In vitro assessment of quality of citrate-phosphate-dextrose-adenine-1 preserved feline blood collected by a commercial closed system

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Background: Optimal procedure for storage of feline blood is needed. Open-collection systems have been employed in feline medicine, thus limiting the possibility for storage.

Objectives: To evaluate indicators of quality of feline blood stored for 35 days at 14°C in a closed-collection system specifically designed for cats.

Animals: Eight healthy adult European domestic shorthair cats with a weight of 5-6.8 kg.

Methods: This is a case series study. A bacteriological test, CBC, blood smear, pH, osmotic fragility, 2,3-diphosphoglycerate (2,3-DPG), and adenosine triphosphate (ATP) measurement were performed weekly on whole blood (WB) units from day 1 to day 35 after donation. The hemolysis index, lactate and potassium concentrations, prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen were measured on plasma aliquots.

Results: One out of eight blood units (BUs) had bacterial growth (Serratia marcescens) at day 35. No significant differences were found regarding CBC, morphology, pH, and osmotic fragility. Despite high inter-individual variability and low starting levels, significant decreases in the mean concentrations of 2,3-DPG (T0 1.99 mmol/g Hb, SD 0.52, T35 1.25 mmol/g Hb, SD 1.43; P < .003) and ATP (T0 1.45 mmol/g Hb, SD 0.71, T35 0.62 mmol/g Hb, SD 0.51; P < .001) were detected during the study, as opposed to an increase in hemolysis index, lactate and potassium concentrations, prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen were measured on plasma aliquots.

Conclusions and Clinical Importance: The commercial BU kit is appropriate for blood collection and conservation of WB in cats. The maintenance of WB quality indicators during storage is essential for future improvements of feline transfusion medicine.

KEYWORDS: blood unit, feline, quality, storage, transfusion, whole blood

Abbreviations: ACD-A, anticoagulant citrate dextrose solution A; aPTT, activated partial thromboplastin time; AS-3, additive solution formula 3; ATP, adenosine triphosphate; BB, blood bank; BU, blood unit; CPDA-1, citrate-phosphate-dextrose-adenine; 2,3-DPG, 2,3-diphosphoglycerate; H INDEX, hemolysis index; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; OF, osmotic fragility; pRBC, packed red blood cells; PT, prothrombin time; RBC, red blood cells; SD, standard deviation; WB, whole blood.
1 | INTRODUCTION

Transfusion medicine represents an expanding area of research in veterinary medicine and, over the past decades, it became an integral part of intensive medical and surgical care.\(^1\) With the improvement of collection techniques and with the application of test cards for blood typing to ensure the safety of transfusions, this discipline grew remarkably and, after dogs, it was applied also in cats.\(^3\)

Because of the difficulty of feline blood collection, which in most cases implies sedation of cats and owners compliance, fresh whole blood (WB) is the most common form of transfusion in this species.\(^1,3\) Because blood volume of cats is too small to allow the employment of standard closed-collection systems for donation,\(^2\) until now the collection of feline blood has been performed mainly via open systems (syringes connected to a butterfly needle),\(^2,3\) thus limiting the possibility of establishing feline blood banks (BBs). In fact, the collection of blood using open systems makes the storage inadvisable because of the high risk of bacterial contamination of the blood units (BUs).

On the other hand, the ex vivo storage of WB for several days after collection entails a series of modifications of the product. In human medicine, this decline in red blood cells (RBC) quality and function is known as RBC storage lesions.\(^4-7\) These include structural changes (loss of biconcave disc morphology, and formation of echinocytic spines) and metabolic and biochemical changes (consumption of glucose and accumulation of lactic acid, loss of potassium, and decreases in the concentration of adenosine triphosphate [ATP] and 2,3-diphosphoglycerate [2,3-DPG]).\(^8\) As for the clinical implications of storage lesions, although some observational studies suggest that storage is linked to a series of clinical complications, including decreased post-transfusion survival,\(^7\) others do not support any associations.\(^5\) In dogs, blood products age is associated with increased odds of transfusion-related complications, such as hemolysis,\(^5,9\) but it does not seem to affect acute mortality rate.\(^9\) One recent study in dogs reported an increased in vivo hemolysis after the transfusion of older BUs than fresher ones.\(^9\) In feline medicine, little is known regarding the morbidity associated with transfusing products of various storage times in cats.\(^10\)

Given the importance of a good conservation of WB preserved for transfusion purposes, the aim of our study was to evaluate some in vitro quality indicators of feline WB collected by a new commercial transfusion system and stored with citrate-phosphate-dextrose-adenine (CPDA-1) solution and stored for 35 days at \(+4^\circ C \pm 2^\circ C\).

2 | MATERIALS AND METHODS

2.1 | Characteristics of blood donors and sampling protocol

Blood donors were 8 healthy owned adult European domestic shorthair cats that weighed between 5 and 6.8 kg and were aged between 2 and 6 years. Before donation, cats were deeply sedated with intramuscular injection of 2.5 mg/kg of alfaxalone, 0.2 mg/kg of midazolam, and 0.3 mg/kg of butorphanol. After sedation, oxygen mask was applied and an intravenous catheter was placed into the cephalic vein. The whole procedure was monitored through pulse oximetry and ECG. Preoperative hair removal was performed on the jugular area of the neck, followed by surgical skin preparation (chlorhexidine 4%). Blood was drawn through a butterfly needle (21G) connected to the blood bag; 50 mL was collected into the unit and mixed with 8 mL of CPDA-1, previously loaded into a dedicated syringe. A 20-mL aspiration syringe, which produces a lower negative pressure than larger syringes, allowed to split the collection into 3 phases, in order to mix CPDA-1 and blood correctly. At the beginning of each phase, 1/3 of the total CPDA-1 was transferred from the anticoagulant syringe into the aspiration syringe. The connection between the 2 syringes was then closed with the plastic clip. Subsequently, 15 mL of blood was collected into the aspiration syringe, the patient route was temporarily clipped and the bag route was opened. The anticoagulant–blood mix was emptied into the blood bag and the whole procedure was repeated 2 more times. A moderate and regular negative pressure was applied in order to draw blood with a continuous flow. After collection, the PVC tubes were sealed with metal clips and the BUs were stored at \(+4^\circ C\) until the end of the study period.

2.2 | WB CPDA-1 analysis

From each BU, 4 mL of WB was collected weekly starting from day 1 after donation (T0) to day 35 (T7, T14, T21, T28, T35) by sterile Vacutainer system; furthermore, 2 mL of WB was collected at T0 and T35 in order to be tested for bacterial growth and for the pH. The sampling was performed through some specific self-cleaning valves that are part of the units system; these devices allow sampling without impairing the sterility of the BU.

Microbiological cultures for aerobic and anaerobic bacteria were performed by inoculation of 10 μL of WB into 2 nutritive blood agar plates (Blood Agar Base n°2, Biolife, Milano, Italy) with 5% defibrinated sheep blood, Breeding Blood, Teramo, Italy) and into a selective medium for Enterobacteria (McConkey agar, Oxoid, Basingstoke, UK). In addition, 1 mL of blood was added to 9 mL of nutrient broth (Heart Infusion broth Oxoid, Basingstoke, UK) and Thioglycolate broth (THG broth, Sigma Aldrich, Milan, Italy). Blood Agar plates were incubated at 37°C ± 1°C under aerobic and anaerobic conditions, respectively. Broth cultures and selective medium plates were incubated at 37°C ± 1°C in aerobic conditions.

All plates were examined after 24 and 48 hours of incubation and, in case of no bacterial growth, a new seeding was prepared starting from the broth culture. The incubation time for the negative plates was prolonged up to 5 days. Species identification was performed by MALDI-TOF MS: Microflex LT instrument (MALDI Biotyper, Bruker Daltonics) equipped with FlexControl software (FlexControl software version 3.3, Bruker Daltonics).

The pH was measured with a bench top pH meter (GLP21, Crison Instruments, Lainate, Italy) at T0 and T35. The pH meter was calibrated before measurement using manufacturer-supplied controls for acidic, basic, and neutral solutions.
On each 4-ml weekly sample, a CBC was performed on a hematology analyzer (Cell Dyn 3700 analyzer, Abbott Diagnostics Europe, Wiesbaden, Germany); at the same time, a blood smear for the evaluation of cell morphology was prepared and colored with a modified Wright-Giemsa stain (Hematek 2000, Bayer, Leverkusen, Germany). Additionally, 400 lL were used to perform a standard osmotic fragility test, which has been described previously in cats.11 From each sample, a series of distilled water NaCl dilutions was prepared; every series had 12 dilutions containing concentrations of 0.9, 0.75, 0.65, 0.60, 0.55, 0.50, 0.45, 0.40, 0.30, 0.20, 0.10, and 0% NaCl. After a 30-minute incubation at room temperature, the test tubes were centrifuged at 250 g for 10 minutes. Subsequently, the supernatant fluid was divided into three 500 lL aliquots; in each 1 of these, 80 lL of sodium carbonate (Na2CO3) 1 M were added to neutralize the acid pH. After this process, the aliquots were frozen at −80°C until the end of the storage period and analyzed together during the same session.

One aliquot of each acid-extracted sample was used to determine the 2,3-DPG concentration12 by UV spectrophotometry with an enzymatic assay (2-3 Diphosphoglycerate, Roche Diagnostics GmbH, Mannheim, Germany). A second aliquot was used to determine the ATP concentration12 by a luminescence15,16 assay system (ATPLite, Perking Elmer Inc., Waltham, Massachusetts). In order to standardize the outcome according to the number of extracted RBC, the results of both analysis are expressed in µmol/g of Hb, using the Hb concentration obtained from the RBC pellet before acid extraction.

In addition, at each analysis session, a canine blood pool was processed as described and tested for 2,3-DPG and ATP as a control.

### 2.3 | Plasma CPDA-1 analysis

As far as chemistry profile is concerned, we selected some main indicators of good blood storage. At the end of the study period, 1 plasma aliquot of each weekly sample was thawed and analyzed on the clinical chemistry analyzer (Cobas C501 analyzer, Roche Diagnostics GmbH) in order to determine glucose, lactate and potassium concentrations as well as the H index, as indicator of plasma Hb.17 The percentage of hemolysis was calculated with the following formula18,19:

\[
\text{Hemolysis} \% = \left( \frac{100 - \text{hematocrit}}{3} \right) \times \frac{\text{plasma Hb (g/dL)}}{\text{total Hb (g/dL)}}
\]

At the same time, prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen were examined on a coagulation analyzer (ACL 7000 analyzer, Instrumentation Laboratory, Bedford, Massachusetts). PT and aPTT were determined by nephelometric method and the results are expressed in seconds, whereas fibrinogen concentration is expressed in mg/dL, measuring absorbance with Clauss method.

### 2.4 | Statistical analysis

Descriptive analyses were performed to evaluate the distribution of WB and plasma analyses and to assess potential outliers. The variables were evaluated using linear mixed models in which the sampling time was included as fixed effect. Additionally, the sampling time was included in the model as random effect, taking into account the
repeated measures made on the same cat. Given the high skewness of
2,3-DPG, the log-transformation was adopted to allow the application
of the model. The results were expressed as P values. The Akaike Infor-
mation Criterion and the residual diagnostics were used to evaluate the
goodness of fit of the model. All analyses were performed using the
software SAS® v.9.4 (SAS® v.9.4 Software, SAS Institute Inc, Cary,
North Carolina).

3 | RESULTS

3.1 | WB CPDA-1 analysis

At T0, all of the BUs had no bacterial growth, whereas 1 out of 8 units
were positive for Serratia marcescens at T35.

The mean pH values remained within the neutral range, showing a
slight decrease from 7.2 to 7.0 by the end of the storage period.

Mean values of all WB CPDA-1 indicators, together with standard
errors and P values at each observation (from T0 to T35) are shown in
Table 1.

The RBC count, the RBC indices (MCV, MCHC, MCH, RDW), the
hematocrit (HCT), and Hb showed no statistically significant differences
during the 35-day period (Figure 2). The morphological evaluation of
RBC by blood smear identified an increase in the presence of echino-
cytes between T0 and T35, starting from a total absence or weak pres-
ence (1+, corresponding to an average of 5–10 echinocytes per
×1000 field), to a moderate or numerous presence (2+, corresponding
to an average of 11–100 echinocytes per ×1000 field).20

The mean osmotic fragility, expressed as the percentage of saline
concentration (w/w) at which 50% of erythrocytes are hemolyzed, kept
almost constant during the whole observation period (P = .16) (Figure
2), with a mean value of 0.73% at T0 and 0.69% at T35. Despite the high inter-individual variability, changes of 2,3-DPG
over time proved statistically different (P = .003).

The concentrations of 2,3-DPG ranged from 1.31 to 3.53 μmol/g Hb at T0 and from 0.02 to 4.24 μmol/g Hb at T35. The mean 2,3-DPG
values were 1.99 μmol/g Hb at T0 and 1.25 μmol/g Hb at T35 (Figure
2). Despite the high inter-individual variability, changes of 2,3-DPG
over time proved statistically different (P = .003).

### Table 1

Mean levels and standard deviations at different sampling times (T0, T7, T14, T21, T28 and T35) for whole blood CPDA-1 indica
tors (reference ranges are shown between brackets)

| Indicator                  | T0   | T7   | T14  | T21  | T28  | T35  | P     |
|----------------------------|------|------|------|------|------|------|-------|
| RBC (5.10-10.00 M/μL)      | Mean | 5.60 | 5.71 | 5.62 | 5.69 | 5.95 | 5.76  | .52   |
|                           | SD   | 1.11 | 0.83 | 1.01 | 1.05 | 0.97 | 1.28  |       |
| Hb (8.00–15.00 g/dL)       | Mean | 7.67 | 8.05 | 7.94 | 8.00 | 8.38 | 8.16  | .24   |
|                           | SD   | 1.31 | 1.07 | 1.34 | 1.47 | 1.39 | 1.80  |       |
| HCT (30%-45%)              | Mean | 26.53| 27.06| 26.63| 26.81| 28.19| 27.18 | .53   |
|                           | SD   | 4.94 | 3.69 | 4.59 | 4.73 | 5.01 | 6.23  |       |
| OF (0.57%-0.71% NaCl)      | Mean | 0.73 | 0.75 | 0.71 | 0.69 | 0.68 | 0.69  | .16   |
|                           | SD   | 0.04 | 0.05 | 0.08 | 0.07 | 0.06 | 0.07  |       |
| 2,3-DPG (1.63-2.35 μmol/g Hb) | Mean | 1.99 | 2.21 | 2.05 | 1.42 | 0.99 | 1.25  | .003  |
|                           | SD   | 0.52 | 0.89 | 1.17 | 1.03 | 0.81 | 1.43  |       |
| ATP (0.96-1.94 μmol/g Hb)  | Mean | 1.45 | 0.83 | 0.77 | 0.72 | 0.65 | 0.62  | <.001 |
|                           | SD   | 0.71 | 0.49 | 0.56 | 0.48 | 0.48 | 0.51  |       |

Abbreviations: RBC, red blood cells; Hb, hemoglobin; HCT, hematocrit; OF, osmotic fragility; 2,3-DPG, 2,3-diphosphoglycerate; ATP, adenosine
triphosphate.

Statistically significant P values are shown in bold.
ATP concentrations ranged from 0.38 μmol/g Hb to 2.34 μmol/g Hb at T0 and from 0.00 μmol/g Hb to 1.59 μmol/g Hb at T35. The mean ATP values were 1.45 μmol/g Hb at T0 and 0.62 μmol/g Hb at T35 (Figure 2). ATP variation over time proved statistically different, showing a faster decrease in the first 7 days after collection (\(P < .001\)) compared to the rest of the storage period.

The canine blood pool was tested 5 times for both ATP and 2,3-DPG with the following mean results: ATP 1.65 μmol/g Hb ± 0.40, 2,3-DPG 10.09 μmol/g Hb ± 1.28.

### 3.2 Plasma CPDA-1 analysis

Mean values of all plasma CPDA-1 variables, together with standard errors and \(P\) values at each observation (from T0 to T35) are shown in Table 2.

Glucose mean values were high at T0 (30.1 mmol/L) and decreased significantly throughout the observation period to 22.9 mmol/L (\(P < .001\)) at T35. The lactate mean value raised abruptly from 3.30 mmol/L at T0 to 13.36 mmol/L at T35, whether potassium concentrations rose mildly from a mean value of 3.10 mmol/L at T0 to 3.93 mmol/L at T14, and kept steadily around 4 mmol/L until the end of the study period. Both of these parameters showed a statistically significant difference (\(P < .001\)).

The hemolysis increased significantly (\(P < .001\)) during the storage period, ranging from 0.05% to 0.26% at T0 and from 0.54% to 1.08% at T35; the mean value at T0 was 0.11% and 0.84% at T35.

Over time, the coagulation indices showed statistically significant difference (\(P < .001\)), with a slight increase in the PT and aPTT values and a simultaneous drop of the fibrinogen concentration. The mean PT values were 11.2 seconds at T0 and 12.8 seconds at T35. Mean value of aPTT increased from 12.5 seconds at T0 to 18.9 at T35. In contrast, fibrinogen concentration went down from 230.75 mg/dL at T0 to 195.75 mg/dL at T35.

### 4 DISCUSSION

Human standardized closed-donation systems are easily adaptable for canine blood donation because blood pressure and gravity are sufficient for blood withdrawal. On the contrary, considering the vein caliber, the blood pressure and the small blood volume collected, cats need a dedicated closed system with the ability to produce vacuum. Recently, a closed-collection system for blood in cats became commercially available (TEC 724 Kit, Futurlab Srl). The aim of our study was to test the system for blood donation in 8 BD cats, to evaluate feasibility during collection and to assess the sterility and the quality of stored WB. The system (TEC 724 Kit, Futurlab Srl) proved to be suitable and easily manageable for blood collection. As already underlined, the 20 mL syringe allows to split the collection into 3 phases, in order to mix CPDA-1 and blood correctly; as a matter of fact, this procedure ensures the achievement of the right anticoagulant : blood proportion (1 : 7)\(^{18,21–23}\) even in the chance of an incomplete collection. Moreover, in contrast to the 60 mL syringes, the smaller syringe facilitates the aspiration producing a lower negative pressure. As a consequence, the low mean hemolysis value registered at T0 indicates that the procedure caused irrelevant RBC lysis. In fact, troublesome collection, large vacuum, or forceful flow represent all aspects that can lead to hemolysis.\(^{24}\) Moreover, neither visible clots nor change in color were observed in any of the BU.

There are various sedation and anesthesiologic protocols for feline blood donation.\(^{5,18,25–27}\) We chose an association of alfaxalone, midazolam, and butorphanol. In our study, the chosen protocol allowed a...
good, deep sedation, preserving the turgidity of the jugular vein during phlebotomy, and a fluent and continuous flow of blood during aspiration.

In both human and veterinary medicine, bacterial contamination of blood products is still the most prevalent infectious risk in transfusion medicine. Possible mechanisms of bacterial contamination of the BU include contamination during collection, blood processing or storage, contamination of the collection pack, and donor bacteremia. The microbiological test results showed the suitability of the system for the collection and storage of blood, maintaining sterility up to 35 days. At T35, we detected bacterial growth in 1 BU. Unfortunately, even if it is hard to state when the contamination happened, it is more likely that this event occurred during blood collection, considering that the isolated bacterial species, *S. marcescens*, is a member of the Enterobacteriaceae family and a Gram-negative saprophytic bacillus, which has often reported to be a bacterial contaminant of stored blood products. Moreover, in the chance of contamination during collection, the standard culture methods could have resulted negative at T0 because of a low bacterial load. Furthermore, although a careful preparation of the skin before donation decreases the skin bacterial load, a sterile venipuncture cannot be guaranteed because the organisms which are present in the sebaceous glands and hair follicles are inaccessible. We therefore recommend thorough disinfection of the jugular area before collection and careful disinfection of the valve when sampling the bag.

The measured pH levels, with their steady trend and physiological values (from 7.21 at T0 to 7.05 at T35), show that the sodium phosphate buffer contained in the CPDA-1 solution is suitable to keep the pH stable during storage. A previous study, which compared biochemical alterations in rat and human packed RBC (pRBC) stored in CPDA-1 for 29 days, reported a faster decrease in the pH mean levels, lowering from 7.04 at T0 to 6.64 at T29 in rats and from 7.14 at T0 to 6.50 at T29 in humans. Studies on canine pRBC CPDA-1 indicate a lower initial pH (between 6.90 and 6.97) at T0 and a significant drop by T35 (between 6.47 and 6.50). One study on canine pRBC units with other storage solutions showed similar trends as those documented in our study (pH range 7.22–7.30 at T1 and 6.99-7.07 at T31). Differently, pH of feline pRBC stored in anticoagulant citrate dextrose solution A (ACD-A) with additive solution formula 3 (AS-3) decreased progressively from a median value of 6.61 (T1) to 6.01 (T35). The low pH levels reported in the latter study are probably related to the ACD-A solution employed, suggesting that CPDA-1 represents a good solution for feline blood storage.

As previously described, RBC count, RBC indices and Hb showed no statistically significant differences during the 35-day period (Figure 2). In addition, HCT did not change significantly over time; this observation might seem in contrast with the slight increase in the percentage of hemolysis. However, it is important to evaluate the effect of such a small increase of hemolysis on the total RBC count, hence on the HCT. Moreover, HCT is a calculated value, which is based on RBC count and mean corpuscular volume (MCV), 2 parameters that kept almost constant during the whole study period.

Smear evaluation showed a steady increment of echinocytes over the study period. This common finding in stored WB can be considered physiological; as a matter of fact, echinocytosis is likely due to RBC–anticoagulant contact, to storage time, as well as to the constant depletion of ATP and 2,3-DPG. Although it is believed that an alteration of cell morphology during storage results in a decreased deformability of RBC, it has been recently suggested that the capacity to deform and to relax are not affected during storage in the BB and altered cell morphology by itself does not necessarily affect deformability. Moreover, echinocytosis is considered a reversible morphological alteration, compared to others, such as spherocytosis or microvesiculation via membrane loss from the tips of echinocytic spines, which are non-reversible. It has been shown that spherocytocytes and spherocytes have a higher osmotic fragility than that of normal shaped RBC because they are extremely sensitive even to slight osmotic stresses. Because we did not observe the presence of spherocytocytes nor of microvesiculation, we are confident that the prolonged storage and contact with the anticoagulant did not remarkably damage RBC membrane and its deformability. In addition, the mean osmotic fragility, which is a marker of good conservation of RBC, kept almost unchanged, with no statistically significant difference (P = .16), from T0 (0.73%) to T35 (0.69%). These values are higher than the ones reported in previous studies, with healthy control cats ranging between 0.45%–0.57% and 0.48%–0.58%. Higher osmotic fragility mean values could be ascribed to the stress RBC suffered during both blood collection and blood weekly sampling. Nevertheless, considering the steady trend of these values and the fact that we did not observe the presence of spherocytes RBC, it is legitimate to believe that the preservative solution could positively affect felines' RBC membranes during the storage period, making them less likely to acquire membrane-shape alterations, hence more resistant to osmotic stresses.

2,3-DPG is a glycolytic intermediate that can be found within RBC and which works as a major modifier of Hb-oxygen affinity in many species, including human beings, dogs, and rats. Because no previous studies applied this method to feline stored WB, we included a canine blood pool as internal control sample. As previously reported, 2,3-DPG levels were found to be significantly lower in feline RBC than in human beings and dogs, even though we observed high variability among the subjects. The decrease in 2,3-DPG mean concentration, which is a well described process in human and canine stored blood, was found to be statistically significant (P = .003). However, the real usefulness of this indicator in the evaluation of feline erythrocytes viability is questionable because feline Hb-oxygen affinity is scarcely influenced by 2,3-DPG. ATP depletion, which normally occurs during storage of WB, has direct adverse effects on RBC deformability, as ATP provides the necessary energy to maintain RBC membrane elasticity, intracellular viscosity, and an optimal RBC surface area-to-volume ratio. In human beings, the minimum recommended range of ATP concentration in pRBC is 2.3–2.7 μmol/g Hb; these values are correlated to a survival rate of 75% of transfused RBC during the 24 hours after transfusion. In dogs, ATP concentrations <0.75 μmol/g Hb is considered the threshold of transfused RBC availability. In literature, there are no
able.6 As previously described, hemolysis is known to occur during membrane integrity, because it is directly observable and accurately measurable.46 On the other hand, the US Food and Drug acceptable a maximum level of 0.8% of pRBC hemolysis at the end of the storage period.4,19,47

In conclusion, the system (TEC 724 Kit, Futurlab Srl) proved appropriate for blood collection and proper storage of feline WB at +4°C ± 2°C up to 35 days. The CPDA-1 anticoagulant and preservative solution allowed for a correct storage of feline WB, as underlined by the stability of the analyzed biochemical parameters. The system will represent a valuable clinical device for the development of feline transfusion medicine.

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CONFLICT OF INTEREST DECLARATION

Authors declare no conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Informed client consent was obtained by cat owners participating in the study.

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