MILITARY MEDICINE

PAIN MANAGEMENT IN CURRENT COMBAT OPERATIONS

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ABSTRACT

Pain management in the U.S. Military, particularly in combat, shares many of the same principles found in civilian heath care organizations and institutions. Pain is one of the most common reasons for which soldiers seek medical attention in the combat environment, which mirrors the civilian experience.However, the combat environment exacerbates the typical challenges found in treating acute pain and has the additional obstacles of a lack of supplies and equipment, delayed or prolonged evacuation times and distances, devastating injuries, provider inexperience, and dangerous tactical situations. These factors contribute to the difficulty in controlling a soldier's pain in combat. Furthermore, civilian health care providers have also learned the importance of practicing pain management principles in austere and tactical environments because of recent natural and man-made domestic disasters. Pain management research, education, and treatment strategies have been created to try to achieve adequate battlefield analgesia, and these lessons learned may aid civilian health care providers if the circumstances arise. This article presents a brief history and current overview of pain management for combat casualties on today's battlefield. Recent natural disasters and increased threats for terrorist acts have proven the need for civilian health care providers to be properly trained in pain management principles in an austere or tactical environment. **Key words:** pain; pain management; battlefield; combat

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INTRODUCTION

The U.S. Military's response to battlefield pain control has been shaped by the nation's conflicts and the pain management technologies available. During the Revolutionary War, prior to the development of anesthesiology as a medical specialty, which was not to occur for almost a century, "anesthetic" medications for war surgery were limited to opium, wine, grog (rum), vinegar, or, more commonly, nothing at all. Pain relief depended on the speed and dexterity of the operating surgeon. One physician describing pain care of those injured on the battlefield in 1776 commented, "act in all respects as if your are entirely unaffected by their groans and complaints, but at the same time behave with such caution as not to proceed rashly or cruelly, and be particularly careful to avoid unnecessary pain."[1] The Civil War saw army physicians administering morphine for pain control and, occasionally, cannabis for tetanus and head injuries.[2] Beecher conducted landmark research in World War II, showing that 75% of casualties arriving at a field hospital did not want analgesic agents or had minimal pain after having received morphine at least five hours previously.[3] During the Vietnam War, regional anesthesia (particularly neuraxial anesthesia) was used to increase operating room efficiency.[4] In Somalia, neuraxial anesthesia was used to ensure that a patient could be immediately air-evacuated after debridement. During the present conflict, Operation Iraqi Freedom (OIF), the Tri-service Military Advanced Regional Anesthesia and Analgesia (MARAA) group has championed the use of accepted, cutting-edge analgesic technology and techniques.

While all of these examples demonstrate the Army's commitment to analgesia, the fundamental questions that Beecher's study raised remain unanswered: is combat pain different from noncombat pain, when should pain first be treated in the battlefield, and how does acute pain control affect both immediate and long-term outcomes? Previous studies have shown that failure to recognize and appropriately treat acute pain may result in an increased incidence of chronic pain[5] and posttraumatic stress disorder (PTSD).[1,6] The U.S. Military

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understands the long-term consequences of failing to identify and treat acute pain and that, like our civilian counterparts, we most likely undertreat acute pain.[7] Because of this, there is renewed interest in the recognition of, treatment of, education in, and research in battlefield pain management.

OVERVIEW OF BATTLEFIELD HEALTH SERVICE SUPPORT

The U.S. Army's health service support in combat operations is organized into levels (or echelons) of care from I through IV, with level V care located outside the combat theater and consisting usually of a Department of Defense (DoD) hospital (triservice military hospitals) or Department of Veterans Affairs (VA) hospitals.[8] These levels of care denote capabilities available at that particular level. Patient evacuation usually occurs through each level as necessary, with expansion of medical capability at each additional level. Level I health care is the first medical care a soldier receives and is unit-level health care that includes treatment and evacuation from the point of injury or illness to the unit's aid station. This level of care includes immediate lifesaving measures, disease and nonbattle injury prevention, combat stress support, casualty collection, and evacuation to supporting medical treatment. The initial treatment may be provided at the point of wounding or injury by self-aid or buddy aid and followed by trained medical personnel, usually an Army combat medic ("68Whiskeys" [68Ws]). 68Ws are trained to give morphine intramuscularly and intravenously. Furthermore, they are trained on how to administer oral transmucosal fentanyl citrate (OTFC). However, advanced providers (Special Forces medics, physician assistants, etc.) are trained in advanced analgesic administration and techniques as discussed below. First aid is provided on scene, and then the casualty is usually conveyed or directed to the aid station. The aid station provides essential emergency care and prepares the casualty for evacuation to the rear. The aid station has assigned advanced providers to include physicians and physician assistants. Although an advanced provider such as a physician assistant or physician may treat sick and wounded at the level I and IIa capability in a combat zone, these "roles" are still considered "prehospital." Casualties are then evacuated through the higher levels of care as required, to include level IIa (forward surgical team), level III (combat support hospital), level IV (field or general hospital), and level V, as described above.

Varieties of analgesic modalities for battlefield pain are available at each level of care, building on the previous capability, and are summarized in Table 1.

PAIN MANAGEMENT AT LEVELS I AND IIA

In the forward area of combat health care (levels I and IIa), care rendered here is considered "prehospital." The U.S. Military has recognized the need to identify and treat combat pain at the point of injury. In previous conflicts, the main treatment for acutely wounded soldiers in the "prehospital" setting of the battlefield was morphine, usually delivered by the intramuscular route. However, on today's battlefield, intravenous morphine is emphasized for combat casualties requiring analgesia.[8–10] Improved intravenous access training and newer intraosseous devices have improved the access and delivery of analgesia.[11,12] Furthermore, many medics now carry promethazine to relieve nausea associated with pain and opioid administration. In addition to improved delivery and titration of opioids for combat pain, most Special Forces in the prehospital combat environment carry a "pill pack." This pack contains meloxicam, a cyclooxygenase (COX)-2-selective nonsteroidal anti-inflammatory drug (NSAID), and acetaminophen to be self-administered by the individual soldier who sustains a painful injury. The reason a COX-2-selective NSAID instead of a nonspecific NSAID is used for the treatment of moderate pain on the battlefield is because NSAIDs have the potential for platelet dysfunction.[13,14] Meloxicam does not appear to have this effect.[15,16] An earlier iteration of the pill pack contained the selective COX-2 inhibitor rofecoxib, which is being replaced with meloxicam after concerns arose regarding rofecoxib. These oral medications in combination are synergistic, provide multimodal analgesia, are opioid-sparing, and do not prevent the soldier from carrying his weapon.

Finally, other newer agents and routes of delivery are currently being utilized on the battlefield to treat analgesia. OTFC has been found to relieve moderate to severe pain on the battlefield[17] and is currently carried by many Special Forces medics. An initial dose of 400 μg is used, which typically causes a peak plasma concentrations of no greater than 2 ng/mL; this plasma concentration is associated with a marked increase in the risk of respiratory depression. OTFC has a black box warning, and its use is off label, for the treatment of acute pain in opioid-naïve patients.[18] Because OTFC reaches maximum serum levels after approximately 30 minutes, redosing may start 15 minutes after the previous unit has been completed (30 minutes after the start of the previous unit). It is important to note that while the median time to peak plasma concentration (T_{peak}) for 400 μg was 25 minutes, T_{peak} demonstrated a wide range (20–240 minutes).[19]

Ketamine has also been utilized successfully as a prehospital analgesic in the combat setting.[20] Ketamine in subanesthetic doses is an almost ideal analgesic because of its profound pain relief,[21,22] its potentiation of

TABLE 1. Description of Combat Health Service Support and Modalities of Analgesia

Levels of Care	Capability/Examples*	Providers	Modalities of Analgesia
I	Immediate care at the scene	Combat lifesaver/medic/paramedic	Morphine IM/IV/IO PO meloxicam/acetaminophen Peripheral blocks Advanced splinting
	Treatment facility (basic emergency treatment) Holding for a few hours only	Physician/physician assistants	As above, plus PCA
IIa	Increased ancillary staff, holding capability and equipment (i.e., x-ray) Basic emergency treatment with increased holding for 72 hours No surgical capability	Physician/physician assistants	As above
IIb	Specialized surgical teams Lifesaving "damage control" and resuscitative surgery (general, orthopedic, limited neurologic)	General surgery, orthopedic, anesthesia, and critical care nursing	As above, plus basic regional anesthesia
III	Highest level of care in combat zone (modular hospital, i.e., combat support hospital [CSH])	Fully staffed hospital with some pain specialist capabilities	As above, plus advanced regional anesthesia, acute and chronic pain services
IV	Definitive medical care outside the combat zone (usually a field or general hospital)	As above, plus advanced pain specialists with multidiscipline ability	As above, plus pain service consultation
V	Designated DoD and VA hospitals within the continental United States	As above, plus chronic pain management and rehabilitation specialist	As above

*Each branch of service (Army, Navy, Air Force, and Marines) has different units and capabilities at each level of care.
DoD = Department of Defense; IM = intramuscular; IO = intraosseous; IV = intravenous; PCA = patient-controlled analgesia; PO = oral; VA = Veterans Affairs.

opioids,[23] its role in preventing opioid hyperalgesia,[24] and its large margin of safety.

Education and training in and performance of peripheral nerve blocks are also now being utilized in the prehospital combat environment by Special Forces medics, especially for extremity injuries.[20,25] More difficult techniques such as catheter insertions and advanced nerve blocks are not done in this setting because of limitations in equipment and training. However, local wound infiltration or basic nerve blocks such as fascia iliacus,[26] intercostal,[27] or suprascapular[28] blocks performed before transport can provide profound analgesia. These blocks also afford a very low risk–benefit ratio. Use of regional anesthesia is an important technique for treating combat casualties. When performed in the prehospital setting on the battlefield, regional anesthesia does not cause changes in respiratory or mental status and allows the soldier to possibly perform some minimal duty while awaiting evacuation.

PAIN MANAGEMENT AT LEVELS IIB AND III

At levels IIb and III there are specialized providers with additional pain management skills. It is important to note that in combat casualties a wide range of pain pathologies and etiologies are also found that are unrelated to battle injuries. Pain diagnoses often reflect the more mundane causes found in the civilian population. Postsurgical pain, motor vehicle injuries, heavy lifting, falls, physical training, extended diving, and wearing heavy gear accounted for over 65% of the causes that led to evacuation out of theater.[29] A review of 162 patients who were medically evacuated from theater and referred to a tertiary pain center showed that only 17% were injured during battle.[29] This mimics previous conflicts, where nonbattle injuries and illness accounted for the major source of combatant attrition.

Combat hospitals contain a pharmacy similar to that found in smaller U.S. hospitals, with many now possessing portable patient-controlled analgesia (PCA) devices that are both air-worthy and battery-operated. These PCAs can move throughout the entire continuum of care with the patient. There is also the availability of fluoroscopy to assist in imaging more advanced nerve blocks. In addition to single-shot peripheral nerve blocks, both neuraxial and advanced regional pain techniques are routinely employed when necessary. When pain was addressed and treated in Iraq in 38 patients with these more advanced techniques such as epidural steroids, facet blocks, and directed pharmacotherapy by a pain physician, the return-to-duty rate was approximately 80%.[30] This is markedly different from the 2% return-to-duty rate that was seen when 162 pain patients were treated outside the combat theater.[29] This also mimics return-to-duty rates seen with other injuries, where approximately 50% of soldiers will return to duty if treated in theater, whereas very few will return to duty if treated in a treatment facility in the United States.

There is no clear explanation for the different return-to-duty rates, but the quicker recognition and use of advanced analgesic techniques for the treatment of

acute pain may have contributed to the high return-to-duty rate. It may have simply been due to the logistics of returning soldiers to theater once evacuated. Unfortunately, there is no clear evidence, even in the civilian literature, of the best therapy for pain. This is especially true with the heterogeneity of acute, chronic, and acute-on-chronic pain, the wide range of causes, and the wide range of treatment seen in this population.

Pain Management during Evacuation and Critical Care Transport

The most seriously injured casualties are evacuated by specially trained and equipped critical care teams. These patients are typically transported out of theater within 24 hours after injury, receiving continuous infusions of sedatives and opioids in flight. The military is looking at computer-assisted algorithms such as target-controlled infusions (TCIs) and closed-loop sedation and analgesia to improve efficacy, increase safety, and reduce provider workload. The majority of patients who are less seriously injured, the "walking wounded," are medically evacuated through the air evacuation command system. Because of the high patient-to-provider ratio on these flights, analgesia is limited to routes, drugs, and doses that minimize adverse events. Intermittent boluses of morphine, PCAs, and continuous nerve catheters are the primary modalities used on these flights.[31] Devices such as the cutaneous fentanyl PCA, once approved by the Food and Drug Administration (FDA), are currently being considered and may offer chances not only to provide effective analgesia, but also to reduce the analgesic gaps that are amplified in an austere environment.[32,33]

ADJUNCTS TO PAIN MANAGEMENT

Appropriate analgesic therapy for combat patients in pain is not limited to pharmacologic agents. Although adequate and liberal use of agents is important, many nonpharmacologic interventions recommended to improve pain management are also utilized on today's battlefield.[14,34,35] In the prehospital combat setting, physical strategies that utilize nonpharmacologic interventions have proven useful. They include heat and cold application, massage or touch, positioning, comfort splinting, and temperature regulation.[20,35] Other adjuncts to pain management are added at higher levels of care.

While opioids remain a mainstay of pain management, many adjuncts are now being used to reduce the total amount of administered opioids. In addition to the well-known side effects of opioids (respiratory depression, nausea, pruritus, etc.), there is a body of evidence of less-appreciated side effects (immunosuppression, hyperalgesia, etc.). Furthermore, there is a growing recognition that multimodality pain relief provides distinct advantages over single-agent opioid therapy.[36]

The currently used adjuncts act by a variety of mechanisms. Low-dose ketamine is being used as both a part of total intravenous anesthesia (TIVA) and an effective analgesic. NSAIDs and acetaminophen are being used similarly to trends seen in civilian practice. Clonidine is being used in hemodynamically stable patients as an anxiolytic and as an opioid-sparing medication. Lastly, there has been interest in administering gabapentin for acute pain. Whereas the Cochrane Review on gabapentin for acute and chronic pain stated there was no clear benefit, several studies point to gabapentin as being effective in this setting.[33,37,38] The role of gabapentin in the treatment of chronic neuropathic pain is less controversial. Pregabalin may also be effective and yield more consistent results secondary to its more predictable bioavailability.

As important as these nonopioid adjuncts are in the management of acute pain, they may play an even greater role in preventing chronic pain. Prevention may not simply be a function of reducing the intensity and quantity of acute pain; rather, there may be mechanisms that are blocked (e.g., punctuate hyperalgesia) that are essential to the development of chronic pain. The idea of preemptive and preventive analgesia remains under intense investigation and controversy. Because of the enormous financial and emotional burden that chronic pain places on the military health care system, early delivery of these adjuncts for acute combat pain management should be emphasized. These adjuncts are relatively available, easy to administer, and useful in treating acute pain, and have a low side effect profile.

FUTURE DIRECTIONS

The U.S. Military currently has several areas of research involving the identification and relief of combat-related pain. One such project entering human trials, "Novel Pain Therapeutics," involves developing a medical therapeutic agent that completely alleviates pain without affecting cognition, consciousness, or respiratory drive. This monoclonal antibody for nerve growth factor (NGF) may act as prophylaxis against experiencing intense pain.[39] This is sometimes incorrectly referred to as the "pain vaccine." The Battlefield Pain Control Task Area is organized to evaluate the optimal treatment of pain, the interaction of analgesic therapy with resuscitation, and the epidemiology of pain throughout the battlefield and recovery.

Also, the U.S. Army is aggressively investigating less-invasive routes of delivery for proven analgesics. For example, the Army is helping fund clinical trials of intranasal ketamine. These trials have shown great promise to date.[40] The Army is also working with manufacturers to develop nasal formulations of opioids. Other areas of research previously mentioned in this article include TCI, closed-loop delivery, cutaneous fentanyl PCAs, and "pain vaccines." There is also

interest in more distant products such as super-long-acting local anesthetics.

CONCLUSION

Ongoing improvements in battlefield pain management have included better education in, training in, research in, and availability of state-of-the-art medications and techniques. These have improved the ability of the military's health care providers to provide safe and effective analgesia in "austere," combat environments. Battlefield pain management remains a priority for the U.S. Military's Combat Casualty Care research program.

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