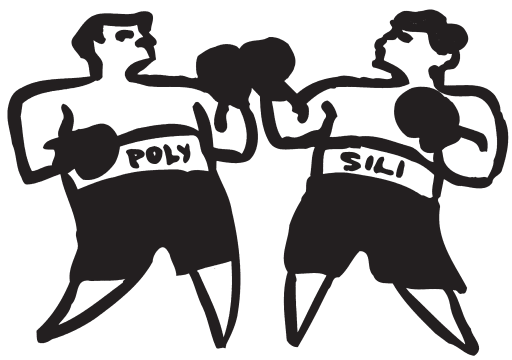
Vascular Access Catheter TipS

SHARING INFORMATION TO IMPROVE LONG-TERM VASCULAR ACCESS

Polyurethane vs. Silicone

Catheter materials have undergone relatively unchanged over the past 20 years. Silicone, Tygon®, and Polyethylene catheter materials have been used by researchers for many years. Since the 1960's silicone has found widespread use in medical applications. The relative newcomer to the field is polyurethane which rapidly gained acceptance in both human and laboratory products, during the 1990's. Faced with the choice of either silicone or polyurethane catheters, one needs to rely on in vitro and in vivo testing. Material composition of the catheter has an influence on such parameters as biocompatibility and thrombogenicity as well as clinical outcomes.



A brief overview of their characteristics.

Biocompatibility - the intent of such testing was established by regulatory agencies to ensure that the benefits provided by the product exceed any potential risks produced by the material. The biocompatibility of ***silicone*** has been touted as "the most biocompatible and biostable material currently available for catheter manufacture." In extensive testing silicone has exhibited superior compatibility with tissue and body fluids and an extremely low response when implanted. Silicone rubbers are synthetic polymers with an unusual molecular structure - a giant backbone of alternating silicone and oxygen atoms. It is this strong silicone oxygen chemical structure that gives silicone its unique performance properties such as biocompatibility, superior chemical and temperature resistance. ***Polyurethane*** as a catheter material has been evaluated over many years both in vitro and in vivo studies. Polyurethane is currently the material of choice for human PICC catheters. The favorable properties (see back page) of polyurethane have made it the popular choice for long-term catheterization by laboratory animal researchers.

Thrombogenicity - the potential for the generation of a thrombus in or on a catheter. Thrombogenicity has been studied extensively with animal models. In addition, in vitro testing of catheter materials on the role of materials and thrombogenecity, has provided additional insight. In early studies, the rate of platelet adhesion was reported significantly higher on the surface of silicone than polyurethane catheters[1-3]. However, more recent clinical studies have shown silicone to be less thrombogenic than originally reported.[4] A reason for this contradiction may be a result of changes in insertion techniques (in human patients) as well as the definition of thrombogenesis itself, rather than changes in the material.
The disparity in platelet adhesion on catheter surfaces may be due to the difference in smoothness of the surfaces. An article by Heckler[5] concluded that rougher catheters are more thrombogenic than smooth catheters irrespective of the catheter material. It is reasonable to conclude that roughness is a contributing factor to thrombogenicity as fibrin, platelets and red blood cells could lodge in the irregularities and so act as a base for the formation of a thrombus.

References

1. **Linder LE, et al.** 1984. Material thrombogenicity in central venous catheterization: A comparison between soft, antebrachial catheters of silicone elastomer and polyurethane. JPEN 8(4): 399-406.

2. **Curelaru I, et al.** 1983. Material thrombogenicity in central venous catheterization. II A comparison between plain silicone elastomer and plain polyethylene long antebrachial catheters. Acta Anaesth Scand Suppl 110: 158-164.

3. **Linder LE. et al.** 1985. "Half-way" venous catheters. IV. Clinical experience and thrombogenicity. Acta Anaesth Scand Suppl 81: 40-46.

4. **Borow M et al.** 1985. Evaluation of central venous catheter thrombogenicity. Acta Anesth Scand Suppl. 81: 59-64.

5. **Heckler.** 1981. Effects of roughness on the thrombogenecity of plastic. J.Biomed. Mat. Res. 15: 1-7.

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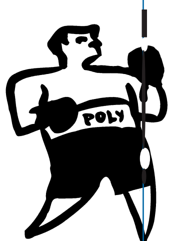
From a review of the literature, it becomes evident that all catheter materials available have both advantages and disadvantages. The choice of catheter material is therefore often application dependent. While both polyurethane and silicone are biocompatible and are good choices for long-term catheterization, a generalization of advantages and disadvantages may be helpful in determining which catheter material is right for your particular application.



Polyurethane

Benefits

- Larger internal diameter compared with same French size silicone catheter (4 Fr. polyurethane internal diameter approx. 0.032” compared with 4 Fr. silicone, internal diameter approx. 0.024”).
- Increased flow rate due to larger internal lumen. Polyurethane requires less wall thickness for strength compared with silicone).
- Easier to insert and advance due to initial stiffness.
- Softens upon warning to body temperature which may reduce vein trauma.
- Easily coated with a variety of specialized coatings.

Disadvantages

- More difficult to modify than silicone.
- Initial stiffness may be more damaging to the vessel than softer silicone.
- Polyurethane cannot be autoclaved.

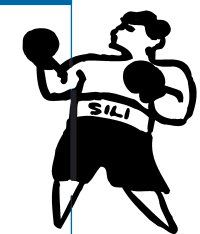
Silicone

Benefits

- Smaller internal diameter compared with same French size polyurethane catheter (4 Fr. polyurethane internal diameter approx. 0.032” compared with 4 Fr. sili cone, internal diameter approx. 0.024”).
- Kink resistant when extruded with greater wall thickness.
- Softness, a durometer of 50-60A, may reduce vein trauma.
- Easily modified step up, step down, suture handles etc.
- Can be autoclaved.

Disadvantages

- Slightly textured surface (microscopically) may increase thrombogenesis.
- More difficult to insert and advance due to softness.
- Difficult to coat with specialized coatings
- Kinking possible in lower durometer/thin walled tubing.



In recent years newer compounds have shown incompatibility with both polyurethane and silicone necessitating the use of less favorable catheter materials such as polyethylene, Teflon® and PVC.
To reduce some of the problems associated with these stiffer materials, such as, increased vein trauma due to stiffness, they can be combined with silicone or polyurethane.

GUEST TIP

A recent discussion with a customer revealed a problem he was having with his V-A-P's™ flipping or migrating. He found a unique solution to this problem by attaching Dacron® felt onto the bottom of the V-A-P before implantation. The Dacron felt provided the necessary tissue ingrowth which fully secured the V-A-P within a week following surgery. Using this technique our customer reported that flipping and migrating was no longer a problem. This technique requires the use of very few or no sutures.

We welcome your tips, inquiries, criticisms, comments and suggestions.

Email your tip to Access Technologies:

info@norfolkaccess.com

NEW IN THE LITERATURE

Below are two recent articles discussing the use of Vascular-Access-Ports (V-A-P™). The first article used the implantable Esox™ pump in conjunction with the port.

Weiss C. et al. 2000. The M1 Muscarinic Agonist CI-1017 Facilitates Trace Eyeblink Conditioning in Aging Rabbits and Increases the Excitability of CA1 Pyramidal Neurones. J. of Neuroscience 20(2):783-790

Cowart RP. et al. May1999. Factors Optimizing the Use of Subcutaneous Vascular Access Ports in Weaned Pigs. Contemporary Topics 38(3): 67-70