AN APPARATUS FOR THE CONTINUOUS ADMINISTRATION OF FLUIDS AND ELECTROLYTES IN LARGE ANIMALS

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FLUID AND ELECTROLYTE THERAPY is seldom used in adequate amounts in large animal medicine, primarily because a simple, efficient apparatus for administering the large volumes of fluid required has not been available. Watt and Stenhouse (2) stated that such an apparatus must fulfill the following criteria: (1) the apparatus must be readily available; (2) it must be inexpensive, disposable and sterile; (3) it must be simple to use; (4) it must be of flexible design so it is readily adaptable to all individuals and species; (5) there must be reasonable freedom of movement for the patient; (6) it must give continuous, reliable performance.

The apparatus and technique to be described fulfill the above criteria except that in order to reduce the cost, instead of being disposable the equipment is made of material that can withstand repeated heat sterilization.

MATERIALS AND METHODS

Indwelling Intravenous Catheters

The Touhy-Borst adapter[1] used in conjunction with a 15 cm. (6 inch) length of 1.32 mm. (0.052 inch) outer diameter polyethylene tubing was the least expensive, most versatile and most satisfactory indwelling intravenous catheter studied. This apparatus can be used for small newborn calves but also permits a rapid infusion rate for animals weighing more than 455 kg. (1,000 pounds).

The Branula[2] was the second most useful intravenous catheter studied. Although simpler to use than the Touhy-Borst adapter and polyethylene catheter, the Branula required a skin incision over the jugular vein in order to prevent the Branula from bending while being inserted through the skin. In spite of being sutured to the skin, the Branula had a tendency to work out of the jugular vein.

Venocath[3] was easy to insert into the jugular vein but the protective shield was too long and when the patient moved slightly the fine polyethylene tubing kinked and the flow of fluid was arrested.

Tubing and Drip Chamber

The most satisfactory tubing was a 3.7 meter (12 feet) retractable nylon spiral[4] (Figure 1). The spiral would extend when the animal moved away from the fluid reservoir and contract if movement was in the opposite direction. If tension was exerted on the spiral for more than 48 hours there was a tendency for the spiral not to recoil to its original degree. The original degree of elasticity or recoil returned, however, if the nylon spiral was coiled tightly and tied in this position while being autoclaved.

Although it was time consuming to assemble, a satisfactory retractable tube was assembled using a 3 meter (10 feet) length of vinyl tubing and rubber elastic bands. The tubing was arranged to make a loose coil about 30 cm. (12 inches) in diameter. The top edge of each coil was attached to the top of the next coil of the tube, in sequence, using rubber elastic bands (Figure 1 Inset). When assembled and attached to the fluid reservoir bottle a successful degree of extension and recoil could be achieved by adding additional rubber bands where indicated.

Drip Chamber

A standard drip chamber is an essential part of the apparatus in order that the flow rate can be readily adjusted. In the one used, each 15 drops delivered equalled one ml. The drip chamber was inserted in the tubing near the fluid reservoir.

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[1]Manufactured by Becton-Dickinson and Company, Rutherford, New Jersey.

[2]Manufactured by B. Braun, Melsungen, W. Germany.

[3]Abbott Laboratories, Montreal, Quebec.

[4]Moore Thompson and Clinger, Hamilton, Ontario.

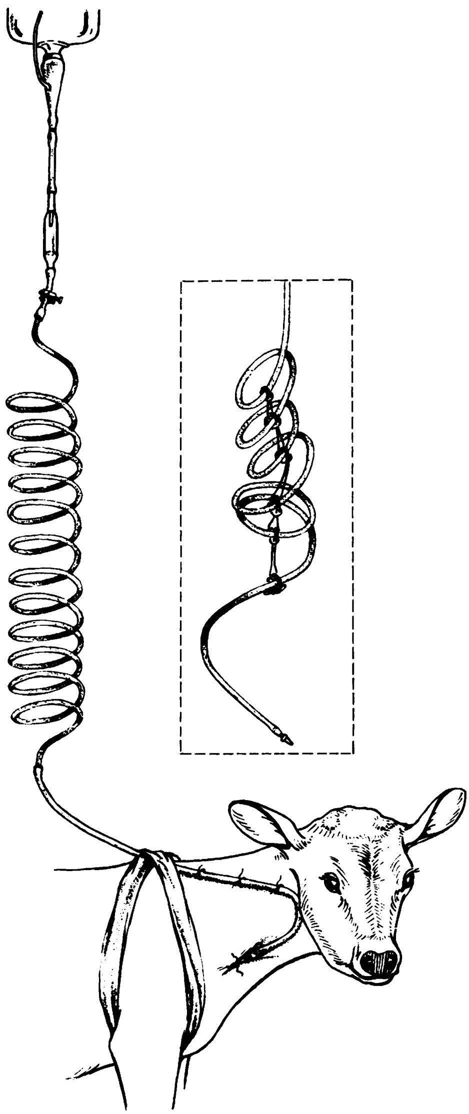

FIGURE 1. Diagrammatic illustration (from top to bottom) of fluid reservoir, flutter valve, drip chamber, flow regulator, nylon spiral, figure of eight bandage around forelimbs, tube sutured to neck and Touhy-Borst Adapter held in place over jugular vein by inverting non-absorbable suture.

FIGURE 1 INSET. Coiled nylon tubing with attached elastic bands.

It was desirable to have the drip chamber parallel the height of the animal, and thereby maintain a constant flow rate independent of whether the animal was standing or lying down. When inserted lower in the tubing, however, the drip chamber frequently was tipped and the flow of fluid was arrested.

Assembly of Apparatus and Venous Catheterization

For restraint, animals that are unaccustomed to being tied must be placed in a small pen. A suitable, improvised pen for small calves can be fashioned by arranging two or three layers of straw bales to form a square or rectangular pen. Larger animals must be tied in a conventional barn stall or tied with a halter to the wall of a pen.

The fluid reservoir must be firmly attached by a cord to a beam, the side support of a manger, or some other suitable location.

The flutter valve is placed over the neck of the reservoir bottle, the bottle inverted and attached to the support above the animal. The flow rate regulator is opened, removed and placed on the rubber tubing below the nylon spiral and closed after fluid pours freely from the end of the tubing.

By attaching the reservoir first and allowing the tube to fill, the time required for venous catheterization is sufficient to allow thorough "wetting" of the nylon spiral and allows air trapped in the tubing to rise up the tubing and escape at the reservoir or drip chamber.

The best site to insert the venous catheter is in the middle third of the jugular vein. The hair is clipped and the skin is washed and prepared as for other surgical procedures.

The jugular vein can usually be raised, even in severely dehydrated animals, with the exception of calves under two weeks of age. To facilitate raising the jugular vein in these calves, they are restrained in lateral recumbency, the operator kneels behind the animal and drapes the animal's neck over the toe of the shoe. The jugular vein is then distended with blood by occluding it in the distal jugular groove with one hand, while stroking or massaging the jugular vein in a proximal to distal manner with the other.

Difficulty may be encountered when attempting to insert even a sharp hypodermic needle through the skin of a severely dehydrated animal. A useful technique is to first position the point of the needle over the jugular vein, and while holding the hub of the needle between the thumb and index fingers, drive the needle perpendicularly through the skin by a sharp blow with the other hand. Once through the skin, the needle can easily be inserted into and directed towards the distal end of the jugular vein.

The Touhy-Borst adapter and polyethylene tubing are placed in position by first introducing a 14 gauge needle into the jugular vein. A 15 cm. (6 inch) length of polyethylene tubing is used, three inches of which is inserted through the needle into the jugular vein (Figure 2A). The polyethylene tubing usually can be palpated within the vein and the needle is withdrawn by simultaneously compressing the vein over the tubing and slowly withdrawing the needle (Figure 2B). Once the needle has been removed the Touhy-Borst adapter is placed on the end of the polyethylene tubing and firmly tightened

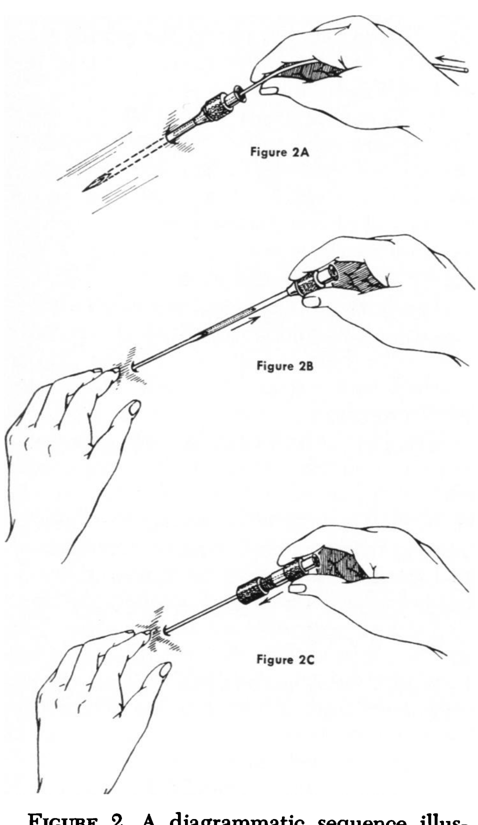

FIGURE 2. A diagrammatic sequence illustrating the method of introducing polyethylene tubing into the jugular vein (A), withdrawing the hypodermic needle (B), and attaching the Touhy-Borst Adapter (C).

(Figure 2C). The Touhy-Borst adapter-polyethylene tubing union is tested by giving one or two firm tugs. The polyethylene tubing is then inserted further into the vein, up to the hub of the adapter. The male adapter on the tubing is then attached and fluid allowed to flow, otherwise the blood in the tubing will clot. A piece of non-absorbable suture material about 30 cm. (12 inches) in length, is placed around the center of the adapter and knotted. Each of the free ends of the suture are inserted through the skin above and below the jugular vein to form an inverting mattress-type suture (Figure 3). The inverted skin serves to shield the adapter and protects the catheter from accidental withdrawal or kinking.

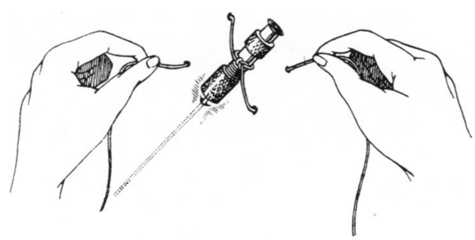

FIGURE 3. A diagrammatic illustration of the method of suturing the Touhy-Borst Adapter (with polyethylene tubing attached and inserted into the jugular vein) to the skin in order to produce an inversion of the skin over the adapter.

The tubing is placed along the side of the neck and folded back to exit from the highest point on the shoulder. Figure 4 shows the tubing in place. Having the tubing exit from the highest point of the patient's shoulder prevents tension from being applied to the intravenous catheter, allows complete freedom for head and neck movement and serves as the fulcrum point should the patient elect to stand or turn in the pen. A non-absorbable suture can be used to anchor the tubing to the point of the shoulder, however a figure-of-eight bandage or strap placed around the front legs and crossing over the shoulder, as shown in Figure 1, is an effective and more desirable method of securing the tube to the patient. The upper end of the nylon spiral can be tied with a cord or adhesive tape to either the reservoir or its support to prevent the patient from pulling the flutter valve off the

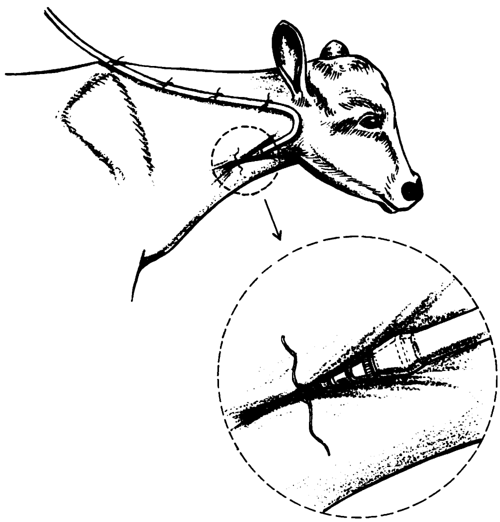

FIGURE 4. A diagram showing the preferred sites of attaching the tubing to the side of the animal's neck and shoulder and the skin inverted over the Touhy-Borst Adapter (inset).

reservoir bottle. Such accidents are rarely encountered as the flutter valve acts as a breaking point should the animal get loose.

Calculating Rate of Fluid Administration

The rate of fluid administration depends on the nature of the clinical case, the fluid or electrolyte loss, or both, and the nature of the fluid to be administered. A simple method of calculating the rate of administration (1) is by the use of the following formula:

Drops per minute × drop factor = ml. per hour.

Drops per minute = no. of drops delivered from the drip chamber per minute.

Drop Factor = 60 divided by the number of drops that are needed to deliver 1 ml. from the drip chamber. Example: The drip chamber used in this report delivers 15 drops to equal 1 ml. Thus the Drop factor is 60/15 or 4. If one determines, for example, that an animal requires 4,800 cc. of fluid in 24 hours (or 200 cc. per hour), the flow rate regulator will be set to deliver 50 drops per minute: i.e. 50 × a drop factor of 4 = 200 ml. per hour.

DISCUSSION

A nylon spiral in conjunction with the Touhy-Borst adapter and polyethylene tubing has been used to administer fluid and electrolytes to a variety of bovine clinical cases where dehydration was the major feature of the disease syndrome. Such fluids were administered continuously for periods up to four days.

Thrombosis of the jugular vein at the site of intravenous cannulation has not been observed either in cases that were necropsied or in cases that survived. Fibrin clot formation at the end of the polyethylene tubing within the jugular vein will occur if the flow of the fluid stops. On occasion, the clot can be removed by aspiration by a syringe but usually the polyethylene tubing must be withdrawn and a new intravenous catheter inserted.

SUMMARY

A nylon spiral in conjunction with a Touhy-Borst adapter and polyethylene intravenous catheter tubing for the continuous administration of fluids and electrolytes to large animal patients is described. The apparatus is reliable, easy to use, and allows limited freedom of movement by the patient. When the apparatus is properly assembled, fluid can be administered continuously for extended periods of time.

The main difficulty encountered was fibrin clot formation at the end of the polyethylene tubing within the vein. Such clots will form when the flow of fluid has been arrested. These clots have not caused thrombosis.

When clots occur the best procedure is to withdraw the polyethylene tubing and insert a new one.

RÉSUMÉ

On décrit l'utilisation d'une spirale, d'un adapteur Touhy-Borst et d'un cathéter intraveineux en polyéthylène pour l'administration continue de fluides et d'électrolytes chez les grands animaux. L'appareil est d'un fonctionnement sûr, facile à utiliser et permet certains mouvements du patient. Quand l'appareil est bien assemblé, le liquide peut être administré continuellement pendant des périodes prolongées.

La difficulté principale réside dans la formation des caillots de fibrine, dans la veine, à l'extrémité du tube de polyéthylène. De tels caillots se forment quand l'écoulement du liquide s'arrête. Ces caillots n'ont pas causé de thrombose.

ACKNOWLEDGMENTS

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ABSTRACTS

Todd, G. C., and Krook, L. (1966). Nutritional hepatic necrosis in beef cattle: "sawdust liver."—Pathologia vet. 3, 379–400 (g.) (Dep. Pathology, State Vet. Coll., Cornell Univ., Ithaca, New York).

Histological examination of sawdust liver indicated that the focal liver necrosis was an expression of vitamin E-selenium deficiency. The condition was set up in steers by a diet rich in polyunsaturated fatty acids and poor in protein, vitamin E and selenium. Lesions also occurred in the kidney, heart, skeletal muscles and pylorus. Addition of dietary protein or injection of selenium partially prevented the condition. Cellular anoxia with formation of hyaline bodies in the liver and kidney was considered to be the common denominator of the degenerative changes. Because of the relatively mild tissue changes, plasma glutamic oxalacetic transaminase and ornithine carbamyl transferase determinations were found to be of no diagnostic value.

Storz, J., Shupe, J. L., Smart, R. A., and Thornely, R. W. (1966). Polyarthritis of calves: experimental induction by a psittacosis agent.—Am. J. vet. Res. 27, 987–995 (State Univ., Logan, Utah).

A psittacosis-lymphogranuloma (PL) agent, strain LW-613, was isolated from synovial fluid of a polyarthritic calf. The special effects of this agent on synovial and other joint tissues were investigated in colostrum-treated, day-old and two-week-old calves. The day-old calves died 36 to 48 hours after subcutaneous inoculation. The older calves died 6 to 14 days after s/c or intra-articular (i/a) inoculation. Viraemia was detected within 18 hours in the calves inoculated i/a, and their blood remained infective for up to six days. The s/c inoculated calves had viraemia 24 hours after inoculation. The blood of all calves again contained chick embryo-infective levels of PL agent during the terminal phase of the experimentally induced disease. Irrespective of the route of exposure, all joints of all limbs were grossly affected, and the PL agent was recovered from a high proportion of the joints tested. The greatest number of nucleated cellular elements in synovial fluid of different calves ranged from 45,000 to 68,000/cu. mm. The PL strain LW-613 is antigenically related to the PL agents that cause polyarthritis in lambs and to a strain causing inclusion conjunctivitis and systemic infection in g. pigs. It differs, however, in its antigenicity and pathogenicity from one bovine PL strain isolated from epizootic bovine abortion.

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