2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats

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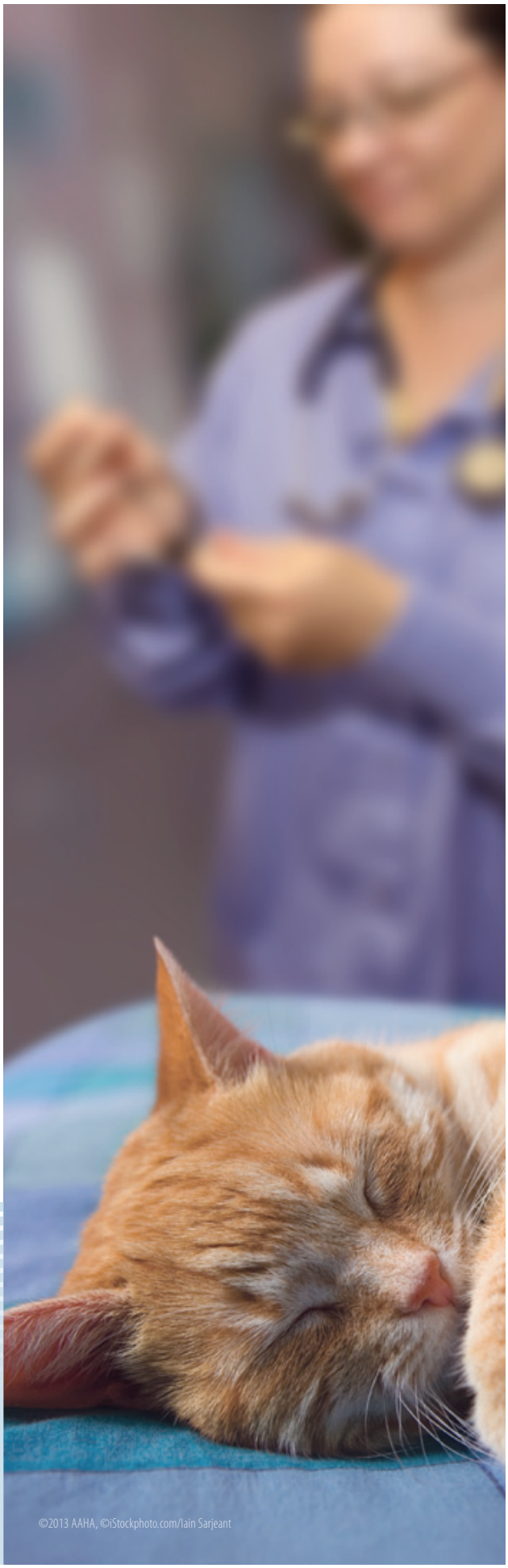

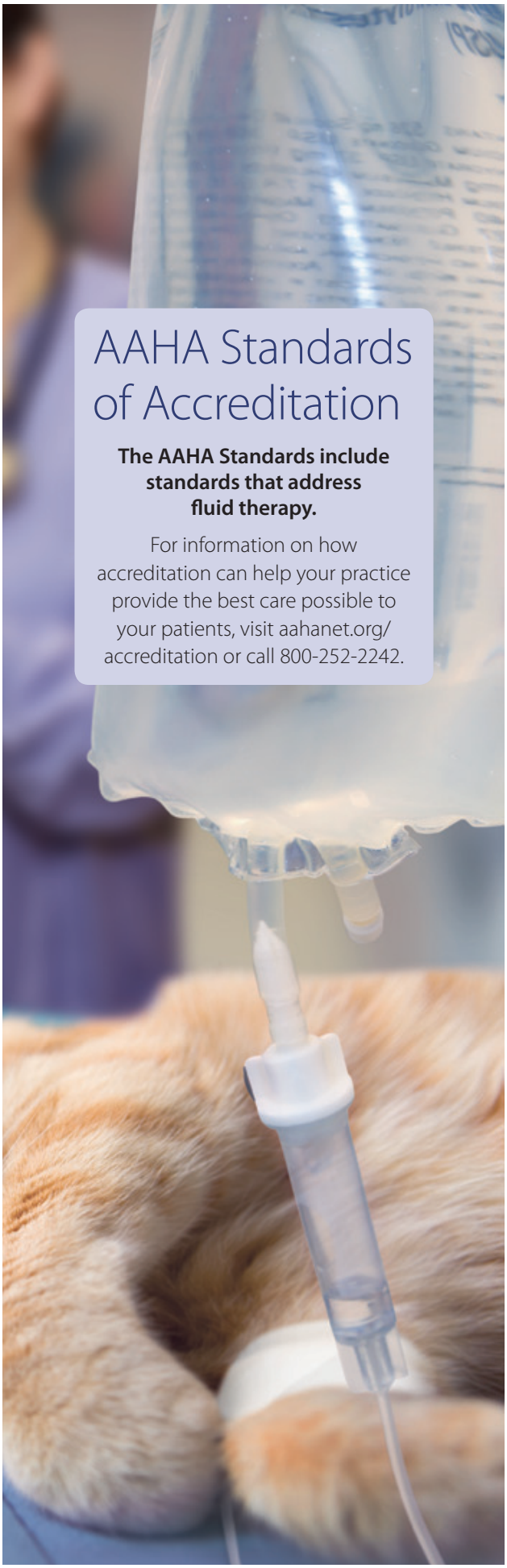

AAHA Standards of Accreditation

The AAHA Standards include standards that address fluid therapy.

For information on how accreditation can help your practice provide the best care possible to your patients, visit aahanet.org/accreditation or call 800-252-2242.

Why Guidelines Matter

Veterinary practice guidelines, such as the recently published *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats*, help to ensure that pets get the best possible care. Guidelines keep your hospital staff—from medical director to veterinary assistant—on the cutting edge of veterinary medicine.

The *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats* is the most complete and medically sound compilation of updates, insights, advice and recommendations ever developed for helping to ensure that your patients receive appropriate, individualized fluid therapy.

AAHA guidelines review the latest information that helps the veterinary team address treatment challenges and perform essential tasks in order to improve the health of the pet. In addition, guidelines define the role of each staff member, so everyone on the health care team can work together to offer the best-quality medical care.

Guidelines are just that—a guide established by experts in a particular area of veterinary medicine. Guidelines do not outweigh the veterinarian's clinical judgment; instead, they help veterinarians develop and carry out treatment plans that meet each patient's needs and circumstances.

Aligning your practice's protocols with guideline recommendations is a key step in ensuring that your practice continues to deliver the best care.

To support your dedicated efforts, AAHA is pleased to offer this toolkit. Here, you'll find facts, figures, highlights, tips, client handouts and other tools you can use every day to implement the recommendations of the *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats*.

Thank you for helping to advance our shared mission to deliver the best in companion animal medical care. Together, we can make a difference!

Michael T. Cavanaugh, DVM

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AAHA Executive Director and CEO

When selecting fluid therapy products, as well as other types of products, veterinarians have a choice of products formulated for humans and those developed and approved for veterinary use. Manufacturers of veterinary-specific products spend resources to have their products reviewed and approved by the U.S. Food and Drug Administration for canine and/or feline use. These products are specifically designed and formulated for dogs and cats and have benefits for their use; they are not human generic products. AAHA suggests that veterinary professionals make every effort to use veterinary FDA-approved products and base their inventory purchasing decisions on what product is most beneficial to the patient.

Summary of Key Points

Individualized care

- Fluid therapy must be individualized and tailored to each patient.
- Therapy is constantly re-evaluated and reformulated according to changes in patient status.
- Fluid selection is dictated by the patient's needs, including volume, rate and fluid composition required, and location the fluid is needed (interstitial versus intravascular).
- The appropriate route of fluid administration depends on the patient's condition.
  - Use oral fluids for patients with a functioning gastrointestinal system and no significant fluid imbalance.
  - Use subcutaneous fluids to prevent losses. This route is not adequate for replacement therapy in anything other than very mild dehydration.
  - Use intravenous or intra-osseous fluids for patients undergoing anesthesia; for hospitalized patients not eating or drinking normally; and to treat dehydration, shock, hyperthermia or hypotension.

Fluids during anesthesia

- The decision about whether to provide fluids during anesthesia, and the type and volume used, depends on the patient's signalment, physical condition, and the length and type of procedure.
- Current recommendations are for less than 10 mL/kg/hr to avoid adverse effects of hypervolemia. Consider starting the anesthetic procedure at 3 mL/kg/hr in cats and 5 mL/kg/hr in dogs.

Maintenance fluid rates

Cat: *Formula* = 80 × body weight (kg) 0.75 *Rule of thumb* 2–3 mL/kg/hr

Dog: *Formula* = 132 × body weight (kg) 0.75 *Rule of thumb* 2–6 mL/kg/hr

Fluids for the sick patient

Assess for three types of fluid disturbances.

1. Changes in volume (e.g., dehydration, blood loss, heart disease)
   a. Fluid deficit calculation for dehydration: body weight (kg) x % dehydration = volume in liters to correct.
   b. Treatment for hypervolemia includes correcting underlying disease (e.g., chronic renal disease, heart disease) decreasing or stopping fluid administration, and possibly use of diuretics.
2. Changes in content (e.g., hyperkalemia, diabetes or renal disease)
   a. In general, the choice of fluid is less important than the fact that it is isotonic. Volume benefits the patient much more than exact fluid composition. Isotonic fluids will begin to bring the body's fluid composition closer to normal, pending laboratory results that will guide more specific fluid therapy.
3. Changes in distribution (e.g., pleural effusion, edema)
   a. For pulmonary edema or pleural/abdominal effusions, stop fluid administration. For blood loss (i.e., splenic rupture), administer crystalloids, colloids or blood products.

Staffing and monitoring

- Provide staff training on assessment of patient fluid status, catheter placement and maintenance, use and maintenance of equipment related to fluid administration, benefits and risks of fluid therapy, and drug/fluid incompatibility.
- Use equipment and supplies that enhance patient safety, such as fluid pumps, small fluid bags, Luer-lock connections and Elizabethan collars.

2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats*

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Abstract

Fluid therapy is important for many medical conditions in veterinary patients. The assessment of patient history, chief complaint, physical exam findings, and indicated additional testing will determine the need for fluid therapy. Fluid selection is dictated by the patient's needs, including volume, rate, fluid composition required, and location the fluid is needed (e.g., interstitial versus intravascular). Therapy must be individualized, tailored to each patient, and constantly re-evaluated and reformulated according to changes in status. Needs may vary according to the existence of either acute or chronic conditions, patient pathology (e.g., acid-base, oncotic, electrolyte abnormalities), and comorbid conditions. All patients should be assessed for three types of fluid disturbances: changes in volume, changes in content, and/or changes in distribution. The goals of these guidelines are to assist the clinician in prioritizing goals, selecting appropriate fluids and rates of administration, and assessing patient response to therapy. These guidelines provide recommendations for fluid administration for anesthetized patients and patients with fluid disturbances.

Introduction

These guidelines will provide practical recommendations for fluid choice, rate, and route of administration. They are organized by general considerations, followed by specific guidelines for perianesthetic fluid therapy and for treatment of patients with alterations in body fluid volume, changes in body fluid content, and abnormal distribution of fluid within the body. Please note that these guidelines are neither standards of care nor American Animal Hospital Association (AAHA) accreditation standards and should not be considered minimum guidelines. Instead these guidelines are recommendations from an AAHA/American Association of Feline Practitioners (AAFP) panel of experts.

Therapy must be individualized and tailored to each patient and constantly re-evaluated and reformulated according to changes in status. Fluid selection is dictated by the patient's needs, including volume, rate, and fluid composition required, as well as location the fluid is needed (interstitial versus intravascular). Factors to consider include the following:

- Acute versus chronic conditions
- Patient pathology (e.g., acid-base balance, oncotic pressure, electrolyte abnormalities)
- Comorbid conditions

A variety of conditions can be effectively managed using three types of fluids: a balanced isotonic electrolyte (e.g., a crystalloid such as lactated Ringer's solution [LRS]); a hypotonic solution (e.g., a crystalloid such as 5% dextrose in water [D5W]); and a synthetic colloid (e.g., a hydroxyethyl starch such as hetastarch or tetrastarch).

General Principles and Patient Assessment

The assessment of patient history, chief complaint, and physical exam findings will determine the need for additional testing and fluid therapy. Assess for the following three types of fluid disturbances:

1. Changes in volume (e.g., dehydration, blood loss)
2. Changes in content (e.g., hyperkalemia)
3. Changes in distribution (e.g., pleural effusion)

The initial assessment includes evaluation of hydration, tissue perfusion, and fluid volume/loss. Items of particular importance in evaluating the need for fluids are described in **Table 1**. Next, develop a treatment plan by first determining the appropriate route of fluid administration. Guidelines for route of administration are shown in **Table 2**.

Consider the temperature of the fluids. Body temperature (warmed) fluids are useful for large volume resuscitation but

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*This document is intended as a guideline only. Evidence-based support for specific recommendations has been cited whenever possible and appropriate. Other recommendations are based on practical clinical experience and a consensus of expert opinion. Further research is needed to document some of these recommendations. Because each case is different, veterinarians must base their decisions and actions on the best available scientific evidence, in conjunction with their own expertise, knowledge, and experience. These guidelines are supported by a generous educational grant from Abbott Animal Health.

AAFP, American Association of Feline Practitioners; AAHA, American Animal Hospital Association; BP, blood pressure; D5W, 5% dextrose in water; DKA, diabetic ketoacidosis; K, potassium; KCl, potassium chloride; LRS, lactated Ringer's solution

provide limited usefulness at low IV infusion rates. It is not possible to provide sufficient heat via IV fluids at limited infusion rates to either meet or exceed heat losses elsewhere.[1]

Fluids for Maintenance and Replacement

Whether administered either during anesthesia or to a sick patient, fluid therapy often begins with the *maintenance rate*, which is the amount of fluid estimated to maintain normal patient fluid balance (**Table 3**). Urine production constitutes the majority of fluid loss in healthy patients.[2,3] Maintenance fluid therapy is indicated for patients that are not eating or drinking, but do not have volume depletion, hypotension, or ongoing losses.

Replacement fluids (e.g., LRS) are intended to replace lost body fluids and electrolytes. Isotonic polyionic replacement crystalloids such as LRS may be used as either replacement or as maintenance fluids. Using replacement solutions for short-term maintenance fluid therapy typically does not alter electrolyte balance; however, electrolyte imbalances can occur in patients with renal disease or in those receiving long-term administration of replacement solutions for maintenance.

Administering replacement solutions such as LRS for maintenance predisposes the patient to hypernatremia and hypokalemia because these solutions contain more sodium (Na) and less potassium (K) than the patient normally loses.Well-hydrated patients with normal renal function are typically able to excrete excess Na and thus do not develop hypernatremia. Hypokalemia may develop in patients that receive replacement solutions for maintenance fluid therapy if they are either anorexic or have vomiting or diarrhea because the kidneys do not conserve K very well.[4]

If using a replacement crystalloid solution for maintenance therapy, monitor serum electrolytes periodically (e.g., *q* 24 hr). Maintenance crystalloid solutions are commercially available. Alternatively, fluid made up of equal volumes of replacement solution and D5W supplemented with K (i.e., potassium chloride [KCl], 13–20 mmol/L, which is equivalent to 13–20 mEq/L) would be ideal for replacing normal ongoing losses because of the lower Na and higher K concentration. Another option for a maintenance fluid solution is to use 0.45% sodium chloride with 13–20 mmol/L KCl added.[5] Additional resources regarding fluid therapy and types of fluids are available on the AAHA and AAFP websites.

TABLE 1

Evaluation and Monitoring Parameters that May Be Used for Patients Receiving Fluid Therapy

- Pulse rate and quality
- Capillary refill time
- Mucous membrane color
- Respiratory rate and effort
- Lung sounds
- Skin turgor
- Body weight
- Urine output
- Mental status
- Extremity temperature
- Packed cell volume/total solids
- Total protein
- Serum lactate
- Urine specific gravity
- Blood urea nitrogen
- Creatinine
- Electrolytes
- BP
- Venous or arterial blood gases
- O2 saturation

BP, blood pressure.

Fluids and Anesthesia

One of the most common uses of fluid therapy is for patient support during the perianesthetic period. Decisions regarding whether to provide fluids during anesthesia and the type and volume used depend on many factors, including the patient's signalment, physical condition, and the length and type of the procedure. Advantages of providing perianesthetic fluid therapy for *healthy animals* include the following:

- Correction of normal ongoing fluid losses, support of cardiovascular function, and ability to maintain whole body fluid volume during long anesthetic periods
- Countering of potential negative physiologic effects associated with the anesthetic agents (e.g., hypotension, vasodilation)
- Continuous flow of fluids through an IV catheter prevents clot formation in the catheter and allows the veterinary team to quickly identify problems with the catheter prior to needing it in an emergency

When fluids are provided, continual monitoring of the assessment parameters is essential (Table 1). The primary risk of providing excessive IV fluids in healthy patients is the potential for vascular overload. Current recommendations are to deliver < 10 mL/kg/hr to avoid adverse effects associated with hypervolemia, particularly in cats (due to their smaller blood volume), and all patients anticipated to be under general anesthesia for long periods of time (**Table 4**).[6–8] In the absence of evidence-based anesthesia fluid rates for animals, the authors suggest initially starting at 3 mL/kg/hr in cats and 5 mL/kg/hr in dogs. Preoperative volume loading of normovolemic patients is not recommended.

The paradigm of "crystalloid fluids at 10 mL/kg/hr, with higher volumes for anesthesia-induced hypotension" is not evidence-based and should be reassessed. Those high fluid rates may actually lead to worsened outcomes, including increased body weight and lung water; decreased pulmonary function; coagulation deficits; reduced gut motility; reduced tissue oxygenation; increased infection rate; increased body weight; and positive fluid balance, with decreases in packed cell volume, total protein concentration, and body temperature.[9,10] Note that infusion of 10–30 mL/kg/hr LRS to isoflurane-anesthetized dogs did not change either urine production or O_2 delivery to tissues.[11] A fluidconsuming "third space" has never been reliably shown, and, in humans, blood volume was unchanged after overnight fasting.[12]

Preanesthetic Fluids and Preparing the Sick Patient

Correct fluid and electrolyte abnormalities in the sick patient as much as possible before anesthesia by balancing the need for preanesthetic fluid correction with the condition requiring surgery. For example, patients with uremia benefit from preanesthetic fluid administration.[13] Further, develop a plan for how fluids will be used in an anesthesia-related emergency based on individual comoribund conditions, such as hypertrophic cardiomyopathy and oliguric/polyuric renal disease.

Monitoring and Responding to Hypotension During Anesthesia

Blood pressure (BP) is the parameter often used to estimate tissue perfusion, although its accuracy as an indicator of blood flow is not certain.[11,14,15] Hypotension under anesthesia is a frequent occurrence, even in healthy anesthetized veterinary patients. Assess excessive anesthetic depth first because it is a common cause of hypotension.[7,16] Exercise caution when using fluid therapy as the sole method to correct anesthesia-related hypotension as high rates of fluids can exacerbate complications rather than prevent them.[10,11]

If relative hypovolemia due to peripheral vasodilation is contributing to hypotension in the anesthetized patient, proceed as described in the following list:

- Decrease anesthetic depth and/or inhalant concentration.
- Provide an IV bolus of an isotonic crystalloid such as LRS (3–10 mL/kg). Repeat once if needed.
- If response is inadequate, consider IV administration of a colloid such as hetastarch. Slowly administer 5–10 mL/kg for dogs and 1–5 mL/kg for cats, titrating to effect to minimize the risk of vascular overload (measure BP every 3–5 min).[9] Colloids are more likely to increase BP than crystalloids.[15]
- If response to crystalloid and/or colloid boluses is inadequate and patient is *not* hypovolemic, techniques other than fluid therapy may be needed (e.g., vasopressors or, balanced anesthetic techniques).[9]
- Caution: Do not use hypotonic solutions to correct hypovolemia or as a fluid bolus because this can lead to hyponatremia and water intoxication.

Postanesthetic Fluid Therapy

Postanesthetic fluid administration varies based on intra-anesthetic complications and comorbid conditions. Patients that may benefit from fluid therapy after anesthesia include geriatric patients and patients with either renal disease or ongoing fluid losses from gastrointestinal disease. Details regarding anesthesia management may be found in the *AAHA Anesthesia Guidelines for Dogs and Cats.*[17]

Fluid Therapy in the Sick Patient

First, determine the *initial rate and volume* based on whether the patient needs whole body rehydration or vascular space volume expansion. Next, determine the fluid type based on replacement and maintenance needs as described in the following sections. Fluid therapy for disease falls into one or more of the following three categories: the need to treat changes in volume, content, and/or distribution.

Typically, the goal is to restore normal fluid and electrolyte status as soon as possible (within 24 hr) considering the limitations of comoribund conditions. Once those issues are addressed, the rate, composition, and volume of fluid therapy can be based on ongoing losses and maintenance needs. Replace the deficit as well as normal and abnormal ongoing losses simultaneously (e.g., continued vomiting/diarrhea as described below in the "Changes in Fluid Volume" section). Accurate dosing is essential, particularly in small patients, to prevent volume overload.

Monitor Response to Fluid Therapy

Individual patients' fluid therapy needs change often. Monitor for a resolution of the signs that indicated the patient was in need of fluids (Table 1). Monitor for under-administration (e.g., persistent increased heart rate, poor pulse quality, hypotension, urine output), and overadministration (e.g., increased respiratory rate and effort, peripheral and/or pulmonary edema, weight gain, pulmonary crackles [a late indicator]) as described in Table 1. Patients with a high risk of fluid overload include those with heart disease, renal disease, and patients receiving fluids via gravity flow.[16]

Cats require very close monitoring. Their smaller blood volume, lower metabolic rate, and higher incidence of occult cardiac disease make them less tolerant of high fluid rates.[7,18]

Changes in Fluid Volume

Examples of Common Disorders Causing Changes in Fluid Volume

Dehydration from any cause
Heart disease
Blood loss

The physical exam will help determine if the patient has whole body fluid loss (e.g., dehydration in patients with renal disease), vascular space fluid loss (e.g., hypovolemia due to blood loss), or hypervolemia (e.g., heart disease, iatrogenic fluid overload). Acute renal failure patients, if oliguric/anuric, may be hypervolemic, and if the patient ispolyuric they may become hypovolemic. Reassessment of response to fluid therapy will help refine the determination of which fluid compartment (intravascular or extravascular) has the deficit or excess.

TABLE 2

Determining the Route of Fluid Administration

Patient parameter	Route of fluid administration
Gastrointestinal tract is functional and no contraindications exist (e.g., vomiting)	Per os
Anticipated dehydration or mild fluid volume disturbances in an outpatient setting	Subcutaneous. Caution: use isotonic crystalloids only. Do not use dextrose, hypotonic (i.e., D5W), or hypertonic solutions. Subcutaneous fluids are best used to prevent losses and are not adequate for replacement therapy in anything other than very mild dehydration
Hospitalized patients not eating or drinking normally, anesthetized patients, patients who need rapid and/or large volume fluid administration (e.g., to treat dehydration, shock, hyperthermia, or hypotension)	IV or intraosseous
Critical care setting. Used in patients with a need for rapid and/or large volume fluid administration, administration of hypertonic fluids and/or monitoring of central venous pressure	Central IV

D5W, 5% dextrose in water.

Dehydration

Estimating the percent dehydration gives the clinician a guide in initial fluid volume needs; however, it must be considered an estimation only and can be grossly inaccurate due to comorbid conditions such as age and nutritional status (**Table 5**).

Fluid deficit calculation

Body weight (kg) × % dehydration = volume (L) to correct

General principles for fluid therapy to correct dehydration include the following:

- Add the deficit and ongoing losses to maintenance volumes. Replace ongoing losses within 2–3 hr of the loss, but replace deficit volumes over a longer time period. The typical goal is to restore euhydration within 24 hr (pending limitations of comorbid conditions such as heart disease).
- Frequency of monitoring will depend on the rate at which fluid resuscitation is being administered (usually *q* 15–60 min). Assess for euhydration, and avoid fluid overload through monitoring for improvement.
- Maintenance solutions low in Na should not be used to replace extracellular deficits (to correct dehydration) because that may lead to hyponatremia and hyperkalemia when those solutions are administered in large volumes.

Hypovolemia

Hypovolemia refers to a decreased volume of fluid in the vascular system with or without whole body fluid depletion. Dehydration is the depletion of whole body fluid. Hypovolemia and dehydration are not mutually exclusive nor are they always linked. Hypotension may exist separately or along with hypovolemia and dehydration (Figure 1). Hypotension is discussed under "Fluids and Anesthesia."

Common causes of hypovolemia include severe dehydration, rapid fluid loss (gastrointestinal losses, blood, polyuria), and vasodilation. Hypovolemic patients have signs of decreased tissue perfusion, such as abnormal mentation, mucous membrane color, capillary refill time, pulse quality, pulse rate, and/or cold extremity temperature.

Hypovolemia due to decreased oncotic pressure is suspected in patients that have a total protein < 35 g/L (3.5 g/dL) or albumin < 15 g/L (1.5 g/dL).[19] Patients in shock may have hypovolemia, decreased BP, and increased lactate (> 2 mmol/L).[20–22] Note that cats in hypovolemic shock may not be tachycardic.

Treating hypovolemia

When intravascular volume expansion without whole blood is needed, use crystalloids, colloids, or both. IV isotonic crystalloid fluids are the initial fluid of choice. If electrolytes such as K are needed in the emergent situation, administer through a second IV catheter. High K administration rates may lead to cardiac arrest; therefore, do not exceed 0.5 mmol/kg/hr.[23–25]

TABLE 3

Recommended Maintenance Fluid Rates (mL/kg/hr)[49]

Cats	Dogs
Formula: 80 × body weight (kg)$^{0.75}$ *Rule of thumb*: 2–3 mL/kg/hr	*Formula*: 132 × body weight (kg)$^{0.75}$ *Rule of thumb*: 2–6 mL/kg/hr

TABLE 4

Recommendations for Anesthetic Fluid Rates

- Provide the maintenance rate plus any necessary replacement rate at < 10 mL/kg/hr
- Adjust amount and type of fluids based on patient assessment and monitoring
- The rate is lower in cats than in dogs, and lower in patients with cardiovascular and renal disease
- Reduce fluid administration rate if anesthetic procedure lasts > 1 hr
- A typical guideline would be to reduce the anesthetic fluid rate by 25% *q* hr until maintenance rates are reached, provided the patient remains stable

  Rule of thumb for cats for initial rate: 3 mL/kg/hr
  Rule of thumb for dogs for initial rate: 5 mL/kg/hr

How to administer crystalloids

- Standard crystalloid shock doses are essentially one complete blood volume.[26]
- Shock rates are 80–90 mL/kg IV in dogs and 50–55 mL/kg IV in cats.
- Begin by rapidly administering 25% of the calculated shock dose. Reassess the patient for the need to continue at each 25% dose increment.
- Monitor signs as described in the patient assessment portion of this document. In general, if 50% of the calculated shock volume of isotonic crystalloid has not caused sufficient improvement, consider either switching to or adding a colloid.
- Once shock is stabilized, replace initial calculated volume deficits over 6–8 hr depending on comorbidities such as renal function and cardiac disease.

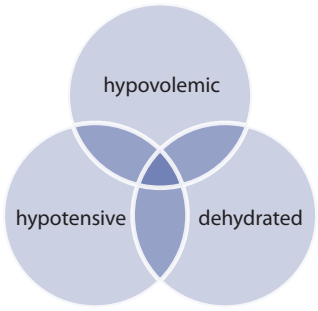

FIGURE 1

Patients may be hypovolemic, dehydrated, hypotensive, or a combination of all three.

When to administer colloids

- When it is difficult to administer sufficient volumes of fluids rapidly enough to resuscitate a patient and/or when achieving the greatest cardiovascular benefit with the least volume of infused fluids is desirable (e.g., large patient, emergency surgery, large fluid loss).
- In patients with large volume losses where crystalloids are not effectively improving or maintaining blood volume restoration.
- When increased tissue perfusion and O_2 delivery is needed.[27]
- If edema develops prior to adequate blood volume restoration.
- When decreased oncotic pressure is suspected or when the total protein is < 35 g/L (or albumin is < 15 g/L).
- When there is a need for longer duration of effect. Preparations vary, and some colloids are longer lasting than crystalloids (up to 24 hr).[28] Use of colloids can prolong the effects of hypertonic saline administration. The typical hydroxyethyl starch dose for the dog is up to 20 mL/kg/24 hr (divide into 5 mL/kg boluses and reassess). For the cat, the dose range is 10–20 mL/kg/24 hr (typically, 10 mL/kg in 2.5–3 mL/kg boluses).[29–31] Titrate the amount of colloid infused to effect.

Simultaneously administering crystalloids and colloids

- Use this technique when it is necessary to both increase intravascular volume (via colloids) and replenish interstitial deficits (via crystalloids).
- Administer colloids at 5–10 mL/kg in the dog and 1–5 mL/kg in the cat. Administer the crystalloids at 40–45 mL/kg in the dog and 25–27 mL/kg in the cat, which is equivalent to approximately half the shock dose. Titrate to effect and continually reassess clinical parameters to adjust rate and type of fluid administered (crystalloid and/or colloid).

Using hypertonic saline

- To achieve the greatest cardiovascular benefit with the least volume of infused fluids (typically reserved for large patients or very large volume losses).
- To achieve translocation of fluids from the interstium to the intravascular space (e.g., for initial management of hemorrhage).
- In animals with hemorrhagic hypovolemic shock as a fast-acting, low-volume resuscitation. Shock doses of

TABLE 5

Dehydration Assessment

Dehydration	Physical exam findings*
Euhydrated	Euhydrated (normal)
Mild (~ 5%)	Minimal loss of skin turgor, semidry mucous membranes, normal eye
Moderate (~ 8%)	Moderate loss of skin turgor, dry mucous membranes, weak rapid pulses, enophthalmos
Severe (> 10%)	Considerable loss of skin turgor, severe enophthalmos, tachycardia, extremely dry mucous membranes, weak/thready pulses, hypotension, altered level of consciousness[50]

* Not all animals will exhibit all signs.

hypertonic saline are 4–5 mL/kg for the dog and 2–4 mL/kg for the cat. Direct effects of hypertonic saline last 30–60 min in the vascular space before osmotic forces equilibrate between the intra and extravascular space. Once the patient is stabilized, continue with crystalloid therapy to replenish the interstitial fluid loss.

- In conjunction with synthetic colloids to potentiate the effects of the hypertonic saline.[28,29]
- Do *not* use hypertonic saline in cases of either hypernatremia or severe dehydration.

Treating hypovolemia due to blood loss

The decision of when to use blood products instead of balanced electrolyte solutions is based on the severity of estimated blood loss. Use of blood products is addressed elsewhere.[32,33] If blood products are not deemed necessary, note that patients with low vascular volume (due to either vasodilation or hemorrhage) will benefit more from the use of colloids than crystalloids. Following 15 mL/kg of hemorrhage, even 75 mL/kg of crystalloid will not return blood volume to prehemorrhage levels because crystalloids are highly redistributed. Large volumes may be needed to achieve blood volume restoration goals, and large volumes may be detrimental to patients with normal whole body fluid volume but decreased vascular volume resulting from acute blood loss.[34]

Hypervolemia

Hypervolemia can be due to heart failure, renal failure, and/or iatrogenic fluid overload. Hypertension is not an indicator of hypervolemia. Treatment is directed at correcting underlying disease (e.g., chronic renal disease, heart disease), decreasing or stopping fluid administration, and (possibly) use of diuretics. Consider using hypotonic 0.45% sodium chloride as maintenance fluid therapy in patients susceptible to volume overload (such as those with heart disease) due to the decreased Na load.

Hyperthermia

Increased body temperature can rapidly lead to dehydration. Treatment includes administering IV replacement fluids while monitoring for overhydration. Subcutaneous fluids are not adequate to treat hyperthermia.

Changes in Fluid Content

Examples of Common Disorders Causing Changes in Fluid Content

Diabetes
Renal disease
Urinary obstruction

Patients with body fluid content changes include those with electrolyte disturbances, blood glucose alterations, anemia, and polycythemia. Patient assessment will dictate patient fluid content needs. It is acceptable, and often desirable, to initiate fluid therapy with an isotonic balanced crystalloid solution while awaiting the electrolyte status of the patient. Tailor definitive fluid therapy as the results of diagnostic tests become available.

Hyperkalemia

Suspect hyperkalemia in cases of obvious urinary obstruction, uroabdomen, acute kidney injury, diabetic ketoacidosis (DKA), or changes on an electrocardiogram. If life-threatening hyperkalemia is either suspected or present ($K > 6$ mmol/L), begin fluid therapy immediately along with medical therapy for hyperkalemia.[35]

There are several benefits associated with administering K-containing balanced electrolyte solutions pending laboratory test results. Volume expansion associated with the fluid administration results in hemodilution and lowering of serum K concentration. The relief of any urinary obstruction results in kaliuresis that offsets the effect of the administered K. The relative alkalinizing effect of the balanced solution promotes the exchange of K with hydrogen ions as the pH increases toward normal.

Most K-containing balanced electrolyte solutions contain lower K concentrations than those typically seen in cats with urethral obstruction, so the use of such solutions does not affect blood K in those cats.[36] LRS contains 4 mmol/L, which is typically much lower than the serum K levels in cats with urethral obstruction.

Hypokalemia

Charts are available in many texts to aid in K supplementation of fluids and determination of administration rate.[37] It is essential to mix added KCl thoroughly in the IV bag as inadvertent K overdoses can occur and are often fatal. Do not exceed an IV administration rate of 0.5 mmol/kg/hr of K.[38] If hypophosphatemia exists along with hypokalemia (e.g., DKA), use potassium phosphate instead of KCl.

Hypernatremia

Hypernatremia may be common, yet mild and clinically silent.Causes of hypernatremia include loss of free water (e.g., through water deprivation), and/or iatrogenically (through the long-term use [> 24 hr] of replacement crystalloids). Another cause of hypernatremia is salt toxicity (through oral ingestion of high salt content materials).

Provide for ongoing losses and (in hypotensive patients) volume deficits with a replacement fluid having a Na concentration close to that of the patient's serum (e.g., 0.9% saline). Once volume needs have been met, replace the free water deficit with a hypotonic solution (e.g., D5W). Additionally, for anorexic patients, provide maintenance fluid needs with an isotonic balanced electrolyte solution. The cause and duration of clinical hypernatremia will dictate the rate at which Na levels can be reduced without causing

cerebral edema. *Do not exceed changes in Na levels of 1 mmol/hr in acute cases or 0.5mmol/hr in chronic cases because of the risk of cerebral edema*. Although the complexities of managing Na disorders often benefits from the involvement of a specialist/criticalist, this is not always feasible. The amount of free water (in the form of D5W) to infuse over the calculated timeframe (to decrease the Na concentration by the above guidelines) can be calculated as follows:

Volume (L) of free water (D5W) needed =
([current Na concentration/normal Na concentration] – 1)
× (0.6 × body weight [kg][33]

Hyponatremia
Hyponatremia is most commonly seen in DKA and with water intoxication. Changes in serum Na levels must occur slowly, as with hypernatremia. Monitor electrolyte levels frequently, and use a fluid with Na content similar to the measured plasma Na to keep the rate of change at an appropriate level.

In patients with water intoxication, restrict water and/or use diuretics with caution. Patients with DKA may have pseudohyponatremia associated with osmotic shifts of water following glucose into the intravascular space. In pseudohyponatremia, a relationship exists between serum glucose and serum Na levels: the higher the glucose, the lower the Na. Specifically, for every 100 mg/dL increase in serum glucose over 120 mg/dL, the serum Na will decrease by 1.6 mmol/L.[39]

Hypoproteinemia/hypoalbuminemia
Colloid osmotic pressure is related to plasma albumin and protein levels and governs whether fluid remains in the vascular space. Fluid loss into the pulmonary, pleural, abdominal, intestinal, or interstitial spaces is uncommon until serum albumin is < 15 g/L or total protein is < 35 g/L.[19,40] Evidence of fluid loss from the vascular space is used in conjunction with either serum albumin or total solid values in determining when to initiate colloid therapy.

Guidelines for fluid therapy when treating hypoalbuminemia include the following:

- Nutritional support is critical to treatment of hypoalbuminemia.
- Plasma administration is often not effective for treatment of hypoalbuminemia due to the relatively low albumin levels for the volume infused. Human serum albumin is costly and can cause serious hypersensitivity reactions.[41] Canine albumin is not readily available in most private practice settings but may be the most efficient means of supplementation when available.[42]
- Synthetic colloids (e.g., hydroxyethyl starch) are beneficial because they can increase oncotic pressure in patients with symptomatic hypoalbuminemia to maintain fluid in the intravascular space; however, synthetic colloids will not appreciably change total solids as measured by refractometry. Therefore, patient assessment determines response.[43] Use up to 20 mL/kg/day of hetastarch for dogs and 10–20 mL/kg/day for cats.[29–31]

Hyperglycemia
Fluid therapy in hyperglycemic patients is aimed at correcting dehydration and electrolyte abnormalities. Monitor the patient to guide the rate of correction. As with hyperkalemia, the choice of initial replacement fluid is not as important as correcting the patient's hydration status. See the AAHA Diabetes Management Guidelines for details on managing hyperglycemia.[44]

Hypoglycemia
Initial therapy for hypoglycemia is based on severity of clinical signs more than on laboratory findings. Treatment options include oral glucose solutions, IV dextrose-containing fluids, or food (if not contraindicated). To prepare a dilute dextrose solution of 2.5–5% dextrose, add concentrated stock dextrose solution (usually 50% or 500 mg/mL) to an isotonic balanced electrolyte solution (e.g., add 100 mL of 50% dextrose to 900 mL of fluid to make a solution containing 5% dextrose).

Anemia and Polycythemia
Blood products may be needed to treat anemia. The decision to transfuse the anemic patient is not based on either the packed cell volume or hematocrit alone, but on multiple factors as described in the "General Principles and Physical Assessment" section of this document. Use of blood products is not addressed in this document. Blood loss and hemorrhage are discussed above in volume changes.

Treatment of symptomatic polycythemia involves reducing the number of red blood cells through phlebotomy and replacing the volume removed with balanced electrolyte solutions to reduce viscosity and improve blood flow and O_2 delivery.

Multiple Content Changes
Many patients present with multiple serum chemistry abnormalities, making appropriate fluid choice problematic. The vast majority of patients will benefit from early empirical fluid therapy while awaiting lab results, knowing that more specific treatment will be tailored to individual needs as diagnostic information becomes available.

Changes in Fluid Distribution

Examples of Common Disorders Causing Changes in Fluid Distribution

Any disease causing pulmonary or peripheral edema
Any disease causing pleural or abdominal effusion

Fluid distribution abnormalities include edema (pulmonary, peripheral, interstitial) and effusions (pleural, abdominal, through the skin of burn patients). Two main causes of edema/effusion are loss of intravascular oncotic pressure and loss of vascular integrity. Consider concurrent dehydration and whole patient volume deficits when treating patients with abnormal fluid distribution.

Suggested specific approaches to fluid therapy include the following:

- Pulmonary edema/volume overload: stop fluid administration, consider diuretics, address cardiovascular disease if present, and provide mechanical ventilation with positive end-expiratory pressure (if indicated).
- Pleural/abdominal effusions: stop fluid administration, administer diuretics if indicated, address cause(s) of effusion, perform either abdomino- or thoracocentesis if respiration is compromised.

Equipment and Staffing

Staffing considerations and a description of useful equipment for delivery of fluid therapy are described below.

Staff

To optimize the success of fluid therapy, it is critical to provide staff training on assessment of patient fluid status, catheter placement and maintenance, use of equipment related to fluid administration, benefits and risks of fluid therapy, and drug/fluid incompatibility. A variety of veterinary conferences and online resources from universities and commercial vendors provide such continuing education.[45]

IV fluid administration is ideally monitored continually by trained technical staff. Without adequate monitoring, severe consequences can occur and patient care is compromised; however, there are many practices that are either unable to provide 24 hr care or are geographically unable to refer to a 24 hr facility. If it is not possible to monitor around the clock and unmonitored fluid administration is deemed necessary, take the following steps to make the process as safe as possible:

- Consider giving higher rate of fluids while staff members are present, and administer subcutaneous fluids overnight.
- Use fluid pumps whenever possible, and check them regularly for proper function and calibration.
- Use a smaller volume of fluid in the bag to reduce chance of overloading (note that even 250 mL could fatally volume-overload a small patient. Know the maximum volume for safe infusion over a given time [based on rates described in this document], and match the unattended volume to that value).
- Consider using an Elizabethan collar to prevent patient removal of the catheter.
- Luer lock connections prevent inadvertent disconnection.

General Guidelines for IV Fluid Administration

- Use a new IV line and bag for each patient, regardless of route of administration.[46]
- Ensure lines are primed to avoid air embolism.[47]
- Fluid pumps and gravity flow systems require frequent monitoring. Check patients with gravity flow systems more frequently because catheter positioning can affect rate.
- If using gravity flow, select appropriate size/volume bag for patient size, particularly in small patients, to minimize risk of inadvertent overload if the entire bag volume is delivered to the patient.
- Use a buretrol if frequent fluid composition changes are anticipated to reduce changing entire bag.
- Consider using T-ports to easily medicate a patient receiving IV fluids and Y-ports in animals receiving more than one compatible infusion.

TABLE 6

Relearning What You Thought You Knew*

- Current recommendations for routine anesthetic fluid rates are for < 10 mL/kg/hr to avoid adverse effects[6,7]
- The use of a K-containing balanced electrolyte solution does not increase blood K in cats with urethral obstruction[51]
- LRS will not exacerbate lactic acidosis[52]
- Patients with subclinical hypertrophic cardiomyopathy may be able to tolerate cautious fluid boluses for hypotension if their volume status is questionable, but they should be closely monitored for fluid overload and congestive heart failure[53]
- LRS or acetated Ringer's solution may be used in liver disease. LRS contains both D- and L-lactate and is unlikely to increase blood lactate levels[52]
- When flushing an IV catheter, normal saline is as effective as heparin solution[48,54]
- In general, the choice of fluid is less important than the fact that it is isotonic. Volume benefits the patient much more than exact fluid composition. Isotonic fluids won't have a severe negative impact on most electrolyte imbalances, and their use will begin to bring the body's fluid composition closer toward normal pending laboratory results that will inform the clinician of more specific fluid therapy[36]

* See text for details.

LRS, lactated Ringer's solution.

- Consider using a syringe pump to either infuse small amounts of fluids or to provide a constant rate infusion. For small volume infusions, place the end of the extension set associated with the small volume delivered close to the patient's IV catheter so that the infusion will reach the patient in a timely manner.
- Consider a pressure bag for the delivery of boluses during resuscitation.

Catheter Maintenance and Monitoring

- Clip the hair and perform a sterile preparation.
- Maintain strict aseptic placement and maintenance protocols to permit the extended use of the catheter.
- Place the largest catheter that can be safely and comfortably used. Very small catheters (24 gauge) dramatically reduce flow.
- Flush the catheter *q* 4 hr unless continuous fluid administration is being performed. Research suggests that normal saline is as effective as heparin solutions for this purpose.[48]
- If a nonsterile catheter is placed in an emergency setting, prepare a clean catheter site and insert a new catheter after resolution of the emergency.
- Unwrap the catheter and evaluate the site daily. Aspirate and flush to check for patency. Replace if the catheter dressing becomes damp, loosened, or soiled. Inspect for signs of phlebitis, thrombosis, perivascular fluid administration, infection, or constriction of blood flow due to excessively tight bandaging.
- To minimize the risk of nosocomial infection, the Centers for Disease Control recommend that fluid administration lines be replaced no more than *q* 4 days.[46]

Conclusion

Fluid therapy is important for many medical conditions in veterinary patients. It is dictated by many factors and is highly patient variable. Fluid selection for a given patient may change during therapy, depending on patient needs. The goal of these guidelines is to assist the clinician in prioritizing goals, selecting appropriate fluids and rates of administration, and assessing patient response to therapy.

The reader must recognize the highly individual patient variables and dynamic nature of fluid therapy. Because fluid therapy can be highly individualized in complex cases, having a relationship with a referral facility for consultation can be helpful.

Ongoing research is challenging current dogma regarding fluid administration rates, particularly rates for administration during anesthesia (**Table 6**). There are few evidence-based recommendations, and limited research has been performed related to fluid administration in veterinary patients. The reader is encouraged to be alert to future data as it becomes available and incorporate that information in practice protocols. ■

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Improve Your Practice with a **Model Protocol**

2013 AAHA/AAFP Fluid Therapy Guidelines Protocol Template

Download this template from aahanet.org/Library/FluidTherapy.aspx to prompt discussion and to record how your practice will implement the guidelines.

Hospital name
Date created/updated
Implementation date
Next review/update

Purpose: Outline the purpose of this protocol and how it furthers your practice mission/vision.

Team member(s) responsible for carrying out this protocol:

Supervisor/point person for managing implementation:

Training: Specify who is trained, on what topics and how often/when.
- Who performs training and where?

Areas to address

General:
- Use algorithms and checklists, as well as tables and charts.
- Decide when fluids will be administered in our hospital (i.e., every anesthetic procedure?).

Medical record:
- How will the fluid therapy plan be recorded?
  - Who will be responsible for doing so?
- How will monitoring be recorded?
  - Who will be responsible for doing so?
  - How often will notations be made?
- Will there be checklists used on a whiteboard, cage-side or in the surgery room?
  - If so, when/how is that information transferred to the client record?

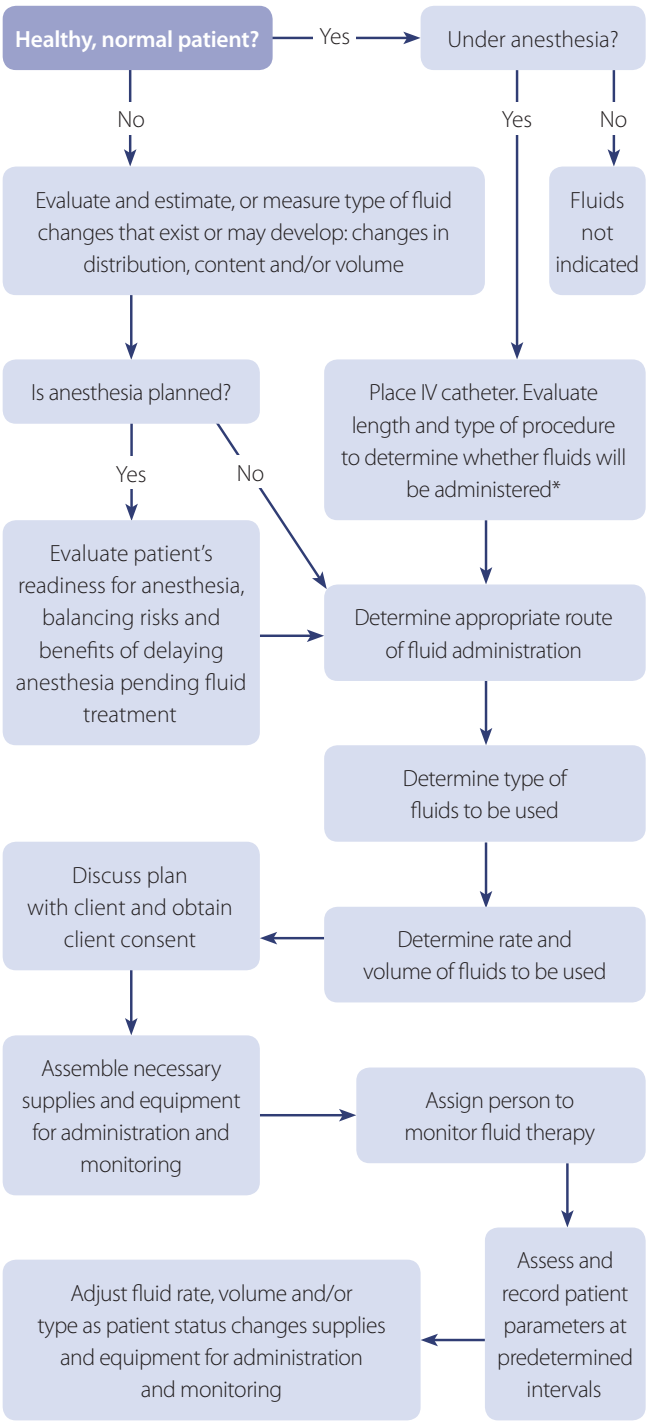
Client communication:
- Who is responsible for updating the client on patient status?

Inventory/supplies:
- What items need to be kept in stock and in what quantities?
  - *Fluids*
    - What fluids and electrolytes will we keep in stock?
    - Who is responsible for monitoring inventory levels?
  - *Supplies*
    - What supplies are essential for fluid therapy?
    - Who is responsible for monitoring inventory levels?
  - *Equipment*
    - What is the maintenance and monitoring schedule for our equipment?
    - Who is responsible?
    - Where are technical support numbers kept?
  - *Client educational materials*
    - What materials do we need and for what conditions or situations?
    - Who is responsible for ensuring clients receive appropriate materials and instructions?

Team motivation:
- How will we stay excited about fluid therapy?

Model Algorithm

Approach to Using the *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats*



*For factors to consider, please see the *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats.*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Get Everyone on Board

- Ask all team members to review the *2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats* and to arrive with questions for discussion at your next team meeting.
  - Consider holding a meeting of veterinarians and technicians to discuss how you will implement and/or integrate the guidelines into your fluid therapy protocols.
  - Hold a whole-team meeting to discuss how you plan to use the guidelines.
- Familiarize yourself with all the items in the guidelines.
- Review the parts of the toolkit and discuss how you will use each portion.
- Discuss each team member's role in fluid therapy, client communication and record-keeping.
- Discuss the ways you can inform your clients about fluid therapy (e.g., information and links on your website, as printed material, via social media and in the practice).
- Encourage questions. Only when team members are sure of the relevance of every item will they be able to make confident recommendations.

Client Service Representatives

- Be prepared to answer general client questions or to let clients know who will answer more-specific medical questions.
- Ensure that every client receives relevant printed information upon checkout. Review with them the procedures that were performed with their pet.
- Ensure that clients are aware that fluid therapy involves more than just using a product; it includes selecting appropriate fluids and monitoring the patient.

Technicians

- Discuss the entire toolkit and guidelines with the doctors. Discuss the actions that the technician will perform and which ones will be reviewed/performed by the veterinarian.
- Review and discuss with the practice manager and veterinarians the desirable location of technical materials, charts and checklists for ease of use.
- Ensure fluid therapy procedures and assessments are documented in the record.
  - Use charts and checklists as appropriate during ongoing fluid therapy. (Several checklists and charts are available in this toolkit and online at aahanet.org.)
- When discussing fluid therapy with clients, ensure they are aware that fluid therapy involves more than just using a product; it includes selecting appropriate fluids and monitoring the patient.
- Share educational materials with the client.
- Be prepared to demonstrate and coach clients in administering subcutaneous fluid therapy.

Veterinarians

- Discuss the entire toolkit and guidelines with the other veterinarians and the technicians. Determine the items that will be reviewed and/or performed by the technician and those that will be reviewed/performed by the veterinarian.
- Review/discuss with the practice manager and the technicians a desirable location of technical materials, charts and checklists for ease of use.
- Ensure fluid therapy procedures and assessments are documented in the record.
- Review the fluid therapy plan with clients before and after treatment is implemented. Ensure that clients are aware that fluid therapy involves more than just using a product; it includes selecting appropriate fluids and monitoring the patient.

Practice Manager

- Meet with the veterinarians and the technicians to discuss how the guidelines and the toolkit will be used.
- Investigate and create copies of useful supplemental information available from AAHA and the AAFP.
- Ensure there is an adequate supply of materials in appropriate locations.
  - Client education materials in exam rooms and at the reception desk
  - Technical and background information/materials in a designated location for easy access
  - Charts and checklists in treatment area
- Plan for team meetings and follow-up training to ensure the entire team is on board with the plan for fluid therapy.
  - Have team members partner up to study and then present a particular facet of the guidelines to the rest of the team.
  - Create a fun learning game to ensure everyone is on board, using partners or teams to compete. Model your learning using the format of television game shows or trivia board games.

Encourage questions. Only when team members are sure of the relevance of every item will they be able to make confident recommendations.

Answer 5 Common Client Questions

Offer facts and reassurance to help clients accept your recommendation of fluid therapy.

1 Why does my pet need IV fluids? (For the sick pet.)
"[Pet's name] is sick, and I know you want him to get better as soon as possible. Because he is not drinking normally and he's losing fluids, there are imbalances in chemicals occurring in the body that can lead to other problems, and he is becoming dehydrated. Chances are, by providing the fluids and electrolytes he needs, we can get him feeling better sooner."

2 Do I have to agree to pay for fluids during anesthesia?
Explain your practice philosophy about risk management for anesthesia and how you monitor the pet. Explain the type of procedure and any risk factors that might indicate the need for fluid therapy (e.g., length of procedure or existence of disease).

3 Why do fluids cost so much? I saw on the Internet that you can buy a bag of saline for $5. Why are you charging me so much?
"It's true that the bag of fluids doesn't cost much, but there are other factors to take into consideration. These include supplies and equipment necessary to safely administer fluids to your pet and the cost of monitoring [pet's name] to ensure he is responding to treatment. Our veterinarians choose the correct type of fluid and electrolytes based on your pet's condition; then our technicians or assistants carefully monitor [pet's name] to see how he's doing. We check the patient's status frequently throughout the day. The veterinarians may need to make changes to the amount or types of fluids he's receiving. That way [pet's name] has the best chances of getting better soon."

4 Why do you have to do this in the hospital? Can't you inject fluids under the skin like they did with my friend's cat?
"The way we administer fluids varies with the patient's condition. Some pets, mainly cats, with ongoing medical problems can be managed with subcutaneous fluids. However, that route doesn't work well in situations like this one. [Pet's name] has a better chance of recovering sooner if he can receive intravenous fluids in the hospital. We hope he can go home soon!"

5 What happens at night?
Explain what you do at night. Be sure you are in compliance with your state regulations regarding unattended pets. Offer referral to a 24-hour facility if indicated and available.

Your Pet and Fluid Therapy

What is fluid therapy?

Fluid therapy is administration of specially formulated liquids for treatment of disease or prevention of problems. More than half of body weight is water, so all animals need to take in fluids every day.

Why is fluid therapy given?

Pets normally take in enough fluids by drinking. There are many reasons a pet might not get enough fluids.

A healthy pet that is undergoing anesthesia may need to receive fluids to help maintain normal blood pressure during the procedure to replace fluids lost in surgery. In addition, the catheter serves as an access point should the need for emergency drugs arise.

A sick pet that is not drinking, or is vomiting or experiencing diarrhea also needs fluids to make up for what is not being taken in or is being lost.

Some pets have problems with organs, such as the kidneys, which prevent their bodies from utilizing the fluids they drink.

Other sick pets have problems with their electrolytes, such as sodium or potassium. Fluids are given to these pets to help bring them back to a normal electrolyte balance.

What is in the fluids?

There are several kinds of fluids and electrolytes that we can use, and our veterinarians choose the specific ones that will best help your pet. Fluids have water, of course, and they may contain sodium, potassium and/or glucose, plus other electrolytes. For the safety of your pet, all of the fluids are sterile, which requires special packaging and handling.

How are fluids given?

Fluids are generally administered through a catheter placed in your pet's vein. This is called intravenous fluid (IV) therapy. It gets the fluids into the body fairly quickly, and it allows us to measure and control the amount and rate of fluids that are administered.

Sometimes veterinarians work with pet owners so owners can give fluids to their pet at home. This type of administration is referred to as subcutaneous because the sterile fluids are placed just under your pet's skin.

This usually occurs when a pet has an ongoing condition, where the pet has received initial treatment in the hospital and then is being maintained on a regular schedule of subcutaneous fluids at home. If this is necessary for your pet, we will teach you how.

Your veterinary practice's contact information

Verify Key Tasks as You Perform Them

Use this checklist to remind yourself to perform key tasks in administering fluid therapy. Make multiple copies and laminate them so you can use them repeatedly in the surgical suite. This checklist is available as a download at aahanet.org/library/FluidTherapy.aspx.

Catheter placement, maintenance and monitoring

- Shave the area and perform a sterile preparation.
- Maintain strict aseptic placement and maintenance protocols to extend catheter life.
- Place the largest-size catheter that can be safely and comfortably used (very small catheters greatly reduce flow).
- If a catheter is placed in an emergency situation, prepare a new site and place a new catheter once the emergency is resolved.
- Flush the catheter every 4 hours unless fluids are being continuously administered. Normal saline is as effective for flushing as heparin solution.
- Unwrap and evaluate daily. Follow the steps below:
  - Aspirate and flush to check for patency.
  - Replace the catheter if the dressing becomes loose, soiled or damp.
  - Inspect for signs of phlebitis, thrombosis, perivascular fluid administration, infection or constriction of blood flow due to too-tight bandaging.

Intravenous fluid administration

- Prepare a new bag of fluids with a new administration set for each patient regardless of route of administration.
- Ensure lines are primed to avoid air embolism.
- Use Luer-lock connections when possible to prevent inadvertent disconnection.
- Select the appropriate size/volume bag according to patient size if using gravity flow to minimize the risk of volume overload if the entire volume were to be inadvertently delivered to the patient.
- Use a buretrol if frequent fluid composition changes are anticipated.
- Consider using t-ports to easily medicate a patient receiving IV fluids if the medication is compatible with the fluid type.
- Consider using a y-port in patients receiving more than one compatible infusion.
- Consider a syringe pump for small-volume infusions or for constant-rate infusions (CRIs). Place small-volume CRIs close to the patient's IV catheter so that the infusion will reach the patient in a timely manner.
- Consider a pressure bag for bolus delivery in an emergency situation.
- Follow CDC recommendations for changing fluid administration lines no more than every 4 days to reduce the chance of nosocomial infection.

Monitoring fluid therapy

- Use fluid pumps whenever possible and monitor the pump frequently.
- Monitor the patient for over-administration. Symptoms include the following:
  - Increased respiratory rate and effort
  - Peripheral and/or pulmonary edema
  - Weight gain
  - Pulmonary crackles (a late indicator)
- Monitor the patient for under-administration. Symptoms include the following:
  - Persistent increased heart rate
  - Poor pulse quality
  - Hypotension
  - Decreased urine output
- Monitor during anesthesia. Follow the steps below:
  - Assign a staff member to monitor fluid administration and patient status.
  - Consider current recommendations of an anesthetic rate less than 10 mL/kg/hr to avoid hypervolemia, especially in cats (rule of thumb start at 3 mL/kg/hr in cats and 5 mL/kg/hr in dogs).
  - Consider reducing the anesthetic rate in procedures lasting longer than 60 minutes by 25% each hour, if beginning at higher-than-maintenance rate, until the maintenance rate is reached.

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This implementation toolkit was developed by the American Animal Hospital Association (AAHA) to provide information for practitioners regarding fluid therapy for dogs and cats. The information contained in this toolkit should not be construed as dictating an exclusive protocol, course of treatment or procedure; nor is it intended to be an AAHA standard of care.

AAHA
The Standard of Veterinary Excellence

About AAHA—The American Animal Hospital Association is an international organization of nearly 6,000 veterinary care teams comprising more than 48,000 veterinary professionals committed to excellence in companion animal care. Established in 1933, AAHA is recognized for its leadership in the profession, its high standards for pet health care, and most important, its accreditation of companion animal practices. For more information about AAHA, visit aahanet.org.

American Association of FELINE PRACTITIONERS

About the American Association of Feline Practitioners—The American Association of Feline Practitioners (AAFP) improves the health and welfare of cats by supporting high standards of practice, continuing education and scientific investigation. The AAFP has a long-standing reputation and track record in the veterinary community for facilitating high standards of practice and publishes guidelines for practice excellence which are available to veterinarians at the AAFP website. Over the years, the AAFP has encouraged veterinarians to continuously re-evaluate preconceived notions of practice strategies in an effort to advance the quality of feline medicine practiced. The Cat Friendly Practice program is the newest effort created to improve the treatment, handling and overall healthcare provided to cats. Its purpose is to equip veterinary practices with the tools, resources, and information to elevate the standard of care provided to cats. Find more information at www.catvets.com.

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