Technical Report

Use of a urologic set for improved fluid administration rates

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This study was designed to compare flow rates of three sets of tubings: a large bore (8 mm) Y-urologic set (Y-URO); a Y-URO with an added in-line blood filter (Y-URO + BF); and a currently used (3.5 mm diameter) blood transfusion set (Y-TRANSFUSION). The time required to empty a one litre bag of Ringer's Lactate from a 1.0 meter vertical drop was measured while using four different IV catheters (9.5, 10, 14 and 16 gauge), and the flow rates calculated.

When a 9.5-gauge catheter was used, the flow rates obtained by the Y-URO and the Y-URO + BF were respectively 269 and 162 per cent higher than those achieved by the Y-TRANSFUSION. This wide margin was decreased to 41 and 39 per cent with a 16-gauge catheter. A 9.5-gauge catheter, when compared to a 16-gauge, allowed a 346 per cent improvement in flow rates with the Y-URO, a 225 per cent with the Y-URO + BF and only a 71 per cent increase with the Y-TRANSFUSION. The urologic set allows better fluid flow because of the larger diameter of its tubing. This adaptation of a large bore urologic irrigation set can be very useful when rapid fluid administration is imperative.

Key words

EQUIPMENT: fluid infusion sets, blood infusion sets.

Anaesthetists deal on occasion with patients in hypovolemic shock, brought into the emergency room with unstable or absent vital signs. One key in resuscitating these patients is to obtain rapid haemodynamic stability via adequate fluid replacement, using large bore intravenous catheters.¹ Even though pressure devices are also used to increase flow, intravenous replacement may be far behind the blood loss and sometimes is unable to keep up with massive bleeding. Less resistance in the infusion apparatus would be necessary to reach adequate flow.

We thought that when the usual Y-transfusion set is used in concert with a large bore IV catheter, a major part of the resistance might be attributable to the small diameter of the tubing of the transfusion set.

The goal of our study was to compare the flow of a Newtonian fluid (an homogeneous fluid whose dynamic viscosity does not change with the velocity of flow)^{2,3} between a large bore urologic irrigation set and a blood transfusion set, while using different sizes of IV catheters.

Methods

Three sets of tubings were compared. The first (Y-URO) was an urologic Y-irrigation set (T-U-R Y-Set, Abbott Laboratories) non vented, sterile and non pyrogenic. It has a length of 244 cm and an external diameter of 8 mm. It ends with 9 cm of soft latex tube. The second (Y-URO + BF) was the same urologic set with an added in-line blood filter (Blood Inline Filter Adaptor, Abbott Laboratories, Figure 1). The third set (Y-TRANSFUSION) was a currently used Y-type blood transfusion set (Non Vented Blood Y-Type Set 100, Abbott Laboratories). This infusion set has a blood filter incorpo-

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FIGURE 1 Schema of the second set (Y-URO + BF): T-U-R Y-SET with a blood in-line filter adaptor.

rated into the drip chamber. Its tubing is 250 cm long and it has an external diameter of 3.5 mm.

With each of the three sets, four types of intravenous infusion catheters were compared: a 9.5-gauge (10.5 F), 10.8 cm long pulmonary artery catheter introducer without the side-port (Percutaneous Sheath Introducer Set 8 F, Arrow International); a 10-gauge (10 F), 7.6 cm catheter (Angiocath, Deseret); a 14-gauge (6.3 F) and a 16-gauge (5.0 F), 5.7 cm long catheter (Cathlon IV, Critikon). The junction seal between the urologic tubing and the IV catheter was easily achieved by sliding the latex end over the catheter hub.

TABLE Time* required to flow one litre of Ringer's Lactate through the three sets, using different IV catheters

IV catheters (gauge)	Infusion time (min:sec)		
	Y-URO	Y-URO + BF	Y-TRANSFUSION
—†	0:49	1:23	4:12
9.5	1:09	1:37	4:14
10	1:21	1:44	4:15
14	2:49	3:01	5:06
16	5:08	5:16	7:14

*Time above is average of two observations in min:sec.

†No catheter used.

With a stop watch, we measured, *in vitro*, the time required to freely empty a one litre bag of crystalloid (Lactate Ringer's Injection USP 1000 ml, Viaflex, Travenol) at room temperature through each set. This was obtained by suspending the one litre bag on a IV stand with a vertical drop of 1.0 metre, from the fluid bag piercing point. Measurements were recorded twice and the mean value taken, for the three sets alone and then with the four catheters attached. Each set was pre-filled before measurements. The average flow in $\text{ml} \cdot \text{min}^{-1}$ was calculated by dividing 1000 ml by the time required to empty the fluid bag.

Results

Our results are presented in the Table, where the time required to empty one litre of Ringer's Lactate is expressed in minutes and seconds for the three sets with the different IV catheters. Figure 2 represents the flow in $\text{ml} \cdot \text{min}^{-1}$ calculated from the data in the Table.

When no intravenous catheters were used, the flow rates through the Y-URO ($1224 \text{ ml} \cdot \text{min}^{-1}$) and the Y-URO + BF ($723 \text{ ml} \cdot \text{min}^{-1}$) were respectively 412 and 204 per cent superior to those of the Y-TRANSFUSION ($238 \text{ ml} \cdot \text{min}^{-1}$). With a 9.5-gauge catheter, the flow rates obtained by the Y-URO ($870 \text{ ml} \cdot \text{min}^{-1}$) and the Y-URO + BF ($619 \text{ ml} \cdot \text{min}^{-1}$) were respectively 269 and 162 per cent superior to those achieved by the Y-TRANSFUSION ($236 \text{ ml} \cdot \text{min}^{-1}$). This large difference decreased to 41 and 39 per cent with a 16-gauge catheter.

When comparing the Y-URO and the Y-URO + BF, the addition of the in-line blood filter accounted for a 29 per cent decrease in flow providing a

FIGURE 2 Flow rates through the three sets using different IV catheters (* = no catheter used).

9.5-gauge catheter was used. This difference was reduced to three per cent with a 16-gauge catheter.

When a 9.5-gauge catheter was used instead of a 16-gauge, the urologic sets allowed a major improvement in flow rates, which increased by 346 per cent with the Y-URO and by 225 per cent with the Y-URO + BF. However, with the Y-TRANSFUSION, a difference of only 71 per cent in flow rates was observed when compared with the smaller catheter.

Discussion

This study showed that the urologic irrigation set allows a better fluid flow than the usual blood transfusion set. Our experience was conducted *in vitro* and did not include the resistance related to the venous system. The results cannot be completely extrapolated to the use of blood, a non Newtonian fluid, where an increase in flow velocity causes a decrease in dynamic viscosity.^{2,3}

Considering tubings of a comparable length, with a driving pressure and a fluid viscosity equal in all groups, the improved flow rates of the urologic sets can be attributed to the larger diameter of the tubing, according to Poiseuille's law. However, the flow differences between the sets decrease as the

catheters become smaller and account for a larger part of the resistance. Better flow rates in each of the sets could be obtained with a pressure device, as described by Philip.⁴

Because an important part of the resistance in the Y-TRANSFUSION comes from the small diameter of the tubing, the use of a large bore IV catheter (9.5-gauge, 10-gauge) does not allow an adequate increase in flow over the smaller catheters.

We believe that, for massive fluid replacement, prewarmed solutions (37°C) should be available in order to prevent hypothermia and to lower blood products viscosity.⁵ Central pressure monitoring (CVP or PAP) should be instituted to prevent overloading. The in-line blood filter may be added to the urologic tubing only when necessary and may easily be replaced after a few blood transfusions. Even though the urologic set contains no injection port, medication can be given through the latex portion without causing a subsequent leak.

Until a more appropriate intravenous set for aggressive fluid replacement is designed, this adaptation of a large bore urologic irrigation set can be very useful.

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Résumé

Cette étude compare les débits liquidiens obtenus avec trois tubulures différentes: une tubulure urologique de gros calibre (Y-URO, diamètre de 8 mm), une tubulure urologique avec un filtre sanguin ajouté en série (Y-URO + BF) et une tubulure pour transfusion (Y-TRANSFUSION, 3.5 mm). Le temps requis pour écouler un litre de lactate Ringer, à partir d'une dénivellée de 1.00 m, fut mesuré en utilisant quatre cathéters intraveineux de calibres différents (9.5, 10, 14, 16 gauge), et les débits furent calculés.

Lors de l'utilisation d'un cathéter de 9.5 gauge, les débits des tubulures Y-URO et Y-URO + BF étaient respectivement 269 et 162 pour cent supérieurs à ceux de la tubulure Y-TRANSFUSION. Ces différences étaient réduites à 41 et 39 pour cent avec un cathéter de 16 gauge. Lorsque comparé à un cathéter de 16 gauge, un cathéter de 9.5 gauge permet une amélioration du débit de 346 pour cent avec la tubulure Y-URO, de 225 pour cent avec la Y-URO + BF et seulement de 71 pour cent avec la Y-TRANSFUSION. La tubulure urologique permet de meilleurs débits liquidiens en raison de son plus grand calibre. Cette adaptation d'une tubulure urologique peut être très utile lors de la réanimation d'un patient hypovolémique.