage Tips for Technicians

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Triage has long been a system used in the medical field to prioritize patients presenting to a hospital based on their medical needs. While the veterinary profession has no standardized system for triage, general guidelines have been established based on human medical models.

In general, levels of triage can be categorized under 3 groups. The first level, the most critical group, includes those cases that require immediate attention to prevent loss of life. Such cases include pets who present unconscious, not breathing or in severe respiratory distress, in cardiac arrest, or with an abnormal mentation. These are patients brought immediately to a doctor for medical care. The next level of triage is urgent patients, those who require medical attention within the hour to prevent life-threatening deterioration. Examples of these patients include a hemoabdomen or gastric dilatation-volvulus (GDV), a urinary tract obstruction, or a patient having large losses from vomiting. The third level of triage includes those patients who are stable; patients who do not have life-threatening injuries or are not at risk of deterioration within 4-6 hours.

To help determine which category a patient falls into, performing a brief physical exam will assist in identifying more critical patients.[1] It is important to remember that these categories, just like the patients being assessed, are dynamic and can change after they have been evaluated. Therefore, clients should always be informed at the time of triage that if anything changes, they should communicate these changes with staff.

1. History

Obtain a concise history if time allows. Inquire about the presenting complaint, current symptoms, previous medical history, and medications the pet may be receiving. If the patient is deemed unstable on initial assessment, these inquiries may need to be addressed after initial stabilization is started. Examples of such patients include actively seizing pets, those in respiratory distress, toxin ingestion, or any patient with altered mentation or who is nonresponsive.

2. Perfusion parameters

Assessment of perfusion includes evaluating a patient's heart rate, pulse quality, mucous membranes, and capillary refill time. A patient's heart rate and blood pressure can be quick ways to assess for shock. While obtaining a blood pressure on initial triage is often not practical, pulse quality has been shown to provide a fairly accurate interpretation of whether a patient is hypotensive or normotensive.[2] Poor pulse quality, bounding pulses, or asynchronous pulses indicate a poorly perfused patient and should receive care more expeditiously. Pale pink, white, cyanotic, or injected/bright red mucous membranes also serve as indications of a poorly perfused patient or one in shock. Similarly, a prolonged capillary refill time (greater than 2 seconds) often indicates poor perfusion and further attention is required.

3. Respiratory status

Respiratory rate and pattern can be quick indicators of a critical problem as soon as the patient is brought through the doors. Patients with a respiratory rate greater than 40 should receive more immediate attention. Likewise, patients with an abdominal breathing component, inspiratory noise, shallow breathing, open-mouth breathing/gasping, or an orthopneic posture warrant further investigation.

4. Mentation

Evaluation of a patient's mental status includes assessing whether they are alert, responsive to stimuli, or nonresponsive. Any patient that is not alert should be deemed urgent until otherwise notified.

5. Comfort

Patient comfort should be addressed as soon as possible; providing this may allow an otherwise stable patient the ability to wait to be seen while more critical patients are being addressed. This would include patients

Dog with cyanotic mucous membranes

presenting with lacerations or broken bones. Conversely, providing pain relief to more critical patients immediately, such as a cat with an arterial thromboembolus or urinary tract obstruction, can alleviate some of the anxiety and suffering they are facing while receiving more aggressive stabilization.

Following these steps will help to determine which category of triage a patient falls into. It is important to remember to correlate these parameters to the patient in front of you. A young and excitable large breed dog may have an elevated heart rate and be perfectly stable or a previously healthy cat may be purring, bradycardic, and in cardiogenic shock. When in doubt, it is never wrong to follow up with a veterinarian immediately.

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appearance to the mesentery. Pneumoperitoneum of at least 0.5mL in volume can be reliably identified radiographically with increased detection rates on lateral compared to VD projections.[8] When the presence of pneumoperitoneum is questionable, the use of a horizontal x-ray beam can help identify gas accumulation in a nondependent portion of the abdomen (Figure 4). Use of this technique may be limited in private practice, as a rotating x-ray tube head is required to obtain the view. The patient should be positioned in left lateral recumbency and a VD radiograph obtained with the horizontal x-ray beam. Free abdominal gas should collect in the nondependent region of the abdominal cavity adjacent to the body wall. Left lateral recumbency is preferred, as collection of gas within the gastric fundus on a right lateral view can complicate interpretation.

Even with the use of these additional radiographic techniques, a definitive diagnosis of a GI foreign body/mechanical ileus may not be possible with radiography alone. In this situation, the use of alternative imaging modalities, such as abdominal ultrasonography or CT scan, may be required.

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aldosterone antagonist such as spironolactone is recommended. However, amlodipine is often started initially or concurrently for adequate blood pressure control.

Beta blockers are often used in hyperthyroid cats, especially in the face of severe tachycardia and cardiac dysfunction with hypertrophic cardiomyopathy.

Emergency management is needed in patients that present with acute and sometimes life-threatening signs of TOD, such as seizures, collapse, acute blindness, severe arrhythmias, etc. These cases should be referred to a 24-hour emergency facility for parenteral therapy and careful monitoring, to achieve a sustained but controlled reduction in blood pressure.

Once therapy has been instituted, it is recommended to recheck the blood pressure again for clinically stable patients in approximately one week and adjust dosing as needed. If at all possible, it is useful to have the same doctor or technician perform the repeat measurement for consistency.

Blood pressure measurement remains a challenging task in veterinary medicine, especially in light of situational hypertension. However, when combining the results of repeated measurements with the clinical picture, we stand to gain valuable information for our patients and have a greater chance of meaningful therapeutic intervention prior to development of significant TOD. As more widespread use of newer therapeutics comes into play, additional recommendations are sure to be forthcoming.

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↘ Dr. Laurence Sawyer, Medical Director of Angell at Nashoba.

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(W/B) Services also available at our Waltham location

↘ Our Service Locations

BOSTON & WALTHAM	BOSTON ONLY
Avian & Exotic Medicine 617 989-1561	**Anesthesiology** 617 541-5048
Behavior 617 989-1520	**Dentistry** 617 522-7282
Cardiology 617 541-5038	**Dermatology** 617 524-5733
Diagnostic Imaging 617 541-5139	**Nutrition** 617 522-5011
Internal Medicine 617 541-5186	**Oncology** 617 541-5136
Neurology 617 541-5140	**Ophthalmology** 617 541-5095
Physical Rehabilitation** 781 902-8400	**Pain & Palliative Care** 617 541-5140
Surgery 617 541-5048	**Pathology*** 614 541-5014

24/7 Emergency & Critical Care ■ Boston: 617 522-5011 ■ Waltham: 781 902-8400

*Boston-based pathologists serve both Boston and Waltham locations **Available only in Waltham

angell
Kindness and Care for Animals®

We mail one complimentary copy of our newsletter to each of our referring partners. Please circulate this copy within your practice.

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Please consider adding Angell's main numbers to your after-hours phone message.

■ angell.org/directions (free parking) ■ angell.org/hours ■ angell.org/ce

↘ Angell Now Offering High Flow Oxygen Therapy

Angell's Emergency/Critical Care service in Boston is pleased to offer High Flow Oxygen Therapy (HFOT) for patients in respiratory need. HFOT can be a lifesaving option for patients in acute respiratory distress that are not responding to traditional oxygen therapy (oxygen cages or unilateral/bilateral nasal cannulas) and require more aggressive oxygen therapy, short of mechanical ventilation.

What is HFOT?

HFOT has been used in human medicine as a bridge between traditional oxygen therapy and mechanical ventilation. There is limited veterinary research over the last three years evaluating HFOT in healthy dogs and dogs with moderate-to-severe hypoxemia, which has demonstrated a significant increase in PaO2 with initiation of HFOT.

When should I consider it?

HFOT is a therapy for patients in mild to moderate forms of respiratory distress and hypoxemia, such as:

· Intermediate therapy between traditional oxygen and mechanical ventilation

· Targeted oxygen weaning with specific FiO2

· Hypoxemia refractory to traditional oxygen therapy, such as:

– Pneumonia
– Pulmonary contusions
– ARDS
– Post-ventilation weaning
– Post-op anesthetic recovery
– Post-BAL / tracheal wash recovery
– Brachycephalic animals
– +/- pulmonary edema conditions (NCPE, cardiac)

HFOT allows for warming and humidification of air to provide greater patient comfort and potentially reduce airway inflammation, increased mucociliary clearance, alveolar recruitment, dead-space washout, and reduced work of breathing.

Traditional oxygen therapy uses flow rates of 100 mL/kg/min compared to HFOT, which uses up to 40 L/min. HFOT is a safe and effective method for oxygen delivery for critically ill patients with respiratory disease.

For more information, visit angell.org/HFOT or contact our Emergency & Critical Care team at 617 522-7282.