small but definite risk of serum hepatitis. The doppler ultrasound method is convenient and results are rapidly obtainable (Evans, 1970), but its application is limited to the detection of thrombi obstructing large vessels from the level of the popliteal fossa upwards into the thigh (Evans, 1970). The technique that we have described may be performed with minimal inconvenience to the patient and results are available in 30 minutes.

The radiopharmaceutical ^{131}I -M.A.A., which has been in common use as a lung scanning agent for about 10 years, has been shown to be safe at a dose three times higher than that used in this procedure. From the known affinity of M.A.A. particles for venous thrombi, both in vitro and in vivo (Webber *et al.*, 1969), it seemed likely that deep venous thrombosis would be associated with a retention or delayed clearance of M.A.A. particles from the limb after intravenous injection into the foot. It seemed possible that a simple scintillation detector system would be adequate to detect this altered clearance pattern.

The results obtained in our patients showed two distinct patterns of clearance, rapid and delayed. Definitive and easily applied criteria were chosen which separate these two clearance patterns. These patterns when compared with phlebography showed a high degree of correlation between delayed M.A.A. clearance and the presence of thrombi (86%), and between rapid M.A.A. clearance and the absence of thrombi (90%). Correlation of the site of thrombi, however, whether above or below the knee, showed less agreement between the two methods. An explanation for this discrepancy in localization is not readily evident. It may, however, be due to the known insensitivity of phlebography or to the relative insensitivity of both methods.

The test as performed here requires the use of the other leg as a control, and so evaluation of both legs simultaneously is not

possible. This is a serious limitation of this technique, as deep venous thrombosis is frequently bilateral. Attempts are being made to eliminate the use of the control leg by using another reference source—for example, a postinjection blood sample.

These preliminary studies indicate that this new isotope test is a safe, convenient, rapid, and accurate method of detecting thrombosis in leg veins, and thus it deserves further evaluation.

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MEDICAL MEMORANDA

Potassium Overdosage: A Potential Hazard of Non-rigid Parenteral Fluid Containers

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The use of non-rigid plastic parenteral fluid containers is becoming increasingly widespread in hospital practice. Recently the contamination of the contents of such containers by a plasticizer used in their manufacture has been reported (Jaeger and Rubin, 1972). The two cases reported here, of probable transient hyperkalaemia resulting from the addition of a supplement of potassium chloride to such a container, suggest a further potential hazard. Experimental evidence is offered to explain why this may have occurred.

Case Reports

Case 1.—A 30-year-old woman was treated with parenteral fluid therapy and nasogastric suction for suspected subacute intestinal obstruction. Her serum potassium on admission was 3.8 mmol/l.

Satisfactory progress followed maintenance on normal saline (159 mmol/l) for eight hours at a rate of 250 ml an hour. A supplement of potassium chloride solution (13 mEq K⁺ in 5 ml) was injected into the dependent injection side-arm of the intravenous plastic fluid container (Viaflex 500 ml, Baxter Laboratories of Canada Ltd.). After about 10 minutes she became unconscious and clonic contractions of the right side of her body were observed. The radial pulse and blood pressure were unrecordable. Within five minutes she had fully recovered.

Case 2.—A 34-year-old man was similarly given parenteral fluid therapy for suspected intestinal obstruction. The serum potassium on admission was 3.9 mmol/l. Normal saline (500 ml) was infused at a rate of 300 ml an hour for three hours. A supplement of potassium chloride was added to the saline as in the previous case. After 10 minutes he complained of severe pain at the infusion site. He rapidly became restless, pale, and clammy and lost consciousness. A grand-mal convulsion lasting 30 seconds followed. Within 10 minutes he had made a complete recovery.

In each case the infusion was immediately stopped. Samples of the infusion fluid and of ampoules of potassium chloride belonging to the same batch were sent for bacteriological and biochemical analysis. No irregularity was found. It was thought that inadequate mixing of the injected potassium solution may have resulted in a transient hyperkalaemia which subsequently gave rise to the clinical presentation.

Experimental Method and Results

A half-litre of normal saline in a bottle and in a plastic container were arranged for infusion in the normal way. Potassium chloride solution (13 mEq K⁺ in 5 ml) was injected with a plastic syringe, over 10 seconds, through the bottle bung and

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through the dependent side-arm of the plastic container. The infusions were then started at a rate of 5 ml a minute and serial 15-ml aliquots were collected for potassium estimation. The experiment was repeated after adding a blue dye to the potassium supplement. Attempts were made to mix the solutions in the flexible container while it hung in the position normally used for infusion and with the container inverted before injection.

Comparative potassium concentrations in the outflowing solutions are shown in the table. It is clear that a high transient effluent concentration follows injection of potassium chloride into the plastic container in its normal position. This was not recorded after a similar injection into the glass bottle or into the plastic container inverted before injection.

Potassium Concentration (mmol/l.) in Serial Aliquots after Injection of 5 ml Potassium Chloride Solution (13 mEq) into 500 ml N. Saline

Serial 15 ml Aliquots	500 ml N Saline in Glass Bottle	500 ml N Saline in Plastic Container	Plastic Container Inverted Before Injection of K ⁺
1	5	0	0
2	44	505	10
3	44	930	26
4	29	180	26
5	26	22	27
6	26	4	26

FIG. 1—Pooling of dye at base of container.

FIG. 2—Thorough mixing of dye when injected into inverted container.

After injection into the plastic container the dye was shown to pool at the container base and to flow unmixed into the infusion tubing chamber (fig. 1). Attempts to mix the dye by squeezing the plastic container while in the position of function were not effective. Such manipulations tended to pump the dye into the infusion chamber. Injection with the plastic container inverted and the injection side-arm uppermost resulted in a thorough mixing of the dye (fig. 2).

Comment

The symptom complex described in these two cases was consistent with transient hyperkalaemia (Weiner and Epstein, 1970). The maximum infusion rate of potassium chloride in solution is generally accepted to be that which will provide 20 mEq of potassium an hour (Blacow, 1972). From the experiments carried out it appears that injection of potassium chloride solution into a flexible plastic parenteral fluid container leads to pooling of the injected solution and to a hyperkalaemic bolus. The total dose of potassium supplement (13 mEq K⁺) would thus be given in the first 60 ml of infusion. At an infusion rate of 5 ml a minute the total dose would be delivered within 12 minutes of starting the infusion. The effects produced were quite marked in relatively fit young patients, and the possible consequences in older or less fit patients may be more serious.

Poor mixing of the injected solutions is perhaps an inherent property of the flexible plastic container, possibly potentiated by both the dependent position and the length of the injection side-arm.

The manufacturers indicate in their literature distributed to hospital pharmacies that inversion of the containers followed by agitation is desirable when adding high-density solutions to their products (Travenol Laboratories Inc., 1972). This may not be generally appreciated, however, and no such warning appears on the container or its package. This point should be noted in view of the increasingly widespread use of these flexible plastic parenteral fluid containers.

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