EPIDURAL ANALGESIA IN THE POSTOPERATIVE PERIOD

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ABSTRACT

Postoperative pain is an unwanted side effect of surgery, and is associated with many postoperative complications. This descriptive study was conducted to determine which surgical patients experienced the most analgesia with the fewest side effects when receiving epidural analgesia in the postoperative period. A retrospective chart audit of 200 surgical patients who received epidural medications for pain management was conducted. The sample was obtained from a 90-bed hospital. A description of the patients' age, gender, type of surgery, type of epidural medication, side effects, incidence of breakthrough pain, and treatments were recorded and cross-tabulated. The following surgical categories emerged: abdominal, orthopedic, thoracic, and lower extremity/vascular. Breakthrough pain was reported in 27% of the cases. Lower extremity/vascular surgery patients had the lowest incidence of side effects. Thoracic surgery patients had the highest incidence of breakthrough pain, and abdominal surgery had the highest incidence of nausea/vomiting, pruritis, and respiratory depression. Morphine and bupivacaine provided the best analgesia, but had the highest incidence of side effects.

Keywords: **Postoperative Pain Epidural Narcotics Opioid Local Anesthetics Side Effects**.

EPIDURAL ANALGESIA IN THE POSTOPERATIVE PERIOD

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PREFACE AND FOREWORD

This research was conducted to determine if any relationships exist between the types of surgery, efficacy of epidural analgesia, and the occurrence of side effects. It was designed to provide a foundation for those health care providers who manage postoperative pain to ensure adequate pain relief is achieved with the fewest side effects.

DEDICATI ON AND ACKNOWLEDGEMENT

To the most important people in our lives, we dedicate the creation of this thesis. Without their love, encouragement, and support, the attainment of a dream and the creation of this would not have been possible.

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CHAPT ER I: INTRODUCTION

Background

Postoperative pain is a significant problem. Dahlman, Dykes, & Elander, (1999) Cite several studies where patients received inadequate analgesia after surgery (Bamberger et al.; Brown & Mackey; Closs et al.; and Elander et al. [as cited in Dahlman et al.]). Bell (1999) found that 58.9% of the patients in her study had breakthrough pain.

Ineffective postoperative analgesia causes human suffering and increases healthcare costs. Postoperative pain may lengthen a patient's recovery by causing adverse respiratory, cardiovascular, gastrointestinal, urinary, and neuroendocrine systems effects. Postoperative pain is also a major source of fear and anxiety in hospitalized patients (Ready, 2000).

Pain is difficult to define because it is a subjective phenomena. McCaffery and Beebe (1989) define pain as whatever the person experiencing it says it is and existing wherever the person says it does. The International Association for the Study of Pain defines pain as (an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage) (as cited in Ready, 2000, p. 2324). Therefore, pain is a unique and personal experience; so alleviating postoperative pain is a complex problem (Leinonen, 1999).

Nurses in general and Certified Nurse Anesthetists (CRNAs) in particular are in a position to improve postoperative analgesia. The assessment and management of postoperative pain has become an important domain of nursing practice (White, 1999). The author states that nurses spend more time with patients in pain than any other health professional. The nurse is usually the first person to hear about the patient's pain and is

the professional on hand to assess the pain, intervene, and evaluate the effectiveness of the intervention. CRNAs are specially trained in pain management. In fact, it is listed as one of their capabilities in the Professional Practice Manual for the CRNA (American Association of Nurse Anesthetists, 1999) "The CRNA scope of practice includes, but is not limited to….Ordering, initiating, or modifying through the utilization of drugs, regional anesthetic technique, or other accepted pain relief modalities...", (p. 3). DeVane (1996) states that it is at the core of every nurse anesthetist's professional and ethical obligation to manage pain and alleviate suffering.

Frenette (1999) found that the inadequate treatment of postoperative pain was more often due to improper application of available therapies than to the unavailability of effective drugs and techniques. He found that the establishment of an acute pain service improved the safety and efficacy of postoperative pain control. This involved using specially trained nurses and physicians, and increasing staff education. This is consistent with White's (1999) findings that a Clinical Nurse Specialist (CNS) improved acute pain management after spinal surgery. Ready (2000) also states that postoperative pain management utilizing a collaborative team practice model is becoming commonplace.

Carr and Thomas (1997) describe the two current categories of postoperative pain management techniques as either pharmacological or nonpharmacological. Nonpharmacological methods involve strategies such as distraction, use of touch, empathy, and support to help the patient cope with the pain. Pharmacological involves the use of primarily opioids. The opiods may be given intramuscularly (IM), intravenously (IV), orally (PO), subcutaneously (SQ), rectally (PR), subarachanoid (SAB), or epidurally. Most of the routes described require that the medication be

administered by a trained professional, usually a registered nurse. Some routes such as IV, SQ, and epidural routes may employ the use of a patient controlled analgesia (PCA) device. Epidural analgesia involves the administration of medication or medications into the epidural space (Brown, 2000). Frenette (1999) found that epidural analgesia has the most positive effect on postoperative pain control.

Physiology of Postoperative Pain

The sensation of pain begins in receptors named nociceptors (Sorkin & Wallace, 1999). Nociceptors are unencapsulated nerve endings that are activated in response to stimuli that threaten or actually produce tissue damage. These nociceptors are innervated by small-diameter myelinated (Adelta) or unmylinated (C) fibers. The nociceptors are juxtaposed with small blood vessels and mast cells. The three together comprise the functional unit in pain modulation. When the nociceptor is activated, neurotransmitters including substance P and glutamate are released into the periphery. Tissue injury can also result in increased local concentrations of arachidonic acid metabolites (prostaglandins and leukotrienes). These substances can either activate C fibers, degranulate mast cells, or lead to plasma extravasation and perhaps edema.

Pain sensation depends on stimulating fibers that are specific for signaling real or impending tissue damage (Sorkin & Wallace 1999). Adelta fibers produce a brief prickling sensation (first pain). C fibers produce a poorly localized burning sensation (second pain). Only stimulation of fibers connected to nociceptors produces pain. Stimulation of fibers connected to other receptor types never results in pain.

The peripheral afferent neuron, termed the first-order neuron, has its cell body located in the dorsal root ganglion and sends axonal projections into the dorsal horn and

other areas of the spinal cord. At this point, a synapse occurs with a second-order afferent neuron, which can be categorized, depending on the afferent input they receive, as nociceptive-specific or wide-dynamic-range neurons. Nociceptive-specific neurons process afferent impulses only from nociceptive afferent fibers, whereas Abeta, Adelta, and C fibers communicate with wide-dynamic-range (WDR) neurons. WDR cells take their name from their ability to respond in a graded fashion to both innocuous and noxious stimuli over a wide range of stimulus intensities (Sorkin & Wallace, 1999).

The dorsal horn of the spinal cord is divided into laminae based on the types of neurons and their organization. These include lamina I (the marginal zone), lamina II (substantia gelatinosa), and laminae III-VI (nucleus proprius). The principal spinal cord target of somatic C nociceptors is ipsilateral lamina II, whereas Adelta nociceptors terminate in ipsilateral lamina I and to a lesser extent, lamina V. C nociceptors from the viscera have a more diffuse projection to lamina II that is spread out over several segments, as well as bilateral projections to lamina V and X. These projection patterns correspond to the dorsal horn areas, with the highest concentrations of cells receiving nociceptive input. This widespread distribution of the visceral C fibers is thought to account for the diffuse quality of visceral pain (Sorkin & Wallace, 1999)

Sorkin and Wallace (1999) state that there is a relationship between afferent fiber input and spinal cord output to the brain leading to pain perception. However, even in the processing of acute nociceptive input, this relationship is not immutable, and the output is dependent on far more than the hard-wiring. The behavioral relevance of the signal, attention, movement, and previous experience are all factors. Plasticity of the input-output relationship is the function of several types of modulation; some produce increases

in the gain of the system (hyperalgesia) or reduce the threshold (allodynia), whereas others decrease the output (analgesia).

One characteristic of some cells with convergent input from A and C fibers (usually WDR cells) is a phenomenon called windup. Normally spinal cells have a fixed stimulus-dependent response to a defined stimulus. In certain cells, if the stimulus activates C fibers and is repeated at frequencies of more than 0.33 Hz, the cellular response increases in both magnitude and duration. Windup seems to co-vary with a progressive and sustained partial depolarization of the cell. This brings it closer to threshold and allows smaller afferent inputs to result in action potentials (Sorkin & Wallace, 1999).

Both windup and most forms of central sensitization are thought to be initiated by the co-release of neurokinins, particularly Substance P working at Neurokinin1 (NK1) receptors and excitatory amino acids most likely via an N-methyl-D-aspartate (NMDA) receptor link. Windup is blocked by NMDA receptor antagonists and specific NK1 receptor antagonists. Drugs that suppress windup include the opioids, alpha$_2$-agonists, and the N-type calcium channel blockers. The opioids bind to mu receptors in the substantia gelatinosa to block neurotransmitter release from C fibers and to hyperpolarize nociceptive dorsal horn neurons (Sorkin & Wallace, 1999).

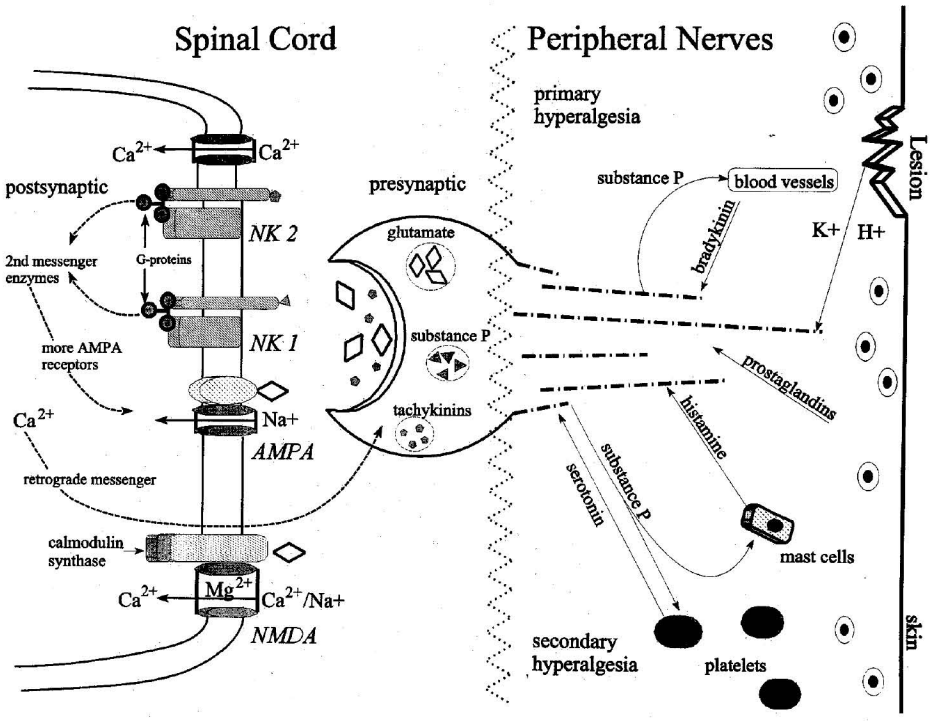

Figure 1.

Illustration of windup, primary, and secondary hyperalgesia.

Supraspinal transmission of nociceptive signals involves transmission of the action potential along the second-order neuron through the lateral spinothalamic tract. Along the way this neuron divides and sends axonal branches that synapse in the regions of the reticular formation, nucleus raphe magnus, periaqueductal gray, and other areas in the brain stem. In the thalamus, the second-order neuron synapses with a third-order afferent neuron, which sends axonal projections into the sensory cortex (Lubenow, Ivankovich, & McCarthy, 1997). Refer to Figure 2 for a graphical illustration of the ascending pain pathway.

Supraspinal modulation of nociception involves descending inhibitory tracts at the brain stem level which originate from cell bodies located in the region of periaqueductal gray, reticular formation, and nucleus raphe magnus. These inhibitory tracts descend into the dorsolateral fasciculus and synapse in the dorsal horn. Neurotransmitters act presynaptically on the first-order neuron and postsynaptically on the second-order neuron of spinothalamic tract or on the internuncial neuron pool. Internuncial neurons can be inhibitory in nature and can regulate synaptic transmission between primary and secondary afferent neurons in the dorsal horn. One group of fibers involved in this inhibition involves the opioid system and contains the neurotransmitters beta-endorphin and enkephalins as well as other neuropeptides. These opiod projections from the nucleus raphe magnus and reticular formation interface presynaptically with the first-order afferent neurons. Neurotransmitters released from these projections hyperpolarize the Adelta and C fibers, which serves to negate or shunt out the depolarizing current that approaches the terminal end plate, thereby diminishing the release of neurotransmitters such as substance P (Lubenow et al., 1997). Refer to Figure 2 for a graphical illustration of descending modulating pathways.

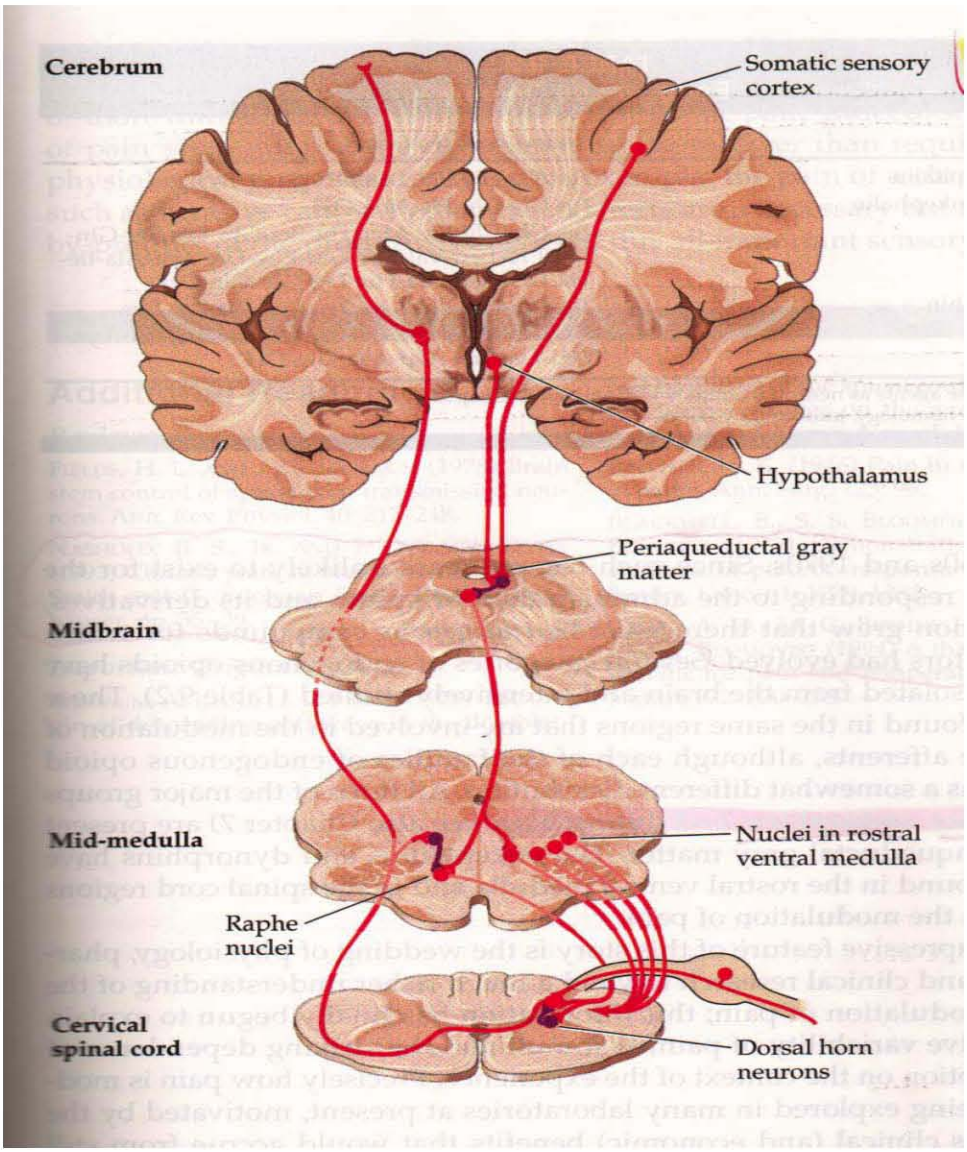

Figure 2.
Pain pathways. Note: The ascending pain pathway is shown on the left side. The descending, modulating pathways are shown on the right side.

The physiology of pain modulation at higher cerebral levels is complex and involves an individual's perception of the pain. The cerebral cortex has several interconnections that communicate with the reticular formation, periaqueductal gray, and other structures in the brain

and brain stem. Perception is the phenomenon by which noxious stimuli reach consciousness in the cerebral cortex. Perception can be divided into cognition and attention. Cognitive modulation of pain involves the patient's ability to relate a painful experience to another event. For example, pain experienced in a pleasant environment elicits less pain response than pain experienced in a setting of depression. Whereas attention operates on the premise that only a fixed number of afferent stimuli can reach cortical centers. If a patient in pain concentrates on a separate and unrelated image, it is possible to reduce the effect of a painful sensation (Lubenow et al., 1997).

Surgery produces local tissue damage with the consequent activation of nociceptors (Ready 2000). The impulses are then transmitted via the Adelta and C nerve fibers to the dorsal horn of the spinal cord (neuraxis). Here the nerve fibers transmit to the anterior and anterolateral horns of the spinal cord to provoke segmental reflex responses. Other nerve fibers transmit the impulses to higher cortical centers via the spinothalamic and spinoreticular tracts, where they elicit cortical responses. Segmental reflex responses to surgery include increased skeletal muscle tone and spasm with associated increased oxygen consumption and lactic acid production. Stimulation of the sympathetic neurons causes an overall increase in metabolism and oxygen demand. Cortical responses include increased anxiety and apprehension resulting in additional hypothalamic stimulation.

Implications of Postoperative Pain

Postoperative pain may cause several adverse effects in the surgical patient (Ready 2000). Postoperative pain may cause cardiovascular, pulmonary, gastrointestinal and urinary dysfunction. The deleterious effects arise from the body's response to pain.

Surgical stress and pain elicit a consistent and well-defined metabolic response, involving release of neuroendocrine hormones and cytokines that leads to a myriad of detrimental effects. In addition to the rise in catabolically active hormones such as catecholamines, cortisol, angiotensin II, and antidiruretic hormone, stress causes an increase in the levels of adrenocorticotropic hormone, growth hormone, and glucagon. The stress response results in lower levels of anabolic hormones, such as testosterone and insulin. Finally, catecholamines sensitize peripheral nociceptive endings, which serve to propagate more intense pain and may contribute to a viscious pain-catecholamine release-pain cycle (Lubenow et al., 1997).

The cardiovascular effects of pain are initiated by the release of catecholamines from sympathetic nerve endings and the adrenal medulla, of aldosterone and cortisol from the adrenal cortex, and of antidiuretic hormone from the hypothalamus, and by activation of the renin-agiotensin system. These hormones have direct effects on the myocardium and vasculature, and they augment salt and water retention, which places a greater burden on the cardiovascular system. This results in subsequent tachycardia, increased stroke volume, cardiac work and myocardial oxygen consumption. Therefore, the risk of myocardial ischemia or infarction may be increased (Ready, 2000).

Increases in extracellular lung water may contribute to ventilation-perfusion abnormalities. Surgical procedures performed on the thorax and abdomen may cause pain-induced reflex increases in skeletal muscle tension which may lead to decreased total lung compliance, splinting, and hypoventilation. These changes promote atelectasis, contribute to further ventilation-perfusion abnormalities, and result in hypoxemia. Hypoxemia typically stimulates increases in minute ventilation. Although tachypnea and

hypocapnia are common initially, prolonged increases in the work of breathing may result in hypercapnic respiratory failure. Pulmonary consolidation and pneumonitis may occur because of hypoventilation and further aggravate the clinical scenario. These sequelae are especially significant in patients with preexisting pulmonary disease, upper abdominal and thoracic incisions, advanced age, or obesity.

Studies have shown that pain-induced sympathetic hyperactivity may cause reflex inhibition of gastrointestinal function. This promotes postoperative ileus, which contributes to postoperative nausea, vomiting, discomfort and delays resumption of a regular diet. Failure to resume an early regular enteral diet may be associated with postoperative morbidity including septic complications and abnormal wound healing (Ready, 2000).

Urinary dysfunction results from an increase in sympathetic activity. This increased activity causes reflex inhibition of most visceral smooth muscle, including urinary bladder tone. This results in urinary retention with subsequent urinary tract infections and related complications.

Postoperative pain also causes adverse effects on the immune system, coagulation, and the patient's general well-being (Lubenow et al., 1997). The pain-related stress response suppresses both cellular and humoral immune function and results in lymphopenia, leukocytosis, and depression of the reticuloendothelial system. Stress-related effects to coagulation include increased platelet adhesiveness, diminished fibrinolysis, and promotion of a hypercoagulable states. These increase the risks of thromboembolic events when combined with the immobility of the postoperative period. Poorly controlled postoperative pain also contributes to insomnia, anxiety, and a feeling

of helplessness. These psychological factors create a postoperative atmosphere that has been feared by most patients.

Epidural Pharmacology

There are two major classes of medications which produce analgesia when administered epidurally. They are opiods and local anesthetics. The pharmacokinetics and pharmacodynamics of each class are different, and they may act synergistically when used concomitantly (Rawal, 1999). As previously described epidural analgesia involves epidural placement of medications to alleviate pain. A medication delivered into the neuraxis interferes with the pain pathways described in the previous text. An epidural block will also inhibit the sympathetic nervous system and the corticospinal system that controls motor functions of the body (Brown, 2000).

Local Anesthetics

There are two subgroups of local anesthetics, esters and amides. Esters have a shorter duration of action, are metabolized in the blood by pseudocholinesterases, and are more allergenic. Amides have a longer duration of action, are metabolized by cytochrome P450 in the liver, and not very allergenic (Miller, 1998).

Local anesthetics mechanism of action involves the reversible blockade of sodium channels in the neural axon. On the molecular level, a local anesthetic is comprised of three groups: a lipophilic group (usually an aromatic ring) connected to an intermediate chain, which is connected to an ionizable group (usually a tertiary amine). These medications bind reversibly to a receptor near the intracellular side of the axon membrane. The drug is in its uncharged form more readily penetrates the membrane. It

is the ionized form of the drug that is most active at the receptor site. These medications are weak bases with pKa's of 8.0-9.0 (Miller, 1998).

Opioids

Opioids are medications that are derived from the opium poppy, *Papaver somniferum*. Approximately twenty alkaloids are obtained from the poppy, with morphine being the most abundant. There are also synthetic opioids. These medications work at opioid receptor binding sites. Three types of receptors that have been identified are mu, delta, and kappa. The opioids have dissimilar affinities and effects at different receptor types. The mu receptor is named for morphine, and morphine has its strongest effect there. The principal site for analgesia is the mu receptor. These receptors are found primarily in the brain and in the spinal cord regions involved in the transmission and modulation of pain. A high concentration of opioid receptors is found in the dorsal horn of the spinal cord both presynaptically in the first-order neuron and postsynaptically on the second-order neuron. A high concentration of opioid receptors is also found in the ventral caudal medulla. Opioids may also reduce pain via the descending pain modulating pathways that project to the dorsal horn, most notably the substantia gelatinosa. There are also high concentrations of opioid receptors in the medulla, periaqueductal gray matter, and in the locus ceruleus (Way, Fields & Way, 1998).

Opioids produce analgesia by binding to the opioid receptors in the spinal cord and inhibiting the release of excitatory transmitters from the primary afferents and by directly inhibiting the dorsal horn pain transmission neurons. In the spinal cord, this is accomplished by closing a voltage-gated calcium channel on the presynaptic nerve terminal, or opening a potassium channel on the postsynaptic neuron, causing

hyperpolarization. Opioids have a different mechanism of action in the brain. They inhibit some neurons, but activate neurons that send impulses to the descending pain modulating fibers (Way et al., 1998).

Metabolism and excretion of opioids are accomplished via the liver and kidneys. One group of opioids, the phenylpipeidines, is metabolized in the liver via oxidation. However, morphine is conjugated in the liver with glucuronic acid to form an active metabolite. The opioids are converted to polar metabolites and excreted via the kidneys (Way et al., 1998).

Side Effects

Epidural analgesia using opioids may cause a variety of side effects. These side effects are dose dependent. The most common are: pruritis, urinary retention, decreased gastrointestinal (GI) motility, nausea and vomiting, and respiratory depression (Rawal, 1999).

The most common side effect is pruritis. It is theorized that pruritis is caused by cephalad migration of the drug in the cerebrospinal fluid (CSF) to the trigeminal nucleus in the medulla. The theory is that there is an "itch center" located there. The incidence is varied, but the risk of severe and distressing itch is <1%. Pruritis may be treated with antihistamines or naloxone. The naloxone also diminishes the analgesic properties of opioids (Rawal,1999).

Urinary retention may also be attributed to epidural analgesia and is theorized to be caused by opioid interaction in the sacral spinal cord. This inhibits parasympathetic outflow causing etrusor muscle relaxation. This causes increased bladder capacity and urinary retention. This can also be reversed with naloxone, but analgesia will be

diminished. The incidence of urinary retention is difficult to estimate due to the frequency of indwelling urinary catheters in surgical patients postoperatively (Rawal, 1999).

Nausea and vomiting is also a side effect of opioid administration. It is thought to be caused by cephalad migration of the opioid in the CSF to the area postrema in the floor of the fourth ventricle of the brainstem. Sensitization of the vestibular system and decreased gastric motility also are suspected causes of postoperative nausea and vomiting. The incidence of postoperative nausea and vomiting caused by opioids is approximately 30% (Rawal, 1999).

Respiratory depression is the most deleterious side effect. Early onset respiratory depression may occur within minutes after administration of a lipophilic opioid. Delayed onset is hypothesized to be caused by cephalad migration of the opioid in the CSF. It is thought to migrate to the respiratory center in the medulla. Late-onset respiratory depression is potentially more dangerous than early-onset because it may occur hours later. It is usually caused by lipophobic opioids. Studies have shown an incidence of $\leq 0.9\%$ of respiratory depression related to epidural morphine usage. This is comparable to parenteral morphine which has a risk of 0.9% of causing respiratory depression (Rawal, 1999).

Opioids decrease GI motility through central and peripheral mechanisms. Such effects are a mixture of excitatory and inhibitory actions. Opioid peptides and their receptors are found throughout the GI tract, especially in the gastric antrum and proximal duodenum. Centrally opioids interfere with vagal nerve mediation of GI motility. Peripherally morphine and related opioids inhibit electrically evoked acetylcholine

release from nerves in the GI tract thereby decreasing peristalsis. However, postoperative ileus is a common complication after abdominal surgery, and local anesthetics alone or in combination with opioids delivered epidurally actually improve recovery of bowel function slightly (Rawal, 1999).

Problem

Postoperative pain is an unwanted side effect of surgery and is associated with many postoperative complications. Currently postoperative pain is undertreated. It has been demonstrated that epidural administration of opioids and local anesthetics reduces the incidence of postoperative pain. However, epidural analgesia also has unwanted side effects. There is a difference in the number and severity of side effects caused by different types of epidural analgesic medications. There is a need to determine which type of surgical patients benefit the most from epidural analgesia, and which epidurally delivered medications cause the fewest side effects with the most efficacious analgesia. This will aid CRNAs in their administration of effective postoperative analgesia.

Purpose of the Study

The purpose of this study was to examine one institution's epidural pain management service, using a retrospective chart audit. A description of the patients' age, sex, type of surgery, type of medications administered, side effects, and treatments for side effects and breakthrough pain were generated. These data will provide a description of the type of surgical patients that benefited the most from epidurally-administered medications, and which medications produced the most analgesia with the fewest side effects.

Research Question

Which surgical patients experienced the greatest amount of pain relief while experiencing the fewest side effects utilizing postoperative epidural analgesia?

Conceptual Framew ork

This study used Faye Abdellah's conceptual framework for nursing (Abdellah, Beland, Martin, and Matheney, 1960). Abdellah incorporated the physiological, sociological, and emotional needs of the patient into her concept of nursing (Fitzpatrick & Whall, 1989). This framework describes the anesthesia providers' duty to the patient during surgery. It is also symbolic of the CRNA's and floor nurse's duty to the patient during the perioperative period because Abdellah views nursing as a helping profession which seeks to do something to or for the person with the goal of meeting needs, increasing or restoring self-helpability, or alleviating impairment (Hilton, 1997). Abdellah et al. (1960) defined nursing as:

> a service to individuals and families, therefore to society...based upon an art and a science which molds the attitudes, intellectual competencies and technical skills of the individual nurse into the desire and ability to help people sick or well cope with their health needs, and may be carried out under general or specific medical direction. (p. 24)

Therefore, it is the CRNA's and perioperative nurse's duty to help surgical patients to cope with their disability by alleviating postoperative pain and restoring the patient's independence.

Abdellah et al. (1960) identified 21 nursing problems that must be addressed to meet the needs of the patient. They are: (a) to maintain good hygiene and physical

comfort; (b) to promote optimal activity; exercise, rest, and sleep; (c) to promote safety through prevention of accident, injury or other trauma and through the prevention of the spread of infection; (d) to maintain good body mechanics and prevent and correct deformities; (e) to facilitate the maintenance of a supply of oxygen to all body cells; (f) to facilitate the maintenance of nutrition of all body cells; (f) to facilitate the maintenance of elimination; (g) to facilitate the maintenance of fluid and electrolyte balance; (h) to recognize the physiological responses of the body to disease conditions-pathological, physiological and compensatory; (i) to facilitate the maintenance of regulatory mechanisms and functions; (j) to facilitate the maintenance of sensory function; (k) to identify and accept positive and negative expressions, feelings, and reactions; (l) to identify and accept the interrelatedness of emotions and organic illness; (m) to facilitate the maintenance of effective verbal and nonverbal communication; (n) to promote the development of productive interpersonal relationships; (o) to facilitate progress toward achievement of personal spiritual goals; (p) to create and/or maintain a thereapeutic environment; (q) to facilitate awareness of self as an individual with varying physical, emotional, and developmental needs; (r) to accept the optimum possible goals in the light of limitations, physical and emotional; (s) to use community resources as an aid in resolving problems arising from illness; (t) to understand the role of social problems as influencing factors in the cause of illness.

This framework applies to CRNAs and perioperative nursing including postoperative analgesia in several ways. The primary goal of postoperative analgesia is to maintain patient comfort and allow optimal activity, rest, and sleep. This facilitates the delivery of oxygen to the body by allowing the patient to breathe without pain. Adequate

postoperative analgesia should have a positive effect on the patient's emotional well-being therefore facilitating the healing and recovery processes. The framework also provides guidance in respect to assessing and treating side effects of epidural analgesia. For instance, elimination may be adversely affected, vomiting may cause fluid and electrolyte imbalances, respiratory depression may result, and sensory function will most likely be depressed from the use of epidural analgesia. It is ultimately the anesthesia provider's duty to ensure that the deleterious effects of postoperative analgesia are kept to a minimum.

Definitions: Conceptual and Operational

Surgical Cases

Operational definition. Operations that patients received in a military hospital in the Midwest in which patients received epidural analgesia for pain management. These operations occurred from February 1998 to September 2000. A target of 200 patients was reached.

Epidural Analgesia

Operational definition. Epidural administration of an opioid and or local anesthetic for the purpose of providing postoperative pain relief.

Pain

Conceptual definition. Suffering or distress to the body which hinders optimal health.

Operational definition. The presence of pain during patient post-operative recovery using a Verbal Numerical Scale, with 0 = no pain, and 10 = worst pain imaginable, as recorded for patients during the study period.

Side Effects

Conceptual definition. Unwanted signs and symptoms attributed to epidural analgesia which hinder optimal health.

Operational definition. The presence of pruritis, nausea and vomiting, respiratory depression, or urinary retention as recorded during post-operative recovery for patients during the study period.

Assumptions

1. Pain relief and the presence of side effects were documented appropriately.
2. Patients desire to be free of post-operative pain.

Limitations

This was a retrospective study conducted at only one medical facility. The generalizability of the findings are limited.

Summary

Postoperative pain is a significant problem in clinical practice. It has been demonstrated that postoperative pain affects numerous physiological processes thereby prolonging recovery. A quotation credited to John J. Bonica (as cited in Frenette, 1999) provides insight:

> For nearly thirty years I have studied the reasons for inadequate management of postoperative pain, and they remain the same…inadequate or improper application of available information and therapies is certainly the most important reason for inadequate postoperative pain relief. (p. 143)

There is a need to improve postoperative pain management. Identifying which epidural medications produce the best analgesia for specific surgical cases will aid health care

providers to administer effective analgesia. This will assist surgical patients in their recovery and return to health.

CHAPTER II: LITERATURE REVIEW

Introduction

A review of the current literature on the topic of post-operative pain management and the use of epidural medications to alleviate postoperative pain revealed the following information. Several different types and combinations of medications may be used for epidural analgesia with differing efficacy and frequency of side effects. Other routes of medication administration for the purpose of post-operative analgesia have been compared to the epidural route with differing results.

Overview

Epidural medications are administered into the epidural space (Brown, 2000). This places the medications in the anatomical space between the ligamentum flavum and the dura mater. Therefore, epidural medications must be absorbed through the dura mater or into blood vessels in the epidural space before reaching the central circulation. Rawal (1999) states that the rate of absorption and route of administration dictate the amount of drug administered and the overall pharmacodynamics of the drug.

Epidural Opioids

Brown (2000) states that opioids are one class of drug that may be used for epidural analgesia. The two most commonly used opioids are preservative-free morphine (Duramorph) and fentanyl (Sublimaze). One important difference between the two opioids is that morphine is hydrophilic and does not readily dissolve in lipids, but fentanyl is lipid-soluble (Rawal, 1999).

This difference changes the length of time that each drug is available for uptake and analgesia. For instance, Rawal states that epidural morphine may provide more than 20

hours of analgesia. On the other hand, the author states that morphine takes three to four times as long to provide analgesia than fentanyl.

Combination of Opiod and Local Anesthetic

Epidurally administered opioids may be combined with local anesthetics such as bupivacaine (Marcaine). The addition of a local anesthetic provides a different type of analgesia to the epidural block (Biebuyck, 1995). Akerman, Arwestrom and Post (1988) studied the effects of combining a local anesthetic with morphine. Their experiment compared intrathecal administration of mixtures of morphine with lidocaine or bupivacaine with the effects of these medications when administered alone in mice. They used various tests to measure antinociception and motor blockade. These included a hot plate test and a tail-flick test. The authors found a statistically significant ($P<0.05$) increase in antinociception when 0.1 ug of morphine was combined with 25 ug of bupivacaine when compared to single doses of either. This included doses as high as 1.6 ug of morphine and 25 ug of bupivacaine when used alone.

Dahl, Rosenberg, Hansen, Hjortso, and Kehlet (1992) tested this theory in humans in a double-blind, randomized study with 24 patients scheduled for elective abdominal surgery. The patients were randomly assigned to receive either a continuous epidural infusion of morphine (0.05 mg/ml) alone at a rate of 4 ml/hr, designated group M ($n = 12$), or a continuous epidural infusion of morphine (0.05 mg/ml) and bupivacaine (0.5 mg/ml) at a rate of 4 ml/h, designated group M+B ($n = 12$). A visual analogue scale (VAS) was used to determine the effectiveness of analgesia at rest, during mobilization, and during coughing. Levels of sensory analgesia and motor blockade also were measured. The measurements were made at 4, 8, 12, 24, 30, and 48 hours by an

investigator blinded to the treatment groups. Binomial data were evaluated with Fisher's exact test, and morphine consumption and pain score were evaluated between groups by the Mann-Whitney rank sum test. A P value of <0.05 was considered statistically significant.

Dahl et al. (1992) found no significant difference in pain scores at rest, but a significant difference was found during mobilization and during coughing. The M+B group had better analgesia during the mobilization and coughing measurements ($P<0.05$). No cardiovascular or respiratory complications were observed during the study. The authors concluded that epidural combination of local anesthetics and opioids improved the quality of analgesia after abdominal surgery.

Studies of the Effects of Epidural Analgesia

A multitude of research has been undertaken to determine the best combination of epidurally delivered medications to provide the most analgesia with the fewest side effects. One such study (Saito, Uchida, Kaneko, Nakatani & Kosaka, 1994) compared morphine and bupivacaine to fentanyl and bupivacaine when both combinations were administered via a continuous epidural infusion. They used 85 patients, American Society of Anesthesiologists (ASA) class I or II, who were undergoing upper abdominal and/or thoracic surgery, and were scheduled to receive postoperative care in the intensive care unit (ICU). The morphine and bupivacaine group (MB, n = 45), received the epidural infusion of morphine at the rate of 0.2 mg/hr, and bupivacaine at 10 mg/hr for the first 24 hours or 5 mg/hr for the second 24 hours, using a combination of 0.005% morphine and 0.25% or 0.125% bupivacaine respectively. The fentanyl and bupivacaine group (FB, n = 40), received the epidural infusion of fentanyl at the rate of 20 ug/h and

bupivacaine at 10 mg/hr for the first 24 hours or 5 mg/hr for the second 24 hours using a combination of 0.0005% fentanyl, and 0.25% bupivacaine or 0.125% bupivacaine, respectively. The authors used the visual pain scale (VPS) to measure pain relief. The side effects evaluated were: hypotension, pruritus, nausea, vomiting, drowsiness, numbness, respiratory depression, and motor block.

Saito et al. (1994) found that there was not a statistically significant difference between the two infusion methods and the degree of analgesia, but they found a statistically significant difference in side effects between the two groups, using the Wilcoxon signed-rank test and chi-square test to compare the two groups, $P<0.05$. Thirty-three patients out of 45 in the MB group (73%) did not require additional analgesia, and 30 out of 40 in the FB group (75%) did not require additional analgesia. However, hypotension and pruritis were more common in the MB group than the FB group. Hypotension was defined as a systolic reading below 80 mmHg, and pruritis was recorded when the patient complained of it. Thirty-three out of 45 in the MB group (73%) suffered hypotension compared to 18 out of 40 in the FB group (45%). Pruritis was experienced by 80% of the MB group compared to only 25% of the FB group complaining of pruritis. Respiratory depression was not experienced by either group. Saito et al. hypothesized that the lipophillic nature of fentanyl may reduce side effects because it is rapidly absorbed into the spinal cord, and therefore less is present in the cerebrospinal fluid (CSF) to spread rostrally towards the brain. The authors concluded that at equianalgesic doses epidural fentanyl and bupivacaine produce fewer side effects than morphine and bupivacaine.

In a similar study, Berti et al. (1998) compared epidural infusion of fentanyl and bupivacaine to epidural infusion of morphine and bupivacaine after orthopedic surgery. The authors performed a prospective, randomized, double-blind study of 30 ASA status I and II patients undergoing total hip replacement. Postoperative epidural analgesia was by continuous infusion of bupivacaine 0.125% at 4 ml/hr with either 0.05 mg/ml morphine or 0.005 mg/ml fentanyl. The MB group had 15 subjects, and the FB group had 15 subjects. The VAS was used to assess analgesia. Sedation was measured by a four point scale. Respiratory rate, pulse oximetry, rescue analgesics, and supplemental oxygen were also measured. All variables were recorded by a blind observer at1, 3, 6, 9, 12 and 24 hours after surgery. The authors compared the two groups using a two-factor ANOVA and a Scheffe and Dunnett tests for multiple comparisons. Side effects were compared with Fisher exact test.

Berti et al. (1998) found that there were no statistically significant differences between either group in the degree of pain relief or side effects. Although the need for antiemetics was 50% less in the FB group, it did not reach statistical significance, but the authors alluded to the fact that previous studies with higher rates of nausea were done in abdominal surgery populations. None of the subjects in either group suffered respiratory depression as defined by the study. The authors stated that they used a higher bupivacaine dose and lower opioid concentrations than previous studies. They felt that their dose ratio of 10:1 between opioids was equianalgesic, and was adequate. Berti et al. also discussed the possible synergistic effect of combining opioids and local anesthetics in epidural blocks, and the differences in lipid solubility of morphine and fentanyl without making any generalizations.

Biebuyck (1995) provided information about the benefits, side effects and risks of epidural analgesia for postoperative pain relief. One benefit found was the reduction of the sympathetic stress response due to the medications effects, primarily local anesthetics, on the sympathetic nervous system. This sympathetic blockade has been found to reduce myocardial ischemia, and reduce postoperative ileus. On the other hand, the same local anesthetics administered epidurally can cause hypotension through the same sympathetic mechanism, and opioids by any route potentiate nausea. While Biebuyck demonstrated that epidural analgesia has increased pulmonary function postoperatively, but also has been implicated in respiratory failure (Rawal, 1999). Risks of epidural analgesia include accidental dural puncture with resultant post-dural puncture headache (Biebuyck, 1995).

Bell (1999) examined the efficacy and side effects of epidural analgesia in abdominal, thoracic, and orthopedic surgeries. The author looked at 133 surgical patients. Breakthrough pain was reported in 75% of abdominal, 22% thoracic, and 40% orthopedic patients. Side effects were respiratory depression 4.7% (n = 6), nausea and vomiting abdominal 34.9% thoracic 31.8%, pruritis 17.6% (n = 18) in abdominal, 22.7% (n = 5) in thoracic.

Side Effects of Epidural Analgesia

Chaney (1995) discusses only the side effects associated with epidural administration of opioids for the purpose of analgesia. The four classic side effects were pruritis, nausea and vomiting, urinary retention, and respiratory depression. There were 14 other side effects described in his review. The author claimed that the incidence of pruritis was anywhere from 0 to 100% and was due to cephalad migration of the drug in

the CSF and subseqent interaction with the trigeminal nucleus located in the medulla. Chaney has reported that the incidence of nausea and vomiting to be approximately 30% for opioids and also was due to cephalad migration of the drug in CSF, and its action on the area postrema in the medulla. Urinary retention has occurred anywhere from 0 to 80% and was likely related to interaction with opioid receptors in the sacral spinal cord. The most feared side effect of epidural opioids is respiratory depression. Its incidence has been reported by Chaney to be about one percent and was due to cephalad migration of the opioid in the CSF to the respiratory center in the pons and medulla. Chaney also stated that morphine was more likely to cause side effects due to its relative lipid insolubility. Fentanyl, on the other hand, is 800 times more lipid soluble than morphine. Therefore, according to Chaney the length of analgesia provided by morphine, which may last 24 hours, must be weighed with its possible side effects.

Alternatives to Epidural Analgesia

A search for literature describing practical alternatives to epidural analgesia for postoperative pain revealed two recent studies comparing intravenous patient controlled analgesia (PCA) with epidural analgesia (Boylan et al.,1998; Tsui et al., 1997). Boylan et al. (1998) compared epidural bupivacaine and morphine to PCA with morphine among 40 patients, ASA class II or III, who underwent elective infrarenal aortic surgery. The epidural group (EPI) had 19 patients randomly assigned to receive an infusion 0.125% bupivacaine and 0.1% morphine postoperatively. The PCA group (n=21) received 0.1 mg/kg morphine intravenously (IV) postoperatively. A VAS pain assessment measured analgesia. Other variables measured included time to tracheal extubation, sedation, respiratory effects, rescue analgesics administered, and S-T segment depression.

Statistical analysis between groups was completed using the Mann-Whitney U test. The authors found that the EPI group had lower pain scores, less rescue analgesia, and shorter extubation times than the PCA group ($P<0.05$). There also was a low incidence of postoperative apneas, slow respiratory rates, and S-T segment depression. Boylan et al. concluded that epidural morphine and bupivacaine provided better analgesia with comparable side effects to PCA morphine.

Tsui et al. (1997) compared epidural infusion of bupivacaine and fentanyl to PCA with morphine among 120 women, ASA class I or II, who underwent gynecological surgery. Nine patients were dropped from the study for various reasons that would have affected the data. The remaining 111 were randomly assigned to either an EPI group ($n = 57$) or a PCA group ($n = 54$). The EPI group received an epidural infusion of 0.0625% bupivacaine with 3.3 ug/ml fentanyl at 10 ml/hr. The PCA group received morphine IV (on demand) 1 mg every five minutes to a maximum dose of 0.1 mg/kg without a basal infusion. A verbal rating system (VRS) was used to assess analgesia every four hours. Side effects and vital signs were monitored by ward nurses. All data were collected prospectively, and a Mann Whitney U test was used to compare VRS scores between the groups. The authors found that the EPI group had significantly more effective analgesia postoperatively when compared to the PCA group. Side effects were relatively equal with the EPI group experiencing more pruritis ($P<0.04$), and lower limb weakness ($P<0.01$), but the PCA group experienced more dizziness ($P<0.04$). Tsui et al. concluded that although both methods (PCA and epidural) were effective, the epidural provided a better quality of analgesia in this sample of patients.

Summary

The studies reviewed indicate the effectiveness of epidural analgesia in the postoperative period. Side effects are comparable to other techniques of postoperative pain management. Epidural analgesia has been demonstrated to be effective after many different types of surgery. However, the data available do not contain information describing what types of surgery patients benefit the most from postoperative epidural analgesia. Therefore, an analysis of these data would provide valuable information to nurse anesthetists, who are an integral part of the postoperative pain management team, and to nurses in general, who are responsible for their patients' comfort in the postoperative period.

CHAPTER III: METHODOLOGY

Research Question

Which surgical patients experienced the greatest amount of pain relief while experiencing the fewest side effects utilizing postoperative epidural analgesia?

Research Design

In this study, data were collected for a retrospective, descriptive analysis of postoperative epidural administration of opioids and local anesthetics. Data were collected through a retrospective chart review using pharmacy records and analgesia flowsheets.

Sampling and Setting

The sample consisted of charts from surgical patients who received epidural analgesia postoperatively at one military Medical Treatment Facility (MTF). Data were collected from charts dated from September 2000 and working in descending order until a total of 200 charts were reviewed. This number of charts was sufficient to provide meaningful descriptive data.

Measurement Methods

Data were recorded using a spreadsheet listing the variables (see Appendix A). Demographic variables included age and sex. Independent variables included type of surgery and medications infused. Dependent variables included measurements of pain, respiratory depression, nausea, vomiting, pruritis, and urinary retention. Data for these nominal variables were encoded to facilitate computer analysis.

Data Analysis

Data were cross-tabulated by type of surgery and medication infused against the other collected variables to determine if any association between them existed. Coding was used to facilitate analysis of the data (see Appendix B). Statistical analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS) software version X. Data were presented in text and tables.

Protection of Study Subjects

The study participants were protected by several methods including their anonymity, and the retrospective nature of the study. The study also met two Institutional Review Boards (IRBs). One was at the MTF where the actual study occurred, and the other was at the Uniformed Services University of the Health Sciences (USUHS).

CHAPTER IV: STUDY FINDINGS

Introduction

The purpose of this study was to determine which surgical patients experienced the greatest amount of pain relief while experiencing the fewest side effects utilizing post-operative epidural analgesia. One institution's epidural pain management service was examined using a retrospective chart audit. Type of surgery and type of medication administered were compared with the incidence of side effects.

Characteristics of the Sample

A convenience sample was obtained by reviewing the charts of any patient who had an epidural catheter placed for the purpose of postoperative analgesia. Two-hundred charts were audited. The surgeries occurred between February 19, 1998 and September 20, 2000. There were 90 abdominal surgeries, 54 orthopedic surgeries, 32 thoracic surgeries, and 24 lower extremity vascularization or amputation surgeries. The age of the patients ranged from 14 – 84 years old, and included 105 males and 95 females. Surgeries were divided into four categories.

Medications used for Analgesia

Five different medication modalities were administered via the epidural infusion. These were: (a) morphine (M), (b) fentanyl (F), (c) bupivacaine (B), (d) morphine and bupivacaine (M+B), or (e) fentanyl and bupivacaine (F+B). Ropivacaine was used in place of bupivacaine in two cases. Due to similarity of the two local anesthetics, these were entered as bupivacaine for statistical purposes. As shown in Table 1, the combinations of M+B and F+B were used in 95% of the cases reviewed. The composition of the M+B solution was morphine 0.1mg/cc (0.01%) with bupivacaine

1mg/cc (0.1%) and the F+B solution consisted of fentanyl 5ug/cc (0.0005%) and bupivacaine 1mg/cc (0.1%).

Table 1

Epidural Medication Modalities Utilized

Medication	M	F	B	M+B	F+B
# Cases	3(2%)	4(2%)	5(3%)	145(73%)	43(22%)

Side Effects by Type of Surgery

One hundred-eighteen (59%) of the patients experienced some side effect postoperatively. The side effects analyzed in this study were: (a) breakthrough pain, (b) nausea/vomiting, (c) pruritis, (d) respiratory depression, and (e) urinary retention. The overall incidences of side effects are described in Table 2. All patients except for one had a foley catheter placed during the perioperative period, so only one case of urinary retention was recorded. Therefore, the incidence urinary retention will not be further described in this research.

Table 2

Overall Incidence of Side Effects

Side Effect	Breakthrough Pain	Nausea/ Vomiting	Pruritis	Respiratory Depression
# Cases	54(27%)	53(27%)	39(20%)	6(3%)

Orthopedic Cases

There were 54 orthopedic cases that included hip or knee replacements. As described in Table 3, an infusion of B alone was used for two of the cases, F+B was used

for 13 of the cases and M+B was used for 39 cases. The overall incidence of side effects for orthopedic surgery included: (a) breakthrough pain in 17 cases, (b) nausea/vomiting 16 cases and (c) pruritis occurred in six cases.

Table 3

Percentage of Orthopedic Patients with Side Effects Compared with Type of Medication Utilized

Type of Side Effect	Medication Utilized			
	B (n=2)	M+B (n=39)	F+B (n=13)	Total (n=54)
Breakthrough Pain	100%	21%	54%	31%
Nausea/Vomiting	50%	13%	8%	13%
Pruritis	0%	36%	8%	28%
Respiratory Depression	0%	0%	0%	0%
Overall Incidence of Side Effects	38%	17%	17%	18%

Thoracic Cases

There were 32 thoracic cases that included lobectomies and pneumonectomies. Table 4 shows that M was used two cases, B was used in one case, M+B was used in 22 cases, and F+B was used in seven cases. In thoracic surgery patients overall, breakthrough pain occurred in 14 cases, nausea/vomiting occurred in six cases, pruritis occurred in six cases, and respiratory depression occurred in one case.

Table 4

Percentage of Thoracic Patients with Side Effects Compared with Type of Medication Utilized

Type of Side Effect	Medication Utilized				
	M (n=2)	B (n=1)	M+B (n=22)	F+B (n=7)	Total (n=32)
Pain	50%	0%	41%	57%	44%
Nausea/Vomiting	0%	0%	27%	0%	19%
Pruritis	0%	0%	27%	0%	19%
Respiratory Depression	0%	0%	5%	0%	3%
Overall Incidence of Side Effects	13%	0%	25%	14%	21%

Abdominal Cases

There were 90 abdominal cases that included bowel surgeries, hysterectomies, and nephrectomies. As shown in Table 5, M was used in one case, F was used in two cases, M+B was used in 69 cases and F+B was used in 18 cases. In abdominal surgery patients, the incidence of side effects included: (a) breakthrough pain in 19 cases, (b) nausea/vomiting in 28 cases, (c) pruritis in 23 cases, and (d) respiratory depression occurred in five cases.

Table 5

Percentage of Abdominal Patients with Side Effects Compared with Type of Medication Utilized

Type of Side Effect	Medication Utilized				
	M (n=1)	F (n=2)	M+B (n=69)	F+B (n=18)	Total (n=90)
Pain	0%	0%	19%	33%	21%
Nausea/Vomiting	100%	50%	26%	44%	31%
Pruritis	0%	0%	29%	17%	26%
Respiratory Depression	0%	0%	6%	6%	6%
Overall Incidence of Side Effects	25%	13%	20%	25%	21%

Lower Extremity Cases

There were 24 lower extremity surgeries involving revascularization or amputation. Table 6 shows that F was used in two cases, B was used in two cases, M+B was used in 15 cases, and F+B was used in five cases. The incidence of side effects for lower extremity patients included: (a) four cases of breakthrough pain, (b) four cases of nausea/vomiting, and (c) four cases of pruritis.

Table 6

Percentage of Lower Extremity Patients with Side Effects Compared with Type of Medication Utilized

Type of Side Effect	Medication Utilized				
	F (n=2)	B (n=2)	M+B (n=15)	F+B (n=5)	Total (n=24)
Pain	0%	50%	7%	40%	17%
Nausea/Vomiting	0%	0%	27%	0%	17%
Pruritis	0%	0%	27%	0%	17%
Respiratory Depression	0%	0%	0%	0%	0%
Overall Incidence of Side Effects	0%	13%	15%	10%	13%

Summary: Side Effect by Type of Surgery

Side effects and types of surgery were cross-tabulated to examine possible relationships between the two. These data are presented in Figure 3. In summary, it was found that breakthrough pain occurred most frequently with thoracic procedures at a rate of 44%. Nausea/vomiting had the highest incidence with abdominal surgeries at 31%. Pruritis occurred most frequently with abdominal cases at 26%, and respiratory depression occurred most frequently with abdominal cases at 6%.

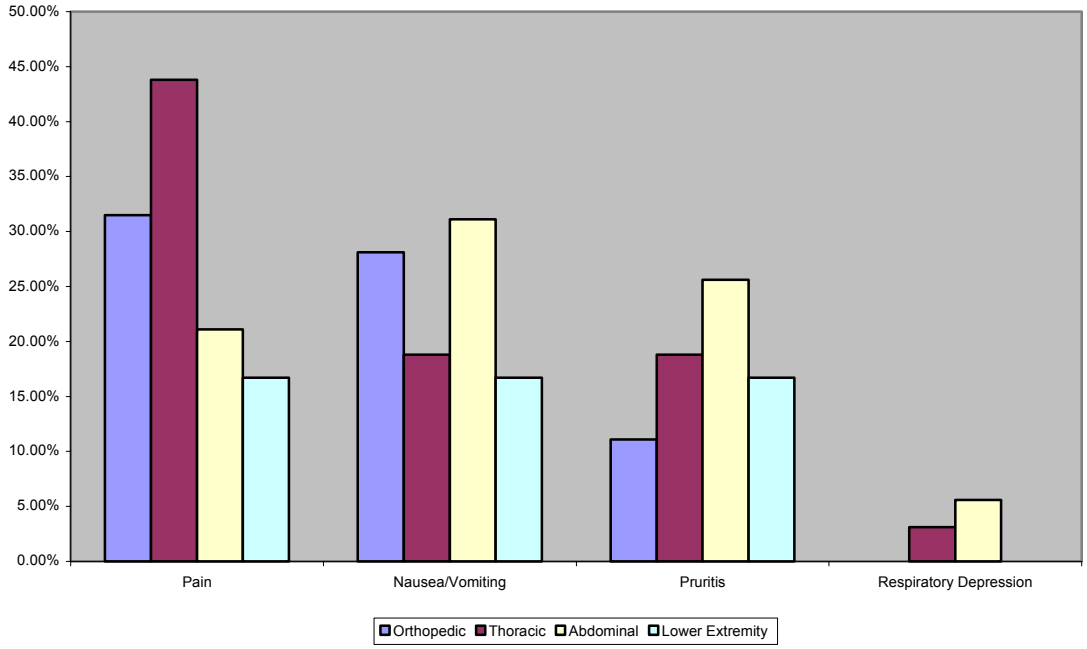

Figure 3.

Incidence of side effects compared to type of surgery.

Side Effects by Type of Medication

The overall incidence of side effects compared to type of medication also was cross-tabulated to explore any relationships. These data are presented in Figure 4. In summary, F by itself did not have any incidence of breakthrough pain. Breakthrough pain occurred in 21% of the patients who received M+B and in 44% of the patients who received F+B. There were no cases nausea/vomiting in the F group, but the M+B group had a 29% incidence of nausea/vomiting compared to a 21 % incidence of nausea/vomiting in the F+B group. There were no cases of respiratory depression in the F group. The incidence of respiratory depression was 2% for patients who received F+B and 3% for patients who received M+B.

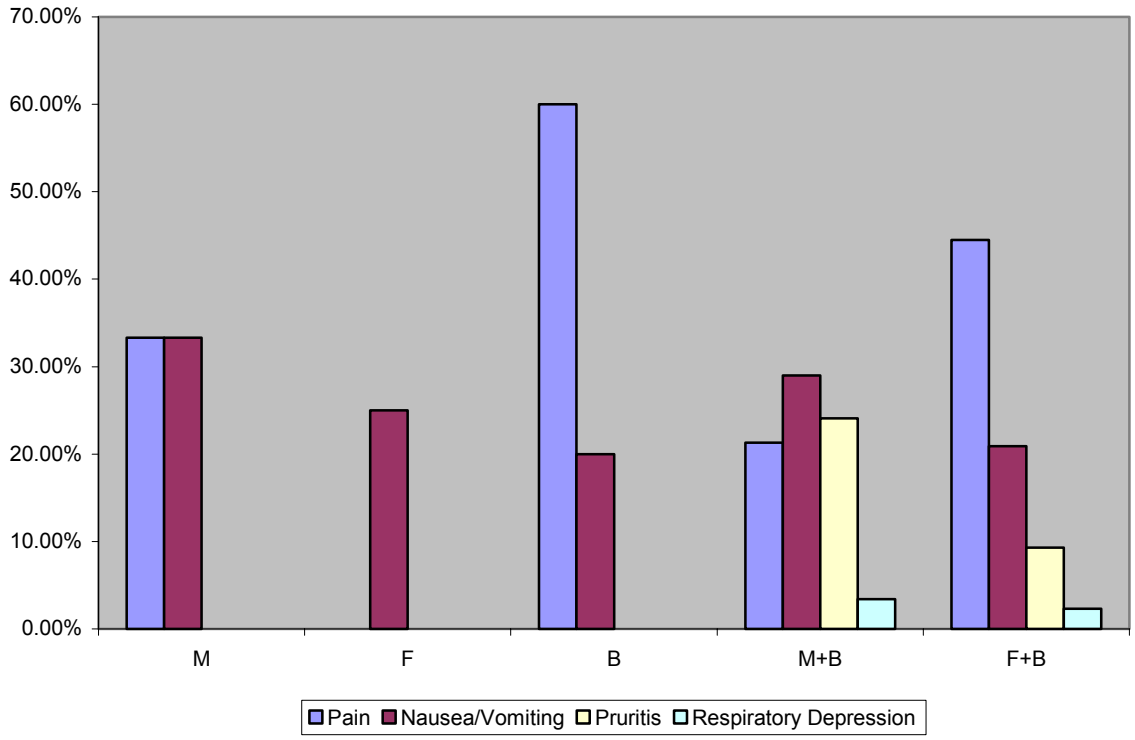

Figure 4.

Incidence of side effects compared to type of medication administered.

Incidence of Side Effects According to Gender

Although not by design, this study had an almost equal number of females and males included. There were 105 males and 95 females. The incidence of side effects was almost equal when cross-tabulated by gender. For example, both genders had a 27% incidence of breakthrough pain, and the overall incidence of any side effect was 21% for females and 18% for males. Table 7 describes the incidence of each side effect according to gender.

Table 7.

Incidence of Side Effects Compared to Gender Shown by Percentage

Type of Side Effect	Gender	
	Female (n=95)	Male (n=105)
Breakthrough Pain	27%	27%
Nausea/Vomiting	29%	25%
Pruritis	21%	18%
Respiratory Depression	4%	2%
Incidence of Any Side Effect	21%	18%

Description of Side Effect Treatment

A portion of this study involved reviewing the medical records of the study subjects to determine how side effects were treated. This also entailed exploring the efficacy of those treatments. This descriptive data was obtained from the epidural flowsheets and the progress notes. Examples of the epidural flowsheet, and standing epidural orders are included in Appendix C.

The treatment of the side effect of breakthrough pain involved determining the cause of inadequate postoperative analgesia. Four causes of inadequate analgesia were identified: equipment problems, lack of staff vigilance, insufficient patient education, and inadequate medication infusion rate. Examples of equipment problems included malfunctioning infusion pumps, disconnected epidural tubing and leaks in the medication reservoir bag. The overall incidence of equipment problems as a cause of breakthrough pain was 2%. Fixing the equipment problem effectively treated these cases. Lack of staff vigilance caused breakthrough pain in one instance because the infusion was

interrupted due to an empty medication reservoir bag. After the infusion was reestablished, the patient regained adequate analgesia. Insufficient patient education was responsible for one case of breakthrough pain. In this instance, the patient had a right total knee replacement, but was lying on his left side. The patient was taught that the epidural medication would provide more analgesia if he was supine or on his right side, and he regained adequate analgesia.

The most common cause of breakthrough pain was an inadequate medication infusion rate. The methods to treat this were diverse and did not always include increasing the infusion rate. Some providers utilized the existing infusion to give a 3-5cc bolus and then increased the infusion rate or number of allowable PCA doses. Other providers bolused with 0.25% bupivacaine or 2% lidocaine regardless of the medication currently infusing and either did or did not increase the infusion rate or PCA limit. One provider added an intravenous (IV) morphine PCA to a patient who had a bupivacaine epidural infusion. Another patient had IV ketorolac added to his analgesics. Of the 54 patients who experienced breakthrough pain, 11 (20%) had their epidurals discontinued for inability to reestablish adequate postoperative analgesia.

Nausea and vomiting occurred in 53 patients. In compliance with the standing orders, the majority of these received 10mg of IV metoclopramide as the first line treatment, the dose could be repeated every six hours as needed. Other drugs used in the treatment of nausea/vomiting were ondansetron and promethazine. Ondansetron was administered to five patients. One patient received this as the first line treatment. Promethazine was administered to six patients, in two cases this was used as the first line drug. In one instance the patients nausea/vomiting was unable to be controlled with

metoclopramide or ondansetron, as it was during the night, the surgical staff ordered lorazepam to be administered. This allowed the patient to sleep. One patient requested that his basal rate be decreased. It was decreased and the nausea/vomiting decreased, while maintaining adequate pain control. One patient had her epidural discontinued due to the inability to control nausea/vomiting.

Pruritis occurred in 39 patients. In compliance with the standing orders, 25 mg of diphenhydramine IV was administered, and could be repeated every six hours as needed. Occasionally the initial dose was 12.5 mg instead of 25mg, with good relief. Adequate relief was obtained in 10% of the patients who were given diphenhydramine. Three other drugs were used to treat pruritis after diphenhydramine proved ineffective. One patient received 5 mg nalbuphine with adequate resolution of symptoms. A naloxone drip was used on two patients. In both cases it was not effective. Two patients received boluses of propofol, 20-30mg. It was moderately effective in one case. In one patient the epidural mix was changed from M+B to F+B, before the pruritis was resolved. This patient had received naloxone, diphenhydramine and propofol prior to the epidural medication change. Two patients were switched to a B infusion, one remained pruritic, but he decided to keep the epidural for the time remaining. The other had the epidural removed for unresolved pruritis and inadequate pain control.

Six patients were noted to have respiratory depression. Two of the patients had the epidural catheter removed. The other four had the rate of the epidural infusion decreased. One of these four patients received a dose of nalbuphine. Cardiopulmonary arrest requiring Advanced Cardiac Life Support (ACLS) did not occur in any of these patients with decreased respirations.

CHAPTER V: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

A retrospective chart audit of 200 charts was conducted to determine which surgical patients experienced the greatest amount of pain relief while experiencing the fewest side effects using postoperative epidural analgesia. The charts of patients who had abdominal, orthopedic, thoracic and lower extremity vascularization or amputation surgeries between February 1998 and September 2000 were reviewed and compared. Type of epidural medication and side effects were the variables analyzed. Urinary retention as a side effect was not studied because all but one patient had foley catheters.

Discussion

This study found that the overall incidence of breakthrough pain was 27%. The lowest incidence of breakthrough pain was 0% in the patients who received fentanyl. However, only four patients out of the 200 patients reviewed in this study received fentanyl. This was only 2% of the sample studied, so it would be difficult to show the significance of these results. The next lowest incidence of breakthrough pain was 21% in the patients who received morphine and bupivacaine epidurally. This group represented 73% of the study sample. Fentanyl/bupivacaine epidural infusions had a higher incidence of breakthrough pain at 45%, and were used in 22% of the study sample.

As stated earlier, one hundred-eighteen (59%) of the patients reviewed in this study experienced some side effect postoperatively. While these side effects cannot be entirely attributed to the epidural infusion, the data gathered demonstrate some patterns. Fentanyl had the lowest overall incidence of side effects (6%), but as stated above, only

four patients received this medication. Morphine had a 17% overall incidence of side effects, but only three patients received this medication. Morphine/bupivacaine and fentanyl/bupivacaine both had a 19% incidence of side effects, and 188 (95%) patients received one of these combinations.

An examination of the data in this study shows that patients undergoing lower extremity vascular surgery had the lowest incidence of breakthrough pain and other side effects. Thoracic surgery had the highest incidence of breakthrough pain. Abdominal surgery had the highest incidence of nausea and pruritis and also was associated with the highest incidence of respiratory depression.

Conclusions

There is a marked difference in pain control when comparing this study to a similar study by Bell (1999). This study had an overall incidence of breakthrough pain of 27%; including 21% of abdominal patients, 43% of thoracic patients, and 31% of orthopedic patients. Bell found an overall incidence of 59%; including 75% of abdominal patients, 77% of thoracic patients, and 40% of orthopedic patients. In Bell's study, 84% of the patients received an infusion of morphine, only 16% received a combination of an opioid and a local anesthetic. In our study 95% of the patients received a combination of an opioid and a local anesthetic. Similar results where noted by Dahl (1992). A combination of morphine and bupivacaine provided superior analgesia than morphine alone. The data suggest that the addition of a local anesthetic to an opioid provides better epidural post-operative pain control.

In comparing the type of opioid/local anesthetic combination, the data from this study suggest that morphine/bupivacaine was more efficacious that fentanyl/bupivacaine.

The incidence of breakthrough pain was 21% and 44% respectively. Two prospective studies comparing morphine/bupivacaine and fentanyl bupivacaine found no statistical difference in analgesia between the two combinations (Saito et al., 1994; Berti et al., 1998).

In comparing the incidence of the other side effects, these data suggest that fentanyl/ bupivacaine was associated with fewer side effects than morphine/bupivacaine. The incidence of nausea/vomiting was 21% and 29% respectively. The incidence of pruritis was 9% and 24%, respectively. Respiratory depression was 2% and 3% respectively. Saito et al. (1994) found incidences of nausea/vomiting similar, but pruritis was 25% and 80%, respectively Berti et al. (1998) found a 50% reduction in the need for antiemetics with fentanyl/bupivacaine. From the data gathered during this study, it would appear that morphine/bupivacaine provided the best analgesia but was associated with more side effects.

In conclusion, postoperative pain remains a serious problem facing anesthesia providers in their day-to-day practice. Epidural analgesia is an effective treatment for postoperative pain in a select group of surgical patients, but side effects are common. This study demonstrates that side effects can be effectively treated, so that patients can continue to receive epidural analgesia without serious complications. This study also demonstrates that the type and frequency of side effects may be partly dependent upon the type of surgery.

Recommendations

Postoperative analgesia may be enhanced by improved education. Education is an important aspect of postoperative epidural care for patients and staff. Patients should be

aware of potential side effects and that they are often readily treatable. By communicating early with staff, pain control and comfort may be maximized. Nursing staff must be aware of potential side effects, and remain vigilant, especially for respiratory depression. Staff must know what side effects they can treat and when they need to call an anesthesia provider.

There remain many questions for future researchers in this area. One area that this study examined briefly was the effect of gender on frequency and type of side effects. Although this research did not demonstrate a significant difference in side effects between the sexes, future studies may want to focus on this aspect to reach a definitive decision.

Future researchers may be able to gain more insight into the treatment of postoperative pain by designing a prospective study due to the limitations of a retrospective study. Some variables that could be manipulated include: types of medications, rates of infusion and standardized treatments for side effects. It is often difficult to compare studies when different concentrations of local anesthetic and opioids are used. Studies could focus on the same medications, but compare different concentrations. Studies also could focus on other medications that may also be administered epidurally, such as hydromorphone and clonidine.

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APPENDICES

Appendix A: Data Collection Tool

Appendix B: Coding Sheet

Appendix C: Epidural Analgesia Forms

APPENDIX A

Data Collection Tool

data collection

	date	ID #	Age/S	type of surgery	ortho type	medication	pain	resp dep	N/V	pruritis	urinary retention	treatment	effective	notes
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
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25														
26														
27														
28														
29														

APPENDIX B

Coding Sheet

Coding

Sex:

1. Male

2. Female

Type of Surgery:

1. Orthopedic

2. Thoracic

3. Abdominal

If orthopedic, type:

1. Hip

2. Knee

3. Other

Type of Medication:

1. Morphine

2. Fentanyl

3. Bupivacaine

4. Morphine and Bupivacaine

5. Other

Pain:

1. Present- 4 or greater on VAS

2. Absent- less than 4 on a VAS

Respiratory Depression

1. Present

2. Absent

Nausea and Vomiting

1. Present

2. Absent

Pruritis

1. Present

2. Absent

Urinary Retention

1. Present

2. Absent

3. Foley

Treatment

1. None

2. Yes-write in

If yes, effective:

1. Yes

2. No

APPENDIX C

Epidural Analgesia Forms

ANESTHESIA POST-OPERATIVE EPIDURAL NOTES

DATE	**NamePlate**
PATIENT NAME Height: Weight:	
PROCEDURE	**SURGEON**
ANESTHESIA TEAM	**TYPE OF ANESTHESIA**
INTERSPACE PLACED	**CENTIMETERS (of needle) TO EPIDURAL SPACE**
OTHER INTERSPACES ATTEMPTED	**CENTIMETERS AT SKIN (catheter)**

PARASTHESIA

yes [ ]	R [ ]	transient [ ]	placement re-attempted
no [ ]	L [ ]	persistent [ ]	2nd to parasthesia [ ]

INFUSION

meds infused_____	infusion begun intra-op [ ]	preop teaching done:
time infusion began [ ]	infusion begun post-op [ ]	[ ] anesthesia [ ] nursing

COMPLICATIONS

POST-OPERATIVE MONITORING

Date	Rate	Meds Infused	Level of Local Anes.	VAS PAIN SCORE** (0 - 10)	SIDE EFFECTS REQUIRING Rx (Y or N)				COMMENTS
					Somnolence	N/V	Pruruitis	Urinary Retention	
(POD #0)									
(POD #1)									
(POD #2)									
(POD #3)									
(POD #4)									
(POD #5)									
(POD #6)									

REMOVAL DATE	**COMMENTS**

****VAS Pain Score**

0 1 2 3 4 5 6 7 8 9 10

no pain — worst pain

POST - OPERATIVE PAIN MANAGEMENT: EPIDURAL INFUSION

SURGEON	FIRST ASSISTANT	SECOND ASSISTANT	
ANESTHETIST	ANESTHETIC		TIME BEGAN:
			TIME ENDED:
CIRCULATING NURSE	SCRUB NURSE	TIME OPERATION BEGAN	TIME OPERATION COMPLETED

OPERATIVE DIAGNOSES

POST- OP PAIN

DRAINS *(Kind and number)*	SPONGE COUNT VERIFIED

MATERIAL FORWARDED TO LABORATORY FOR EXAMINATION

OPERATION PERFORMED

_____ Epidural Catheter Inserted/Infusion Set-up

_____ Catheter Removal

DESCRIPTION OF OPERATION *(Type(s) of suture used, gross findings, etc.)*	PROSTHETIC DEVICES *(Lot no.)*	DATE OF OPERATION

Activity: Date: Time Started: Time Ended: Anesthesia Team:

Epidural Started: _____ _____ _____ _____

Epidural Removal: _____ _____ _____ _____

Complications: YES: _____ NO: _____

What Complications: _____

SIGNATURE OF SURGEON	DATE
PATIENT'S IDENTIFICATION *(For typed or written entries give: Name-last, first, middle; grade; date; hospital or medical facility)*	REGISTER NO. / WARD NO.

For Each Set of Orders, Record the Date and Time, Sign, and Cross Out the Unused Lines

PATIENT IDENTIFICATION	DATE OF ORDER / TIME	NURSE'S SIGNATURE
	Postoperative Epidural Analgesia Infusion Orders	
	1. Pt. received opioid bolus dose of _____ in	
	epidural space at _____ hrs.	
	2. Continuous Infusion mixture: opioid _____ conc..	
	_____ and local anesthetic _____ conc. _____	
	to run at _____ cc/hr via epidural catheter	
	3. PCEA demand dose: Patient to receive _____ cc of	
	above mixture epidurally every _____ min. prn.	
NURSING UNIT / ROOM NO. / BED NO.		

PATIENT IDENTIFICATION	DATE OF ORDER / TIME	
	4. One hour lockout: Pt. to receive maximum of ____ cc	
	of above mixture every hour.	
	5. No sedatives/analgesics except by order of Anesthesia	
	Service while patient receiving epidural infusion.	
	6. Maintain IV access for 6 hrs. after stopping continuous	
	infusion.	
	7. Monitor and document: Resp. rate every 2 hrs.; pain	
	level and sedation scale ever 4 hrs.; Temp., Pluse, BP &	
NURSING UNIT / ROOM NO. / BED NO.	check dressing every 8 hrs.	

PATIENT IDENTIFICATION	DATE OF ORDER / TIME	
	8. For pruritis: Benadryl 25mg. IV every 6 hrs. prn.	
	9. For nausea/vomitting: Reglan 10mg IV every 6hrs prn.	
	10. Notify Anesthesia on call (Beeper 060) for any of the	
	following reasons:	
	(PLEASE OBTAIN A FULL SET OF VS PRIOR TO	
	CALLING ANESTHESIA).	
	a. Respiratory rate less than 8 per min.	
	b. Sedation scale greater than 4.	
NURSING UNIT / ROOM NO. / BED NO.	c. Persistent nausea and vomiting.	

PATIENT IDENTIFICATION	DATE OF ORDER / TIME	
	d. Persistent pruritis.	
	e. Temp. greater than 101.5 Degrees (po) of unknown	
	etiology.	
	f. Epidural catheter site erthematous and/or tender.	
	g. Inadequate pain relief.	
	h. Leakage around catheter site.	
	i. Change in mental status.	
	j. Initiation of ant-coagulant therapy with heparin/	
NURSING UNIT / ROOM NO. / BED NO.	Low Molecular weight heparin.	

PATIENT IDENTIFICATION	DATE OF ORDER	TIME	NURSE'S SIGNATURE
	Postoperative Epid. Analgesia Infusion Order Cont..		
	11. Have Naloxone ampule (0.4mg) with T.B. syringe		
	available at bedside.		
	12. Record I&O. May straight cath every 6 hrs. prn.		
	for urinary retention.		
	13. Activity level as ordered by physician.		
	14. If Local Anesthetic has been added to the epidural		
	infusion, patient must have assistance from staff or		
NURSING UNIT / ROOM NO. / BED NO.	family when ambulating.		

PATIENT IDENTIFICATION	DATE OF ORDER	TIME	
NURSING UNIT / ROOM NO. / BED NO.			

PATIENT IDENTIFICATION	DATE OF ORDER	TIME	
NURSING UNIT / ROOM NO. / BED NO.			

PATIENT IDENTIFICATION	DATE OF ORDER	TIME	
NURSING UNIT / ROOM NO. / BED NO.			