Title: Blood Flow Through Two Types of I.V. Catheters

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Introduction: Anesthesiologists are often confronted with the problem of having to give large volumes of crystalloid solutions or blood to patients with veins too small to allow insertion of large IV catheters. A new IV catheter, made of a polyurethane-based polymer called Aquavene, developed by MenloCare, Inc., enlarges and softens with hydration from exposure to aqueous fluid. A previous study demonstrated that 20 g. Aquavene catheters increased in diameter to allow flow exceeding that of 18 g. Teflon catheters[1]. That study used 0.9% saline. Because blood, either packed or whole, has markedly different flow characteristics than saline[2], it is possible that the results found with saline might not pertain to blood. We therefore studied the rate of blood flow through two types of I.V. catheters as a function of catheter gauge and catheter type.

Methods: Two types of catheters were studied: Streamline (made of Aquavene by MenloCare, Palo Alto, CA) and Jelco (made of Teflon by Critikon, Tampa, FL). Several sizes of each type were evaluated: MenloCare: 22, 20, and 18 gauge. Critikon: 22, 20, 18, and 16 gauge. All catheters were 1.25 inches in length. The MenloCare catheters were fully hydrated in 37° C water for at least 90 minutes. Three catheters of each size (24 catheters total) were tested in random order. Catheters were tested by measuring the rate of blood flow through each catheter. Five units of either whole blood or packed cells diluted with saline (1:1) were used. The blood, not outdated, had been rejected by the Blood Bank because of hepatitis antibodies, elevated LFT's, or air contamination. All units were brought to 37° C in a water bath before testing and mixed by hand every 1-2 minutes during testing .

Flow was calculated after measuring the time to fill 20 mls of a 100-ml graduated cylinder. The path of the blood from the transfusion bag was via a large-bore blood administration set (Abbott Labs, No. 8964) without a filter. The height of the blood bag was adjusted to maintain the meniscus of the blood in the bag 30 inches above the outlet of the infusion set.

The rheology of blood can vary over time with any given unit of blood as well as between different units of blood. Therefore, a method for controlling for these effects was used where each catheter was tested against a "control" catheter. Each unit of blood was spiked twice with identical tubing systems: one tubing set ended in the control catheter (Criticon 18 gauge, 1.25 in.) and the other set ended in the "test" catheter. The tubing sets were opened simultaneously, and the time for 20 mls to flow was recorded for each of the two catheters. A ratio of the flow (mls/min) through each test catheter to the flow through the control catheter was than calculated. This flow ratio was used as a corrected measurement of flow for comparison between different catheters.

Results: The absolute blood flow through the test catheters ranged from 6 to 80 mls/min. The flow through the control catheter varied considerably, depending on which unit of blood was used and how much blood had already been withdrawn from a given unit. Even with frequent mixing, the first 100 mls from a unit ran more slowly than the rest of that unit. These effects were compensated for by simultaneously testing the control catheter and using the ratio of the two flow rates. The ratios ranged from 0.39 for the 22 gauge Teflon to 1.60 for the Teflon 16 gauge and Aquavene 18 gauge catheters (Figure 1).

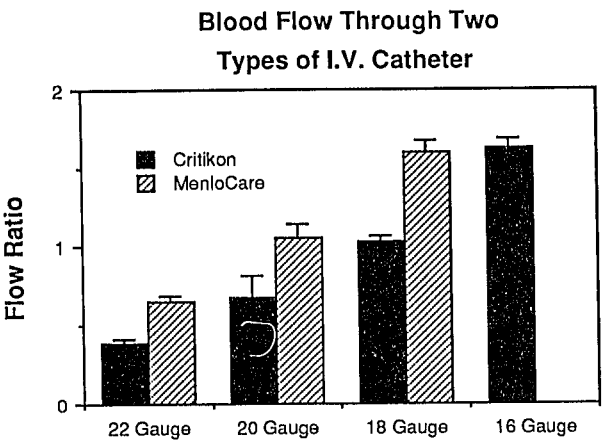

Figure 1: Three catheters of each size were tested. The Flow Ratio (flow though test catheter / flow through control catheter) compares each test catheter to a control catheter where both are tested simultaneously, thus correcting for changes in blood rheology with time and between units. Menlo Care catheter sizes shown are the starting size, but they enlarge with hydration to accomodate flow equivalent to that of Teflon catheters two gauge sizes larger. Bar lengths indicate means and S.D.

Discussion: Previous studies have shown that MenloCare Streamline catheters made of Aquavene expand and allow increased flow of crystalloid solutions compared with Teflon catheters of similar starting diameter. This change occurs with hydration which occurs after catheter insertion. This study shows that this increased flow after hydration also occurs with blood. A MenloCare catheter of a given starting gauge will accomodate flow that is equivalent to flow through a Teflon catheter two gauge sizes larger.

Administration of blood and blood products requires larger diameter intravenous catheters. In some patients, it may be difficult to insert large IVs. Use of MenloCare catheters will permit the insertion of smaller catheters while still allowing the flow of larger catheters, in these patients who may require blood transfusions.

References:

1. Cooke J, Walker J: Evaluation of a Unique Hydratable I.V. Catheter, Anesthesiology 67:A208, 1987

2. Fluid Dynamic and Hemorheologic Considerations. In: Guidelines for Blood-Material Interactions, Report of the National Heart, Lung, and Blood Institute Working Group, pg 71, 1985.