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TECHNICAL NOTE

A DUAL-LUMEN CATHETER FOR CONTINUOUS BLOOD SAMPLING*

THE development of a catheter able to deliver an adequate uninterrupted blood sample for extended periods of time to analytical modules is becoming a matter of prime importance to many *in-vivo* investigations. The factors interfering with the solution of this problem are protein and fibrin deposition in the *in-vitro* plumbing and patient discomfort due to vessel irritation. In the development of a dual-lumen catheter to fulfill the above requirements, the following design criteria were used:

(1) The blood should come in contact with a minimum of surface area.
(2) The surface should be very smooth and the material nonthrombogenic.
(3) Heparin introduction should be accomplished as soon as possible.
(4) The flow patterns should be non-pulsatile and laminar if possible.
(5) Uniform introduction of the heparin solution into the efferent blood cannula.
(6) There should be little pressure drop in the catheter.
(7) The catheter should be disposable or easily cleaned and sterilizable.
(8) It should be easy to introduce into the desired vessel.
(9) It should be flexible so that it will not traumatize the vessel wall.
(10) The outer diameter of the monitoring cannulas should be no greater than a 17 gauge needle.
(11) The insertable length of the cannulas should be no greater than 4 in. (10 cm).
(12) There should be no danger of heparinizing the subject.

Several preliminary designs were fabricated and used for *in-vivo* experiments of up to 5 hr. All had problems with uniform flow, fibrin deposition, leaks, and post-experiment subject discomfort (i.e., vein irritation).

Later designs were more successful in that the number and severity of these problems were reduced. The final catheter eliminated all of the difficulties associated with the earlier cannulas and performed successfully for over 50 experiments, each of 5 hr duration.

It is constructed using an inner lumen of polyethylene (o.d. = 0·038 in., i.d. = 0·025 in.) made by BD 'Formocath' and an outer lumen which is a 3 in. by 19 gauge BD 'Long Dwell' teflon catheter with a plastic hub. They are connected using a specially made stainless steel housing (FIG. 1). Flow tests have confirmed that the plume of the heparin solution around the distal tip of the inner lumen is less than 1/2 mm with no visible pulsations (a problem with earlier models which caused variable dilution and thus affected data). This enables safe operation with less than 3 mm distance between the distal tips of both lumens. The flow used was 0·73 ml/min (i.e., blood = 0·5 ml/min and heparin/saline = 0·23 ml/min). The heparin concentration was 250 units/ml in 0·9 per cent NaCl. The advantages of this catheter include:

(1) Stainless steel construction.
(2) Completely and easily dismantled for cleaning.
(3) Flared inner lumen to prevent possibility of losing any of the parts in vein.
(4) A bushing butted against the flare provides one additional deterrent to inner lumen motion.
(5) Outer lumen tapered so that inner lumen will not pass through it unless it is firmly pushed through.
(6) All parts in contact with blood or patient are disposable and/or gas sterilizable.
(7) Substitution of any part during a run is easy to accomplish in a few seconds.
(8) Flow may be interrupted by removing the inner lumen and casing as a unit and inserting an obturator into the outer lumen which is left in the vein.
(9) It is small and therefore easily taped to subject's limb.
(10 Blood does not come into contact with metal.
(11) Provides a sample with a constant dilution.
(12) Based on *in-vitro* tests and fluid flow calculations, there is no danger of introducing heparin into the subject's blood stream.
(13) Subject discomfort was virtually eliminated post-experimentally in over 50 trials.

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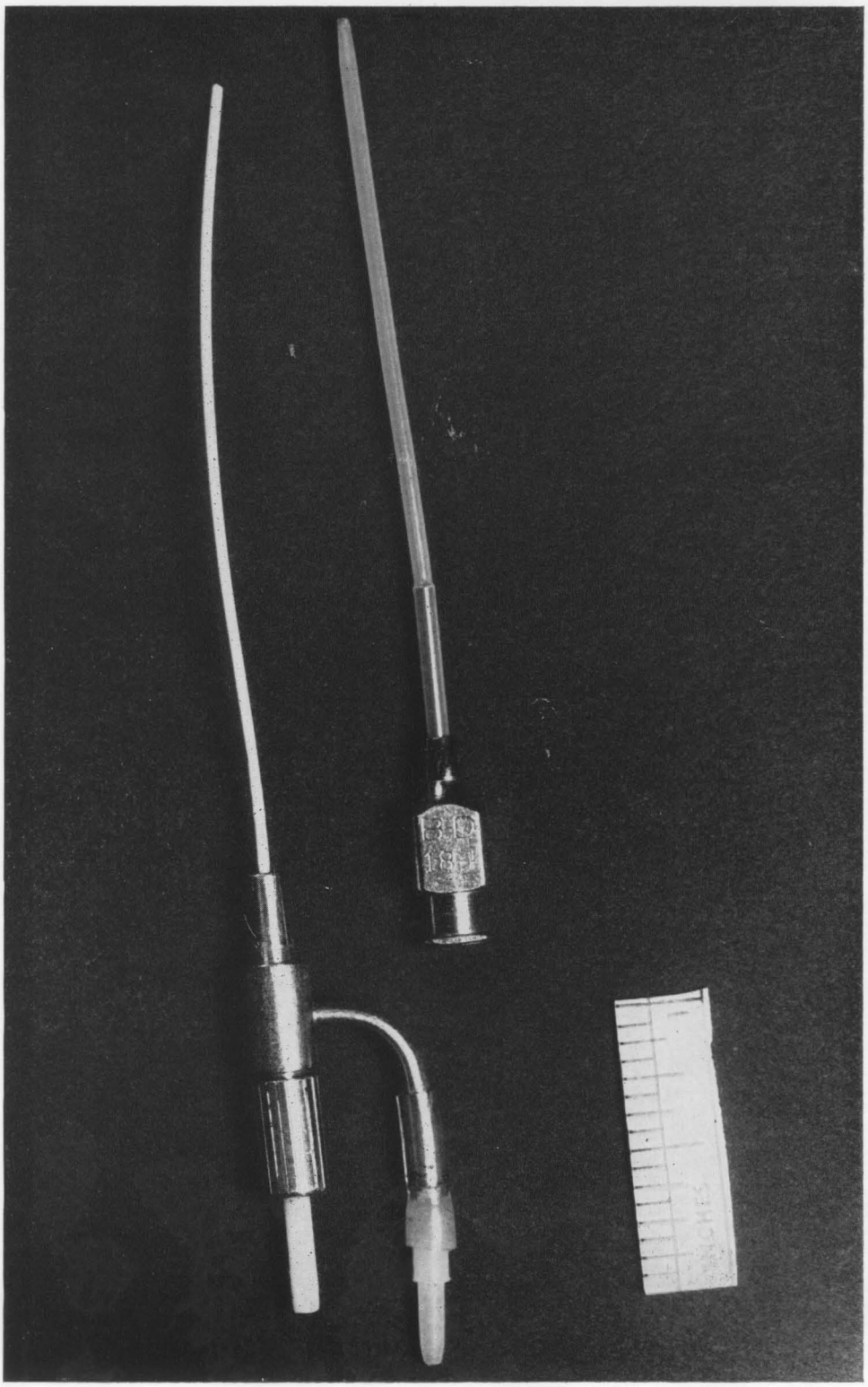

FIG. 1. Dual-lumen catheter for continuous blood withdrawal.

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