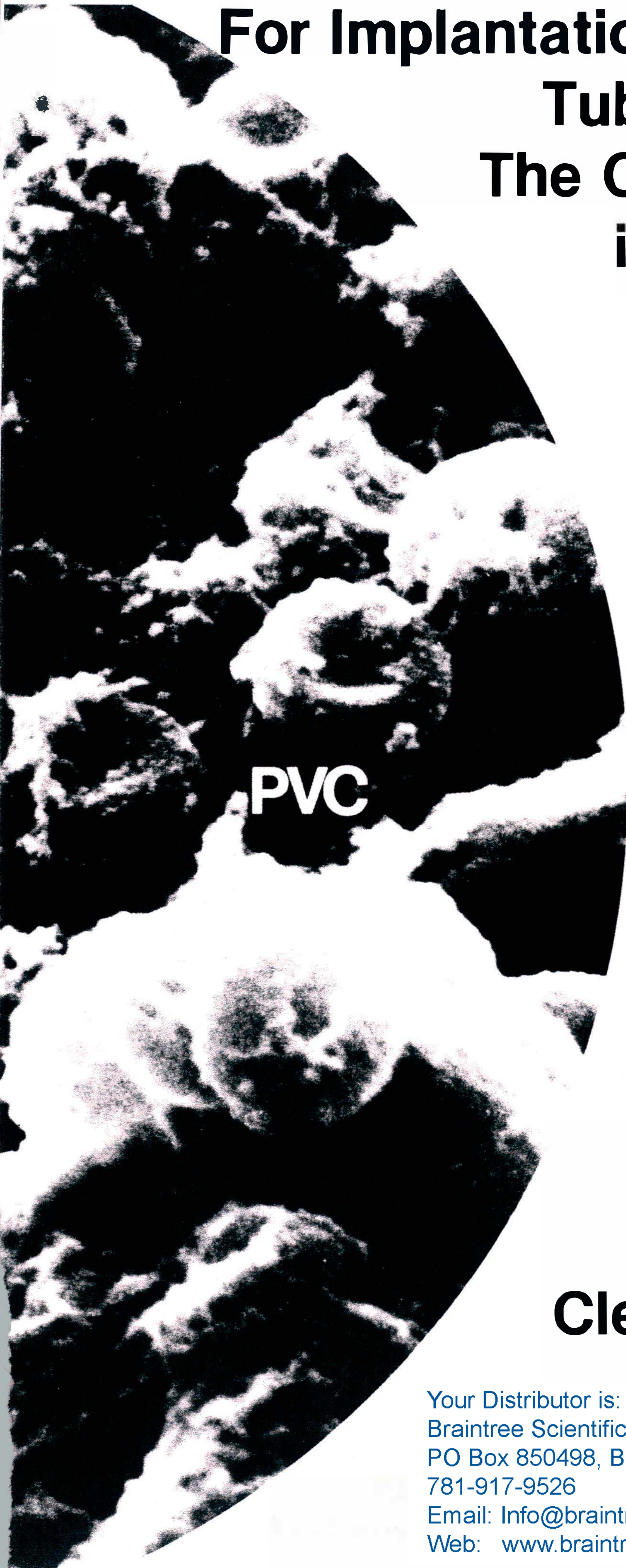
For Implantation and Catheter Tubing
The Choice is



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Micro-Renathane®

Polyurethane Catheter Tubing

Braintree Scientific is proud to present a major advance in chronic catheter material. In our opinion, **Micro-Renathane®** is the most blood-compatible tubing ever made. For implantation studies in experimental animals this new tubing offers extended catheter life and reduces the probability of intravascular thrombosis.

The scanning electron micrographs (approx. 10,000X) on our cover illustrate the dramatic difference between Renathane tubing and conventional tubing. After use in hemodialysis, Renathane showed significantly less surface deposits of platelets, proteins, trapped red cells and other blood elements than other tubings.

Micro-Renathane® vs. PVC

Renathane is a new polyurethane based elastomer with exceptional physical and biological properties. Renathane contains no plasticizers, metallic antioxidants, tints, colorants or light stabilizers: Its color is very faintly yellow. Polymeric physical properties include high abrasion resistance, high tensile strength, and exceptional elasticity. Renathane possesses outstanding hydrolytic stability. It is unaffected by exposure to most nonpolar solvents, formaldehyde solution, alcohols, and other common medicinal solutions. As with other materials, prolonged contact with bleach solutions or other strong oxidants is not recommended.

Conventional catheter tubing is made from PVC, poly vinyl chloride. PVC is a clear, brittle thermoplastic material made from the polymerization of vinyl chloride monomer. Recent toxicological studies have caused considerable alarm due to the carcinogenic nature of vinyl chloride monomer[1]. There is cause for concern on behalf of the user of PVC products since these products contain very small amounts of vinyl chloride monomer. At this time, there is no evidence to show that very low levels in finished products are harmful. The New York Academy of Sciences[2] has published a recent report on this subject, "The Toxicity of Vinyl Chloride — Polyvinyl Chloride."

Vinyl chloride monomer is not the only potentially toxic material present in PVC. In order to transform rigid, glassy PVC polymer into a soft, flexible device, plasticizers are added. Plasticizers impart flexibility to the polymer and allow fabrication without excessive heat. They become solubilized into the polymer's structure and act as internal lubricants. Plasticizers are of special concern to users in the medical community since they are potentially toxic and as much as 40% of a finished PVC product is plasticizer. Plasticizers can be of many different chemical structures. In medical plastics, di(2-ethyl hexyl)phthalate, DEHP is the plasticizer most often used. DEHP is a clear, viscous liquid. The oily feel of vinyl surfaces is due to this ingredient.

A great deal of physiological research has been done to determine the quantities of plasticizer which leach from vinyl surfaces into fluids and tissues. In some early work, it was found by Guess, Jacob and Autian[3] that significant amounts of plasticizer are leached from PVC blood bags. Many of these plasticizer extracts were toxic to mammalian cell cultures. Similar findings have been reported by Marcel and Noel[4]. Jaeger and Rubin[5] have measured the accumulation of DEHP in blood stored at 4°C in PVC blood bags. It was found to be 0.25 ± .03 mg/100 ml-day. The same authors have also detected DEHP in human lung tissue in microgram amounts after cardiopulmonary bypass and blood transfusion[6]. In hemodialysis it has been reported that 70 mg of plasticizer is absorbed by the patient during each dialysis treatment[7]. Unfortunately, one cannot stop plasticizer migration from PVC into the blood. Prolonged rinsing simply increases the quantity and rate of plasticizer washout[8].

Although DEHP has an extremely high oral LD_{50} (30 g/kg in rats and rabbits[9]), intensive investigation of its chronic and subtle acute toxicity have linked DEHP exposure to drug inhibition[10], disturbances in rat brain[10], altered reticuloendothelial function[10], microaggregation of platelets[10 11], teratogenic effects in chick embryos[12], reduced ability for fetal implantation and adverse effects on parturition in rats[13], toxic hepatitis[14], hemolysis[15], and disturbances in cellular replication in embryonic tissue[16]. Recent studies have raised questions concerning the toxicity of the metabolites of DEHP[17]. An excellent source of information on DEHP toxicity is the January 1973 issue of "Environmental Health Perspectives" which is entirely devoted to this subject.

In addition, PVC is relatively unstable to heat and light. Since most flexible vinyls are processed at temperature in excess of 350°F., heat stabilizers are employed, usually at levels of 0.1 to 3.0%. Heat stabilizers used in PVC medical products include alkaline earth and heavy metal organics. Guess and coworkers[18] have reported toxicological effects from PVC stabilizers.

Other additives less commonly used in vinyl medical products are ultraviolet stabilizers such as the hydroxybenzophenones, lubricants such as stearic acid, fatty acid amides, and tints. Bluing tints are employed to mask the discoloration of the vinyl article after processing.

In summary, flexible PVC devices contain a mass of polymer, 30 to 40% oil (plasticizer) and numerous other additives which are free to migrate from the plastic into the catheter lumen. In contrast, Renathane consists almost exclusively of high molecular weight polymer. Renathane contains no plasticizer as flexibility is an inherent property of the material. Additives are at a minimum level (below 1%) and are not as free to migrate. Therefore, it is more desirable to use Renathane and avoid potentially toxic materials that leach foreign chemicals into tissues.

"MEDICAL GRADE" PLASTICS

It is appropriate to clarify the definition of the phrases "medical grade" plastic and "FDA approved" plastic. There is no approved "medical grade" plastic or resin. Each individual supplier has his own criteria for what polymer and additive combinations constitute suitability for medical use. Similarly, there is no "FDA approved" plastic or resin. In the Code of Federal Regulations, Food and Drugs, Title 21, Part 121, the FDA has listed the additives allowable in plastics intended for food contact use. In formulating a PVC compound for medical use the manufacturer generally chooses plasticizers, stabilizers, antioxidants, colorants, etc. which are acceptable for food use.

MEDICAL USES OF POLYURETHANE

Polyurethane based polymers are relatively new materials introduced into the United States from Germany. Early biomedical applications of polyurethanes were described by Boretos and Pierce[19]. They reported excellent vascular acceptability in experimental heart-assist pump chambers and arterial cannulae. In subsequent work Boretos[20] reported the absence of acute toxicity for segmented polyurethanes. He also reported that polyurethane rings did not deteriorate or cause tissue reaction after implantation for 18 months. Lyman and coworkers[21]. have also investigated polyurethanes for the fabrication of heart assist devices. Artificial heart devices were constructed of this material and implanted in calves. Other uses of polyurethanes as biomaterials have been described by Bruck[22 23]. Polyurethane based polymers are currently commercially employed in hollow fiber kidneys, vascular catheters and intra-aortic balloons[24]. Due to the slightly higher costs of polyurethanes, they have only been used where exceptional biologic and blood compatibility is required.

During development, Renathane has been subjected to an extensive biomaterials testing protocol to insure its safety and efficacy. A partial list of the test protocol is as follows:

Toxicological Tests
- USP Plastics Container Tests
- Pyrogen Tests
- Intramuscular Implants with Histopathology
- Ethylene Oxide Residues

Extraction Tests
- Tissue Culture with Human Cells
- Acute Intracutaneous Injections of Extracts into Animals
- Acute Systemic Injections of Extracts into Animals
- Heavy Metal Content
- UV Spectroscopy Scans
- Gas-Liquid Chromatography

Tests with Human Blood
- Thrombogenicity
- Differential Cell Count
- RBC Fragility
- Hemolysis
- Electrophoresis
- Immunoelectrophoresis
- Scanning Electron Microscopy of Blood Lines Used in Hemodialysis

Overall, Renathane exhibited outstanding biocompatibility in all categories. No cytopathic or reactive effects were noted in any test.

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HANDLING TECHNIQUES

for Micro-Renathane®

TAPERING: Immerse a short loop of tubing, without tension, beneath the surface of sesame oil heated to 200-220 °C. When the heated segment is observed to "relax" (shorten and swell slightly), remove from the oil and pull steadily. Hold extended a few seconds until tubing cools. This method may be used to produce extremely fine terminal segments. The rate of taper depends on both oil temperature and pulling rate.

END SHAPING: To form flares or end beads, dip tubing end into hot oil. After relaxation occurs, withdraw and form with a mandrel or surgical instrument.

BONDING and CUFF ATTACHMENT: Cuffs for the 040 size **Micro-Renathane®** may be cut from 080 **Micro-Renathane®** and attached with silicone adhesive of the "bathtub seal" variety.

STERILIZING: **Micro-Renathane®** may be gas sterilized. Compatibility with chemical sterilants should be evaluated before use.

STABILITY: Since no ultraviolet stabilizer has been added, **Micro-Renathane®** may yellow slightly with age. Although this has no effect on its properties, you may wish to protect unused tubing from light.

AVAILABLE IN THE FOLLOWING SIZES:

TYPE MRE 025	.025 O.D. x .012 I.D.
TYPE MRE 033	.033 O.D. x .014 I.D.
TYPE MRE 040	.040 O.D. x .025 I.D.
TYPE MRE 080	.080 O.D. x .040 I.D.
TYPE MRE 095	.095 O.D. x .066 I.D.
TYPE MRE 160	.160 O.D. x .091 I.D.

SATISFACTION GUARANTEED

Micro-Renathane® is sold only for experimental use in laboratory animals. Please contact us for information on other applications.