Ketamine Administration by Special Operations Medical Personnel During Training Mishaps

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ABSTRACT

Background: Opioids can have adverse effects on casualties in hemorrhagic shock. In 2014, the Committee on Tactical Combat Casualty Care (CoTCCC) recommended the use of ketamine at the point of injury (POI). Despite these recommendations the adherence is moderate at best. Poor use may stem from a lack of access to use ketamine during training. The United States Special Operations Command (USSOCOM) is often in a unique position, they maintain narcotics for use during all training events and operations. The goal of this work is to demonstrate that ketamine is safe and effective in both training and operational environments. **Methods:** This was a retrospective, observational performance improvement project within United States Special Operations Command and Air Combat Command that included the US Army's 75th Ranger Regiment, 160th Special Operations Aviation Regiment, and US Air Force Pararescue. Descriptive statistics were used to calculate the doses per administration to include the interquartile range (IQR), standard deviation (SD) and the range of likely doses using a 95% confidence interval (CI). A Wilcoxon signed-rank test was used to compare the mean pre-ketamine pain scores to the mean post-ketamine on a 0-to-10 pain scale. **Results:** From July 2010 to October 2017, there was a total of 34 patients; all were male. A total of 22 (64.7%) received intravenous ketamine and 12 (35.3%) received intramuscular ketamine and 8 (23.5%) received intranasal ketamine. The mean number of ketamine doses via all routes administered to patients was 1.88 (SD 1.094) and the mean total dose of all ketamine administration was 90.29mg (95% CI, 70.09–110.49). The mean initial dose of all ketamine administration was 47.35mg (95% CI, 38.52–56.18). The median pre-ketamine pain scale for casualties was noted to be 8.0 (IQR 3) and the median post-ketamine pain scale was 0.0 (IQR 3). **Conclusion:** Ketamine appears to be safe and effective for use during military training accidents. Military units should consider allowing their medics to carry and use as needed.

KEYWORDS: *ketamine; opioids; training; war-related injuries; analgesia*

Introduction

Providing appropriate analgesia is an important aspect of caring for the combat wounded. For nearly 150 years dating back to the Civil War through the wars in Iraq and Afghanistan, the US military relied on morphine as the primary analgesic at the point-of-injury (POI). Opioids, particularly morphine, can have adverse effects on patients in hemorrhagic shock.[1] To change the dynamics, in 2014, the Committee on Tactical Combat Casualty Care (CoTCCC) developed guidelines for the use of ketamine at the POI.[1]

Despite the CoTCCC recommendations for the use of ketamine in hemorrhagic shock at the POI, the adherence is suboptimal.[2,3] Some of the problem stems from a lack of access to use ketamine during training creating a lack of familiarity and comfort amongst medics. This may be attributable to several issues including untrusting or inexperienced medical directors who are often general medical officers, to hospital pharmacies and medical logisticians whose only experience with ketamine might be knowledge of illicit use, as well as the overall procedural, regulatory and logistical challenges of obtaining proper medical items for both training and combat.

The United States Special Operations Command (USSOCOM) is often in a unique position because they internally manage most of their medical training and logistics. This allows them to maintain narcotics for use during training events and operations. Limited data has shown ketamine to be efficacious in combat, but there are no data supporting its use in the military training environment. We undertook this review to demonstrate that ketamine is also safe and effective in training environments. In turn, we hope to influence allowance of conventional force medics to the use of ketamine during training events and hopefully help to improve adherence to the CoTCCC guidelines during operations.

Methods

This was a retrospective, observational performance improvement project within United States Special Operations Command

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and Air Combat Command. Participating units included the US Army's 75th Ranger Regiment, 160th Special Operations Aviation Regiment, and US Air Force Pararescue. The deidentified data was collected from After Action Reviews (AARs) in an anonymous manner from training mishaps and injuries. The AARs were part of ongoing internal Quality Assurance/Quality Improvement measures. The skill level of the medical providers included special operations combat medic (SOCM) or pararescueman (PJ), physician assistant, and physician. Descriptive statistics were used to calculate the doses per administration to include the interquartile range (IQR), standard deviation (SD) and the range of likely doses using a 95% confidence interval (CI). A Wilcoxon signed-rank test was utilized to compare the mean pre-ketamine pain scores to the mean post-ketamine on a 0-to-10 pain scale.

Results

From July 2010 to October 2017, there was a total of 34 patients in whom ketamine was used for training injuries, all were male. Due to reporting limitations, ages were not reported in all cases; furthermore, there was some pain data lacking within the set, therefore this was not reported in the final data. The data that was not available for four of the patients was documentation regarding their level of pain pre and/or post administration of ketamine. The injury patterns for training injuries were also reviewed.

The training injuries were delineated by the type of injury and the mechanism of injury (MOI) based on the documentation provided by the units (Table 1). The injury types determined in the study included: back, extremity, head/neck, pelvic, and polytrauma. In the cases for two documented injuries, the potentially most severe injury was used as the primary injury. "Back" injuries were musculoskeletal injuries to the back. "Extremity" injuries were any injuries to the extremity such as a fracture or gunshot wound. "Head/neck" injuries included musculoskeletal and/or blunt trauma. "Pelvic" injuries were injuries sustained to pelvis. Last, "Polytrauma" was determined to be three or more documented injuries. The injuries were categorized into MOI.

There were five MOI determined for this study. The MOI included: airborne operations (airborne ops), blunt, penetrating, other, and unknown. "Airborne operations" included injuries sustained during any operations involving exiting an aircraft while in flight. "Blunt" were simply determined to be an MOI with no penetrating injuries such as a fall; thereby, "penetrating" MOIs were those that penetrated the patient's body in some manner. "Other" indicated MOI that did not fit into the previously described categories, yet had an outlying MOI in the documentation by which this was the only MOI of that type in the data, such as "Rappel accident." Finally, "unknown" was used to categories injuries where no MOI was documented.

The most common training injury type appears to be extremity injuries with a total of 23 (67.65%) of the casualties sustaining these injuries. The second most common injury type was back injuries sustained by 4 (11.76%), followed by both pelvic and polytrauma injuries each having 3 (8.82%) incidents. There was only 1 (2.94%) head/neck injury sustained. The leading causing MOI were the "unknown" injuries with 24 (70.59%) not being noted in the data. The second leading MOI was airborne operations with 5 (14.71%) casualties, followed by other and penetrating each with 2 (5.88%) incidents and one (2.94%) incident of blunt trauma. Ketamine was used to treat all of these casualties.

TABLE 1 *Injury Demographics*

Injury Type and MOI	Number of Injuries	Percent of Injuries
Back	4	11.76%
Airborne Ops	2	5.88%
Other	1	2.94%
Unknown	1	2.94%
Extremity	23	67.65%
Airborne Ops	3	8.82%
Penetrating	1	2.94%
Unknown	19	55.88%
Head/neck	1	2.94%
Blunt	1	2.94%
Pelvic	3	8.82%
Unknown	3	8.82%
Polytrauma	3	8.82%
Other	1	2.94%
Penetrating	1	2.94%
Unknown	1	2.94%
Total	34	100.00%

The mean total dose of all ketamine administration was 90.29mg (95% CI, 70.09–110.49) (Table 2). The mean number of ketamine doses via all routes administered to patients was 1.88 (SD 1.094) (Table 3). The mean initial dose of all ketamine administration was 47.35mg (95% CI, 38.52–56.18). Nineteen (55.9%) of the patients received a second dose of ketamine. The mean second dose was 62.89mg (SD 60.903; 95% CI, 35.51–90.28). Seven (20.6%) received a third dose, with a mean of 23.57mg (SD 12.488; 95% CI, 14.32–32.82), while only 3 (8.8%) patients received a fourth dose of ketamine with a mean of 26.67mg (SD 20.817; 95% CI, 3.11–50.23). Only 1 (2.9%) casualty received a total of six doses of ketamine, at 10mg for both doses five and six.

Of the 34 patients, a total of 22 (64.7%) received ketamine via intravenous (IV) route (Table 4). Intramuscular (IM) route of administration was used for a total of 12 (35.3%) patients. Initially, 10 (29.4%) of the patients received an IM dose and 2 (5.9%) received additional doses via IM route. Intranasal (IN) doses of ketamine were used for 8 (23.5%) patients for the first dose. Last, none of the training patients were noted to have received intraosseous (IO) doses of ketamine, though IO is a potential route of administration.[4]

There were 16 (47.1%) patients who received their first dose of ketamine via IV, the mean dose was 48.44mg (SD 28.967; 95% CI, 34.25–62.63) (Table 5). There were 10 (29.4%)

TABLE 2 *Ketamine Dosing (mg) for All Training Casualties*

Number of Casualties	Mean Dose (SD)	95% CI	Range	Minimum Dose	Maximum Dose	IQR
34	90.29 (60.098)	70.09–110.49	310	15	325	83

TABLE 3 *Ketamine Training Casualty Dosing (mg) per Dose*

Dose	Number of Casualties	Mean (SD)	95% CI*	Range (mg)	Minimum Dose (mg)	Maximum Dose (mg)	IQR
1	34	47.35 (26.263)	38.52–56.18	105	15	120	28
2	19	62.89 (60.903)	35.51–90.28	265	10	275	75
3	7	23.57 (12.488)	14.32–32.82	40	10	50	5
4	3	26.67 (20.817)	3.11–50.23	40	10	50	—
5	1	10 (0)	—	0	10	10	—
6	1	10 (0)	—	0	10	10	—
Total**	34	1.88 (1.094)	1.51–2.25	5 Doses	1 Dose	6 Doses	—

*Due to sample sizes <30, variations may be noted with 95% CI calculations and SD should be considered.
**Data regarding number of doses received, *not* dosage (mg) of ketamine.

TABLE 4 *Ketamine Administration Routes (N = 34)*

Initial Administration Route			Additional Administration Route			Administration Route Totals
Route	Number of Casualties	% of Casualties	Route	Number of Casualties	% of Casualties	Number of Casualties (%)
IM	10	29.4	IM	2	5.9	12 (35.3%)
IN	8	23.5	IN	0	0	8 (23.5%)
IO	0	0	IO	0	0	0 (0%)
IV	16	47.1	IV	6	17.6	22 (64.7%)
—	—	—	N/A	26	76.5	—

IM = intramuscular, IN = intranasal, IO = intraosseous, IV = intravenous, N/A = not applicable/no additional route.

patients whose initial dose was IM and the mean dose was 37.00mg (SD 18.135; 95% CI, 25.76–48.24). Last, 8 (23.5%) of the patients received their first dose of ketamine IN, with the mean dose being 58.13mg (SD 27.247; 95% CI, 39.25–77.01).

Patients' pain assessment was based on a 0-to-10 pain scale, with 0 being no pain and 10 being the worst pain of their life. Four cases were not included because the data was incomplete; therefore, the data for 30 patients were evaluated. Due to the limited population size, and the data not being normally distributed, nonparametric testing was used to determine if there was any significance between the pre- and post-ketamine pain scales.

A Wilcoxon signed-rank test examined the results of the patients' pre-ketamine pain scale and post-ketamine pain scale. A significant difference was found in the results ($Z = -4.791$, $p < 0.05$). The post-ketamine pain scale results were better than pre-ketamine pain scale results. This significance demonstrates that ketamine was effective in contributing to the relief of the patients' pain. The median pre-ketamine pain scale for patients was noted to be 8.0 (IQR 3) and the median post-ketamine pain scale was 0.0 (IQR 3) (Table 6). Other medications were also provided to some of the casualties.

Among other medications given were midazolam, hydromorphone, ondansetron, midazolam and oral transmucosal fentanyl citrate (OTFC) (Table 7). Midazolam was administered the most, a total of 15 times (51.72%), via multiple known routes: IM, IN, and IV. IM was used for three (8.82%) patients with a mean of 4.667mg (SD 0.577; 95% CI, 4.01–5.32). Three (8.82%) patients also received IN midazolam with a mean of 2.10mg (SD 0.361; 95% CI, 1.69–2.51). The most prevalent route of midazolam was via IV whereby 9 (26.47%) of the patients received midazolam, with a mean of 2.11mg (SD 0.546; 95% CI, 1.75–2.47). There were three occurrences of 2mg hydromorphone IV being administered, and 800 µg oral transmucosal fentanyl citrate lozenge (OTFC) was given eight times. With regard to all the patients who received ketamine, there were limited potential adverse reactions.

There were no significant adverse reactions regarding hemodynamic or respiratory compromise. Among the 34 patients in the study, 7 (20.58%) had potentially adverse reactions (Table 8). Of these seven patients who had potentially adverse reaction, 1 (2.94%) was noted as having a "mild emergence reaction" and the casualty stated after discharge that "it wasn't that bad." One (2.94%) experienced a "possible hypertonia adverse event." Other noted reactions were hallucinations, amnesia, and potential hypertonia. There were 4 (11.76%) patients noted to have experienced hallucinations and 3 (8.82%) who experienced amnesia. None of the reactions were noted to have interfered with the patients' care and were ultimately well tolerated.

Discussion

In our experience the use of ketamine was safe and effective in the military prehospital training environment. The idea that inexperienced, young medics could have the clinical judgement to titrate morphine in a polytrauma patient in the prehospital setting is unrealistic. In the early years of the conflicts in Iraq and Afghanistan, morphine was often the only analgesic option.[1] It is concerning that morphine is still routinely used by the US military, despite the CoTCCC recommendations, which are 5 years old.[1,4] The approval to use ketamine as an analgesic was important to improve the therapeutic index for battlefield medics for pain control because of the deleterious effects of morphine on blood pressure, gag reflex suppression and respiratory depression in trauma patients.[1]

Unfortunately, the data collection method did not capture pain reduction with each dose, only the overall pain scale reduction. Likely, the majority of additional doses were due to re-dosing as the analgesic effect wore off. The measure of pain is subjective and often difficult to assess and quantify. Though the pain scale is used routinely in studies and clinical care, it is still not an accurate tool for determining a consistent and accurate measure of pain due to the subjective variance of pain perception between patients. Despite this, pain management

TABLE 5 *Initial Ketamine Route and Dose (mg) for Training Casualties*

Route	Number of Casualties	% of Casualties	Mean (SD)	95% CI*	Range (mg)	Minimum Dose (mg)	Maximum Dose (mg)	IQR
IM	10	29.4	37.00 (18.135)	25.76–48.24	55	20	75	25
IN	8	23.5	58.13 (27.247)	39.25–77.01	95	25	120	10
IO	0	0	—	—	—	—	—	—
IV	16	47.1	48.44 (28.967)	34.25–62.63	85	15	100	33

*Due to sample sizes <30, variations may be noted with 95% CI calculations and SD should be considered

TABLE 6 *Pain Scores Pre- and Post-Ketamine Administration (N = 30*)*

	Median (IQR)	Range	Minimum Pain	Maximum Pain
Pre-ketamine	8.0 (3)	5	5	10
Post-ketamine	0.0 (3)	8	0	8

*Four casualties excluded related to incomplete pain documentation.

in the tactical setting is important for patient comfort, tactical efficiency, and consensus that pain associated with traumatic events can potentiate posttraumatic stress disorder (PTSD) and chronic pain syndromes.[1] Previous studies have found that by treating pain, it can help prevent the development of PTSD.[5–7] This study demonstrated pain scores were greatly reduced after the administration of ketamine. The dissociative effects of ketamine may also play a role in long term benefit to the psychological health of the combat casualty, and therefore amnesia may not be a deleterious effect.[5]

Ketamine is thought to act as an NMDA receptor antagonist at the GABA receptor complex causing anesthesia.[8] It is further postulated that ketamine excites delta and mu opioid receptors within the basal ganglia and thalamus producing analgesia, as well as stimulating catecholamine receptors and decreasing production of nitric oxide leading to a decrease of hemodynamic instability frequently seen with opiates.[9] Thus, ketamine has prevalent mechanistic uses for sedation, analgesia, and anxiolysis.

Ketamine was formally endorsed by the Defense Health Board in 2012 along with endorsement from the TCCC.[1] In recent years, low dose ketamine has been utilized in far forward environments and is currently the first line pain medication for patients in shock or at risk of bleeding according to TCCC guidelines.[10] Discordant with the TCCC and DHB approving the use of ketamine as a front analgesic, only 39% of patients in Afghanistan from October 2012 to March 2013 received pain control at the point of injury despite receiving good pain control at Role 1 health care facilities in deployed locations.[11]

As demonstrated in Schauer's 2015 *Battlefield Analgesia: TCCC Guidelines Are Not Being Followed*. These changes were not fully implemented for in theater training until March of 2014, demonstrating a 5-month lag from the announcement.[3] During the time period of this study, from July 2013 to March 2014, less than half of all patients received analgesia at the point of injury, with the highest rates of adherence occurring within the SOF community. The delay in adoption, and lower rates of use of ketamine and pain treatment may have been attributed in part to a paucity of civilian clinical training opportunities, minimal use of ketamine during training events, and the lack of experience of supervising physicians with ketamine. While the trend for better adherence would improve over time, the overall compliance with the TCCC analgesic guidelines remains suboptimal.[2,4]

There are surgeons and emergency medicine physicians who are not comfortable receiving a minimally responsive or unresponsive trauma patient who has been given ketamine in the prehospital setting (personal communication). When given in larger doses, ketamine can cause significant sedation and on initial presentation to a trauma center, an obtunded trauma patient may cause the attending physician concern regarding the possible presence of TBI despite no physical findings. This concern may result in additional testing and possibly unnecessary procedures such as endotracheal intubation. A well-documented GCS by the medic prior to the administration of ketamine would help assuage this concern. Ideally, a prehospital system should gain the buy in from their receiving hospitals prior to using ketamine in the field. This method could increase awareness with the use of ketamine and address points of concern in different practice patterns. It may be worth noting that the documentation of the mental status and Glasgow Coma Score prior to ketamine administration may reduce the concern for altered mental status related to ketamine in trauma patients.

US military medical officers should have a pain management protocol for their organization and this protocol should be in

TABLE 7 *Other Drugs Administered With Ketamine (mg*)*

Drug	Route	Number of Casualties	% of Casualties	Range (mg)	Minimum Dose (mg)	Maximum Dose (mg)	Mean (SD)	95% CI**
Midazolam	IM	3	8.82	1	4	5	4.667 (0.577)	4.01–5.32
Midazolam	IN	3	8.82	0.70	1.80	2.50	2.10 (0.361)	1.69–2.51
Midazolam	IV	9	26.47	2	1	3	2.11 (0.546)	1.75–2.47
Hydromorphone	IV	3	8.82	—	2	2	2.00 (0.000)	—
Ondansetron	IM	1	2.94	—	4	4	0.00 (0.000)	—
Ondansetron	Unknown	2	5.88	4	4	8	6.00 (2.828)	2.08–9.92
OTFC (µg)	PO	8	23.53	800	800	1600	900 (282.843)	704.00–1095.99

*Oral transmucosal fentanyl citrate (OTFC) doses are in µg, *not* mg.
**Due to sample sizes <30, variations may be noted with 95% CI calculations and SD should be considered.

TABLE 8 *Potential Adverse Reactions From Ketamine*

Number of Casualties	Casualties with Potential Reaction	Reaction Notes*
34	7 (20.58%)	• Vivid hallucinations for ~40 minutes with retrograde amnesia • Mild emergence reaction or "party zone" dose discomfort. Patient complained that he felt like he was in the movie "Interstellar" and was not comfortable with that. After discharge the patient stated "it wasn't that bad". • Patient was only treated at POI for 10 minutes but at the 6–10 minute mark his speech became unintelligible and pain response was not proportionate to injuries. Patient continued to complain throughout transfer and was sedated in the hospital setting 45 minutes post injury. Patient continued to yell in pain but responses were unintelligible. Patient now has no recollection of procedures post impact until he awoke 12 hours post hospital sedation. • Patient continued to laugh uncontrollably for about 50 minutes but stated he was not in pain. Patient initially reached nystagmus and started to "freak out" due to hallucinations. After midazolam was administered, patient remained calm and continued to hallucinate with uncontrollable laughter. • Patient had anterograde amnesia and was not in pain throughout the duration of his ketamine experience. Patient started to hallucinate and became very talkative. • Patient went through a mild hallucination for about 2 min until medication took complete effect • Possible hypertonia adverse event

*Deidentified documentation from casualties' records submitted by providers.

place for training exercises as well: train as you fight. The medical officer needs to oversee the training for implementation of ketamine use and supervise its use in the training environment. This supervision may be direct (i.e., at the scene), or indirect through the use of patient reports, phone/radio consultation, or after-action reviews. If the medical officer is unfamiliar with the use of ketamine, then they should obtain training in its use prior to adding it to their pain management protocol.

The concern that many medical directors have with ketamine use, is based on ketamine's potential adverse events, despite the improved therapeutic ratio relative to morphine. This study was undertaken by select SOF organizations that routinely used ketamine for medical coverage of training accidents. Our experience confirms the safety and efficacy of ketamine for traumatic pain in the prehospital setting. There were no significant adverse events. The adverse event most concerning in the previously discussed patients was a single occurrence of emergence phenomenon, also referred to as emergence reaction, emergence delirium, recovery reaction or recovery agitation. This patient initially received a 50mg IM of ketamine for analgesia prior to rotary wing evacuation, and experienced a mild episode of emergence phenomenon while being loaded into the aircraft. Once IV access was established, an additional 100mg of ketamine and 2.5mg of midazolam were administered, both given IV. The patient reported disturbing hallucinations until the IV dose took effect. While this particular episode did not cause any further complications, it is important to discuss the issue of emergence phenomenon and how it can be mitigated. We have chosen to give midazolam for emergence reactions and not prophylactically, since these are trauma patients, in whom we wish to avoid potential exacerbation of hypotension or respiratory depression.

Emergence phenomenon can be defined as a self-limiting dissociative state of aggressive delirium seen in the early stages of post anesthesia recovery.[12] The prevalence of emergence phenomenon can be increased by a high level of pre-anesthesia anxiety caused by pain[13], which is obviously and frequently associated with traumatic patients. While the perfect chemical compound for analgesia and procedural sedation in the emergency setting does not exist, ketamine is valued by providers in austere tactical environments due to its negligible effects on the cardiovascular and respiratory systems. However, when administered without an anxiolytic there is an associated 10–30% risk of emergence phenomenon.[13,14] Furthermore, one double blind, randomized control trial specifically examining the adverse effects of ketamine found that nearly 45% of participants developed this side effect.[14] A recent systematic review found adverse events often not recorded.[15] Anecdotally, within the SOF community, during combat, ketamine adverse events include hallucinations, nausea and vomiting, even attempts at self-extubation.

The agents most frequently administered to mitigate ketamine induced emergence phenomenon are benzodiazepines, specifically midazolam. A study of 60 perioperative patients received ketamine alone (1–3mg/kg) IV or a combination of ketamine with midazolam (1–2.5mg) IV.[16] In the 1-hour period post-operation, ketamine infusion (n = 30) and ketamine with midazolam (n = 30) had various results of adverse events associated with emergence phenomena. Adverse events for ketamine alone included vomiting (n = 7), delirium (n = 3), nystagmus (n = 3), and salivation (n = 1). There were no adverse events reported in the ketamine with midazolam group. In the second hour, adverse events in the ketamine alone group included vomiting (n = 10), delirium (n = 6), nystagmus (n = 8), hallucination (n = 8), and salivation (n = 4). Again, there were no adverse events reported in the ketamine with midazolam group.

Sener et al. evaluated 182 patients who received either IV ketamine with midazolam or without midazolam.[17] The dosage parameters in this study were 1.5mg/kg IV or 4mg/kg IM, with or without 0.03mg/kg midazolam. The results demonstrated for recovery agitation in IV ketamine alone in 10 (22%), IV ketamine with midazolam in 3 (7%), IM ketamine alone 3 (28%), and IM ketamine with midazolam 4 (9%). These data suggested that the use of midazolam in combination with either IM or IV ketamine can reduce the incidence of recovery agitation in adult ED patients. There appeared to be no difference in the incidence of any adverse events with either route (IM versus IV) of ketamine administration.

IV doses of midazolam as low as 0.02mg/kg have shown to completely eliminate the occurrence of emergence phenomenon when administered prior to ketamine induction of 1mg/kg IV.[12,16] These doses are identical to the dual agent procedural analgesia protocol found in the U.S. Special Operations

Command's Tactical Medical Emergency Protocols (TMEPs) for Special Operations advanced tactical paramedics. Specifically, the TMEPs dual agent procedural analgesia protocol uses midazolam 2mg IV/IO over 1 minute, followed by 0.5–1mg increments after 5 minutes to a maximum total dose of 4mg plus ketamine, 20mg IV/IO over 1 minute, followed by 20mg increments every 30–60 seconds until nystagmus occurs or a maximum total dose of 100mg.[19] This protocol is for the performance of painful procedures, not specifically to be use as a pain medication protocol for combat trauma pain.

Limitations

This was a retrospective, observational case series without controls and is subject to confounding, selection, and recall bias. Second, the reporting system offered partial entries and the limited documentation is a factor potentially impacting the data. Additionally, the total number of patients is small, possibly limiting extrapolation. This analysis is unable to determine the impact of other medications given, though in general, ketamine is often given after a fentanyl lozenge has failed. Midazolam is given for anxiolysis or to potentiate ketamine. Further research is required to determine the effects and efficacy, if any, of the other drugs on the patients' pain relief. Previous research has demonstrated that ketamine is at least as effective as fentanyl or morphine.[19–22] Finally, and perhaps most challenging of all, is that pain is a subjective measurement even when a standardized Likert scale is used. Though the pain scale is an accepted, standardized method for documenting patients' pain in the United States, it is still not a physiologically accurate tool for determining a consistent and accurate measure of pain. This is due to the subjective variance of pain perception between patients.

Conclusions

Ketamine appears to be a safe and effective analgesic for use on trauma patients injured during military training. There were no reported instances of hypotension or respiratory depression. Our experience is consistent with the known benefits of ketamine for pain management from trauma. Ketamine is widely used in civilian and military medicine, but has not been expanded to routine use for medics at home station. Opportunities for medics to obtain more training in civilian settings need to be broadened. The use of the TCCC analgesic protocol should be standard for medic coverage of military training to provide consistency across training and real-world missions, to benefit our patients, and increase the medics' familiarity with the medications. We should always train as we fight.

Disclaimer

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 University of New Mexico School of Medicine, Zucker School of Medicine, University of the Incarnate Word, the Department of the Army, Department of the Air Force, or the Department of Defense.

Disclosures

None

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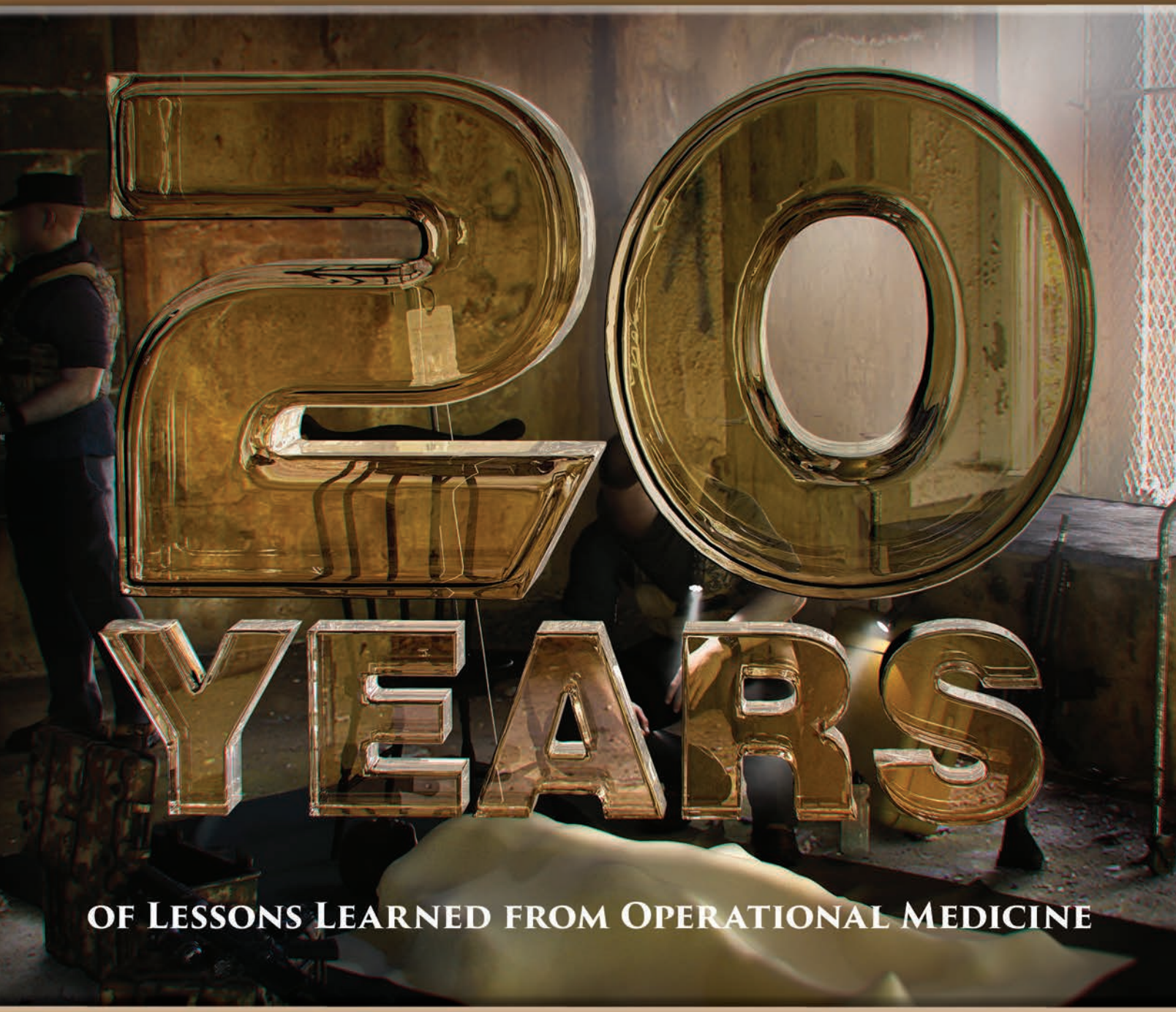

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