Analgesia and Sedation for Tactical Combat Casualty Care

TCCC Proposed Change 21-02

Andrew D. Fisher, MD, MPAS; Taylor T. DesRosiers, MD; Wayne Papalski NRP, FP-C, TP-C; Michael A. Remley, NRP; Steven G. Schauer, DO, MS; Michael D. April, MD, DPhil, MS; Virginia Blackman, PhD, RN, CNS; Jacob Brown, 18Z; Frank K. Butler, MD; Cord W. Cunningham, MD, MHA, MPH; Jennifer M. Gurney, MD; John B. Holcomb, MD; Harold R. Montgomery; Margaret M. Morgan, MD; Sergey M. Motov, MD; Stacy A. Shackelford, MD; Timothy Sprunger; Brendon G. Drew, DO*

ABSTRACT

Analgesia in the military prehospital setting is one of the most essential elements of caring for casualties wounded in combat. The goals of casualty care is to expedite the delivery of life-saving interventions, preserve tactical conditions, and prevent morbidity and mortality. The Tactical Combat Casualty Care (TCCC) Triple Option Analgesia guideline provided a simplified approach to analgesia in the prehospital combat setting using the options of combat medication pack, oral transmucosal fentanyl, or ketamine. This review will address the following issues related to analgesia on the battlefield:

1. The development of additional pain management strategies.
2. Recommended changes to dosing strategies of medications such as ketamine.
3. Recognition of the tiers within TCCC and guidelines for higher-level providers to use a wider range of analgesia and sedation techniques.
4. An option for sedation in casualties that require procedures.

This review also acknowledges the next step of care: Prolonged Casualty Care (PCC). Specific questions addressed in this update include:

1) What additional analgesic options are appropriate for combat casualties?
2) What is the optimal dose of ketamine?
3) What sedation regimen is appropriate for combat casualties?

PROXIMATE CAUSE FOR THIS CHANGE

1. The Joint Trauma System has observed evolving trends in battlefield analgesia practice, as reflected in several publications that have examined the use of analgesia on the battlefield.[1–5]
2. Lengthy discussions of the CoTCCC and review of combat medic AARs demonstrate several concerns, to include a strong desire to potentially prevent posttraumatic stress disorder (PTSD), a need for sedation to tolerate multiple life-saving interventions, lack of effectiveness of OTFC for more severe injuries, and the challenge of incomplete dissociation associated with moderate doses of ketamine.
3. It is well recognized that first responders on the battlefield have differing skills sets, which is reflected in the tiered approach in the new TCCC curricula. The updated Department of Defense TCCC curricula reflects 4 tiers of TCCC skills, ranging from nonmedical first responders to combat paramedics, physicians, and physician assistants (PAs.) This tiering of capabilities allows higher-level providers to provide more advanced analgesia as well as sedation for painful procedures.

Background

Varying levels of pain often accompany combat injuries. Providing adequate levels of analgesia not only eases the acute pain suffered by the casualty, but has also been shown to lessen the severity PTSD. Reports from the conflicts in Iraq and Afghanistan suggest that early pain control may reduce the incidence of long-term deleterious outcomes, such as PTSD.[6,7] Other studies demonstrate associations between inadequate management of acute pain and other chronic problems such as chronic pain syndromes and mental health issues.[6–8] The current TCCC Triple-Option Analgesia approach to analgesia at the point of injury considers both the severity of pain and casualty's hemodynamic status.

Tiered Approach

Recent updates to Tactical Combat Casualty Care (TCCC) training recognize four separate tiers based upon different categories of responders. The tiers include ASM – All Service Members (Tier 1), CLS – Combat Lifesaver (Tier 2), CM/HM – Combat Medic/Hospital Corpsman (68W/8404/4N) (Tier 3), and CP – Combat Paramedic/Provider (Tier 4). Under the current guidelines, all *medical* personnel (Tier 3 and 4) may administer all analgesics recommended by the Committee on TCCC (CoTCCC). The new guidelines will provide additional options for tier 4. Both Tier 3 and Tier 4 will still follow the current recommended options as the primary initial response to injury. Tier 4 will also have the option of ketamine infusion,

*Correspondence to anfisher@salud.unm.edu
Author affiliations are given on page 165.

IV midazolam, and IV fentanyl. The expanded recommendations are currently designated as Tier 4 interventions in the prehospital environment due to the increased complexity, need for increased monitoring, and potential adverse events associated with use of these agents in these manners.

A Chronology of Analgesia Recommendations in TCCC

Since the Civil War, opioids, in particular morphine, have been the mainstay of treatment for pain.[9] However, opioids are well known to impact resuscitation measures by decreasing blood pressure, heart rate, and respiratory efforts, potentially leading to increased mortality in the prehospital setting.[10] TCCC first recommended the discontinuation of intramuscular (IM) morphine from battlefield trauma care in 1996. IM morphine use decreased as better options for analgesia (OTFC and ketamine) became available. IM autoinjectors were subsequently removed from the DoD logistics system in 2018.[11–16]

Following the successful use of oral transmucosal fentanyl citrate (OTFC) pioneered by the 75th Ranger Regiment and the Army Special Missions Unit,[17] the CoTCCC recommended the addition of OTFC (fentanyl lozenges) as an option for opioid analgesia in 2004. OTFC is a potent, rapid-acting analgesic that does not require intravenous (IV) access; OTFC has been proven to be safe and effective for battlefield use in the recent conflicts in the Middle East.[17,18] In 2012, the CoTCCC added ketamine as a nonopioid option for battlefield analgesia.[19] Ketamine has the advantage of not compromising hemodynamic or pulmonary function, which is especially important for casualties who may already be in hemorrhagic shock or respiratory distress,[20] although that does not negate the need for careful monitoring of the casualty after ketamine administration.[21]

In 2014, as the result of a direct request from combat medics in Afghanistan, the CoTCCC created a more simplified and structured approach to battlefield analgesia: the "Triple-Option Analgesia" approach.[9, 22] In 2016, the American College of Emergency Physicians subsequently advocated a similar approach to prehospital analgesia in a position statement.[23]

This update now includes recommendations distinguishing the definitions and indications between analgesia and dissociative sedation.

Specific questions addressed in this update:

1. What additional analgesic options are appropriate for combat casualties?
2. What is the best initial dose of ketamine?
3. What sedation regimen is optimal for the combat casualty?

A Brief Review of Battlefield Analgesic Reports

A multicenter, prospective, observational study from October 2012 – March 2014 evaluated the analgesics given from the point of injury (POI) to Role III.[4] The study included 532 casualties with 378 receiving an analgesic. Patients with blast injuries were less likely to receive an analgesic ("no analgesic" 65% vs "any analgesic" 48%; $P = .02$). Conversely, patients with penetrating injuries were more likely to receive an analgesic ("no analgesic" 26% vs "any analgesic" 45%; $P < .01$). The decision to administer analgesics did not differ by injury severity score (injury severity score [ISS] <15 vs ≥15; $P = .48$). Analgesic options used included ketamine, morphine, fentanyl, ketamine + opioid, and multiple opioids. Patients with an ISS ≥ 15 were most likely to receive ketamine + opioids. Patients with head injuries were less likely to receive ketamine ($P < .01$). These was no detectable difference between analgesia recipients versus all others with regards to vital signs, including systolic blood pressure, heart rate, respiratory rate, and oxygen saturation with the administration of any analgesic combination.

In a retrospective, cross-sectional study of 6,755 patients, Blackman et al. found six variables predicted analgesic administration: 1. documentation of any vital signs, 2. pain severity, 3. trauma type, 4. mechanism of injury, 5. ISS and 6. year. Compared to patients with blunt trauma, patients with penetrating trauma were twice as likely to receive a prehospital analgesic: odds ratio (OR) 2.0 (confidence interval [CI] 1.6–2.5). Likewise, patients with the mechanism of injury (MOI) of gunshot or explosion were more likely to receive prehospital analgesics than those with other causes of injury: ORs 2.0 (CI 1.2–3.2) and 1.5 (CI 1.0–2.3), respectively.[28]

A small case series by Lyon et al. found ketamine was effective in controlling pain for 10 patients, after receiving opioids at the POI.[29] Two studies had a heavy focus on pain management during TACEVAC. Shackelford et al. prospectively collected data on casualties evacuated from POI to surgical hospitals from October 2012 to March 2013.[3] This study captured POI and TACEVAC data. Of the 309 casualties included in the study, unfortunately, only 119 (39%) received pain medication at the POI. However, TACEVAC platforms were able to provide analgesia for 283 (92%) casualties. Analgesic medications administered at the POI were largely opioids, OTFC, n = 33, morphine IV (mg) 8.3 ± 2.8, n = 30 and morphine IM (mg) 9.4 ± 2.5, n = 24. More often, casualties received ketamine in conjunction with morphine or fentanyl (n = 38). Responders administered IV fentanyl to 87 casualties, with the dose range of 77 ± 38ncg.

Petz et al. performed a prospective study on prehospital analgesia.[1] There were 305 doses of analgesics administered to 237 casualties. Fifty (22%) casualties received IV fentanyl, with a median dose of 75mcg. Ketamine was the most common analgesic drug administered (52%), with a median dose = 50mg (IV 43 ± 25mg, n = 81 and IM 58 ± 26mg, n = 35). To achieve adequate analgesia, 30% of the patients required two medications. The research team noted that:

"Further prehospital research should aim to compare the analgesic effectiveness in an interventional trial of the most frequently used drugs in this study, via different routes (including intranasal), and record their side effect profiles, hemodynamic effects, effect on pain reduction, and ease of use by the provider."

In a retrospective review from January 2007 to August 2016 from the Department of Defense Trauma Registry (DoDTR), OTFC and ketamine use increased after the institution of new TCCC guidelines.[31] Specifically, there was an increase of ketamine administration from 3.9% in 2007–2012, to 19.8% in 2013–2016 (n = 515/2,604, $P < .001$). Ketamine use increased from 10% in 2010 and 2011 to 19.5% in 2012, and then to 38.4% in 2013.[28] Fentanyl use also increased over time: 34.9% in 2010, 32.5% in 2011, 52.4% in 2012, and 46.4% in 2013. During the same time, morphine use decreased: 68.2% in 2010, 70.3% in 2011, 44.2% in 2012, 40.0% in 2013.

Some casualties may not need analgesia based on assessment or even decline analgesics; therefore, analysis of recipients of analgesics may not be the most accurate way to assess guideline compliance. In all the analyses, the data is limited by not knowing whether a patient did not receive analgesics because it was not felt to be clinically warranted or if the patient declined pain medication. Patients may decline pain medications specifically to "remain in the fight" or may decline pain medications based on their perception of pain. Tactical considerations, including multicasualty incidents, must always be accounted for and the tactical environment may preclude analgesic administration. Therefore, retrospective record review is limited in discerning compliance vs. real time best judgement.

QUESTION 1: What additional analgesic options are appropriate for the combat casualties? Level of Evidence: C

NSAIDS

Nonsteroidal antiinflammatory drugs (NSAIDs) work through the arachidonic acid pathway by blocking cyclooxygenase (COX). NSAIDs can decrease inflammation and thereby decrease pain. Current CoTCCC guidelines recommend meloxicam which acts on COX-2 receptors and does not impair platelet function, making it the preferred NSAID in a bleeding patient. Furthermore, there is a logistical advantage with meloxicam as dosing comprises only a single tablet every 24 hours whereas ibuprofen and naproxen require multiple doses a day.

Acetaminophen

Acetaminophen (Tylenol) is a pain medication with an unknown mechanism of action with potent antipyretic and analgesic mechanisms. Acetaminophen reduces prostaglandin metabolites in the urine and may reduce prostaglandin in the brain. It may also exert its effect via an as yet unidentified cyclooxygenase molecule, COX-3.[32]

Opioids

Oral Transmucosal Fentanyl Citrate

Fentanyl was originally synthesized in the 1950s as an intravenous opioid with fewer side effects in comparison to morphine, specifically for its relative cardiovascular stability in critically ill patients. Fentanyl has a rapid distribution of 1.0–1.7 minutes, and administration may occur in intramuscular, intravenous, neuraxial, transdermal, transmucosal, and inhalational routes with effective analgesia. After large or multiple doses, fentanyl accumulates, improving efficacy and facilitating a longer duration of effect.[34] OTFC is a powerful, rapid-acting opioid analgesic that does not require IV/IO access to administer and is a safe and effective battlefield analgesic recommended by TCCC since 2004.[9,17,18,35] The TCCC guidelines recommend a dose of 800mcg with redosing with a second lozenge in 15 minutes from the initial dose, which yields safe outcomes in military application.[9,18] A safety advantage of OTFC is that, if providers tape the lozenge to the casualty's hand as recommended in TCCC, then the weight of the patient's upper extremity will pull the lozenge out of the mouth in the event that the casualty becomes obtunded, stopping drug administration.

Parenteral (Intravenous) Fentanyl

Intravenous fentanyl, while not currently in the TCCC analgesia recommendations, has been recently utilized in prehospital military settings with success. Shackelford et al. in 2015 performed a prospective collection on 309 casualties evacuated from POI and determined the mean dose of IV fentanyl administered at POI was 129 ± 49mcg. During TACEVAC, the mean dose was 77 ± 38mcg. In all instances of fentanyl administration, there was no reported need for any airway intervention, highlighting IV fentanyl's safety profile when used by medical personnel at appropriate doses.[5] Additionally, a retrospective chart review of 2,129 prehospital civilian all-comer EMS patients who received IV fentanyl for pain management in the field revealed that only six patients (< 0.3%) experienced vital sign changes. Investigation of response to analgesia continued through the Emergency Department (ED) for 611 patients, with only seven (1.1%) demonstrating vital sign abnormalities attributed to analgesia.[36]

In a study conducted on 763 nonhypotensive trauma patients in the prehospital trauma environment, 217 (28%) of the trauma patients received 100ncg fentanyl IV. The investigators adjusted for confounding through multivariable linear regression controlling for fentanyl administration, prehospital shock index (SI), and Trauma and Injury Severity Score (TRISS). Soriya et al. found that the SI in patients who received fentanyl was better (–0.03; 95% confidence interval: 0.05 to 0.00) compared with patients who did not receive fentanyl.[37] The CoTCCC does not currently recommend the intranasal (IN) delivery route for fentanyl. However, it is important to note that this could be a potential future direction as a recent 2020 publication comparing IN fentanyl to IV hydromorphone found noninferiority of IN fentanyl for an inpatient cancer population.[38] Additional future studies will inform future inclusion of this delivery method for fentanyl.

Sufentanil Sublingual Tablet

Sufentanil was approved for use in November 2018 for the management of acute moderate and severe pain. It is a transmucosal opioid analgesic. It comes as a 30mcg tablet administered into the sublingual space using a disposable, prefilled, single-dose applicator carried in small lightweight packaging that is easy to administer and minimizes the risk of it being dropped or loose. The recommended dosage is 30 micrograms sublingually as needed with a minimum of one hour between doses, not to exceed 12 tablets in 24 hours, for a maximum cumulative daily dose of 360mcg.

In a recent 2020 review on the status of this new drug, the authors concluded that the 30ncg nanotablets of sufentanil provided effective pain relief in moderate to severe pain, but carried the usual side effect profile of opioids including nausea, vomiting, and sedation.[40] Pooling of 9 phase 2 and phase 3 studies demonstrated that 44% of sufentanil recipients versus 33.5% control patients (varied opioids and/or placebo) experienced adverse events (AE) including nausea, protracted vomiting, and oxygen saturation decreases. The authors also noted that due to its potency, sufentanil increases the risk of serotonin syndrome. The authors concluded that administration in a supervised healthcare facility can provide effective pain control, and additional phase 4 studies are ongoing to fully elucidate the role of this new medication. A second review pooling 16 studies including 2,311 patients reported similar frequencies of the same adverse events. The authors however did find high levels of patient satisfaction of 70% or above for those receiving sublingual sufentanil.[41] Many of the publications surrounding this new medication appear to have

ties back to industry, with just 7 original articles spawning 8 reviews, highlighting a paucity of primary data relevant to this medication.[42]

In September 2019, the CoTCCC considered the addition of sufentanil to the TCCC analgesia guidelines for patients with moderate to severe pain without shock, respiratory distress, or significant risk of developing either condition while in the Tactical Field Care or Tactical Evacuation settings.[43] Although administering sufentanil does not require IV access, the delivery method of sufentanil is complicated secondary to the size of the tablets and the delivery system; the small tablets could easy fall out of the dispenser and get lost. Another challenge is that it is not rapidly cleared, increasing the risk of adverse reactions when compared to OTFC. Similar challenges were published in 2020 where hospital-based nurses and physicians rated the applicator as "somewhat easy" or "easy to dose" 97% of the time, however with reclined patients, this percentage dropped to 87%, and in limited lighting situations this percentage dropped further to 77%.[41]

While the Army has added sufentanil to their medical supply system, it is not being added to the medic/prehospital kits as of the time of this writing. There is some evidence that sufentanil is an effective analgesic, but there are few studies describing its use as an analgesic in emergency department settings and there were no studies found that evaluated sufentanil in a head-to-head comparison with OTFC or ketamine. The CoTCCC recommends obtaining additional experience and addressing this research gap before it can be considered for prehospital use. Cost should also be taken into consideration. The current cost of sufentanil is $44.32/dose while 1600mcg of OTFC is $15.65/dose.[43]

QUESTION 2: What is the best initial dose of ketamine? Level of Evidence: B

Ketamine synthesis first occurred in 1965 during an effort to find an ideal IV anesthetic.[45] It is a derivative of phencyclidine (PCP) and has analgesic properties along with being a potent anesthetic and amnestic agent. The term dissociative anesthetic referenced the unique state patients experience following ketamine administration.[46] Ketamine is an *N*-methyl-D-aspartate (NMDA) calcium channel antagonist.[45] It is on the World Health Organization's Essential Drug List.[47]

Unlike opioids, which have a tendency to lower blood pressure, heart rate, and respiratory rate, ketamine can maintain hemodynamic stability and can increase blood pressure and heart rate.[48] In a resource limited environment in patients with an injury severity score of greater than eight, an association existed between ketamine receipt and improved systolic blood pressure versus opioid analgesia (P = .03).[50] A previous concern with concomitant use of ketamine with eye injuries and TBI was based on overturned analyses and case reports; all subsequent research suggest that ketamine is safe for use in these casualties.[9,51–59]

Ketamine's properties make this medication more appropriate than opioids for use in many tactical combat injury situations.[60–63] It appears to be neuroprotective,[64,65] which may explain its role in decreased incidence of PTSD.[7] The neuroprotective aspects relate to its antiinflammatory properties.[65–67] Ketamine use in the hospital and perioperative setting is effective for pain management and reduced opioid consumption.[68–72] Ketamine also has a broad safety profile, making it difficult to overdose,[73] though rapid administration and coadministration with benzodiazepines may lead to laryngospasm and transient apnea and providers administering ketamine in high doses should prepare to secure the airway if necessary.[74] Of note, the mechanism of this apnea and laryngospasm is unclear and may relate more to vagal stimulation than the primary effect of ketamine itself.[75]

Ketamine has been more frequently utilized since the development of the TCCC Triple-Option Analgesia Plan in 2014.[9] Schauer et al. report that from 2007 to 2016, the proportion of casualties receiving ketamine rose from 3.9% to 19.8%.[76] Petz et al. in 2015 found that ketamine was the most commonly delivered prehospital analgesic, given to 52% of casualties requiring pain control.[1]

Subdissociative (Low Dose) Ketamine Dosing

Low Dose Ketamine (LDK) has been reported between 0.1mg/kg/dose to 0.4mg/kg dose. This dose is intended to provide analgesia without producing dissociation. 20mg IV or 50mg IM/IN is the 2014 Triple-Option Analgesia Plan recommended dose.[9] A recent small case series of ketamine use in SOF training mishaps (n = 34), found LDK was effective, but often needed additional doses.[77] Because of the safety of these straight doses as well as the undesirability of having to perform math on the battlefield, neither the 2014 guidelines nor the current TCCC guideline updates recommend weight-based dosing under duress or stressed situations.[9] Given that the weight of many service members exceeds 70 kg, it is important to recognize that 20mg IV ketamine may be an inadequate initial dose, hence the recommendation to administer a range of 20–30mg. To reduce the steps required for adequate pain control in the prehospital environment, ketamine dosing in this change is based on a 100-kg patient. The wide safety margin of ketamine at lower doses allows for standardized dosing. Keeping a weight-based option for dosing allows personnel in more static environments to exercise their preference for finer tuned dosing and preserve resources. This recommendation reflects the concern that the current dose is not adequate while also staying within the safe nondissociative dosing range of 0.1–0.4mg/kg for a majority of Service members. While this is an effective strategy, some medical personnel may prefer weight-based dosing.

The efficacy of LDK has been established in emergency department settings.[78] Miller and colleagues performed a study on adult patients with acute abdominal, flank, low back, or extremity pain.[20] Forty-five patients either received LDK at 0.3mg/kg or 0.1mg/kg of morphine intravenously. Ketamine provided maximum pain relief (change in Numeric Rating Scale [NRS] of 4.9) within 5 minutes while morphine maximum pain relief (change in NRS 5.0) occurred at 100 minutes. While LDK yielded equal pain reduction scores compared to morphine, LDK provided maximum analgesia significantly faster within 5 minutes and provided a moderate reduction in pain for two hours. A randomized controlled trial (RCT) by Motov et al. yielded similar results, concluding that LDK was a safe and effective method of providing short term pain relief when compared to morphine.[79] Several other studies, including a systematic review and meta-analysis support these two papers showing that LDK is as effective as morphine with mild adverse events and should be used routinely for pain greater than 5 on the NRS scale.[80–83]

Overall, the data both in hospital and prehospital/operational settings supports the current dosing strategy of low dose ketamine (LDK). Based upon a study finding that the weight of the average service member as of 2016 is 76.7 kg.[44] and the presumption of combat injury patterns requiring high doses of analgesia, the CoTCCC recommends an initial ketamine dose of 20–30mg. The 30mg dose corresponds to 0.39mg/kg for a 76.7-kg patient (the upper limit of the 0.1–0.4mg/kg non-dissociative dose range). While this amount slightly exceeds 0.4mg/kg for a 70-kg service member (corresponding to 0.42mg/kg), we believe this is a reasonable risk based upon the preponderance of service members requiring higher doses. LDK remains the ideal initial dosing strategy to minimize side effects. Providers can redose and titrate this ketamine dose to achieve the desired analgesic effect while maintaining safety.

Intranasal (IN) Dosing Considerations

The intranasal (IN) route for administering medications is a desirable method for several reasons including direct drug delivery to the central nervous system and bypassing the time and skill for IV placement. An ED study comparing IN ketamine via atomization of a 50mg/mL solution dosed at 0.75mg/kg found similar pain control in migraine patients when compared to standard protocols.[84] Atomizers help achieve maximum efficacy in delivery.[85] Atomizers are a small tool that can be added to the tip of a syringe and improve drug delivery by creating smaller particles that absorb better, enhancing systemic drug delivery and reducing leak and loss of medication.[86] Notably, the patient must be cooperative patient and without dried blood or dirt in the nasal cavity for this method of administration to work. IN dosing has to date proven to be difficult to sustain with limited effectiveness in the deployed setting.[31]

Dosing Considerations

Ideally, casualties should receive one drug at the POI. This simplistic approach is optimal for better patient care and mitigates the risk of polypharmacy and adverse events in a chaotic environment and prior to monitor placement.

Ketamine has an excellent safety profile. However, as previously discussed, adverse events may increase with higher dose and rate of administration. To mitigate any adverse events, the CoTCCC recommends that responders administer ketamine in more frequent smaller doses versus one larger dose.

Ketamine Side Effects and Adverse Events

The effects of ketamine are rate and dose dependent.[87,88] Rapidly pushing ketamine can induce unpleasant sensations, as well as impact the risk of apnea, nausea, vomiting, and dizziness. Nausea and vomiting are common side effects. While generally considered cardioprotective, IV ketamine has been reported to cause hypotension when pushed too rapidly or when medication errors result in a large overdose of IV ketamine.[90,91] Similarly, a recent observational analysis from the National Emergency Airway Registry (NEAR) found a greater risk of periintubation hypotension with ketamine as compared to etomidate, though most of these patients received ketamine in doses exceeding the low dose range.[21] These observational findings require further study by randomized trial designs, but responders should understand the uncommon but nevertheless possible outcome of ketamine administration reducing blood pressure, perhaps due to alleviation of catecholamine release associated with pain.

Ahern et al. noted that 18 out of 500 patients receiving low dose ketamine (LDK) (3.5%) had psychomimetic or dysphoric reactions, however, only 3 required a benzodiazepine. The authors of that study concluded that the "use of LDK as an analgesic in a diverse ED patient population appears to be safe and feasible for the treatment of many types of pain."[92] Elsewhere, Sin's review of four studies (n = 428) using LDK ranging from 0.2–0.3mg/kg found only one case of psychological disturbances.[93] Another study evaluating the service members' ability to perform military tasks when given 50mg IM ketamine demonstrated that patients were aware of their impairment and performed tasks slower when compared to morphine (10mg IM).[94] The mid-range dosing of ketamine, 0.5–0.8mg/kg IV, is used by recreational users and for ketamine-assisted psychotherapy as it begins to produce euphoria and hallucinations. When used in patients in pain, this dose range can produce disruptive hallucinations as the patient is not yet fully dissociated. At higher doses of 0.8–2mg/kg IV, patients become dissociated from their environment generally with preserved cardiac and respiratory status. This is most likely due to the disruption of the thalamocortical and limbic systems.[48] These effects last 20–30 minutes and vary by patient. While this dissociation may appear traumatic in itself, a prehospital study using ketamine in severe agitation noted there was no increased incidence of required psychiatric evaluations or admissions in the patients administered various doses of prehospital ketamine.[95]

Emergence Phenomenon and Incomplete Dissociation

The unpleasant sensations associated with incomplete dissociation and emergence phenomenon are often confused and poorly defined. Incomplete dissociation and emergence phenomena are very similar in terms of signs and symptoms, though incomplete dissociation tends to occur with the mid-range dosing of ketamine (0.5–0.9mg/kg IV) while emergence reactions occur as a patient resurfaces after full dissociation. Descriptions of emergence phenomenon have included feelings of unreality, "spaced out," euphoria, disconnectedness, restlessness, agitation, crying, inconsolability, hallucination, vivid dreaming, floating, and delirium.[93,96,97] A single double-blind study comparing morphine to ketamine (0.5mg/kg) for patients with long bone fractures demonstrated that ketamine was effective but also had an emergence phenomenon in 9.5% of the patients.[98]

There is no available data on the incidence of emergence phenomenon on the battlefield. Fisher et al. describe incomplete dissociation in an operational setting but without emergence phenomenon issues, implying that true emergence phenomenon is uncommon in this setting.[99] Hence, the initial treatment of unpleasant sensations should be redosing of ketamine. If redosing ketamine is not possible or if responders suspect a true emergence reaction, the CoTCCC recommends administering a benzodiazepine such as midazolam.[100] However, it is of the utmost importance to emphasize that responders should not routinely administer benzodiazepines together with ketamine because of their respiratory depressant effect. A retrospective study from Iraq reported that paramedics gave 5mg diazepam to 32% (n = 713) of the patients who received ketamine.[50] It appears that many of these doses were prophylactic and may have affected vital signs, however the authors do not report the changes in vitals for that cohort. Additionally, a review of 35 studies with 8,282 pediatric patients found the

administration of a benzodiazepine did not improve rates of recovery agitation.[101]

While altered mental status can occur with ketamine and opioid administration, the provider must evaluate alterations in behavior, mentation, and sensorium. These changes may also be due to other causes including hypotension, hypoxia, hypercarbia, hypo/hyperthermia and head injury. Treat life-threatening concerns prior to providing analgesia.

QUESTION 3: What sedation regimen is appropriate for the combat casualty? Level of Evidence: B

This iteration of the TCCC guidelines recognizes that sedation may be needed in certain combat casualty scenarios and includes a ketamine sedation option due to its safety profile and relative simplicity. A slow IV push of 1–2mg/kg followed by an infusion of 0.3mg/kg over 5–15 minutes can serve as an effective sedation plan. This is ideal for a myriad of operational situations including prolonged evacuation or need to undertake complex procedures. Sedation is also appropriate for casualties with severe injuries requiring multiple interventions.

Analgesia Versus Dissociative Sedation

It is imperative that prehospital responders understand the distinction between analgesia and sedation. Simply stated, analgesia is the reduction of pain whereas sedation is the drug-induced decreased level of consciousness ranging from anxiolysis to deep sedation.[102] The American Society of Anesthesiologists describes sedation in a tiered manner, using minimal/anxiolysis, moderate/analgesia (conscious sedation), deep/analgesia, and general anesthesia (Table in Reference 103).[103] Dissociative sedation is equivalent to moderate sedation (previously referred to as conscious sedation). Deep sedation and general anesthesia are generally used for surgical procedures and not routinely indicated in the prehospital environment. The current guideline update exclusively addresses the use of ketamine for moderate sedation, which carries both analgesic as well as sedative properties with dissociative dosing.

The TCCC guidelines have standardized and simplified analgesia on the battlefield to allow for safe administration of medications without the need for continuous monitoring. Procedures and clinical situations that require sedation will necessitate continuous monitoring. Any level of sedation requires patient positioning to maintain and protect the airway. This holds especially true when entering deeper sedation levels beyond just anxiolysis. While opioids may decrease respiratory rate, many of the medications used in sedation either primarily blunt the respiratory response or have secondary effects that may affect ventilation and oxygenation. Thus, when able, it is essential that responders plan and prepare for all sedation tasks prior to execution. At a minimum, sedation should use pulse oximetry which provides information about the patient's oxygen saturation and heart rate. Preferably, responders should also utilize capnography or capnometry. $ETCO_2$ monitors ventilation (breathing) and will identify a lack of respiratory effort minutes before pulse oximetry values may decrease.[104]

Due to ketamine's safe hemodynamic profile, pulse oximetry and/or capnography should suffice for safe ketamine-only sedation. While utilizing these tools is ideal, these guidelines also recognize the rare cases where emergency necessitates action over ideal settings, again highlighting the decision to use ketamine which even at high doses should have relatively few risks. Shackelford et al. found no significant decrease in systolic blood pressure (SBP), respiratory rate (RR), heart rate (HR), or oxygen saturation (SpO_2) for 4 patient groups at POI who received either no pain medication, morphine, fentanyl, or ketamine ($n = 99$, $P > .05$).[5] In fact, they found that an association existed between ketamine administration and an increase in systolic blood pressure (SBP) (+7 ± 17 mmHg). Conversely, an association exists between opioid administration and a decrease in SPB (–3 ± 14 mmHg). This study, in addition to Petz et al., supports ketamine's general hemodynamic stability; though it is always important to keep in mind that the higher the dose and faster the rate of administration, unwanted side effects do increase.[1] While dissociative sedation of greater than 1mg/kg IV should not impact respirations or compromise the patient's ability to protect their own airway, fast pushes may lead to periods of apnea particularly with higher doses 3mg/kg and beyond. Nevertheless, the monitoring recommendations as well as the availability of bag valve mask and definitive airway supplies support good practice to prepare for unexpected outcomes.

When Should Sedation Be Utilized?

The use of ketamine for procedures is well established in the literature.[105–110] In general, responders should utilize sedation when significant, severe, injuries require sedation (or dissociative sedation) for the safety of the patient, safety of surrounding service members, and if required to ensure mission success. The following examples are not a comprehensive list; the examples are intended to offer guidance for when patient safety and comfort is achievable through sedation and complete dissociation:

- During transportation, sedation by infusion may be a safer option as compared to multiple boluses of one-time medications. Consider instead: In the En Route Care environment when monitoring is possible and continuous infusion is safer and more practical than multiple boluses of medication.
- When either the mission itself or transportation options are space limited and patient movement must be minimized.
- During life-saving or high-risk interventions that cannot be disrupted (i.e., cricothyrotomies).
- When an evacuation may be prolonged, continuous monitoring is available and prolonged sedation is necessary;
- And where operational tempo necessitates.
- It is essential that prior to dissociative doses of ketamine being administered, the provider have full awareness of medical and personnel logistics that full dissociation requires. Not only will the patient require close monitoring, but also a team to complete movement.

Conclusions

1. The triple option analgesia guideline has demonstrated success and safety in multiple military operational situations and remains well-suited for delivery on the battlefield. However additional needs, such as sedation, prolonged care, and paramedic-level alternatives were not incorporated into previous CoTCCC recommendations.
2. This update adds IN/IV fentanyl as an option for tier 4 (paramedic level) TCCC providers.

3. The meloxicam and acetaminophen contained in the CoTCCC-recommended Combat Wound Medication Pack provides moderate analgesia and avoids adverse effects, and will be more easily supported logistically with the 1000mg dose of acetaminophen. Acetaminophen is more widely available as 500mg tabs in the military medical logistical system in comparison to the previously recommended 1300mg dose, which was based on two 650mg tabs. This should be used for casualties whose pain is not severe and who are still able to be effective combatants.
4. Ketamine provides excellent analgesia, particularly at the increased dose of 30mg. This agent minimizes the risk of cardiorespiratory depression and hence is the preferred single agent for pain control for any patient at risk of developing shock or respiratory distress. Ketamine administration may occur via IV, IO, IM, or IN routes.
5. Some situations will require prolonged analgesia or full dissociation. While it is unreasonable to outline every situation in which this need may occur, responders may utilize sedation for cases of severe injury to ensure safety and mission completion or cases where procedural sedation is necessary. The use of sedation requires monitoring with pulse oximetry and preferably $ETCO_2$.
6. Tier 4 (paramedic level) responders should rarely need to administer midazolam with patients experiencing untoward effects of ketamine such as dysphoria or emergence phenomena. If the patient appears only partially dissociated, it is preferrable to administer more ketamine rather than administering an additional drug. If behavioral disturbances or unpleasant sensations occur and ongoing pain control is not needed (for example a procedure is complete, the CASEVAC has arrived at the next level of care, etc.), then responders may consider midazolam to address these unpleasant sensations but should avoid this medication unless it is clearly needed because of the concern regarding respiratory depression. Alterations in behavior, mentation, and sensorium may also be due to other causes including hypotension, hypoxia, hypercarbia, hypo/hyperthermia and head injury and responders should treat those underlying causes.
6. Responders should not administer benzodiazepines prophylactically, in unmonitored patients, or in casualties who have received opioids.

Current Wording in the TCCC Guidelines

Analgesia

a. Analgesia on the battlefield should generally be achieved using one of three options:

Option 1

- Mild to Moderate Pain
- Casualty is still able to fight
  - TCCC Combat Wound Medication Pack (CWMP)
    - Tylenol – 650mg bilayer caplet, 2 PO every 8 hours
    - Meloxicam – 15mg PO once a day

Option 2

- Moderate to Severe Pain
- Casualty IS NOT in shock or respiratory distress

AND

- Casualty IS NOT at significant risk of developing either condition
  - Oral transmucosal fentanyl citrate (OTFC) 800 µg
    - Place lozenge between the cheek and the gum
    - Do not chew the lozenge

Option 3

- Moderate to Severe Pain
- Casualty IS in hemorrhagic shock or respiratory distress OR
- Casualty IS at significant risk of developing either condition
  - Ketamine 50mg IM or IN

OR

  - Ketamine 20mg slow IV or IO
    - Repeat doses q30min PRN for IM or IN
    - Repeat doses q20min PRN for IV or IO
    - End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes)

Analgesia notes:

a. Casualties may need to be disarmed after being given OTFC or ketamine.
b. Document a mental status exam using the AVPU method prior to administering opioids or ketamine.
c. For all casualties given opioids or ketamine – monitor airway, breathing, and circulation closely
d. Directions for administering OTFC:
   - Recommend taping lozenge-on-a-stick to casualty's finger as an added safety measure OR utilizing a safety pin and rubber band to attach the lozenge (under tension) to the patient's uniform or plate carrier.
   - Reassess in 15 minutes
   - Add second lozenge, in other cheek, as necessary to control severe pain
   - Monitor for respiratory depression
e. IV Morphine is an alternative to OTFC if IV access has been obtained
   - 5mg IV/IO
   - Reassess in 10 minutes.
   - Repeat dose every 10 minutes as necessary to control severe pain.
   - Monitor for respiratory depression.
f. Naloxone (0.4mg IV or IM) should be available when using opioid analgesics.
g. Both ketamine and OTFC have the potential to worsen severe TBI. The combat medic, corpsman, or PJ must consider this fact in his or her analgesic decision, but if the casualty is able to complain of pain, then the TBI is likely not severe enough to preclude the use of ketamine or OTFC.
h. Eye injury does not preclude the use of ketamine. The risk of additional damage to the eye from using ketamine is low and maximizing the casualty's chance for survival takes precedence if the casualty is in shock or respiratory distress or at significant risk for either.
i. Ketamine is a useful adjunct to reduce the amount of opioids required to provide effective pain relief. It is safe to give ketamine to a casualty who has previously received morphine or OTFC. IV Ketamine should be given over 1 minute.
j. If respirations are noted to be reduced after using opioids or ketamine, provide ventilatory support with a bag-valve-mask or mouth-to-mask ventilations.
k. Ondansetron, 4mg Orally Dissolving Tablet (ODT)/IV/IO/IM, every 8 hours as needed for nausea or vomiting. Each 8-hour dose can be repeated once at 15 minutes if nausea and vomiting are not improved. Do not give more than 8mg in any 8-hour interval. Oral ondan-

setron is NOT an acceptable alternative to the ODT formulation.

l. Reassess – reassess – reassess!

Proposed New Wording in the TCCC Guidelines:

Tactical Field Care

a. *TCCC Non-Medical First Responders (All-Service Member and Combat Life Savers [Tiers 1&2])* should provide analgesia on the battlefield achieved by using:

Option 1

- Mild to Moderate Pain
- Casualty is still able to fight
  - TCCC Combat Wound Medication Pack (CWMP)
    - Acetaminophen – 500mg tablet or 650mg bilayer tablet, 2 PO every 8 hours
    - Meloxicam – 15mg PO once a day

TCCC Medical Responders (Combat Medic/Corpsman and Combat Paramedic/Provider [Tiers 3&4]):

Option 1

- Mild to Moderate Pain
- Casualty is still able to fight
  - TCCC Combat Wound Medication Pack (CWMP)
    - Acetaminophen – 500mg tablet or 650mg bilayer tablet, 2 PO every 8 hours
    - Meloxicam – 15mg PO once a day

Option 2

- Moderate to Severe Pain
- Casualty IS NOT in shock or respiratory distress AND Casualty IS NOT at significant risk of developing either condition
  - Oral transmucosal fentanyl citrate (OTFC) 800µg
    - May repeat once more after 15 minutes if pain uncontrolled by first dose

TCCC Combat Paramedics or Providers (Tier 4) Only:

- Fentanyl 50mcg IV (0.5–1ncg/kg)
  - May repeat q 30 min
- Fentanyl 100mcg IN
  - May repeat q 30 min

Option 3

TCCC Medical Responders (Combat Medic/Corpsman and Combat Paramedic/Provider [Tiers 3&4]):

- Moderate to Severe Pain
- Casualty IS in hemorrhagic shock or respiratory distress

OR

- Casualty IS at significant risk of developing either condition
  - Ketamine 20–30mg (or 0.2–0.3mg/kg) slow IV or IO push
    - Repeat doses q 20min PRN for IV or IO
    - End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes)
  - Ketamine 50–100mg (or 0.5–1mg/kg) IM or IN
    - Repeat doses q20–30 min PRN for IM or IN

Option 4

TCCC Combat Paramedics or Providers Only:

Sedation required: significant severe injuries requiring dissociation for patient safety or mission success or when a casualty requires an invasive procedure; must be monitored and be prepared to secure the airway:

- Ketamine 1–2mg/kg slow IV push initial dose
  - Endpoints: procedural (dissociative) sedation
  - Ketamine 300mg IM (or 2–3mg/kg IM) initial dose
    - Endpoints: procedural (dissociative) anesthesia
  - If an emergence phenomenon occurs, consider giving 0.5–2mg midazolam.
  - **If continued dissociation is necessary, move to the Prolonged Casualty Care (PCC) analgesia and sedation guidelines.**[111]

If longer duration analgesia is necessary:

- Ketamine slow IV infusion 0.3mg/kg in 100 ml 0.9% sodium chloride over 5–15 minutes
  - Repeat doses q45min PRN for IV or IO
  - End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes)

Analgesia and sedation notes:

a. Casualties need to be disarmed after being given OTFC, fentanyl, ketamine, or midazolam.
b. The goal of analgesia is to reduce pain to a tolerable level while still protecting their airway and mentation.
c. The goal of sedation is to stop awareness of painful procedures and ensure safety.
d. Document a mental status exam using the AVPU method prior to administering opioids or ketamine.
e. For all casualties given opioids, ketamine or benzodiazepines – monitor airway, breathing, and circulation closely.
f. Directions for administering OTFC:
   1. Place lozenge between the cheek and the gum.
   2. Do not chew the lozenge.
   3. Recommend taping lozenge-on-a-stick to casualty's finger as an added safety measure OR utilizing a safety pin and rubber band to attach the lozenge (under tension) to the patient's uniform or plate carrier.
   4. Reassess in 15 minutes.
   5. Add second lozenge, in other cheek, as necessary to control severe pain.
   6. Monitor for respiratory depression.
g. Ketamine comes in different concentrations; the higher concentration option (100mg/ml) is recommended when using IN dosing route to minimize the volume administered intranasally.
h. Naloxone (0.4mg IV/IM/IN) should be available when using opioid analgesics.
i. TBI and/or eye injury does not preclude the use of ketamine. However, use caution with OTFC, IV fentanyl, ketamine, or midazolam in TBI patients as this may make it difficult to perform a neurologic exam or determine if the casualty is deteriorating.
j. Ketamine may be a useful adjunct to reduce the amount of opioids required to provide effective pain relief. It is safe to give ketamine to a casualty who has previously received a narcotic. IV Ketamine should be given over 1 minute.
k. If respirations are reduced after using opioids or ketamine or benzodiazepines, reposition the casualty into

a "sniffing position." If that fails, provide ventilatory support with a bag-valve-mask or mouth-to-mask ventilations.

l. Ondansetron, 4mg Orally Dissolving Tablet (ODT)/IV/IO/IM, every 8 hours as needed for nausea or vomiting. Each 8-hour dose can be repeated once after 15 minutes if nausea and vomiting are not improved. Do not give more than 8mg in any 8-hour interval. Oral ondansetron is NOT an acceptable alternative to the ODT formulation.

m. Benzodiazepines are not pain medications, therefore the routine use of benzodiazepines such as midazolam is NOT recommended for analgesia. Responders should only administer benzodiazepines during procedural sedation WITH KETAMINE to treat behavioral disturbances or unpleasant (emergence) reactions. Responders should not administer benzodiazepines prophylactically and this is not commonly necessary when administering appropriate doses of ketamine to achieve analgesia or sedation.

n. Polypharmacy is not recommended; responders should NOT administer benzodiazepines in conjunction with opioid analgesia.

o. If a casualty appears to be partially dissociated, it is safer to administer more ketamine than to use a benzodiazepine.

p. Consider dosing ketamine 30–50mg for casualties over 90 kg

Tactical Evacuation Care (same as above)

Considerations for Further Research and Development

1. Continue efforts for 50mg intramuscular ketamine autoinjectors available for use by US combat forces.
2. Explore options for the use of S-ketamine in TCCC.
3. Randomized Controlled Trials comparing sufentanil to both OTFC and ketamine for the treatment of acute pain.
4. Observational studies of the reduction in pain produced by the TCCC Combat Wound Medication Pack.
5. Randomized controlled trials in the civilian setting comparing both OTFC and ketamine to other analgesic options for the treatment of acute pain in the prehospital phase of care.

Acknowledgments

The authors gratefully acknowledge the research assistance provided by Mrs. Danielle Davis and Ms. Geri Trumbo of the US Army Institute of Surgical Research and by Ms. Ann Holman of Walter Reed National Military Medical Center. Finally, we would also like to acknowledge Erin M. Eickhoff, DNP, RN, and Patricia N. Meza, PhD, RN, their valuable review and input.

Disclaimers

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Defense Health Agency or the Department of Defense. This recommendation is intended to be a guideline only and is not a substitute for clinical judgment.

Disclosures

The authors have nothing to disclose.

Release

This document was reviewed by the director of the Joint Trauma System and by the Public Affairs Office and the Operational Security Office at the DoD's Defense Health Agency. It is approved for unlimited public release.

References

1. **Petz LN, Tyner S, Barnard E, et al.** Prehospital and en route analgesic use in the combat setting: a prospectively designed, multicenter, observational study. *Mil Med*. 2015;180(3 Suppl):14–18.
2. **Schauer SG, Fisher AD, April MD, et al.** Battlefield analgesia: adherence to Tactical Combat Casualty Care guidelines. *J Spec Oper Med*. 2019;19(1):70–74.
3. **Schauer SG, Robinson BR, Mabry RL, Howard JT.** Battlefield analgesia: TCCC guidelines are not being followed. *J Spec Oper Med*. 2015;15(1):63–67.
4. **Schauer SG, Mora AG, Maddry JK, Bebarta VS.** Multicenter, prospective study of prehospital administration of analgesia in the US combat theater of Afghanistan. *Prehosp Emerg Care*. 2017;21(6):744–749.
5. **Shackelford SA, Fowler M, Schultz K, et al.** Prehospital pain medication use by US Forces in Afghanistan. *Mil Med*. 2015;180(3):304–309.
6. **Holbrook TL, Galarneau MR, Dye JL, et al.** Morphine use after combat injury in Iraq and post-traumatic stress disorder. *N Engl J Med*. 2010;362(2):110–117.
7. **McGhee LL, Maani CV, Garza TH, et al.** The correlation between ketamine and posttraumatic stress disorder in burned service members. *J Trauma*. 2008;64(2 Suppl):S195–198; Discussion S197–198.
8. **Buckenmaier CC 3rd, Rupprecht C, McKnight G, et al.** Pain following battlefield injury and evacuation: a survey of 110 casualties from the wars in Iraq and Afghanistan. *Pain Med*. 2009;10(8):1487–196.
9. **Butler FK, Kotwal RS, Buckenmaier CC III, et al.** A triple-option analgesia plan for Tactical Combat Casualty Care: TCCC guidelines change 13-04. *J Spec Oper Med*. 2014;14(1):13–25.
10. **Malchow RJ, Black IH.** The evolution of pain management in the critically ill trauma patient: emerging concepts from the global war on terrorism. *Crit Care Med*. 2008;36(7 Suppl):S346–S357.
11. **Nordberg G, Borg L, Hedner T, Mellstrand T.** CSF and plasma pharmacokinetics of intramuscular morphine. *Eur J Clin Pharm*. 1985;27(6):677–681.
12. **Stanski DR, Greenblatt DJ, Lowenstein E.** Kinetics of intravenous and intramuscular morphine. *Clin Pharm Ther*. 1978;24(1):52–59.
13. **De Rocquigny G, Dubecq C, Martinez T, et al.** Use of ketamine for prehospital pain control on the battlefield: a systematic review. *J Trauma Acute Care Surg*. 2019;88(1):180–185.
14. **Buckenmaier CC 3rd, Brandon-Edwards H, Borden D Jr, Wright J.** Treating pain on the battlefield: a warrior's perspective. *Curr Pain Headache Rep*. 2010;14(1):1–7.
15. **Glare PA, Walsh TD.** Clinical pharmacokinetics of morphine. *Ther Drug Monit*. 1991;13(1):1–23.
16. **Mahinda TB, Lovell BM, Taylor BK.** Morphine-induced analgesia, hypotension, and bradycardia are enhanced in hypertensive rats. *Anesth Analg*. 2004;98(6):1698–1704.
17. **Kotwal RS, O'Connor KC, Johnson TR, et al.** A novel pain management strategy for combat casualty care. *Ann Emerg Med*. 2004;44:121–127.
18. **Wedmore IS, Kotwal RS, McManus JG, et al.** Safety and efficacy of oral transmucosal fentanyl citrate for prehospital pain control on the battlefield. *J Trauma Acute Care Surg*. 2012;73(6 Suppl 5):S490–S495.
19. **Defense Health Board.** Prehospital use of ketamine in battlefield analgesia 2012-03 (2012). https://www.health.mil/Reference-Center/Reports/2012/03/08/Prehospital-Use-of-Ketamine-in-Battlefield-Analgesia. Accessed 3 May 2022.
20. **Miller JP, Schauer SG, Ganem VJ, Bebarta VS.** Low-dose ketamine vs morphine for acute pain in the ED: a randomized controlled trial. *Am J Emerg Med*. 2015;33(3):402–408. doi:10.1016/j.ajem.2014.12.058
21. **April MD, Arana A, Schauer SG, et al.** Ketamine versus etomidate and peri-intubation hypotension: a national emergency airway registry study. *Acad Emerg Med*. 2020;27(11):1106–1115.

22. **Kotwal RS, Butler FK, Edgar EP, et al.** Saving lives on the battlefield: a Joint Trauma System review of pre-hospital trauma care in combined joint operating area? Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77–85.
23. **American College of Emergency Physicians.** Sub-dissociative dose ketamine for analgesia Policy Resource and Education Paper (PREP). American College of Emergency Physicians. 2019. https://www.acep.org/globalassets/new-pdfs/preps/sub-dissociative-dose-ketamine-for-analgesia---prep.pdf. Accessed 3 May 2022.
24. **Schauer SG, Naylor JF, Ahmed YM, et al.** Prehospital combat wound medication pack administration in Iraq and Afghanistan: a Department of Defense trauma registry analysis. *J Spec Oper Med*. 2020;20(3):76–80.
25. **Rogers E, Wright C, King P.** Fentanyl lozenge story part 2: from military procurement to package. *J Royal Army Med Corps*. 2018;164(6):458.
26. **Gurney JM, Stern CA, Kotwal RS, et al.** Tactical Combat Casualty Care training, knowledge, and utilization in the US Army. *Mil Med*. 2020;185(Suppl 1):500–507.
27. **Office of the Under Secretary of Defense for Personnel and Readiness.** DOD insruction 1322.24 Medical Readiness Training (MRT). 2018. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/132224p.pdf?ver=2018-03-16-140510-410. Accessed 3 May 2022.
28. **Blackman VS, Cooper BA, Puntillo K, Franck LS.** Prevalence and predictors of prehospital pain assessment and analgesic use in military trauma patients, 2010–2013. *Prehosp Emerg Care*. 2016;20(6):737–751.
29. **Hahn RG, Lyons G.** The half-life of infusion fluids: an educational review. *Eur J Anaesthesiol*. 2016;33(7):475–482.
30. **Andersson JO, Nasic S, Herlitz J, et al.** The intensity of pain in the prehospital setting is most strongly reflected in the respiratory rate among physiological parameters. *Am J Emerg Med*. 2019;37(12):2125–2131.
31. **Schauer SG, Naylor JF, Maddry JK, et al.** Trends in prehospital analgesia administration by US Forces from 2007 through 2016. *Prehosp Emerg Care*. 2019;23(2):271–276.
32. **Botting RM.** Mechanism of action of acetaminophen: is there a cyclooxygenase 3? *Clin Infect Dis*. 2000;31 Suppl 5:S202–S210.
33. **CADTH Rapid Response Reports.** *1000mg versus 600/650mg acetaminophen for pain or fever: A review of the clinical efficacy*. Ottawa, ON: Canadian Agency for Drugs and Technologies in Health; 2016.
34. **Peng PW, Sandler AN.** A review of the use of fentanyl analgesia in the management of acute pain in adults. *Anesthesiology*. 1999;90(2):576–599.
35. **Butler FK, Jr., Holcomb JB, Giebner SD, et al.** Tactical Combat Casualty Care 2007: evolving concepts and battlefield experience. *Mil Med*. 2007;172(11 Suppl):1–19.
36. **Kanowitz A, Dunn TM, Kanowitz EM, et al.** Safety and effectiveness of fentanyl administration for prehospital pain management. *Prehosp Emerg Care*. 2006;10(1):1–7.
37. **Soriya GC, McVaney KE, Liao MM, et al.** Safety of prehospital intravenous fentanyl for adult trauma patients. *J Trauma Acute Care Surg*. 2012;72(3):755–759.
38. **Banala SR, Khattab OK, Page VD, et al.** Intranasal fentanyl spray versus intravenous opioids for the treatment of severe pain in patients with cancer in the emergency department setting: a randomized controlled trial. *PLoS ONE*. 2020;15(7):e0235461.
39. **AcelRx Pharmaceuticals, Inc.** Highlights of prescribing information. http://www.dsuvia.com/pdf/FINAL_DSUVIA_Prescribing_Information_10.30.19_rev_C.pdf. Accessed 3 May 2022.
40. **Porela-Tiihonen S, Kokki H, Kokki M.** An up-to-date overview of sublingual sufentanil for the treatment of moderate to severe pain. *Expert Opin Pharm*. 2020;21(12):1407–1418.
41. **Hutchins JL, Leiman D, Rafique Z, et al.** Pooled dosing and efficacy analysis of the bufentanil sublingual tablet 30mcg across demographic subgroups for the management of moderate-to-severe acute pain. *J Perianesth Nurs*. 2020;35(1):22–28.
42. **Bantel C, Laycock HC.** Between evidence and commerce – the case of sufentanil sublingual tablet systems. *Anaesthesia*. 2018;73(2):143–147.
43. **Butler FK, Giebner S.** Committee on Tactical Combat Casualty Care meeting minutes. 2019. https://jts.amedd.army.mil/assets/docs/cotccc/CoTCCC_Meeting_Minutes_2019_02.pdf. Accessed 3 May 2022.
44. **Clark HL, Heileson J, DeMay J, Cole RE.** Misperceptions of weight status in military men and women. *Mil Med*. 2017;182(5):e1792–e1798.
45. **Mion G.** History of anaesthesia: the ketamine story – past, present and future. *Eur J Anaesthesiol*. 2017;34(9):571–575.
46. **Corssen G, Domino EF.** Dissociative anesthesia: further pharmacologic studies and first clinical experience with the phencyclidine derivative CI-581. *Anesth Analg*. 1966;45(1):29–40.
47. **World Health Organization.** Model list of essential medicines 21st list. 2019. https://apps.who.int/iris/bitstream/handle/10665/325771/WHO-MVP-EMP-IAU-2019.06-eng.pdf. Accessed 3 May 2022.
48. **White PF, Way WL, Trevor AJ.** Ketamine: its pharmacology and therapeutic uses. *Anesthesiology*. 1982;56(2):119–136.
49. **Xiang L, Calderon AS, Klemcke HG, et al.** Fentanyl impairs but ketamine preserves the microcirculatory response to hemorrhage. *J Trauma Acute Care Surg*. 2020;89(2S Suppl 2):S93–S99.
50. **Losvik OK, Murad MK, Skjerve E, Husum H.** Ketamine for prehospital trauma analgesia in a low-resource rural trauma system: a retrospective comparative study of ketamine and opioid analgesia in a ten-year cohort in Iraq. *Scand J Trauma Resusc Emerg Med*. 2015;23:94.
51. **Gardner AE, Dannemiller FJ, Dean D.** Intracranial cerebrospinal fluid pressure in man during ketamine anesthesia. *Anesth Analg*. 1972;51(5):741–745.
52. **Bebarta VS, Mora AG, Bebarta EK, et al.** Prehospital use of ketamine in the combat setting: a sub-analysis of patients with head injuries evaluated in the prospective life saving intervention study. *Mil Med*. 2020;185(Suppl 1):136–142.
53. **Zeiler FA, Teitelbaum J, West M, Gillman LM.** The ketamine effect on ICP in traumatic brain injury. *Neurocrit Care*. 2014;21(1):163–173.
54. **Långsjö JW, Kaisti KK, Aalto S, et al.** Effects of subanesthetic doses of ketamine on regional cerebral blood flow, oxygen consumption, and blood volume in humans. *Anesthesiology*. 2003;99(3):614–623.
55. **Drayna PC, Estrada C, Wang W, et al.** Ketamine sedation is not associated with clinically meaningful elevation of intraocular pressure. *Am J Emerg Med*. 2012;30(7):1215–1218.
56. **Halstead SM, Deakyne SJ, Bajaj L, et al.** The effect of ketamine on intraocular pressure in pediatric patients during procedural sedation. *Acad Emerg Med*. 2012;19(10):1145–1150.
57. **Peuler M, Glass DD, Arens JF.** Ketamine and intraocular pressure. *Anesthesiology*. 1975;43(5):575–578.
58. **Gregers MCT, Mikkelsen S, Lindvig KP, Brochner AC.** Ketamine as an anesthetic for patients with acute brain injury: a systematic review. *Neurocrit Care*. 2020;33(1):273–282.
59. **Cohen L, Athaide V, Wickham ME, et al.** The effect of ketamine on intracranial and cerebral perfusion pressure and health outcomes: a systematic review. *Ann Emerg Med*. 2015;65(1):43–5 e2.
60. **Green SM, Clem KJ, Rothrock SG.** Ketamine safety profile in the developing world: survey of practitioners. *Acad Emerg Med*. 1996;3(6):598–604.
61. **Bisanzo M, Nichols K, Hammerstedt H, et al.** Nurse-administered ketamine sedation in an emergency department in rural Uganda. *Ann Emerg Med*. 2012;59(4):268–275.
62. **Bull PT, Merrill SB, Moody RA, et al.** Anaesthesia during the Falklands campaign. The experience of the Royal Navy. *Anaesthesia*. 1983;38(8):770–775.
63. **Jowitt MD, Knight RJ.** Anaesthesia during the Falklands campaign. The land battles. *Anaesthesia*. 1983;38(8):776–783.
64. **Carlson AP, Abbas M, Alunday RL, et al.** Spreading depolarization in acute brain injury inhibited by ketamine: a prospective, randomized, multiple crossover trial. *J Neurosurg*. 2018:1–7.
65. **Wang CQ, Ye Y, Chen F, et al.** Posttraumatic administration of a sub-anesthetic dose of ketamine exerts neuroprotection via attenuating inflammation and autophagy. *Neuroscience*. 2017;343:30–38.
66. **Tan Y, Wang Q, She Y, et al.** Ketamine reduces LPS-induced HMGB1 via activation of the Nrf2/HO-1 pathway and NF-kappaB suppression. *J Trauma Acute Care Surg*. 2015;78(4):784–792.
67. **Bell JD.** In vogue: ketamine for neuroprotection in acute neurologic injury. *Anesth Analg*. 2017;124(4):1237–1243.
68. **Sadove MS, Shulman M, Hatano S, Fevold N.** Analgesic effects of ketamine administered in subdissociative doses. *Anesth Analg*. 1971;50(3):452–457.

69. **Kissin I, Bright CA, Bradley EL Jr.** The effect of ketamine on opioid-induced acute tolerance: can it explain reduction of opioid consumption with ketamine-opioid analgesic combinations? *Anesth Analg*. 2000;91(6):1483–1488.
70. **Kugler NW, Carver TW, Juul J, et al.** Ketamine infusion for pain control in elderly patients with multiple rib fractures: results of a randomized controlled trial. *J Trauma Acute Care Surg*. 2019;87(5):1181–1188.
71. **Liang HS, Liang HG.** Minimizing emergence phenomena: subdissociative dosage of ketamine in balanced surgical anesthesia. *Anesth Analg*. 1975;54(3):312–316.
72. **Schmid RL, Sandler AN, Katz J.** Use and efficacy of low-dose ketamine in the management of acute postoperative pain: a review of current techniques and outcomes. *Pain*. 1999;82(2):111–125.
73. **Green SM, Clark R, Hostetler MA, et al.**.Inadvertent ketamine overdose in children: clinical manifestations and outcome. *Ann Emerg Med*. 1999;34(4 Pt 1):492–497.
74. **Morgan MM, Perina DG, Acquisto NM, et al.** Ketamine use in prehospital and hospital treatment of the acute trauma patient: a joint position statement. *Prehosp Emerg Care*. 2020:1–5.
75. **Safavi M, Honarmand A, Khazaei M.** The effects of propofol, ketamine and combination of them in prevention of coughing and laryngospasm in patients awakening from general anesthesia: a randomized, placebo-controlled, double blind clinical trial. *Adv Biomed Res*. 2016;5:64.
76. **Schauer SG, Naylor JF, Maddry JK, et al.** Trends in prehospital analgesia administration by US Forces from 2007 through 2016. *Prehosp Emerg Care*. 2018:1–6.
77. **Fisher AD, Schwartz DS, Petersen CD, et al.** Ketamine administration by Special Operations medical personnel during training mishaps. *J Spec Oper Med*. 2020;20(3):81–86.
78. **Beaudoin FL, Lin C, Guan W, Merchant RC.** Low-dose ketamine improves pain relief in patients receiving intravenous opioids for acute pain in the emergency department: results of a randomized, double-blind, clinical trial. *Acad Emerg Med*. 2014;21(11):1193–1202.
79. **Motov S, Rockoff B, Cohen V, et al.** Intravenous subdissociative-dose ketamine versus morphine for aanalgesia in the emergency department: A randomized controlled trial. *Ann Emerg Med*. 2015;66(3):222–229.
80. **Mo H, Campbell MJ, Fertel BS, et al.** Ketamine safety and use in the Emergency Department for pain and agitation/delirium: a health system experience. *West J Emerg Med*. 2020;21(2):272–281.
81. **Mahshidfar B, Mofidi M, Fattahi M, et al.** Acute pain management in emergency department, low dose ketamine versus morphine, a randomized clinical trial. *Anesth Pain Med*. 2017;7(6):e60561.
82. **Lee EN, Lee JH.** The effects of low-dose ketamine on acute pain in an emergency setting: a systematic review and meta-analysis. *PLoS ONE*. 2016;11(10):e0165461.
83. **Balzer N, McLeod SL, Walsh C, Grewal K.** Low-dose ketamine for acute pain control in the emergency department: a systematic review and meta-analysis. *Acad Emerg Med*. 2021;28(4):444–454.
84. **Benish T, Villalobos D, Love S, et al.** The THINK (Treatment of Headache with Intranasal Ketamine) Trial: a randomized controlled trial comparing intranasal ketamine with intravenous metoclopramide. *J Emerg Med*. 2019;56(3):248–257.
85. **Borland M, Jacobs I, King B, O'Brien D.** A randomized controlled trial comparing intranasal fentanyl to intravenous morphine for managing acute pain in children in the emergency department. *Ann Emerg Med*. 2007;49(3):335–340.
86. **Bailey AM, Baum RA, Horn K, et al.** Review of intranasally administered medications for use in the emergency department. *J Emerg Med*. 2017;53(1):38–48.
87. **Guldner GT, Petinaux B, Clemens P, et al.** Ketamine for procedural sedation and analgesia by nonanesthesiologists in the field: a review for military health care providers. *Mil Med*. 2006;171(6):484–490.
88. **Allen CA, Ivester JR Jr.** Ketamine for pain management-side effects & potential adverse events. *Pain Manag Nurs*. 2017;18(6):372–377.
89. **Sigtermans MJ, van Hilten JJ, Bauer MC, et al.** Ketamine produces effective and long-term pain relief in patients with Complex Regional Pain Syndrome Type 1. *Pain*. 2009;145(3):304–311.
90. **Emerling AD, Fisher J, Walrath B, Drew B.** Rapid ketamine infusion at an analgesic dose resulting in transient hypotension and bradycardia in the emergency department. *J Spec Oper Med*. 2020;20(1):31–33.
91. **Simon E.** Ketamine: Safe until it's not – a terrifying trip to the K-hole. *J Emerg Med*. 2019;57(4):587–588.
92. **Ahern TL, Herring AA, Anderson ES, et al.** The first 500: initial experience with widespread use of low-dose ketamine for acute pain management in the ED. *Am J Emerg Med*. 2015;33(2):197–201.
93. **Sin B, Ternas T, Motov SM.** The use of subdissociative-dose ketamine for acute pain in the emergency department. *Acad Emerg Med*. 2015;22(3):251–257.
94. **Gaydos SJ, Kelley AM, Grandizio CM, et al.** Comparison of the effects of ketamine and morphine on performance of representative military tasks. *J Emerg Med*. 2015;48(3):313–324.
95. **Lebin JA, Akhavan AR, Hippe DS, et al.** Psychiatric outcomes of patients with severe agitation following administration of prehospital ketamine. *Acad Emerg Med*. 2019;26(8):889–896.
96. **Abu-Shahwan I, Chowdary K.** Ketamine is effective in decreasing the incidence of emergence agitation in children undergoing dental repair under sevoflurane general anesthesia. *Paediatr Anaesth*. 2007;17(9):846–850.
97. **Surrett G, Franklin J, Wedmore I.** Pain control in austere settings. *Curr Sports Med Rep*. 2015;14(2):117–122.
98. **Majidinejad S, Esmailian M, Emadi M.** Comparison of intravenous ketamine with morphine in pain relief of long bones fractures: a double blind randomized clinical trial. *Emerg (Tehran)*. 2014;2(2):77–80.
99. **Fisher AD, Rippee B, Shehan H, et al.** Prehospital analgesia with ketamine for combat wounds: a case series. *J Spec Oper Med*. 2014;14(4):11–17.
100. **Perumal DK, Adhimoolam M, Selvaraj N, et al.** Midazolam premedication for Ketamine-induced emergence phenomenon: a prospective observational study. *J Res Pharm Pract*. 2015;4(2):89–93.
101. **Green SM, Roback MG, Krauss B, et al.** Predictors of emesis and recovery agitation with emergency department ketamine sedation: an individual-patient data meta-analysis of 8,282 children. *Ann Emerg Med*. 2009;54(2):171–180.
102. **Barends CRM, Absalom AR, Struys M.** Drug selection for ambulatory procedural sedation. *Curr Opin Anaesthesiol*. 2018;31(6):673–678.
103. **American Society of Anesthesiologists.** Continuum of depth of sedation: Definition of general anesthesia and levels of sedation/analgesia. 23 October 2019. https://www.asahq.org/standards-and-guidelines/continuum-of-depth-of-sedation-definition-of-general-anesthesia-and-levels-of-sedationanalgesia. Accessed 3 May 2022.
104. **Lam T, Nagappa M, Wong J, et al.** Continuous pulse oximetry and capnography monitoring for postoperative respiratory depression and adverse events: a systematic review and meta-analysis. *Anesth Analg*. 2017;125(6):2019–2029.
105. **Merelman AH, Perlmutter MC, Strayer RJ.** Alternatives to rapid sequence intubation: contemporary airway management with ketamine. *West J Emerg Med*. 2019;20(3):466–471.
106. **L'Hommedieu CS, Arens JJ.** The use of ketamine for the emergency intubation of patients with status asthmaticus. *Ann Emerg Med*. 1987;16(5):568–571.
107. **Filanovsky Y, Miller P, Kao J.** Myth: Ketamine should not be used as an induction agent for intubation in patients with head injury. *CJEM*. 2010;12(2):154–157.
108. **Upchurch CP, Grijalva CG, Russ S, et al.** Comparison of etomidate and ketamine for induction during rapid sequence intubation of adult trauma patients. *Ann Emerg Med*. 2017;69(1):24–33 e2.
109. **Estime SR, Kuza CM.** Trauma airway management: induction agents, rapid versus slower sequence intubations, and special considerations. *Anesthesiol Clin*. 2019;37(1):33–50.
110. **Price B, Arthur AO, Brunko M, et al.** Hemodynamic consequences of ketamine vs etomidate for endotracheal intubation in the air medical setting. *Am J Emerg Med*. 2013;31(7):1124–1132.
111. **Joint Trauma System.** Prolonged Casualty Care Guidelines (CPG ID:91) (DoD). 21 December 2021. https://jts.amedd.army.mil/assets/docs/cpgs/Prolonged_Casualty_Care_Guidelines_21_Dec_2021_ID91.pdf. Accessed 3 May 2022.

KEYWORDS: *analgesia; prehospital; casualties; Tactical Combat Casualty Care (TCCC) Triple Option Analgesia guideline; fentanyl; ketamine*

MAJ Andrew D. Fisher, MD, MPAS, ARNG, is a physician assistant in the Texas Army National Guard and currently a general surgery resident at the University of New Mexico School of Medicine. He previously served on active duty as a physician assistant with the 75th Ranger Regiment.

LCDR Taylor T. DesRosiers, MD, USN, is an emergency medicine physician currently completing her critical care fellowship at Walter Reed National Military Medical Center. She is the current Director of the Combat Trauma Research Group, Bethesda.

HMC Wayne Papalski is a search and rescue critical care flight paramedic, a member of the Committee on Enroute Combat Casualty Care, and the Joint Trauma System liaison to the Navy. He is currently serving as the Trauma & Medical Education program manager at Naval Special Warfare Group Two.

MSG Michael A. Remley is a Special Operations combat medic and a member of the Committee of Tactical Combat Casualty Care. He currently serves as the senior enlisted leader for the Joint Trauma System.

MAJ Steven G. Schauer, DO, MS, is an emergency medicine physician at the US Army Institute of Surgical Research and the Brooke Army Medical Center.

MAJ Michael D. April, MD, PhD, MSc, is an US Army emergency physician currently serving on active duty with previous deployment experience to Afghanistan. He currently serves as commander of the 40th Forward Resuscitative Surgical Detachment.

Virginia Blackman, PhD, RN, CNS, is the executive officer, Naval Medical Research Center-Asia/NAMRU-TWO, Singapore.

MSG Jacob Brown is a Special Operations medic assigned to the United States Army Special Operations Command (USASOC) at Fort Bragg, NC.

CAPT (Ret) Frank K Butler, USN, was a Navy SEAL platoon commander before becoming a physician. He is an ophthalmologist and a Navy underseas medical officer with more than 20 years of experience providing medical support to Special Operations Forces. Dr Butler has served as the command surgeon at the US Special Operations Command and was the chairman of the Department of Defense's Committee on TCCC for 11 years. He currently serves as a consultant to both the JTS and the CoTCCC.

Cord W. Cunningham, MD, MHA, MPH, is a board-certified emergency medicine physician with subspecialty board certification in EMS. He served as the battalion surgeon for 2nd Ranger BN and surgical resuscitation team member for USSOCOM deploying in direct and prehospital medical support of Special Operations Forces in both Iraq and Afghanistan. Dr Cunningham also served as a flight surgeon and medical director for a 15-ship Army MEDEVAC unit and aviation brigade as well as the medical director for the Army's Critical Care Flight Paramedic Program. After serving over 20 years on active duty, Dr Cunningham is currently a colonel in the US Army Reserves with USASOC and performs duties as the chairman of the Joint Trauma System Committee on En-Route Combat Casualty Care and faculty for the Carl R Darnall Army Medical Center Emergency Medicine Residency Program at Fort Hood, TX, and the Fort Hood EMS Medical Director. Dr Cunningham is also still a full-time practicing EM physician.

Jennifer M. Gurney, MD, is a trauma surgeon and chief of the Joint Trauma System, Defense Health Agency.

John B. Holcomb, MD, is a trauma and critical care surgeon and a professor of surgery at the University of Alabama at Birmingham. Dr. Holcomb completed his general surgery training in 1991 and then deployed with the Joint Special Operations Command for the next decade. From 2002 to 2008, COL Holcomb was the commander of the US Army Institute of Surgical Research and trauma consultant for the Army surgeon general, with multiple deployments to Iraq. He has been a member of the DoD's Committee on Tactical Combat Casualty Care since 2001.

Harold R. Montgomery, SOCM, ATP, is a retired Special Operations medic whose assignments were the senior enlisted medical advisor of USSOCOM and the senior medic for the 75th Ranger Regiment with multiple combat deployments. He is program coordinator for the Committee on Tactical Combat Casualty Care of the Joint Trauma System division of the Defense Health Agency.

Margaret M. Morgan, MD, FACS, is a trauma and acute care surgeon and flight surgeon in the USNR assigned to the USNR Wing, 4th MAW.

Sergey M. Motov, MD, is an emergency medicine attending physician and professor of emergency medicine practicing in the Department of Emergency Medicine at Maimonides Medical Center, Brooklyn, NY. He graduated from Medical Academy of Latvia and completed his EM residency at Maimonides Medical Center. Dr Motov is a research director who is passionate about safe and effective pain management in the ED. He has numerous publications on the subject of opioid alternatives in pain management and is actively involved in growing this body of work both nationally and globally.

Stacy A. Shackelford, MD, is in the US Air Force, is a trauma surgeon, and was chief of the Joint Trauma System, Defense Health Agency from 2018 to 2022.

CSM Timothy J. Springer is the SEA for US Army Regional Health Command Central, he enlisted in the United States Army as a 91A, medical specialist (now 68W) and attended Basic Combat Training at Fort Knox, KY, and Advanced Individual Training at Fort Sam Houston, TX.

Brendon G. Drew is the current chair of the Committee on Tactical Combat Casualty Care and is affiliated with the I Marine Expeditionary Force, Camp Pendleton, CA.

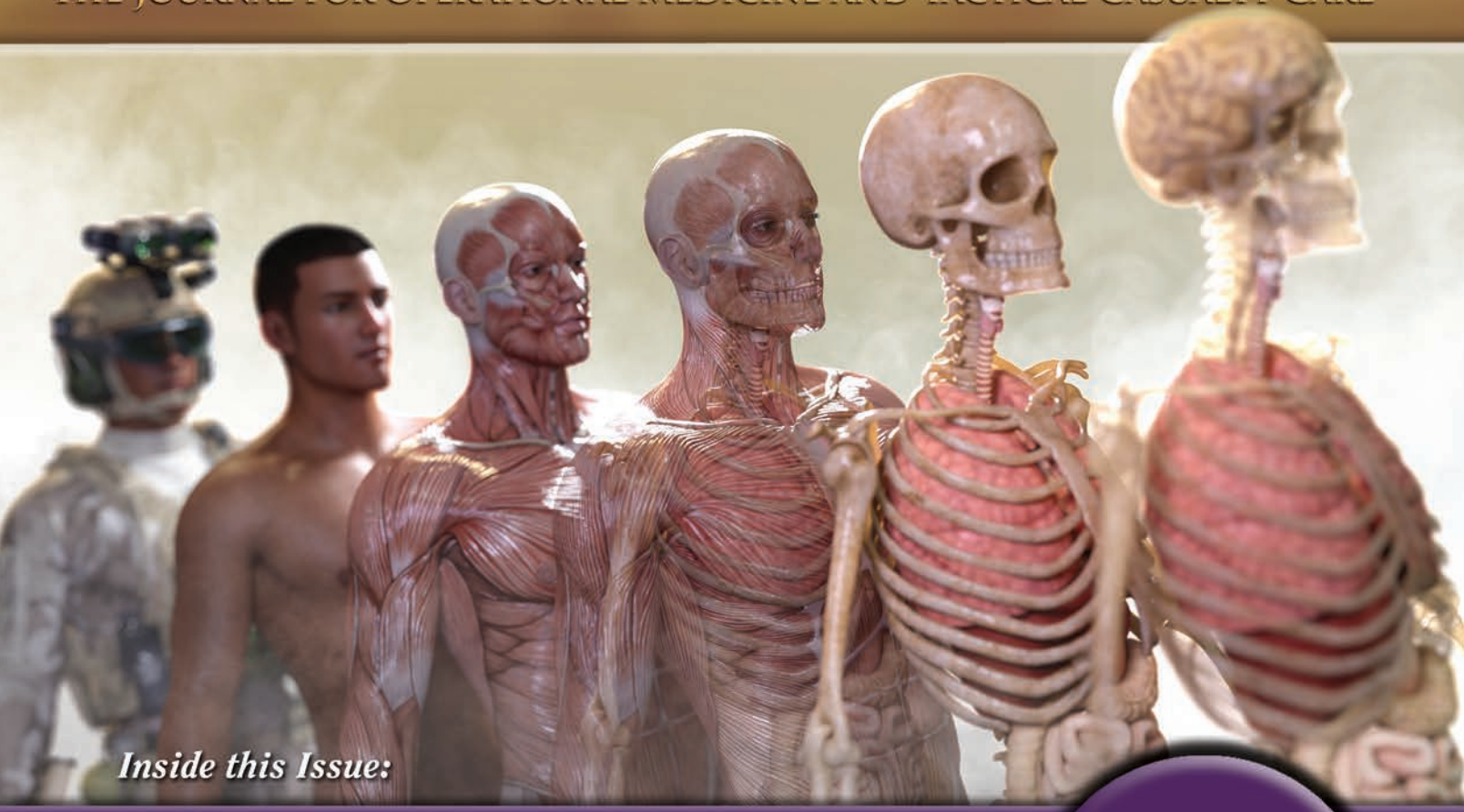
The Special Operations Medical Association's Official Journal

JSOM

JOURNAL *of* SPECIAL OPERATIONS MEDICINE™

Summer 2022
Volume 22, Edition 2

The Journal for Operational Medicine and Tactical Casualty Care



Inside this Issue:

- FEATURE ARTICLES: TCCC Maritime Scenario: Shipboard Missile Strike
- 20th SFG(A) Non-Trauma Module (NTM) Course
- Training Collaboration With a Medical School
- Assessing Body Composition Using Kinanthropometry
- CRITICAL CARE MEDICINE: The *JSOM* Critical Care Supplement
- Austere Crush Injury Management › Analgesia and Sedation in the Prehospital Setting
- Prehospital Traumatic Brain Injury Management › Shock and Vasopressors
- Prehospital Anemia Care › Prehospital Treatment of Thrombocytopenia
- Prehospital Electrolyte Care › Pathophysiology and Treatment of Burns
- Noninvasive Positive Pressure Ventilation › Mechanical Ventilation
- Acute Lung Injury and ARDS › Traumatic Coagulopathy: Prehospital Provider Review
- Prehospital Critical Care › Pediatric Sepsis in the Austere Setting
- LETTER TO THE EDITOR: Arctic Tactical Combat Casualty Care
- ONGOING SERIES: Injury Prevention, Psychological Performance, There I Was, TCCC Updates, Book Review, *and more!*

Dedicated to the Indomitable Spirit, Lessons Learned & Sacrifices of the SOF Medic

A Peer Reviewed Journal That Brings Together The Global Interests of Special Operations' First Responders