

Chapter 26

COMBAT TRAUMA OUTCOMES TRACKING AND RESEARCH

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INTRODUCTION

Military pain management was ushered into the modern era with Friedrich Sertürner's discovery of the "sleep-inducing factor" of the poppy, which he named after the Greek god of sleep and dreams, Morpheus, and is now known as morphine.^{1,2} By the American Civil War (1861–1865) and the Franco-Prussian War (1870–1871), the use of morphine in managing battlefield trauma was widespread, so much so that opioid addiction among wounded veterans was common and termed "soldier's disease."³ Despite the life-threatening side effects associated with morphine, its effectiveness in managing complex battlefield trauma was beyond dispute. Although the consequences of opioid monotherapy for pain, particularly addiction, were well known, the lack of viable alternatives left military physicians with little choice because these medications were essential for managing the war wounded. Following World War I (1914–1918), Ernest Bishop, MD, professor of medicine at the New York Polyclinical Medical School, commented "that opiate addiction is and will be one of the medical problems of this war is recognized and must be openly met."⁴ He suggested that opioid addiction was unavoidable because opioid use was the only way to manage battlefield pain, and learning to manage addiction was the only humane and rational response to the problem.⁴

Between World War I and World War II (1939–1945), research into pain mechanisms and management remained rudimentary. For most physicians at the time, pain was considered an unfortunate and unavoidable consequence of wounding or surgery, and many considered anesthetic agents unnecessary and possibly a hindrance to recovery.⁵ Opioids remained the primary, and often sole, solution for managing pain in World War II. The growing number of opioid-related deaths during this time prompted the first large-scale study on pain management practice within the US military.⁶ John Bonica, MD, a military anesthesiologist working at Madigan Army Hospital in Washington, was inundated with pain management cases from World War II and frustrated at the general lack of understanding within the medical community concerning pain management. This situation defined Bonica's career for the next 20 years as he crusaded for multidisciplinary pain clinics, promoted the medical specialty of pain medicine, and wrote his seminal text, *The Management of Pain*.⁷ Bonica's efforts provided a foundation for pain medicine development, but military and civilian medical communities were slow to adopt changes in traditional opioid-based pain management practices. Morphine remained the primary drug for war trauma

pain in World War II, the Korean War, and the Vietnam War, although early innovators began to change that paradigm. Captain J Markowitz used spinal analgesia to great effect on World War II prisoners of war in Thailand who required amputations in austere medical conditions.⁸ Gale Thompson pioneered the use of regional anesthesia in Vietnam War wounded, improving operating room efficiency and patient analgesia.^{9,10} In the following decades, others such as Alon Winnie, who developed many of the peripheral nerve block procedures used today, commented on the value of regional anesthetic catheters on the modern battlefield that "would allow analgesia to last as long as necessary."¹¹ While these were significant steps forward in improving pain care for the wounded warrior, within the military medical establishment pain remained a consequence of war and wounding that was poorly understood, subjectively diagnosed, and difficult to treat. In military culture, pain was expected to be endured, as evidenced by common expressions such as "no pain, no gain" and "pain is weakness leaving the body."

Following the terrorist attacks on the United States on September 11, 2001, and the onset of the Afghanistan and Iraq conflicts, reliance on morphine as the sole battlefield analgesic had essentially remained unchanged from the 19th century. Research data on the impact of pain on the combat casualty was nonexistent. The stagnant evolution of pain management methods likely relates to a general lack of understanding of the impact poorly managed pain has as a disease process involving both the peripheral and central nervous systems.¹² In previous conflicts, the wounded tended to remain static for days or even weeks in theater until they were stable enough for transport. Managing pain exclusively with morphine was likely a viable strategy in this situation because static patients could be appropriately monitored and the drug correctly titrated. This has not been the case in contemporary conflicts because the current paradigm for casualty management relies on rapidly evacuating stabilized casualties by air out of theater within hours to days. The exclusive use of morphine in this challenging, relatively austere aeromedical environment has not been ideal because of the inherent challenges in patient monitoring and the potentially life-threatening side effects associated with opioid medication.

Perhaps even more concerning has been the continued paucity of data from modern conflicts on the impact of pain following wounding. In a systematic review of prehospital analgesia, Park et al¹³ noted a general lack of evidence to inform pain management

practice in these environments, despite broad search and inclusion criteria. The wide-ranging lack of understanding about battlefield trauma pain is made more poignant with improved understanding of the relationship between chronic pain, posttraumatic stress injury, and traumatic brain injury (termed the “polytrauma clinical triad”).¹⁴ Additionally, the impact of poorly managed pain on the US general population, estimated at \$100 billion annually in increased healthcare expenses, lost income, and lost productivity, was seen by the US military as a significant unmet military healthcare problem that lacked a comprehensive strategy to address deficiencies.¹⁵ In response to this emerging issue, the US Army surgeon general, Lieutenant General Eric B Schoemaker chartered the Pain Management Task Force in August 2009 to review current military pain practice and make recommendations for a pain management strategy “that was holistic, multidisciplinary, and multimodal in its approach, utilizes state of the

art/science modalities and technologies, and provides optimal quality of life for soldiers and other patients with acute and chronic pain.” The Pain Management Task Force report was published in May 2010 and determined that the general lack of military pain data was causing “difficulty in making responsible decisions on the myriad of possible treatment modalities.”¹⁵ The surgeon general of the British Defence Medical Services, Lieutenant General L Lillywhite, made improvements in wounded warrior pain management one of his main efforts in 2007, suggesting the United Kingdom (UK) military was coming to similar conclusions from their experience.¹⁶

With this historical perspective, which clearly indicates a general lack of data on pain in combat wounded, the ensuing chapter will focus on recent successes and developing efforts to study pain in combat casualties and build a new approach to military pain management for the 21st century.

JOINT THEATER TRAUMA REGISTRY

Following the Vietnam War (1955–1975), many key advances in military trauma care were transferred into civilian medicine and became the modern trauma system seen today. Civilian proponents of modern trauma systems recognized the need for outcomes measurement to justify the expense of these systems through improved survival and outcomes.¹⁷ In an effort to mimic civilian success in trauma system development, the Joint Theater Trauma Registry (JTTR) was developed as a battlefield database designed to inform processes resulting in “the right patient, to the right place, at the right time, to receive the right care (R4).”¹⁸ It would be difficult to overestimate the impact the JTTR has had on battlefield trauma care in current conflicts. Perhaps most notable have been

the 27 evidence-based clinical practice guidelines that have been developed from the data generated by the JTTR. As important as the JTTR has been to refining the military medical response to battlefield trauma, it has not provided additional insight into the impact of pain following wounding. Pain data was not even part of the JTTR until 2007, and the information is limited to visual analogue scale (VAS) data. Clearly this information, though valuable, is insufficient to use for practice recommendations for pain management. As noted in the Pain Management Task Force report, a system for obtaining actionable pain data from the battlefield, throughout evacuation, at home, and into recovery is needed if evidence-based improvements are going to be made to battlefield pain management.

MEASURING PAIN

Due to the subjective nature of pain, its measurement as an indicator of severity or clinical success with treatment has always been difficult. Since the 1970s, most clinicians have accepted the VAS as the preferred method for measuring pain and determining pain relief.¹⁹ Outside of a research protocol that consistently controls how pain is measured, there is rarely uniformity in how clinicians use VAS pain scores when managing patients, making it problematic to compare VAS pain scores among facilities or groups of providers. Beyond the universal paucity of pain data from the present conflicts is the general lack of agreement in how to consistently measure pain in wounded soldiers.

The UK sought to establish a pain-measuring system that was simple, consistent with the World Health Organization’s “pain ladder,” and easily administered by all levels of providers in austere medical environments. The UK has selected a simple 0-to-3 pain scale (see Chapter 19, Scoring Pain, Table 19-1) with examples of possible therapeutic interventions based on the pain ladder.²⁰ Scores of 2 or 3 are considered unacceptable and prompt pain intervention.

The United States wanted to retain the familiarity and scientific value of the 0-to-10 VAS, but ground these values with functional anchors to provide consistency in scale administration, enhance clarity for patients and providers, and provide a common bench-

mark for comparing treatment effectiveness. There was also a desire to evaluate the biopsychosocial influence of pain through its impact on general activity, mood, stress level, and sleep. This resulted in the Defense and Veterans Pain Rating Scale (DVPRS; Chapter 19, Scoring Pain, Figure 19-1). The DVPRS was developed to provide a standardized method for pain assessment

that would be easily adapted to US military databases, useful across all roles of care (eg, medics, ward nurses, primary care providers, and pain specialty care), and consistent with current validated pain research tools. Based on initial validation studies, the US military is in the process of applying the DVPRS standard throughout all roles of care.²¹

COMMUNICATION AND PAIN MANAGEMENT THROUGH THE ROLES OF CARE

One of the more significant barriers to improving pain management on the modern battlefield has been communication between roles of care throughout the evacuation chain. Early in the recent conflicts, continuous peripheral nerve block (CPNB) was identified as valuable analgesia in the preponderance of extremity wounds.^{22,23} While detailed records of care were maintained at each role along the evacuation chain, this information did not routinely travel with the patient beyond an air evacuation summary document, preventing pain data collection and hindering the introduction of pain management innovation beyond morphine. As a result, few manuscripts on pain levels or management innovation in combat wounded, beyond small surveys and reviews, exist from the current conflicts.²⁴⁻²⁶ The lack of scholarly publication on pain care for wounded service members represents a missed opportunity to advance the science of pain

care and prevent providers from having to start over in the next conflict.

The increased use of regional anesthesia on the battlefield illustrates how enhanced communication supports advancements in pain management. The use of CPNB catheters requires daily review by health professionals supplied with sufficient information on CPNB pain infusion. Initially, this information was passed between pain specialists within the evacuation chain via e-mail. Although e-mail was successful, it was an unsatisfactory way to transmit this sensitive information. The United States has developed military-sanctioned electronic pain notes that allow proper communication between providers, although this system is used inconsistently. As capability and complexity of pain management techniques continue to evolve, medical communication systems will need to be developed with sufficient bandwidth to support military medicine into the 21st century.

ACUTE PAIN SERVICES AND ROLE 3: AN OVERDUE REQUIREMENT

Pain relief following trauma or surgery remains a significant medical challenge despite contemporary understanding of the detrimental impact inadequate pain management has on rehabilitation and recovery.²⁷ Civilian healthcare providers in most developed societies have recognized the benefits of an interdisciplinary team approach to supervising and administering analgesic medications and techniques provided by acute pain services (APS) within the hospital setting. Many anesthesia accreditation bodies, such as the UK Royal College of Anaesthetists and the Australian and New Zealand College of Anaesthetists, require APS as a prerequisite for training programs.²⁸ Although many agree that APS improves patient pain relief and results in enhanced appreciation of its recovery benefits, optimal APS structure and cost effectiveness remain ill defined.^{29,30} Nevertheless, most anesthesiologists understand that more sophisticated pain management plans that include medications beyond morphine or that integrate sophisticated techniques such as CPNB require an interdisciplinary team approach, which is most easily embodied through APS.

Although the need for more general improvements to pain practices on the battlefield was recognized

earlier, the first use of CPNB in the current conflicts occurred in 2003.³¹ Although CPNB was an exciting innovation in battlefield pain care at the time, it was used in combat support hospital (CSH) conditions where patient-controlled analgesia or analgesics beyond morphine were unavailable. Among the many lessons learned since 2003 is the realization that battlefield pain care must operate in a continuum that begins at the point of injury, extends through the battlefield and evacuation system to home, continues in home-country medical centers, and stretches into the rest of the veteran's life.³² The problem with pain management on the modern battlefield was that it has been considered the responsibility of every healthcare provider within theater; this meant that since everyone was responsible, no one was held accountable.

Military providers have always done their best to provide exceptional pain care, despite minimal guidance and a lack of sophisticated equipment. Through improvisation, they have often overcome the disadvantageous conditions to improve pain care standards. Yet these efforts have been unsustainable and dependent on innovative providers; therefore, casualties' pain management has depended on which providers

were deployed to their locations when they were injured. In addition to inconsistency in pain care, the lack of a clinical pain infrastructure (eg, APS) with defined personnel made standardization of pain care and data collection challenging in the field environment.

UK and US military anesthesiologists began rectifying this situation through a collaborative acute pain research and care initiative that involved the deployment of a US Army APS to a UK-commanded CSH in Camp Bastion, Afghanistan, in 2009.³³ The APS was composed of a physician trained in acute pain medicine as well as pain nurses within each care ward of the CSH. It was outfitted with a pain medicine augmentation chest that included pain infusion pumps, regional anesthesia equipment, a portable ultrasound machine, and other specialized equipment. The Camp Bastion CSH leadership prioritized pain management and made it a key indicator of care quality during this deployment. During this effort, approximately 455 trauma cases were managed (average 5.62 daily) at the CSH, and the APS staff served as the facility pain consultants on many of these cases based on injury severity or specific issues with pain. Of the 71 casualties managed by the APS, 51 (71.8%) received regional anesthesia, though all wounded under APS care were managed with individualized multimodal analgesic care plans (Table 26-1). In this series, the average percentage of improvement in pain, based on the service members' recall estimate at point of injury to air evacuation, was 51.9% (\pm 31.2). The realities of battlefield medicine precluded the establishment of a control group for this combat-injured population, but the significant pain relief brought about by the APS is undeniable. Of greater significance was the emphasis on pain management in daily rounds and routine CSH leadership meetings that prioritized this care issue.

A survey of healthcare providers was conducted to evaluate their perceptions of the value added by a CSH APS to wounded warrior care. The purpose of this investigation was to provide meaningful data for the British Defence Medical Services and the US Department of Defense to guide future plans and policies for APS deployment.³³ A majority sample of 70 UK and US military healthcare providers at Camp Bastion during the APS pilot completed the survey instrument. The survey tool consisted of 12 items designed to represent concepts and impressions of APS outcomes, complexity of care, decision-making, satisfaction, pain-management education, and areas

TABLE 26-1
FREQUENCY OF INTRAVENOUS AND ORAL ANALGESIC ADMINISTRATION

| Medication | No. of Patients | Frequency of Patients (%) |
|--------------------|-----------------|---------------------------|
| Paracetamol (IV) | 66 | 93.0% |
| Diclofenac (IV) | 59 | 83.1% |
| Morphine (IV) | 30 | 42.3% |
| Oramorph SR* (PO) | 19 | 26.8% |
| Codeine (PO) | 5 | 7.0% |
| Ketamine (IV) | 5 | 7.0% |
| Ketorolac (IV) | 5 | 7.0% |
| Ibuprofen (PO) | 4 | 5.6% |
| Tramadol (PO) | 4 | 5.6% |
| Acetaminophen (PO) | 1 | 1.4% |
| Amitriptyline (PO) | 1 | 1.4% |
| Co-codamol (PO) | 1 | 1.4% |
| Methocarbamol (PO) | 1 | 1.4% |

*Manufactured by Xanodyne Pharmaceuticals, Newport, KY.

IV: intravenous

PO: per os (by mouth)

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needing improvement. The survey demonstrated a high degree of enthusiasm for the CSH-based APS concept, with the majority of respondents agreeing that wounded soldiers managed with APS consultation reported decreased levels of pain (64.8%) and obtained greater relief (73.9%). Furthermore, the majority (73.5%) agreed that, overall, the APS had a significant impact on patient outcomes.

Although the survey demonstrated casualty care improvements after the CSH APS was put into place, this activity remains the exception rather than the accepted standard. The United States has established a Joint Theater Practice Guideline for pain and sedation³⁴ that establishes the requirement for APS in US CSHs; however, it will take a general command emphasis within the military medical system to make this policy a reality in the next conflict.

THE FUTURE OF PAIN MANAGEMENT ON THE BATTLEFIELD

If there is anything beneficial about war, it is that war is a catalyst for medical innovation and advancement. In terms of trauma pain management, recent

conflicts validate this sentiment. Pain practice has changed tremendously since the beginning of the present conflicts, with the introduction of new medications,

techniques, technologies, and provider emphasis on pain management. The key challenge is to ensure that these lessons are not lost for the next war and that they become part of military medical culture. Collecting and analyzing pain data from present conflicts is essential.

The following conditions should become a focus for military medical planners if improvements in wounded warrior pain management are to become the standard:

- Pain education must become a routine component of medical training at all levels.
- Pain measurement using a common tool, such as the DVPRS, must become a routine part of all casualty assessment.
- Pain measurement data must be collected. It should be used as a marker of care effectiveness within the CSH and throughout the evacuation chain.
- The JTTR should collect DVPRS data on all casualties.
- The APS should become as integral to a medical facility's function (CSH) as the surgery or medical services.
- The APS must be staffed with physician (usu-

ally an anesthesiologist) and nursing assets that are dedicated to and specifically tasked with handling pain issues within the institution.

- The APS should become the accepted conduit for introducing novel pain management strategies in future conflicts.
- Communication (preferably secure and electronic) between roles of care in the evacuation chain must include casualty pain data.
- Provisions for specialized pain equipment sets must become a routine component of the CSH.
- The incidence, intensity, and management of pain on the battlefield must become a research priority, as should alternatives to opioid use for pain management.

All the components exist for establishment of APSs in Role 3 through home-based facilities within the US and UK military medical systems. Once established, the APS will serve as the conduit for trauma pain data flow, research, and innovation. As John Bonica observed in *The Management of Pain*, "The proper management of pain remains, after all, the most important obligation, the main objective, and the crowning achievement of every physician."

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