Autologous blood transfusion in dogs with thoracic or abdominal hemorrhage: 25 cases (2007–2012)

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Abstract

Objective – To describe the use and outcome following autologous blood transfusion (ABT) in dogs.


Setting – Private veterinary referral center.

Animals – Twenty-five dogs that underwent ABT secondary to thoracic or abdominal hemorrhage.

Interventions – None.

Measurements and Main Results – The hospital transaction database was searched using the keyword “autotransfusion” from January 2007 to July 2012. Data collected included signalment, body weight, etiology of hemorrhage, source and method of collection, volumes and method of ABT administration, use of anticoagulant, reported complications, and outcome. Twenty-five dogs were included for a total of 27 ABTs. Causes of hemorrhage included vascular trauma (14/25 dogs, 56%), ruptured tumor (8/25, 32%), and coagulopathy attributed to brodifacoum toxicosis (3/25, 12%). Autologous blood was collected from the abdominal (19/25, 76%), thoracic (5/25, 20%), or abdominal and thoracic cavities (1/25, 4%). Anticoagulant was added to the ABT blood in 13 of 25 (52%) cases. A median ABT volume of 29.3 mL/kg (range 2.9–406.9 mL/kg) was infused through either a 210 µm blood administration filter (21/27, 78%) or an 18 µm hemonate filter (6/27, 22%). Reported complications that may have been associated with ABT included hypocalcemia (4/17, 24%), hemolyzed serum (5/19, 26%), and prolonged coagulation times (4/5, 80%). These complications were considered of minimal clinical significance. Additional blood products were administered in 17 of 25 (68%) dogs. Seventeen (68%) dogs survived to discharge. Cause of death in the remaining cases was euthanasia or cardiac arrest secondary to uncontrollable hemorrhage.

Conclusions – ABT is an adjunct to volume replacement in dogs with thoracic or abdominal hemorrhage secondary to vascular trauma, ruptured tumor, or anticoagulant rodenticide toxicosis. ABT may be used as a bridge to definitive hemorrhage control, particularly when other blood products are not available or affordable. Complications may include hypocalcemia, prolonged coagulation times, and hemolysis.

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Keywords: autotransfusion, canine, hemoabdomen, hemothorax

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ABT</td>
<td>autologous blood transfusion</td>
</tr>
<tr>
<td>ACT</td>
<td>activated clotting time</td>
</tr>
<tr>
<td>aPTT</td>
<td>activated partial thromboplastin time</td>
</tr>
<tr>
<td>DA</td>
<td>direct aspiration</td>
</tr>
<tr>
<td>PT</td>
<td>prothrombin time</td>
</tr>
<tr>
<td>SA</td>
<td>surgical aspiration</td>
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Introduction

Thoracic or abdominal hemorrhage in veterinary patients has been attributed to vascular injury caused by trauma, organ torsion, ruptured neoplasia, or coagulopathy.1–3 In cases of closed cavitary hemorrhage, shed blood can be collected and rein infused intravenously as an autologous blood transfusion (ABT) to provide blood components and intravascular volume quickly.1,4,5
Blundell first described ABT in dogs in 1818, when he removed and reinfused blood into a dog by syringe. Various ABT techniques have since been described in the veterinary literature and are referred to as technically simple and inexpensive to perform. Complications reported in the human and canine medical literature include hemolysis, coagulation disorders, microembolism, air embolism, sepsis, and metastasis through reinfusion of neoplastic cells. Studies documenting the clinical use and outcome of ABT in dogs are limited to single or small case series. The purpose of this retrospective study was to describe the use, technique employed, complications encountered, and outcome of ABT in dogs in a single institution.

Materials and Methods
The hospital computer financial transaction database from January 2007 to July 2012 was searched using the keyword “autotransfusion” to identify patients that received an ABT. The sole criterion for inclusion was having received an ABT during that time frame. Patient signalment, body weight, as well as location and etiology of internal hemorrhage were retrieved from the medical record. Recorded parameters included: collection technique and method of ABT administration, volume of ABT blood administered, use of anticoagulant, infusion of allogeneic blood products, recognized complications, survival to discharge, and 2-week survival. When available, serum color; serum ionized calcium concentration; coagulation panels (prothrombin time [PT], activated partial thromboplastin time [aPTT], activated clotting time [ACT]); and physical or biochemical evidence of sepsis, microemboli, or air emboli were recorded to identify complications. Patients were then divided into 1 of 3 groups based on etiology of hemorrhage: dogs with vascular trauma, dogs with ruptured neoplasia, or dogs with coagulopathy.

Statistical Methods
Descriptive statistics were calculated to determine mean and standard deviation for the continuous variables that met the assumptions of normality. To account for multiple measurements in 2 dogs, a linear regression analysis was performed to compare the continuous variables across categories. If the assumption was not met, medians were used to describe the variable and linear regression analysis was performed on the log converted outcome after checking for assumption again. Frequencies and percentages were reported for categorical variables. Chi-square analysis was used to determine whether addition of anticoagulant to ABT, blood filter pore size, body cavity from which blood was collected, hemolysis, or etiology of hemorrhage affected a categorical outcome. An alternative Fisher’s exact test was used if any of the cells in the contingency tables contained fewer than 5 cases. All analyses were performed with statistical software and P < 0.05 was considered significant for all comparisons.

Results
Records of 26 dogs that received ABT between January 2007 and July 2012 were identified. No cats were identified in the search. One case was excluded because there was no documentation of ABT administration in the medical record. Of the 25 dogs included in the analyses, the mean age was 5.8 ± 3.1 years. There were 2 intact males, 10 neutered males, 2 intact females, and 11 spayed females. Ten breeds were represented: 6 mixed breed dogs, 5 Labrador Retrievers, 3 Golden Retrievers, 3 German Shepherd Dogs, 2 Bernese Mountain Dogs, 2 Coonhounds, and 1 of each Pit Bull, Shih Tzu, Newfoundland, and Rottweiler. Specific case information is presented in tabular form in Appendix 1.

In the 25 dogs evaluated, hemorrhage was localized to and thus collected from the thoracic cavity (5/25, 20%), the abdominal cavity (19/25, 76%), or both cavities (1/25, 4%). A total of 27 ABTs were performed. Two dogs received 2 ABTs: 1 from both abdominal and thoracic hemorrhage, and the other from abdominal hemorrhage both pre- and intraoperatively. The method used for collection and administration of ABT varied, and appeared to be based on whether hemorrhage was identified in the thoracic or abdominal cavity and whether blood was collected by centesis (10/27, 37%) or intraoperatively by suction (17/27, 63%). There was no significant association between survival and the body cavity from which the blood was collected (P = 1.00).

The etiologies for hemorrhage included vascular trauma (14/25, 56%), ruptured neoplasia (8/25, 32%), and coagulopathy (3/25, 12%). Vascular trauma was caused by organ torsion due to gastric dilation and volvulus with hemorrhage from torn short gastric and splenic vessels in 6 of 14 (43%) dogs; postoperative ovariohysterectomy or neuter in 3 of 14 (21%) dogs; and blunt force trauma in 5 of 14 (36%) dogs. In the blunt force trauma group, 4 dogs were hit by a car and 1 had trauma of unknown cause. Three of the dogs with blunt force trauma had injury to the spleen and liver confirmed through surgical abdominal exploration.

Ruptured neoplasia was the cause of hemorrhage in 8 (32%) dogs: 6 (75%) had splenic masses, 1 (12.5%) had bilateral renal masses, and 1 (12.5%) had an intrathoracic mass. Gross or histopathologic metastasis was present at the time of ABT in 6 of 8 (75%) of the neoplastic cases.
Histopathology performed in 4 cases confirmed a diagnosis of hemangiosarcoma. Histopathology was not performed in the other 4 cases.

Coagulopathy due to brodifacoum toxicosis was the cause of hemorrhage in 3 (12%) dogs. One of 3 dogs had confirmation of ingestion through owner history and visual inspection of the package. Two dogs were not observed to ingest the compound but had positive qualitative blood tests for brodifacoum by mass spectrometry. In addition to ABT, each of these dogs was treated with a single subcutaneous injection of vitamin K₁ in hospital (4.0 ± 1.0 mg/kg), oral vitamin K₁ for 30 days (3.5 ± 1.8 mg/kg/day), and allogeneic donor whole blood transfusion (24.7 mL/kg, range 19.8–25.3 mL/kg).

ABTs were administered either during initial resuscitation or during surgery. One of 2 techniques of ABT collection and administration was used. The collected blood cells were not washed or processed in either technique. The first technique was direct aspiration (DA), in which blood was collected from the body cavity via centesis, after aseptic preparation, by manual aspiration using a butterfly catheter attached to a 60 mL syringe. The DA technique was used in 10 of 27 (37%) ABTs. The ABT blood was then reinfused by 1 of 2 methods. In the first variation (DA₁; 6/27 [22%] ABTs), the blood was reinfused into a vein from the collection syringe using a 3-way stopcock, extension fluid tubing, and an in-line 18 μm hemonate filter. The DA₁ technique was used to collect blood from the thoracic cavity. In the second variation (DA₂; 4/27 [15%] ABTs), the collected blood was transferred via syringe into a blood transfusion collection bag or in a sterile, empty crystalloid fluid bag for reinfusion through an in-line 210 μm blood administration filter. The DA₂ technique was used to collect blood from the abdominal cavity.

The second technique was surgical aspiration (SA), which involved the intraoperative collection of cavitory hemorrhage through a Poole suction tip and sterile tubing, and into a sterile canister using mechanical suction at a collection pressure <100 mm Hg. The SA technique was used in 17 of 27 (63%) ABTs. Blood was then transferred from the canister into either a blood transfusion collection bag or a sterile, empty crystalloid fluid bag for reinfusion through an inline 210 μm blood administration filter into a vein. Transfer of the blood from the canister to the sterile fluid bag was accomplished aseptically via needle and syringe transfer or by pouring the blood into the bag after removing a corner with sterile scissors.

ABTs given by DA₁ (6/27, 22%) or DA₂ (4/27, 15%) were administered during initial resuscitation, while those given by SA (17/27, 63%) were administered during surgery. Seventeen of 25 (68%) patients had surgery for bleeding control and the majority of those (16/17, 94%) did not have ABT as part of the presurgical resuscitation.

Blood was administered through a 210 μm blood administration filter in 21 of 27 (78%) of ABTs: 4 using the DA₂ technique and 17 using the SA technique. In the remaining 6 of 27 (22%) ABTs, blood was infused through an 18 μm hemonate filter using the DA₁ technique. There was no significant association between survival and the filter pore size (P = 1.00) or ABT collection method used (P = 0.86) in any group of dogs.

The median infused ABT volume for all etiologies was 29.3 mL/kg (range 2.9–406.9 mL/kg). The median ABT volume in the dogs with vascular trauma was 34.8 mL/kg (range 2.9–406.9 mL/kg), in dogs with ruptured neoplasia was 36.0 mL/kg (range 7.3–122.2 mL/kg), and in dogs with anticoagulant rodenticide toxicosis was 18.0 mL/kg (range 11.0–22.0 mL/kg). ABT volume administered was significantly higher in cases with ruptured tumor (P = 0.029) or trauma (P = 0.05) compared to cases with brodifacoum toxicosis. Anticoagulant was added to collected blood in 13 of 25 (52%) dogs. No anticoagulant was used in any of the dogs with anticoagulant rodenticide intoxication. An average of 0.17 ± 0.05 mL of anticoagulant per milliliter of ABT blood was added. In 12 of 13 (92%), the blood was transferred directly into a blood collection bag containing citrate phosphate dextrose adenine. Acid citrate dextrose was added to blood collected into a sterile suction canister and transferred into an empty crystalloid fluid bag in 1 of 13 (8%). There was no significant association between outcome and the addition of anticoagulant to blood used for ABT (P = 1.00).

Additional blood products were administered to 17 of 25 (68%) dogs. A median of 24.46 mL/kg (range 9.5–132.4 mL/kg) of allogeneic donor whole blood was administered to 17 of 25 (68%) dogs. Of the dogs receiving whole blood, 9 had vascular trauma and received whole blood at a median dose of 24.3 mL/kg (range 16.5–132.4 mL/kg), 5 had ruptured neoplasia and received a median dose of 21.4 mL/kg (range 9.5–28.3 mL/kg), and 3 had anticoagulant rodenticide toxicosis and received a median dose of 24.7 mL/kg (range 19.8–25.3 mL/kg). Other blood products administered included packed RBCs (5.5 mL/kg) administered to 1 dog with vascular trauma; frozen plasma (4.9 mL/kg) administered to 1 dog with a ruptured tumor; and bovine hemoglobin-based oxygen carrier (Hb-200, Oxyglobin) administered to 3 dogs suffering vascular trauma (6.8 mL/kg, range 1.8–17.7 mL/kg).

There were no reports of increased rectal temperature, urticaria, erythema, vomiting, labored breathing, impaired blood flow, or other reactions associated with...
Table 1: Five cases with post-ABT hemolyzed serum

<table>
<thead>
<tr>
<th>Patient</th>
<th>Pre-ABT serum color</th>
<th>Immediately post-ABT serum color</th>
<th>Recheck post-ABT serum color</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Clear</td>
<td>Hemolyzed</td>
<td>Clear (1.5 h after ABT)</td>
</tr>
<tr>
<td>5</td>
<td>Clear</td>
<td>Hemolyzed</td>
<td>Hemolyzed (48 h after ABT)</td>
</tr>
<tr>
<td>12</td>
<td>Straw</td>
<td>Hemolyzed</td>
<td>Hemolyzed (1 h after ABT)</td>
</tr>
<tr>
<td>14</td>
<td>Hemolyzed</td>
<td>Hemolyzed</td>
<td>None</td>
</tr>
<tr>
<td>17</td>
<td>Clear</td>
<td>Hemolyzed</td>
<td>Clear (3 h after ABT)</td>
</tr>
</tbody>
</table>

ABT, autologous blood transfusion; h, hour.

Potential complications of ABT identified from medical records included hemolysis, hypocalcemia, and prolongation of coagulation times. Serum color was documented in 19 dogs. Hemolyzed serum color was observed post-ABT in 5 of 19 (26%) dogs (Table 1). Of these dogs, 1 had hemolyzed serum color prior to ABT and died of cardiac arrest secondary to uncontrolled hemorrhage. In 2 of these dogs, the hemolyzed serum color cleared within 3 hours of ABT; in 1 the hemolyzed serum color persisted through the time of hospital discharge 48 hours after ABT; and 1 dog was euthanized prior to the serum clearing. Neither clinical evidence of kidney dysfunction nor other complications attributable to hemolysis were reported in the records. There was no significant association between survival and hemolyzed serum color ($P = 0.63$). There was also no significant difference between the occurrence of hemolyzed serum and the method of ABT ($P = 0.60$). Of the 5 patients with hemolysis, 6 ABTs were performed with 5 of 6 utilizing the 210 micron filter and 1 of 6 with a hemonate.

Serum ionized calcium concentration was measured post-ABT in 17 dogs, all of which received stored donor whole blood in addition to ABT. Hypocalcemia was documented in 4 of 16 (25%) dogs tested (Table 2), all of which had anticoagulant added to their ABT. No clinical signs attributable to hypocalcemia (eg, muscle fasciculations, dysrhythmias) were reported in any of the dogs. Two of the 4 dogs with hypocalcemia survived, 1 of them having been treated with calcium gluconate. Improved to normal or near-normal range in both dogs. In the remaining 3 dogs (1 from each etiology category), post-ABT PT and aPTT were reported. All had slightly prolonged aPTT, and 1 had a slightly prolonged PT. No evidence of continued hemorrhage, bruising, or petechiation was reported.

Seventeen of 25 (68%) dogs survived to hospital discharge. The cause of death in the 8 dogs that did not survive to discharge was euthanasia in 5 dogs and cardiac arrest secondary to uncontrolled hemorrhage in 3. In the dogs that died from ongoing hemorrhage, cardiopulmonary arrest occurred in surgery or immediately postoperatively. Necropsies were not performed in any dogs. Survival to discharge was 71% (10/14) for dogs with vascular trauma, 50% (4/8) for dogs with ruptured neoplasia, and 100% (3/3) for dogs with a coagulopathy from anticoagulant rodenticide ingestion. There was no significant association between survival and the etiology of hemorrhage ($P = 0.22$).

Fifteen of the 17 dogs that were discharged were alive at 2 weeks. The 2 dogs that died during the 2-week post-ABT period had a confirmed diagnosis of hemangiosarcoma with evidence of metastatic disease.
developed recurrence of hemoperitoneum suspected to be from metastatic neoplasia. One dog presented deceased the day after ABT and no necropsy was permitted. The other dog had a recurrence of hemoperitoneum 2 days after ABT and was euthanized.

Discussion
ABT has been described extensively in the human literature with few complications reported.\textsuperscript{7,10,15–19} Reported advantages of ABT when compared to allogeneic blood transfusion include immediate availability, blood compatibility, avoidance of transfusion reactions, normothermic transfusion, no transmission of infectious agents, higher levels of RBC 2,3-diphosphoglycerate, and decreased overall cost.\textsuperscript{1,4,7,9,10,12,20} The procedure is not widely reported to be performed in veterinary medicine, possibly due to a lack of data on clinical outcome associated with ABT. This study is the largest retrospective investigation to date to describe the use of and techniques for performing ABT, and the outcome of dogs that have received it. To the authors’ knowledge, this study is also the first to describe the successful use of ABT as an adjunct to volume replacement in dogs hemorrhaging from anticoagulant rodenticide toxicosis.

Eight of the dogs in this study received ABT using blood collected from a cavity with a ruptured neoplasm. It is unknown whether administering an ABT obtained from the hemorrhage of a ruptured tumor could contribute meaningfully to metastatic cancer spread in dogs. Some authors state that ABT is contraindicated in cases of neoplastic disease.\textsuperscript{8,10,16} However, investigations in people have failed to demonstrate worse outcome or increased metastatic rate associated with administration of ABT to patients undergoing oncological surgery.\textsuperscript{21–25} and no association has been found between the presence of circulating neoplastic cells and poorer prognosis.\textsuperscript{21,22} Nonetheless, the use of leukocyte depletion filters has been recommended when performing ABT in human cancer patients to reduce the number of malignant cells infused.\textsuperscript{26,27} Such filters were not used in these dogs. Since 6 of 8 (75%) of the dogs with neoplasia in this study had gross or histopathologic metastasis at the time of ABT, the risk of cancer dissemination from ABT could not be determined. Prospective, long-term studies regarding the use of ABT in cases of ruptured hemangiosarcoma and other neoplasms are needed.

The blood collected for ABT in this study was neither washed nor processed other than passage through a blood filter during administration. Well-described techniques for ABT in companion animals\textsuperscript{1,4} were used in this study, and differed from the ABT technique described using a cell saver device.\textsuperscript{13} Recommendations to minimize lysis of ABT RBCs during collection include minimizing aspiration of air or mixing of the collected blood with air;\textsuperscript{1,4} keeping the vacuum suction tip below the surface of the blood pool to decrease the blood-air interface; and maintaining an ideal vacuum pressure between 40 and 60 mm Hg, and always below 100 mm Hg.\textsuperscript{1,5,10,19}

The filter pore size selected in the 25 dogs coincided with the site of blood collection. An 18 μm hemonate filter was used to reinfuse blood collected from the thoracic cavity, and a 210 μm blood administration filter was used to re-infuse blood collected from the abdominal cavity. This difference likely occurred because the DA technique was used for all thoracic blood collection, and as such, an insertable, in-line filter was more practical for blood administration. The manufacturer of hemonate filters\textsuperscript{6} recommends they be changed every 50 mL of blood transfused, or sooner if they become clogged. The literature recommends a filter size between 20 and 270 μm to filter particles and minimize trauma to RBCs.\textsuperscript{1,8,10} Four dogs in this study developed hemolytic serum color following ABT administration; it is unclear whether technique or filter pore size was associated with hemolysis in these dogs. There was no association between survival and filter pore size or technique used in this study.

Adding anticoagulant to ABT blood is controversial. Blood becomes defibrinated when in contact with the thoracic or abdominal serosal surfaces for more than 1 hour.\textsuperscript{1,28} Therefore, blood that has been in contact with a peritoneal surface for more than 1 hour may not require anticoagulation prior to ABT.\textsuperscript{28} When active hemorrhage is the source of ABT blood, the addition of anticoagulant may be warranted.\textsuperscript{1,4,5} It has been recommended in the veterinary literature to add either 0.05–0.07 mL of anticoagulant per milliliter of collected blood\textsuperscript{1,4,10} or 0.14 mL of anticoagulant per milliliter of collected blood.\textsuperscript{9,26,29} In this study, 12 dogs had the collected blood transferred into commercial blood bags containing 63 mL citrate phosphate dextrose adenine. The bags are meant to be filled with 450 mL blood but in these cases were not always filled to capacity, and may have contained a higher ratio of anticoagulant to collected blood than intended. No association was found between survival and the addition of anticoagulant to ABT. Further studies are needed to determine the appropriate indications and dose for anticoagulant in these cases.

Additional blood products were administered in 68% of the dogs receiving ABT. Due to the administration of other blood products, it is impossible to determine if some of the complications were solely due to ABT. Timing of the administration of other blood products in relation to the ABT could not be determined from the record in most cases.

There are a number of nonhematologic and hematologic complications reported secondary to ABT. Nonhematologic complications reported in people...
The causes of hemolysis are numerous. In an average person weighing 70 kg, the serum had cleared in 2 of the dogs within 3 hours of testing, and 1 dog continued to have hemolytic serum color when it was discharged 48 hours post-ABT. Hemolysis can occur due to prolonged exposure of blood to serosal surfaces, and during collection and refrigeration of RBCs associated with exposure to air, mechanical stress from vacuum pressures, or excessive air-fluid interface exposure. The causes of hemolysis in the 5 dogs in this study were unknown, and no clinical signs or problems were attributed to hemolysis in any of the dogs. Human and veterinary literature report that hemolysis associated with ABT should resolve within 48–72 hours. The serum had cleared in 2 of the dogs within 3 hours of testing, and 1 dog continued to have hemolytic serum color when it was discharged 48 hours post-ABT. The final 2 dogs with hemolytic serum color died as a result of uncontrollable traumatic hemorrhage, with hemolysis not likely a contributing factor. Monitoring for hemolysis post-ABT is recommended.

Citrate toxicosis has been suggested as a possible complication of autotransfusion due to the large total doses of anticoagulant administered. Citrate binds divalent cations such as calcium and inhibits coagulation during blood collection. Unbound citrate given in the ABT can bind to calcium in the recipient’s blood and cause hypocalcemia. There are numerous reports of citrate toxicosis in human medicine secondary to allogeneic blood transfusion, but overall incidence is low and clinical signs are mild. Four of 16 (25%) dogs in this study with pre- and post-ABT serum calcium concentrations reported developed new hypocalcemia post-ABT transfusion, all of which had anticoagulant added to their ABT blood. No clinical signs were attributed to hypocalcemia. To the authors’ knowledge, this is the first study to report that hypocalcemia may have occurred as a result of the ABT in canine patients. However, all 4 of these patients also received allogeneic blood products containing anticoagulant that could have contributed to the hypocalcemia. It is recommended to monitor serum ionized calcium concentration in patients after massive transfusions in human and canine medicine. Based on the data from this series of ABT dogs, it may be beneficial to extend these recommendations to veterinary patients receiving ABT.

In this study, coagulation parameters including PT, PTT, or ACT were measured in 5 dogs post-ABT. Of the 5 tested dogs, coagulation profiles were normal or near-normal following ABT. Two of these dogs had prolonged coagulation parameters pre-ABT. However, the impact of ABT on coagulation test results in these 2 is unknown, because these dogs had bridifacoum toxicosis and were thus treated concomitantly with plasma-containing blood products. In previous reports, small increases in PT and PTT were noted but self-corrected within 72 hours of ABT. Dilutional coagulopathy in people has been reported when transfusion volume exceeds 3,500 mL. There are guidelines for plasma administration for people receiving ABT, with the recommendation that either 1 unit of fresh frozen plasma be given for every 2 units of ABT administered, or that plasma be administered to effect when the ABT volume exceeds 3,500 mL. In an average person weighing 70 kg, 3,500 mL is 50 mL/kg. In our study, 9 of 25 dogs received an ABT blood volume ≥50 mL/kg but due to the fact that only 1 of 9 had post-ABT coagulation testing, we cannot accurately discuss dilutional coagulopathy in our patient population.

This study documents a 68% (17/25 dogs) survival to hospital discharge, and a 60% (15/25 dogs) survival rate after 2 weeks. Our dogs had a similar survival to discharge rate as that reported by Crowe (67%) and higher than reported by Niebauer (28%). Of the 8 dogs that did not survive to discharge, 5 were euthanized and 3 suffered cardiopulmonary arrest attributed to uncontrollable blood loss. The highest survival rate was in the coagulopathy category at 100%, followed by the vascular trauma category at 71%, and the ruptured tumor category at 50%. The 2 dogs that died during the 2-week period following discharge from the hospital were from the ruptured tumor category and received their ABT during a chemotherapy recheck. Fatalities secondary to ABT in people have been reported when intraperitoneal bleeding was collected and administered that had been allowed to remain within the peritoneal cavity for >72 hours. Thus, the benefits of ABT should be weighed against possible complications in situations where blood may have dwelled in a body cavity for an extended period of time.

The retrospective nature of this study presents a major limitation. The lack of consistent clinicopathologic data, physical parameter monitoring, and reporting in the medical records prevents conclusions regarding many aspects of ABT. Unfortunately, physiologic parameters...
such as blood pressure, heart rate, and pulse quality; PCV measurements; and the timing and types of other fluid therapies in relation to ABT were not consistently recorded. Due to the inconsistent presence of these data points, they were purposely omitted from this paper to avoid providing misleading information about the ability of ABT to restore perfusion or improve oxygen-carrying capacity. The authors believe that this information is best collected, evaluated, and presented through a controlled prospective clinical trial.

There are many factors that may have affected clinician choice to use ABT, such as availability of other products, cost, and patient selection. Our hospital maintains a whole and component blood bank intended to meet the needs of patients. However, patient transfusion requirements occasionally exceed the quantity of blood products available. A randomized trial that compares ABT with banked blood products and their associations with outcome is warranted.

Furthermore, due to the retrospective nature of the study, there is a possibility of unrecognized or unrecorded reactions to ABT. Lack of consistent data collection severely limits the statistical power of our study. Small sample size and large variations in the data set introduce the possibility of type 2 error. While no statistical differences were found between survival and etiology of hemorrhage, filter pore size, ABT retrieval or administration technique, addition of anticoagulant, and occurrence of hemolysis, these results should be interpreted cautiously due to the small sample size and group heterogeneity. A prospective study with more dogs treated by a standardized protocol is recommended for further evaluation.

Conclusion

ABT is a viable adjunct to volume resuscitation in dogs with abdominal or thoracic hemorrhage secondary to vascular trauma, ruptured tumor, or coagulopathy from anticoagulant rodenticide intoxication. ABT may provide a necessary bridge to definitive hemorrhage control for intracavitary hemorrhage from a variety of causes. Complications may include hypocalcemia, prolonged clotting times, and hemolysis.

Footnotes

1. Blood Gas Analyzer, NOVA Biomedical, Waltham, MA.
3. SAS version 9.31, SAS Institute, Cary, NC.
4. Antech Diagnostics, Rodenticide Screen, Oak Brook, IL.
5. K-ject 10 mg/kg, Butler Animal Health Supply, Dublin, OH.
7. Nipro Scalp Vein Set, Nipro Medical Corporation, Miami, FL.
8. Hemo Nate Blood Filtration System, Jorgensen Laboratories Inc, Loveland, CO.
10. Veterinary Plasma-lyte A Injection pH 7.4 (Multiple Electrolyte Injection Type 1 USP), Abbott Laboratories, North Chicago, IL.
15. Nipro Scalp Vein Set, Nipro Medical Corporation, Miami, FL.
16. Veterinary Plasma-lyte A Injection pH 7.4 (Multiple Electrolyte Injection Type 1 USP), Abbott Laboratories, North Chicago, IL.

References
