

as heart rate. Respiration is not depressed, and laryngeal and pharyngeal reflexes are preserved in doses used clinically.^{7,8} The onset of analgesia and anaesthesia is more rapid with Ketamine than with phencyclidine. However, Ketamine is less potent than phencyclidine on a mg/kg dose. Muscle tone is often well preserved, and may in fact be increased slightly.

Ketamine crosses the placenta rapidly, but does not appear to have any toxic effect on the foetus, as shown by tests in dogs.⁹ Total body analgesia may be produced without loss of consciousness with low dosages; the eyes remain open and some chewing movements may be present. Hallucinations occur occasionally and may be extremely vivid.

METHOD

Premedication

All the patients had atropine given either by the intramuscular route about an hour before or by the intravenous route just before induction of anaesthesia.

Induction and maintenance with Ketamine

All the patients received an induction dose of 1-1.25 mg/kg intravenously. Subsequently, patients were maintained on an intravenous infusion containing Ketamine ($\frac{1}{2}$ mg/ml in 5 per cent dextrose). The amount of Ketamine required to maintain analgesia and anaesthesia was determined by titrating the rate of infusion of the drip to the response of the patient; this resulted in a rate between 1.5 to 2 mg/kg/hour. In some of the patients, especially children, intermittent intravenous injections of Ketamine were given every 15 minutes in preference to the continuous infusion in order not to overload the patient with too much fluid.

Supplementary agents

Patients who required controlled respiration during the procedure were given intravenous d-tubocurarine to produce muscle relaxation. In these patients, and also in others when it was deemed essential for the safety of the patient, endotracheal or nasotracheal intubation was carried out using suxamethonium.

In the six patients in whom anaesthesia was observed to be inadequate for surgical manipulation, 70 per cent nitrous oxide in oxygen was given in addition to Ketamine. The use of nitrous oxide in these cases helped to prevent movements of the patients and also kept the dose of Ketamine within the prescribed amount stated in our methodology.

RESULTS

Table I shows the types of surgery performed on the patients in this series. There were 100 patients altogether, including ten children. In 94 of these patients the anaesthesia was satisfactory and provided good operating conditions. In six patients whose requirements of Ketamine exceeded the standard dose needed to prevent movements during surgery, 70 per cent nitrous oxide in oxygen was given. The use of nitrous-oxide-oxygen mixture helped to minimize the dose of Ketamine in these six patients.

TABLE I
TYPE OF SURGERY

Elective caesarean section	18
Emergency caesarean section	17
Abdominal	12
Thoracic	4
Neurosurgical	10
Ear, nose, and throat	14
Maxillo-facial	10
Orthopaedic	15
Total	100

It was found that during surgery there was nearly always an increase in pulse rate and blood pressure. The increase in blood pressure was of the order of 15-30 mm Hg systolic and 5-15 mm Hg diastolic. Table II shows the incidence and severity of this rise. It was also observed that respiration was not depressed with Ketamine. In 20 adult patients in whom the respiration was monitored with a Wright's manometer, the minute volume was sometimes up to 10 litres.

TABLE II
EFFECT ON BLOOD PRESSURE

Number of patients	Blood pressure rise (%)
26	0-10
68	10-25
6	over 25
100	

Table III shows the incidence of unwanted side effects in the patients in this series. Twelve patients had some limb movements during surgery, while 15 patients had very rigid limbs. When the dosage of Ketamine was increased by running the drip faster, the limb movements were brought under control in six of these twelve patients without exceeding the standard dose. In the remaining six patients, nitrous-oxide-oxygen mixture was required to prevent these movements completely.

TABLE III
UNWANTED SIDE EFFECTS

Limb movements	12
Limb rigidity	15
Hallucination	2
Nausea/vomiting	4
Nystagmus	6
Restlessness	5

POSTOPERATIVE COMPLICATIONS

Table III also shows the complications that were observed postoperatively, such as restlessness, hallucination, and vomiting. Restlessness was observed in five of

the patients. These include a one-year-old child who had decortication, a 49-year-old man who had drainage of liver abscess, and a 28-year-old soldier who had debridement of gunshot wound of the head.

Hallucination was observed in only two of the patients, and one of these was also restless in the postoperative period. In describing his hallucination, one of the two patients said that it was a strange frightening experience. He was surrounded by many faces of different shapes and sizes all gazing at him in a room with a most intense, brilliant, and colourful illumination. The hallucination in the second patient was not as frightening as it was in the first patient. In this series only four of the patients had nausea or vomiting postoperatively.

DISCUSSION

From this series, it would appear that Ketamine is a safe and potent anaesthetic agent, and is especially so in poor-risk patients. In very ill patients where general or regional anaesthesia may be considered unsafe or unsuitable, Ketamine may be found to be especially useful.

For example, one of the patients in this series was a woman with very severe kyphoscoliosis and who also had an acute exacerbation of chronic bronchitis at the time that she developed obstructed labour. She was not suitable for either general anaesthesia or regional analgesia. She was managed very well under Ketamine anaesthesia, with additional oxygen administered through the face mask.

In very ill patients where it may be desirable to use 100 per cent oxygen and still maintain anaesthesia, as happened with the two children who had palliative operations (Cooley Waterston and Blalock respectively) for Fallot's tetralogy, there may be a good indication for the use of Ketamine anaesthesia. The additional use of curare will ensure that there is no movement of the patient during this delicate operation. With this technique it was possible to maintain a Pa_{O_2} of 77.5 mm Hg as against the preoperative value of 25 mm Hg in these two patients. This technique was also very useful in a child who had haemoptysis preoperatively and in whom a one-lung anaesthesia was not achieved. When he developed haemoptysis during his lobectomy operation, frequent tracheobronchial suction and controlled respiration with oxygen using curare helped to keep him alive.

In this series, Ketamine has been found to provide a greater margin of safety than conventional anaesthesia alone.

It is often difficult to know the exact amount of Ketamine that would be required to prevent movements of the limbs during surgery. When such movements do occur it is necessary to increase the rate of administration of Ketamine. In six patients where it was impossible to prevent such movements without exceeding the standard dose, the administration of 70 per cent nitrous oxide in oxygen stopped the movements and helped to reduce the amount of Ketamine required.

Hallucination was found to occur in only two patients in this series. It would appear that the incidence is much less than after phencyclidine.

Domino *et al.*⁷ found that there was a considerable increase in blood pressure with Ketamine administration. In the present series it was observed, however, that the increase in blood pressure and pulse rate was only slight. Ninety-four per

cent of the patients in this series had a rise in blood pressure of not more than 25 per cent of the preoperative level. It would appear from our findings that this effect on blood pressure should not preclude its widespread clinical acceptance. However, great care should be exercised when using the drug on hypertensive patients, and it may be wise to avoid its use on such patients entirely.

SUMMARY

Ketamine (CI-581) is a derivative of phencyclidine. It produces analgesia and anaesthesia very rapidly, has a short duration of action, and is rapidly metabolized in the body. For this reason it has been used for continuous intravenous infusion or intermittent intravenous injections. It increases blood pressure and heart rate slightly. Respiration has not been found to be depressed during its use.

A report of the use of Ketamine in 100 consecutive patients is presented. Many of these patients were considered poor risks, and it is felt that Ketamine provided a greater margin of safety than conventional anaesthesia would have done. The dose used for induction was 1-1.25 mg/kg, while the maintenance dose was 1.5-2 mg/kg/hour.

RÉSUMÉ

La Kétamine (CI-581) est un dérivé de la phencyclidine. Elle produit l'analgésie et l'anesthésie très rapidement, son action est de courte durée et elle est métabolisée rapidement. C'est pourquoi on l'a utilisé en perfusion veineuse continue ou en injections intraveineuses intermittentes. Elle produit une légère élévation de la pression sanguine et du rythme cardiaque. On n'a pas observé de dépression respiratoire pendant son utilisation.

On présente un rapport sur l'usage de la Kétamine pour 100 cas consécutifs. Plusieurs des malades étaient considérés comme de mauvais risques et il semble que la Kétamine a procuré une marge de sécurité supérieure à celle de l'anesthésie conventionnelle chez ces malades. La dose utilisée pour l'induction a été de 1-1.25 mg/kg alors que la dose d'entretien a été de 1.5-2 mg/kg/heure.

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