When nitrous oxide was substituted Paco₂ rose from 44-6 to 50-5 mm Hg. This difference is statistically significant (P <0-01). Full details of the blood gas changes are shown in the Table.

Discussion
Cardiac arrhythmias are a common occurrence during laparoscopy, especially when carbon dioxide is used to inflate the peritoneal cavity. These arrhythmias are almost certainly related to the high Paco₂ in conjunction with the use of halothane, but they may occasionally be due to reflex activity from the distending abdomen. They are sometimes seen when the Paco₂ is relatively low. There is little evidence, however, that these arrhythmias are harmful to the patient. The fear that they may progress to ventricular fibrillation or cardiac arrest would seem groundless (Scott, 1970) but it would seem that these are due to carbon dioxide embolus resulting from accidental insertion of the Verres needle into the pregnant uterus, no pressure-limiting device having been used during insufflation.

The arrhythmias most commonly seen in this series were fusion beats occurring after the P waves and causing bigeminy. This arrhythmia is often impossible to diagnose by palpation of the radial pulse as the extrasystoles occur only fractionally before the expected normally conducted beat. Little or no haemodynamic disadvantage is likely to accrue from this arrhythmia. Alexander (1971) described "nodal" arrhythmias during oral surgery which may be identical with those observed by us, but we would not consider them to be supraventricular.

Carbon dioxide has been chosen as the gas for peritoneal insufflation because of its high solubility. This ensures the rapid absorption of any remaining gas postoperatively and gives a degree of safety if, by mishance, the gas is injected intravascularly. However, nitrous oxide has advantages over carbon dioxide for this purpose. Cardiac arrhythmias are much less frequent and the respiratory drive is less pronounced owing to the lower Paco₂ that is produced. Our results indicate that the major cause of a rise in Paco₂ when carbon dioxide is used is due to absorption from the peritoneal surface. The splitting of the diaphragm which undoubtedly occurs is responsible for about 25 to 30% of the rise and, of course, still occurs if nitrous oxide is used. Nitrous oxide has a high solubility in plasma (68% of that of carbon dioxide) and the residual gas left in the abdomen will disappear quickly. It does support combustion, but as there is no question of the diathermy setting fire to the abdominal contents this is of no importance. Reduced respiratory drive compared with that seen with carbon dioxide gives a quieter field for the surgeon. Several hundred laparoscopies have now been carried out with nitrous oxide in this way without untoward incidents.

We wish to thank Professor R. J. Kellar for allowing us to study his patients. Miss E. McLachlan, Mr. A. McKinnon, and Mr. T. McFetters gave invaluable technical help. We are especially grateful to Dr. H. L. Marriott, St. Petersburg, Florida, U.S.A., and Professor Schamroth, Witwatersrand University, South Africa, for their valued opinions regarding the E.C.G. tracings.

References

Role of Venous Needle Hub in Extracorporeal Pressure Changes during Haemodialysis

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Summary
Certain types of stainless steel needles with metal hubs, and also a fistula set with projecting internal edges, were used at the venous end of the haemodialysis circuit and found to be associated with undesirable rises in extracorporeal pressure in 56 to 64% of dialyses. These increases in pressure are likely to be the result of platelet thrombus formation at the hub of the needle brought about by turbulent flow. The use of a plastic cannula and a stainless steel needle with a plastic hub, both of which have smooth internal surfaces, resulted in increases in pressure in only 4 to 12% of dialyses.

Introduction
Wide fluctuations of pressure in the extracorporeal system have been observed during maintenance haemodialysis. Such pressure increases inadvertently promote ultrafiltration and can result in the uncontrolled removal of extracellular fluid. Our findings suggest that the properties of the venous needle hub may significantly influence the incidence of pressure increases.

Method
Five 14 gauge needle assemblies were tested (Fig. 1). The first (alloy) was the Bardic needle (No. 1614 EPS—alloy) with an aluminium alloy hub. The second (alloy-modified) was basically the first needle altered locally so as to create a smooth internal incline at the hub. The third (plastic hub) was the Bardic plastic hub needle (No. 1614 EPS—plastic). The fourth (fistula set) was the Travenol arteriovenous fistula set (No. AKM0276), which has a shaft set into a plastic (nylon) hub attached to plastic tubing (approximately 34 cm long and 2-8 mm internal diameter). The thin-walled stainless steel shafts of the needles were all siliconized. The fifth assembly (cannula) was the 14 gauge Argyle Medicut, which has an extruded polypropylene cannula with partly siliconized, smoothly-curving luminal contours between tip and base, there being no sharply demarcated hub. Although all five needle assemblies were nominally 14 gauge, indicating that the external diameters of the shafts...
were between 2.00 and 2.12 mm (British Standard 3387:1962), the haemodynamically important internal diameters vary more (Table I).

The trial needle assemblies were used in the return vein only. The plastic hub needle was used throughout the trial for the arterial end. Except for the fistula set, the needles and the cannula were all connected to the blood return (venous) line by an 8-cm length of plastic extension tubing (Stewart et al., 1969).

![Fig. 1—Types of needle assemblies tested: 1a, alloy; 1b, alloy-modified; 2, plastic hub; 3, fistula set; 4, cannula. Except for 3, each is shown with the extension tube attached.](image)

TABLE I—Incidence of Increases in Venous Pressure

<table>
<thead>
<tr>
<th>14 Gauge Needle Assembly</th>
<th>Shaft Diameter*</th>
<th>Shaft Length§</th>
<th>No. of Dialyses Assessed</th>
<th>Increased Pressures</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic hub</td>
<td>2.10</td>
<td>1.83</td>
<td>47</td>
<td>49 ± 11</td>
<td>54 ± 14</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Cannula</td>
<td>2.10</td>
<td>1.83</td>
<td>47</td>
<td>47 ± 15</td>
<td>60 ± 24</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>Alloy</td>
<td>2.10</td>
<td>1.83</td>
<td>47</td>
<td>49 ± 10</td>
<td>54 ± 14</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Alloy-modified</td>
<td>2.10</td>
<td>1.83</td>
<td>47</td>
<td>47 ± 15</td>
<td>60 ± 24</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>Fistula set</td>
<td>2.00</td>
<td>1.55</td>
<td>47</td>
<td>47 ± 15</td>
<td>60 ± 24</td>
<td>P &lt; 0.05</td>
</tr>
</tbody>
</table>

*Supplied by manufacturer on request.
†Measured 15 mm proximal to tip.
‡Measured at tip (minimum internal diameter).
§Measured from end of metal within hub to near-end of bevel at tip.

The five patients studied had Brescia-Cimino fistulae and all were dialysed in two sessions for a total of 16-24 hours per week. Ten plastic hub needles and five of each of the other varieties were allocated to each patient in a predetermined but random order.

The dialysis system consisted of a monitored pump dialysate supply (Dylade Model B Series 2) with disposable coil units (Travenol Ultra-fllo 100) enclosed in a steel container (Wakefield et al., 1970).

Heparin (mucous B.P.) (25,000 units in 500 ml of 5% w/v dextrose in water) was infused continuously into the arterial line at a rate of about 25 ml per hour. Half-hourly clotting times, on samples taken proximal to the point of heparin infusion, were maintained between 20 and 45 minutes.

The "venous pressure" gauge of the Dylade pump-monitor was used to record pressures hourly from the air-bubble trap. The blood pump rate was fixed at 180 ml per minute. An increase in venous pressure was defined as a rise exceeding 50% of the initial pressure for that dialysis. Whenever venous pressures in excess of 100 mg Hg were observed the needle was repositioned in the vein. If this failed to reduce the pressure the needle was irrigated with heparinized saline. If both manoeuvres failed the venous pressure was reduced by decreasing the blood pump rate. As a last resort the needle assembly was replaced with the plastic hub type which never required changing because of high pressures. Dialyses in which the needle was changed, or which resulted in a burst coil, were excluded from the trial and repeated.

Results

Incidence of Venous Pressure Increases (Table I).—Use of the plastic hub needle and the cannula was associated with a 4% and 12% incidence of increases respectively, compared with a 56% to 64% incidence for the other needles (P < 0.001). There was some individual patient variation with the incidence of increases per patient ranging from a minimum of 17% to a maximum of 43% irrespective of the needle assembly used (P < 0.05 for the maximum difference).

Mean Venous Pressures during Dialysis (Table II).—The mean of the initial venous pressure on beginning dialysis was significantly higher with the fistula set (68 mm Hg) than with the other needle assemblies (47 to 49 mm Hg) (P < 0.001). A comparison of the mean maximum pressures recorded for each type of needle assembly showed that the value for the plastic hub needle was significantly lower (P < 0.001) than the value for the alloy needles or the fistula set, and it was also probably significantly lower than for the cannula (P < 0.05). Differences in the maximum pressures recorded with the alloy needles and fistula set were not significant. Modification of the alloy hub made no difference either to the incidence of pressure increases or to the mean venous pressure levels at the onset of, or during, dialysis.

Blood Clot Formation.—We failed to establish a definite correlation between demonstrable clots, found on reaming-out the needle hub immediately after dialysis, and the higher venous pressures. Clots were found at only 7 (13%) out of 54 examinations of the needle hubs. In six of the seven instances high venous pressures had been recorded. On 47 (87%) occasions the needle was "clear," despite a 36% incidence of recorded venous pressure increases.

Discussion

Nidus et al. (1971) showed the haemodynamic importance of the internal diameter and length of the needles and the tubing of fistula sets. The higher initial venous pressure found with the fistula set reflects influences on blood flow before any thrombus formation has taken place, and could be explained by the comparatively narrower bore and longer shaft of the needle, the narrower and longer plastic tube or the haemodynamic characteristics of the hub, or a combination of these. The data do not permit particularization.

The progressive increases in pressure often noted during dialysis are probably the result of platelet thrombus formation. Blood platelets are known to play a key part in the beginning of thrombus formation in areas of high-velocity blood flow (Jørgensen et al., 1967; Mustard and Packham, 1970). Adequate
Acute Renal Failure and Open Heart Surgery

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Summary

A retrospective study of 428 open heart operations showed the incidence of mild and severe renal failure to be 28% and 47%, respectively. The mortality rate was 38%, in the mild cases and 70%, in the severe cases. Only half of the patients whose death was associated with renal failure showed macroscopic or microscopic renal lesions at necropsy. The patients who developed renal impairment had significantly higher mean preoperative blood urea (40 mg/100 ml) than the non-renal-failure cases (33 mg/100 ml). Periods of perfusion over 60 minutes, mean perfusion pressures below 80 mm Hg, and multiple valve replacement operations also increased the incidence of renal failure. There was no statistical correlation between the age of individual patients, the degree of cooling, and postoperative blood urea values. There was no evidence to suggest that frusemide or mannitol separately or together influenced the development of renal failure. Peritoneal dialysis was preferred for initial treatment of patients with severe renal failure, and haemodialysis was required only in special cases.

Introduction

Acute renal failure is a serious complication of operations which involve total body perfusion, but the reported incidence of the complication has varied widely between 2-0 and 13-5% (Rand et al., 1963; Sawrey et al., 1963; Norman et al., 1964; Yeh et al., 1964; Kalitilake and Shackman, 1965; Porter et al., 1966, 1967).

The present report is based on a retrospective study of 428 open heart operations with total body perfusion carried out on 267 male and 161 female patients aged 5 to 65 years during the period January, 1968 to June 1970 (Table 1).

The Melrose rotating disc oxygenator was used in 317 cases and Temptrol or Rygg bag bubble oxygenators in 111. The oxygenators were primed with a mixture of 1,500 ml of whole blood (acid citrate dextrose), 500 ml of Hartmann’s solution, and 1,000 ml of 5% dextrose; sodium bicarbonate 60 mEq was added whenever the body surface exceeded 1.3 m². Flow rates...