BSA

4th EDITION

MANUAL OF TRANSFUSION MEDICINE

INDEX

BSA TEAM

Rui Ferreira. DVM, PhD.
CEO Animal Blood Bank Portugal, Spain and Benelux.

Graduated in Veterinary Medicine at Institute for Biomedical Sciences Abel Salazar – Oporto University (ICBAS–UP) in 2005. PhD in Veterinary Sciences at ICBAS–UP in 2014. Joined Oporto's Veterinary Hospital from 2005 to 2008, focusing the areas of emergency and critical care, physical therapy and hemotherapy. Started in 2008 a PhD in Veterinary Sciences entitled "Transfusional Medicine in canines – from the donor's health to the efficacy in the receptor", by the Institute for Biomedical Sciences Abel Salazar. Participated as a speaker in several Transfusional Medicine related lectures and national congresses. Author of several scientific articles published in national and international magazines in the area of collection and processing of blood units from canines and hemotherapy. Founder and CEO of Animal Blood Bank since 2011.

Ignacio Mesa Sánchez. DVM, MSc, PhD, Dipl.ECVIM-CA.
CEO Animal Blood Bank Spain.

Graduated in Veterinary Medicine from the University of Córdoba in 2008. PhD from the University of Córdoba (2015). Founding member of the Animal Blood Bank Spain in 2015. European Veterinary Specialist from the European College of Internal Medicine (ECVIM–CA Internal Medicine) in 2016. Editor and author of the books "Practical guide to analytical interpretation and differential diagnosis in small animals" Ed. Servet (2016) and "Internal Medicine in small animals" Ed. Elsevier (2019). He is currently the Clinical Director of the Animal Blood Bank, President of the Internal Medicine working group of AVEPA and an internist in the Internal Medicine Service at the Hospital Auna Veterinary Specialties.

Kris Gommeren. DVM, MSc, PhD, Dipl.ECVIM, Dipl.ECVECC.
General Coordenator Animal Blood Bank Benelux.

Kris Gommeren graduated in 2002 at Ghent University, where he performed an internship and a residency in internal medicine. He became a diplomate in internal medicine in 2009, and briefly worked in a private referral practice, before moving to Liège University, where he is in charge of the ECC–service. Kris is past–president of the European Society of Emergency and Critical Care (EVECCS). He obtained his PhD on the effects of systemic inflammation on the cardiovascular system. In 2017 he became Diplomate in Emergency and Critical Care. He also works on a consultancy basis for Evidensia, in order to develop facilities and train personnel. His main fields of interest are point of care ultrasound, the cardiovascular system, fluid therapy and the assessment of volume status. Founding member of the Animal Blood Bank Benelux in 2021.

João Araújo. DVM, MSc.
CEO Animal Blood Bank BENELUX.

João took is DVM Degree with the Universidade de Trás-os-Montes e Alto Douro (UTAD) at 2006. He did is last year practical year at Hospital Veterinario do Porto having joined there Emergency and Critical Care team after that until 2014. Volunteer at Africa in humanitarian campaigns twice. At 2016 he was elected to OMV (National Statutory Body) where he correctly posses as treasurer of Northen OMV Council. Invited on 2016 to be General Board member of European Veterinary Emergency and Critical Care Society being frequent moderator of both European Congress (EVECCC) and International Congress (IVECCS). Frequent speaker on the ECC topic to firefighters and general public trying to raise awareness on the topic of ECC on companion animals. Founding member of the Animal Blood Bank Benelux in 2022.

Inês Cardoso. DVM, MSc, PhD Student.
General Coordenator.

Graduated in Veterinary Medicine at ICBAS–Oporto University in 2008. Have done several externships and post graduation studies in exotic animal medicine and surgery namely in Avian and Exotic Animal Clinic of Indianapollis (USA), Loro Park (Tenerife, Spain) and Vets Now Referrals (Swindon, UK). Also had special formation in Veterinary Pathology in NationWide Laboratories (UK). Gave veterinary assistance to several small animal clinics in Portugal and worked with Cedivet – Centro Diagnóstico Veterinário (Veterinary laboratory) as a exotic animal veterinary pathologist. Currently working as a vet in Animal Blood Bank (Banco de Sangue Animal – Oporto) since 2013 and doing a PhD about "Transfusion Medicine in Rabbits (O.cuniculli): collection, preparation and storage of hemocomponents.". Her main professional interests are exotic animal clinical pathology and transfusion medicine and their conjunction with veterinary clinical practice.

Raquel Soares. DVM, MSc.
General Coordenator and Quality Manager.

Integrated Master degree in Veterinary Medicine by the Faculdade de Medicina Veterinária, Universidade de Lisboa (FMV–UL) concluded in 2015. Curricular internship in research, microbiology and food safety, with the total duration of eight months. This intership was held in three diferent locations: in an industrial slaughterhouse of birds, in the Animal Source Food of Microbiology Laboratory of FMV, associated with the Interdisciplinary Research Centre for Animal Health (CIISA) and in the National Laboratory of Gastrointestinal Infections Reference, of the Department of Infectious Diseases of the Instituto Nacional de Saúde Doutor Ricardo Jorge (INSARJ), in Lisbon. Masters thesis in Veterinary Medicine entitled: "Codetection with Helicobacter pullorum and Campylobacter spp. in poultry origen materials. Joined the Animal Blood Bank team in December 2015 as Veterinary in the Lisbon.

OUR SITES

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BSA
ANIMAL BLOOD BANK

OUR MISSION
To provide quality blood components to veterinarians, as a treatment aid in their clinical practice, following in house good practice and strict quality criteria guided by protocols used in human medicine.
To provide a significant platform connecting donor animals and critical patients in veterinary clinics and hospitals who require blood transfusions.

OUR VISION
To be recognised as the most qualified national and international association in transfusion medicine in the veterinary industry, and within the development and investigation of new blood components and transfusion methods necessary to improve the effectiveness and quality of veterinary transfusion therapy.

OUR VALUES
We want BSA to always maintain the respectable name, credibility and reliability of products and our services available, in such a way that it always remains a respected Animal Health Institution.

OUR COMMITMENT
To work relentlessly to ensure that all transfusions are performed with safe blood components, that are free from infectious agents, thus ensuring the provision of the best medical care.
To pursue the continuous optimisation of resources, to consolidate and ensure that the quality of our services provided to veterinarians and owners of our donors is recognised.
To sustain continuous personal development, to ensure the most recent scientific research is applied to our protocols and the most advanced knowledge is always available to our team members. To perform all activities in accordance with strict quality requirements, continuously seeking improvement and focusing on the satisfaction of our customers.
Carry out all our activities in accordance with the highest quality criteria, ensuring the effort for continued improvement and to fulfil the expectations of our customers and other stakeholders.

OUR POLICY

The BSA GROUP accomplishes their Mission, pursues their Vision, guarantees their Values, and fulfils their Commitments, ensuring the below:

- The implementation and maintenance of a Quality Management System, in accordance with the NP EN ISO 9001 Standard;
- Compliance with the requirements of NP EN ISO 9001 in addition to the appropriate legal obligations and other principles and necessities of good manufacturing practice;
- Compliance with Good Manufacturing Practices for Veterinary Medicines, according to Ordinance No. 1048/2008.

CERTIFICATES & LICENSES

Our personal, equipment, facilities, protocols and animal welfare concerns have been recognised or certified by institutions of excellence:

- Bureau Veritas – Quality Certification ISO9001
- General Directorate of Food and Veterinary Medicine (Portugal) – Authorisation for Animal Blood Bank
- Veterinary Medicines Directorate (United Kingdom) – Authorisation for Animal Blood Bank
- International Society of Feline Medicine – Cat Friendly Clinic
- Fear Free Certified Professionals – 2 certified vets

QUALITY ASSURANCE

- Quality System certified by Bureau Veritas: an extremely demanding certification, which allows, among other things: protocol control, strict management of suppliers and customers, and unprecedented product traceability.
- Animal Welfare – Cat Friendly and Fear Free Certified professionals – Commitment to animal welfare is of paramount importance. Our donors are an example of kindness and altruism. Their well–being has always been the highest priority of our team and is safeguarded by the implementation of protocols carefully reviewed and scrutinised by the International Society of Feline Medicine. The Cat Friendly certification is a great example of our commitment, confirming that our team, rooms, equipment, and processes are developed to provide the best care to our donors and guarantee their well–being during donations.
- Donor selection – all BSA donors are selflessly and independently enrolled by their owners. BSA guarantees the vaccination and parasiticide treatment (endo– and ectoparasites), in addition to performing regular blood tests – complete blood count, biochemical analysis and infectious agent screening.
- PCR & serology screening for each unit – full analysis system to test for infectious agents in every blood unit donated (all these results are available and fully accessible to owners or vets via the online 'Reserved Area'):
  - PCR for Ehrlichia spp, Anaplasma spp, Babesia spp, Leishmania spp and Brucella canis (dog)
  - PCR for FeLV provirus, Mycoplasma haemofelis, Candidatus Mycoplasma haemominutum, Candidatus Mycoplasma turicencis and Bartonella spp. (cat)
  - Serology for Ehrlichia spp, Leishmania spp and Dirofilaria immitis (dog)
  - FeLV and FIV serology (cat).
- Leukodepletion filtration in every canine unit – prevents the production of prothrombotic microparticles and inflammatory cytokines during storage, reducing the haemolysis of the unit, preventing the transmission of

Our donor selection and blood collection protocols have been validated through 2 major scientific studies on the adverse effects after 4439 canine and 3690 feline donations in our blood bank. *Feline blood donation adverse reactions: classification and description of acute and delayed reactions in a donor population. J Feline Med Surg. 2022 Apr;24(4):284–289. Canine blood donation adverse reactions: classification and description of reactions in a donor population. Abstract presented in 2022 annual European Veterinary Emergency and Critical Care Congress.*

Another study published by the BSA confirmed the safety of our protocols regarding the volumes of donated blood and their periodicity in dogs. *Effects of repeated blood donations on iron status and haematologic variables of canine blood donors. J Am Vet Med Assoc. 2014 Jun;244(11):1298–1303.*

infectious diseases carried by leukocytes (e.g. Leishmania), reducing the inflammatory response in the recipient and thus the risk of transfusion reactions, and it also increases the shelf–life of stored erythrocytes.
- Blood typing of donors.
- Use of closed systems of blood extraction in dogs and cats that guarantee the sterility of the unit.
- Strict cleaning and sterility procedures during collection, processing, and storage process, to ensure a closed collection system is maintained.
- Quality control of processed units – by carrying out bacterial blood cultures, analysis of packed cell volume, haemoglobin concentration and percentage of haemolysis.
- Deep freezing of plasma units, cryoprecipitate and platelet gel (–80°C), ensuring the therapeutic properties of stored proteins.
- Temperature control during transport and storage.
- Procedures established according to the standards and requirements of the European Council for Human Blood Banks.
- Informatic systems that integrates donors, owners, units, analysis, and clinic data, allowing an adequate control of the traceability of any haemocomponent unit.

Our BSA infectious agent detection results have been published in these 2 recent scientific studies.
Transfusion transmissible pathogens are prevalent in healthy cats eligible to become blood donors. J Small Anim Pract. 2021 Feb;62(2):107–113.
Prevalence of transmissible canine blood pathogens in a blood donor population tested on every donation. Abstract presented in 2022 annual European Veterinary Emergency and Critical Care Congress.

BSANIMAL APP FOR IPHONE AND ANDROID

The BSA have a free App for iPhone and Android devices. To help the transfusion process, we have developed an App where you can place orders, confirm protocols, volumes and administration speeds for each blood component, or discover the most common transfusion reactions. It also allows access to a Haemocalculator, which automatically calculates volumes and administration rates, according to the patient's species and weight.

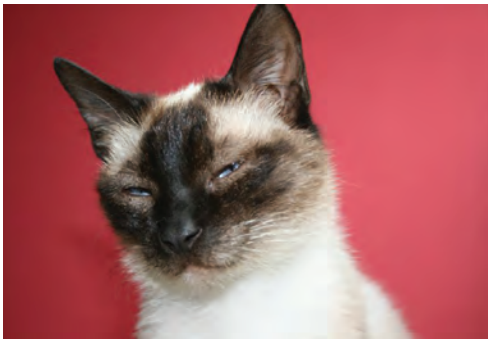
RESERVED AREA AT BSANIMAL WEBSITE

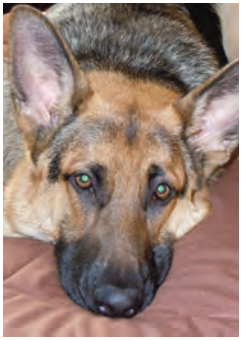
The Animal Blood Bank provides an online management system specifically designed to control every unit requested, in stock and consumed. Here you can place orders, consult previous orders, invoices, donor analysis, quality controls, prices and scientific documents or transfusion protocols. Additionally, it is possible to use an internal stock system that allows the management of transfused, expired, or active units in stock. To log in you will need specific credentials provided by the Animal Blood Bank.

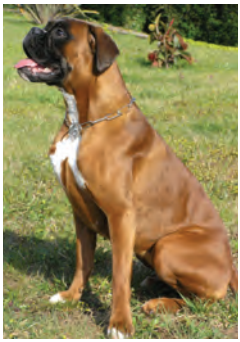
Visit us at bsanimal.com | .co.uk | .es | .be

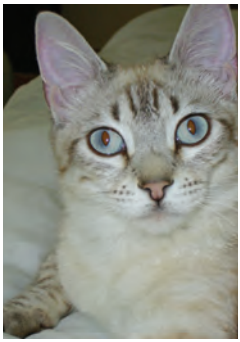
OUR BELOVED 10.000 DONORS









BSA ANIMAL BLOOD BANK

VOLUNTEERS ONLY, 100% PRIVATE OWNED ANIMALS
OVER 2800 OWNERS INVOLVED FROM 5 DIFFERENT COUNTRIES

PACKED RED BLOOD CELLS

INDICATIONS

Indicated for the replacement of blood cells that are capable of transporting oxygen to maintain tissue viability. Packed red blood cells should be used primarily in the treatment of symptomatic anaemias (regenerative or non–regenerative):

- Haemolytic anaemias – Immune–mediated haemolytic anemia; oxidative damage (intoxication by zinc, paracetamol, onion...); poisoning (snake bite, bee...); microangiopathic hemolysis (e.g. hemangiosarcoma, heartworm, endocarditis, haemolytic–uremic syndrome, splenic torsion); hypophosphatemia (insulin or refeeding syndrome); hereditary erythrocyte enzyme deficiencies (pyruvate kinase or phosphofructokinase deficiency);
- Non–regenerative anemias – precursor–targeted IMHA, pure red cell aplasia, myelodysplastic syndrome, myeloproliferation, myelophthisis, myelofibrosis, infection, chronic inflammatory disease, renal disease, or iron deficiency anaemia;
- Surgeries – prior correction of anaemia or when large, intraoperative blood loss is expected;
- During cardiopulmonary resuscitation, to allow for increased oxygenation capacity.

The benefits of packed red blood cells (pRBC) are temporary, and the primary disease always requires specific treatment.

IN GENERAL, PRBC TRANSFUSION IS INDICATED IF THE PATIENT PRESENTS WITH:

- Clinical signs of hypoperfusion: pale mucous membranes, exercise intolerance, tachycardia, tachypnoea, hypotension;
- Estimated bleeding of >30% of blood volume. In acute haemorrhage, pRBC can be combined with plasma, platelet concentrate, crystalloid or synthetic colloid solutions;
- PCV < 18–21% in dogs with acute presentation anaemia; PCV < 15–18% in chronic presentation anaemia;
- PCV < 25–28% in patients who require anaesthesia;
- Laboratory parameters indicative of hypoperfusion are present: lactate > 4 mmol/L; metabolic acidosis; base excess < –8.

For a more exhaustive assessment of the need for transfusion in dogs and cats, follow the Transfusion Need Scale tables at the end of this manual.

ADVANTAGES OF PRBC OVER WHOLE BLOOD:
Avoids volume overload in patients that do not require plasma proteins.
Avoids the risk of immune–mediated reactions to plasma proteins (the major cause of transfusion reactions).
Avoids wasting unnecessary components that can be used in other patients
Allows longer storage time for erythrocytes (up to 6 weeks instead of 4 weeks in whole blood).

DID YOU KNOW THAT...
Transfused erythrocytes may improve primary haemostasis? A PCV decrease of 15% increases bleeding time by 60%, regardless of the platelet count.
Increasing PCV corrects bleeding times because erythrocytes stimulate the production of thromboxane and ADP. Besides, the increased erythrocyte mass displaces the platelets to the vessel periphery, increasing interaction with the vascular endothelium.
Recommendations in human medicine: treat patients with anaemia and thrombocytopenia with pRBC to increase PCV over 30–35% before planning platelet transfusion.
Transfusion. 2007 Oct;47(4 Suppl):206S–248S.

CONTENTS

Erythrocytes, non–viable platelets, and leukocytes (in cats), and a small volume of plasma.

DOG

Each 220 ml contains approximately:

Erythrocytes	PCV 55–70%
CPD anticoagulant solution (citrate–phosphate–dextrose)	10 ml
SAG–M preservative additive solution (saline–adenine–glucose–mannitol)	70 ml
Plasma	10 ml

CAT

Each 25 ml contains approximately:

Erythrocytes	PCV 40–55%
CPD anticoagulant solution (citrate–phosphate–dextrose)	1 ml
SAG–M preservative additive solution (saline–adenine–glucose–mannitol)	8 ml
Plasma	2 ml

STORAGE

42 days at 2–6°C. After 28 days always perform an haemolysis test before transfusion.

- If the unit is kept at room temperature for more than 15 minutes, it must be used in the following 6 hours or be refrigerated again and used within 24–hours. However, a recent study carried out by our team demonstrates that exposure to room temperature for a longer period does not necessarily imply a dangerous increase in the percentage of haemolysis or the risk of bacterial contamination in the unit.
  Effects of Room Temperature in Packed Red Blood Cells Units. Abstract presented at the 19th annual European Veterinary Emergency and Critical Care Congress.
- Periodic monitoring of the refrigerator temperature (2–6°C) is advised, with a thermometer or datalogger, and a careful regulation of the thermostat if needed.
- It is recommended to use an exclusive refrigerator for blood products in order to avoid contamination with chemical and biological products, as well as to avoid temperature changes due to frequent door opening.
- Avoid opening the refrigerator frequently, as temperature changes significantly decrease the lifespan of stored erythrocytes.

In BSA, canine pRBC units do not contain leukocytes because we use leukodepletion filters, in order to reduce the risk of transfusion reactions, the risk of transmission of infectious agents and the percentage of haemolysis during storage. The use of leukoreduction filters is essential for the superior quality of these components, following the guidelines of Human Blood Banks.
Leukoreduction effect on the haemolysis of canine packed red blood cells units. Abstract presented in 2020 annual European Veterinary Emergency and Critical Care Annual Congress.

The expiration date of pRBC is an estimation and may change due to several factors related to the donor, collection, shipment, and storage conditions. According to published studies of the BSA, before using units with more than 28 days of storage, it is recommended to value their % of haemolysis, using quantitative or qualitative methods.
In vitro quality control analysis after processing and during storage of feline packed red blood cells units. BMC Vet Res. 2018 14: 141.
In vitro hemolysis of stored units of canine packed red blood cells. J Vet Emerg Crit Care. 2018 Oct:2–6.

VOLUME PER UNIT

Dog: 220 ml (1/2 unit – 100 ml)
Cat: 25 ml
Volume may differ 10%

ADMINISTRATION

- Canine pRBC should only be used in dogs and feline pRBC units should only be used in cats.
- The pRBC should not be actively warmed before administration. Allowing 10–15 minutes at room temperature prior to use is recommended because overheating the unit can lead to hemolysis, agglutination, clot formation and bacterial overgrowth.
- The preferred route for pRBC administration is intravenous, preferably with an 20–24 G catheter that should be placed no earlier than 24 hours prior to transfusion; if it is not the case, a new catheter should be placed. In small patients, neonates or with circulatory impairment, the intramedullary route can be used (80–95% of cells are in the circulation after 5 minutes); an 18–20 G needle or a bone marrow aspiration needle should be introduced in the femur trochanteric fossa or the humerus greater tubercle.
- During transfusion, the intravenous catheter should be used exclusively for the administration of blood products. Avoid the concomitant use of intravenous medication, non–isotonic fluids, or lactated Ringer's.
- An administration system with filter must be used. The 170 µm filters prevent clots, cellular debris, fibrin, and other protein precipitates from entering the vasculature. In general, in small animals (e.g. < 3 kg) it may be advisable to use infusion pumps and transfusion system with 18 µm paediatric filters, to retain less volume and allow better volume control and administration rate. In animals weighing more than 3 kg, the use of infusion pumps should be avoided whenever possible, considering the possible increased haemolysis induced by the infusion pump.
- The administration of antipyretics, antihistamines or glucocorticoids before the transfusion does not reduce the risk of allergic reaction, febrile non–hemolytic reaction, or other types of transfusion reactions, so their use before the transfusion is generally not recommended.
- The efficacy of the transfusion can be assessed by measuring the PCV immediately after the end of the transfusion (with no significant differences compared to measuring it 4 hours after the end of the transfusion)

DID YOU KNOW THAT...
You should avoid the use of infusion pumps?
The administration of erythrocytes through infusion pumps can produce physical damages and has been associated with an increased risk of early elimination of transfused erythrocytes comparing to the administration by gravity.
J Vet Emerg Crit Care (San Antonio). 2011 Jun;21(3):209–16

HOWEVER...
The use of infusion pumps together with in line pediatric filters of 18 µm, could be especially useful in dogs and cats of small size (e.g. <3 kg), allowing better control of the volume and administration rate, without significant increase in haemolysis.
Am J Vet Res. 2019 Sep;80(9):852–861
J Vet Emerg Crit Care 2014;24(2):162–7

A recent study, carried out by our team in cats, showed that the use of linear peristaltic infusion pumps (NIKI V4 [Everest] and Infusomat FmS [B Braun]) does not produce a significant increase in haemolysis.
Quantitative assessment of infusion pump–mediated haemolysis in feline packed red blood cell transfusions. J Feline Med Surg. 2021 Dec;23(12):1149–1154

TRANSFUSION VOLUME

Basic rule: 10 ml/kg of pRBC increases the PCV by 5–8%.
The desired post–transfusion PCV is the minimum necessary to stabilise the patient and guarantee stable levels of oxygenation (approximately 5–8% higher than the PCV before the transfusion).

INFUSION RATE

For the first 15–30 minutes a slow infusion rate should be used (0,25–0,5 ml/kg/h) to allow for the monitoring of the patient for any transfusion reaction evidence. This slow rate should not be used initially if the recipient is in hypovolemic shock due to acute haemorrhage.
In normovolemic dogs the rate should be 5–10 ml/kg/h for 1–4 hours, and in cats 3–5 ml/kg/h for 2–4 hours.
In animals with hypovolemic shock due to acute haemorrhage, rates up

HOW TO CALCULATE INFUSION RATE IN ADMINISTRATION BY GRAVITY?
Use our HEMOCALCULATOR to calculate the number of drops/min. Available in the mobile App BSANIMAL or in the BSA website.

to 20–60 ml/kg/h can be used. However, as arrhythmias due to hypocalcemia may occur, it is advisable to monitor the ECG and serum calcium levels. If higher administration rates are needed, manual compression of the bag or syringe bolus administration may be used, allowing higher rates than by classic infusion methods, without producing significant erythrocyte damage.
In animals at risk of developing volume overload (heart failure, renal failure, hypertension) the infusion rate should be 1–3 ml/kg/h, starting with the slowest rate and gradually increasing it if there are no transfusion reactions signs (e.g. tachypnoea, dyspnoea or jugular vein distension).
In cases of active bleeding due to the deficiency of clotting factors, fresh frozen plasma must also be administered.

PRECAUTIONS / CONTRAINDICATIONS

- Always blood type before the first transfusion in dogs (recommended) and cats (mandatory).
- In dogs, the crossmatching test should be done before the second (and subsequent) transfusion, if more than 3 days have passed since the first transfusion. More detailed information at the end of this chapter.
- Do not simultaneously infuse lactated Ringer's (in the same line). If needed, the safest fluid is 0,9% NaCl. There is no benefit in a simultaneous infusion of crystalloids unless a rapid expansion of the blood volume is needed.
- Use infusion systems with a filter. Do not re–use them for subsequent transfusion.
- Despite blood typing and crossmatching, adverse transfusion reactions may still occur, thus careful monitoring during and after transfusion should be ensured.
- Flush the catheters with 0,9% NaCl solution before and after transfusion.
- Do not administer parenteral medications via the same route used for transfusion.
- Gently mix the contents of each bag for 15 seconds before starting the transfusion.
- Discard any pRBC unit that is damaged, has visible clots, appears discoloured or has a high haemolysis percentage.

DOG
It is recommended to blood type before the first transfusion. In the first transfusion, DEA 1 negative units can be used in DEA 1 negative or DEA 1 positive patients. In case of maximum need, DEA 1 positive units can be used in DEA 1 negative dogs in the first transfusion, and in the following ones until 3 days after the first transfusion, as there is no risk of acute hemolytic reaction.

CAT
Typing prior to the first transfusion is mandatory and transfused pRBC should be compatible, as acute haemolytic transfusion reactions can be fatal in blood group B recipients.

HAEMOLYSIS EVALUATION

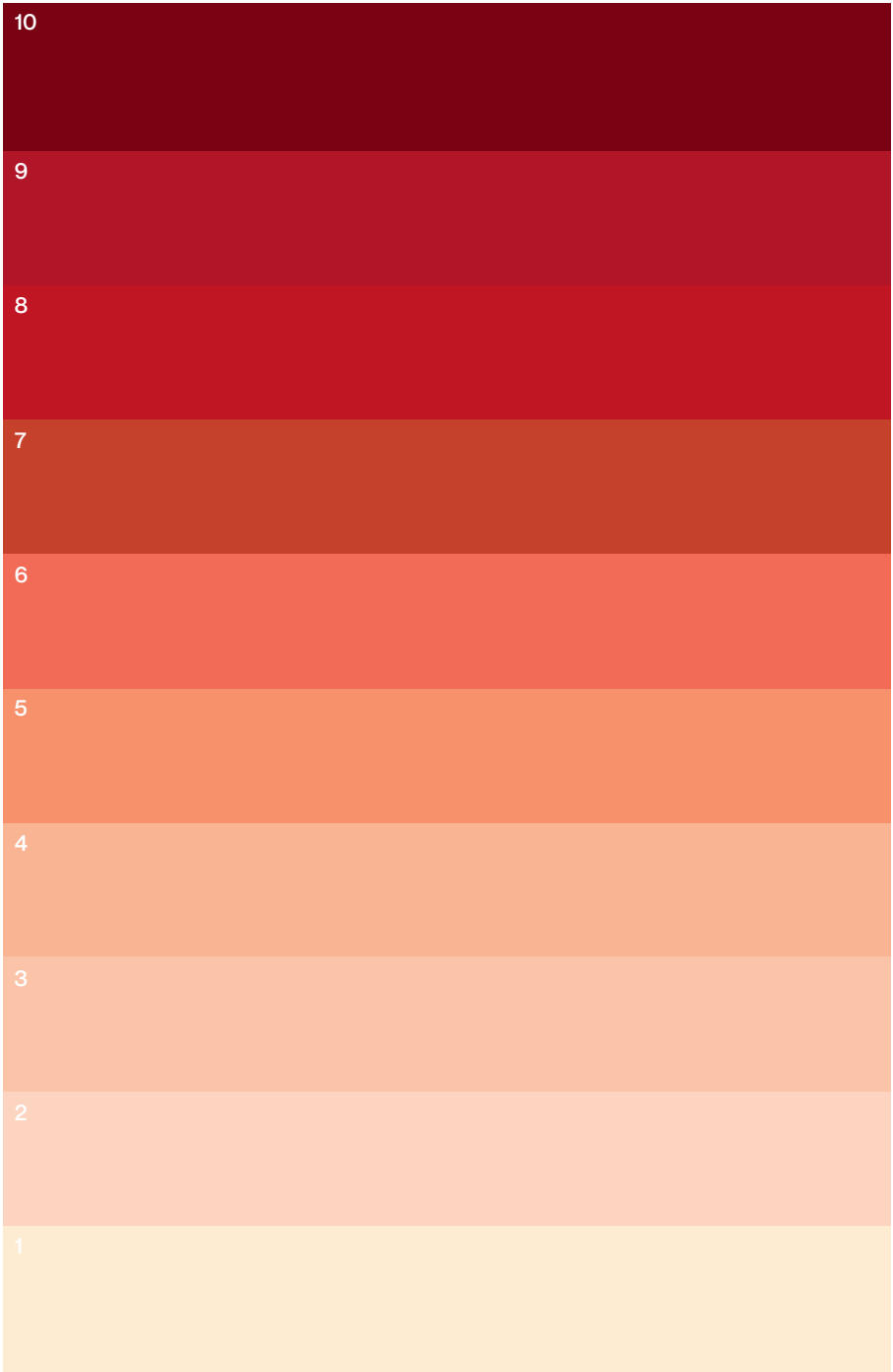
The percentage of haemolysis is an indicator of the viability of stored erythrocytes. If haemolysis is >1% in dogs, or >1,5% in cats, the pRBC unit should not be used. This qualitative method of haemolysis evaluation was developed by BSA and correlates with laboratory quantitative evaluation. The goal is to help clinicians decide whether the pRBC unit should be used or discarded.

This test should perform if the pRBC unit:

- was stored for more than 28 days
- cold chain was broken >3 hours
- presents a strange discoloration

PROTOCOL

- Gently invert the pRBC unit few times over 10 seconds
- Discard the first 10 drops and transfer a sample of the pRBC to a micro-hematocrit capillary tube (never use the small aliquots attached to the pRBC unit)
- Centrifuge the capillary tube at 5000 rpm for 10 minutes
- Insert the capillary tube into the mobile "reading segment" of this card and, under neutral or natural light, evaluate the colour of the supernatant



Colour 1 – 5 UNIT IS SUITABLE FOR USE
Colour 6 – 10 DO NOT USE THE UNIT
(haemolysis % > 1% in dogs or >1,5% in cats).

CROSSMATCHING TEST

These tests help to evaluate the presence of antibodies against additional antigens not detected by the blood typing tests (e.g. Dal, Mik antigen). However, they are not very sensitive to detect antibodies against those blood groups responsible for delayed haemolytic reactions.

Crossmatching can be performed using laboratory tests (agglutination test in a tube or gel column), using commercial rapid tests (gel or immunochromatography) or manually in the clinic.

To perform the manual crossmatching test at the clinic:

- Centrifuge at 3500 rpm (5 minutes) 2 ml of patient blood in EDTA (the same with donor blood if it is not pRBC). Extract and store the plasma in an eppendorf.
- Wash erythrocytes with saline: resuspend 0,25 ml of erythrocytes in 2–4 ml of saline, mix and centrifuge at 3500 rpm for 1 minute. Remove the supernatant and repeat this procedure 2 more times. In emergency situations, the erythrocyte washing can be omitted to avoid a delay in the transfusion.
- Resuspend 0,1–0,2 ml of erythrocytes in 4,8 ml of saline to obtain a 2–4% solution.
- Perform the following reactions in two microscope slides or eppendorfs:
  - Major crossmatching – mix 2 drops of donor's erythrocyte solution with 2 drops of patient's plasma
  - Minor crossmatching – mix 2 drops of patient's erythrocyte solution with 2 drops of donor's plasma.
- Incubate at 37°C for 20 minutes
- Evaluate the presence of macroscopic or microscopic agglutination. In the compatible samples, there should be no haemolysis or agglutination.

FRESH FROZEN PLASMA

INDICATIONS

- Plasma protein deficiency including coagulation factors, von Willebrand factor, fibrinogen, albumin, immunoglobulins (passive immunity), antithrombin and protease inhibitors (e.g. α–2–macroglobulin):
- Volume and clotting factor replacement in massive transfusions;
- Congenital coagulopathies: haemophilia A, haemophilia B, von Willebrand disease, hypofibrinogenemia, etc.
- Acquired coagulopathies: rodenticide poisoning, liver disease, severe cholestasis, DIC or coagulopathy due to acute trauma, hyperfibrinogenemia, etc;
- Colloidal support in patients with refractory hypotension or severe hypoalbuminemia;
- Altered vascular permeability and inflammation in critically ill patients with severe SIRS (e.g. sepsis, necrotising pancreatitis, parvovirus, panleukopenia, acute trauma with haemorrhagic shock and blood failure);
- Passive immunity deficiency.

The benefits of fresh frozen plasma (FFP) are temporary, and the primary disease always requires specific treatment.

NOTE...
Canine FFP preserves the concentration and activity of every coagulation factor of a fresh whole blood unit while maintaining the same therapeutic power.
J Vet Intern Med. 2014 Mar–Apr;28(2):571–5.

Although a decrease in the activity of some coagulation factors (II, VII, VIII, XI and XII) has been observed, feline FFP stored for 1 year between –18°C and –25°C is considered haemostatically active and most coagulation factors coagulation remains within the reference ranges.
Stability of coagulation factors on feline fresh frozen plasma after one year of storage. Abstract from the 2020 European Congress of Veterinary Internal Medicine.

CONTENTS

May also contain a small amount of erythrocyte fragments responsible for plasma pigmentation. However, their administration confers no risk to the patient due to the small amount of free haemoglobin.

DOG

Each 220 ml contains approximately:

Plasma	180 ml
CPD anticoagulant solution (citrate–phosphate–dextrose)	40 ml

CAT

Each 25 ml contains approximately:

Plasma	20 ml
CPD anticoagulant solution (citrate–phosphate–dextrose)	5 ml

DID YOU KNOW THAT...?
Therapy with synthetic colloids in dogs admitted to the intensive care unit, increases the risk of acute renal failure and mortality (dose–dependent).
In human medicine, its use is already limited to cases of haemorrhagic hypovolemia during the first 24 hours.
J Vet Emerg Crit Care (San Antonio). 2016 Jan–Feb;26(1):35–40

The use of plasma as a natural colloid is an alternative to increase oncotic pressure in hypoalbuminemia or hypotensive cases.
J Vet Emerg Crit Care (San Antonio). 2021 Mar;31(2):263–268.

STORAGE

1 year at temperature ≤ –18°C
After this period, we consider that labile coagulation factors (V and VIII) are lost, and it´s relabeled as **FROZEN PLASMA** with an **additional expiry date of four years** at a temperature ≤ –18°C.

- Keep bags in an upright position, to easily detect possible thawing.
- Handle frozen bags carefully as they rupture easily. Store in a dedicated freezer to avoid contamination with chemical and biological products.
- It is recommended to place a thermometer or datalogger in the freezer in a central area. Periodic temperature monitoring should be ensured, and the thermostat adjusted as indicated.
- Avoid opening the freezer frequently because temperature fluctuations can shorten the shelf life of this component.
- If you defrost the unit in the refrigerator for a period of less than 24 hours, you can refreeze it; although, the validity is reduced to half the time. If it is defrosted at room temperature, it must not be refrozen and it can be used up to 6 hours after defrosting, or keep the unit refrigerated to be used within 24 hours.

Despite this general idea mentioned by several authors, plasma frozen during 5 years at –30°C appeared to be haemostatically active when evaluated by TEG, with lower the activity of clotting factor VIII and X but not of factor V. *J Vet Intern Med. 2013; 27:964–969*

After thawing, canine plasma retained over 50% coagulation factor activity for up to 28 days and was considered to have adequate haemostatic potential for transfusion. *J Vet Emerg Crit Care. 2022 Mar;32(2):189–195.*

VOLUME PER UNIT

Dog: 220 ml (1/2 unit – 100 ml)
Cat: 25 ml
Volume may differ 10%

ADMINISTRATION

- Canine plasma should only be used in dogs, and feline plasma should only be used in cats.
- Defrost frozen plasma within a protective plastic bag in a water bath at 30–35°C for 20–30 minutes and stir occasionally; avoid overheating as temperatures over 37°C are responsible for the denaturation of proteins. Do not defrost in the microwave due to the risk of overheating or plastic rupture.
- The preferred route of plasma administration is intravenous, preferably with an 20–24 G catheter that should be placed no earlier than 24 hours prior to transfusion; if it is not the case, a new catheter should be placed. In small patients, neonates or with circulatory impairment, the intramedullary route can be used; an 18–20 G needle or a bone marrow aspiration needle should be introduced in the femur trochanteric fossa or the humerus greater tubercle.
- During transfusion, the intravenous catheter should be used exclusively for the administration of blood products. Avoid the concomitant use of intravenous medication, non–isotonic fluids, or lactated Ringer's.
- An administration system with filter must be used. The 170 µm filters prevent cellular debris, fibrin clots and other protein precipitates. In general, in small animals (e.g. < 3 kg) it may be advisable to use infusion pumps and transfusion system with 18 µm pediatric filters, to retain less volume and allow better volume control and administration rate.
- An Infusion pump may be used.
- The administration of antipyretics, antihistamines or glucocorticoids before the transfusion does not reduce the risk of allergic reaction or other types of transfusion reactions, so their use before the transfusion is generally not recommended.

TRANSFUSION VOLUME

Basic rule in hypocoagulation, hypoalbuminemia or decreased passive immunity:

- 10 ml/kg every 6–24 hours in refractory cases as needed
- 20–60 ml/kg in severe cases associated with refractory hypotension

In cases of severe hypoalbuminemia, large volumes of plasma may be necessary to increase albumin.
Up to 10–20 ml/kg may be necessary to increase albumin by 0,2 g/dL.

Goal: improvement of symptoms, haemorrhage control, decrease of clotting times or increase albumin concentration up to 2 g/dl.

Use our HEMOCALCULATOR to calculate doses and rates. Available in the mobile App BSANIMAL or in the BSA website.

INFUSION RATE

For the first 15–30 minutes a slow infusion rate should be used (0,25–0,5 ml/kg/h) to allow for the monitoring of the patient for any evidence of transfusion reaction. This slow rate should not be used initially if the recipient is in hypovolemic shock due to acute haemorrhage.
In normovolemic dogs the rate should be 5–10 ml/kg/h for 2–4 hours, and in cats 3–5 ml/kg/h for 2–4 hours.
In animals at risk of developing volume overload (heart failure, renal failure, hypertension) the infusion rate should be 1–3 ml/kg/h, starting with the slowest rate and gradually increasing it if there are no transfusion reactions signs (e.g. tachypnoea, dyspnoea or jugular vein distension).

PLASMA Constant Rate Infusion (CRI)...
In human medicine, an approximate albumin dose of 0,8 g/kg/day is recommended in critically ill patients with hypoalbuminemia. The mean albumin concentration of canine FFP is approximately 21–25 g/L, thus 32–38 mL/kg of FFP may be required to provide this dose. In hypoalbuminemic patients, plasma can be administered via CRI over 12–24 hours (approximately 1,5–3 ml/kg/h) to achieve increments of 0,3–0,5 g/dL.

ADMINISTRATION TIME...
Use the unit within 4 hours after opening, to minimise the risk of bacterial contamination. However, despite this general indication, a study published recently by our team indicates that transfusion periods of up to 12 hours do not increase the risk of contamination nor significantly change the clotting factor activity or albumin concentration.
Evaluation of canine fresh frozen plasma continuous rate infusion exposed to room temperature for 12 hours: risk of contamination and effects on albumin and coagulation factors. J Vet Emerg Crit Care (San Antonio). 2022; In press.

PRECAUTIONS / CONTRAINDICATIONS

- In dogs, blood typing in plasma administration is not necessary, as it does not reduce the risk of transfusion reaction to plasma proteins.
- In cats, blood typing should always be performed, and the administration of compatible units is mandatory.
- It is not necessary to perform minor crossmatching in dogs, but in theory it is advised in cats.
- Do not simultaneously infuse lactated Ringer's (in the same line). If needed, the safest fluid is 0,9% NaCl. There is no benefit in a simultaneous infusion of crystalloids unless a rapid expansion of the blood volume is needed.
- Use infusion systems with filter.
- Typing for plasma protein antigens is not possible, meaning there is no way to predict and avoid immune–mediated transfusion reactions. Monitoring the animal for these and other reactions like volume overload, is very important during and after transfusion.
- Flush the catheters with 0,9% NaCl solution before and after transfusion.
- Do not administer parenteral medications in the same route used for transfusion.
- Dispose any damaged or perforated unit. The red pigmentation of some plasmas does not constitute a risk because the amount of free haemoglobin in the unit is very low.
- The presence of flakes in suspension or gelatinous clots resulting from the formation of fibrin from fibrinogen is considered normal. This process is enhanced by exposure to temperatures above body temperature.

PLATELET CONCENTRATE

INDICATIONS

Primary haemostatic disorders:

- Severe thrombocytopenias: bone marrow disorders, DIC, neoplasia, immune–mediated or infectious agents (e.g. Ehrlichia, Anaplasma);
- Congenital thrombocytopathies (e.g. Glanzmann's disease) or acquired (e.g. NSAIDs, clopidogrel, uremia, liver failure);
- Prophylaxis in patients with thrombocytopenia or thrombocytopathia submitted to invasive procedures (e.g. biopsy, surgery, endoscopy). Previous transfusion with platelet concentrate (PC) is recommended if < 80 x 10^3 platelets/ µL.

The benefits of PC are temporary, and the primary disease always requires specific treatment.

Platelet concentrate is not recommended in patients without active bleeding, except as prophylaxis for invasive procedures.
In immune–mediated thrombocytopenia, a rapid destruction of transfused platelets is expected, therefore transfusion with platelets is recommended only in the presence of severe uncontrolled active bleeding.

CONTENTS

Platelets, leukocytes (non–viable) and plasma.
May also contain a small amount of erythrocyte fragments responsible for platelet units' pigmentation. However, their administration confers no risk to the patient due to the small amount of free haemoglobin.

DOG

FRESH PC
Each 50 ml contains approximately:

Platelets	600.000 – 1.500.000/µL
CPD anticoagulant solution (citrate–phosphate–dextrose)	9 ml
Plasma	40 ml

FROZEN PC
Each 10 ml contains approximately:

Platelets	600.000 – 1.500.000/µL
CPD anticoagulant solution (citrate–phosphate–dextrose)	1 ml
Plasma	8 ml
DMSO cryoprotectant (dimethyl sulfoxide) – toxic in cats	0,5 ml

STORAGE

Fresh PC: 18–24°C, with constant agitation, 7 days.
Frozen PC: ≤ –80°C, 12 months.

VOLUME PER UNIT

Fresh PC: 50 ml.
Frozen PC: 12 ml. Each unit is connected to 30ml unit of FFP, in order to reconstitute the PC before its administration.
Volume may differ 20%

PREPARATION OF FROZEN PC UNIT

- Keep the PC unit and 1/2 unit of FFP within the protective case at room temperature for 20 minutes.
- Carefully handle frozen units because the tube linking the two bags is extremely fragile and can break easily.
- Defrost 1/2 unit of FFP in a water bath (30–35°C), keeping the PC out of the bath. As the volume is very small, the platelet concentrate thaw is very fast at room temperature.
- When both units have thawed, remove both clamps and transfer the FFP to the bag containing the PC.
- Clamp the tube to avoid reflux.
- Undo the larger lumps (platelet aggregates) that form in the bag to where the FFP has been transferred by massaging gently with a gauze swab.
- When most lumps have disappeared, let the unit rest for 1 hour.
- Massage again to dissolve some of the larger lumps.

ADMINISTRATION

- The canine PC only must be used in dogs.
- An intravenous 20–22 G catheter should be placed no earlier than 24 hours prior to transfusion; if it is not the case, a new catheter should be placed.
- During transfusion, the intravenous catheter should be used exclusively for the administration of blood products. Avoid the concomitant use of intravenous medication, non–isotonic fluids, or lactated Ringer's.
- An administration system with a filter should be used.
- Avoid using infusion pumps.
- The administration of antipyretics, antihistamines or glucocorticoids before the transfusion does not reduce the risk of allergic reaction, or other types of transfusion reactions, so their use before the transfusion is generally not recommended.

How to avoid the use of infusion pumps?
Use our HEMOCALCULATOR to calculate doses and rates. Available in the mobile App BSANIMAL or in the BSA website.

TRANSFUSION VOLUME

The volume transfused should be 1 PC unit of 40–70 ml/10 kg SID–TID, until effect. Expected increase of 10–40 x 10^3 platelets/µL in each transfusion. This increase in platelets may not be detected by the automatic count, as many of them may be fragmented. However, the haemostatic potential continues to be effective in control of bleeding.

INFUSION RATE

For the first 15–30 minutes a slow infusion rate should be used (0,25–0,5 ml/kg/h) to allow for the monitoring of the patient for any evidence of transfusion reaction. This slow rate should not be used initially if the recipient is in hypovolemic shock due to acute haemorrhage.
Infusion rate should be 5 ml/kg/h in normovolemic dogs.
In dogs at risk of developing volume overload (heart failure, renal failure, hypertension) the infusion rate should be 1–3 ml/kg/h, starting with the slowest rate and gradually increasing it if there are no transfusion reactions signs (e.g. tachypnoea, dyspnoea or jugular vein distension).

PRECAUTIONS / CONTRAINDICATIONS

- Blood typing is not necessary, as it does not reduce the risk of transfusion reaction to platelets or plasma proteins.
- It is not necessary to perform crossmatching tests.
- For Frozen PC – use the unit within the first 3 hours after its preparation.
- Do not simultaneously infuse lactated Ringer's (in the same line). If needed, the safest fluid is 0,9% NaCl.
- Avoid using infusion pumps.
- Use infusion systems with filter.
- Typing for platelets or plasma protein antigens is not possible, meaning there is no way to predict and avoid immune–mediated transfusion reactions. Monitoring the animal for these and other reactions like volume overload, is very important during and after transfusion.
- Sometimes reactions such as tremors, salivation or urticaria can occur caused by a reaction to platelet fragments or substances such as histamine or serotonin. These can be released during the centrifugation process, which may induce inflammatory reactions.
- Flush the catheters with 0,9% NaCl solution before and after transfusion.
- Do not administer parenteral medications in the same route used for transfusion.
- Dispose any damaged or perforated unit.
- The platelet isolation protocol may lead to the contamination of the PC with a residual number of erythrocytes, being normal a red pigmentation of some units. There is no risk for its administration, as the amount of free haemoglobin is very low.

CRYOPRECIPITATE

INDICATIONS

- Von Willebrand's disease – treatment or prevention in invasive procedures;
- Haemophilia A (factor VIII deficiency) – treatment or prophylaxis in invasive procedures;
- Hyperfibrinolysis and hypofibrinogenemia (acute trauma, liver disease, DIC, angiostrongylosis...). The goal is to maintain the fibrinogen > 1,5 g/dL.

The benefits of cryoprecipitate are temporary, and the primary disease always requires specific treatment.

ADVANTAGES

Allows for the replenishing of the necessary clotting factors without transfusing large amounts of whole blood or plasma. This reduces the risk of volume overload, or transfusion reactions, and optimises use of blood components.

CONTENTS

Factor VIII, XIII, von Willebrand factor, fibrinogen (10–25 g/L) and fibronectin.

DOG

Each 50 ml contains approximately:

Cryoprecipitate	45 ml
CPD anticoagulant solution (citrate–phosphate–dextrose)	5 ml

STORAGE

1 year at temperature ≤ –18°C

- Keep bags in an upright position, to easily detect possible thawing.
- Handle frozen bags carefully as they rupture easily. Store in a dedicated freezer to avoid contamination with chemical and biological products.
- It is recommended to place a thermometer or datalogger in the freezer in a central area. Periodic temperature monitoring should be ensured, and the thermostat adjusted if needed.
- Avoid opening the freezer frequently because temperature fluctuations can shorten the shelf life of this component.
- If you defrost the unit, it must not be refrozen and it can be used up to 2 hours after defrosting.

VOLUME PER UNIT

45 ml

Volume may differ 10%

ADMINISTRATION

- Canine cryoprecipitate should only be used in dogs.
- Defrost the unit within a protective plastic bag in a water bath at 30–35°C for 20–30 minutes and stir occasionally; avoid overheating as temperatures over 37°C are responsible for the denaturation of proteins. Do not defrost in the microwave due to the risk of overheating or plastic rupture.
- The preferred route of cryoprecipitate administration is intravenous, preferably with an 20–22 G catheter that should be placed no earlier than 24 hours prior to transfusion; if it is not the case, a new catheter should be placed. In small patients, neonates or with circulatory impairment, the intramedullary route can be used; an 18–20 G needle or a bone marrow aspiration needle should be introduced in the femur trochanteric fossa or the humerus greater tubercle.

- During transfusion, the intravenous catheter should be used exclusively for the administration of blood products. Avoid the concomitant use of intravenous medication, non–isotonic fluids, or lactated Ringer's.
- An administration system with filter must be used. The 200 µm filters prevent cellular debris, fibrin clots and other protein precipitates. In general, in small animals (e.g. < 3 kg) it may be advisable to use infusion pumps and transfusion system with 18 µm paediatric filters, to retain less volume and allow better volume control and administration rate.
- An Infusion pump may be used.
- The administration of antipyretics, antihistamines or glucocorticoids before the transfusion does not reduce the risk of allergic reaction or other types of transfusion reactions, so their use before the transfusion is generally not recommended.

TRANSFUSION VOLUME

4 ml/kg (up to 5 ml/kg, in severe cases) – single dose, SID or BID (depending on the aetiology and coagulation time).
If preventive treatment before surgery is indicated, perform a transfusion in the previous 4 hours. In more invasive surgical procedures, repeat this dose every 30 minutes.

INFUSION RATE

In the first 15–30 minutes, rate should be slow (0,25 ml/kg/h) to evaluate possible transfusion reactions.
As cryoprecipitate has a gelatinous consistence, a slow rate not higher than 2–4 ml/kg/h should be used (depending on the risk of the volume overload).
In animals at risk of developing volume overload (heart failure, renal failure, hypertension) a lower infusion rate 1–3 ml/kg/h should be used, starting with the slowest rate, and gradually increasing it if there are no transfusion reactions signs (e.g. tachypnoea, dyspnoea or jugular vein distension).

PRECAUTIONS / CONTRAINDICATIONS

- Blood typing in cryoprecipitate administration is not necessary, as it does not reduce the risk of transfusion reaction to plasma proteins.
- It is not necessary to perform minor crossmatching.
- Do not simultaneously infuse lactated Ringer's (in the same line). If needed, the safest fluid is 0,9% NaCl. There is no benefit in a simultaneous infusion of crystalloids unless a rapid expansion of the blood volume is needed.
- Use infusion systems with filter.
- Typing for plasma protein antigens is not possible, meaning there is no way to predict and avoid immune–mediated transfusion reactions. Monitoring the animal for these and other reactions like volume overload, is very important during and after transfusion.
- Flush the catheters with 0,9% NaCl solution before and after transfusion.
- Do not administer parenteral medications in the same route used for transfusion.
- Dispose any damaged or perforated unit. The red pigmentation of some units does not constitute a risk because the amount of free haemoglobin in the unit is very low.
- Gently stir the contents of the cryoprecipitate bag before starting the transfusion.
- Use the unit within 2 hours after opening.

CRYOSUPERNATANT

INDICATIONS

- This component allows the restoration or increase of albumin levels, passive immunity, thermostable clotting factors (II, V, VII, IX and X) or anti–inflammatory mediators. Cryosupernatant is useful for the same indications as FFP, except von Willbrand's disease, haemophilia A and hyperfibrinolysis or hypofibrinogenemia states. Thus, it can be used in cases of:
- Severe hypoalbuminemia (<1,5 g/dL)
- Rodenticide poisoning
- Vitamin K deficiency
- Disseminated intravascular coagulation
- Haemophilia B (factor IX deficit)
- Contribution of passive immunity (deficit of immunoglobulins)

The benefits of CS are temporary, and the primary disease always requires specific treatment.

DID YOU KNOW THAT...?
The administration of cryosupernatant in continuous infusion (average rate 1,8 ml/kg/h; mean transfusion duration of 16 hours) increases the albumin concentration (average increase of 0,6 g/dL).
J Vet Emerg Crit Care 2019;29(3):314–20.

CONTENTS

Coagulation factors – Vit–K dependent (II, VII, IX and X) and factors XI, XII; albumin, globulins, anti–inflammatory mediators, antithrombin and protease inhibitors (e.g. α–2–macroglobulin).
May also contain a small amount of erythrocyte fragments responsible for plasma pigmentation. However, their administration confers no risk to the patient due to the small amount of free haemoglobin.

DOG
Each 170 ml contains approximately:

Cryosupernatant	135ml
CPD anticoagulant solution (citrate–phosphate–dextrose)	35 ml

STORAGE

5 years at temperature < –18°C

- Keep bags in an upright position, to easily detect possible thawing.
- Handle frozen bags carefully as they rupture easily. Store in a dedicated freezer to avoid contamination with chemical and biological products.
- It is recommended to place a thermometer or datalogger in the freezer in a central area. Periodic temperature monitoring should be ensured, and the thermostat adjusted conveniently if needed.
- Avoid opening the freezer frequently because temperature fluctuations can shorten the shelf life of this component.
- If you defrost the unit in the refrigerator for a period of less than 24 hours, you can refreeze it; although, the validity is reduced to half the time. If it is defrosted at room temperature, it must not be refrozen and it can be used up to 6 hours after defrosting, or keep the unit refrigerated to be used within 24 hours.

VOLUME PER UNIT

170 ml
Volume may differ 10%

ADMINISTRATION

The same as for fresh frozen plasma units. Dogs only.

TRANSFUSION VOLUME

Basic rule for hypocoagulation, hypoalbuminemia or decreased passive immunity:

- 10 ml/kg can be repeated every 6–24 hours in refractory cases as needed.
- 20–60 ml/kg in severe cases associated with refractory hypotension

Up to 10–15 ml/kg may be necessary to increase albumin by 0,2 g/dL.

Goal: improvement of symptoms, haemorrhage control, decrease of clotting times or increase albumin concentration up to 2 g/dl.

A recent study suggests the administration of cryosupernatant in CRI to increase albumin levels and colloid oncotic pressure in critically ill patients. The administration of a mean dose of 31 ml/kg, during a mean infusion time of 16 hours, with a mean administration rate of 1,8 mL/kg/h, allowed a mean albumin increase of 0,6 g/dL.
J Vet Emerg Crit Care 2019;29(3):314–20.

INFUSION RATE

The same as for fresh frozen plasma units. Dogs only.

PRECAUTIONS / CONTRAINDICATIONS

The same as for fresh frozen plasma units. Dogs only.

PLATELET GEL

INDICATIONS

Helps the regeneration of hard and soft tissues.
Treatment of external/complex lesions and those that are unresponsive to conventional treatment:

- Burns
- Fistulae (e.g. perianal, oesophagocutaneous)
- Cleft palate/ cleft lip
- Musculoskeletal lesions (osseous nonunion...)
- Lesions secondary to neuropathy
- Lesions secondary to vasculitis.
- Complete reduction of lesion size (margins or depth).
- Partial reduction of the size of the lesion (margins or depth) that allows the surgical procedure.
- Pain reduction.

Platelet concentrate in local regenerative therapy

- A platelet lysate is obtained after freezing of non–cryopreserved platelet concentrate, promoting rupture of its platelets; this results in dissolved growth factors and platelet cytokines into the extracellular environment ("plasma rich in platelet growth factors").
- Thawed platelet lysate can be activated (by adding calcium salt), promoting the formation of the clot ("platelet gel") in 15–30 minutes, full of growth factors and platelet cytokines.
- Both platelet gel (gel presentation) and platelet lysate (liquid presentation) can be used in regenerative therapy
- Through local application for the treatment of difficult–to–heal cutaneous lesions, joint, tendon, bone or muscle injuries.
- Its high concentration of platelet growth factors could have an effect of chemotaxis on endothelial and mesenchymal cells (e.g. fibroblasts, osteoblasts, chondrocytes, muscle cells or adipocytes), producing greater collagen production, cell proliferation, angiogenesis and restoring microcirculation. This would have an anabolic effect in the injuries, promoting tendons, ligaments, muscles, and cutaneous wounds repair.

DID YOU KNOW THAT...?

In a canine study, the topical treatment with platelet gel in chronic wounds decreased the wound diameter by 93% in 1 month, compared to a decrease of only 13% in the control group. *Vet Surg. 2014 Aug. ;43(6):726–33.*

In orthopaedics, intraarticular platelet concentrate administration in dogs with osteoarthritis, due to cranial cruciate ligament rupture, improves joint function. *PLoS One. 2018 Mar 19;13(3):e0194752.*

Platelet concentrate in traumatic bone fractures improves healing. *Int J Mol Sci. 2019 Mar 1;20(5):1075.*

The platelet concentrate in local application allows the resolution of prostatic cysts. *Can J Vet Res. 2018 Oct;82(4):264–270.*

CONTENTS

Growth factors such as PDGF (platelet–derived growth factor), TGF–β (transforming growth factor – β), IGF (insulin–like growth factor), FGF (fibroblastic growth factor), EGF (epidermal growth factor), VEGF (vascular endothelial growth factor), NGF (neurotrophic growth factor), HGF (hepatocyte growth factor), and a small volume of plasma.
May also contain a small amount of erythrocyte fragments responsible for plasma pigmentation. However, their administration confers no risk to the patient due to the small amount of free haemoglobin.

DOG

Each 15 ml contains approximately:

Platelet lysate	600.000 – 1.500.000/µL
CPD anticoagulant solution (citrate–phosphate–dextrose)	3 ml
Plasma	12 ml

PREPARATION

Platelet gel units are sent as small unit of frozen Platelet Concentrate (PC) and a bottle of 10% calcium gluconate. Calcium gluconate must be added to the PC unit to form a usable gel.

- Remove the unit from the freezer and allow it to thaw in a water bath at 30–35°C for 10 minutes.
- Use a syringe and a needle, add calcium gluconate to the unit through the rubber opening. Add a volume of calcium gluconate that corresponds to 10% of the unit volume.
- Stir gently for 60 seconds and leave it at room temperature or at 37°C.
- In 5–10 minutes, a gel will form, and the bag volume will increase. Gelling times may vary according to the temperature of PC, room temperature and fibrinogen concentration. A small portion of the unit may remain liquid.
- Aseptically cut the bag to remove the gel and apply it over the wound. An hydrophobic bandage should be used to cover the gel.
- In a sterile environment, the PC can also be transferred to a sterilised bowl after thawing, by using a syringe and a needle (22G or larger). Add a volume of calcium gluconate that corresponds to 10% of the unit volume.
- The gel should be applied within the first hour after gelling.

STORAGE

2 years at temperature ≤ –80°C

- Handle frozen bags carefully as they rupture easily. Store in a dedicated freezer to avoid contamination with chemical and biological products.
- It is recommended to place a thermometer or datalogger in the freezer in a central area. Periodic temperature monitoring should be ensured, and the thermostat adjusted conveniently if needed.
- Avoid opening the freezer too often as temperature increase will quickly thaw the unit.

VOLUME PER UNIT

15 ml
Volume may differ 20%

APPLICATION

- Platelet gel must be used in dogs.
- Canine platelet gel has been used successfully in feline patients, with no reported adverse reactions. Nevertheless, further research is needed to ensure the safety of this procedure.
- Blood typing is not necessary, as it does not reduce the risk of transfusion reaction to platelets or plasma proteins.
- It is not necessary to perform crossmatching tests.
- Before application, dead tissue should be removed, and the wound borders might need to be surgically reopened for proper effect.
- It should be applied every 3–4 days until wound resolution (usually for 4–8 weeks). This protocol may be adjusted depending on the individual responses and injury characteristics. If there is no response within 3–4 weeks, stop the treatment.

PRECAUTIONS / CONTRAINDICATIONS

- Blood typing is not needed when applying Platelet Gel.
- It should not be applied to infected lesions. These should be treated, and the platelet gel applied only after infection has cleared.
- Do not apply platelet gel in case of neoplasia on the area of the lesion or when there is disseminated neoplasia.
- The effect of the platelet gel application in patients with viremia is unknown and, therefore, unadvised.
- Tissue hypoxia limits the Platelet Gel effect – tissue oxygenation should be a major concern.

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TRANSFUSION FORM

DATE OF TRANSFUSION: ____/____/____ START TIME: ____:____ STOP TIME: ____:____
RESPONSIBLE: _____ PERFORMED BY: _____

PATIENT INFORMATION

NAME: ID:
SPECIES: BREED:
AGE: SEX:
BLOOD TYPE:
WEIGHT: TRANSFUSION N°:
GENERAL ANAESTHESIA?

DONOR INFORMATION

SPECIES: UNIT N°:
COMPONENT:
BLOOD TYPE:
DONATION DATE: / /
EXPIRATION DATE: / /
CROSSMATCHING: ☐ NOT PERFORMED
☐ COMPATIBLE
☐ INCOMPATIBLE

DIAGNOSIS/REASON FOR TRANSFUSION:

TRANSFUSION VOLUME: _____ ml
PRE–TRANSFUSION PCV: _____ %

VOLUME INFUSED: _____ ml
POST–TRANSFUSION PCV: _____ %

	BEFORE TRANSFUSION	☐ 0,5 mL/Kg/h ☐ ___mL/Kg/h		☐ 5 mL/Kg/h ☐ 10 mL/Kg/h ☐ ___mL/Kg/h			
	0'	15'	30'	1h	2h	3h	4h
BEHAVIOUR							
HEART RATE / PULSE							
RESPIRATORY RATE							
MUCOUS MEMBRANE COLOUR							
TEMPERATURE							
SYSTOLIC BLOOD PRESSURE							
PLASMA COLOUR							
URINE COLOUR							

OBSERVATIONS: PERFORMED BY:

TRANSFUSION REACTION (DATE, TIME)

☐ URTICARIA/PRURITUS/ANGIOEDEMA ___/___/___ ___:___
☐ FEVER ___/___/___ ___:___
☐ TREMORS/CONVULSIONS ___/___/___ ___:___
☐ SIALORRHOEA ___/___/___ ___:___
☐ VOMITING ___/___/___ ___:___
☐ DIARRHOEA ___/___/___ ___:___
☐ DYSPNOEA ___/___/___ ___:___
☐ COUGH ___/___/___ ___:___
☐ RHINORRHOEA ___/___/___ ___:___
☐ OEDEMA ___/___/___ ___:___
☐ CHEMOSIS ___/___/___ ___:___
☐ HYPOTENSION ___/___/___ ___:___
☐ SHOCK ___/___/___ ___:___
☐ ANURIA ___/___/___ ___:___
☐ HAEMOLYSIS ___/___/___ ___:___
☐ PETECHIAE/BRUISES ___/___/___ ___:___
☐ PULMONARY THROMBOEMBOLISM ___/___/___ ___:___
☐ CARDIAC ARREST ___/___/___ ___:___

TRANSFUSION REACTIONS

FEBRILE NON-HAEMOLYTIC-REACTIONS

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- 90% of transfusion reactions.
- Increase in temperature to ≥1°C during transfusion or 4 hours later
- Alloantibodies present in the receptor against plasma proteins and leukocyte or platelet antigens from the donor. Presence of inflammatory cytokines released by leukocytes during storage.
- More frequent in platelet products or non–leukopleted units.

DIAGNOSIS
- Most likely cause of fever in transfused patients.
- Important to differentiate from acute haemolytic reactions, transfusion-related acute lung injury (TRALI), sepsis secondary to bacterial contamination and transmission of infectious diseases.

TREATMENT
- Low clinical relevance.
- Stop the transfusion and later resume it at lower speed once the clinical signs are controlled.
- Does not require treatment with antipyretics.

CIRCULATORY OVERLOAD ASSOCIATED WITH THE TRANSFUSION

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Acute non-immunological reaction secondary to an increase in blood volume.
- Patients at risk: normovolemic anaemias, systemic hypertension, pediatrics, cardiac, respiratory or renal pathology, fast rate or high volume transfusions.
- Cats are particularly susceptible.

DIAGNOSIS
- Acute respiratory distress and pulmonary oedema within 6 hours after transfusion.
- Dyspnoea , tachypnoea, orthopnoea, cyanosis, coughs, crackles.
- Reduced oxygen saturation or PaO2.
- Radiograph: bilateral pulmonary infiltrate, pleural effusion, perihilar oedema, pulmonary venous congestion, cardiomegaly.
- Echocardiography: left atrial / aorta ratio >2, increased caudal vena cava, hepatic venous congestion, left ventricle dilatation and reduced ejection fraction.
- Increase in NT-proBNP.

TREATMENT
- Oxygen therapy.
- Furosemide 1–2 mg/kg IV.

TRANSFUSION–RELATED ACUTE LUNG INJURY (TRALI)

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Acute immune reaction.
- Antigen-antibody interaction in the lungs.
- Presence of antibodies in donor plasma against recipient leukocytes.
- Sequestration of neutrophils in the pulmonary endothelium, increased pulmonary vascular permeability, non-cardiogenic oedema and acute respiratory distress syndrome.
- Especially associated with the transfusion of plasma products.
- 6 first hours after the transfusion.

DIAGNOSIS
- Dyspnoea, fever, hypotension, tachycardia and tachypnoea.
- Acute hypoxia (oxygen saturation < 90%)
- Radiograph: pulmonary oedema without evidence of volume overload.
- Echocardiography without volume overload.
- Normal natriuretic peptide.

TREATMENT
- Oxygen therapy.
- Mechanical ventilation.
- Glucocorticoids?.
- Avoid furosemide.

ALLERGIC REACTIONS

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Acute immune reactions.
- Type I hypersensitivity response (mediated by IgE and mast cells).
- Exposure to donor plasma proteins.
- Especially with plasma and platelet components.
- 4 first hours of the transfusion.

DIAGNOSIS
- Urticaria, pruritus, erythema, angioedema, bronchoconstriction (especially in cats), vomiting, nausea, diarrhoea and abdominal pain.
- Severe cases: hypotension, syncope, haemoabdomen, coagulopathies and anaphylactic shock

TREATMENT
- Stop the transfusion and monitor.
- Diphenhydramine 1 –2 mg/kg IV or IM.
- Epinephrine 0,1 –0,2 mg/kg IV or IM, followed by CRI at 0,05 –0,1 µg/kg/min IV in severe cases.

ACUTE IMMUNE–MEDIATED HEMOLYTIC REACTION

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS

- Type II hypersensitivity reaction.
- Incompatibility of erythrocytes between donor and recipient.
- Dogs: After a second incompatible transfusion due to the development of sensitisation antibodies following the first transfusion against the DEA 1, DEA 4 or DAL blood groups.
- Cats: commonly have naturally occurring alloantibodies. Incompatibility at the time of first transfusion is therefore possible. Especially serious in type B cats that receive type A red cells. Also described in Mik negative cats with naturally occurring alloantibodies after a first transfusion with positive Mik blood.

DIAGNOSIS

- Fever, tachycardia, hypotension, oliguria / anuria or DIC.
- Inadequate increase in PCV.
- Haemoglobinemia, haemoglobinuria.
- Jaundice and increased bilirubin.
- Spherocytes and ghost cells.
- Positive Coomb's test.

TREATMENT

- Oxygen therapy if there is hypoperfusion.
- Glucocorticoids.
- Ensure renal perfusion and adequate blood pressure.
- Possible need for new transfusions.

DELAYED IMMUNE-MEDIATED HAEMOLYTIC REACTION

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS

- Secondary immune response against donors erythrocytes.
- Secondary to natural or sensitisation antibodies.
- Dogs: presence of natural antibodies against DEA 3, 5 and 7 blood groups; or by sensitisation antibodies 2-5 days after an incompatible transfusion.
- Cats: administration of type B blood to A cats.
- Extravascular haemolysis of transfused erythrocytes (between 24 hours and 28 days afterward).
- Underestimated incidence.

DIAGNOSIS

- Asymptomatic. Some patients experience fever, nausea, vomiting, tachycardia, hypotension or dyspnoea.
- PCV drop between 3 -5 days after transfusion.
- Jaundice and increased bilirubin.
- Spherocytosis.
- New incompatibilities in crossmatching.

TREATMENT

- Usually not necessary.

NON – IMMUNE–MEDIATED HAEMOLYTIC

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Delayed reaction.
- Due to exposure to high temperatures, prolonged storage, overheating prior to transfusion, administration of non-compatible substances with the pRBC unit (e.g. hypotonic fluids), unit freezing, use of unauthorised infusion pumps, catheters that are too small or bacterial contamination.

DIAGNOSIS
- Usually asymptomatic.
- Inadequate PCV increase.
- Some patients show an increase in bilirubin due to extravascular haemolysis.

TREATMENT
- Usually not necessary.

TRANSMISSION OF INFECTIOUS DISEASES

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Acute or delayed non–immunological reaction.
- Secondary to transfusion with contaminated blood products.
- Hours or years after the transfusion.

DIAGNOSIS
- Evaluate the presence of (at least) : Dogs: Leishmania spp., Ehrlichia spp., Babesia spp., Anaplasma spp. and Brucella spp; Cats: FeLV, FIV, Bartonella spp. and haemotropic Mycoplasmas.

TREATMENT
- Specific treatment for each infectious agent.

BACTERIAL CONTAMINATION

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS
- Contamination of the unit with bacteria from the donor's skin during the donation, by donor bacteremia, contamination during the unit's laboratory processing or contamination during the administration.

DIAGNOSIS
- Fever, tachycardia, dyspnoea, vomiting, diarrhoea, hypotension and circulatory collapse.
- Colour changes or other changes in the pRBC unit.
- Culture of the patient's and unit's blood.

TREATMENT
- Intravenous antibiotics until you receive the results of the blood culture, then adjust if necessary.

CITRATE TOXICITY

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS

- Acute non-immunological reaction.
- Citrate excess levels in the patient due to massive transfusions or lack of hepatic metabolism (liver failure, hepatic vascular anomalies or paediatric patients).

DIAGNOSIS

- Ptosis, hypersalivation, facial pruritus, hypotension, arrhythmias, vomiting, tetany, muscle tremors or convulsions.
- Hypocalcemia and hypomagnesemia.

TREATMENT

- Calcium gluconate when ionised Ca is less than 0,9 mmol/L: 4,5-14 mg/kg of elemental calcium IV, slow for 20-30 minutes, diluted if needed; or CRI at 2,5-3,5 mg/kg/h of elemental calcium.

HYPERAMMONEMIA

PATHOPHYSIOLOGY AND GENERAL CONSIDERATIONS

- Acute non–immunological reaction.
- Ammonia accumulation in the unit during its storage.
- Patients with liver dysfunction (liver failure, portosystemic shunt or newborns with immature functional liver).

DIAGNOSIS

- Mental status alteration, ataxia, head pressing, circling or convulsions.

TREATMENT

- Hepatic encephalopathy treatment.

TRANSFUSION THERAPY BEST CHOICE

	PACKED RED BLOOD CELLS	FRESH FROZEN PLASMA	FROZEN PLASMA / CRYOSUPERNATANT	CRYOPRECIPITATE	COLLOIDS	PLATELET CONCENTRATE
ANAEMIA	●					
ANAEMIA WITH HYPOPROTEINEMIA	●	●	●		●	
HAEMORRHAGIC ANAEMIA (>30% TOTAL BLOOD VOLUME)	●	●			●	
ANAEMIA WITH COAGULOPATHY	●	●				
EVAN'S SYNDROME	●					●
PANCYTOPENIA	●					●
RODENTICIDE POISONING		●	●			
DIC	●	●	●	●		
HAEMOPHILIA A (FACTOR VIII)		●		●		
HAEMOPHILIA B (FACTOR IX)		●	●			
VON WILLEBRAND'S DISEASE		●		●		
WARFARIN POISONING		●	●			
THROMBOCYTOPENIAS/ THROMBOPATHIES						●
HYPOPROTEINEMIA		●	●		●	
PROTHROMBIN DEFICIENCY		●		●		
FIBRINOGEN DEFICIENCY		●		●		
SEPSIS		●	●			
HYPOGLOBULINEMIA (PARVOVIRUS)		●	●			
LIVER DISEASE WITH COAGULOPATHY		●				
LIVER DISEASE WITH ANAEMIA	●	●				
PANCREATITIS		●				
NEONATAL ISOERYTHROLYSIS	●					

● FIRST CHOICE COMPONENT
● ALTERNATIVE COMPONENT

TRANSFUSION NEED SCALE FOR PACKED RED BLOOD CELLS

This Transfusion Need Scale (TNS) aims to offer an integrated protocol that helps to standardise the decision to transfuse packed red blood cells in dogs and cats, providing an efficient tool in routine veterinary practice. After evaluation of the patient, a transfusion final score (TFS) is obtained by adding 3 partial scores (A+B+C) according to these canine and feline protocols.

TRANSFUSION SHOULD BE PERFORMED IF TFS IS ≥ 5 AND SHOULD BE AVOIDED IF TNS SCORE < 5.

IMPORTANT: This algorithm is just a guide to help the transfusion decision. It has not yet been evaluated scientifically and should never prevail over the clinical judgement of the veterinarian. Thus, this scale should be seen as a tool to help with the final decision, where the evaluation of the entire clinical case as a whole must always prevail.

CANINE PATIENTS

SCORE A	0	1	2	3
PCV	≥28	25–27	21–24	<21

SCORE B	0	1	2
MUCOUS MEMBRANES COLOR	SALMON PINK	SLIGHTLY PALE	MODERATELY/SEVERELY PALE
CAPIL. REFILL TIME	≤2 SECONDS	—	≥3 SECONDS
PULSE QUALITY	NORMAL	BOUNDING	—
PULSE RATE (PPM)	MEDIUM/GIANT BREEDS 65–109 SMALL BREEDS 80–119	MEDIUM/GIANT BREEDS 110–140 SMALL BREEDS 120–160	MEDIUM/GIANT BREEDS >140 SMALL BREEDS >160
RESPIRATORY RATE (RPM)	15–24	25–40	>40
SAP/ DAP (mmHg)	>100/60	90–100/50–60	<90/<50
MENTATION, EXERCISE TOLERANCE	NORMAL, WALKING	QUIET BUT ABLE TO WALK	LETHARGIC, UNABLE TO WALK
TEMPERATURE	>37°C	—	≤37°C

Score B is determined by the rounded average of the ratings

SCORE C	0	1	2
CARDIOVASCULAR OR RESPIRATORY COMORBIDITIES	NO	YES	
SEVERE ACUTE HAEMORRHAGE	NO	—	YES
RISK OF ISCHAEMIA	NO	YES	
ANAESTHESIA	NO		YES
LACTATE	NORMAL	HIGH	
BASE EXCESS	NORMAL	LOW (< –8)	

Score C is determined by the highest score of the evaluated variables

FELINE PATIENTS

SCORE A	0	1	2	3
PCV	≥24	19–23	16–18	<16

SCORE B	0	1	2
MUCOUS MEMBRANES COLOR	SALMON PINK	SLIGHTLY PALE	MODERATELY/SEVERELY PALE
CAPIL. REFILL TIME	≤2 SECONDS	—	≥3 SECONDS
PULSE QUALITY	NORMAL	BOUNDING	WEAK
PULSE RATE (PPM)	<200	200–220	≥221
RESPIRATORY RATE (RPM)	15–24	25–40	>40
SAP/ DAP (mmHg)	>100 / 60	90–100 / 50–60	<90 / <50
MENTATION, EXERCISE TOLERANCE	NORMAL, WALKING	QUIET	LETHARGIC, UNABLE TO WALK
TEMPERATURE	>38°C	37–38°C	<37°C

Score B is determined by the rounded average of the ratings

SCORE C	0	1	2
CARDIOVASCULAR OR RESPIRATORY COMORBIDITIES	NO	YES	
SEVERE ACUTE HAEMORRHAGE	NO	—	YES
RISK OF ISCHAEMIA	NO	YES	
ANAESTHESIA	NO		YES
LACTATE	NORMAL	HIGH	
BASE EXCESS	NORMAL	LOW (< –8)	

Score C is determined by the highest score of the evaluated variables

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