# ANALGESIA AND SEDATION IN THE EMERGENCY ENVIRONMENT

*Early assessment of pain should result in prompt and adequate pain management.*

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Pain should be assessed and managed as an early priority, once the ABCs (Airway, Breathing, Circulation) have been managed, allowing greater precision in further management. Pain is often difficult to measure in an emergency situation, and the usual assessment tools are more relevant to chronic pain. However, factors such as anxiety level and the patient's personality are important.

In an emergency pain is assessed rapidly using both verbal and behavioural cues. Pain is clearly a parameter of clinical need that deserves attention sooner rather than later, and looking at 'incident to analgesia time' may reduce the time taken to provide pain management. This could also include 'incident to spinal board time', 'incident to comfort time'. Pain can be graded as none, mild, moderate, and severe.

Early analgesia will reduce the neuro-endocrine response to stress, which produces an increase in adrenocorticotrophic hormone (ACTH), cortisol, antidiuretic hormone (ADH), growth hormone (GH) and glucagon. The stress response reduces insulin uptake, causing hyperglycaemia, relative glucose intolerance and insulin resistance, and promotes catabolism of proteins and lipids. Pain produces sympathetic hyperactivity, resulting in an increase in heart rate, stroke volume, and myocardial oxygen consumption, and a decrease in gastrointestinal motility and urine output. Factors that drive this stress response are anxiety, pain, hypo-/hyperthermia, acidosis, starvation, dehydration, hypoxia, infection, and prolonged immobilisation.

What distresses patients? The following were found in patients who had been through an emergency unit and then been admitted to an intensive care unit: pain, anxiety, lack of rest, thirst, endotracheal intubation, nasogastric intubation, intravenous cannulation, urinary catheterisation, lying on a spinal board, ill-fitting cervical spine collars, feeling cold, and poor communication. All of the above are part of the pre-hospital and emergency unit environment. The pre-hospital setting may include extrication after entrapment, splinting of fractured limbs, and other unpleasant procedures.

Analgesic requirements can be reduced by attending to simple matters first. Effective, confident communication with the patient and attending staff (both nursing and paramedic) will create an atmosphere of trust and co-operation that will facilitate management. Measures that will reduce the amount of analgesia required are cooling and covering burns, cooling muscle injuries, elevating, splinting and immobilising an injured limb. Sedation should be considered once adequate analgesia is achieved as pain relief should allay much of the patient's anxiety.

## DRUG ADMINISTRATION

A variety of routes for administering analgesia are needed in an emergency. The gold standard is the intravenous route — as it is the most efficient and direct, the

drug can be titrated, and can be given intermittently or continuously. Other routes of administration are useful under varying circumstances. The intramuscular route is discouraged except in the case of an unco-operative/aggressive patient, because absorption rates are unpredictable. The oral route is useful in patients who have been triaged as category green (priority three) and are assessed as having mild to moderate pain. These will benefit from paracetamol, codeine, or paracetamol/codeine combinations. Sublingual lorazepam is very effective for moderately anxious individuals.

The intranasal route is convenient and safe, and an attractive alternative to parenteral administration, and is the route of choice in children for morphine and midazolam. Ketamine sometimes causes a mild burning/unpleasant taste, but is accepted by the majority of children.[1,2] The rate and extent of absorption, and plasma concentrations, are comparable with intravenous drug administration. The atomised pump is the best nasal delivery system, due to good mucosal distribution of the drug. The bioavailability of midazolam with an atomiser is 83%, compared with 50% when using a dropper. The bioavailability of opioids and ketamine with an atomizer is approximately 50% — ketamine via the rectal route has a bioavailability of 25%. Naloxone has a bioavailability of close to 100% via an atomiser. Limiting factors include a blocked, infected, traumatised, painful or bleeding nose.

Although the endotracheal route is seldom used, it can be used for selected drugs, e.g. naloxone. For adults, double the dose of the drug and follow with a 10 ml saline or water flush. The rectal route can be used for benzodiazepines, paracetamol, and non-steroidal anti-inflammatory drugs, especially in unco-operative paediatric patients.

Analgesia is sometimes withheld, or administered in inappropriate doses due to ignorance and/or misinformation. Patients with head injuries should be given adequate analgesia to reduce raised intracranial pressure caused by pain. Patients with acute abdomens should receive good analgesia. This aids the surgeon's assessment and investigation. Patients with fractured ribs and contused chest walls should be given intercostal or haematoma blocks at the site of injury, rather than large doses of opioids with the risk of further respiratory depression.

## ANALGESIC DRUGS

Get to know a few drugs very well, rather than knowing too little about many drugs that are not used regularly. I have limited my discussion to drugs that are regarded as 'need to know about' in the emergency environment.

### Opioids

#### *Morphine*

The 'king' of the opioids has two main metabolites — 85% of the drug is metabolised to anti-analgesics, 10% is metabolised to a chemical that is 40% more potent than morphine. Patients with compromised liver function should be given fentanyl in preference to morphine, as fentanyl has no metabolites. However fentanyl is nauseating, especially if given orally to children.[3]

**Recommended administration of morphine**

Dilute10 mg in normal saline/water to a 1:10 dilution (1 ml = 1 mg), administer 0.1 mg/kg intravenously as a slow bolus over 1 minute, as a 'loading' dose. Reassess after 10 minutes, add (titrate)1 - 2 mg aliquots at 5-minute intervals until satisfactory pain relief.[4] Nausea caused by morphine is related to the concentration of the drug and rapidity of administration. If morphine is given as suggested, metoclopramide is not needed routinely.[5] Morphine combined with cyclizine (cyclimorph) is not advised, as the cyclizine may limit the dosage of morphine that can be given.

The intranasal route requires the same 'loading dosage' (0.1 mg/kg).[6] The appropriate dose is drawn up in a 1 ml (or 2 ml) syringe and attached to an atomiser. Half the volume is given in each nostril, aiming the nozzle posteriorly, and asking the child to sniff during and after administering the drug. Onset of action is approximately 5 - 10 minutes. Aliquots of 0.5 mg may be given later if required, until satisfactory analgesia is achieved without risking respiratory depression.

Fig. 1 demonstrates a 1 ml syringe being used with an atomiser.

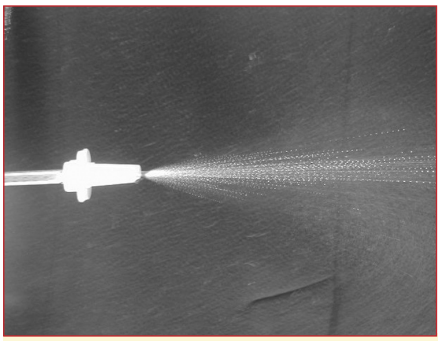

*Fig. 1. A 1 ml syringe used with an atomiser.*

#### *Tramadol (Tramal)*

This is an opioid with intermediate efficacy. It is used pre-hospital and in-hospital. It produces less respiratory depression than morphine. Rapid bolus administration causes flushing, nausea and sweating. 100 mg tramadol =10 mg morphine.

#### *Nalbuphine (Nubain)*

Nalbuphine is used largely in the pre-hospital setting by paramedics. It acts as a partial opioid antagonist, and when subsequent doses of morphine are administered, larger doses than usual will be required to achieve the desired effect; it is for this reason that hospital practitioners should be aware of this drug. Nalbuphine is registered in South Africa, but is currently not commercially available.

#### *Tilidine (Valoron)*

This drug is effective when given sublingually, provided it is in the correct dosage. The previously recommended dosage of 1 drop per year of age is inadequate, and a dose of 1 mg/kg (1 drop = 2.5 mg) is more appropriate. Overdose may cause convulsions.

### *Codeine*

Codeine is a low efficacy opioid. It is useful to have codeine tablets available for patients who have mild to moderate pain, have been triaged as 'green', and may have some time to wait before they are attended to by a doctor. Combination tablets containing codeine and paracetamol are very effective — 20 mg codeine plus 500 mg paracetamol is available as Empacod. For patients who cannot tolerate codeine, paracetamol should be available.

### Opioid antagonism

The opioid antagonist naloxone (Narcan) must be available wherever opioids are administered. The neonatal preparation should not be used as it is too dilute. Use only the full strength (0.4 mg/ml) preparation. Naloxone reverses both the analgesic and respiratory depressant effects of opioids. The contents of an ampoule should be diluted 1:10 with water/normal saline, and an initial dosage of 0.2 mg given intravenously. After 3 minutes, further aliquots of 0.1 mg should be given (titrated) until the desired effect is achieved. This will reduce respiratory depression, while minimising the reduction in pain relief. Naloxone acts for 30 - 45 minutes, which is significantly shorter than the action of most opioids (other than fentanyl). It may therefore be necessary to set up an infusion by adding 8.0 mg to 200 ml normal saline and infusing at a rate of 25 ml/hour.

### Entonox

A mixture of 50% nitrous oxide and 50% oxygen is available in cylinders; patients can self-administer using a demand valve that is triggered by forceful inhalation. It should be available in the pre-hospital setting as well as in emergency units. It is a convenient, effective, and safe analgesic that is underutilised in emergencies in South Africa. However, certain precautions and contraindications must be taken into account. At 6°C the nitrous oxide and oxygen separate and an anoxic gas mixture may be delivered. The contraindications are related to nitrous oxide diffusing more rapidly than nitrogen. They include undrained pneumothorax, post-SCUBA diving and head injuries (raises intracranial pressure).

### Non-steroidal anti-inflammatory drugs (NSAIDs)

In general NSAIDs should be avoided in compromised patients, as they impair renal perfusion, and cause retention of sodium and fluid. Giving NSAIDs to a dehydrated patient increases the risk of renal damage. Many emergency doctors agree that NSAIDs should be reserved for 24 hours post-stabilisation, when renal perfusion/function would most likely have returned to normal. This includes the newer intravenous NSAIDs. Diclofenac eye drops are useful for corneal abrasions, superficial corneal/scleral lacerations, and post-corneal foreign body removal.

## SEDATION IN THE EMERGENCY ENVIRONMENT

Some patients may require sedation without analgesia in an emergency, for example in situations such as the sudden death of a loved one. The most appropriate drug is sublingual lorazepam, given as a 1 mg tablet (up to a maximum of 4 mg).

The benzodiazepines are the favoured group of drugs for sedation after analgesia has been given. Emergency environment terminology of sedation may be confusing and inappropriate. Conscious sedation, monitored anaesthetic care, and dissociate anaesthesia are all anaesthetic terms. Procedural sedation is a more appropriate term and has been recommended by the American College of Emergency Physicians. The definition of conscious sedation may be used to describe procedural sedation: a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is maintained. If left undisturbed the patient may fall asleep, but is easily aroused by auditory or tactile stimuli. Protective airway reflexes are intact.[7,8]

Synergism between opioids and benzodiazepines is both positive and negative in implication:

Analgesia + sedation = procedural sedation

1 + 1 (should) = 2

If the synergistic action is not understood/anticipated, this could be seen as:

Opioid + benzodiazepine = respiratory depression

OR

1 + 1 = 3

Good practice could be seen as:

1 + 1/2 = 2

### Benzodiazepines

The benzodiazepines are divided into short-acting, intermediate-acting and long-acting drugs. Emergency doctors should get to know one of each category.

### *Midazolam (Dormicum)*

This short-acting benzodiazepine is 2 - 3 times more potent than diazepam, and is available in three strengths. Keep only one strength in the emergency unit — 5 mg/5 ml. This will minimise dosing errors and allow familiarity with a consistent concentration of the drug. Midazolam is well known for its idiosyncratic effects. It has active metabolites, and can accumulate. Its duration of action is approximately 45 minutes. The adult loading dose is 2 mg intravenously over 30 seconds. The maximum effect is in 3 minutes. After 3 minutes, increments of 1 mg can be given every 3 minutes until the desired effect is achieved. Common errors are made by not waiting the full 3 minutes before administering further drug, which may cause respiratory depression. Elderly patients should be given half of the above-recommended dosage. Children can be given midazolam orally, rectally, intranasally, or intravenously. The paediatric doses are as follows: intranasal 0.4 mg/kg, oral/rectal 0.5 mg/kg, intravenous 0.1 mg/kg.

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*The intramuscular route is discouraged except in the case of an unco-operative/aggressive patient, because absorption rates are unpredictable.*

The intravenous dose is an anaesthetic induction dose, so when using intravenous midazolam after the child has had morphine, halve the dosage and continuously monitor oxygen saturation. The intranasal route has several advantages and is effective in 5 - 10 minutes. In the fitting child, midazolam via this route is superior to rectal diazepam.

### *Lorazepam (Ativan)*

An intermediate-acting benzodiazepine which has no metabolites. The 1.0 mg sublingual tablets and the 4 mg/ml ampoules should be available, and are useful in acute anxiety, acute psychosis, alcohol withdrawal, and status epilepticus. The maximum safe adult dosage is 4 mg, and the minimum effective dose should be titrated to the individual patient's needs. The intravenous dose for children is 0.1 mg/kg. However, if administered after an opioid this dose should be halved.

### *Diazepam (Valium)*

A long-acting benzodiazepine which is less potent than the previous two. It has active metabolites, and a sclerosing effect on veins. The intravenous dosage of 0.1 mg/kg applies to both adults and children, and the rectal dosage is 0.5 mg/kg.

### *The benzodiazepine antagonist — flumazenil*

Flumazenil binds competitively to benzodiazepine receptors and reverses the central sedative effects of benzodiazepines. The adult dose is 0.2 mg. After 2 minutes further increments of 0.1 mg can be given every minute until the desired effect is achieved. If an intermediate- or long-acting benzodiazepine has been given, start an infusion of flumazenil — 1.0 mg in 200 ml normal saline at a rate of 50 ml/hour.

### Barbiturates

Phenobarb and phenytoin are second-line drugs for status epilepsy in patients who have not responded to a second dose of a benzodiazepine. They are also used prophylactically in patients with head injuries who are at high risk of fitting (depressed skull fracture, localised cortical injury, subdural haematoma).

Phenobarbitone is very viscous and should be given as a slow bolus over 1 - 2 minutes at the site of the intravenous cannula. If it is injected into the giving set it may settle in the tubing and not flow into the patient. The loading dosage is 18 mg/kg.

The phenytoin (Epanutin) loading dose infusion of 18 mg/kg needs to be run in over 30 minutes, which is not efficient in seizure control as it takes 30 minutes before therapeutic levels of the drug are reached. The advantage of its use in patients with head injuries is that it has little effect on level of consciousness. Phenytoin is incompatible with glucose solutions, and will form a solid mass if mixed with 5% glucose. Hypotension and respiratory depression are disadvantages. Subcutaneous extravasation has been known to cause skin necrosis.

## OTHER SEDATIVE DRUGS

### Haloperidol (Serenace)

This is the drug of choice for delirium, and is a useful adjunct to lorazepam in the management of agitated, aggressive, psychotic states. The adult intramuscular/intravenous dose is 5.0 mg. This may be given after 4 mg of lorazepam if this has not worked within 15 - 20 minutes. Extrapyramidal effects (dystonia, akathisia) of haloperidol can be treated with biperiden (Akineton) 2 mg slow IV and this dose may be repeated to a maximum of 8 mg. Analgesic requirements may then be assessed, and an appropriate analgesic administered in a safe (conservative) dosage.

### Dexmedetomidine (Precedex)

This new drug will probably be available in South Africa during the course of 2004. It has both anxiolytic and analgesic properties. It does not cause respiratory depression, and patients maintain cognition and are easily rousable. The bradycardia and hypotension that are produced and the delay in onset of analgesia (1 hour) are factors that may limit its use in the emergency environment.

### Ketamine for procedural sedation

Ketamine is well known for producing dissociative anaesthesia and is useful in an emergency. It is a safe, reliable and predictable drug, with potent analgesic properties and patients can maintain their own open airway. It also has a bronchodilatory effect, and increases the pulse rate and blood pressure. Atropine is sometimes used in conjunction with ketamine because of the increase in salivation and lacrimation, but I have not found this necessary. Laryngospasm has been reported, but is due to secretions draining onto the vocal cords and not to the drug *per se*. Positioning the patient so that saliva can drain out of the mouth should prevent this. Benzodiazepines, opioids, and local anaesthetic agents are compatible and safely used with ketamine.[9-14] Contraindications include hypertension,

recent myocardial infarction, head injury/raised intracranial pressure, and psychiatric conditions.

In the pre-hospital environment ketamine may facilitate procedures carried out before extricating entrapped patients. Adults require a benzodiazepine before ketamine, to reduce/eliminate emergence phenomena which include excitation and hallucination. Cannulate the patient, and initially give adults 5.0 mg diazepam intravenously 5 minutes before the intravenous induction dose of ketamine — 2 mg/kg over 1 minute. Procedural sedation occurs within 1 minute, and the duration of action is approximately 10 minutes. A further maintenance dose may be required. This should be 50% of the induction dose. Further small (1 - 2 mg) increments of diazepam can be given, tailored to the needs of the patient.

In the emergency unit ketamine can help the successful management of painful procedures on children, who do not experience emergence phenomena to the same extent as adults and so do not usually need a benzodiazepine as well. After a sub-anaesthetic dose of 2.0 mg/kg intramuscularly, the drug is effective in 5 - 6 minutes and allows 15 - 20 minutes in which to complete the procedure. Ketamine has been used intranasally at a dosage of 5 mg/kg and it is reported to produce a burning sensation and a bitter taste. It may also be administered orally, by mixing in a cooldrink, at a dosage of 6 mg/kg when the drug is used alone, or at a lower dosage of 3 mg/kg when used in conjunction with a benzodiazepine or an opioid. Nausea and vomiting associated with ketamine is reported in 14% of paediatric patients.

### Ketamine/midazolam

The following dosages are advised when using these two drugs in combination for paediatric procedural sedation:

- intravenous route — ketamine 1 mg/kg, midazolam 0.01 mg/kg
- oral route — ketamine 3 mg/kg, midazolam 0.5 mg/kg (in flavoured cooldrink).

## REQUIREMENTS FOR PROCEDURAL SEDATION

The responsible doctor should have passed the three Advanced Life Support courses and have anaesthetic experience, and should be assisted by a professional nurse trained in monitoring vital signs. The patient must be on a surface that can be tilted, and if sedation is performed without intravenous access, then equipment for vascular access must be immediately available. Suction apparatus, oxygen, oropharyngeal airways, bag/valve/mask, endotracheal tubes, and a laryngoscope must be at hand. The patient must be connected to a cardiac monitor, and oxygen saturation must be measured during and after the procedure until it is thought safe to discontinue monitoring. Prior to discharge, the patient should be able to speak normally and walk with assistance.

### Sedation for intubation

So-called rapid sequence intubation should be a controlled procedure under the best conditions that circumstances permit. The induction agent of choice in an emergency is etomidate (Hypnomidate). It has minimal respiratory and cardiovascular depressant properties. An intravenous dose of 0.3 mg/kg over 30 seconds is effective in 60 seconds and has a duration of action of 4 minutes. Involuntary muscle movements (which will be reduced by prior administration of a benzodiazepine or an opioid) and a brief period of apnoea should be anticipated.

Other drugs used as induction agents for intubation are propofol (Diprivan), thiopentone, and midazolam, all of which have disadvantages compared with etomidate in the emergency environment.

### Paralysing agents

#### *Suxamethonium*

This should be used unless a contraindication exists, in which case the non-depolarising agent atracurium (Tracrium) is an alternative. The paralysing agent should be administered only once the induction agent has started to take effect. Suxamethonium is a depolarising (non-competitive) agent with a rapid onset of action which is preceded by muscle fasciculation after a dose of 1 mg/kg (and not one ampoule). Its duration of action is approximately 4 minutes. Most problems associated with its use are related to hyperkalaemia, e.g. burns, major trauma/crush injuries, and severe sepsis. Caution should be used in patients with penetrating eye injuries because the drug raises intraocular pressure. The first sign of malignant hyperthermia is demonstrated by lack of masseter muscle relaxation after the effects of the drug should have worn off.

#### Atracurium

The intubation dosage is 0.3 mg/kg, the onset of action is 2 minutes, and the duration of action is 15 - 30 minutes. The drug breaks down spontaneously to inactive metabolites, and has negligible cardiovascular effects. Histamine release occurs when high doses (i.e. full paralysing doses) are used. Burns patients have a relative resistance to the drug due to low plasma cholinesterase activity, so an increased dosage is required — 0.4 mg/kg. Its action can be reversed by neostigmine at a dose of 0.06 mg/kg by slow intravenous bolus. Neostigmine causes bradycardia, so atropine should be administered concomitantly. As with most/all drugs the pharmacological activity is prolonged in hypothermic patients, so the dose used should be reduced, e.g. 0.2 mg/kg of atracurium should be used instead of 0.3 mg/kg.

## LOCAL ANAESTHESIA/ ANALGESIA

The agents used in local anaesthesia in emergency medicine are lidocaine (synthetic lignocaine), prilocaine, and bupivacaine. These are useful under different headings: topical, local, and regional.

Local anaesthetic toxicity is usually caused by overdose or by accidental intravascular administration. Local anaesthetics should be used with caution in epilepsy, porphyria, and in patients on cimetidine (which inhibits the metabolism of these agents).

### Lidocaine

The onset of action is 1 - 2 minutes, and duration of action approximately 2 hours. Maximum dosage is 200 mg for adults, and 3 mg/kg for children.

- 1% lignocaine = 10 mg/ml, and the maximum dose is 20 ml
- 2% lignocaine = 20 mg/ml, and the maximum dose is 10 ml. Dental cartridges do not permit aspiration, and contain 1.8 ml of 2% lignocaine. Therefore 6 cartridges contain 216 mg. Lignocaine is used mainly for local infiltration for short procedures.

Topical skin anaesthetic agents are of dubious use in an emergency. They do not provide pain relief for intramuscular injections in children, but they are of some help when only skin anaesthesia is required, e.g. for intravenous cannulation or blood sampling.

EMLA (eutectic mixture of local anaesthetics) cream comprises 25 mg prilocaine and 25 mg lignocaine. A full 60 minutes are required for adequate effect. Amethocaine (Tetracaine) gel/ointment (Ametop) has greater skin penetration and takes less time to become effective — 30 - 40 minutes. However this preparation is not available in SA.

Mucous membranes are adequately anaesthetised by lidocaine preparations. Remicaine jelly is available as a 2% in a 20 ml tube (400 mg/20 ml) — 200 mg is the recommended maximum dose when anaesthetising the male urethra for catheterisation. Xylocaine spray delivers 10 mg of lidocaine per spray, so 20 sprays equals the maximum dose.

### Bupivacaine (Macaine 0.5% = 5 mg/ml)

Onset of action is up to 30 minutes. Duration of action is 4 - 8 hours. The maximum dose is 150 mg (30 ml of 0.5%), and 2 mg/kg for children. Bupivacaine is used for nerve blocks and there is now evidence to support its use in digital blocks since 25% of lignocaine digital nerve blocks have to be repeated.

### Prilocaine

This is the agent of choice for regional anaesthesia, e.g. Bier's block. 1% = 10 mg/ml, and the maximum dose of 400 mg = 40 ml. However it is not available as an intravenous preparation in South Africa.

In the pre-hospital arena regional anaesthetic blocks will be used more in the future, as people become skilled in this practice. Practitioners of emergency medicine should familiarise themselves with the techniques associated with the common emergency blocks — intercostal, femoral, and haematoma blocks, as well as techniques using intra-articular lidocaine for acute anterior shoulder dislocations.[15] Details of these blocks are beyond the scope of this article. There is now an annual workshop offering training in regional analgesia/anaesthesia. The next one will take place on 27 July 2004 at the University of Cape Town (tel. Wendy on 082-7885759).

### The use of adrenalin with local anaesthetic agents

Adrenalin acts as a vasoconstrictor, reduces blood loss, increases the duration of action and decreases toxicity by delaying systemic absorption, thereby allowing the maximum dose of the local anaesthetic agent to be doubled. Adrenalin is contraindicated when an end-artery is involved, and in regional anaesthesia, such as Bier's block. Adrenalin should be avoided in patients with ischaemic heart disease, hypertension, peripheral vascular disease, thyrotoxicosis, with beta blocker usage, and in phaeochromocytoma.

*References available on request.*

## IN A NUTSHELL

Keep it simple and safe.

Document times, drugs, dosages, route of administration.

Consider local, regional, general analgesia.

Provide analgesia first, regarding morphine as the 'gold standard' in a loading dose of 0.1 mg/kg intravenously, followed after 5 minutes by aliquots of 1 - 2 mg until adequate pain relief without any sign of respiratory depression.

Monitor oxygen saturation.

Assess need for sedation — use conservative dose of sedative drug if indicated.

Monitor and reassess continuously until satisfied that the patient is comfortable and not compromised in any way.