PATIENT CONTROLLED ANALGESIA (PCA) MODULE
Education Manual for Nursing Staff

Acute Pain Management Service (APMS)
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1. INTRODUCTORY OUTLINE OF APPROACH TO POST OPERATIVE PAIN MANAGEMENT

Post operative pain can be managed using several options.

Using a patient information pamphlet, a menu of alternative strategies can help focus discussion of these options between caregivers and the patient.

Ideally this results in a pain management plan (PMP) being formulated as part of the overall plan for the surgical patient. This PMP is comprehensive in addressing selection of pain control modalities and agents, patient education and preparation, preventative measures to reduce post operative pain, intra-operative and Recovery Ward analgesia, and ongoing multimodal therapy in the Ward to successfully block pain until it subsides, as well as manage any side effects of treatment.

The regular assessment of pain levels is fundamental to pain management. The tool for adult pain level assessment adopted by the APMS is the verbal analogue scale (a visual scale can be used for children).

Verbal Analogue Scale:

The patient rates their pain according to the scale using numbers related to descriptive words denoting varying intensities of pain. The patient chooses the number that most nearly describes the pain they are experiencing.

![Figure One: Verbal Pain Scale](image)
Present knowledge tells us of the multiplicity of mechanisms that need to be blocked to effect good analgesia. In some instances certain mechanisms can be pre-emptively blocked before pain is initiated. However, in the majority of cases there is a need to treat pain as it arises using a variety of pharmacologic and non pharmacologic, regional and non regional means in an attempt to shut each pain pathway/mechanism ‘door’ and so keep the pain from getting through.

Different surgical procedures require different approaches to pain management. Most can be managed using relatively simple measures. Others require more advanced techniques of analgesia.

The APMS objective is to be comprehensive in applying the variety of approaches in a way, which is appropriate for each and every situation.

These situations refer broadly to three aspects:

1. Type and site of surgery
2. Severity of pain
3. Degree of rehabilitation required

When considering the simpler, non advanced techniques we traditionally use a variety of pharmacologic agents usually considered under the categories of mild analgesics, non steroidal anti-inflammatory drugs (NSAIDS), opioid and non opioid analgesics and adjuvant agents. These will often be used in combination to achieve multimodal/mechanism analgesia. For instance, many patients will receive regular Paracetamol as a background analgesic while receiving, and after completion of, opioids and advanced analgesia techniques. NSAIDS may also be used in this way.

Cornerstone too much of acute severe pain management is the use of opioids.
1. ADULT OPIOID POLICY

What is the correct dose of opioid for an adult?

Because of the variables involved the general answer to the question is “the right dose is enough”.

This right dose should be based initially on patient age and adjusted by titration. This titration should be based on the patient’s analgesic response and side effects. Patients vary greatly in their dose requirements and responses to opioid analgesics.

Each patient has a fairly constant blood level range within which they will get pain relief. It can be thought of as an “Analgesic Corridor” (see diagram below).

![Analgesic Corridor Diagram]

Below this level they feel pain, above it they have analgesia but also have side effects.

This corridor may be at high or low blood levels but it stays relatively constant for each patient. Between patients there is a five fold variation in blood level of opioid needed for analgesia. Taking into account pharmacokinetic variables this means that there is at least an eight to ten fold variation in dose requirement between patients.

Whatever opioid and whatever route of administration the aim is to give enough to provide each patient with a blood level which falls inside their analgesic corridor.
There is no correlation between weight of the patient and dose of opioid but there is good correlation between age of the patient and the dose of opioid. So the initial dose is based on patient age but because of the eight to ten fold variation in total dose to analgesic corridor levels titration of subsequent doses will be needed.

Integral to achieving the analgesic corridor is the monitoring of effect. Regular pain assessments are required so the end point or goal is know to have been reached. This also facilitates opioids being given on a regular basis. The “when necessary”, prn, (as required) administration has definite limitations in delivering consistent ongoing analgesia. Commonly under the prn system pain is not reported until it is severe. The delay between time of reporting, administration of next dose, and absorption, therefore means a significant period of moderate to severe pain is experienced. This is far from ideal.

The prn system may have some merit late in the post operative course when the pain level is diminished. However, for the first 48 hours when the pain level is usually steadily high opioids should be given on a regular, not a prn, basis. From early in the post operative period, following the initial titration and results obtained from regular pain assessments and the first few regular doses given, the correct dose and dosing interval should be decided upon. Under the ‘supervision/monitoring’ provided by the regular, at least three hourly, pain score assessments opioid should then be administered on a regular basis for at least the first 24 hours.

**Considering the Pros and Cons of the Various Routes of Administration of Opioids**

The preferred and most convenient route is the oral one. Numerous preparations in various strengths are available. However, most patients will require parenteral because the oral route cannot be used, ie nil by mouth, have nausea + vomiting, cannot swallow, have GIT obstruction, or require rapid onset of pain relief in an acute situation.

For historical reasons most parenteral opioids in hospital are given intramuscularly (IM) despite the obvious disadvantages. IM injections have not only a delayed and unpredictable time of onset, they also result in variable blood concentrations depending on the site of the injection, muscle perfusion and motor activity of the patient. Other disadvantages include the discomfort of the injection, increasing tissue damage with repeated injections and the potential for abscess formation.

The risk of IM injections is underestimated as the delayed onset of side effects, like respiratory depression might occur unnoticed. This can be minimised by the strictly regular observing and recording of vital parameters, such as respiratory rate, sedation and pain scores, BP and pulse rate.

This applies to whichever route of administration is used. It is inherent in the method of pain relief when using opioids. For the reasons already given this is the method of **individualising pain relief by titration** so that the appropriate dose and dose interval is determined as quickly and accurately as possible for each patient. This concept must be remembered to avoid approaching each patient with the same dose and dosing interval. This applies particularly to IM, SC, PO and PR
routes and less so to the IV route. Obviously there is a more or less standardized approach used in this method but it still needs to be individualised to each patient.

Recognising and considering the somewhat complex nature of the above approach the ideal route of parenteral administration of opioids is the intravenous one.

(i) Intravenous (IV) administration

IV injections of opioids results in a rapid predictable onset of action, because obviously the agent is placed directly into the blood stream. It facilitates the stepwise titration of the patient’s pain. However, it needs to be done with definite knowledge and care to avoid overdosing resulting in side effects including respiratory depression. A possible disadvantage of only using the IV titration of small doses of opioid is the nursing demands involved.

The preferred device for longer term IV opioid use is the patient controlled analgesia pump (PCA). A correctly programmed PCA works similarly to the above mentioned protocol and is inherently safe, as long as continuous infusion and human error are avoided. (Continuous IV infusions of opioids using burette systems and simple driver pumps [eg: syringe pumps] pose potential dangers such as manipulation/theft by unauthorised persons, dosing errors, erroneous pump settings, etc and should not be used routinely in the opioid naive patient. Continuous IV or SC infusions of opioids, which are not controlled by the feedback loop of the IV guidelines, PCA device etc have a five times higher incidence of respiratory depression, especially at night. There is a definite use in the opioid experienced patient (eg cancer patient) however.

(ii) Intramuscular (IM) administration

![Figure Four: Analgesic Drug Concentration with Intramuscular Administration](image)

Peak absorption is usually within 30 minutes

Figure Four: Analgesic Drug Concentration with Intramuscular Administration
The previous diagram shows what can happen if Morphine and Pethidine are given at four hourly intervals. To last four hours (especially Pethidine) the dose may need to be of a size that will produce some side effects initially. This is commonly reported by patients who may say they are “allergic to morphine” when in fact, they become nauseated and vomited soon after the injection as their blood level peaked above their analgesic corridor. It is better to order the doses at lesser intervals (eg: 2 to 3 hourly).

Ideally for the first 48 hours, once dose and intervals are determined, the opioid should be ordered for, and effect monitored, at regular intervals, by the clock. Obviously this regular dose would be withheld if respiration rate and/or sedation score contraindicated it.

Later in the post operative period when the need for opioid is diminished orders could revert to prn dosing.

Alternatively, if the “as necessary”, prn, approach was taken it could be ordered “2-3 hourly prn” with satisfactory observations/recordings. Ensure that prn means “offered frequently” and NOT waiting for the patient to ask. A “little less more often” can result in blood levels staying within the analgesic corridor.

(Interestingly the concept of the “four hourly dose” regime seems to date back to a clinical study completed in the 1950’s when the time between the injection of opioid and return of severe pain was found to be four hours!)

So integral to these schedules, the patients pain should be assessed at regular intervals to determine the efficacy of the opioid action, presence of side effects, or the need for dosage adjustment (up or down), or supplemental doses for breakthrough pain.

Finally a combination of these two approaches would be to order that initially the opioid dose be given at a regular interval (dose and interval to be determined/decided upon for/by each patient’s response), unless the recordings contraindicated it or the patient declined the dose because of not being in pain or was asleep.

As an example only: Morphine 5 to 10 mgIM/SC Q3H unless recordings, patient, or sleep prevents

(iii) Oral administration (PO)

Once the patient is taking oral fluids, oral opioids can be very effective providing the difference between oral and parenteral doses is understood. Onset of action is a little slower and duration of action a little longer than IM/SC injections.

Morphine as elixir, tablets, granules or MST tablets is suitable. While oral Pethidine tablets are available and efficacious it will produce higher levels of Norpethidine than parenteral Pethidine because of the “first pass effect” and so is not recommended for longer use.

Codeine phosphate is partly metabolised to morphine and this most probably accounts for its effect.
(iv) Rectal administration (PR)

It has the benefit that the drug does not pass through the liver before entry into the systemic circulation. Absorption PR is often irregular and incomplete but can be used if oral ingestion is unreliable.

(v) Subcutaneous Administration (SC)

For non IV longer term opioid use the options are IM, subcutaneous (SC), PO or PR. Each of these routes has its advantages and disadvantages for example: the placement of a loaded and non flushed SC butterfly needle or IV cannula avoids the regular needle sticks of IM injections, and produces good comparable absorption of morphine. Pethidine is not so good SC as it is an ‘irritable’ and higher volume solution.

Patient Categories

The patients’ individual response to opioids differs or alters depending on their previous exposure to opioids, their condition and their stage of disease. Different sets of guidelines for different groups of patients apply therefore as follows:

The opioid naive patient

Patients with no recent history of opioid use, eg the normal post operative or post trauma patients are at the highest risk of respiratory depression. They should therefore only receive intravenous opioids as per the guideline or via PCA pump according to the following steps:

(i) Intravenous opioids according to intravenous opioid guideline
(ii) The Acute Pain Management Service should be contacted by the primary team if the patient requires repeated administration of opioids, or if this administration is ineffective
(iii) PCA (with an appropriate programme and no background infusion) or alternative treatments will be started by the Acute Pain Management Service.

The opioid experienced patient

Patients who have for some time been on a regular dose of opioids, for example oncology patients who are admitted on MST or methadone, are regarded as opioid experienced and of significantly reduced risk of respiratory depression. As they may require increased amounts of opioids to achieve pain control the following steps should be considered:

(i) Intravenous opioids according to intravenous opioid guideline
(ii) Early involvement of the Acute Pain Management Service by the primary team with a view to commencing PCA
(iii) The use of a PCA will be preferably with a background infusion to substitute the previous opioid intake.

2. OPIOIDS

Opioids are drugs which bind to opioid receptors includes antagonists such as morphine and fentanyl, as well as antagonists such as naloxone and naltrexone.

Opiates are drugs derived from opium, mostly morphine, codeine and their families. However, it is commonly, but incorrectly, used to include other opioid agonists such as pethidine and methadone.

Narcotics was originally used for drugs that produced sleep-like state (narcosis), then for drugs (usually from opium) that both produced pain relief and a sleep-like state, it is no longer a medically useful term, because it has been hijacked into legal circles and is now often used illegally such as cannabinoids, amphetamines, etc that have nothing to do with opium.

**Opioid Receptors**

The binding of drug molecules to their specific receptor molecule is often described as similar to a key fitting in a lock. The term binding affinity refers to the strength of attachment of a drug to the receptor site and various drugs bind with varying strengths.

Receptors probably evolved for the purposes of interacting with endogenous compounds. Opioid receptors are located in the central nervous system, pituitary gland and the gastrointestinal tract. They proliferate in the dorsal horn of the spinal cord. These cells release neuro-transmitters such as adenosine triphosphate, glutamate and substance ‘P’. Endogenous and exogenous opioids lock onto opioid receptors and block the release of neuro-transmitters, principally substance ‘P’.
Nociceptive (painful) stimulation can cause a persistent enhancement of the excitability of the spinal cord. This is known as “wind up”. The NMDA (N.methol D.espartate) receptor is one of the receptors for the excitatory amino acid glutamate which is widely used in the central nervous system.

**N-methyl-D-asparate (NMDA) – Receptors**

*Figure Five: Opioid Receptors, McCaffery/Pasero (1999)*

*Figure Six: Pain Transmission, McCaffery/Pasero (1999)*
as a transmitter and has been strongly implicated in the responses of dorsal horn (spinal) neurones to prolonged painful stimulation.

In addition the activation of the NMDA receptors is associated with alterations in opioid responsiveness seen in different pain states.

“Wind up” is an important spinal mechanism mediated by the activation of the NMDA receptor and may be one of the events underlying prolonged and/or chronic pain states and the production of so called central hypersensitive states (allodynia). NMDA antagonists (such as Ketamine) when used in combination with opioids can profoundly inhibit nociceptive responses, and low doses of both drugs can produce powerful synergistic effects with a low side effect liability.

**Opioid Receptors and side effects**

In addition to producing analgesic opioid drugs produce a number of other effects including constipation (the most common side effect) due to decreased intestinal motility. This occurs from opioid binding to receptors located in the GI tract and the central nervous system. Nausea and vomiting are the result of opioid binding to receptors located in the fourth ventricle of the brain.

Urinary retention occurs from binding in the spinal cord. Respiratory depression from binding in the ventral medulla of the brain stem and sedation from binding in the brain.

**Classes of Opioid Receptor sites**

Four major types of opioid receptor sites are involved in analgesia. *Mu (μ), Delta (δ), Kappa (κ) and Sigma (σ)*. When a drug binds to any of these receptor sites as an *agonist* it produces analgesia. *Antagonists* are drugs that also bind to opioid receptors but produce no analgesia. *Agonist – antagonists* are drugs that are agonists at one opioid receptor type and antagonists at another.

When a drug binds to any of the opioid receptor sites as an antagonist analgesia and other effects are blocked. This is the action of naloxone, an opioid antagonist which binds to the Mu receptor site and reverses analgesia and other opioid side effects such as respiratory depression and sedation.

**Opioid Responsiveness**

There are a number of terms in use when discussing opioid analgesics and patients response to them that are commonly confused and misused. Such terms include words such as *efficacy, potency, responsiveness and resistance*. 
Efficacy – in the clinical setting efficacy refers to the maximal effect that can be produced by a drug. It is the level or degree of analgesia that can be achieved by increasing the dose of the drug to the point of limiting side effects. By this definition the true maximal effect of a drug may not be always achieved until unacceptable side effects are treated.

Potency – this term is often confused with efficacy, it refers to the dose of a drug required to produce a specified effect. A common misconception is that more potent a drug is the more therapeutically superior it is. In reality all opioid analgesics are capable of producing the same degree of analgesia if the doses are appropriately adjusted. Increased potency alone does not provide any advantages because the more potent drugs also have an increased ability to produce side effects.

Opioid responsiveness and resistance – opioid responsiveness refers to the probability that adequate analgesia (tolerable and manageable side effects and satisfactory pain relief) can be achieved during dose titration. Opioid responsiveness is influenced by patient characteristics and the particular type of pain being treated. It is a common misconception that certain patient characteristics such as age or types of pain such as neuropathic (nerve pain), are opioid resistant. In fact all individuals and types of pain are opioid responsive but they vary in the degree to which they respond, indeed there may be significant variation between patients responsiveness to opioids.

Tolerance

Tolerance refers to a process characterised by decreasing effects of a drug at a constant dose of the drug or conversely the need for a higher dose of drug to maintain an effect. Tolerance should be viewed as a descriptive label that indicates a change in the relationship between dose and response.

Continued exposure to a drug is the primary cause of tolerance. In terms of tolerance to opioid drugs it is a physiological response that should be expected when an individual takes an opioid drug for several days or longer. Tolerance should not be confused with addiction and it is not a predictor of abuse. It occurs regardless of why the opioid is used. Both persons abusing opioids and those taking opioids for pain relief will develop tolerance to some drug effects. The term does not apply when a decrease in a drugs effect can be attributed to a worsening of the pathological condition or physiological reasons rather than to drug exposure.

Tolerance to analgesia may be evident after a few days of treatment. The first indication of tolerance is most commonly a decrease in the duration of analgesia followed by a decrease in analgesic effect.

This can be easily treated usually by increasing the opioid dose or shortening the interval between doses.

Tolerance to the side effects of opioids also develops over time although this varies. For example patients usually develop tolerance to mental clouding and nausea within days or weeks but rarely
if ever develop tolerance to constipation. This is why a bowel management regime should be routinely implemented in the patient receiving long term opioids.

Tolerance to respiratory depression usually develops within a few days of opioid administration. Tolerance to this effect allows escalation to whatever dose is required for analgesia. It is important to realise that although there appears to be no limit to the degree of tolerance to respiratory depression that may develop, there is always a lethal dose for the individual.

Figure Seven: Declining Analgesic Effect, McCaffery/Pasero (1999)

**Cross Tolerance**

<table>
<thead>
<tr>
<th>Differential Diagnosis for Declining Analgesic Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INCREASED ACTIVITY IN NOCICEPTIVE PATHWAYS</strong></td>
</tr>
<tr>
<td>Increasing activation of nociceptors in the periphery</td>
</tr>
<tr>
<td>Due to mechanical factors (e.g., tumor growth)</td>
</tr>
<tr>
<td>Due to biochemical changes (e.g., inflammation)</td>
</tr>
<tr>
<td>Due to peripheral neuropathic processes (e.g., neurona formation)</td>
</tr>
<tr>
<td>Increased activity in the central nociceptive pathways</td>
</tr>
<tr>
<td>Due to central neuropathic processes (e.g., sensitization, shift in receptive fields, change in modulatory processes)</td>
</tr>
<tr>
<td><strong>PSYCHOLOGIC PROCESSES</strong></td>
</tr>
<tr>
<td>Increasing psychologic distress (e.g., anxiety or depression)</td>
</tr>
<tr>
<td>Change in cognitive state leading to altered pain perception or reporting (e.g., delirium)</td>
</tr>
<tr>
<td>Conditioned pain behavior independent of the drug</td>
</tr>
<tr>
<td><strong>TOLERANCE</strong></td>
</tr>
<tr>
<td>Due to pharmacodynamic processes</td>
</tr>
<tr>
<td>Due to pharmacokinetic processes</td>
</tr>
<tr>
<td>Due to psychologic processes</td>
</tr>
</tbody>
</table>

**Physical Dependence**

Physical dependence is a physiological phenomenon which manifests in the development of withdrawal syndrome after sudden discontinuation or substantial reduction of therapy or administration of an antagonist drug such as naloxone. It is usually seen in individuals who have taken large doses of opioids over a long period of time.

Physical dependence requires no treatment unless withdrawal symptoms occur or are anticipated. Withdrawal can be suppressed with gradual reduction of dose over 7 – 10 days. One formula for weaning adults is to give half the previous dose for the first 2 days then reduce the dose by 25% every two days. When the dose reaches the equivalent of approximately 30mg/day of oral morphine this dose may be given for 2 days then discontinued.

There is much misunderstanding and confusion regarding the differences between physical dependence and addiction that create barriers to effective pain control. **Physical dependence**
indicates neither the presence nor the absence of addiction and addiction may exist with or without the capacity for withdrawal that defines physical addiction.

**Addiction**

Addiction is more a type of psychological dependence as opposed to a physical dependence. The American Pain Society (1992) defines addiction as “a pattern of compulsive drug use characterised by a continued craving for an opioid and the need to use the opioid for effects other than pain relief”.

It is important to realise that the taking of opioids for pain relief is not addiction no matter how long or at what doses the person takes opioids for.

How likely is it that addiction will occur as a result of taking opioids for pain relief? In a study of 2,000 hospital based patients with no history of drug abuse who received opioids during hospitalisation only four developed an addiction disorder, only one of which was described as major.

Behaviours indicative of uncontrolled pain or fear of uncontrolled pain are often misinterpreted as addiction. Patients who receive opioid doses that are too low or at intervals greater than the drugs duration of action may try and manipulate staff into giving them more analgesic, exhibit demanding behaviour, requesting extra opioids for fear of running out and experiencing severe pain. These behaviours are referred to as pseudo addiction and when appropriate and adequate pain relief is given, these behaviours typically disappear.

To summarise:  
*Addiction is not drug tolerance*  
*Addiction is not physical dependence*  
*Addiction is not drug seeking*
3. PATIENT CONTROLLED ANALGESIA (PCA)

Sechzer (1968) noted in a publication concerning the measurement of pain that good post operative analgesia could be obtained using repeated small bolus doses of an intravenous opioid administered by a nurse observer following a patient demand. Subsequently he and others developed machines that enabled the patient to administer small intravenous doses when required. In the early 1970’s the first commercially available PCA machines were released. PCA has only come into widespread and worldwide use in the last few years following a more organised approach to acute pain management and the introduction of acute pain services.

PCA is an interactive method of pain management in that it permits patients to treat their pain themselves thereby giving the patient an element of control. The PCA approach recognises that only the patient can feel the pain and only the patient knows how much analgesia will relieve it.

Control as a variable has been shown to be important in both clinical and laboratory settings for both acute and chronic pain. Attribution of control to internal rather than external factors has become a key factor in the clinical treatment of pain. Providing patients with some degree of control over pain stimulation can reduce stress and increase pain tolerance, furthermore the expectation of control can lead to improved performance even under conditions of learned helplessness.
As well as the benefit of giving the patient a element of control the flexibility of PCA helps to overcome the wide inter-patient variation in opioid requirements (eight to tenfold) and enable them to keep within their “analgesic corridor”.

The dose of intravenous opioid can be given immediately eliminating delay and can be titrated according to increases and decreases of each patient pain stimulus.

**Appropriateness of PCA**

A number of factors need to be considered in determining whether a patient is a candidate for PCA.

Frequently age is used inappropriately as a criteria for PCA and this has presented a barrier to its use in children and the elderly. PCA has been used effectively and safely in developmentally normal children as young as five years old. Often PCA is withheld for use in the elderly for fear of producing confusion in these patients, however factors other than opioids can cause confusion.

To be a candidate for PCA, patients must be able to understand the relationship between pain, pushing the PCA button and pain relief. In cases where PCA is warranted patients should not be denied access to this modality simply because of their age. Instead they should be carefully screened for their cognitive and physical ability to manage their pain by PCA.

**PCA Contraindications**

**Untrained Nursing and Medical Staff**

Using PCA is a very effective way of providing good analgesia but the results depend on a good understanding of the technique. An inadequate understanding of PCA, the drugs and doses used, the monitoring requirements and the management of common problems can at worst increase the risk of complications. At best it can prove a very expensive way of providing poor analgesia.

**Patient Rejection**

The majority of patients appreciate the control that PCA gives them. This is one of the reasons why patients using PCA sometimes express a greater satisfaction with PCA as opposed to epidural analgesia even though the degree of pain relief may be less. Some patients however do not want this control and prefer the nursing and medical staff to manage the analgesia. Others will reject PCA due to previous experience with inadequate treatment of side effects e.g. nausea/vomiting. With these patients PCA will often fail.

**Inability to comprehend the technique**

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For PCA to be used both safely and effectively the patient must be able to understand the technique. Patients should not automatically be excluded from consideration if there is mild mental impairment or a language barrier. It is also important to realise that an understanding of PCA does not necessarily have to be detailed as long as it is safe.

**Footnote**
A current or past history of addiction to opioids was often thought to be a contraindication to PCA. It is now realised that PCA can be a very useful way of managing acute pain in this population when supervised by Acute Pain Teams. Much larger opioid doses will usually be required.

**PCA Variables**

**Loading Dose**

It is important to realise that PCA is essentially a maintenance therapy, it will not be effective if moderate or severe pain is present when it commences.

To make the patient comfortable before PCA is started a loading dose of the opioid is needed. There is an enormous inter-patient variation in the amount of opioid required as a loading dose and this will need to be individualised for each patient.

**Incremental (Bolus) Dose**

The bolus dose is the amount of opioid that the PCA pump will deliver when the demand button is pressed. The size of the incremental dose along with the lock out interval can determine the effectiveness of PCA. The aim is to give good analgesia with a minimum of side effects. Smaller PCA doses at shorter delay intervals are best for opioid naive patients while larger PCA doses at longer delay intervals are best for opioid tolerant patients with cancer or chronic non malignant pain.

**Lock out Interval**

The time from the end of the delivery of one dose until the PCA pump will respond to another demand is called the “lock out” interval. This is to allow the effect of one dose to be felt before another can be given and is one of the safety features of the PCA pump. If analgesia is inadequate it is better to **increase the bolus dose** rather than **decrease the lock out interval**. Remember also that when the PCA pump is programmed the lock out time comes first, that means that usually for the first five minutes after commencement of PCA the patient will not be administered any increments of opioid despite pushing the demand button. This makes the need for an initial loading dose of opioid even more relevant.

**Continuous background infusion (Basal rate)**

The purpose of a continuous infusion (basal rate) is to help maintain a stable analgesia level. Therefore when a bolus dose of opioid was delivered the blood level reaches the “analgesia
corridor” more rapidly. It was also hoped the continuous infusion would enable the patient to make fewer demands, sleep for longer periods and wake in less pain.

The addition of a basal rate has been shown to increase the risks of side effects including respiratory depression and does not always result in better analgesic or improved sleep patterns. The routine use of a basal rate before an adult patient’s opioid requirements are known is therefore not recommended. However, there may be benefits to be gained from the use of a basal rates in the opioid tolerant patient. Patients requiring long term PCA (eg burns, oral mucositis) may benefit from a basal rate at night. A typical approach is to order a continuous infusion that provides 30 – 50% of a patient’s known hourly opioid dose. Key to the safe use of basal rates is close nurse monitoring of sedation and respiratory status.

**Injection/Attempts**
Records the number of attempts (demands) by the patient as opposed to the number of doses delivered.

Individual (not cumulative) hourly injection/attempt ratios should be recorded in the appropriate columns on the PCA Treatment Sheet (QMR004E) (see Appendix A).

If PCA does not seem to be providing adequate analgesia it is worth looking at the average number of doses the patient has received over the preceding few hours. If the patient has received fewer than one or two doses per hour further instruction is needed and the patient should be encouraged to use the PCA more often. On the other hand if the patient is already receiving three four or more doses each hour the size of the bolus dose should be increased by 50 – 100%.

**“Zeroing” the Pump**
The PCA pump should be “zeroed” (cleared) of the injection/Attempts at the end of each eight hour nursing shift. The fact the pump has been cleared should be documented in the appropriate column on the PCA Treatment Sheet (QMR004E) (see Appendix A).

**Hourly Limit**
The maximum amount of medication (opioid) that the pump will deliver in any one hour (excluding loading doses).

**History**
Press History button to review pump operating history. Continue pressing history until desired information is displayed.
**Syringe Changes**
Should be documented in the appropriate column of the PCA Treatment Sheet (QMR004E) (see Appendix A).

**Pain Scores**
Should be documented in the appropriate column of the PCA Treatment Sheet (QMR004E) (see Appendix A). Scores of 3 or above require review by the APMS.

**Patient Controlled Analgesia Vital Sign Recordings**

Hourly respiration and sedation score should be recorded for the first 12 hours then 4 hourly if stable, unless a basal infusion rate is used in which case hourly observations should continue.

Recordings are documented on the PCA treatment sheet (QMR004E)

Pain but not sedation scores can be omitted in sleeping patients.

**No other opioids** are to be given without discussion with APMS.

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**TO CONTACT THE APMS AT CHRISTCHURCH HOSPITAL**

**In hours:**
- APMS Nurse (Christchurch Hospital) Beep 8114
- APMS Nurse (Christchurch Women’s Hospital) Beep 7015
- Duty Anaesthetist Beep 8120

**After hours:**
- On-call Anaesthetic Registrar Beep 8212
- Or On-call Anaesthetist via telephone office

**APMS Nurse hours:**
- Monday – Friday 0800-1630 hours
- Saturday 0800-1200 hours
- Sunday 0800-1200 hours

Developed by: Richard Craig, Clinical Pain Nurse Consultant,
Acute Pain Management Service
For Department of Nursing, Christchurch Hospital, CDHB
Last Updated: June 2011-07-04
Opioid Drugs used in Patient Controlled Analgesia

**Morphine**

Named after Morpheus the Greek God of Sleep, the Mu agonist morphine is the standard with which all other opioid drugs are compared and is the main pharmacologically active constituent of opium. The variable herbal mixture of opium was analysed into its constituent components in the nineteenth century. The most powerful faction of which was found to be morphine while a weaker component, codeine was also found to be effective against less severe pains. If you enjoy black humour you may be interested in the late nineteenth century discovery by the Bayer company of a morphine derivative which they named “heroin” as a particularly powerful narcotic that was claimed to be free of an addiction potential!

Morphine is hydrophilic (soluble in aqueous solution) which contributes to it’s relative slow onset and long duration of action compared with the more lipophilic (soluble in fatty tissue) opioid drugs. Morphine has a short half-life of 2 – 4 hours. Morphine does not persist in tissues; 24 hours after the last dose tissue concentrations are low. It is estimated that approximately 40% of the given dose of oral morphine is available for therapeutic effect because of breakdown in the liver or what is known as the “first pass” effect. This is why the recommended dose of morphine by the oral route is higher that by the parental route.

Globally morphine remains the strong opioid of choice and is widely used as an analgesic for cancer and postoperative pain. PCA syringes of morphine at Christchurch Hospital are premixed to a concentration of 1mg per ml and are distributed via pharmacy.

**Pethidine**

Pethidine continues to be the most widely used opioid analgesic for the management of pain in spite of sufficient evidence that it is not appropriate for a first line opioid analgesic for the management of any type of pain.

Numerous misconceptions about Pethidine persist:

<table>
<thead>
<tr>
<th>Misconception</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pethidine causes less respiratory depression</td>
<td>At equianalgesic doses opioid analgesics produce equal respiratory depression</td>
</tr>
<tr>
<td>2. Pethidine is less likely than morphine to cause</td>
<td>The abuse liability doses opioid is comparable to that of morphine. In other words people addicted to opioids find morphine and pethidine equally attractive</td>
</tr>
<tr>
<td>addiction</td>
<td></td>
</tr>
<tr>
<td>3. Pethidine causes less constriction of the</td>
<td>Both pethidine and morphine cause constriction of the sphincter of oddi and</td>
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<tr>
<td>sphincter of oddi and the biliary tract than does</td>
<td>the biliary tract. Laboratory studies show that morphine may cause more</td>
</tr>
<tr>
<td>morphine</td>
<td>constriction in animals, but this has never been shown to be clinically</td>
</tr>
<tr>
<td></td>
<td>relevant in humans</td>
</tr>
<tr>
<td>4. Pethidine is less constipating than morphine</td>
<td>Pethidine may be less constipating but only when used chronically and chronic use is not recommended</td>
</tr>
<tr>
<td>5. Long term clinical experience with pethidine</td>
<td>Although pethidine has been a frequently prescribed opioid for several</td>
</tr>
<tr>
<td>proves it is safe and effective</td>
<td>decades therapeutic doses were</td>
</tr>
</tbody>
</table>

Developed by: Richard Craig, Clinical Pain Nurse Consultant, Acute Pain Management Service
For Department of Nursing, Christchurch Hospital, CDHB
Last Updated: June 2011-07-04
seldom used and studies show that many patients were under treated for pain. Furthermore problems may have gone unnoticed because of the existence of the metabolite norpethidine was not known and patients were not assessed for signs of neurotoxicity. Pethidine cannot be used safely if pain is treated aggressively.

Some of the appeal of pethidine may lie in its rapid onset of action peak effect and short duration of action. When given orally the analgesic effects of pethidine are felt within 30 minutes. Its peak effect is within 1 to 2 hours and its duration is approximately 3 hours. However pethidine is less than one fourth as effective orally as when delivered parenterally. This means that if a patient is receiving 75mg IV over a 3 - 4 hour period, 300mg will be required orally to produce equianalgesia. By the subcut and IM routes onset of action is 10 minutes and peak effect is 30 minutes with a duration of up to 4 hours, however the rate of absorption is erratic after IM injection with a wide range of plasma concentrations.

Probably the major drawback to the use of Pethidine is its active metabolite Norpethidine. Norpethidine is a central nervous system stimulant and can produce irritability, tremors, muscle twitching, myoclonic jerks, agitation and grand mal convulsions. Norpethidine has a half-life of 15 – 20 hours compared with pethidine's half-life of 3 hours. Because Norpethidine is eliminated by the kidneys pethidine should not be used in patients with decreased renal function. It is a particularly poor choice in the elderly and is rarely indicated for use in children. It should not be prescribed for patients requiring long term opioid treatment such as those with cancer or chronic non malignant pain.

Pethidine is contra indicated in patients receiving MAOI (monoamine oxidase) inhibitors (antidepressants) as a potentially fatal interaction (the serotonin syndrome) may occur between the two. Pethidine should be used with extreme caution in patients with pre existing convulsive disorders and in patients with supraventricular tachycardias. There is a higher incidence of delirium and vomiting in postoperative patients with Pethidine as opposed to other opioids.

The most appropriate candidates for pethidine are patients with acute pain who are otherwise healthy and who have definite allergic reactions to other opioids such as morphine or have demonstrated a more favourable outcome with pethidine than other opioid drugs.

If pethidine is used in these patients frequent high doses should be avoided. The duration of treatment with pethidine should be restricted to no more than a few days with the dosage limited to 600mg within any 24 hours period.

Pethidine PCA syringes are premixed to a dose strength of 10mg per ml. (NB note the different concentration from morphine) and are distributed via pharmacy.
Fentanyl

Fentanyl is a highly lipid synthetic opioid that does not cause histamine release. Fentanyl like morphine is a strong Mu agonist and administered intravenously and epidurally for the treatment of acute pain. Fentanyl is metabolised in the liver and has no active metabolites, thus making it a more appropriate opioid for patients with renal impairment. It differs from morphine in terms of onset and duration of action. When given as a single IV bolus its onset is faster (1-5 minutes) and its duration is shorter at less than one hour as the drug moves from blood to muscle to fat. Repetitive dosing or a continuous infusion achieves a steady state. Fentanyl has a reported half life of approximately 3-4 hours. Respiratory depression and apnoea can occur with rapid IV administration of fentanyl. Because of its fast onset this occurs usually within minutes of administration.

N-methyl-D-asparate (NMDA) Antagonist

Ketamine

Ketamine is a dissociative NMDA antagonist anaesthetic agent capable of producing amnesia and marked analgesia. Sub-anaesthetic doses of ketamine have been shown to produce safe and effective pain control during a wide variety of procedures ranging from debridement and grating of burn wounds to transport of patients with overwhelming pain. Advantages of ketamine include rapid onset (30 seconds) and less respiratory depression at subanaesthetic doses than opioids.

A combination of ketamine in low doses with morphine delivered via IV PCA provides superior pain relief at lower dosage of morphine and with fewer side effects than when using morphine alone. Morphine plus ketamine is both a safe and effective means of providing superior post operative analgesia.

At Christchurch Hospital the usual adult dose of ketamine prescribed to PCA is 1 mg per ml.

A2 Adrenergic Agonist Drugs

A2 Adrenoreceptors (or A2 receptors) are located on periphery sensitive nerve terminals, and in the spinal cord and brain stem. They have an inhibitory effect on pain transmission.

Clonidine (Catapres)

Clonidine is the A2 agonist most commonly used in clinical practice. Approximately 50% of Clonidine is metabolised in the liver, the remainder being excreted unchanged by the kidney. Like Ketamine, Clonidine has an opioid sparring effect when used in combination with an opioid. The usual adult dose of Clonidine prescribed to PCA is 1mcg per ml.
4. CO-ANALGESICS

Non Steroidal Anti Inflammatory Drugs (NSAIDs)

NSAIDs act as potent prostaglandins synthetase inhibitors and possess analgesic, anti-platelet and anti-inflammatory properties. They have their main pharmacological action in the periphery where the pain originates however they do have some activity in the central nervous system as well. They do not bind to the narcotic receptor sites and tolerance or physical dependence does not develop with the use of these drugs.

NSAIDs have a ceiling effect in that increasing their dose beyond a certain level does not produce additional analgesia although it may increase the duration of effect. Also it is known that there is a definite correlation between serum blood levels of an NSAID and it’s clinical efficacy.

It is known that NSAIDs inhibit platelet aggregation by affecting prostaglandin synthesis through a reversible mechanism. This is in contrast to aspirin, which has an irreversible effect on platelets. Thus the inhibitor of platelet aggregation by NSAIDS only lasts as long as there is an effective drug concentration. All NSAIDS by this action of platelet inhibitor can make the patient more prone to bleeding.

NSAIDS may also cause drug induced renal inefficiency and nephrotoxicity probably by blocking intrarenal vasodilatory prostaglandins. Patients who are most at risk for developing acute renal failure when treated with NSAIDS are those with congestive heart failure, chronic renal insufficiency and patients being treated with diuretics.

Gastrointestinal side effects such as indigestion, reflux, bleeding ulceration and perforation may occur in patients treated with NSAIDS. Interestingly women appear to be at greater risk than men. If NSAIDS are taken with, or immediately after meals the adverse effects may be lessened, however antacids when administered with NSAIDS can reduce the absorption of the NSAID and therefore its effectiveness. With the advent of Cox 2 inhibitor NSAIDS such as Celebrix and gastrointestinal side effects have been significantly reduced.

NSAIDS are contraindicated for use in the asthmatic patient because of prostaglandin implications in the mechanism of bronchi spasm.

Paracetamol (Acetaminophen)

Although technically an NSAID acetaminophen (paracetamol) is only a weak inhibitor of peripheral prostaglandin synthesis. Its action is believed to result from inhibition of prostaglandin synthesis within the central nervous system. Paracetamol is analgesic and antipyretic but only weakly anti inflammatory. When given REGULARLY paracetamol has a significant opioid sparing effect. Therefore all patients (unless contraindicated) receiving IV PCA should be prescribed regular paracetamol (adult dose 4gm/24hrs) as soon as practicable.

Paracetamol (Perfalgen) is also available in intravenous form (10mg/ml). Administer undiluted over 15 minutes.
OPIOIDS

Morphine Sulphate Tablets (M.S.T.)

For those patients who are already taking M.S.T. tablets pre PCA therapy their usual dose should be continued whilst PCA administration is in progress.

For your interest, the formula for converting intravenous morphine dosage to an equi analgesic oral morphine dosage is:

- Total IV dosage over 24 hour period eg 120mg
- Double this amount ie 240mg
- Split into two daily doses ie 120 B.D.

**M.S.T. dose will be 120mg B.D.**

Footnote:
Acute Pain Teams will usually factor a safety margin into this equation on the premise that it is better to initially underdose slightly than overdose. For the above equation we would commence the dose at 100mg B.D. in the first instance

Oxycodone

Oxycodone is a potent analgesic with a similar pharmacology to morphine. It is indicated in the use of moderate to severe pain and is a useful alternative to morphine. Oxycodone has a higher oral bioavailability than morphine (70 – 80%) as opposed to morphines (20 – 40%). Oxycodones plasma half life is approximately the same as morphine (3 hours). It is metabolised by the liver and excreted by the kidneys.

Oxycodone is available in two forms:

(i) **Oxycontin** tablets analgesia **continuous** (slow release).
(ii) **OxyNorm** capsules analgesia **now** (immediate release).

**Oxycontin capsules (slow release)**

- Available 5mg, 10mg, 20mg, 40 mg, 80mg
- Has a biphasic absorption pattern. A quick immediate release followed by a slower release phase – when converting from immediate to slow release there is no need to give the last dose of immediate release with the first dose of slow release.
- Like morphine the slow release formulation is given 12 hourly.

**Oxynorm tablets (immediate release)**

- Available 5mg, 10mg, 20mg , also available by injection 10mg/ml or 20mg/ml for subcutaneous or intravenous injection.
- Like morphine the immediate release preparations are given 4 hourly (perhaps 6 hourly).

**Weak Opioids**

**Codeine Phosphate**

Codeine is a naturally occurring alkaloid like morphine. It is metabolised in the liver where 5 – 10% of the dose is converted to morphine. This probably accounts for the main analgesic action of codeine as the drug itself has a very low affinity for opioid receptors. Codeine is usually given for the treatment of mild to moderate pain. About 10 – 15% of the population lack the enzyme necessary to convert Codeine to Morphine. For these people, Codeine will be ineffective.

For patients who are receiving IV PCA opioids oral codeine is **not recommended** until the PCA regime is finished.

**Tramadol (Tramal)**

Tramadol is a synthetic centrally acting analgesic with a unique mode of action displaying both weak opioid and non opioid properties. The opioid properties relate to mu, kappa and delta opioids receptor antagonism with a 20 fold preference for the mu receptor. The non opioid properties result from stimulation of serotonin release and inhibition of re uptake of nor adrenaline both of which are neurotransmitters involved in the activation of descending inhibitory pathways which modulate nociception (pain). Taken parenterally Tramadol is approximately one tenth as potent as morphine and is usually prescribed as an alternative to codeine.

Tramadol is usually administered in doses of 50 – 100mg, 4 – 6 hourly (adult), however because of its high association with nausea it is important to start the dose off low (eg 50mg) and increase it over time.

Tramadol is also available in intravenous form 50mg in 1ml (usually prescribed in 100ml NaCL and given over 30 minutes).

**Opiate Antagonist**

**Naloxone (Narcan)**

An opioid antagonist acts at all receptor sites. The most commonly used of these drugs is Naloxone.

Naloxone (Narcan) 0.4mg Ampoule

By titrating the dose of naloxone it is possible to reverse opioid induced respiratory depression and excessive sedation while still retaining reasonable analgesia. The initial dose of 40 – 100 mcg is given intravenously and repeated every few minutes as required. If for any reason there is no venous access available naloxone can be given in larger doses (eg 400 mcg) by subcutaneous or intramuscular injection. If a patient is on chronic opioid therapy it is especially important to titrate the doses of naloxone to avoid precipitation of withdrawal signs and symptoms. It is important to...
realise that naloxone has a short duration of action (less than one hour) therefore there is a risk of patient renarcotisation.

Rapid reversal with naloxone may cause hypertension, tachycardia, nausea and vomiting, and potentially a return of pain.

**Low dose Naloxone as an adjuvant to opiates**

Recent pre-clinical and clinical studies have demonstrated that co treatments with extremely low doses of opioid receptor antagonists such as Naloxone enhance the efficacy and specificity of morphine. In addition it has also been demonstrated that an attenuation of development to tolerance and several adverse side effects of morphine such as vomiting and pruritis may be reduced by approximately 40%.
5. ADDITIONAL INFORMATION FOR ANALGESIA IN CHILDREN
   (notes prepared by Dr Peter Kempthorne, Specialist Anaesthetist)

Introduction

Children require slight different protocols because they are:

1. Unable to take responsibility for their analgesia themselves
2. The adult doses are based on an average weight. All doses for children need to be adjusted on a dose per kilogram basis.
3. Assessment techniques for pain in children vary with age.

IV Bolus Morphine

This is commonly prescribed when analgesic requirement is uncertain. It is a useful interim measure until a definitive analgesic technique is decided. The basis is for boluses of 20 mcg/kg to be given until a satisfactory level of analgesia is established with adequate time to assess the child’s response to the drug.

Patient Controlled Analgesia

Children from six years will potentially be able to use PCA. Exclusions may be delayed development and some physical disabilities.

It is important for parents to realise that it is patient-controlled and not parent-controlled analgesia.

In some clinical situations it is appropriate to use the PCA pump to give nurse-administered boluses. An example is where the only access is a central venous line and using the PCA allows bolusing without breaching the integrity of the line.

The variable weight of children means that the concentration in the syringe is individually chosen for the patients. A dose of:

| 1mg/kg morphine in 50mls 0.9% Saline |

A bolus size of 1 ml gives a bolus of 20g/kg.

A background infusion with PCA boluses on top leads to unpredictable episodes of sedation and for this reason children with a PCA with background infusion must be in PHDU or in CHOC.

| Background Rate: 0.5mls/hr = 10mcg/kg/hr |
Summary of PCA

1mg/kg Morphine in 50 mls = 20mcg/kg/dose
Bolus Size 1 ml
Delay time 5 mins
Background Rate 0.5ml/hr = 10mcg/kg/hr
One hour limit 12 ml/hr

Figure Ten: The connections for Paediatric PCA
6. SIDE EFFECTS OF OPIOIDS

The opioids commonly used for pain management act primarily at Mu (μ) receptor sites and therefore all have a similar spectrum of side effects. In equianalgesic doses and in most patients the incidence of side effects is generally very similar regardless of the opioid used.

<table>
<thead>
<tr>
<th>Opioid Receptors</th>
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<tbody>
<tr>
<td>Receptor</td>
</tr>
<tr>
<td>Mu (μ)</td>
</tr>
<tr>
<td>Kappa (κ)</td>
</tr>
<tr>
<td>Delta (δ)</td>
</tr>
<tr>
<td>Sigma (σ)</td>
</tr>
</tbody>
</table>

Macintyre, Ready (1996)

**Opioid Effects on the Respiratory System**

Opioids can affect ventilatory pattern in a number of ways which may result in progressive clinical respiratory depression indicative of excessive opioid dose, or in episodes of intermittent hypoxemia which may develop with doses that are not excessive. The effects that can occur are:

- upper airway obstruction (obstructive apnoea)
- a decrease in respiratory rate and/or changes in respiratory rhythm
- a decrease in tidal volume

With normal respiration an increase in tone of the muscles of the upper airway precedes contraction of the diaphragm and inspiration. In the presence of opioids and sleep this coordination can be abolished and closure of the upper airway on inspiration may result. This may manifest itself in snoring (partial upper airway obstruction) or complete upper airway obstruction.

Opioids also directly depress the respiratory centre resulting in decreases in respiratory rate and tidal volume.

**Respiratory Depression**

Respiratory depression is a relatively uncommon (though much feared) complication of opioid administration. Traditionally respiratory rate has been used as an indicator of clinical respiratory depression but a *decrease in respiratory rate is now recognised to be a late and unreliable sign.*
A normal respiratory rate may co-exist with marked respiratory depression. The best indicator of early respiratory depression is sedation.

The sedation is presumed to be a combined effect of the opioid and the increase in $\text{PCO}_2$ level. Sedation can be monitored using a sedation score.

When respiratory rate is counted it should be the unstimulated rate that is before the patient is roused. In general a rate of less than 8 per minute is considered to indicate respiratory depression although as mentioned before respiratory depression can co-exist with a normal respiratory rate.

The administration of sedatives (including benzodiazepines and antihistimines) will markedly increase the risk of respiratory depression and they should not routinely be given to patients receiving opioids. If sedatives are considered necessary smaller than normal doses should be used in the first instance.

As well as increasing the risk of respiratory depression the addition of a sedative can make it impossible to give sufficient opioid to achieve patient comfort without causing excessive sedation.

**Pain Antagonises Respiratory Depression**

Pain is an effective antagonist to opioid induced respiratory depression. If a patient has received a large dose of opioid as treatment for pain and then for example a local anaesthetic block is given to manage that pain onset of the block may be followed by respiratory depression. A similar result may follow the cause if the pain is removed. For example the opioids self administered by a patient using PCA for the abdominal pain caused by urinary retention may cause respiratory depression when a urinary catheter is inserted and the pain settles.

All opioids in equianalgesic doses cause the same degree of respiratory depression. If opioids are properly titrated the risk of respiratory depression is small.

**Sedation/Respiratory Depression (guide)**

- Check no other reason for sedation (eg administration of a sedative).
- Sedation score = 2 respiratory rate $\geq 8/\text{min}$ halve the bolus dose.
- Sedation score = 2 respiratory rate $< 8/\text{min}$ halve the bolus dose. If close supervision of the patient is not possible, consider administration of Naloxone 100ug IV and repeat PRN.
- Sedation score = 3 (regardless of respiratory rate give Naloxone 100ug IV and repeat PRN, cease PCA until patient is more awake. Restart at half the dose.
**Opioids Effects on the Central Nervous System**

**Nausea and Vomiting**

Opioids cause nausea and vomiting by stimulation of the chemo receptor trigger zone in the medulla and the effects are enhanced by vestibular stimulation. Opioids also increase vestibular sensitivity. Even slight movement such as turning the head may be enough to trigger nausea and vomiting in some patients. For this reason drugs that are used for motion sickness such as transdermal scopolomine are sometimes useful in the treatment of opioid induced nausea and vomiting.

The patient on PCA very quickly realises that the opioid is causing nausea. A direct association is formed between pushing the button for pain relief and nausea occurring and they stop using the PCA. If it comes to a choice between having pain or having nausea/vomiting patients will opt for the pain everytime. It is this direct association between obtaining pain relief via the PCA and nausea occurring that is the giveaway the opiate is indeed the culprit.

Larger doses of opioid are more likely to cause nausea and vomiting than smaller ones so trial of a reduction in dose may be appropriate as well as the administration of the better anti emetics now available eg ondansetron. Antiemetics may be prescribed by the APMS to be added to the PCA syringe facilitating a combined dose of opioid and antiemetic with each dose administrated. Individual patients may be more sensitive to one particular opioid so changing to another opioid is worth considering if other measures have failed.

Opioids are not the only cause of post operative nausea and vomiting (PONV), other factors that have been shown to influence the incidence of PONV are patient age, gender, phase of menstrual cycle, anxiety, a full stomach, type and duration of surgery, history of motion sickness or previous PONV, anaesthetic drugs and movement of the patient.

**Nausea and Vomiting Summary**

Administer antiemetics and add additional antiemetics if ineffective.

**Recommendations (Adult)**

1. Ondansetron 4mg IV Q8Hrly do not repeat if an initial does is ineffective or within 6 hours of any intraoperative dose.
2. Droperidol 1.25mg in 50ml PCA syringe can be very effective.
3. Cyclizine 25mg IV Q8Hrly. **NB** reduce dose in elderly, avoid Cyclizine in confused patients, those with heart failure, day surgery patients and neurosurgical patients. Be cognizant of sedative effects of Cyclizine.
4. Consider Dexamethesone 4 – 8mg single dose if patient has not received it in theatre (avoid diabetics/ clear with medical team first re any other contraindications).
5. Consider scopoderm patch.(may cause dry mouth)
6. Consider metoclopermide
• If nausea seems related to the PCA demand, try reducing the size of the bolus dose (if requirements are low).
• Consider other possible causes (e.g., ileus).
• Rotate to another opioid.

Miosis, Sedation, Euphoria, Muscle Rigidity and Confusion

Opioids cause constriction of the pupils (miosis) (pethidine does not cause miosis, it is the exception), and sedation, but it is important to remember that any sedation may indicate respiratory depression. While a mild euphoria may be associated with opioid administration, dysphoria and hallucinations occur occasionally. If hallucinations are caused by the opioids the patient usually has insight into this, that is they realise they are hallucinating and they realise it is not reality but they cannot stop them. Many patients on PCA experience particularly vivid dreams and in some cases nightmares, it is important to ask patients on PCA if they are having any such dreams and if so is it frightening for them.

Muscle rigidity (myoclonus) has been reported following large doses of opioid. Be very vigilant with patients on PCA pethidine who exhibit this symptom. It may be an early sign of norpethidine toxicity.

Post-operative confusion is often blamed on opioids but opioids in therapeutic doses are usually not the cause or at least not the sole cause. A common and often easily reversible reason for post-operative confusion is hypoxia. Other causes of confusion include sleep deprivation, withdrawal from alcohol and other drugs and sepsis. Elderly patients may become confused when placed in an unfamiliar environment.

Pruritis

Some opioids cause histamine release from mast cells which may result in local or generalised itching. If these opioids are given by intravenous injection a localised urticaria may sometimes be seen at the site of injection or along the track of the vein into which the drug is being injected. This is due to local histamine release and does not usually indicate a true allergy to the opioid.

Although the exact mechanism of action is not known, pruritis due to opioids may be centrally mediated presumably as a consequence of Mu receptor activation. It is not associated with a rash and is not an allergic response to the drug. It is more common in obstetric patients as a result of oestrogen interaction with the opioid receptors.

Pruritis is sometimes generalised all over the body but usually is located to the face, neck or upper thorax. It is more common with morphine than pethidine or fentanyl and does not always require treatment. If the patient is disturbed by this side effect the safest treatment in the first instance is to change drugs. Antihistamines because of their sedative effects may add to the risk of sedation and respiratory depression. Pruritis may also respond to small carefully titrated doses of intravenous naloxone.

Pruritis (summary)

Developed by: Richard Craig, Clinical Pain Nurse Consultant, Acute Pain Management Service
For Department of Nursing, Christchurch Hospital, CDHB
Last Updated: June 2011-07-04
• Check pruritis is likely to be opioid related.
• Consider a change (rotation) to another opioid.
• Naloxone IV (adult 10 – 20mcg Q15 min, PRN max 4 doses).
• Antihistamines may increase the risk of sedation and may not be effective as the pruritis is thought to result from an action on opioid receptors rather than histamine release.

**Opioid Effects on the Cardiovascular System**

Opioids cause arterial and venous dilation by a direct effect on vascular smooth muscle. Some opioids notably morphine, diamorphine (heroin), pethidine and codeine may release histamine which will also lead to vasodilation. If a significant decrease in blood pressure is seen following administration of an opioid in a supine patient it is often because the patient is also hypovolemic.

Opioids can also produce a vagally mediated bradycardia. The exception is pethidine which may cause a slight tachycardia due to its atropine like effects.

**Opioid Effects on the Gastrointestinal and Genito Urinary Systems**

**Constipation**

Opioids alter smooth muscle activity leading to delayed gastric emptying, inhibition of bowel motility and constipation. This inhibition is both locally and centrally mediated. While some decrease in bowel motility is inevitable it is usually not necessary or appropriate to withhold opioids to facilitate the return of bowel function after surgery.

Constipation is the most common opioid side effect and the only one for which individuals do not develop tolerance, thus it requires a preventative approach, regular assessment and aggressive management.

**Constipation Summary**

• Anticipatory treatment where possible.
• Discourage use of PCA to cover discomfort resulting from resumption of penstalsis.
• If pain becomes severe, consider bowel obstruction.
• Encourage mobilisation.
• Peppermint capsules (Colpermin – available from pharmacy) may be as effective as anticholenergic drugs such as Hyoscine and have fewer side effects.

**Patients with obstructive sleep apnea**

Developed by: Richard Craig, Clinical Pain Nurse Consultant,
Acute Pain Management Service
For Department of Nursing, Christchurch Hospital, CDHB
Last Updated: June 2011-07-04
The prevalence of obstructive sleep apnea (OSA) in the adult population is surprisingly high: approximately one in five adults has at least mild OSA, and one in 15 has moderate to severe OSA. Importantly in the acute pain setting, around three-quarters of those who could benefit from treatment remain undiagnosed.

There is little good evidence to guide the ‘best choice’ of acute pain management regimen in patients with OSA. Non opioid analgesics and regional analgesic techniques are usually recommended, either as the sole means of pain relief or in addition to opioids, because of concerns that the patient with OSA is at increased risk of opioid-induced respiratory depression and hypoxia if given opioid or sedative drugs.

However, many patients who have undiagnosed OSA will be given opioids for the management of their acute pain. It is therefore essential that any opioid administered to any patient is titrated safely. This requires the use of appropriate doses, the avoidance of a background infusion with PCA (at least in the initial stages of therapy, or unless the patient is opioid tolerant), close monitoring of the patient’s level of sedation, and a reduction in opioid dose +/− IV naloxone should the patient become excessively sedated eg (sedation score = 2 or 3 ), regardless of their level of pain.

Supplemental oxygen given to patients with OSA (not in a perioperative setting) has been shown to be as effective as CPAP (continuous positive airway pressure) in reducing the risk of significant hypoxemia. The routine use of supplemental oxygen would therefore seem appropriate in all patients with OSA (or suspected of having OSA) and receiving opioids for the treatment of their pain.

**Urinary Retention**

Opioids may cause urinary retention, again because of alteration in smooth muscle activity. This may necessitate catheterisation.

**Discontinuation of PCA**

Ideally the decision to discontinue PCA should be the patients. The APMS, primary nurse and medical staff should also have input into this decision. A good knowledge of the patients pain status and the patient having pain levels that are acceptable to them are integral in the decision to discontinue PCA.

Bear in mind that a general trend in diminishing requirement for analgesia via PCA should be evident before cessation and adequate oral analgesics should be prescribed. Routine cessation of PCA should be done mane not in the pm or night shifts.
Registered Nurse Assisted Dosing of Patient Controlled Analgesia (NAA)

Nurse assisted analgesia via PCA is intended for use in the situation where a co-operative patient requires assistance to utilise the PCA. It is not intended to be another way of giving manual IV opioid increments.

Patients who have been assessed by the Acute Pain Management Service or their primary nurse as not optimally utilising PCA and who would be capable of learning how to do so if they had a bridging period where the nurse assisted them in the use of the PCA should have the opportunity to receive NAA.

The authority for commencement of NAA lies with the APMS.
7. GENERAL GUIDELINES (PCA)

**Patient Education**

The decision to use PCA should be made preoperatively so that the patient can receive instruction in its use. Obviously, only patients able to comply with instructions are suitable candidates for PCA.

The patient should be instructed in:

- a) The rationale of PCA
- b) Use of the pump
- c) Explanation of safety features
- d) Explanation of monitoring eg pain, respiration, sedation scores
- e) Likely duration of therapy

This instruction should be given by a Ward Nurse assessed as competent in PCA procedure. The PCA patient information brochure includes the above and should be given to each patient due to have PCA as well.

1. Naloxone 0.4mg should be readily available.
2. Oxygen is commonly ordered for the patient. Hypoxia due to respiratory depression, can cause problems more rapidly than hypercarbia.
3. A one way anti-reflex valve and antisiphon device are part of the PCA extension set. The primary IV infusion line is connected to this so that opioid cannot pass back up the drip line if the IV cannula becomes blocked. This system is primed in the usual way (to purge air from the tubing) before connection to the cannula.

**APMS Guidelines on PCA NAA**

1. Only Registered Nurses with a current IV Certificate may look after patients using a PCA.
2. An Anaesthetist will write and sign orders on the PCA Treatment Sheet (QMR004E) specifying the opioid used and programme prescription.
   - ml per injection
   - delay time (minutes)
   - basal rate ml/hr (usually zero)
   - one hour limit (mls)
3. Loading dose of opioid will usually be given in OT/Recovery Ward by Anaesthetist or Recovery Staff.
4. The key to the PCA pump is kept on the Controlled Drug key ring in each ward.
5. The PCA programme will be checked at each shift, after each syringe change and if QMRO04E sheets needs renewing (such as when completely used/full with recordings). For the latter instance the prescription will need to also be renewed – contact the APMS for this.
6. Inadequate analgesia (pain scores 3-5) requires review – contact the APMS.
7. Except for the case of Nurse Assisted Analgesia (NAA) the patient is the only person who is to push the PCA button
8. Excessive sedation (score 2 or over) or respiratory depression (< 8 breaths/mm) requires urgent intervention:
   - stop the pump
   - instruct patient to breath and/or assist with airway and ventilation with bag and mask if necessary
   - administer high flow O2
   - administer Naloxone 0.1-0.2mg increments 3 minutely till satisfactory respiratory rate. NALOXONE 0.4mg SHOULD BE AT THE BEDSIDE

APPENDICES

APPENDIX A  Adult PCA Treatment Sheet (QMR004E)
APPENDIX B  Child PCA Treatment Sheet (C260024) Information Sheet – Adult

REFERENCES