CITRATE INTOXICATION FOLLOWING A RAPID MASSIVE BLOOD TRANSFUSION

BY

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The technique of rapid intravenous transfusion has become routine in the treatment of massive haemorrhage and severe shock and has so far not resulted in ill effects.

The following case is of interest in that the rapidity of transfusion of a large volume of bank blood would appear responsible for an instance of ventricular fibrillation.

CASE REPORT

A woman of 27 weighing 60 kg was submitted to surgery for Fallot's tetralogy. She had been an invalid all her life and was unable to walk more than a few steps. At operation dilatation of the pulmonary valve and punch excision of an infundibular stenosis was performed via the left pulmonary artery. This operation was uneventful apart from some considerable blood loss both from the pulmonary artery and from some pleural adhesion at the apex of the left lung. During the operation 1080 ml of blood were given, the second bottle still running on her return to the ward.

Two and a half hours later, as she was being sat up, the intercostal drain suddenly delivered 440 ml of almost pure blood and continued so to drain for the next 6 hours. Altogether in the 10 hours following her operation 1080 ml of blood were given, the second bottle still running on her return to the ward.

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Her general condition at this time remained good; the blood pressure and pulse being steady, it was decided that the chest should be re-opened. On return to the theatre, however, her general condition had deteriorated considerably. The pulse was practically impalpable and the blood pressure unrecordable. This situation responded well to a rapid transfusion of blood with a Martin pump and the chest was re-opened. After removing a large quantity of fresh clot the heart was observed to be in normal rhythm, in which state it remained for the next 20 minutes.

During this time a large quantity of blood was transfused, 2700 ml in all, and the general condition was improving steadily. No obvious bleeding point was found; the pulmonary artery was secure but there was considerable oozing from the raw lung surface at the left apex.

Twenty minutes after the commencement of the operation the heart, which had been in normal rhythm, suddenly entered ventricular fibrillation. The use of a defibrillator and intracardiac neostigmine failed to restore normal rhythm, but as a large quantity of blood had been transfused, citrate intoxication was considered. 2 ml of 10 per cent calcium chloride were given intracardially and the heart was immediately restored to normal rhythm.

Although cardiac massage had been maintained throughout the period of fibrillation, and despite the use of hypertonic sucrose solution, the patient died 48 hours later as a result of cerebral damage, presumably accounted for by the 8-minute period of fibrillation.

DISCUSSION

The sudden change from normal rhythm to ventricular fibrillation would seem worthy of comment. The circulation had been restored and was maintained by rapid infusion. At all times a high concentration of oxygen was administered, and there had been no undue handling of the heart. The reversal to normal rhythm following calcium chloride is significant. During the previous 20 minutes 2700 ml of bank blood had been infused. This fluid contained 2100 ml of blood, 500 ml of 2 per cent disodium citrate and 50 ml of 15 per cent dextrose solution. Thus 10 gram molecules of disodium citrate had been infused in 20 minutes. Mollison (1951) states that the harmful effect of citrate infusion will not be seen unless the dosage exceeds 250 mg/kg/hour, and in this case approximately 500 mg/kg/hour had been given.

Shafer (1936) attributes the toxicity of citrate to its ability to lower the free Ca ions thus producing paralysis of the cardiac vagus, and Shafer and Crisman (1936) have shown that this effect takes place more readily in animals that have been bled: so that protection may be obtained by the prophylactic use of calcium.

During the storage of blood, potassium passes out of the cells into the plasma and after storage
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for 10–14 days the level of potassium in the plasma of stored blood is between 80 and 100 mg/100 ml (Loutit, Mollison and Young, 1943). The blood used in this case was all reasonably fresh and under 10 days old and approximately 900 mg of potassium were therefore given in 20 minutes. DeGowin, Hendin and Harris (1940) administered 473 mg of potassium in 12 minutes and were unable to demonstrate electrocardiographic changes, and only a small rise in serum potassium. It would seem, therefore, that the potassium content of the blood transfused was not unduly high.

In replacement therapy in infants for haemolytic disease of the newborn, it is customary to remove part of the supernatant fluid and to give calcium in order to minimize these toxic effects from the stored blood (Mollison, 1951), and it would seem a useful precaution, when massive rapid transfusion is contemplated, that a source of free calcium ions be used as a prophylactic measure against the occurrence of citrate toxicity. Ten per cent calcium gluconate solution provides such a free source and when such transfusions are given, may be added to the blood being transfused.

In paediatric practice 1 ml per 100 ml of blood transfused is added, but in these larger transfusions 10 ml of calcium gluconate per 1500 ml of blood transfused is an easy way of providing this free source of calcium ions.

SUMMARY
A case of citrate toxicity following rapid massive whole blood transfusion is described.

It is suggested that a source of free calcium ions be provided when such a transfusion is used.

REFERENCES

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vascular effects can be easily controlled. The only circumstances in which respiratory depression has interfered seriously with the induction and maintenance of adequate anaesthesia have occurred when respiratory depressants such as papaveretum or the longer acting barbiturates have been given pre-operatively.

The Boyle vaporizer has already been condemned as dangerously obsolete when used with trichloroethylene (Gilchrist and Goldsmith, 1956). When I started to use Fluothane in this vaporizer I must confess that I was at times rather disconcerted by the sudden and profound changes in the depth of anaesthesia which often followed alterations in the lever position of as little as 0.3 cm. With increasing experience, however, it soon became possible satisfactorily to control the vaporizer and since then, both in the operating theatres and in the recovery rooms, Fluothane has consistently given me results incomparably better than any I have ever obtained with other agents and techniques; at the time of writing over 1,300 patients have been anaesthetized, the operations and anaesthetic technique being essentially similar to those already reported (Johnstone, 1956) with the exception that pure oxygen has been used in the low flow technique. I am convinced, however, that, if accidents and misconceptions are to be avoided, it will be necessary to introduce a standard vaporizer. This means vaporizers so carefully made and delicately calibrated that they can be changed without loss of accuracy.

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REFERENCES