suicidal but others deplorably accidental, usually because the material has been transferred to an inappropriate container, such as a soft-drink bottle. Typically there has been a falsely reassuring interval of a day or two after ingestion. Then lung changes of a proliferative kind have developed, sometimes to the accompaniment of renal, hepatic, and myocardial damage, these last three features often being reversible. The pulmonary disorder has, with few exceptions, progressed relentlessly, and no treatment appears to avail.

There have been numerous instances of children swallowing coal-tar vaporizing fluid, and, though none has died, many of them have been quite ill and have required intensive treatment before survival. Parents do not realize how hazardous such a preparation can be. Some of the motion-sickness remedies have been similarly troublesome. So, too, has been a proprietary symptomatic antidiarrhoeal medicine containing diphenoxylate and atropine. To this an infant can be especially vulnerable, and a child aged 2 died after taking only about 12 tablets.

Surprisingly, also, another child, a 1-year-old who devoured 10 to 20 Easton's tablets, died with symptoms of strychnine poisoning.

To quote the more esoteric examples, there was a homicidal episode in which cyanide was slipped successfully into a glass of Guinness, and another in which a demented man injected himself with T.A.B. vaccine direct into the heart.

On the more favourable side the so-called poisonous plants rarely cause more than a few mild symptoms, and though surgical spirit has been given to infants on numerous occasions in mistake for gripe-water no real harm has arisen.

Finally, when dealing with calls there is a definite impression that doctors are still too ready to undertake gastric lavage. If the substance is non-toxic there is no point in trying to wash it out, and with materials like paraffin, turpentine substitute, and products such as polishes containing these solvents lavage may be positively hazardous on account of the risk of bronchopneumonia.

NEW APPLIANCES

Woven Silicone Rubber as a Venous Prosthesis

Mr. F. ASHTON, Mr. R. GEDDES, and Mr. J. FEJFAR, of the Department of Surgery, Queen Elizabeth Hospital, Birmingham 15, write: In vessels with high blood flow, such as the aorta and great vessels, prostheses of many designs and materials will remain patent and function satisfactorily as blood conduits.

In the inferior vena cava, particularly below the entrance of the renal veins, the clotting-rate in prostheses is very high. Patency in these tubes depends on several factors, some of which are ill understood. The blood flow rate and the linear velocity of flow in this vessel in this region cannot be much lower than that in the aorta. It is therefore difficult to understand why prostheses do clot so readily. Another factor is the mechanical stability of the graft—its ability to withstand circumferential compression by fibrous tissue which has been excited by the presence of the plastic material, and which flattens and finally occludes it. Autogenous vein grafts give satisfactory results in the inferior vena cava even though they are collapsible presumably because of the absence of a significant fibrotic reaction. They also have a lining endothelium, which prostheses take time to develop.

To date, attempts to maintain patency in the inferior vena cava have taken well-defined lines or combinations of them. These are, firstly, the use of a non-thrombogenic surface—of two varieties: the chemical bonding of heparin to a plastic surface or the development of a natural endothelial surface induced by using an arteriovenous fistula to produce a temporary high flow state. Secondly, the building in of rigidity to the prosthesis to counteract the strangling effect of fibrosis. Thirdly, the use of a high flow state brought about by a long-standing

arteriovenous fistula, which is allowed to persist.

This paper reports the use of a new tubular prosthesis as a vena caval substitute. The material from which this tube is made was developed in the laboratory at this hospital. It is a multilayer helix of medical grade silicone rubber (Ashton *et al.*, 1967). First manufactured for arterial prostheses, this material has a large pore size and stability of form with all the elastic properties to be expected of a rubber. Tubes of this material have been used as vena caval prostheses in dogs.

MATERIALS AND METHODS

Tubes of this porous silicone rubber were implanted in the inferior vena cava of nine dogs from just above the confluence of the common iliac veins to just below the renal veins. In another animal the tube was 10 cm. long and connected the cut end of the inferior vena cava just above the renal veins to the side of the inferior thoracic vena cava. The proximal cut end of the abdominal cava was tied off and the upper anastomosis was end-to-side just below the right atrium. This was part of an experiment to measure hepatic venous blood flow in the isolated segment of the inferior vena cava.

The technique of suturing was similar in all experiments, 6/0 silk on a 10-mm. needle being used. Simple over-and-over suturing was used, piercing the vein from without in so that the vein tended to be carried into the prosthesis.

The fate of the implanted prosthesis was observed by serial phlebograms carried out through a superficial leg vein. An injection

of 20 ml. of 45% Hypaque (diatrizoic acid) was given as rapidly as possible, and gridded films used at 75 kV with a 15 milliamperes-seconds exposure (Fig. 1). This examination was carried out every day for 10 days, then weekly for two weeks, and then monthly and three-monthly thereafter.

RESULTS

The results in terms of patency are given in the Table. The dogs were killed at varying periods after implantation and the patent grafts examined macroscopically and microscopically.

Fate of 10 Porous Silicone Rubber Prostheses in the Inferior Vena Cava of Dogs

	Length of Graft		Fate of Graft When Killed
	in.	cm.	
Prosthesis in infrarenal vena cava	1 × 3	2.5 × 0.9	Patent at 7 months
	1 × 3	2.5 × 0.9	Clotted at 6 days (twisted)
	3 × 3	7.6 × 0.9	Clotted at 6 days
	3 × 1	7.6 × 1.9	Patent 2 years 2 months
	3 × 2	7.6 × 1.9	Clotted at 10 days
	4 × 1	10.2 × 1.3	Patent at 2 years 1 month
	4 × 1-1	10.2 × 1.6-1.9	Patent when died at 7 days
	3 × 3	0.9 × 7.6	Clotted at 7 days, retained swab
Prosthesis in supra-renal vena cava	1 × 3	1.3 × 7.6	Patent 1 year
	4 × 1	10.2 × 1.3	Patent at 8 months

Macroscopic Features (Fig. 2).—In every case there was a thin, firmly adherent peritoneal layer over the outside of the prosthesis. The interior of the tube was lined with a thin, smooth surface of presumptive endothelium. The silicone rubber fibres of the prosthesis could be seen shining through the endothelium, which was translucent and firmly attached to the wall.

Microscopical Features (Fig. 3).—There appeared to be a satisfactory ingrowth of tissue into the body of the prosthesis. The neointima was well marked and contained many fibroblasts, and there appeared to be a layer of flattened cells next to the lumen, probably endothelium.

COMMENT

The difficulty of getting prosthetic grafts to stay patent in the infrarenal vena cava is well known. Thus Steinman *et al.* (1966) reported a 7% patency rate with Teflon and Dacron grafts. Mitsuoka and Howard (1968)

found only one out of eight Teflon prostheses patent at three months. Similar figures (seven out of eight crimped Teflon tubes clotted in a few days) were obtained by Bower *et al.* (1960). No Dacron grafts were patent in the inferior vena cava of dogs in the series of Dale and Scott (1963). Similar results have been reported by Hambræus and Andersen (1962) and Todd *et al.* (1963).

The presence of an arteriovenous fistula improved the results of Mitsuoka and Howard (1968) to 60% patency at three months, and if the graft was prevented from collapsing by rigid rings in addition to the fistula then 80% of the prostheses were patent at three months.

The maximum length of graft implanted by the above authors varied from 1 in. (2.5 cm.) (Hambræus and Andersen, 1962) to 5 cm. (Bower *et al.*, 1960; Mitsuoka and Howard, 1968).

Against this rather gloomy background our results of five out of nine grafts patent in the infrarenal inferior vena cava and patency of the only suprarenal inferior vena caval

graft appear remarkable, particularly when it is remembered that no fistula or splint had been used.

No attempt at modifying the surface by heparin bonding had been made. The lengths of the prostheses were up to 4 in. (10 cm.).

It does appear that this material holds promise for human venous implantation. Such sites might be in the iliac or portal systems in certain examples of venous thrombosis and portal venous obstruction.

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FIG. 1.—Phlebogram showing inferior vena cava. The prosthesis is seen as a slightly narrowed area. A faint linear opacity parallel to and just outside the blood stream represents the prosthesis itself.

FIG. 2.—Graft at two years opened longitudinally to show the smooth lining membrane blending at the ends with the lining of the inferior vena cava.

FIG. 3.—Transverse section of silicone rubber inferior vena caval prosthesis $\times 110$. Clear oval spaces represent areas occupied by silicone rubber fibres. The lumen of the vessel is uppermost.