MAGNESIUM INTOXICATION: AN UNCOMMON CAUSE OF PROLONGED CURARIZATION

Case Report

A. J. C. de Silva

SUMMARY
In many parts of the world magnesium sulphate is still in use for the treatment of pre-eclamptic toxæmia and eclampsia. This report is of a patient with pre-eclamptic toxæmia who failed to breathe adequately after anaesthesia for Caesarean section. Tubocurarine had been administered and it is suggested that the neuromuscular block was potentiated by a high magnesium concentration in the extracellular fluid, resulting from magnesium sulphate therapy.

CASE REPORT
A 30-year-old primigravid patient, 34 weeks pregnant, was admitted to hospital with severe oedema of the face and feet and an arterial pressure of 170/110 mm Hg. She had gross albuminuria. Her weight was 88.4 kg, having increased by 3.5 kg in the preceding 2 weeks. Pre-eclampsia was diagnosed and she was treated with: rest in bed, diazepam 10 mg i.m. 6-hourly, and magnesium sulphate 5 g i.m. followed by magnesium sulphate 20 g/L given as an intravenous infusion at the rate of 50 ml/hr. After 24 hours, artificial rupture of the membranes was performed and an infusion of syntocinon 20 units/L was commenced. Caesarean section was performed 3 hours later on account of foetal distress.

The patient was preoxygenated and anaesthesia was induced with thiopentone 300 mg followed by suxamethonium 75 mg. An 8.5-mm cuffed endotracheal tube was inserted and respiration was controlled using a mixture of 33% oxygen in nitrous oxide until respiratory activity started to return, when tubocurarine 30 mg was injected and controlled ventilation continued. Pethidine 50 mg and ergometrine 0.25 mg were injected i.v. after the birth of the baby. The operation lasted 1 hour because of the removal of a dermoid cyst of the right ovary. The blood loss was estimated to be less than 1 L and no blood was transfused. The arterial systolic pressure remained at about 170 mm Hg throughout the procedure and there was no important change after the injection of ergometrine 0.25 mg. Following closure of the abdominal wall, atropine 1.2 mg and neostigmine 2.5 mg were injected to reverse the effect of the tubocurarine. Soon afterwards the patient's breathing became spontaneous although it was shallow and rapid; about 5 minutes later she showed signs of waking and intolerance of the endotracheal tube. Exubration was performed and the patient was moved to the recovery room for further observation.

Fifteen minutes after the end of the operation breathing was still shallow and the patient complained of weakness and inability to move her arms and legs. On command, she could not raise her head off the pillow. There was a marked tracheal tug and the deep tendon reflexes were absent. Her arterial pressure was 160/90 mm Hg and her pulse rate was 110/min. Oxygen (4 l/min) was administered from a nasal catheter and there was no cyanosis. The clinical picture was that of incomplete reversal of a neuromuscular blocking drug. Treatment with tetrahydroaminacrine 30 mg, atropine 0.6 mg and calcium gluconate 10 ml in a 10% solution in water did not improve the patient's breathing.

In the absence of any factors that could account for the failure of proper reversal of tubocurarine, an increased magnesium blood level was considered and a specimen of arterial blood was sent for biochemical analysis. The results were: sodium 134 m.equiv/L; potassium 4.0 m.equiv/L; magnesium 7.0 m.equiv/L; calcium 7.8 m.equiv/L; pH 7.24; PaO2 75 mm Hg; PaCO2 31 mm Hg; standard bicarbonate 14 m.equiv/L; base excess —13 m.equiv/L.

Because of the metabolic acidosis sodium bicarbonate 200 m.equiv. was infused intravenously. In view of the very high level of serum magnesium, potentiation of tubocurarine by magnesium was presumed. The patient's breathing was observed, but no active treatment was given, as there was a steady improvement in her breathing and 3 hours after the commencement of the operation she could move her arms and legs and could lift her head off the pillow; there was no tracheal tug. Further recovery was uneventful and the serum magnesium concentration measured later the same day had decreased to 5.7 m.equiv/L and on the following morning it was 2 m.equiv/L.

DISCUSSION
On clinical grounds this patient's condition was assumed to be the result of neuromuscular blockade. The response to a nerve stimulator would have been of value, not only in establishing the diagnosis but also in assessing the subsequent improvement. Unfortunately, no peripheral nerve stimulator was available.

Many factors contribute to the failure of proper reversal of tubocurarine and similar drugs. These include electrolytic abnormalities, circulatory impairment, changes in pH (Feldman, 1963), the use of volatile anaesthetic agents and certain antibiotics, and myasthenia gravis. In this patient the obvious

A. J. C. DE SILVA, M.B.B.S., Department of Anaesthesia, Waikato Hospital, Private Bag, Hamilton, New Zealand.
Abnormalities were the very high serum magnesium concentration (normal 1.2-2.5 m.equiv/l.) and the metabolic acidosis. It is possible that the acidosis was secondary to hypoxia occurring before the administration of oxygen.

Magnesium intoxication causes a neuromuscular block which has clinical features similar to that of curare. Del Castillo and Engbaek (1954) have shown that this is the result of:
(1) a decrease in the amount of acetylcholine liberated at the neuromuscular junction;
(2) a decrease in the sensitivity of the endplate to the depolarizing action of acetylcholine;
(3) a decrease in the excitability of the muscle membrane.

Calcium, on the other hand, stimulates the release of acetylcholine. A fall in the Ca++/Mg++ ratio depresses acetylcholine release and the two ions behave as though competing for some reactive site in the membrane (Cookson and Paton, 1969). Feldman (1963) suggests that the effect of an increased magnesium concentration may be additive to that of curare and similar drugs. This view has been supported by Giesecke et al. (1968), using the cat sciatic nerve/gastrocnemius muscle preparation. Ghoneim and Long (1969), however, using the isolated rat phrenic nerve/diaphragm preparation concluded that magnesium potentiated the action of tubocurarine, suxamethonium and decamethonium. Their study was prompted by a failure of antagonism of tubocurarine in two patients receiving magnesium sulphate therapy. They argued that magnesium ions decreased the amount of acetylcholine released at the motor nerve ending, thus freeing more receptors for occupation by tubocurarine. Similarly, desensitization of the postsynaptic membrane would be expected to be enhanced by depolarizing neuromuscular blocking drugs. A serum magnesium level of 7.0 m.equiv/l. was found in both this patient and in one of the patients reported by Ghoneim and Long. This suggests that it is at about this concentration that the action of tubocurarine may be potentiated by magnesium.

Acknowledgements
I wish to thank Drs J. B. Cotton and D. J. Ekanayake, Consultant Anaesthetists, for advice in the preparation of this manuscript, and Miss L. J. Douglas, Librarian, for her assistance with this article.

References

6th World Congress of Anaesthesiologists

On account of the successful journey to the World Congress of Anaesthesiologists in Japan in 1972, the Belgian Professional Association of Anaesthetists will be organizing three different tours on the occasion of the 6th World Congress to be held in Mexico in April, 1976.

For further information please apply to Dr Et. Troch, Marcel de Backerstraat, 2 2070 Ekeren, Belgium.