Small Animals

The optimal approach to fluid therapy in awake and anesthetized patients is controversial. There are multiple studies in the human literature evaluating the clinical effects of various types of fluids, the ideal fluid volume for administration, and the optimal end points for monitoring effectiveness of fluid therapy. Similar questions have been raised in veterinary medicine; however, there is a relative lack of published research on these topics to date. Whereas current IV fluid therapy practices in various settings in human medicine have been evaluated, little is known about current fluid therapy practices in veterinary medicine. Additionally, small animal patients may receive subcutaneous fluid therapy, but this practice is poorly described in the veterinary literature.

OBJECTIVE
To determine common fluid therapy practices of small animal practitioners and identify fluid therapy–related knowledge gaps that may benefit from improved educational efforts, targeted research, or both.

DESIGN
Online survey.

SAMPLE
1,496 small animal veterinarians

PROCEDURES
An online survey was provided to members of the Veterinary Information Network between December 23, 2013, and January 30, 2014. The survey consisted of 24 questions investigating the administration of crystalloid and synthetic colloid solutions, but not blood products, and focused primarily on the choice of fluid type, frequency of administration, type of patient treated with fluids, treatment with fluids subcutaneously versus IV, and potassium supplementation of fluids. Only responses from practicing small animal veterinarians were included. Not all respondents answered every question, and some questions allowed >1 answer.

RESULTS
Balanced crystalloid solutions were the most common fluid type in all clinical scenarios described. The most common maintenance IV fluid rate reported by respondents (762/1,333 [57%]) was 60 mL/kg/d (27 mL/lb/d); calculation of fluid administration rate by means of body surface area was infrequent. Challenges of fluid therapy included determining the appropriate rate (572/1,496 [38%]) and fluid type (497/1,496 [33%]) and determining the need for potassium supplementation (229/1,496 [15%]).

CONCLUSIONS AND CLINICAL RELEVANCE
Small animal veterinarians tended to favor isotonic balanced crystalloid solutions for IV fluid therapy, compared with other common choices such as isotonic saline (0.9% NaCl) solution. Despite its ubiquity, respondents found many aspects of fluid therapy to be challenging, suggesting the need for easy to use, evidence-based guidelines. (J Am Vet Med Assoc 2018;252:553–559)

To improve use of fluid therapy in veterinary medicine, it is important to first have an understanding of current fluid therapy practices. The objectives of the study reported here were to determine, by means of an online survey of VIN members, common fluid therapy practices of small animal practitioners and identify fluid therapy–related knowledge gaps that may benefit from improved educational efforts, targeted research, or both.

Materials and Methods
A questionnaire was developed and distributed by the VIN, a password-protected online community of veterinarians. The survey consisted of 24 multiple-choice questions, (Supplementary Appendix S1, available at avmajournals.avma.org/doi/suppl/10.2460/javma.252.5.553), including 8 questions that provided an “other” option for which respondents could type a free-text response. An introduction to the survey was provided to respondents and stated that the aim of the
survey was “to increase our understanding of how fluid therapy is currently provided to dogs and cats.” There was no restriction on the number of responding veterinarians from a single practice that could answer the survey. Twenty of the 24 survey questions related to administration of crystalloid and synthetic colloid solutions; there were no questions on blood products. Questions focused primarily on the choice of fluid type, frequency of fluid administration, type of patients treated with fluids, use of subcutaneous fluid therapy, and potassium supplementation of fluids.

An email invitation with a cover letter and a link to the electronic survey was sent to all VIN members (32,898 veterinarians) on December 23, 2013, and an email reminder was sent on January 7, 2014. The survey remained open until January 30, 2014. Respondents who reported that they were practicing small animal veterinarians were included in the analysis.

Survey responses were imported into a commercial spreadsheet application. Responses to each question were collated and are reported as whole numbers and as the percentage of the total number of respondents for each question. Free-text answers to questions were listed for each response, interpreted, and then summarized.

For the purposes of the present study, we considered lactated Ringer solution and Hartmann solution to be equivalent; therefore, the term lactated Ringer solution was used to describe both. Two additional acetae-containing isotonic crystalloid solutions were considered equivalent, and the term crystalloid-I was used to describe both of these solutions. Two acetae-containing hypotonic crystalloid solutions were also considered equivalent, and the term crystalloid-H was used to describe both of these solutions.

**Results**

The online survey distributed to 32,898 VIN members was completed by 1,496 respondents; not all respondents answered all survey questions. Most (997/1,435 [69%]) respondents worked in general small animal practices, with smaller numbers working in emergency practices (173/1,435 [12%]) or small animal specialty practices (144/1,435 [10%]). The remaining 121 of 1,435 (8%) respondents who answered this question worked in general mixed-animal practice, feline-only practice, mobile-only practice, or exotics or avian practice. The year of graduation ranged from prior to 1965 to 2013. Half of respondents (557/1,103 [50%]) had graduated in the 12-year period from 2002 to 2013.

Fifty percent (693/1,378) of respondents stated that they did not know how often IV fluid therapy was used in their practice. For 253 of 1,378 (18%) respondents, IV fluid therapy was administered 1 to 2 times/wk in their practice; whereas for 370 of 1,378 (27%) respondents, IV fluid therapy was administered more than twice daily. The most common fluid types stocked by practices represented by survey respondents were isotonic saline (0.9% NaCl) solution (1,311/1,435 [91%] practices), lactated Ringer solution (1,230/1,435 [86%]), crystalloid-I (665/1,435 [46%]), and dextrose 5% in water (659/1,435 [46%]). Practices for 50% of respondents (720/1,435) stocked the synthetic colloid hetastarch. Six percent of respondents (86/1,435) reported that their practices stocked various commercially available crystalloid solutions mixed with dextrose 2.5% or 5%.

The most common fluid types reported for resuscitation of dogs in shock were lactated Ringer solution (826/1,436 [58%]), crystalloid-I (441/1,436 [31%]), isotonic saline solution (271/1,436 [19%]), and hetastarch or tetrastarch (292/1,436 [20%]). Hypotonic saline solution was used by only 103 of 1,436 (7%) respondents. The most common fluid types administered for resuscitation of cats in shock were similar: lactated Ringer solution (804/1,435 [56%]), crystalloid-I (426/1,435 [30%]), isotonic saline solution (296/1,435 [21%]), and hetastarch or tetrastarch (180/1,435 [13%]). Respondents could select >1 fluid type when answering questions; the response rate for the 2 survey questions regarding the fluid type used for resuscitation of dogs and cats was very high (1,435/1,496 [96%]).

Overall, hypertonic saline solution was administered infrequently for resuscitation of dogs and cats in shock, with 722 of 1,367 (53%) respondents reporting they never treated patients with it, 383 of 1,367 (28%) reporting that they used it rarely, 186 of 1,367 (14%) reporting that they sometimes used it, 61 of 1,367 (4%) saying that they often or always used it, and 15 of 1,367 (1%) answering that they did not know or did not remember. Of 593 respondents who treated patients with hypertonic saline solution, 259 (44%) used a solution of approximately 7.2% concentration, 62 (10%) used a solution of approximately 3.5% concentration, and 114 (19%) used a solution with a concentration other than 7.2% or 3.5%; 158 of 593 (27%) respondents did not know what concentration was used. When asked specifically about the use of a synthetic colloid solution (eg, hetastarch) for shock resuscitation, most respondents answered that they rarely (475/1,369 [35%]) or never (292/1,369 [21%]) did so. However, 378 of 1,369 (28%) respondents used synthetic colloid solutions sometimes, 195 of 1,369 (14%) used them often, and 23 of 1,369 (2%) always used them for resuscitation of dogs and cats in shock. Six of 1,369 (0.4%) respondents replied they did not know or did not remember.

Respondents were asked how often they administered IV fluids in 4 clinical scenarios (Table 1). Emergency surgical patients and unstable emergency patients received IV fluid therapy most commonly. The most common type of fluid administered for daily maintenance fluid therapy was lactated Ringer solution (762/1,333 [57%]), followed by crystalloid-I (413/1,333 [31%]). Hypotonic fluids such as crystalloid-H and hypotonic saline (0.45% NaCl) solution were used by 51 of 1,333 (3.8%) respondents. The most common maintenance IV fluid rate was 60 mL/
kg/d (27 mL/lb/d; 565/1,280 [44%]), or 2 to 4 mL/kg/h (0.9 to 1.8 mL/lb/h; 388/1,280 [30%]). Only 167 of 1,280 (13%) respondents reported using a maintenance daily IV fluid rate indexed to body surface area, such as (body weight in kg)$$^{0.75} \times 70$$ or (body weight in kg)$$^{0.75} \times 132$$.

Routine potassium supplementation of IV fluids was performed by 594 of 1,338 (44%) respondents.

Forty-one percent (545/1,338) of respondents reported never administering hypertonic fluids such as hypertonic saline solution or crystalloid-H, whereas 528 of 1,338 (39%) treated patients with them rarely, and 210 of 1,338 (16%) treated patients with them sometimes. Only 55 of 1,338 (4%) respondents used hypotonic fluids often or always. Dextrose 5% in water was also used infrequently, with 241 of 1,339 (18%) respondents never using this fluid, 649 of 1,339 (49%) using it rarely, 414 of 1,339 (31%) using it sometimes, and 35 of 1,339 (2.6%) using it often. The most common reasons selected for using dextrose 5% in water were hypoglycemia (ie, glucose support) for 725 of 1,150 (63%) respondents and hypernatremia for 314 of 1,150 (27%).

The most common fluid types for subcutaneous administration were reported to be lactated Ringer solution (841/1,328 [63%] respondents), crystalloid-I (253/1,328 [19%]), and isotonic saline solution (229/1,328 [17%]). Less than 2% of respondents (7/1,328) used dextrose 5% in water or hypotonic crystalloid solutions for subcutaneous administration. Fluids for subcutaneous administration were never supplemented with potassium by 883 of 1,344 (66%) respondents, rarely supplemented by 273 of 1,344 (20%), sometimes supplemented by 154 of 1,344 (12%), often supplemented by 30 of 1,344 (2%), and always supplemented by 4 of 1,344 (0.3%). Dextrose supplementation of fluids for subcutaneous administration was never performed by 1,160 of 1,337 (87%) respondents, rarely by 127 of 1,337 (10%), sometimes by 39 of 1,337 (3%), often by 9 of 1,337 (0.7%), and always by 2 of 1,337 (0.1%). Calcium supplementation of fluids for subcutaneous administration was never performed by 1,148 of 1,330 (86%) respondents, rarely performed by 147 of 1,350 (11%), and sometimes performed by 35 of 1,330 (3%).

When respondents were asked what they found the most challenging aspect of fluid therapy to be, 572 of 1,496 (38%) answered determining the fluid rate, 497 of 1,496 (33%) answered selection of the appropriate fluid type, 229 of 1,496 (15%) answered determining the need for potassium supplementation, and 198 of 1,496 (13%) noted other challenges. Other challenges described included maintenance of IV catheters, financial constraints of performing optimal fluid therapy, managing electrolyte abnormalities, and fluid therapy in patients with diseases such as congestive heart failure or oliguric to anuric kidney disease.

**Discussion**

In the present online survey of small animal veterinarians, we found that the most common crystalloid fluid type for IV or subcutaneous fluid therapy was lactated Ringer solution and the second most common type was crystalloid-I; hypertonic saline solution and hypotonic solutions were used relatively infrequently. Intravenous fluid therapy was commonly administered to emergency patients and often used for treatment of elective surgical patients and stable dehydrated patients. Respondents of this survey identified several areas of fluid therapy that they found challenging; as such, our findings may help direct future research and educational efforts.

Most respondents to the present survey were from small animal general practices in North America; as such, the results may not be applicable to other veterinary practice populations. Fluid therapy is an essential component of patient care, and it would appear from the results of this study that the frequency of administration of fluid therapy varies from daily to weekly depending on the practice setting. It would be expected that practices with many inpatients or that regularly perform procedures with patients un-

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**Table 1**—Treatment choices of small animal veterinarians regarding IV fluid therapy in 4 clinical scenarios on the basis of responses to an online survey.

<table>
<thead>
<tr>
<th>Frequency of IV fluid therapy</th>
<th>Elective surgical procedures</th>
<th>Emergency surgical procedures</th>
<th>Unstable emergency patients (not anesthetized)</th>
<th>Stable dehydrated patients (not anesthetized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs</td>
<td>Cats</td>
<td>Dogs</td>
<td>Cats</td>
<td>Dogs</td>
</tr>
<tr>
<td>Always</td>
<td>739 (55)</td>
<td>642 (48)</td>
<td>1,168 (87)</td>
<td>1,149 (86)</td>
</tr>
<tr>
<td>Often</td>
<td>321 (24)</td>
<td>395 (29)</td>
<td>133 (10)</td>
<td>143 (11)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>179 (13)</td>
<td>186 (14)</td>
<td>22 (2)</td>
<td>38 (3)</td>
</tr>
<tr>
<td>Rarely</td>
<td>74 (6)</td>
<td>101 (7)</td>
<td>2 (0.2)</td>
<td>8 (0.5)</td>
</tr>
<tr>
<td>Never</td>
<td>22 (2)</td>
<td>24 (2)</td>
<td>11 (0.8)</td>
<td>5 (0.3)</td>
</tr>
<tr>
<td>Total No. of respondents</td>
<td>1,335</td>
<td>1,348</td>
<td>1,336</td>
<td>1,343</td>
</tr>
</tbody>
</table>

**Note:** Data represent number (%) of respondents. Email links to an online survey were sent to 32,898 VIN members; 1,496 completed surveys were received from veterinarians who reported that they treated small animal patients. Not all respondents answered every question. The full survey is available (Supplemental Appendix S1, available at avmjournals.avma.org/doi/suppl/10.2460/javma.252.5.553).
der general anesthesia are likely to administer fluid therapy more frequently than practices that mainly perform outpatient medicine. Additionally, in the present survey, we did not attempt to determine the frequency at which subcutaneous fluid therapy was administered. It is possible that this would be a more common procedure in practices with a predominant outpatient caseload.

Isotonic crystalloid solutions were stocked and administered routinely by far more participants in the present study than hypotonic fluids such as hypertonic saline (0.45% NaCl) solution or crystalloid-H. This reflected a greater use of isotonic crystalloid fluid therapy in small animal patients, with lactated Ringer solution and crystalloid-I being the most common fluid types administered for both shock resuscitation and daily fluid therapy by 86% to 88% of the survey respondents. In contrast, hypotonic fluids are commonly administered to hospitalized human patients.13-15 The role of hypotonic crystalloid fluid therapy has been a topic of recent concern in the human medical literature, as it is considered to contribute to the development of hospital-acquired hyponatremia.13,16,17 Hospital-acquired hyponatremia has been associated with an overall increase in mortality rate in both human18,19 and veterinary20 patients. In severe cases, it can lead to encephalopathy and death.21 Administration of hypotonic fluids may be optimal in some clinical scenarios; however, in the absence of frequent monitoring of serum sodium concentration, isotonic fluid therapy may be a safer approach.

Lactated Ringer solution was the most common fluid administered for resuscitation of dogs (826/1,436 [57%]) and cats (804/1,435 [56%]) in shock in the present study, followed by crystalloid-I (dogs, 441/1,436 [31%]; cats, 426/1,435 [30%]). Isotonic saline solution was administered for resuscitation of dogs and cats in shock by only 271 of 1,436 (19%) respondents and 296 of 1,435 (21%) respondents, respectively. This is in contrast to human medical practice, where isotonic saline solution has long been the predominant fluid administered for resuscitation of patients in shock.3,22 There is an increasing number of recently published studies23-26 highlighting the incidence and negative consequences of the hyperchloremia and acidosis frequently associated with resuscitation with isotonic saline solution versus crystalloid solutions that are considered more “balanced,” such as lactated Ringer solution or crystalloid-I. There are also studies27-31 suggesting adverse effects of lactated Ringer solution, including hypercoagulability and endothelial dysfunction. Resuscitation with crystalloid-I has been reported to be associated with decreased incidence of hyperchloremia, improved acid-base status, and improved renal blood flow when compared with resuscitation with isotonic saline solution.2,24,27 Although there is evidence to support the inferiority of isotonic saline solution, compared with balanced crystalloid solutions (eg, lactated Ringer solution), there are few clinical studies directly comparing specific balanced crystalloid solutions. With the increased interest in balanced crystalloid solutions in human medicine, we suggest that such studies are likely to be performed in the near future.

The participants in the present study administered hypertonic saline (eg, 3.5% or 7.2% NaCl) solution infrequently to patients during shock resuscitation. However, it is quite likely that hypertonic saline solution is used more commonly by emergency practitioners, who were poorly represented in the present study (173/1,435 [12%]). Published evidence suggests that hypertonic saline solution has several benefits, compared with lactated Ringer solution, when administered to patients in shock, including immunomodulatory effects and reduced tissue injury following resuscitation.32 A recent meta-analysis of hypertonic saline solution for the treatment of traumatic hypovolemic shock in human patients was unable to find an improvement in mortality rate, although only 6 randomized controlled trials were available for analysis.33 The role of hypertonic saline solution in shock resuscitation has not been evaluated in veterinary medicine. The most common concentration of hypertonic saline solution administered by respondents in the present study was 7.2%, although 30% (176/593) of respondents reported administering a different concentration. Most studies published to date have evaluated 7.2% to 7.5% NaCl solutions, and information on the clinical effects of other concentrations is limited. There is some evidence to suggest that lower concentrations (ie, 3% to 5%) provide immunomodulatory and tissue protective effects, as for the higher concentrations of hypertonic saline solution,32 but further studies are required to confirm this.

Synthetic colloid solutions were used by 20% (292/1,436) of respondents for resuscitation of dogs in shock in the present study and by 13% (180/1,435) of respondents for resuscitation of cats in shock. Several large studies34 involving human patients have reported no differences between colloid and crystalloid solutions for fluid resuscitation during shock. Given the concerns of colloid-induced acute kidney injury and potential increased risk of death associated with administration of hydroxyethyl starch, the most recent Cochrane review35 recommends crystalloid fluids for resuscitation of critically ill human patients. Strong statements regarding the potential adverse effects of hydroxyethyl starch in human patients were only just being released at the time of the present survey; since that time, there has been a growing awareness of the concerns associated with hydroxyethyl starch administration in veterinary patients, which may have impacted the current use of these products.36,37

Respondents to the present survey administered IV fluids to most emergency surgical and unstable emergency patients, although IV fluid therapy was only administered to dogs by 739 of 1,335 (55%) respondents and to cats by 642 of 1,348 (48%) respondents during an elective surgical procedure, on a
routine basis. There is a lack of evidence-based recommendations for appropriate fluid therapy for anesthetized small animal veterinary patients. Classically, intraoperative fluid administration for veterinary patients has been recipe based, with IV administration of an isotonic balanced crystalloid solution at a rate of 10 to 20 mL/kg/h (4.5 to 9.1 mL/lb/h) commonly recommended to compensate for relative hypovolemia created by anesthetic-induced vasodilation, insensible fluid losses, and fluid extravasation into tissues traumatized by injury or surgery. It is likely that the extent of insensible losses and fluid extravasation are typically overestimated, and the efficacy of crystalloid fluid therapy for management of vasodilation-induced hypotension may be transient at best. Evidence from human medicine suggests that intraoperative fluid administration at rates of 10 to 20 mL/kg/h is likely to be excessive; may promote interstitial edema, contribute to poor wound healing, and impede pulmonary gas exchange; and can potentially lead to overt fluid overload. Approaches to fluid therapy in anesthetized patients on the basis of individual patient needs, such as goal-directed protocols, have been recommended. Research in veterinary patients to determine the optimum monitoring to evaluate response to fluid therapy and to develop appropriate guidelines for patient-specific fluid therapy, particularly in anesthetized patients, is clearly needed.

Of the participants in the present survey, 543 of 1,344 (40%) indicated they would routinely treat stable but clinically dehydrated patients in their practices with IV fluids. Because the survey was not designed to determine how many of these patients were recommended to receive IV fluids but did not because of constraints such as client finances, it is unknown whether the results reflected clinical patient care choices or other (nonclinical) considerations. In addition, we did not ascertain whether these patients received subcutaneous fluids or other treatments; as such, we suggest that this information has limited value. The ideal treatment approach for stable dehydrated small animal patients is not known, but may well depend on the underlying disease process. In addition to fluid type, calculation of fluid rate is important when developing a maintenance fluid therapy plan. Of the 4 options given in the present survey, 60 mL/kg/d (administered by 565/1,280 [44%] respondents) and 2 to 4 mL/kg/h (administered by 388/1,280 [30%]) were the most common maintenance fluid rates used. Although these rates are likely to be satisfactory for most patients, it is important to note that they may underestimate the fluid requirements of very small patients and overestimate the fluid requirements of very large patients. Many participants (572/1,496 [38%]) answered that calculation of fluid rate was the aspect of fluid therapy they found the most challenging, and this may be an important focus for future continuing education.

Less than half (594/1,338 [44%]) of the respondents in the present study routinely supplemented IV fluids with potassium, and 229 of 1,496 (15%) respondents indicated that determining the need for potassium supplementation was the most challenging aspect of fluid therapy. Patients that require IV fluid therapy often have underlying diseases associated with potassium depletion, such as vomiting, diarrhea, and kidney or adrenal disease (urinary potassium loss). In addition, administration of IV fluids can promote increases in distal renal tubular flow, which can further increase potassium excretion. Empiric potassium supplementation of IV fluids has been reported to prevent hypokalemia in critically ill human patients, but its role in stable patients receiving short-term fluid therapy is less well defined. In small animal veterinary medicine, there is a need for investigation of the indications for empiric potassium supplementation and development of evidence-based guidelines for IV potassium supplementation.

Overall, hypotonic fluids were administered infrequently by respondents in the present study. Dextrose 5% in water was stocked by 659 of 1,435 (46%) respondents, but it was reported to be rarely (< 1% of respondents) administered for shock resuscitation or maintenance fluid therapy. The most commonly cited reason for its use was to treat hypoglycemia (ie, to provide ongoing glucose support); the second most common reason was for the treatment of hypernatremia. Dextrose 5% in water is considered a hypotonic fluid, with an osmolality of 252 mOsm/L; this is commonly considered isotonic. However, on IV administration, the dextrose component is rapidly metabolized, such that this IV fluid is a source of free water. It is therefore indicated for the treatment of hypernatremia. The use of dextrose 5% in water for the treatment of hypoglycemia will be effective, but there is the concern that the associated volume of free water given could cause hyponatremia. Use of 25% to 50% dextrose IV fluid solutions for bolus administration or as fluid supplementation allows administration of suitable dextrose doses with minimal associated administration of free water.

Subcutaneous fluid administration is commonly performed in small animal veterinary medicine, but guidelines or research on this topic is lacking. The present study provided some insight into current practices related to subcutaneous fluid administration to dogs and cats. As with other fluid therapy approaches evaluated in this study, lactated Ringer solution was the most common fluid type administered (841/1,328 [63%]), with isotonic saline solution (229/1,328 [17%]) and crystalloid-I (233/1,328 [18%]) also administered regularly. Subcutaneous fluid administration (also known as hypodermoclysis) is performed in human patients. It was the standard of care in the 1940s to the 1960s and is now being reevaluated in pediatric and geriatric care. Subcutaneous fluid therapy in human patients may be facilitated by the initial infusion of hyaluronidase to aid in breakdown of the extracellular matrix, aiding fluid distribution. In children, subcutaneous fluid therapy may be more effective than IV fluid therapy in the
emergency room, primarily because of difficulties in gaining IV access. Subcutaneous fluid therapy has also been found to be safe and effective in geriatric patients, especially if there are issues with patient compliance or venous access. To our knowledge, there are no studies evaluating the efficacy of subcutaneous fluid administration in veterinary medicine. Given the frequency at which subcutaneous fluid therapy is used in small animal patients, studies to determine the ideal patient selection, optimal volume for infusion, frequency of treatment, and possible adverse effects are warranted.

In the present study, fluids for subcutaneous administration were supplemented with potassium uncommonly, with only 34 of 1,344 (2.5%) respondents reporting they often or always added supplemental potassium to subcutaneous fluids. Most respondents (1,160/1,337 [87%]) reported they never supplemented subcutaneous fluids with dextrose. Similarly, 1,148 of 1,330 (86%) respondents never supplemented subcutaneous fluids with calcium. Subcutaneous injection of hypertonic solutions can lead to tissue damage and skin necrosis. Potassium, dextrose, and calcium solutions are commonly very hypertonic as supplied by manufacturers. Thus, if they are added to fluids for subcutaneous administration, it is essential that they are adequately diluted. General fluid therapy guidelines for small animal patients do not recommend hypotonic fluids for subcutaneous administration, and these were used rarely (5/1,328 [0.4%]) by respondents in the present study.

To our knowledge, this was the first study to attempt to describe current clinical approaches to fluid therapy in small animal veterinary medicine. We used an online survey because we wanted to reach a broad cross section of practicing clinicians, rather than reflect the bias of a small number of institutions. However, because this was a voluntary survey, there is no way to ensure that the information represented small animal practices in a balanced manner. Additionally, most survey respondents were in general practice; therefore, our results may not accurately represent emergency or specialty practice. Other limitations of the present study were the lack of specific information on the factors that guided clinician decision-making in terms of fluid therapy and the potential difference between what clinicians recommended to clients as ideal fluid therapy for a patient versus what fluid therapy was actually provided. This is an area of clinical practice that deserves further investigation.

It is clear that despite the frequent use of fluid therapy in clinical practice, the optimal approach is poorly defined and there are many aspects of fluid therapy that clinicians find difficult. Investigations into the ideal fluid type and fluid rates for specific clinical scenarios in small animal veterinary practice are required. In addition, development of easy-to-use, evidence-based guidelines on fluid therapy, supported by ongoing continuing education efforts, would be beneficial.

Acknowledgments

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Footnotes

References

sodium level are associated with an increased risk of death in surgical ICU patients. Crit Care Med 2013;41:135–142.