PREHOSPITAL CARE

Ketamine in prehospital care

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The relief of pain is an essential component of prehospital care and, when required is usually administered on completion of the primary survey. For simple analgesia morphine sulphate titrated to the clinical response and preceded by an antiemetic is usually effective, for example, in the relief of pain in chest trauma or myocardial infarction. For patients with multiple injuries and for those patients requiring manipulation and splintage of fractures and for entrapments and difficult extrications ketamine is a safe and effective option, which avoids the potential decrease in blood pressure and respiratory depression that is associated with opioid analgesia. This paper reports the personal experience in the prehospital administration of ketamine by a non-anaesthetist working as an immediate care practitioner as part of a British Association for Immediate Care (BASICS) Scheme.

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The author is a medical responder predominantly for the West Midlands Ambulance Service NHS Trust and also less frequently for Hereford and Worcester Ambulance Service NHS Trust and Warwickshire Ambulance Service NHS Trust. Call out is normally by pager and may be in response to information given to the call taker, for example, entrapped patients, multiple casualties, or at the request of the ambulance crews in attendance at the scene.

This paper reports the relevant clinical data on all patients who received ketamine as the sole intravenous analgesic/anaesthetic agent attended by a single immediate care practitioner. Ketamine was administered in most cases in sub-anaesthetic doses for its analgesic affect and additional supplements given as required.

RESULTS

Thirty two patients were treated between 1992 and 2002. Nineteen were male with a mean age of 36 (range 16–75). Thirteen patients were female with a mean age of 38 (range 9–87). Table 1 shows the mechanism of injury, predominant injuries, drugs administered, and the reasons for their use.

DISCUSSION

Ketamine produces dissociative anaesthesia in which the limbic system is selectively anaesthetised. Sensory stimuli are therefore prevented from reaching the cerebral cortex producing general anaesthesia and analgesia with a cerebral cortex that is minimally depressed. The brain stem functions normally.

Ketamine is presented as a colourless liquid for single use in glass vials in concentrations of 10 mg/ml (20 ml vial), 50 mg/ml (10 ml vial), and 100 mg/ml (10 ml vial). It is stable at room temperature and does not require any special storage conditions. Administered intravenously at a dose of 2 mg/kg it will produce general anaesthesia within 30–60 seconds, which will persist for 10 to 15 minutes. Anaesthesia can be maintained by repeated bolus injections usually 1–3 mg/min.

Ketamine is metabolised in the liver with an elimination half life of 180 minutes. The two main metabolites norketamine and hydroxynorketamine are both active and analgesia will persist after awakening.[1] Therefore, ketamine can be used in sub-anaesthetic doses for analgesia alone.

In this series the initial bolus dose seems comparatively small compared with the recommended 2 mg/kg for anaesthesia (table 1). Despite this small dose all patients had a period of initial unconsciousness. Where required, additional increments of ketamine were given after the initial bolus to maintain an analgesic effect. (Table 1 case numbers 8, 19, 23, 29). Ketamine was administered either as a single bolus to facilitate manipulation and splintage of fractures and extrication if necessary or by an initial bolus and incremental doses in patients with significant pain at the outset and to maintain pain relief.

To avoid confusion by carrying more than one preparation of ketamine and to facilitate the administration of small incremental doses only the 10 mg/ml vials were carried. This is an important safety issue particularly because many of these patients were treated in difficult, poorly lit environments where there is the potential for an increased risk of drug error.

Ketamine produces dissociative anaesthesia with profound analgesia however; airway, tone, and reflexes are usually maintained. While aspiration during the use of ketamine has been recorded, the drug, however, promotes gut motility and vomiting after administration is unusual. Ketamine produces a sympathomimetic effect due to brain stem stimulation, which leads to catecholamine release and an inhibition of noradrenaline reuptake. As a consequence it increases the pulse rate and volume, and leads to an increase in the mean blood pressure. The patient therefore continues to breathe spontaneously and blood pressure is normal or increased.[2]

In this series there were no significant airway problems after the administration of ketamine or ketamine and midazolam. In those patients hypotensive at the outset (table 1 case 1 and

Table 1 Details of mechanism of injury, predominant injuries, and drugs administered

Case number	Sex/age	Mechanism of njury	Injuries	Ketamine dose	Midazolam	Comments
1	44 M	RTA Driver Entrapment	Pelvis Ipsilateral right closed femoral and compound ankle fracture dislocation	100 mg	1 mg	Ketamine to facilitate extrication and limb splintage. Blood pressure 90 mm Hg systolic
2	16 F	Sports injury	Traumatic patella dislocation	50 mg	0.5 mg	Entonox inadequate
3	39 F	Fall	Posterior right elbow dislocation	100 mg		Alley between houses
4	23 M	Fall from 15 feet	Back injury	100 mg		Difficult transportation from building site
5	37 M	RTA Motorcyclist collision with car	Chest injury Fractured right humerus Fractured right femur Right wrist fracture	100 mg +50 mg +50 mg		Maintained anaesthesia until arrival in A&E
6	18 M	RTA Motorcyclist No other vehicle involved	Ipsilateral left open tibial and closed femoral fractures	50 mg		To facilitate reduction and splintage
7	65 F	Home accident. Fall downstairs	Head injury Agitated GCS 11	50 mg	0.5 mg	To facilitate management including transport
8	68 M	Home accident Fall in toilet	Known multiple myeloma Bilateral closed femoral shaft fractures	25 mg +25 mg +25 mg		Relative entrapment To facilitate extrication and limb splintage
9	34 F	RTA Driver Entrapment	Head injury GCS 11 Combative Fractured shaft of femur	50 mg +50 mg	2 mg	To facilitate management extrication and transportation
10	23 F	RTA Pedestrian Struck by car	Fractured femur pronounced angulation	50 mg	0.5 mg	To facilitate reduction and splintage
11	18 M	Sports injury Fall from a height 30ft. Climbing	Head injury Blunt chest injury Agitation Right wrist fracture	50 mg +20 mg +20 mg		To facilitate management
12	75 M	Fall in street	Compound right ankle fracture	50 mg		To facilitate realignment and splintage of fracture
13	32 M	RTA Non-restrained front seat passenger Entrapment	Pelvic injury Bilateral ankle fractures	100 mg +increments to a total dose 270 mg		2.5 h extrication maintained anaesthesia until hospitalised
14	47 M	RTA Lorry driver Entrapment	Crush injuries to right thigh	50 mg +increments to a total dose of 450 mg	1 mg	5 h 15 min entrapment Compartmental syndrome Hypoperfusion to lower leg
15	25 M	Fall from a height into a 25 feet deep trench	Back injury Spinal cord injury	50 mg +20 mg		Extrication using fire service lifting platform Horizontal on spinal board
16	32 F	Foot trapped in street drain	Soft tissue right foot injury	50 mg		To facilitate extrication in combination with the fire service
17	46 M	Industrial accident Hand trapped in machinery	Severe open crush injury of all fingers Right hand	50 mg +20 mg	1 mg	In combination with peripheral nerve blocks Patient maintained in horizontal position
18	37 F	Fingers trapped in till	Soft tissue crush injury Fingers right hand	50 mg	1 mg	Extreme patient distress
19	29 M	RTA Motorcyclist Collision with car	Head injury Chest injury Left femoral fracture Compound patella fracture	100 mg		To facilitate management and limb splintage
20	19 M	RTA Rear seat occupant	Blunt chest injury Pelvic fracture	50 mg +20 mg +20 mg	0.5 mg	To facilitate extrication using a spinal board

Table 1 Continued

Case number	Sex/age	Mechanism of njury	Injuries	Ketamine dose	Midazolam	Comments
21	37 M	RTA Driver Collision with central reservation Entrapment	Multiple lower limb fractures	50 mg +50 mg		To facilitate extrication and limb splintage
22	19 F	Fall from a horse	Compound right elbow fracture	50 mg +20 mg	1 mg	To facilitate limb splintage
23	87 F	RTA Rear seat car occupant Entrapment	Head injury GCS 15 Right patella fracture Multiple soft tissue injuries	20 mg +20 mg +10 mg		To facilitate extrication spinal boarding and limb splintage
24	37 M	RTA Van driver Head on collision Entrapment	Head injury GCS 13 Abdominal injury Right femoral fracture Left ankle fracture	50 mg +50 mg +20 mg +20 mg		Systolic BP 90 mm Hg To facilitate rapid extrication and patient management
25	17 M	RTA Car *v* tree Entrapment	Head injury GCS 13 Agitated Fractured right femur Fractured both wrists	50 mg +20 mg	1 mg	To facilitate management and extrication
26	9 F	Fall from 8 feet	Compound left ankle fracture	25 mg		To facilitate realignment wound dressing and splintage
27	47 M	RTA Lorry *v* tree Severe Entrapment	Head injury GCS 13 Open abdominal injury Severe crush injury right leg	50 mg +incremental ketamine to a total dose of 210 mg		To facilitate on site above knee amputation Subsequent extrication, spinal boarding. and transportation
28	11 F	Fall in the home Osteogenesis imperfecta	Closed fracture of left femur	25 mg		To facilitate limb splintage
29	84 F	Fall at home	Closed fracture proximal left femur Leg angulated through 130 degrees	25 mg +25 mg		To facilitate realignment of fracture and limb splintage
30	32 F	Jump from 30 feet	Head injury GCS 12 Spinal injury Multiple lower limb fractures	50 mg +25 mg	1 mg	To facilitate immobilisation and packaging
31	53 M	RTA Driver Entrapment	Blunt chest injury Abdominal injury Fractured right femur	50 mg		To facilitate extrication and splintage
32	16 M	RTA Pedestrian	Head injury GCS 14 Bilateral lower limb injuries	50 mg +20 mg		To facilitate realignment of fractures, placement on a spinal board, and transportation

24) blood pressure was maintained. Importantly neither developed an increased systolic blood pressure that could have lead to increased bleeding. It should be noted that after standard anaesthetic doses, increased hypotension can occur in the shocked patient.

Hypersalivation may also occur and is more commonly seen in children. In this series it occurred in case number 26, a 9 year old child and was not a clinical problem.

Historically the use of ketamine in patients with a changed level of consciousness has been questioned. It has been reported that ketamine increases cerebral blood flow and intracranial pressure in spontaneously breathing patients,[3] a scenario that is worsened in the presence of hypercapnia.[4 5] It has subsequently been reported that ketamine confers a direct neuroprotective role,[6] where in the presence of normocapnia it does not increase intracranial pressure and confers haemodynamic stability superior to other analgesics and sedatives.[7–9] In this series ketamine was only prescribed in those patients with head injuries who had a normal respiratory rate and pattern of breathing. While this does not necessarily equate to normocapnia no patients obviously suffered as a consequence of ketamine administration. This has to be a judgement call, particularly as the only other effective alternative may be rapid sequence induction of anaesthesia.

Recovery from ketamine administration can in some cases lead to visual and auditory hallucinations and delirium. These undesirable effects can be minimised by giving benzodiazepines.[10 11] Simultaneous administration of ketamine and midazolam can produce respiratory compromise and in this series midazolam was administered in 12 of the 32 cases when the patients were recovering from their ketamine

administration (table 1). In this series the indication for the administration of midazolam when wakening from ketamine administration was aggression or agitation.

Patients given ketamine have a typical catatonic appearance. They are unconscious and amnesic but their eyes commonly remain open and exhibit nystagmus. It is important to warn members of the emergency services, friends, and relatives present as this can be particularly distressing to onlookers and reassurance is necessary that this is a normal occurrence and that the patient is amnesic and unaware of these events. This was particularly a problem with case 13 (table 1) who was a fireman and had to be rescued by his colleague.

Ketamine can be used to facilitate surgical procedures, in this series an above knee amputation (case 27, table 1). Although an unusual necessity in prehospital civilian practice in the United Kingdom ketamine is commonly used in military surgery.[11]

It must be recognised that ketamine is an anaesthetic agent, therefore the user must be competent in airway maintenance and have training and confidence in managing airway compromise. All patients should have ECG and pulse oximetry monitoring applied. Suction devices and equipment for advance airway interventions should be immediately to hand. In the case of the author, who is a consultant trauma surgeon and who is not trained in rapid sequence induction, to facilitate endotracheal intubation the fallback position includes the administration of midazolam and ketamine to facilitate the passage of a laryngeal mask airway or a surgical airway. As a surgeon frequent airway management practice and skill retention is provided through anaesthetic colleagues.

In conclusion, ketamine has provided safe and effective anaesthesia/analgesia for this cohort of trauma patients that includes adults and children, polytrauma, patients with a changed level of consciousness, and patients who are hypotensive due to hypovolaemia. For the non-anaesthetist it is essential that the immediate care practitioner maintains their knowledge and skill base to be able to confidently manage any airway compromise that may occur.

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