Practice Guidelines for the Management of Pain

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STANDARDS

There are insufficient data to support a treatment standard for pain management for burns.

GUIDELINES

1. All burn centers should have an organized approach to the treatment of burn pain that considers background, procedural, and breakthrough pain.
2. The aim should be for the patients to be awake and alert but comfortable.
3. Pain should be differentiated from anxiety

OPTIONS

1. Control of burn pain must begin upon initiation of medical care. Once intravenous access is gained and resuscitation started, intravenous opioids should be administered. The opioid dose occasionally exceeds the standard weight-based recommendations and is necessary to achieve adequate pain control.
2. Opioids, along with other adjuncts such as benzodiazepines, are used to control background pain and are supplemented to achieve procedural and breakthrough pain control.
3. Standardized metrics should be regularly used to quantify patient pain and anxiety levels

PURPOSE

The purpose of this guideline is to review principles of pain management and to present a reasonable approach to the management of the complex pain associated with burn injury.

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USERS

This guideline is designed to aid those physicians who are responsible for the management of burn pain.

CLINICAL PROBLEM

Although quantifying pain is always difficult, a burn injury must be considered the most painful trauma that a person can sustain. Because the proper treatment of burn injury requires débridment, daily wound care, and surgery, followed by physical therapy that can last for months, the pain that burn patients experience may seem both unendurable and unending. Burn pain is inherently difficult to manage because it is multifaceted and constantly changing as the individual undergoes repeated procedures and manipulation of painful wound sites. Inadequate treatment of burn pain and inconsistency in practice standards has been well documented for nearly two decades.[1,2]

PROCESS

A MEDLINE search of the English-language publications from 1968 to 2005 was conducted using the keywords "burn pain," "treatment," and "assessment." This search produced 94 results, of which 9 were found to be relevant to the assessment and treatment of burn pain. Each of the references were reviewed individually and presented in the evidentiary table Table 1. Selected other references were also used.

SCIENTIFIC FOUNDATION

Patients requiring treatment can have different thresholds for pain, different ability to cope with pain and trauma, and different physiologic responses to their treatment. In addition to the psychological trauma of pain itself, poor pain control causes sleep disturbances that further exacerbate the pain[11] and has been shown to have physiologic effects that impede wound healing.[12]

Table 1. Studies on the control of burn pain

Reference	Description of Study	Data Class	Conclusions/Comments
Cuignet et al 2005[3]	Randomized, double-blind study of 81 patients comparing the analgesic efficacy of single-shot versus 72-hour infusion of ropivacaine for donor site pain	I	There was no benefit with 72- hour infusion. The single-shot group had less paresia and were more satisfied with their pain relief
Cuignet et al[4]	Randomized, double-blind study of 20 patients comparing the efficacy of continuous fascia iliaca compartment block for 72 hours with ropivacaine vs saline to control donor site pain	I	The treatment group had significantly reduced postoperative morphine consumption and significantly reduced pain scores during the first dressing change
Prakash et al 2004[5]	Prospective randomized double-blinded study of 60 patients using patient controlled analgesia to control pain during burn dressing changes	I	Loading dose of 1 μg/kg fentanyl followed by 30-μg demand dose with 5-minute lockout provided the best pain control
Schulte et al 2004[6]	Randomized, double-blind, crossover study of 11 volunteers to evaluate the synergistic effect of a NMDA-receptor antagonist and an opioid	I	First study in humans to show a synergistic analgesic effect with coadministration of a NMDA-receptor antagonist and an opioid
Hoffman et al 2000[7]	Prospective randomized study of 12 patients analyzing virtual reality as an adjunct in the treatment of procedural pain during therapy	I	Virtual reality may be beneficial as an adjunct in the treatment of procedural related pain
Patterson et al 1997[8]	Randomized prospective trial of 79 patients studying the benefit of adding lorazepam to opioids for the treatment of procedural burn pain	I	The addition of lorazepam reduces pain ratings for procedural burn pain
Patterson et al 1992[9]	Prospective randomized study of 30 patients analyzing hypnosis as an adjunct in the treatment of procedural pain during wound care	I	Hypnosis is a viable adjunct for the treatment of procedural burn pain
Gordon et al 1998[10]	Prospective study of 40 patients to evaluate the appropriate pain assessment tool	II	Patients prefer the Faces pain rating scale as a objective measurement tool
Raymond et al 2001[11]	Prospective analysis of 28 patients to analyze the relationship between pain intensity and sleep quality	III	Poor sleep will lead to a more painful procedures the following day

Burn pain is characterized by extreme variation in intensity throughout the healing process rather than declining in a linear fashion as healing progresses. Patients have various types of pain, including background pain, breakthrough pain, and procedural pain.

Background Pain

Background pain is defined as the underlying pain from the initial injury that is ongoing and present even in the absence of activity or procedures. Management of background pain generally is addressed through the use of long-acting analgesic agents. The rationale is to provide continuous analgesia and limit breakthrough pain episodes associated with waning systemic levels of analgesic agent. Most of the current literature is based upon the management of chronic opioid use in cancer and noncancer pain. The initial treatment of the pain should be the use of escalating doses of short-acting intravenous opioid, doubling the dose as necessary until pain is under good control. The use of patient-controlled analgesia (PCA), continuous infusion, or sustained-release agents should then be considered to address the background pain component.[13]

Breakthrough Pain

Breakthrough pain is considered the more intense episodic pain associated with activities of daily living and other minor activities that require movement or manipulation of injured areas. This pain usually is addressed with short acting agents, of any appropriate class or via an appropriate route.

Procedural Pain

This is the pain associated with invasive procedures and ongoing daily burn care such as wound cleansing, dressing changes, and with physical and occupational therapy. A structured approach to pain management is aimed at all three types of pain.

GENERALIZED TREATMENT PLAN

An effective pain management plan, incorporating pharmacologic and nonpharmacologic modalities, must be tailored to variations in individual patient need and institutional capability. An important component of the pain management plan is the education of staff, patients, and families regarding the unique characteristics pain experienced by the burn patient and the negative effects of inadequately treated pain. This education must include training in the communication of pain through the use of appropriate pain scales. It is also very important to provide education regarding the addiction. There is no evidence that opioid addiction occurs more often in burn patients than in other populations requiring opioids for acute pain (approximately 1 in 3000).[14]

The individualized treatment plan ensures individual differences in opioid efficacy and must include monitoring for the development of drug tolerance which is expected with prolonged (greater than 2 weeks) use, and frequently occurs in individuals with histories of recreational opioid use. Development of opioid tolerance is still poorly understood, but there is evidence that cellular mechanisms may be reinforced by chronicity of exposure, opioid potency, and repetitive partial withdrawal in the pain state.[15,16] The mechanisms responsible for burn patient opioid tolerance have not been elucidated. It is important to recognize that to achieve adequate pain control in this patient population it may be necessary to prescribe opioid analgesic doses that significantly exceed those recommended in standard dosing guidelines. With that in mind, the institution should develop a policy that outlines the difference between pain management and conscious sedation. The Joint Commission on Accreditation of Healthcare Organizations,[17] and physician specialty organizations,[18] dictate both general and specific levels of patient monitoring for patients requiring increased levels of analgesia and sedation.

The effectiveness of a guideline-based approach to pain control is well established. Among the most commonly used is the Agency for Health Care Policy and Research[19] supported Acute Pain Management Guidelines[20] and the Agency for Health Care Policy and Research Cancer Pain Management Guideline,[19] which addresses complex issues related to chronic pain. The American College of Critical Care Medicine of the Society of Critical Care Medicine also has published guidelines for managing pain in stable patients as well as in those who are hemodynamically unstable.[21,22] These guidelines define parameters for intravenous sedation, analgesia, and neuromuscular blockade for adult patients in the intensive care unit. Although these resources are not burn specific, they do provide a foundation for the development of an institutional pain management program targeted toward achieving effective pain control for burn patients.

Table 2. Pain guideline recommendations[23]

Promise attentive analgesic care
Chart and display assessment of pain and pain relief
Define pain and relief levels to trigger a review
Survey patient satisfaction
Principles of anesthetic drug treatment
Opioid analgesics
Tolerance and dependence
Acetaminophen and nonsteroidal anti-inflammatory drugs
Adjuvant analgesics
Procedure-related pain
Specialized analgesic technologies
Nonpharmacologic interventions
Monitor the efficacy of pain treatment

An outline of reported pain management guidelines compiled by Janice F. Ulmer, PhD[23] can be adapted to meet institutional needs for appropriate management of pain in burn patients. This is shown in Table 2 and is described in better detail:

ATTENTIVE ANALGESIC CARE

Burn patients and their families need to be educated regarding what is available to them in both pharmacologic and nonpharmacologic interventions for the treatment of pain. Goals for the management of background, breakthrough, and procedural pain should be established. The goals of pain management are to allow for full patient participation in normal daily activities and in an acceptable level of comfort during wound care and rehabilitation activities. Addressing patient concerns about pain control before therapeutic interventions can greatly relieve anxiety and improve compliance with and success of subsequent treatment and activities.

Chart and Display Assessment of Pain and Pain Relief

Regular assessment of pain and pain relief should be monitored and documented with activity, during procedures, and when the patient is at rest. A survey of burn centers reported that 67% use the Visual Analog Scale (Figure 1) to assess pain.[10] A randomized multicenter trial[10] reported that 72% of patients actually preferred the Faces Pain Rating Scale. Regardless of which pain scale is selected by the institution, routine assessment and documentation of pain and pain relief increases awareness of the effectiveness of pain management interventions. The pain scale used must be appropriate for the age and cognitive ability of the patient. The scales could be adapted to different languages to allow complete understanding.

Establish Pain and Relief Levels to Trigger a Review

Acceptable levels of pain should be established with the patient for all three types of pain. It can be done by any burn team member, but probably best would be done with the nurse caring for the patient. Pain scaled beyond these levels serves as a trigger for review and revision of the individual pain management plan and as data to be reviewed for periodic revision and updating of institutional pain management protocols.

Survey Patient Satisfaction

Periodic surveys of patient satisfaction with prescribed analgesic therapy and with responsiveness of the physicians and nurses to the patients pain control needs are also valuable tools in the assessment of the efficacy of the pain-management program.

PHARMACOLOGIC MANAGEMENT OF BURN PAIN

Treatment for each of the types of pain discussed in this guideline requires a specific pharmacologic approach and must be individualized to the patient. Opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), mild analgesics, parenteral and inhaled anesthetic agents and anxiolytics are all valuable in the multifaceted pain management plan.

Opioids

The cornerstone of effective burn pain management is opioid administration. Opioids are potent, the risks and benefits are familiar to the majority of care providers, and they provide some degree of dose-dependent sedation. Opioids are widely available and relatively inexpensive. There is flexibility in action and duration with opioids as a result of flexibility in routes of administration and dosing options. The pharmacokinetics of opioids in burn patients are not consistently different from action in nonburn patients,[24,25] although decreased volume of distribution and clearance, and increased elimination half-life have been reported for morphine in this population.[26] There are also conflicting data as to the change of pharmacodynamic potency of opioids in burn patients.[26,27] It is important to keep in mind that burn patients may require opioid doses many times greater than the maximum recommended to control pain. This issue must be addressed in institutional guidelines regarding the differentiation between pain control and procedural sedation.

Burned children have been documented to develop acute opioid tolerance during the initial phase of their intensive care unit stay.[28] In another case report, modification of such dramatic tolerance was apparently reversed by use of methadone.[29] Other agents demonstrated in other patient populations to help manage opioid tolerance include ketamine, clonidine, and dextromethorphan.

The route of opioid administration is an important topic to address in pain management in burn patients. The oral and intravenous routes are preferred. The development of increasingly potent, fast-acting, orally administered opioids has increased indications for their use: however, normal gut function is necessary for bioavailability of the analgesic. Oral transmucosal administration of opioids has been studied in burn patients[30] and appears to have an advantage in patients without intravenous access when rapid onset of a potent analgesic is indicated. Intravenous opioids are safe and effective in the management of pain. The use of PCA allows the patient to participate actively in the pain management program. Studies comparing PCA with other routes of opioid administration have reached mixed conclusions as to benefit and patient satisfaction.[31–33] A study by Prakash et al[5] compared different demand dosages of fentanyl during burn dressing changes and found that an initial 1 μg/kg bolus followed by a 30-μg demand dose with a 5-minute lockout provided the lowest mean visual analog scale score. The intramuscular route of administration is almost uniformly avoided because of the fact that, in the emergent phase of burn injury, compartmental fluid shifts cause variable and unreliable vascular absorption. Another disadvantage to the intramuscular route is the fact that it requires repeated painful injections and it has no advantage in analgesia.

A brief discussion of commonly used opioid and nonopioid medications follows in the appendix. The reader is encouraged to review these medications in

most textbooks of pharmacology, surgery, medicine, pediatrics, or anesthesiology. A concise set of tables is published in the Agency for Health Care Policy and Research[19] supported Acute Pain Management Guidelines.[19] The reader is cautioned to understand that "equianalgesic" dosing recommendations in published tables are simply approximations usually based upon clinical experience and pharmacokinetic studies. The actual pharmacodynamic result is individual. In starting any analgesic medication, administer small doses first, and escalate as needed.

Nonopiod Drugs

Acetaminophen and NSAIDS decrease the production of mediators that allow nerve endings to transmit "painful" impulses back to the spinal cord and on to the brain. Although their analgesic effect generally is not potent enough for their use as the main component of burn pain management, they may be useful adjuncts in the acute pain management program and are certainly of use in the outpatient setting. Acetaminophen and NSAIDs appear to work via inhibition of prostaglandin and other mediators, although the tissue anti-inflammatory effect may not be significant. These agents also are potent antipyretics. These medications are not necessarily titrated to effect but rather are administered around the clock for treatment of continuous background pain treatment or as needed for breakthrough pain treatment when background pain is of low intensity or not existent. Cyclooxygenase-2 (COX-2)-specific inhibitors offer reduced risks associated with gastrointestinal upset and bleeding and associated platelet dysfunction when compared with nonspecific cyclooxygenase-inhibiting NSAIDs. Neither the safety of nonspecific COX inhibitors nor COX-2 inhibitors in the setting of burn intensive care and extensive skin grafting has been studied.

Opioid agonist-antagonist agents such as nalbuphine (Nubain; Bristol-Myers Squibb, New York, NY), provide analgesia with a limited ceiling and have fewer side effects than opioids. They have been shown to be effective in treating burn pain,[34] although experience is limited. Exercise caution if transitioning between opioid agonist-antagonists and opioids due to variable interactions between the agents.

Anesthetics

Anesthetic agents are being used outside the operating room more commonly to facilitate the performance of painful procedures. Extensive burn dressing changes, staple removal, and emergency bedside procedures in the burn unit, such as escharotomy, are less traumatic when being performed with the aid of parenteral anesthetic agents. Historically, intravenous or intramuscular ketamine has been used for these procedures[36,36] and, more recently, oral ketamine has been found to be useful in children.[37] Newer sedative drugs with rapid onset and short half-lives such as propofol are particularly advantageous because they can be titrated to level of consciousness and duration of action. Use of these medications requires administration by individuals familiar with their effects and functioning within the institutional guidelines for procedural sedation or general anesthesia. This type of sedation has enhanced patient satisfaction and can be an effective cost-saving measure in avoiding the use of the operating room for some surgical burn procedures.

Inhaled nitrous oxide is an anesthetic agent safe for the administration by nonanesthesia personnel when used per approved protocols. It can provide safe and effective analgesia without loss of consciousness when used alone and in lower concentrations, and is a commonly used agent in the treatment of burn pain.[38,39] It is typically self-administered by an awake, cooperative patient via mouthpiece or face mask in a concentration of 50% nitrous oxide and 50% oxygen. There is the secondary benefit of patient control. There is the possibility of a small, but measurable toxicity to patient or staff when exposed to the agent for long periods of time.[40,41] This problem has not been described for burn related care, but the Occupational Health and Safety Administration guidelines exist for its use and exposure limits both in and out of the operating suite.

Topical Anesthetics

It is well known that donor-site pain can be a significant postoperative problem. Occlusive dressings frequently are used to help manage the pain but these often are inadequate by themselves. There are several studies that demonstrate better pain relief with the use of selected dressings.[42–45] A 1999 study[46] also demonstrated the safe use of topical lidocaine and bupivacaine on donor sites after harvest.

Regional Analgesia And Local Anesthetic Injection

Small clinical studies have demonstrated effective analgesia associated with use of local anesthetics for postoperative burn and donor site pain. One group has demonstrated the safety and efficacy of single dose and continuous infusion of bupivacaine via fascia iliaca compartment block for thigh donor site pain treatment.[3,4] Simple use of local anesthetic in the tumescent solution used to harvest split-thickness skin grafts has been effective in a small clinical trial to reduce acute postoperative analgesic agent.[47]

The treatment of phantom pain after burn injury is not well studied. The incidence of phantom pain after burn injury is greater in electrical injuries compared with flame injuries,[48] but the actual incidence is not known. There is a case report that describes the successful treatment of phantom pain, which was not responsive to other systemic therapy, with a brachial plexus block.[49]

Anxiolytics

Anxiety is a known response to the overwhelming situation of being a burn patient and undergoing the treatment necessary to survive the injury. Overall background pain and the anticipation of procedural pain further exacerbate the anxiety, which can in turn exacerbate the pain.[50] The use of anxiolytic drugs has become commonplace in combination with opioids in the treatment of burn pain.[51] Benzodiazepines administered as an adjunct to opioids have been shown to decrease both background pain and pain in those patients with high levels of procedural pain.[8] Patients most likely to benefit from anxiolytic therapy are those with a high level of anticipatory procedural anxiety and high levels of pain.

Method of Delivery

Pain management in an intubated patient with a large burn is much different than in a patient with a small burn that may not need an inpatient stay, but the goal of effective therapy is still the same. The intubated patient usually is given intravenous opioids and anxiolytics, and the patient with the small burn will receive only oral pain medications. There is a trend to changing pain control from the intravenous route to oral as the patient status improves, the patient is able to take pills by mouth, and the patient nears discharge. Every burn center should develop a pain care plan that follows the patient course.

NONPHARMACOLOGIC MANAGEMENT OF BURN PAIN

Hypnosis

Hypnosis can be used as an adjunct to pharmacologic pain management; however, there is no evidence to suggest that it should be used as a substitute. Studies have demonstrated a benefit from hypnosis in relieving pain. In 1992, Patterson et al[9] used the hypnotic technique called rapid induction analgesia and reported a reduction in both patient and staff reports of baseline pain levels. The use of rapid induction analgesia also was found to impact pain perception, anticipatory anxiety, and level of relaxation, both during and after burn care.[52]

Cognitive Interventions

The use of behavioral therapeutic interventions such as hypnosis, stress reduction, and relaxation interventions has been applied to a number of types of acute pain, including the pain of rectal examinations,[53] dental work,[54] and even surgery.[55] There have been only a few studies applying this technique to burn pain.[54]

It is important for the clinician to be aware of the individual patient's coping skills and assist the patient in employing the technique best suited to that individual in developing a pain management plan.

Patients who respond to pain with avoidance will be most likely to benefit from distraction during short procedures. Deep relaxation and distracting imagery will be more useful with longer procedures. This method requires more extensive training for both patients and staff for it to be effective.

Patients who focus on the procedure may benefit from reappraisal techniques. They should be encouraged to differentiate sensory from affective components of pain and evaluate its meaning. These patients benefit from being told that pain sensation is a positive sign of wound healing.

Virtual Reality

Virtual reality takes distraction one step further by using a visual stimulus instead of the power of suggestion to distract the patient from pain. Visual stimulus is provided through a headset that covers the eyes. Additional auditory stimulus can be provided through associated earphones.

A controlled study using virtual reality has shown a reduction in pain, nausea, and anxiety during physical therapy.[56] Another study found significant reduction in pain scores when virtual reality in combination with opioids was compared with opioid analgesics alone and with opioid analgesics with video game distraction during wound care in adolescents.[7] Virtual reality does not diminish in its analgesic effectiveness over time.[51]

SUMMARY

The treatment of burn-related pain needs to be at the forefront of all management decisions made by the burn care team. Opioid analgesia should be the mainstay of treatment. The timing, dose, and route used should be determined by patient needs as part of a unit protocol. The use of benzodiazepines often is needed as an adjunct and should be prescribed as

patient needs suggest. The addition of nonpharmacologic adjuncts to treat burn related pain should be prescribed as needed and as the institutional resources allow. There needs to be an understanding of the different types of pain and a directed approach to its treatment. Following a simple table as shown below, can aid the burn care team through the decision making process.

KEY ISSUES FOR FUTURE INVESTIGATION

Areas of burn pain research that need further investigation include:

1. The use of nonpharmacologic methods to control pain. Could we reduce the dose and thus some of the side effects of high dose opioids by using virtual reality or hypnosis during procedures? The current data suggests that this is possible, but larger studies are needed to support this premise.
2. Could we identify a better pain assessment tool? Currently there is no Class 1 evidence to support the use of any of our current tools.

APPENDIX

Commonly Used Opioid Medications

Morphine sulfate is available in multiple formulations for oral (including sustained release), rectal, and parenteral administration. As with all opioid medications, side effects include nausea, vomiting, itching, constipation, urinary retention, and depression of ventilatory and hypoxic drive mechanisms. Morphine is most likely to be associated with histamine release associated with hypotension when administered quickly by intravenous injection. Primary metabolism is via hepatic and nonhepatic conjugation with glucoronic acid, and renal clearance. Pharmacologically active, morphine-6-glucoronide is analgesic and sedative, whereas morphine-3-glucoronide is neuroexcitatory. Hepatic failure impairs conjugation. Renal failure impairs clearance. Intramuscular pharmacokinetic profile reveals initial onset in 15 to 30 minutes, peak effect 45 to 90 minutes, and duration of action of up to 4 hours. Intravenous administration leads to faster but variable profile. Oral:parenteral effective dose ratio is approximately 3:1.

Meperidine is available in multiple formulations for oral and parenteral administration. It is approximately 1/10th as potent as morphine and has a shorter duration of effect. Its side effect profile is unique from morphine. Anticholinergic effects are the result of its structural similarity to atropine. Normeperidine results from hepatic demethylation and has an extremely prolonged elimination half-time. Accumulation of normeperidine may occur after multiple doses and is associated with seizures, confusion, and myoclonus. Repetitive administration, and use in children, elderly adults, or patients with renal failure is contraindicated.

Hydromorphone is approximately five to eight times more potent than morphine, with a similar duration of effect, and faster clearance. It is available for oral and parenteral administration. Hydromorphone-3-glucoronide is the primary hepatic metabolite has properties similar to morphine-3-glucoronide and it is cleared renally. The side effect profile is similar but may be better tolerated for many patients than morphine.

Methadone is a long-acting opioid with properties similar to morphine, and unique properties associated with its N-methyl-D-apartate (NMDA) antagonist, serotonin reuptake and norepinephrine reuptake inhibitor properties. It is available for oral, rectal, and parenteral administration. It has been shown to be effective in a case report to provide long-acting analgesia in morphine tolerant burn patients.[29] The NMDA antagonist properties are postulated to moderate opioid induced tolerance, hyperalgesia, and neuropathic pain.[58] Initial dosing and titration should proceed cautiously due to variable sedation and dysphoria. Relative potency of methadone to morphine is variable and unpredictable, and is dependent upon chronicity and other factors.

Fentanyl is a synthetic opioid compound with a relative potency to morphine of approximately 100:1. It is available in parenteral formulations for injection, transmucosal, and sustained transdermal application. The onset of action of intravenously injected fentanyl is less than 1 minute, redistribution from the central circulation is rapid, and the duration of action is less than that of morphine, although the elimination half-time is longer than morphine. This pharmacokinetic profile has allowed its successful use as an intravenous PCA agent for burn dressing changes.[5] The transmucosal absorption of fentanyl has allowed its use as a PCA agent via intranasal injection when combined with oral morphine for adult burn dressing changes.[59] It is extensively metabolized through the liver and biliary tract, with elimination via the gut and kidneys. The oral transmucosal formulation has rapid onset and similar peak and elimination to intravenous delivery, and the oralet releases the drug as it is dissolved. The transdermal formulation allows delivery of a constant dose of fentanyl over the course of 72 hours.

Codeine is more stable than morphine when administered orally and is effective in similar doses for parenteral administration. Its side effect profile is sim-

ilar. Approximately 10% of codeine is demethylated in the liver to morphine, and the rest is inactivated to norcodeine, which is renally excreted. Oral:parenteral effective dose ratio is approximately 2:1. Morphine: codeine equianalgesic potency is approximately 1:4 or less. Doses greater than 65mg are associated with higher side effects with reduced incremental analgesia.

Oxycodone is available in both immediate and sustained release oral formulations only. It is a prodrug, converted by the liver to noroxycodone and oxymorphone. Oxycodone has similar pharmacokinetic profile to morphine. The sustained release formulation allows the dose to be released in the gastrointestinal tract over a period of several hours.

Nonopioid Medications

Ketamine is a potent analgesic with NMDA antagonist properties. It has been used as a sedative and analgesic agent in many clinical arenas. A blinded clinical trial demonstrated its effectiveness for oral sedation and analgesia for burn dressing changes in children.[37] A small laboratory clinical trial (double-blind, placebo-control, randomized, crossover) demonstrated ketamine reduction of hyperalgesia after first-degree burn injury.[60] A similar study design has demonstrated a similar reduction of hyperalgesia when ketamine was administered with morphine.[6]

Nonsteroidal anti-inflammatory agents present risks of gastrointestinal bleeding, and platelet dysfunction exacerbating surgical bleeding. Although COX-2 inhibitors present less risk, they have not been uniformly endorsed as safe for intensive care unit or surgical patients in the perioperative period. Gabapentin is an antiepileptic agent with significant neuropathic analgesic properties. Recent clinical studies include its use as a substitute for rofecoxib for postoperative pain after hysterectomy.[61] Gabapentin recently has been evaluated for treatment of itching in burned children.[62] A case report in a burned patient reflects the current experience of using gabapentin to treat neuropathic pain related to complex regional pain syndrome.[63]

Tricyclic antidepressants (TCAs) demonstrate some analgesic properties in other patient populations but they have not been studied as analgesics in burned patients. The use of TCAs in burned children has centered on the treatment of acute stress disorder.[64] TCAs may be appropriate adjunct medications for complex burn patients.

In those patients with chronic pain and/or pain that is not adequately treated with medications previously described, it is suggested that clonazepam or neurontin may be beneficial. There are no studies that discuss the efficacy of clonazepam for the treatment of burn related pain, but it has been described in treating pain in many other situations, including cancer-related neuropathic pain,[65] migraine headaches,[66] and other neuropathic pain syndromes.[67]

Neurontin has been found to be effective in the treatment of itching in children with refractory symptoms.[62] A randomized controlled blinded study[62] performed in 2004 found no benefit in combining neurontin and opioids in the treatment of burn inflammatory pain.

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