Where there is no anaesthesiologist: the many uses of ketamine

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In developing countries the surgeon is often confronted with situations in which surgery is required urgently but in which neither anaesthesiologist nor trained anaesthetist is available. In some instances the surgeon may resort to conduction anaesthesia in its varying forms, eg spinal, nerve block, or local. In many cases, however, conduction anaesthesia is neither appropriate nor available. Often the demands on the time of the surgeon and the comfort of the patient are better served if the patient can be put to sleep.

This paper reports on the use of ketamine in our hospital, a rural mission hospital in the southern extremity of Bangladesh. We have given ketamine to approximately 8000 patients over a period of 15 years. We have had only one anaesthetic death and that death could have been avoided. We have found ketamine to be a most valuable anaesthetic for a great variety of cases and present a short review.

PHARMACOLOGY AND PHYSIOLOGY

The ketamine molecule closely resembles that of phencyclidine, used by members of the drug culture as an hallucinogen. Ketamine is metabolized largely in the liver. It produces what is known as a 'dissociative' anaesthetic state which has been described as a functional and electrophysiological dissociation between the thalamo-neocortical and the limbic systems. It produces a unique anaesthetic state resembling catalepsy in which the eyes may remain open with a slow nystagmic gaze, the corneal and light reflexes remaining intact. Pharyngeal reflexes remain intact or hyperactive. There may be some muscular hypertonus and minor bodily motion unrelated to painful stimuli.

Some patients will report psychic sensations when emerging from ketamine anaesthesia. These are usually reported as changes in mood, sensation of floating, vivid dreams, and occasional frank delirium. The hallucinations tend to occur more in women than in men. Interestingly, the hallucinations experienced by women receiving ketamine for delivery or caesarean sections tend to be predominantly pleasant[1,2]. In other patients, the majority of the hallucinations are also pleasant, though some will be unpleasant. The incidence of hallucinations can be greatly decreased by the use of diazepam, preferably as part of the preoperative premedication or just before emergence[3–7]. We feel it is also helpful not to stimulate the patient during the emergence phase, though there is dispute about this point.

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Ketamine increases pulmonary artery pressure, right ventricular stroke work, arterial blood pressure, and heart rate. This is apparently due largely to direct stimulation of central nervous system structures causing an increase in cardiac index without altering the stroke index. The increase in blood pressure (more commonly seen in those who are acutely ill) can be attenuated by the use of diazepam. In the chronically ill, a direct myocardial depressant effect of ketamine may be unmasked. Ketamine also seems to desensitize the myocardium to catecholamines, making it useful to decrease epinephrine-induced arrhythmias[8–10]. Ketamine causes coronary artery dilation, but the degree of dilation is not ordinarily sufficient to offset the increase in cardiac work that it causes. Even so, ketamine is often used for cardiac surgery, being preferred over halothane by some. Ketamine also increases cerebrospinal fluid pressure, probably by increasing blood flow secondary to cerebral vasodilation and a rise in systemic blood pressure. The increase in cerebrospinal fluid pressure can be blunted by use of diazepam.

Ketamine increases pulmonary compliance[11] and has a rather strong bronchodilatory effect, making it an ideal anaesthetic agent for those with bronchoconstrictive disease[12]. Ketamine does not cause significant respiratory depression except transiently if given rapidly by the intravenous route. There is an increase in salivary and tracheobronchial mucous secretions, necessitating prophylactic use of an antisialagogue. Pharyngeal and tracheal reflexes remain intact under ketamine anaesthesia, offering protection to the airway. Laryngospasm may occur if secretions contact the vocal cords, which seem especially sensitive to contact with blood.

Ketamine anaesthesia produces some increase in muscle tone, occasionally making abdominal

closure difficult. However, this is readily combated by the use of diazepam. Ketamine is shown to stimulate uterine contractions in the first and second trimesters of pregnancy and decreases blood loss in first trimester abortions due to increase in uterine muscle tone[13,14]. Ketamine produces a mild (12%) elevation in blood glucose as compared to that produced by halothane (55%) or thiopental (72%), making it a good anaesthetic for the diabetic patient.

CLINICAL USE

Based on the above information and in keeping with the rather large clinical experience gathered in our institution, we offer the indications and contra-indications for the use of ketamine and also give a protocol for its safe use.

Virtually the only contraindications to the use of ketamine are conditions in which marked increase in blood pressure[9], cardiac work, or intracranial pressure[15] would be dangerous. It is also contra-indicated in the psychiatrically unstable patient.

Ketamine is an ideal anaesthetic agent for:

- the aged, poor-risk patient and for those with dehydration. It is better than a spinal anaesthetic for the elderly patient with an incarcerated hernia, for instance, since it sustains the blood pressure rather than dropping it.
- the anaemic patient, making it good for emergency dilatation and curettage in the first trimester abortion patient.
- the patient with chronic lung disease, especially the patient with asthma[12,16]. It is being recommended as a specific treatment for the patient with status asthmaticus who does not respond to other therapy[8,17-20]. It is also useful for breaking the bronchospasm that sometimes results from the use of halothane[21].
- the obstetrical patient who requires emergency caesarean section (see discussion below).
- the patient requiring endoscopy of any kind[22], such as the inevitable child who has a coin stuck in the upper oesophagus at the cricopharyngeus muscle, as long as you are prepared to put down an endotracheal tube should the need arise.
- the many children who come with a tick or other insect firmly attached to the tympanic membrane. In such cases it saves general inhalation anaesthetic on the one hand or the use of brute force on the other (with the inevitable damage to the tympanic membrane).
- the burn patient who must have frequent, painful dressing changes.
- the patient having facial plastic surgical procedures but who is too young to cooperate with the use of only local, such as the child needing cleft lip repair.
- the patient requiring a short anaesthetic for virtually any procedure, such as myringotomy, incision and drainage of an abscess, insertion of a chest tube, wound debridement, orthopaedic manipulation, dilatation of a urinary stricture, or circumcision.

It can be used for most abdominal procedures. The fact that the drug is metabolized in the liver does not seem to contraindicate its use even in liver disease[9], though, of course, the dosage may have to be reduced and recovery may take longer. When used for abdominal procedures, you may need to supplement the ketamine with additional diazepam to gain sufficient muscle relaxation for wound closure.

TECHNIQUE FOR USE

Preanaesthetic medication should contain an appropriate dose of atropine as well as diazepam (0.22 mg/kg [0.1 mg/lb]). In an emergency they can be given intravenously at the time of induction; however, atropine is more effective in reducing secretions if given intramuscularly thirty minutes prior to induction. Diazepam is best given orally one hour prior to induction, assuming that gastric function is normal. If unable to give the diazepam orally, it should be given intravenously for best effect.

For very short procedures, ketamine is easily used by intramuscular administration. For longer procedures it is often better to have an intravenous line open and to use small incremental doses by that route. Given by slow intravenous push, the dosage is 2.2 mg/kg (1.0 mg/lb) of body weight for induction, and by the intramuscular route it is 4.4 mg/kg (2 mg/lb). These dosages are in the lower-middle range of the various recommendations made in the literature. Onset of anaesthesia occurs in 30–60 s when given intravenously and in 5–7 min when given intramuscularly. The anaesthetic effect lasts 5–10 min by the intravenous route and 10–25 min for the intramuscular route, though there is great variability among patients. It will take a little experience to be able to judge just when subsequent doses are required, because the patients may phonate and even have some bodily movement even though they are actually fully anaesthetized. The drug may be given repeatedly at regular intervals as needed. We have even used it for procedures several hours in length.

There is better minute-to-minute control of the anaesthetic state, earlier awakening, and greater economy if a continuous infusion of ketamine is used as opposed to intermittent doses given by either the intramuscular or intravenous route. An easily controlled concentration is 0.5 mg/ml (250 mg in 500 ml) given at 1.5–3.0 mg/kg/h (up to 5 mg/kg/h in rare instances). This is accomplished in a 50 kg patient with from 38 to 75 regular drops/min.

The above dosages apply to all age groups of patients, making it quite easy to remember and to manage.

There are some special instances about which further comment is in order. First, there is the case of the caesarean section. The dosages mentioned above are not harmful to the infant, though some observers have stated that there is a higher incidence of delayed respiration in the newborn. It has not been so in our experience, and I believe I know why. In the other series[3] that reports such newborn depression, the ketamine was given much further in advance of the cord-clamping and was also augmented by the use of nitrous oxide, which we do not use. Our technique is to give a smaller dose of diazepam in the preoperative medication (only 1 mg given intravenously) and then to wait until the operative site is prepared and the drapes are in place before giving the ketamine intravenously. Given intravenously, ketamine has an onset of analgesia in 30–45 s and full anaesthesia is present in 45–60 s. Thus, when we are fully ready to operate, the attendant gives the appropriate dose of ketamine by slow intravenous push (over a period of 30 s). We watch the clock carefully and make the incision exactly 45 s after the ketamine is fully given. We operate rapidly, allowing us to have the cord clamped within 90 s of starting the incision. Thus, only about two and a half or three minutes elapse from the time the drug was begun until the cord is clamped. If drugs with low molecular weight (ketamine has a molecular weight of 238) are given intravenously to the mother, they will be fully equilibrated in the baby's blood within about 5 min. Since only 3 min elapse from the start of induction to the clamping of the cord, the infant receives only a small amount of ketamine. We emphasize that even if the procedure were done much more slowly so that the drug was fully equilibrated in the baby's blood, the dosage is still of no danger to the baby if the recommended dose is used[3]. The one minute APGAR may be slightly reduced, but by 5 min, the APGAR will be normal[1]. Once the cord is clamped, another 5–10 mg of diazepam can be given intravenously to the mother, preventing hallucinations.

When using ketamine for endoscopy of the oesophagus, bronchus, or pharynx, it is important to allow a little extra time for the anaesthetic to take effect in order to prevent laryngospasm. We have used ketamine many times for oesophagoscopy and bronchoscopy and have never had an episode of laryngospasm, though we always keep a laryngoscope, endotracheal tube, and succinylcholine readily available.

The recovery period for these patients is usually uneventful. It is important that they be allowed to recover without undue stimulation. This seems to decrease the incidence of hallucinations. If diazepam is given (as it should be given to reduce the incidence of hallucinations) the recovery phase will be a bit prolonged. Without diazepam, recovery is usually complete in much less than one hour. A persistent danger for the small child is that the concerned mother may want to hold the child and will not protect the airway. We had one postoperative death when a mother held the child with the neck flexed and the airway obstructed. Allow the patients to awaken by themselves, lying quietly on their side in a protected environment.

In summary, ketamine is a remarkably safe, easy-to-use anaesthetic agent. Its only contraindications are cases in which elevation of blood pressure, increase in cerebrospinal fluid pressure, and increased heart work are undesirable, and in psychiatrically unstable patients. It is of great use to the surgeon who does not have a trained anaesthesiologist or anaesthetist available. A further advantage is that it allows surgery to be done without the expense of the more sophisticated anaesthesia equipment.

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Towards minimizing postoperative wound infection

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SUMMARY
The rate of postoperative wound infection was found to be low at 1.12% overall in a prospective study. This was achieved by careful preoperative preparation, judicious use of cheap prophylactic antibiotics which are included in the WHO model list of essential drugs, and meticulous operative technique.

INTRODUCTION

Recent papers report that the rate of postoperative wound infection was reduced by the use of newer antibiotics such as third generation cephalosporins either alone or in combination with other agents[1,2]. However, such an approach may not be cost effective or applicable in developing countries. In this paper I report that a very low incidence of postoperative wound infection can be achieved by a combination of measures: careful preoperative preparation, judicious use of cheap prophylactic antibiotics which are included in the WHO model list of essential drugs, and meticulous operative technique.

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PATIENTS AND METHODS

Between April 1984 and August 1989 a total of 981 patients underwent a variety of general surgical operations carried out by one surgeon (Table 1). There were 467 male patients and 514 female patients with a mean age of 38.4 years (range 2–85). The majority of operations were elective.

All patients had a bath the evening before surgery or on the morning of operation. This was followed by shaving and marking the operation site. The surgical team used chlorhexidine (Hibiscrub) for scrubbing up and chlorhexidine and spirit was the standard preparation of the operation site.

Operations were classified at the time of surgery[1,3] as clean, clean-contaminated, contaminated and dirty according to conventional usage (Table 1).

Prophylactic antibiotics

The doses were adjusted according to the age and weight of the patient. For clean operations (Table 1) patients were given only one dose of intravenous ampicillin (average adult dose 500 mg) either half an hour preoperatively or with the induction of anaesthesia. For clean-contaminated operations (Table 1) ampicillin and intramuscular gentamicin (average adult dose 80 mg) were given immediately preoperatively and one further dose of each was