

VASCULAR ACCESS CATHETER *TipS*

SHARING INFORMATION TO IMPROVE LONG-TERM VASCULAR ACCESS

Dear Researcher,

Over the past 27 years, distinguishing features of Access Technologies, are the many first's we have introduced to laboratory animal researchers & our record of providing educational & informational resources. Providing useful information has always been a high priority for us. ***It has come to our attention that an important piece of information is missing from our technical library and I am asking for your assistance in the preparation of a new Technical Tool.*** We think the tool will benefit all researchers.

In previous editions of our TipS we have talked of the optimal catheter material, optimal catheter tip location but have made only a brief reference to the ***role played by catheter size in minimizing occlusions.*** There are a number of references in the human literature concerning catheter size, both in ports and CVC and PICC lines, but none that I could find in the research literature, regarding the relationship between catheter diameter and vessel diameter in any animal model. We believe this is a necessary tool. I hope you find the information on this subject interesting and please email me, pwolf@norfolkmedical.com, your thoughts on the subject. The TipS is a forum for sharing and your comments are important.

Regards, Pam

A BALANCING ACT

The optimal proportion between catheter diameter & vessel diameter is a balancing act. According to work done in human medicine, catheter diameter & length have a great effect on medical utility.

It is often forgotten that there are factors other than catheter material & tip location that play a role in patency ***the ratio of the catheter diameter to the vessel diameter is, we believe, an important factor influencing patency.***



Catheter Diameter & Flow Rate

Factors determining flow rate through a catheter are expressed in Poiseuilles Law which states:

$$\text{Flow Rate (Q)} = \frac{\Pi (P_1 - P_2) r^4}{8vl}$$

In simple terms - if you keep everything constant except the radius of the tube, you would see that you need 16 tubes to pass as much fluid as one tube twice their diameter. Flow rate increases proportionally to the 4th power of the lumen radius and decreases in proportion to the length of the catheter. We should not forget that flow rate is also dependent on viscosity & hydrostatic pressure.

Theoretic considerations determined by Poiseuilles Law can have important clinical implications, eg. when you use a 16 gauge (1.7mm) rather than a 14 gauge (2.1mm) catheter, the catheter diameter is reduced by 24% (0.4mm) and the flow rate decreases by 66%. Changes in catheter length have a linear effect on flow rate - if you halve the length, you double the flow rate.

But what is the effect of increased catheter diameter on patency? This is, I am sure you will agree, a major consideration in your long-term studies. (contd. page 2)

Catheter Measurement Systems

Diameters of vascular catheters are designated in one of two measurement systems: French or Gauge. In the French measurement scale, each unit is equivalent to 0.33mm in outer diameter. So, for example the 5 French catheter has an OD of 1.65mm. The Gauge system was introduced to measure solid wires and is an expression of how many wires can be placed side by side in a given space. The gauge varies inversely with the outer diameter of the wire or catheter. However, there is no simple relationship between gauge and other units of measurement and a table of the French-Gauge relationship is a valuable tool.

French	Gauge	Inner Diameter	Outer Diameter
1	27	0.007"/0.2mm	0.16"/0.4mm
2	23	0.012"/0.3mm	0.25"/0.6mm
3	20	0.020"/0.5mm	0.37"/0.9mm
4	18	0.025"/0.6mm	0.47"/1.2mm
5	16	0.030"/0.7mm	0.65"/1.7mm
7	13	0.050"/1.3mm	0.95"/2.4mm
9	11	0.062"/1.6mm	0.125"/3.2mm

Table showing the French-Gauge Conversion of Silicone Tubing

Access "*TipS*"

July 2009

is published by:



tel. 847-674-7131
fax. 847-674-7066
toll free (USA) 877-674-7131
email. pwolf@norfolkmedical.com
www.norfolkaccess.com

Distributed in Japan by:
PRIMETECH

Distributed in Europe by:
UNO ROESTVASTSTAAL BV

VASCULAR ACCESS CATHETER *TipS*

SHARING INFORMATION TO IMPROVE LONG-TERM VASCULAR ACCESS



CATHETER GAUGE

Did I choose too large a catheter?

Besides the emergency situation or if your protocol calls for a specific flow rate, there is no justification for choosing a large diameter catheter. The interplay of vessel size & catheter diameter is well documented in the human literature. Downs et. al. (Arch Surg 108:671-3, 1974) noted a significantly lowered incidence of vascular occlusion with a decrease in catheter size (20ga. compared with 18ga). Bedford (Anesthesiology 47:37-9, 1977) hypothesized that the greater surface area of the 18ga. catheter (20% larger than the 20ga. catheters) may contribute to its susceptibility to thrombus formation. Bedford found that the *incidence of arterial occlusion increased linearly as the ratio of the catheter outer diameter to vessel lumen diameter increased*. Several more human studies have shown that larger catheter sizes produce higher rates of vein thrombosis. This follows the tried and true standard for all infusion therapy (from the Intravenous Nursing Society - Intravenous Therapy, Clinical Applications and Practice, Terry J et. al. 1991) - **Choose the smallest size catheter capable of delivering the prescribed therapy!**

The chart below is from the human literature & shows the percentage of the catheter area versus the vessel size.

Vessel Diam.	Vessel Area	4 Fr. Cath OD 1.35mm 1.43mm ²	5 Fr. Cath OD 1.67mm 2.19mm ²	6 Fr. Cath OD 2mm 3.14mm ²
3.0mm	7.1mm ²	20%	31%	44%
3.5mm	9.6mm ²	15%	23%	33%
4mm	12.6mm ²	11%	17%	25%
4.5mm	15.9mm ²	9%	14%	20%
5mm	19.6mm ²	7%	11%	16%
5.5mm	23.8mm ²	6%	9%	13%

We would like your help!

We believe a similar chart showing the more common vessel sizes in laboratory animal species, from mice to non-human primates, & the catheter size for insertion in each vessel, would be a very useful tool.

Please share your thoughts & expertise.

Thanks, hope to talk with you soon, Pam

CATHETER SELECTION

Using the right size....

The aim of catheter use is to optimize administration of the infusate & minimize complications such as thrombus formation, thrombophlebitis & sepsis. Catheters are foreign bodies & no matter how biocompatible they are, elicit a response. Catheter choice should be such that it minimizes vessel trauma & phlebitis - the inflammatory changes in the vessel due to mechanical trauma, chemical irritation or bacterial colonization. These phlebotic changes occur secondary to the mechanical trauma caused by the intravascular catheter injuring the vessel wall it is in contact with.

While there are a number of other factors that contribute to patency (of the catheter and vessel), including catheter material, catheter tip configuration, coefficient of friction of the catheter, and catheter tip location, *optimal catheter size plays a very important role*. As the percentage of the catheter filling the vein increases, so do patency complications that we believe, are related to blood flow and stasis. We can minimize contact between the catheter and the vessel wall, by using a smaller diameter catheter, thereby reducing the incidence of irritation of the vessel wall by the catheter.

Additionally, a smaller diameter catheter promotes proper hemodilution of the infusate and allows adequate blood flow around the catheter walls which promotes less irritation to the vessel wall.

How large a catheter is too large?

Our hypothesis is:

"When the catheter is over 2% of the total area of the vessel, occlusion is more likely to occur!"

In your experience are we correct?

If the catheter is too large for the vessel, it may occlude the entire lumen of vessel, obstructing the flow of circulating blood; the infusate then flows undiluted, further irritating the vessel wall. This together with stasis in the circulation is a set up for **"trouble down the pipe-line"**.

The size of the vessel & the infusate/therapy should determine the catheter size, it should not be an arbitrary number.

You comments on this or any other subject are most welcome - please email me at pwolf@norfolkmedical.com