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R. E. Ebright
State College of Washington, Pullman

F. Hunter
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C. Doney
State College of Washington, Pullman

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Operation of an Animal Blood Bank

R. E. Ebright, F. Hunter, and C. Doney*

FOLLOWING the work of Belenki,1 Shamov12 and Yudin,13 many investigators have demonstrated the advantages of having preserved blood readily available for immediate use. Veterinary clinicians have long recognized the value of transfused blood in the treatment of various conditions, but because of the frequent lack of available donors and the time consumed in preparing for the operation the technique has not been widely employed. With these difficulties in mind a group of senior veterinary students at the College of Veterinary Medicine, State College of Washington, under the direction of Dr. J. E. McCoy, inaugurated an animal blood bank in 1941. This animal blood bank, the first of its kind to our knowledge, has been in operation since that time.

Between October 1944 and March 1945 this blood bank has collected and transfused 4,000 cc. of horse blood, 8,000 cc. of cow blood, and 3,500 cc. of dog blood. This blood bank has proven its merits and is a valuable adjunct to the Veterinary Clinic.

It is the purpose of this paper to describe the methods used in conducting this blood bank for dogs, horses and cows.

Muether and Andrews7 were the first to use the sodium citrate-dextrose solution with the buffer salts of dibasic and monobasic sodium phosphate as a blood anticoagulant and preservative. Most blood preservatives are based on this formula at the present time. For the preservation of animal blood we are using the following solution described by Muether and Andrews.7

Dextrose 4.68 Grams
Sodium citrate .43 “
Monobasic sodium phosphate .025 “
Dibasic sodium phosphate .25 “

Misce q.s. (distilled water 100 cc.)

Many textbooks and manuals have variations of this formula compounded to meet the requirements of different storage and shipping conditions. The above proportions have given satisfactory results under conditions described in this paper.

The dextrose and sodium citrate are dissolved in distilled water, the two buffer salts are dissolved in distilled water, and then the two solutions are mixed and brought to volume with distilled water. The final solution is autoclaved in colorless bottles (clear serum bottles are satisfactory). Kilduff and DeBakey7 suggest that the solution be sterilized in the autoclave within two hours of preparation to lessen the possibility of reactions due to pyrogens.

To prevent carmelization of the preservative fluid, various methods of autoclaving may be employed. We have used the following technique: The autoclave is adjusted to 10 pounds pressure and maintained for 15 minutes. The pressure is then increased to 15 pounds for 20 minutes. Previously sterilized, unused, rubber skirt stoppers are placed in the bottles immediately after autoclaving to produce a vacuum as the bottles cool.

* Senior students in charge of the blood bank at the College of Veterinary Medicine, State College of Washington, Pullman, Washington.
Another method makes use of a large container of water in the autoclave. The pressure should be increased very slowly up to 15 pounds and left there for 20 minutes.

Carmelization is difficult to prevent, yet in our experience slight carmelization does not induce any untoward reaction.

Sterilizing Equipment

In sterilizing the equipment the following points are noted. The rubber tubes (50 cm. long, 0.6 cm. diameter, non-collapsible) are thoroughly cleaned and washed in a 5 percent sodium citrate solution to provide a thin film of the citrate solution on the inside of the tubing which aids in preventing coagulation of the first blood that passes through. The needles are also subjected to the same treatment. The tubing and needles are then separately wrapped in clean paper and placed in the autoclave at 15 pounds pressure, for 20 minutes.

For immediate or emergency transfusions, a sodium citrate solution may be used instead of the above described preservative. This solution can be prepared in the usual preservative bottles and stored in the refrigerator. Into 10 cc. of a 2.5 percent sodium citrate solution, 90 cc. of blood can be admitted without fear of coagulation or hemolysis if the blood is going to be used within a few hours.

Donors

When drawing blood from a donor, one is often confronted with the problem of how much blood may be taken without producing deleterious effects. Metcalf and Stahl\(^6\) found that a normal dog can donate 10 cc. of blood per pound of body weight at three week intervals without showing harmful reactions.

Santy\(^10\) found that hemoglobin regeneration of human donors took place eight times more rapidly when iron was administered. The diet of the donor, therefore, should be supplemented with iron and liver. To prevent reactions in the recipient caused by the presence of recently absorbed nutrients in the blood, the donor should be fasted four hours before procuring the blood.

In the case of the equine and bovine we have not bled an animal to its physiological limits, taking only 1,000 to 2,000 cc. from each donor.

In all instances the animal must be examined to determine the absence of transmissible diseases and for apparent good health to make it suitable as a donor. Total blood counts and an estimation of the hemoglobin content of the blood are indicated. Blood cultures are not made, but it appears that it would add a measure of safety.

Collection of Blood

Venipuncture is the most common method for collecting blood from dogs, although in our experience direct cardiac puncture has proven to be a more satisfactory procedure since it insures a more rapid flow of blood. This method will be described.

The donor is anesthetized with pentobarbital sodium by the intravenous route and the region of the heart on the left side is surgically prepared. The point for inserting the needle into the heart is determined by placing the fore leg in its normal position and locating a point about 1 cm. downward and backward from the point of the elbow where the heart can be felt to beat the strongest.

A 7.5 cm. 18-gauge needle is used for the cardiac puncture, and on the other end of the tubing a 3.5 cm. 16-gauge needle is used for insertion into the preservative bottle. The rubber stopper of the preservative bottle has previously been sterilized by placing a saturated piece of cotton with tincture of iodine on the top of the stopper.

When a free flow of blood is obtained through the tubing, insert the needle into the preservative bottle and collect the desired amount of blood. Since there is a vacuum in the preservative bottle, caution must be exercised when inserting the needle into the bottle. The vacuum has a tendency to draw the blood through the tube with such force as to collapse the tube unless a clamp or finger pressure is used to control the force of the blood into the bottle. As soon as the two forces of
pressure are more or less at an equilibrium, the clamp or finger pressure can be released to allow a full stream of blood into the preservative bottle. Metcalf and Stahl determined the ratio of blood and preservative as two to three. After the desired amount is obtained rotate the bottle four or five times to insure thorough mixing. Shaking induces hemolysis. Then refrigerate until used.

The above chart shows the equipment necessary in making blood transfusions. The left column shows equipment used in transfusing blood to recipient, and the right column that used in collecting blood from donor.

If only a small amount of blood is desired (30 to 40 cc.) a syringe and needle can be previously sterilized and rinsed in sterile sodium citrate solution. The needle can be inserted into the heart and blood withdrawn into the syringe. This blood can then be immediately placed in the preservative bottle.

In collecting blood from a horse or cow the same equipment as used for dogs is employed with the exception of a larger needle (12 gauge). The jugular vein is the most suitable site for drawing blood. By our method no anesthesia is used, but a local anesthetic may be of some value.

The blood is stored in the refrigerator at a temperature range of 2° C. to 5° C. A little latitude may be allowed in the upper limit of temperature but reduction below 0° C. will result in hemolysis. The bottles should be kept in a dark place.

Out-dated Blood

The erythrocytes settle within 24 to 48 hours and the cell layer is covered by a thin gray layer termed the buffy coat. This consists of leucocytes, platelets, and fibrin. As hemolysis proceeds, a layer of free hemoglobin diffuses upward through the clear plasma coloring it red. After experience is acquired, one can tell outdated blood very easily by looking for this layer, which is more of a crimson color than a true red.

When the blood becomes out-dated as the result of hemolysis the plasma is still preserved and useful. The plasma may be drawn off by vacuum. Drawing off the plasma should be done just as the blood becomes out-dated.

Meuther and Andrews have transfused human blood 90 days old, and DeGowin has transfused blood 45 days old without reaction. We have observed that blood from the equine and bovine can be stored for an average of 121 days, while canine blood can be stored up to 40 days after collection and still give good results.

Transfusion

In the large and small animals the transfusion equipment consists of sterile intravenous tubing and needles of the proper size for venipuncture. If a gauze filter can be placed in the middle of the circuit by using a thistle tube (see fig.) there is a greater margin of safety since this removes fibrin which sometimes forms. We have had no reactions when the filter was not employed, yet in the small animals, because of the smaller needle size, the system may become clogged. The blood and plasma are administered via the jugular vein in the horse and cow, and the radial vein in the dog.

The bottle to be transfused is removed from the refrigerator, and gently rotated to assure mixing of cells and plasma.
Shaking the bottle will increase hemo-
lysis very rapidly. DeGowin, Hardin and
Swanson have shown that preserved
blood should be administered without pre-
heating. It is more convenient and cold or
chilled blood prevents untoward reactions.
A set dosage for blood transfusions has not
been adhered to, but Secord gives the
dosage for the dog as 4 cc. per pound
body weight which can be repeated as
often as necessary. In the large animals,
500 to 3,000 cc. can be used depending
upon the requirements.

Typing of Blood

It has been observed that typing of
blood before transfusing is not necessary
in the bovine or canine subjects, but seri-
ous reactions may occur in the equine pa-
tient if blood compatibility is not de-
terminated. Since at the present time there
is no standard for equine blood types, we
resort to a simple matching of the donor's
and recipient's blood. This procedure is
still in its experimental stages, and more
work must be done to confirm our results.

When the blood is collected from an
equine donor a second smaller sample is
collected at the same time for the sole
purpose of compatibility tests. Prior to
transfusing this blood, 4 cc. of the blood
are obtained from the recipient and
placed with 6 cc. of the buffered preserv-
ing solution. One drop of the recipient's
blood-buffer mixture is then mixed with
a drop of the donor's blood which is ob-
tained in the smaller bottle. Incompata-
bility is detected by agglutination of the
erthrocytes within 5 to 10 minutes.

Contraindications

The most important contraindications are:
1. Acute pulmonary edema.
2. Cardiac decompensation. In other words a
weak or diseased heart must be watched
closely in performing a transfusion because
the added pressure may cause heart failure.
3. Massive pulmonary embolism or infarction.
4. In severe nephritis. A blood transfusion
should be administered with caution in
cases of nephritis as a fatal anuria has been
said to occur due to an obstruction of the
kidney tubules by a hemoglobin precipitate.

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Vitamin-enriched foods may be sold in
most states in this country without being
subject to state controls. In New York,
however, the Board of Pharmacy is now
being sued by the New York Food Mer-
chants Association to end the curb that
limits the sale of many vitamin products
to licensed pharmacists.

Albumin in the urine was described by
several observers before Bright's time:
Frederik Dekker, in Exercitations prac-
ticae cica methodum medendi (1673);
Domenico Cotugno, in De ischiade nervosa
commentarius (1765); William Charles
Wells, in On the Presence of Red Matter
and Serum of Blood in Urine of Dropsy,
which has not originated from scarlet
fever (1811); and Jogh Blackall, in Ob-
servations in the Nature and Care of
Dropsies (1813), all observed albumin
in the urine. But of course Bright's account
in 1827 was the event that put the pro-
cedure of urinalysis into routine clinical
practice.