Red blood cell transfusions in cats: 126 cases (1999)

Debra A. Klaser, DVM; Nyssa J. Reine, DVM, DACVIM; Ann E. Hohenhaus, DVM, DACVIM

Objective—To determine the number of and reasons for RBC transfusions, incidence of acute transfusion reactions, prevalence of blood types, volume of blood administered, change in PCV, and clinical outcome in cats.

Design—Retrospective study.

Animals—126 cats that received RBC transfusions.

Procedure—Medical records of cats that received whole blood or packed RBC transfusions were reviewed for signalment, blood type, pre- and post-transfusion PCV, volume of blood product administered, clinical diagnosis and cause of anemia, clinical signs of acute transfusion reactions, and clinical outcome.

Results—Mean volume of whole blood administered IV was 17.2 mL/kg (7.8 mL/lb) versus 9.3 mL/kg (4.2 mL/lb) for packed RBCs. Ninety-four percent of cats had blood type A. Mean increase in PCV among all cats was 6%. Fifty-two percent of cats had anemia attributed to blood loss, 10% had anemia attributed to hemolysis, and 38% had anemia attributed to erythropoietic failure. Acute transfusion reactions occurred in 11 cats. Sixty percent of cats survived until discharge.

Conclusions and Clinical Relevance—RBC transfusions resulted in an increase in PCV in cats with all causes of anemia in this study. The rate of death was greater than in cats that did not receive transfusions, but seriousness of the underlying disease in the 2 groups may not be comparable. Death rate of cats that received transfusions was not attributable to a high rate of transfusion reactions. Results confirm that pretransfusion blood typing or crossmatching is required to minimize the risk of adverse reactions. (*J Am Vet Med Assoc* 2005;226:920–923)

Veterinarians have been using blood transfusions as a treatment for anemia since the 1950s.[1] In recent decades, an abundance of new information regarding blood groups, blood typing and crossmatching, antibody prevalence, donor screening, product collection and storage, and the adverse reactions associated with the administration of these products has made transfusion therapy a rapidly growing field. Blood transfusions are no longer a treatment restricted to use by referral hospitals but are a common medical therapy used by many practices. Donor programs and veterinary blood banks are increasingly popular and address the need for blood product availability outside university teaching hospitals or large referral centers.

Surprisingly, evaluation of veterinary transfusion practice has been limited. Only 3 large-scale retrospective studies[2-4] have addressed transfusion practices in dogs. To the authors' knowledge, no studies evaluating transfusion practice in cats have yet been published. The objectives of this study were to review blood transfusion in cats during a 1-year period (1999) at The Animal Medical Center to determine the number of and reasons for transfusions, prevalence of blood types, incidence of acute transfusion reactions, volume of blood administered, change in PCV after transfusion, and clinical outcome. Our hypothesis was that cats receive transfusions with blood products for similar reasons and with similar quantities for the treatment of anemia as in dogs and that the incidence of transfusion reactions is low.

From the Bobst Hospital and the Jaqua Transfusion Medicine Service, The Animal Medical Center, 510 E 62nd St, New York, NY 10021. Dr. Klaser's present address is Atlantic Veterinary Internal Medicine, 808 Bestgate Rd, Annapolis, MD 21401.

Address correspondence to Dr. Klaser.

Criteria for Selection of Cases

Records of the Jaqua Transfusion Medicine Service of The Animal Medical Center were reviewed for the period from January to December 1999 for cats that received **whole blood (WB)** or **packed RBC (PRBC)** transfusions. During this period, 192 blood transfusions were administered to 154 cats. Records were excluded from analysis because of unavailability (n = 28), incomplete data (9), and monitoring of hemoglobin concentration rather than PCV (7). Of the 148 transfusions administered to 126 cats, 127 were WB and 21 were PRBCs.

Procedures

Information was gathered from the records of all cats in the study group and included signalment, weight, pre- and post-transfusion PCV, blood type, and clinical signs of acute transfusion reactions[5] (eg, tachypnea, fever, pruritis, angioedema, vomiting, and hemoglobinuria). Post-transfusion PCV was defined as a PCV measured from 2 to 24 hours after completion of the transfusion. The type of blood product and the amount administered as well as the number of transfusions given to each cat in 1999 were recorded. A transfusion unit was defined as 70 mL of WB (60 mL of blood collected in 10 mL of acid-citrate dextrose) or 30 mL of PRBCs prepared from 60 mL of blood collected in 10 mL of acid-citrate dextrose. The transfusion dose was calculated for each cat and expressed in milliliters per kilogram and milliliters per pound of body weight. Cause of anemia was recorded as blood loss, hemolysis, or erythropoietic failure. Some cases were attributed to a multifactorial pathogenesis (ie, chronic renal failure) and thus were assessed and categorized on the basis of the authors' consensus opinion. Clinical outcome for each cat was recorded as survival to discharge from the hospital. For those that did not survive, death was recorded as natural or the result of euthanasia.

Blood donors were from a closed colony of cats of known blood type and with negative screening test

results for infectious diseases potentially transmitted by transfusion. Administration of blood products was generally done after blood typing the recipient to ensure compatibility. Blood donors were typed by use of a tube typing methodology and a backtype. Recipients were typed by use of a commercially available card typing kit or a tube typing methodology.[6] If a cat had not received a prior transfusion, blood typing and transfusion of donor blood of the same type was considered adequate pretransfusion testing. If more than 4 days elapsed between transfusions, a crossmatch was performed because the previous transfusion may have induced production of alloantibodies.[7]

Statistical analyses—Categoric data (breed and sex) were expressed as frequencies and percentages. Continuous data were expressed as mean, median, and range. Categoric comparisons were analyzed by use of χ^2 tests. Unpaired *t* tests were used to compare the group of cats that received transfusions with all other cats hospitalized at The Animal Medical Center during the study period with regard to clinical outcome and signalment. The paired *t* test was used to analyze the differences in pre- and post-transfusion PCV for cats that received WB or PRBC transfusions. The association between cause of anemia and clinical outcome was analyzed by use of χ^2 analysis. For all comparisons, values of $P < 0.05$ were considered significant.

Results

Age of the 126 cats ranged from 6 weeks to 21 years (mean, 9.4 years; median, 10.0 years). Weight ranged from 0.2 to 10.2 kg (0.44 to 22.44 lb; mean, 3.9 kg [8.6 lb]; median, 3.7 kg [8.1 lb]). Fifty-two percent (65/126) were neutered males, 2% (3/126) were sexually intact males, 37% (47/126) were spayed females, and 9% (11/126) were sexually intact females. Domestic longhair, shorthair, and crossbred cats accounted for 80% (101/126) of the cats that received a transfusion. The remaining 25 cats represented 11 additional breeds (Siamese [n = 6], Abyssinian [4], Persian [4], Burmese [2], Himalayan [2], Norwegian Forest Cat [2], and Exotic Shorthair, Maine Coon, Russian Blue, Tonkinese, and Turkish Von [1 each]). Compared with the general hospital population of cats examined in 1999 (n = 9,848), the population that received transfusion was not different in terms of age ($P = 0.051$), breed ($P = 0.558$), or sex ($P = 1.257$). Ninety-five study cats were tested for FeLV, and 10 cats yielded positive results.

One hundred and twenty-five of 126 cats were blood typed prior to transfusion. Ninety-four percent (118/125) of the cats were blood type A, and 6% (7/125) were blood type B. One domestic shorthair cat was not blood typed. Of the domestic longhair, shorthair, and crossbred cats, 95% (95/100) were blood type A and 5% (5/100) were blood type B. Of the purebred cats, 92% (23/25) were blood type A and 8% (2/25) were blood type B. The purebred type B cats were a Turkish Von and an Abyssinian. No cats were identified as blood type AB.

Reasons for transfusions included blood loss, hemolysis, and erythropoietic failure. Fifty-two percent (66/126) of cats received transfusions for anemia secondary to blood loss, 10% (12/126) for hemolytic anemia, and 38% (48/126) for anemia secondary to erythropoietic failure. Causes of blood loss included trauma (n = 6), gastrointestinal bleeding (10), renal failure (9), neoplasia (7), surgery (14), parasitism (4), pyometra or reproductive disease (3), coagulopathy (7), and urinary bleeding (6). Causes of hemolysis included hypophosphatemia (n = 9) and immune-mediated hemolytic anemia (3). Causes of erythropoietic failure included erythroid hypoplasia (n = 8), hematopoietic neoplasia (11), FeLV infection (8), and chronic renal failure (21). Classification was based on the authors' consensus opinion, and some diseases had a multifactorial etiology. The most prevalent of these diseases was chronic renal failure. Gastrointestinal hemorrhage is an important cause of anemia in cats with chronic renal failure because of gastric ulceration secondary to uremia. Blood loss anemia was diagnosed in cats with renal failure and clinical signs such as melena and acute anemia coupled with panhypoproteinemia.[8,9]

Most transfusions used WB (127/148), and the remainder used PRBCs. The mean ± SD volume of WB administered was 17.2 ± 7.5 mL/kg (7.8 ± 3.4 mL/lb) with a median volume of 16 mL/kg (7.3 mL/lb). Range of WB administration dose was 3 to 55 mL/kg (1.4 to 25 mL/lb). The mean volume of the PRBCs administered was 9.3 ± 4.2 mL/kg (4.2 ± 1.9 mL/lb) with a median volume of 8.3 mL/kg (3.8 mL/lb). Range of PRBC administration dose was 6 to 24 mL/kg (2.7 to 10.9 mL/lb).

The mean change in PCV was an increase of 6.4 ± 3.9% for all cats (median, 6.0%; range, –3% to 20%). This included a mean increase of 6.3 ± 3.9% for cats that received WB (median, 6.0%; range, –3% to 20%) and 7.3 ± 4.0% for cats that received PRBCs (median, 6.0%; range, 2% to 17%). Neither the post-transfusion PCV nor the change in PCV for cats that received WB versus PRBC administration was significantly different ($P = 0.243$ and 0.248, respectively). Post-transfusion PCVs were a mean of 20 ± 5.4% (median, 20%; range, 8% to 44%) for the cats that received WB and a mean of 19 ± 4.9% (median, 18%; range, 10% to 28%) for the cats that received PRBCs. The mean pretransfusion PCV of 14 ± 4.5% (median, 14%; range, 5% to 34%) for cats that received WB was significantly higher than the mean pretransfusion PCV of 11 ± 3.4% (median, 11%; range, 5% to 18%) for cats that received PRBCs ($P = 0.011$). The change in PCV between groups (6.9% for hemolysis, 7.7% for blood loss, and 5.4% for erythropoietic failure) was not significantly different ($P = 0.132$).

Acute nonhemolytic transfusion reactions were seen in 10 cats. Five cats had fevers as defined by an increase in rectal temperature by > 2°F (1°C). The remainder of the reactions included face rubbing and angioedema (2 cats), vomiting (1), salivation (1), and volume overload as evidenced by auscultation of moist pulmonary crackles and thoracic radiographs that revealed pulmonary edema (1). One additional cat may have had an acute hemolytic reaction. This cat was not blood typed prior to transfusion. Post-transfusion clinical signs included pigmenturia, fever, and tachypnea. Although the PCV initially increased from 12% to 15%

2 hours post-transfusion, the PCV subsequently declined over the next 72 hours. This cat was considered to have a probable acute hemolytic reaction because of the pigmenturia and clinical signs.

Overall, 60% of the cats (74/126) were discharged from the hospital. Discharge from the hospital based on the category of anemia included 58% (38/66) of cats with blood loss, 25% (3/12) with hemolysis, and 68% (33/48) with erythropoietic failure. Of the cats that did not survive hospitalization, 19 died and 32 were euthanatized because of clinical deterioration, poor prognosis, or both. However, the discharge rate based on the category of anemia was not significantly different among the 3 groups ($P = 0.453$).

Outcome of cats that received transfusions was compared with all cats hospitalized at The Animal Medical Center in 1999 (n = 4,034). Eighty-two percent (3,324/4,034) of cats hospitalized were discharged from the hospital in 1999. Two hundred cats died, and 496 were euthanatized. The population of cats that received transfusions was less likely to be discharged from the hospital than all cats hospitalized at The Animal Medical Center in 1999 ($P < 0.001$).

Discussion

Blood transfusion therapy is a rapidly growing field in veterinary medicine. Thus far, the evaluation of veterinary blood transfusion therapy has been largely limited to the canine population and retrospective studies[2-4] similar to our study have been performed in dogs. Results of those studies documented the reasons for transfusion, effect of blood product administration, and incidence of transfusion reactions in dogs.

The cats in our study received transfusion much more often for erythropoietic failure than the dogs in the previously reported studies.[2-4] We believe this reflects the common diseases of cats. In fact, 38% (21/55) of the transfusions given for anemia of erythropoietic failure were in cats that were anemic as a sequela of chronic renal failure, which has a greater prevalence in cats than dogs.[10] To date, a retrovirus of dogs has not been identified, but infection with FeLV was common in this group of cats and is known to be responsible for anemia in the feline population. Although 17% of cats tested yielded positive results for FeLV, the true incidence of FeLV infection was unknown because < 50% of cats were tested. Another consideration for the difference in the canine and feline populations that received transfusions for erythropoietic failure is the difference between the erythrocyte life span in dogs and cats. Cats have a substantially shorter RBC life span (72 days), compared with other domestic species such as dogs or cattle, which have RBC lifespans of 100 and 130 days, respectively.[11] Consequently, erythropoietic failure may become evident more rapidly in cats than in dogs.

Red blood cells are transfused to increase oxygen carrying capacity in a patient with clinical signs caused by anemia. The dose of RBCs required to increase the oxygen carrying capacity and alleviate the clinical signs of anemia varies from patient to patient, but in the cats of this study, mean dose of RBC products given was usually within current recommendations of 13 to 22 mL/kg (5.9 to 10 mL/lb) of WB and 6 to 10 mL/kg (2.7 to 4.5 mL/lb) of PRBCs.[7] This dose of RBCs resulted in a similar increase in the post-transfusion PCV as in an abstract[a] and is consistent with expectations as reported by other authors.[7] Cats that received WB and PRBCs had similar increases in mean PCV after transfusion. This indicates the dose of RBCs was equivalent in both groups. The difference in volume administered to each was the plasma that was removed from the PRBCs before administration. However, the increase in PCV of 6% may be considered less than an ideal goal of blood transfusions, and the mean post-transfusion PCV in these cats was only 20%. Dogs often had higher post-transfusion PCVs than the cats in our study.[3] Because of its retrospective nature, our study could not determine whether this was related to a greater degree of anemia in the cats, the higher typical PCV in dogs, or a greater physiologic compensatory mechanism in cats during times of anemia, resulting in resolution of the clinical signs of anemia at a lower PCV in cats than in dogs. Additionally, a large percentage of these cats received transfusion for erythropoietic failure, an anemia of slow onset that permits physiologic compensation, compared with dogs for which acute hemorrhage represents a larger proportion.[2,3] Cats therefore appear to tolerate a greater degree of anemia than dogs. The mean increase in PCV of 6% was likely to have improved clinical signs of anemia in the cats as judged by the attending clinician because there was not a transfusion service limit on the number of transfusions a single cat could receive. Because of the retrospective nature of this study, sufficient data were not obtained to make more detailed conclusions about the resolution of the clinical signs of anemia in this group of cats.

The incidence of feline blood types in this study may suggest a variation from previously published data. For the northeast United States, previously reported data indicated a > 99% incidence of type A in the domestic cat population, compared with 94% in our study.[12] This difference could be attributable to a statistical variation or a referral bias in the hospital population. Also, a true shift in the feline population may have occurred since the publication of that study in 1992. Another potential explanation is an inherent difference in the population of cats that develop anemia. The health status of domestic cats previously studied with regard to blood type was not reported, but many may have been healthy cats, whereas this population of cats was hospitalized for medical or surgical conditions. The relationship between blood type and illness in cats is unknown, but in humans, predisposition to a variety of diseases has been linked to blood type.[13] Regardless of the reason for the differences in blood-type incidence in this study, our data confirm the necessity of performing blood typing or cross-matching prior to the administration of blood products because these data and previously reported data indicate it is incorrect to assume all domestic cats in the northeast United States are of blood type A. Certain breeds of cats have previously been reported to have a high percentage of blood type B, and those reported in this study were of breeds expected to be blood type B.[14]

Because of the retrospective nature of this study, only acute but not delayed transfusion reactions could

be identified during the record review process. Of serious concern is the possibility that 1 untyped cat had an acute hemolytic transfusion reaction and, because of this reaction, was suspected to have had type B blood. However, neither crossmatching nor blood typing was performed to verify blood-type incompatibility. The reaction was not immediately fatal or necessarily related to the cause of death. An acute hemolytic reaction secondary to AB mismatch is the most feared transfusion reaction because it can result in death, is preventable, and is a subject well addressed in the literature.[15,16] Transfusion of as little as 1 mL of AB mismatched blood can induce severe clinical signs.[16] As veterinary transfusion medicine has progressed in recent years, the incidence of these reactions should be eliminated because of better understanding of the importance of feline blood groups in acute hemolytic transfusion reactions and the availability of feline blood-typing cards.

Aside from the 1 cat that may have had an acute hemolytic transfusion reaction and 1 cat that was treated with furosemide for fluid overload, the reactions were self-limiting. The occurrence of these reactions confirms the validity of the recommendation for close monitoring during a transfusion, particularly at the onset of administration. The incidence of transfusion reactions in dogs and cats is similar.[2,3,a] Our study likely underestimated the occurrence of acute transfusion reactions in cats. A prospective study with predetermined monitoring criteria is required to identify additional acute transfusion reactions such as ionized hypocalcemia and transfusion-induced hyperkalemia.

For cats that received PRBC transfusions, discharge rate from the hospital appeared to be similar to the previously reported[2,3] survival percentages of 47% and 61% in dogs. Transfusion appears to be a negative prognostic indicator for survival in cats, compared with all other hospitalized cats. The rate of death in cats that received transfusion was greater than in other cats, but the seriousness of the underlying disease in the 2 groups may not be comparable. Although the 2 populations of cats were not different with regard to age, sex, and breed, the control group of 4,034 hospitalized cats included cats admitted to the hospital for elective procedures, such as ovariohysterectomy, castration, and dentistry as well as less serious illnesses than cats in our study. Because of the perception that blood transfusion is a lifesaving treatment in > 80% of cases,[17] it is unlikely that a prospective study evaluating outcome in transfused and nontransfused cats with similar severity of illness will be performed. In the human literature, retrospective studies comparing patients who received transfusions take into account confounding variables, such as age, seriousness of the primary disease, and concurrent diseases.[18] Use of a veterinary validated survival prediction index to stratify patients into risk categories should be performed in future studies of transfusion outcome to determine predictability of survival. A similar study[19] in human medicine has been performed to predict survival probability on the basis of age, gender, transfusion dose, and reason for the transfusion. Overall, our data can only be used to conclude that receipt of a transfusion is a negative prognostic indicator for a hospitalized cat; we hypothesize that prognosis may be related to the severity of the anemia-causing disorder. Our data appear to be similar to those for survival of human blood transfusion recipients.

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