Pain Management in the Wilderness and Operational Setting

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The wilderness and operational setting places unique constraints on one’s ability to treat pain. In this article we will discuss methods for treating pain both in the wilderness and operational setting. By operational we mean the austere deployed military setting, to include both noncombat and combat operations. The authors combined experience with wartime trauma pain management consists of experience in Operation “Just Cause” (Panama Invasion), Operation “Desert Storm” (the Persian Gulf War), Operation “Uphold democracy” (Haiti liberation), Operation “Enduring Freedom” (Afghanistan conflict), and Operation “Iraqi Freedom” (OIF) (Iraq conflict).

Because of the austerity of care for patients in these settings, there is limited evidence based information for “ideal” pain control. We will present what little literature is available as well as providing much information on what is done, what seems to work, and some novel ideas in the area. Much of what will be described will include actual patient care cases. It is hoped this article will provide some basic pain management principles for those who practice in the austere environment.

The information in this article represents only the views and experiences of the authors. It does not represent the official policies of the Department of Defense, the US Army, or any subordinate commands of either.

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Overview

The wilderness and operational setting provides unique challenges for pain assessment and management. The diversity and quantity of pain control medication is limited by the quantity and type of medication one can carry with them into the austere setting. The type of medication may further be limited by the lack of or difficulty in obtaining intravenous (IV) access. This is often due to the difficulty in carrying heavy, bulky IV supplies. In the operational setting there is often difficulty in obtaining IV placement due to a given tactical situation, that is, doing so in a moving tactical vehicle or while under enemy fire. The inability to use IV medications therefore often limits the choice of pain medication that may be used. Consideration must also be given to cases where one must treat multiple casualties at one time, and how to best safely manage pain with limited resources.

The patient in the austere setting may also be required to assist with or actively be involved in his evacuation, limiting the type of medication that can be administered to something nonsedating. In the operational setting a wounded individual may still be required to defend himself and his comrades, also limiting the type of pain control he receives. Other factors of concern include the hydration status of a patient, individuals in the wilderness or military operations tending to be at least minimally dehydrated on a frequent basis. Environmental considerations also become paramount, not only for the patient but for the storage of the medications; for example, any medication requiring refrigeration is poorly suited for austere use. These multiple factors often decide what medications will be ideal for a given situation.

The ideal pain medication for wilderness and operational use would be:

- Light
- Compact
- Can be carried and stored without concern for environment or temperature
- Have a very high therapeutic index particularly with regard to ensuring that airway reflexes are protected
- Not require an IV or other equipment to administer
- Can be used regardless of a patients level of stability

Although no pain control agents perfectly meet these criteria, we will discuss those most commonly used with some of their specific considerations for austere use.

Nonsteroidal anti-inflammatory drugs

Nonsteroidal anti-inflammatory drugs (NSAIDS) have long been the mainstay for oral treatment of mild to moderate pain in the austere setting. So much so that in the operational setting Ibuprofen is colloquially known
as “Ranger Candy.” NSAIDS have been shown to be both effective for moderate pain control as well as to reduce the dosage of narcotics required for adequate pain control [1], thus reducing the risk of oversedation of patients in the austere setting. Ketorolac has often been the military intramuscular (IM) choice of moderate or greater pain control. Ketorolac has variously been shown to have analgesic properties equal to everything from acetaminophen to standard doses of narcotic agents depending on the disease process being treated [2]. Despite its having been shown to have this variable analgesic effect, it is often used as a first-line IM agent. Oral NSAIDs as well as acetaminophen have remained the most commonly used oral medications in the austere environment; they have been covered in detail elsewhere, so we will only discuss their side effects and its influence on austere use.

Three problems with NSAIDs that cause concern with their use in the austere environment are: (1) increased incidence of gastrointestinal distress and bleeding [3,4], (2) the possible risk of inducing renal failure in those already somewhat dehydrated [5,6], and (3) inhibition of effective clot formation due to NSAID “poisoning” of platelet function [7].

These side effect profiles have led to consideration, particularly in the operational setting, of the use of selective cyclooxygenase-2 (COX2) inhibitors. The COX2s do have a lower incidence of gastrointestinal side effects [8]. The risk of inducing renal failure, however, is no different between regular NSAIDs and COX2 [9,10]. There is, furthermore, no difference in pain control between the two classes [11]. Of greater concern, particularly in the tactical environment, is the effect of NSAIDS on platelet function and bleeding time. The COX2s do have an advantage here in they do not appear to effect platelet function and bleeding time [12,13]. Because of this, the Committee on Tactical Combat Casualty Care consensus panel recommended the use of COX2 inhibitors as the NSAID of choice for combat operations [14].

Some military units have, in fact, developed “wound packs,” which are to be taken in the event that a soldier receives a penetrating extremity wound of any type. The packs contain acetaminophen, a COX2, and a fluoroquinolone. Immediately upon wounding the individual will open the pack and take these medications. The addition of acetaminophen to an NSAID has been felt to increase the degree of pain relief while not increasing sedation (Fig. 1).

Anecdotal experience in OIF showed this to be very effective in treating pain from minor penetrating soft tissue injuries (fragment wounds, and so on), although the numbers involved have thus far been small.

The risk of renal injury remains a consideration with NSAID use in the austere environment. Fortunately, the risk of this in healthy individuals is extremely small, the incidence of hospitalization for acute renal failure being 0.6 per 100,000 person years of NSAID use in individuals younger than 64 [5]. Theoretically, one would expect the incidence to be higher in individuals...
with mild dehydration, as is often seen in the wilderness and combat environment. There is, however, no good data on the effect of mild dehydration on the incidence of NSAID-induced renal failure. If we assume that the increased risk of renal failure is probably similar to that seen in older individuals (> 65 years old) who often have impaired renal function due to age, medication use and other factors including volume depletion that decrease renal blood flow, then the risk from NSAID use causing renal failure incidence increases to 4.6 per 100,000 person years [5]. An increased risk to be considered, although again not a high risk.

Oral and IM NSAIDs are the most common types used; however, other forms of NSAIDs have some utility in the austere environment. Topical NSAIDS have some excellent utility in specific situations. They have been shown to be very effective for reducing pain associated with corneal abrasions [15], with a number of them approved for ophthalmologic use [16]. An ibuprofen gel for use in acute soft tissue injuries has also been found to be as effective as oral ibuprofen with obviously less gastrointestinal upset [17].

Opiates

Opiate analgesia is by far the most effective pain management drug class for severe pain. Frequently encountered situations involving injuries in the austere environment will often require opiate medication for adequate pain management. Morphine has been the standard IV opiate analgesic for operational use [18], its familiar dosing and side effect profile being the primary reason to recommend it. Opioids can be given via the oral, IM, and IV routes. IV has been the route of choice due to variable absorption and “first-pass effect” seen with oral and IM dosing methods. The IV method of
delivery, however, may be difficult in the combat setting; the medical experience in the Falklands conflict found the use of IV narcotics to be impractical [19]. Specifics of opiates have been covered in depth elsewhere, so we will not repeat them here. There have been, however, some recent innovations in the use of oral opiates in the tactical setting. Oral opiates are commonly used for pain control, but up until recently oral opiate analgesia have been slow in onset and difficult to titrate to effect without having significant side effects or prolonged absorption profiles. Before OIF, several physicians in the Special Operations community addressed this problem.

Several choices were available; none were perfect. Our ideal opiate analgesic agent would have to be given orally, potentially self-administrable, have a significant safety profile, low side effect profile, and be rapid in onset. Pill-form opiate medications such as oral morphine were of limited use secondary to the prolonged time of onset and limitations in dosages. Liquid agents were limited by the significant first-pass effect of opiate metabolism and the administration and packaging in the field environment. The recent release of an oral preparation of fentanyl citrate under the trade name of Actiq appeared to fit our requirements. Actiq (Oral Transmucosal Fentanyl Citrate, OTFC) is a crystalline form of fentanyl citrate incorporated into a sweetened white lemon-flavored lozenge on a plastic handle (Fig. 2).

Fentanyl citrate is a highly lipophilic synthetic phenylpiperidine derivative that is approximately 80 to 100 times more potent than morphine, and selectively binds to the mu-1 and mu-2 receptors. OTFC is intended to be administered orally over 15 minutes, and reaches maximal serum levels after 10 to 20 minutes following administration. It undergoes metabolism in the liver and intestinal mucosa by the cytochrome P450 3A4 isozyme to an inactive metabolite, norfentanyl. The mechanism of action is both transmucosal and gastrointestinal. OTFC is rapidly absorbed through the oral mucosa, and has an onset of action of 5 to 10 minutes. Only 25% of the total dose is absorbed in this way. The rest of the medication is swallowed and absorbed through the intestinal mucosa. There is a significant first-pass metabolism with the only one third of the swallowed dose reaching the systemic circulation (25% of the total). This gives a total functional absorbed dose of 50% of the administered preparation. The mucosal-absorbed medication accounts for its rapid onset, while the swallowed preparation accounts for the duration effect. The terminal half-life is 6 to 7 hours, and serum concentration increases in a dose-dependent manner. The side effect profile also appears to follow a dose-dependent graph, with the

Fig. 2. Actiq Fentanyl Lozenges. (Courtesy of Troy Johnson, MD, Washington DC.)
most severe side effect, respiratory depression, starting to occur at serum levels of 2 ng/mL. This serum level is reached by using dosages greater than 800 μg [20].

Oral fentanyl citrate is Federal Drug Administration-approved as two preparations, Orulet and Actiq. Orulet is no longer available on the market due to financial reasons. The current Federal Drug Administration approval for Actiq is for opiate-dependent pain in cancer patients that have breakthrough pain. There are several studies documenting its efficacy in this area [21–24]. Several studies using Orulet have also documented its efficacy in the hospital setting with children [25–28]. There is also one study documenting its effectiveness for the use of acute pain in the emergency department setting [29]. In a yet unpublished observational study documenting its use by Special Operations Forces in OIF, it again proved to be a safe and effective analgesic agent (Johnson T, personal communication, pending publication). The packaging held up well to significant wear and tear, and the preparation tolerated a variety of temperatures. Common side effects seen in most studies are pruritis (50–60%), vomiting (40%), and transient oxygen desaturation below 94% (0–24%). Severe side effects can include respiratory depression, bradycardia, and chest wall rigidity, but these have not been seen with standard dosing [30]. The absorption profile can also be altered by swallowing the preparation, which will delay the maximal concentration 20 to 30 minutes [30]. However, the significant first-pass metabolism will lower the serum concentration to 25% of the total swallowed dose. OTFC has been shown to have a morphine equivalency of 8 to 14:1 [31].

Overall, OTFC appears to be ideal for administering safe rapid-onset oral opiate analgesia in the prehospital austere setting.

This was used very effectively during an episode in OIF. Nine patients required care for extremity fractures simultaneously. Due to the tactical situation the placement of IVs was, at best, difficult. Of the nine patients, seven had significant fractures and all had significant pain. All were given OTFC with 90% plus reduction in pain within 15 minutes. Several fell asleep but maintained airway reflexes and oxygen saturation. Two, however, fell asleep with the "lollipop stick" hanging out of their mouth. Because of this it is recommended that the OTFC be taped to the patient’s finger while they use it to prevent inadvertent choking on the same if they became somnolent. Two developed nausea and one had one episode of emesis. All did well with effective pain relief during transport to definitive care.

Another opiate form recommended for austere use includes intranasal butorphanol (Stadol NS). Nasal butorphanol has been shown to be effective for postoperative pain with an onset of approximately 15 minutes [32,33]. It has also been used in the third world as a method of providing postoperative analgesia without the need for IV access [34]. The authors have no experience with this medication, although it shows promise as another method of providing rapid onset pain relief in the austere environment.
Ketamine

Ketamine, a dissociative anesthetic agent, has been used extensively as an anesthetic agent for traumatic war wounds [35,36]. Ketamine fits many of the criteria for an ideal pain control agent: it provides effective analgesia, it provides amnesia to pain and events, and the patient’s airway reflexes remain intact despite dissociation. Airway reflexes are protected to the point where patients maintain oxygen saturations even while spontaneously breathing air during austere surgery [37]. Ketamine is also cardiovascularly stable, and it has both a rapid onset as well as being both relatively short acting and titrateable [38].

Ketamine has been found to be a very effective pain control method for both painful procedures, that is, in burn care [39], as well as for treating pain not otherwise well controlled by other means, that is, in refractory cancer pain [40]. It has been used as a narcotic “sparing agent” to effectively treat postoperative pain [41]. Ketamine has also been used independently as an infusion to treat postoperative pain [42]. Ketamine has also been used preoperatively as an infusion for analgesia of war-wounded individuals awaiting treatment for wounds incurred in fighting along the Thai–Cambodian border. In this situation, ketamine infusion significantly reduced pain, particularly with landmine injuries [43], and was the drug of choice for pain control in hemodynamically compromised individuals.

The doses used for analgesia are less than the typical procedural “conscious sedation doses.” Recommended dose ranges are 0.44 to 1.0 mg/kg IM or 0.2 to 0.5 mg/kg IV [44,45]. The authors typically start with 0.1 mg/kg IV and titrate to effect.

In OIF, a patient with a traumatic knee fracture/dislocation was in significant pain despite IV morphine. The injury was unstable, but fortunately, the popliteal artery appeared intact. To control pain for placement of the injury in a splint as well as for transport, 0.1 mg/kg IV of ketamine was given. The patient’s pain was effectively controlled, allowing stabilization of the injury and transport of the patient to definitive care.

In an incident related by a NATO physician several years earlier, ketamine was also effectively used. A patient with an ankle fracture/dislocation during a parachute training event suffered a fracture/dislocation of the ankle. The physician gave 1 mg/kg of IM ketamine, and was both able to reduce the injury as well as control pain for the patient without the need for an IV.

Author Czarnik had a similar experience with ketamine use in the emergency department. A 27-year-old male sustained an open fracture of the third to fifth metatarsals secondary to a motorcycle accident. He had no other injury and 8/10 pain. A single dose of IV ketamine at 0.5 mg/kg brought on marked pain relief, reducing the pain to 1/10. The patient remained coherent and cooperative throughout.
Because of its limited side effect profile ketamine has been suggested as an easy and effective method of pain control in mass casualty/disaster situations [46,47], the idea being that it can be used quickly on multiple individuals as a single IM injection. Ketamine has furthermore been used as an agent for intravenous anesthesia in very austere surgery. In one study it was used in Somalia and Uganda to perform a number of significant surgeries with spontaneous ventilation and no monitoring equipment [48]. It has likewise been used in diverse warfare conditions from combat injuries in the Falklands to the Thai border to conflict in Afghanistan [19]. Ketamine is not, however, without side effects, although true toxicity is extremely rare [49].

The major side effects of ketamine include “bad dreams” as well as more severe emergence phenomena. Although the “bad dreams” are not so problematic, a patient suffering emergence with access to loaded weapons in a combat zone could be a significant potential problem. The incidence of these side effects does appear to be somewhat dose related [50], with less delirium noted with typical “pain” doses. The concomitant use of benzodiazepines with the ketamine has been shown to reduce psychotomimetic side effects [51–53]. This combination, however, increases the incidence of cardiovascular and respiratory side effects, and is therefore not routinely recommended for austere use, although in the Uganda study the combination was used with little problem [48]. Falkland War experience also showed there to be no problems with emergence when diazepam was coadministered [54]. It has also been shown that the isomer makeup of ketamine determines both its potency and incidence of psychogenic side effects [55]. The typical ketamine used today is a racemic mixture of d and l forms. The d form has been shown to be more potent, and also to have less psychotomimetic side effects [55,56]. Work is being done to use the d-isomer as a pain control medication.

Ketamine is most commonly given IM or IV; however, it is also available in oral, sublingual, rectal, and nasal preparations. Oral tablets appear to have approximately 20% bioavailability. Rectal and sublingual preparations appear to be 30%, and intranasal at least 45% [57]. Intranasal ketamine is being studied for use as an intranasal pain control agent in the operational setting. When using the d-isomer, intranasal ketamine may hold promise as an effective analgesic without the requirement of an IV and with a decreased incidence of psychotomimetic side effects.

### Regional anesthesia

The most often discussed and written [58] about method of wilderness [59] and operational pain control is the use of regional anesthesia, which offers many advantages for the austere environment [18]. Although the
following section is written primarily from an operational standpoint, regional anesthesia works equally well in the wilderness setting.

Wounds received during military conflicts present as challenges that require medical providers to possess a mastery of manifold anesthesia management techniques to deliver optimum care. The mechanism of injury, desires of the patient, and the skills of the practitioner dictate the type of regional anesthesia administered for any military wound. This section will briefly review the physiologic variables, technical highlights, and austere environment considerations for the administration of regional anesthesia to the trauma patient. In addition, common potential complicating factors present in the trauma patient will be discussed. The regional anesthetics discussed below were used whenever time allowed. For example, numerous amputations were performed on Iraqi soldiers during the Persian Gulf War using regional anesthesia and supplemental ketamine.

Regional anesthesia has been administered in one form or another during all major conflicts involving the United States over the last 100 years [60]. It has even been used as the sole method of anesthesia for cranial surgery [61]! Its use has been limited due to sterile environment considerations and the anesthesia provider’s regional anesthesia comfort level. Despite this, it has been recommended as a pain control technique of choice in mass casualty situations as it “provides complete and instantaneous pain relief…and provides an economy in personnel, time and money” [62]. There have been no studies that demonstrate a higher risk of infection with regional anesthetics administered outside of the operating room setting. The level of regional anesthesia experience among anesthesia providers varies greatly due to varying levels of emphasis demonstrated in the different training programs in the United States. This lack of training and familiarity with the involved techniques will likely present the greatest deterrent to use of regional anesthesia for austere pain control.

Regional blocks most frequently used in the austere setting include femoral blocks, ankle blocks, axillary blocks, wrist blocks, facial blocks, and digital blocks. Blocks that have been used by the authors in the field environment include all of these.

The majority of these blocks have been covered elsewhere in this text. We will, therefore, only discuss the techniques for those blocks not previously covered or where the authors have a slightly different approach. Many blocks can be performed in a variety of ways, all of which are acceptable, and dependent solely on the preference of the practitioner.

The femoral nerve block is relatively simple to administer and provides reliable anesthesia. In the hospital setting the common indications for use of femoral nerve block include knee arthroscopy, patella tendon repair, repair of patella fracture, and skin grafting from the anterior aspect of the thigh. The femoral-sciatic block, in particular, has been shown to be effective in reducing postoperative pain after outpatient knee surgery [63].
The femoral nerve originates from the L2 to L4 lumbar roots, and it descends between the psoas major and iliac muscles. In the inguinal region, the nerve is positioned anterior to the iliopsoas muscle (medial to the femoral artery) and inferior to the inguinal ligament. It innervates the muscles of the anterior thigh (quadriceps and sartorius muscles), and supplies articular branches to the hip and knee joints. Sensory branches innervate the skin of the medial thigh, medial part of the lower leg, and the medial part of the foot. With certain injuries, this regional anesthetic may mask the onset of compartment syndrome in the affected extremity; this must be considered if the femoral block is used.

The landmarks for the femoral nerve are inferior to the femoral crease. The insertion point is immediately lateral to the pulse of the femoral artery. The mnemonic NAVES is used to remember the relationship between the femoral nerve and the femoral artery. Structures are ordered lateral to medial: nerve, artery, vein, empty space, lymphatics, pubic symphysis.

To place this block, position the patient in the supine position with a fully extended lower extremity. This block may be accomplished with an iodine-based antiseptic solution and a 22-gauge 2-inch needle in addition to local anesthetic. Successful placement of the block can be performed by eliciting a paresthesia with a needle in the sensory/motor distribution of the femoral nerve. Light sedation of the patient is acceptable, but the use of the paresthesia technique requires an awake and responsive patient.

The landmark region is prepped and draped steriley. Cutaneous anesthesia at the point of needle insertion may be obtained with a skin wheel of local anesthetic. A 2-inch 22-gauge (B bevel/dull point) needle is introduced through the skin at a 45-degree angle directed cephalad and medially toward the umbilicus. An evoked response of the rectus femoris is sought as the needle is carefully advanced. Movement of the patella indicates stimulation of the femoral nerve. If this motion is not found, the needle is brought back to the skin and redirected in a more lateral or medial direction. Once the desired nerve response is elicited, aspirate and inject the local anesthetic (0.5% bupivacaine) in 5-mL increments. A total of 30 mL of local anesthetic is usually injected [64].

In Operation Just Cause, a soldier had sustained an open tib/fib fracture from the airborne insertion. A femoral nerve block was placed, with immediate pain relief lasting several hours until the soldier could be taken to the operating room.

In Operation Desert Storm, an enemy combatant had his foot blown off in combat. A femoral nerve block allowed amputation of the remaining affected limb without pain.

Ankle blocks and brachial plexus blocks may be used to provide surgical anesthesia or pain control. The ankle block is described as the impulse blockade of the five nerves that provide motor and sensory innervation to the foot. These nerves include the superficial peroneal, deep peroneal, saphenous, sural, and tibial nerves. Procedures that lend themselves to use...
of an ankle block include foot debridement, amputations of toes, or short-term pain relief. Anesthesia of the medial foot requires blockade of the superficial, deep peroneal, saphenous, and tibial nerves. Surgery of the lateral aspect of the foot requires blockade of all but the saphenous nerve. The ankle block has been covered elsewhere in this text.

In Operation Desert Storm, an enemy combatant had suffered a gunshot wound to the foot. An ankle block was placed for wound debridement. The procedure as well as subsequent transport of the soldier was done without pain.

Brachial plexus anesthesia will provide excellent anesthesia to the forearm and hand. An axillary block is the most commonly performed variety of brachial plexus anesthesia. The landmarks are easy to identify, and it is associated with fewer complications than other approaches to the brachial plexus. The axillary block does not provide reliable anesthesia above the elbow.

Insert an IV in the opposite arm. With the patient lying supine the arm is abducted to about 90 degrees, externally rotated, and flexed at the elbow. Prepare the axilla using a skin sterilizing solution. Palpate the axillary artery and place a finger on its as high in the axilla as possible. Cutaneous anesthesia at the point of needle insertion may be obtained with a skin wheal of local anesthetic. Slowly advance the 2-inch 22-gauge (B bevel/dull point) needle perpendicular to the skin through the weal toward the artery. A “pop” may be felt as the needle enters the nerve sheath. Correct placement in the sheath is confirmed if the needle gently pulsates, indicating close proximity to the artery or if the patient complains of paraesthesia in nerve distribution areas. Aspirate to exclude intravascular placement of the needle and then inject the local anesthetic in 5-mL intervals. During injection aspirate again to ensure the needle has not changed position and entered a vessel. Injection is easier if an extension set (K-52 tubing) between the syringe and the needle is used. This allows the syringe to be changed without moving the needle. Some anesthesia providers elect to place a plastic cannula in the sheath for further injections. The volume of the local anesthetic injected is between 30 to 40 mL. If an arterial puncture occurs, slowly advance the needle until blood cannot be aspirated (thus indicating needle position in the nerve sheath posterior to the axillary artery) and then slowly inject 5-mL increments while watching for local anesthetic toxicity [65].

In Operation Just Cause, a soldier shot through the hand was given an axillary block. This allowed debridement of the wound as well as pain control for transport back to the United States.

Intercostal (Rib) blocks have been shown to be effective in providing immediate, sedation free pain relief in thoracic trauma, thereby reducing respiratory splinting and the pulmonary complications, which are resultant thereof [66]. Intercostal blocks have been previously covered elsewhere in this volume.
Perhaps the easiest of all blocks, the digital block, has been covered elsewhere in this text, but it is probably the most frequently used by all levels of health care providers.

The authors have used digital blocks on occasions too numerous to individually mention, both in the wilderness and combat zone settings, for injuries to the fingers as well as the toes, all with effective pain relief.

Another simple but effective block that can be used specifically in fracture pain is the hematoma block. This has been shown to be an effective method of providing analgesia for fracture reduction [67,68], and in some cases superior to IV sedation [69]. To perform the hematoma block one first steriley preps the skin over the fracture site. One then inserts a needle into the hematoma at the fracture site, correct placement is confirmed by aspiration of blood. Local anesthesia (5–15 cc) is then injected into the hematoma. This technique should not be used in open fractures or through a dirty skin site [70].

The length of surgical procedure and duration of desired analgesia dictate the best choice of local anesthetic. Procedures lasting 1 to 1.5 hours lend themselves to the use of 3% chloroprocaine (anesthesia onset within 5–10 minutes) with 1:200,000 epinephrine. Mepivacaine or lidocaine 1.5% with 1:200,000 epinephrine will provide dense anesthesia for surgical procedures lasting 2 to 2.5 hours. Bupivacaine 0.5% with 1:200,000 epinephrine will provide anesthesia for over 4 hours. More dilute concentrations of local anesthetic (0.25% bupivacaine) may be used to provide analgesia.

In all of the blocks discussed one must be aware of the toxic doses and signs and symptoms of LA toxicity. These signs follow a pattern associated with the total dose of absorbed local anesthetic include ringing in the ears, metallic taste in the mouth, numbness of the tongue, blurred vision, drowsiness with impaired mentation, restlessness, and apprehension [71]. With larger doses delirium may progress to overt seizure activity. Asphyxia leading to metabolic and respiratory acidosis with cardiac depression and eventual cardiac arrest may develop if the convulsions are not treated rapidly and adequately. Treatment is aimed at maintaining the airway and suppressing seizures. In general, slow intermittent injection and close observation of patient status will prove to be the best safeguard against local anesthetic toxicity.

The use of regional anesthesia is an effective alternative to the use of general anesthesia for both surgical procedures as well as for effective pain control in an austere environment. With practice, the provider can safely administer local anesthesia for nerve blocks in a very expedient manner. The pain relief obtained and patient satisfaction achieved by the authors has shown that regional blocks with IV sedation are a very adequate technique for health care providers. The greatest limitation to use of these techniques is a lack of familiarity and experience with them by medical providers. The authors therefore recommend their increased use in training programs to overcome this shortfall.
Nonpharmacologic pain control

In addition to pharmacologic pain control, several other techniques have been described and used for austere environments. These include the physical pain relief modalities of splinting, compression, cold and heat therapy, as well as the complimentary medical technique of acupuncture [72].

Splinting is a well-known and used technique, which provides pain control by preventing further injury and nerve stimulation by inhibiting movement of injured extremities. It will not be covered, as there is only reason to recommend its continued use and no recommendations against, based on practical experience as well as literature review.

Compression anesthesia tends to be an inadvertent result of wrapping an injured limb either for splinting or hemostasis of bleeding. This typically occurs as an ace wrap is placed over a gauze hemostatic dressing. The resultant compression may also compress the involved peripheral nerves leading to distal anesthesia [73]. Placing a proximal compression bandage on a limb proximal to the injury can likewise induce this.

The authors do not recommend this technique, but if it is used, one must be extremely careful to ensure the paresthesia is not a sign of compartment syndrome.

Cryoanalgesia or application of cold to decrease pain has been used for soft tissue injuries for centuries. This may be done with ice packs, snow, cold water compresses, or commercial cold packs. The standard recommendation is to place a towel or other barrier between the skin and cold pack and apply it for 15 to 20 minutes every few hours [74]. Care must be taken to not cause cold injury to the underlying tissues. Cold application has been shown to have variable efficacy, from no effect [75] to effective in decreasing pain, depending on how it is applied as well as what the treatment is for [76]. If one is careful to avoid cold injury to the tissue, however, there is little downside, and this adjunctive technique is recommended. Heat therapy has not been shown to be particularly effective for acute pain control, and is therefore not recommended.

Acupuncture is another complimentary medicine technique that has been suggested for use in austere pain management [72]. Developed in austere settings thousands of years ago in Asia, acupuncture has been found to be of benefit in certain conditions [77]. It has also shown promise in use in the wilderness setting [78,79]. The supplies themselves are lightweight and compact. Unfortunately, acupuncture requires lengthy prior training. Given the positive recommendations of the National Institutes of Health Consensus Panel on Acupuncture it seems that this is a modality of potential adjunctive use for pain control in the hands of a properly skilled provider.

The austere wilderness and operational setting puts increased strain on injured individuals and those attempting to assess and treat the pain of the
injured. We have attempted to cover some of the unique aspects of pain control in these settings. It is hoped this information will both aid the provider going into the austere environment as well as initiate further discussion and research in this area.

References


