Management of Critically Injured Burn Patients During an Open Ocean Parachute Rescue Mission

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ABSTRACT

Best practices and training for prolonged field care (PFC) are evolving. The New York Pararescue Team has used part task training, cadaver labs, clinical rotations, and a complicated sim lab to prepare for PFC missions including critical care. This report details an Atlantic Ocean nighttime parachute insertion to provide advanced burn care to two sailors with 50% and 60% body surface area burns. Medical mission planning included pack-out of ventilators, video laryngoscopes, medications, and 50 L of lactated Ringer's (LR). Over the course of 37 hours, the patients required high-volume resuscitation, analgesia, wound care, escharotomies, advanced airway and ventilator management, continuous sedation, telemedicine consultation, and complicated patient movement during evacuation. A debrief survey was obtained from the Operators highlighting recommendation for more clinical rotations and labs, mission-specific pack-outs, and tactical adjustments. This historic mission represents the most sophisticated PFC ever performed by PJs and serves to validate and share our approach to PFC.

Keywords: *prolonged field care; military medicine; austere medicine; burns; critical care*

Introduction

PFC has been of growing interest within the Special Operations medical community with more operations in remote and austere areas.[1] Air Force Pararescuemen (PJs) currently have the largest documented experience in PFC, accounting for 37% (20 of 54 cases) of missions in the Joint Trauma System data available on this.[2] While some missions have been in the combat setting, most have occurred during civil search and rescue (SAR) in the open ocean and Alaska. Critical care training is generally infrequent among PJs, corpsman, and medics since they are primarily combat trauma and/or sick call experts, and the intensive training requirements have been difficult to justify given the low utilization of this skill set on missions. However, the New York Pararescue unit has committed to the inclusion of a complex PFC lab in a medical school simulation department, extensive part task training, and various full mission profiles prior to deployments.

This case report describes the operational and medical challenges encountered by USAF PJs, combat rescue officers (CROs), and a flight surgeon (FS) on a civil SAR mission requiring 37 hours of PFC to save two severely burned patients.

Mission Report

Phase 1: Mission Development and Planning

On the morning of April 24, 2017, the US Coast Guard (USCG) was notified by the Portuguese Rescue Coordination Center of a distress call issued by the container ship motor vessel (MV) TAMAR located approximately 1,400 nautical miles (NM) off the coast of Long Island, NY. An explosion and subsequent confined space fire resulted in several burned sailors. At approximately 0800 EST, the USCG alerted the PJ team, requesting SAR assistance. The flight surgeon confirmed the patient count and status included four severely burned patients, two of whom had respiratory compromise. A Canadian Navy ship with a single physician assistant on board was available but would take 12–24 hours to arrive. Based on the injury patterns and past experience, the FS advised tasking the PJs for parachute insertion to optimize chances for patient survival.

The team composition included two CROs and five PJs. One CRO was the team commander (TC) and one PJ was the team leader (TL). The mission plan featured a 5-hour HC-130P flight, an open ocean parachute insertion with zodiacs, ocean surface travel to the TAMAR, and then ship boarding. The TAMAR would remain under way to Portugal until close enough for helicopter extraction. The prolonged care of each patient was projected to last up to 72 hours before extraction.

Planning and pack-out consisted of preparing medical supplies to treat up to four critical burn; however, sufficient critical care equipment (vents, monitors, mechanical suction, and fluid warmers) was available for only two critical patients and 50L of LR was able to be inserted due to real-world logistical constraints.

Phase 2: Infiltration

During prelaunch planning and the 4.5-hour flight, the team was notified of fluctuating patient status via the FS and TAMAR, including the deaths of two patients: one while inflight and the other immediately prior to boarding the vessel, thus leaving two patients to be treated. At 2300 EST, April 24th, the team inserted via two passes of night static-line-square

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parachute jumps within visual range of the TAMAR, with mild sea conditions and zero illumination. To mitigate risks during shipboard operations and facilitate transfer of all equipment on board, the TAMAR came to a dead stop during the insertion until all personnel and equipment were safely loaded on board.

Phase 3: Prolonged Field Care

Patient contact was made at approximately 0100 EST, April 25th. The two patients were physically isolated, so a casualty collection point (CCP) was designated and cleaned. Medical supplies and both patients were brought to the CCP. The ship's crew also directed the team to the location of the two deceased sailors. The absence of vital signs was confirmed, and each sailor was placed in a body bag and secured in a refrigerator.

Patient 1 was a 23-year-old man with 60% total body surface area (TBSA) burns in severe pain. Deep partial- and full-thickness burns were noted on the head, face, circumferential neck, anterior chest, bilateral arms, circumferential forearms, and circumferential hands. There were no signs of hemorrhage. He had neck, maxillofacial and perioral edema, however his airway was intact and his phonation was normal. Respirations were unlabored with no audible grunting or stridor. The patient was alert and oriented with normal vital signs with report of recent void.

Patient 2 was a 44-year-old man with 50% TBSA burns in severe pain. Deep partial- and full-thickness burns were noted on the head, face, circumferential neck, chest, and bilateral arms. There were no signs of hemorrhage. He had maxillofacial and perioral edema with an intact airway. His respirations were unlabored but his voice was hoarse. The patient was alert and oriented with normal vital signs.

Initial interventions followed the MARCH-PAWS format for each patient with focus on airway patency, attaching monitor leads, obtaining intravenous access, starting fluid resuscitation and controlling pain.[3] Propaq MD (Zoll Medical Co., Chelmsford, MA) monitors were used. Initial pain management was with 20mg ketamine IV and 50 mg IM ketamine on patients 1 and 2, respectively. Fluid resuscitation with LR followed the United States Army Institute of Surgical Research (USAISR) "Rule of 10" with an initial fluid rate of 600mL/hr and 500mL/hr for patients 1 and 2, respectively.[4] Both patients were covered with blankets to prevent hypothermia, and satellite communication with the FS in New York was established to discuss the patient findings and treatment plan. Subsequent telemedicine consultation was performed every 6–12 hours and emergently as needed. The TL instituted work-rest cycles for each two-team-member patient care team, with 90 minutes on and 3 hours of rest.

Care during the first 4 hours focused on pain management, fluid resuscitation, and initial wound care. Wounds were debrided of loose skin using scrub brushes and scissors prior to dressing with dry sterile gauze. Pain management continued with intermittent alternating doses of IV ketamine and fentanyl titrated to effect for each patient. Initially, urine output was measured by estimating void volumes in a cup; however, after telemedicine consultation, Foley catheters were placed and fluids were titrated to achieve a urine output of 30–50mL/hr.

Around 0600 EST, patient 1 complained of dyspnea and was breathing in the tripod position. Auscultation of the lungs was clear, but inspection of the oropharynx revealed progressive oropharyngeal edema, prompting the decision to intubate the patient. The patient was informed and agreed to proceed with sedation and intubation. After induction with ketamine and midazolam, the video laryngoscope was used to visualize the cords; however, the first two attempts at intubation failed. The patient vomited after the second attempt and was rolled to the side, suctioned, and successfully intubated on the third attempt without a paralytic. Placement was confirmed with a portable capnometer and auscultation. An Impact 731 portable battery powered ventilator (Zoll Medical Co., Chelmsford, MA) was used to ventilate the patient on room air resulting in pulse oximetry saturations of 94%.

Around 0700 EST, patient 2 began to decompensate quickly with rapid onset of dyspnea, anxiety, sonorous respirations, drooling, and subcostal retractions. After induction with ketamine, video laryngoscopy was performed, but supraglottic edema obscured the vocal cords and the team opted to proceed with a surgical airway. The procedure was complicated by loss of the usual landmarks due to neck edema requiring a second provider to complete the procedure. Endotracheal placement was confirmed by auscultation and capnography and ventilation was supplied with the Impact 731 ventilator without supplemental oxygen resulting in pulse oximetry saturations >90%.

Sedation was maintained for both patients using alternating boluses of intravenous ketamine 100mg, fentanyl 100µg, and midazolam 5mg. A bolus was administered when the patients began to show signs of movement. This occurred generally every 20–45 minutes. Over time, boluses doses were titrated down to conserve resources. Both patients maintained oxygen saturation >90% on the ventilators without supplemental oxygen. Bottled oxygen was reserved for extenuating circumstances because of the limited supply.

Prior to intubation, patient 1 reported severe pain in the left hand and forearm with significant tense swelling. Telemedicine consultation was obtained to confirm the need for an escharotomy. After the patient was intubated and sedated, medial and lateral longitudinal incisions were made over the circumferentially burned portions of both proximal forearms, hands, and fingers. The burned tissue was adequately released and weeping of serous fluid from the incision sites was observed. Hemostasis was obtained with direct pressure using hemostatic gauze and the wounds were dressed. The second patient experienced a similar course and also required forearm, hand, and digital fasciotomies.

Phase 4: Exfiltration

Coordination between the TC, home station, and Portuguese Air Force determined the ship would come into the range of rotary wing evacuation assets near the Azores. Plans were made to evacuate both patients and three PJs. The patients were packaged in Skedco litters (Skedco Inc, Tualatin, OR) with all vents, lines, and tubes secured and medications for the flight were prepared. The patients were lowered with rope systems through two flights of narrow, high angle staircases to the main deck.

The patients and PJs were hoisted into the helicopter by a Portuguese rescue swimmer while the ship was underway. On board the helicopter, a Portuguese Air Force flight surgeon directed the PJs to continue primary care in flight. On an Azores airfield, the patients were transloaded to a Portuguese Air Force aeromedical transport team for fixed wing transport to burn centers in Lisbon, Portugal. The total time from initial patient contact to transload to the aeromedical evacuation team was 37 hours. The PJs on the TAMAR transferred to a tugboat to the Azores where the team reunified and flew home the next day via HC-130P.

Mission Debrief

A week after the mission, a 6-hour flight surgeon led debrief was held and postmission surveys were administered to all Operators involved with the mission, soliciting impressions regarding mission planning and execution as well as suggestions to optimally prepare for future missions. All team members felt adequately prepared to execute this mission, but several recommendations were made.

Training

Nearly every Operator suggested the use of full mission profiles including PFC to be performed on a regular basis (i.e., quarterly). Inclusion of PFC in these training iterations allows reinforcement of the tactical context for medical care and the potential for extended patient care periods. Training rotations through a burn center were suggested for exposure to the multidisciplinary care needed to treat these complex patients.

More training in ventilator management and intermittent bolus sedation, and more regular cadaver labs (every 6–12 months) were suggested. Documentation with a simple flowchart with columns was endorsed over the more complicated "anesthesia style" charting with multiple symbols denoting vital signs on a grid scale. Finally, the team unanimously preferred maintenance of sedation with intermittent boluses of medications compared with continuous infusions.

Equipment

The team suggested creating condition specific medical bags with an associated logistics quick reference card indicating the bag contents. These would optimize team medical kit management by tailoring the supply and resupply to the most common civil SAR conditions: burn, trauma, and acute abdomen and GI bleeding. An additional quick reference guide was also suggested for attachment to the Impact 731 ventilator outlining instructions for implementation and adjustment. The addition of monitors with integrated video teleconferencing would improve telemedicine consultation.

Tactics

The larger team size deployed for this mission was found to be ideal as it provided greater depth in the broad range of skillsets needed including medicine, insertion, extraction, and communications. The larger team also allowed for effective division of work and rest cycles to limit team exhaustion. To combat the sometimes debilitating effects of seasickness, home station ground testing of antiemetic medications was suggested.

Organization and Culture

The sentiment was raised that the PJ medical skills required to save the patient are of equal importance to the skills such as open water parachute insertion needed to deliver the PJs to the patient. It makes little sense to advocate for deployment in a high-risk mission if the Operator's medical acumen and skills are not adequate to appropriately assess, treat, and deliver the patient to the next level of care. Additionally, they expressed the importance of early inclusion of the flight surgeons in mission planning to ensure appropriate tasking for the mission.

Discussion

This mission represents the most complicated medical care ever provided by PJs, and possibly any other Department of Defense medic, for an extended period of time. It validates the role for PJs on complex medical missions that other more advanced medical teams cannot get to, and the potential for SOF medics to train for PFC.

Severely burned patients are the most complex care scenarios Special Operations medics will face. The care including analgesia, airway/ventilator management, sedation, wound care, and monitoring/nursing skills is demanding and competes with other skills that are required for tactical and technical competency. The care of significant burn patients is a challenge in any hospital setting as intensive care unit (ICU) mortality rates for burn patients with >50% TBSA exceed 44%.[5] Care is more challenging than in an ICU when considering PJs are paramedic level providers with limited gear due to insertion constraints on a ship with no medical resources. Consequently, the approach to burn care is guided by protocols specific to the environment, as we have made every attempt to adopt best practices for care based on guidance from physicians at the San Antonio Burn Center, the New York Presbyterian Hospital Burn program (FDNY burn unit), and from USAF trauma surgeons.

Fluid Resuscitation

In 2010, PJs adopted the rule of 10 for initial fluid resuscitation in burn patients.[6] This simple formula calculates the initial fluid administration rate as the percent TBSA burn multiplied by 10mL/hr. Additionally, the rule of 10 tended to produce a starting value closer to the modified Brooke formula, which is half the rate of the Parkland formula and results in markedly lower 24-hour fluid requirements without increased mortality.[5,7] This lower fluid rate has the benefit of reduced potential for overresuscitation, leading to fluid overload, compartment syndromes, airway swelling and obstruction, and acute respiratory distress syndrome.[8] Operationally, this reduces the size of parachute bundles and improves logistics and safety. The key to this fluid resuscitation approach is appropriate monitoring of urinary output, so that initial rates can be adjusted to provide adequate volume for perfusion while avoiding fluid overload. More sophisticated fluid management is possible with software such as the Burn Navigator (Acros Inc., Missouri City, TX), which could be incorporated into patient monitors or a handheld device for use on missions or as an adjunct to telemedical consultation.

Airway and Ventilator Management

Immediate versus delayed airway intervention in an austere setting is different from in a hospital. Traditional hospital airway management of burn patients includes establishing a definitive airway for thermal injury to the airway and inhalation injury. With all the expertise and resources available, more aggressive management in a hospital is warranted.

Deciding to secure the airway before respiratory collapse is a time-sensitive, difficult decision to execute and maintain in PFC.

This brings a commitment of resources to ventilate and sedate the patient, complicates patient transport, and with limited resources, risks agitation, self-extubation, and psychologic harm when ventilator batteries and sedating medications run out.[9]

First-pass success of prehospital intubation has been noted as 69% for medics and 87% for physicians, with proficiency met when performing more than 18 intubations annually, and expert status at more than 304 per year. In initial training, healthcare personnel required a minimum of 57 intubations to be considered competent, but despite this level of training, almost 20% of the individuals still required assistance from proficient providers.[10,11] PJs, like most medics, rarely perform intubations on live patients after initial training. Advocacy for mandatory clinical rotations rich in airway management opportunities is critical.

Not all patients with airway burn injury ultimately require intubation, and unnecessary intubation may compromise the clinical outcome of burned patients due to complications of aspiration and ventilator associated pneumonia, tracheobronchitis, tracheoesophageal fistula, and bronchopulmonary dysplasia.[12,17] Although the patient who was intubated vomited during the attempt, we obtained follow-up and he did not develop an aspiration pneumonia. Due to reflexive actions of the upper airway, frequently, most inhalational burn injuries should not require intubation due to a lack of vocal cord edema.[13] In the hospital setting patients with soot in the oral cavity, facial burns, or body burns should undergo fiberoptic laryngoscopy to view laryngeal edema, after which the visualization of edema is the primary driver for intubation.[13] This practice is impractical in field conditions.

Therefore, our policy is to monitor patients closely if they have signs of airway injury, have all gear at the bedside prepared, and intervene for stridor or respiratory distress. This practice is based on the difficulty of prehospital intubation by paramedics, the fact that not all burned airways require intubation, the potential for complications from successful and failed intubations, and the ability to conserve resources if the patient does not require intubation. Resources include manpower, expertise, supplemental oxygen, and medications. This policy was recommended specifically for PJs by Roger Yurt, MD (former director of the NYP/Cornell burn unit).

On this mission, thermal injury and fluid resuscitation resulted in progressive, symptomatic airway edema requiring intubation and cricothyroidotomy. In the PFC setting of inhalation injury, clear airway compromise (stridor and respiratory distress) should be present before proceeding with emergent intubation or surgical airway. This recommendation is based on risk-benefit analysis for Special Operations paramedics, and not for well-supplied resuscitation or surgical teams with airway experts.

Analgesia and Sedation

In 2018 a consensus statement was issued promoting the use of ketamine as a stand-alone analgesic and adjunct to opioids.[14] Ketamine has been shown to act as antiallodynic and antihyperalgesic, producing pain relief in burn patients.[15] Fentanyl (a μ-opioid receptor agonist) is a mainstay for acute pain management in burn ICUs; however, there is an increased medication requirement for burn patients beyond standard dosing and these patients often develop tolerance.[16–18]

Field providers have the option to deliver analgesia and sedation in metered boluses or via a continuous infusion. Bolus administration requires less training and equipment. These are given at regular intervals with observation for effect and repeat dosing as needed. Infusions can be beneficial when managing multiple casualties as there are fewer opportunities for cross contamination and needle stick injuries, with the potential of using less medication in a resource poor environment. For Pararescue, the addition of continuous infusions would be another competency requirement above their baseline training on bolus administration. For our PJs we will continue using boluses as the primary sedative and analgesic administration technique with the option for continuous infusion for those trained and comfortable with the technique.

Wound Care

The severely burned patient must contend with loss of the skin's natural abilities to regulate temperature, prevent moisture loss, defend against opportunistic infections and provide an elastic covering.[19,20] A key component of burn care consists of evaluating for circumferential eschar which could lead to compartment syndrome or compromised ventilation. Escharotomy is a crucial skill for the management of severe burns and does not require significant equipment to perform. In training, drills incorporate drawing incision lines and making escharotomy incisions on cadavers under surgical direction. While escharotomy can be a bloody procedure when electrocautery is not used, the PJs were able to maintain hemostasis using hemostatic gauze dressing with direct pressure.

When topical antibiotics such as silver sulfadiazine or mafenide acetate are unavailable, dry sterile dressings should be applied after initial debridement. Ideally, wounds would be debrided twice daily and topical agents reapplied afterward. The wound should be inspected at each debridement for any degeneration such as darkening or malodor, which may indicate wound sepsis. If there are signs of sepsis, parenteral antibiotics should be initiated followed by expedited evacuation to a surgeon capable of burn excision. During this mission, dry sterile dressings were used without application of topical antibiotics due to limitations of gear space with priority given to resuscitation fluids during pack-out. The use of dry sterile dressings changed every 24 hours is a simple, logistically feasible, and accepted treatment (personal communications over time by R.S. with senior ICU physician at the US Army Burn Center and staff at NY Presbyterian/Cornell FDNY Burn Unit).

Lessons Learned

PJs and SOF medics must be comfortable with rapid sequence intubation (RSI) and the use of paralytics. To meet this goal, the Special Operations medical community should mandate clinical rotations in anesthesia or emergency medicine, which allow intubation and ventilator management. *Provide clinical rotations in anesthesia or emergency medicine with focus on RSI and intubation skills.*

Mission planning for 72 hours and the basic concepts of PFC drove pack-out for long-term patient management. Beyond planning for stabilizing the patients and the critical care gear, we have considered additional PFC needs (personal protective equipment, contractor bags, patient hygiene supplies, etc.). From a supply standpoint, obtaining large volumes (>50L) of RL for fluid resuscitation presented a logistical challenge and

TABLE 1 *Lessons Learned*

Provide clinical rotations in anesthesia or emergency medicine with focus on RSI, intubation skills, and vent management.
Use a condition specific pack-out checklist.
Bring 2400mg ketamine, 2400μg fentanyl, and 240mg midazolam per patient per day.
Use cadaveric models for escharotomy training and have references available during the procedure.
Train with full mission profile events including PFC segments and high fidelity simulators.
Incorporate regular cadaver and simulation labs to enhance and maintain critical airway and surgical skills and emphasize PFC tenets.

required local healthcare system support. *Use a condition specific pack-out checklist.*

Medication supply for pain management and sedation presented a unique challenge due to experience and training only with the bolus administration. We estimated a single intubated patient would require alternating ketamine 100mg, fentanyl 100μg, and midazolam 5mg every 45 minutes. Despite planning for 72 hours, we nearly depleted analgesics and sedatives over the course of 37 hours. The mission debrief identified the need to pack larger quantities of these medications, building on experience from other PJ burn mission jumps. *Bring 2400mg ketamine, 2400μg fentanyl, and 240mg of midazolam per patient per day.*

Differing directions of the forearm incision of the escharotomy for both patients resulted in very different levels of bleeding. Less bleeding occurred with the escharotomy approach which started proximally and moved distal; senior physicians at NYP/Cornell Burn Unit agreed with this approach, which is critical for reducing blood loss in a PFC scenario. Although the escharotomies were correctly performed from memory, we have created a policy that escharotomy and fasciotomy must be performed with reference materials out at the time of the procedure and all incisions must be drawn on the skin prior to incision. Practice on human cadavers mandating use of the diagrams and using the skin marker ingrains these routines. *Use cadaveric models for escharotomy training and have references available during procedure.*

Based on the postmission survey, the main educational item needed was continued training in burn care with emphasis on airway control and ventilator management. We have addressed this need at the 103rd Rescue Squadron by creating a day-long training event in a state-of-the-art patient simulation room using a script based on the TAMAR mission. *Train with full mission profile events including PFC segments and high-fidelity simulators.*

We attribute the success of this mission to the training culture of the NY PJ team. Over the past decade we prioritized training for complex medical missions during our regular medical training events and during our annual and biannual paramedic recertification courses. Multiple yearly cadaver labs to perform direct and video laryngoscopy, practice surgical skills, and train to the tenets of PFC with work-rest cycles, nursing skills, and telemedicine consultation all contributed to mission success. While we identified areas for improvement, there were no catastrophic shortfalls or missteps. *Incorporate regular cadaver and simulation labs to enhance and maintain critical airway and surgical skills and emphasize PFC tenets.*

Conclusion

This mission illustrates that PJs and SOF medics are capable of basic critical care for multiple critically injured patients in an austere PFC environment. Successful execution of critical medical and surgical skills is possible in this setting but requires recurrent training. Mission readiness depends on a culture which prioritizes medical training in operational contexts and is realistic regarding the limitations of the environment and the Operators. We need to implement these practices widely in anticipation of PFC missions in which we are only able to get Operators, and not physicians or advanced practice providers, into the fight.

Author Contributions

M.H. and J.S. participated in the mission and S.R. provided medical control. S.R. conceived the manuscript concept and obtained approval. J.S. and M.H. were responsible for survey administration, data collection, and analysis. B.S., E.D., C.P., M.H., and S.R. drafted the manuscript. All authors were involved in revisions and approve the final manuscript.

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References

1. **Keenan S.** Deconstructing the definition of prolonged field care. *J Spec Oper Med.* 2015;15(4):125–125.
2. **DeSoucy E, Shackelford S, DuBose JJ, et al.** Review of 54 cases of prolonged field care. *J Spec Oper Med.* Spring 2017;17(1):121–129.
3. **Rush S.** Recent considerations in tactical medicine. *J Spec Oper Med.* 2013;13(2):54-58.
4. **Chung KK, Salinas J, Renz EM, et al.** Simple derivation of the initial fluid rate for the resuscitation of severely burned adult combat casualties: in silico validation of the rule of 10. *J Trauma.* 2010;69(suppl 1):S49–S54.
5. **Pavoni V, Gianesello L, Paparella L, et al.** Outcome predictors and quality of life of severe burn patients admitted to intensive care unit. *Scand J Trauma Resusc Emerg Med.* 2010;18:24. Published 2010 Apr 27. doi:10.1186/1757-7241-18-24
6. **Lednar WM, Poland GA, Holcomb JB.** *Subject: Tactical Combat Casualty Care burn management Guidelines.* August 2010.
7. **Chung KK, Wolf SE, Cancio LC, et al.** Resuscitation of severely burned military casualties: fluid begets more fluid. *J Trauma.* 2009;67(2):231–237; discussion 237. doi:10.1097/TA.0b013e3181ac68cf.
8. **Klein MB, Hayden D, Elson C, et al.** The association between fluid administration and outcome following major burn: a multicenter study. *Ann Surg.* 2007;245(4):622–628. doi:10.1097/01.sla.0000252572.50684.49
9. **Chahraoui K, Laurent A, Bioy A, et al.** Psychological experience of patients 3 months after a stay in the intensive care unit: A descriptive and qualitative study. *J Crit Care.* 2015;30(3):559–605.
10. **Crewdson K, Lockey DJ, Røislien J, et al.** The success of pre-hospital tracheal intubation by different pre-hospital providers: a systematic literature review and meta-analysis. *Crit Care.* 2017;21(31). doi:10.1186/s13054-017-1603-7.
11. **Konrad C, Schüpfer G, Wietlisbach M, et al.** Learning manual skills in anesthesiology: Is there a recommended number of cases for anesthetic procedures? *Anesth Analg.* 1998;86(3).
12. **Sabri A, Dabbous H, Dowli A, et al.** The airway in inhalational injury: diagnosis and management. *Ann Burns Fire Dis.* 2017;30(1):24–29.
13. **Madnani DD, Steele NP, Vries ED.** Factors that predict the need for intubation in patients with smoke inhalation injury. *Ear Nose Throat J.* 2006;85(4):278–280. doi:10.1177/014556130608500421.

14. **Schwenk ES, Viscusi ER, Buvanendran A, et al.** Consensus guidelines on the use of intravenous ketamine infusions for acute pain management from the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. *Reg Anesth Pain Med*. 2018;43(5):456–466. doi:10.1097/AAP.0000000000000806
15. **Mcguinness SK, Wasiak J, Cleland H, et al.** A systematic review of ketamine as an analgesic agent in adult burn injuries. *Pain Med*. 2011;12(10):1551–1558. doi:10.1111/j.1526-4637.2011.01220.x.
16. **Ramos-Matos CF, Lopez-Ojeda W.** Fentanyl. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2019. https://www.ncbi.nlm.nih.gov/books/NBK459275/
17. **Griggs C, Goverman J, Bittner EA, et al.** Sedation and pain management in burn patients. *Clin Plast Surg*. 2017;44(3):535–540. doi:10.1016/j.cps.2017.02.026
18. **Block L, King TW, Gosain A.** Debridement techniques in pediatric trauma and burn-related wounds. *Adv Wound Care (New Rochelle)*. 2015;4(10):596–606. doi:10.1089/wound.2015.0640
19. **Dai T, Huang YY, Sharma SK, et al.** Topical antimicrobials for burn wound infections. *Recent Pat Antiinfect Drug Discov*. 2010;5(2):124–151.
20. **Singer AJ, Lee CC.** *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 9th ed; 2018:715-723.e2.

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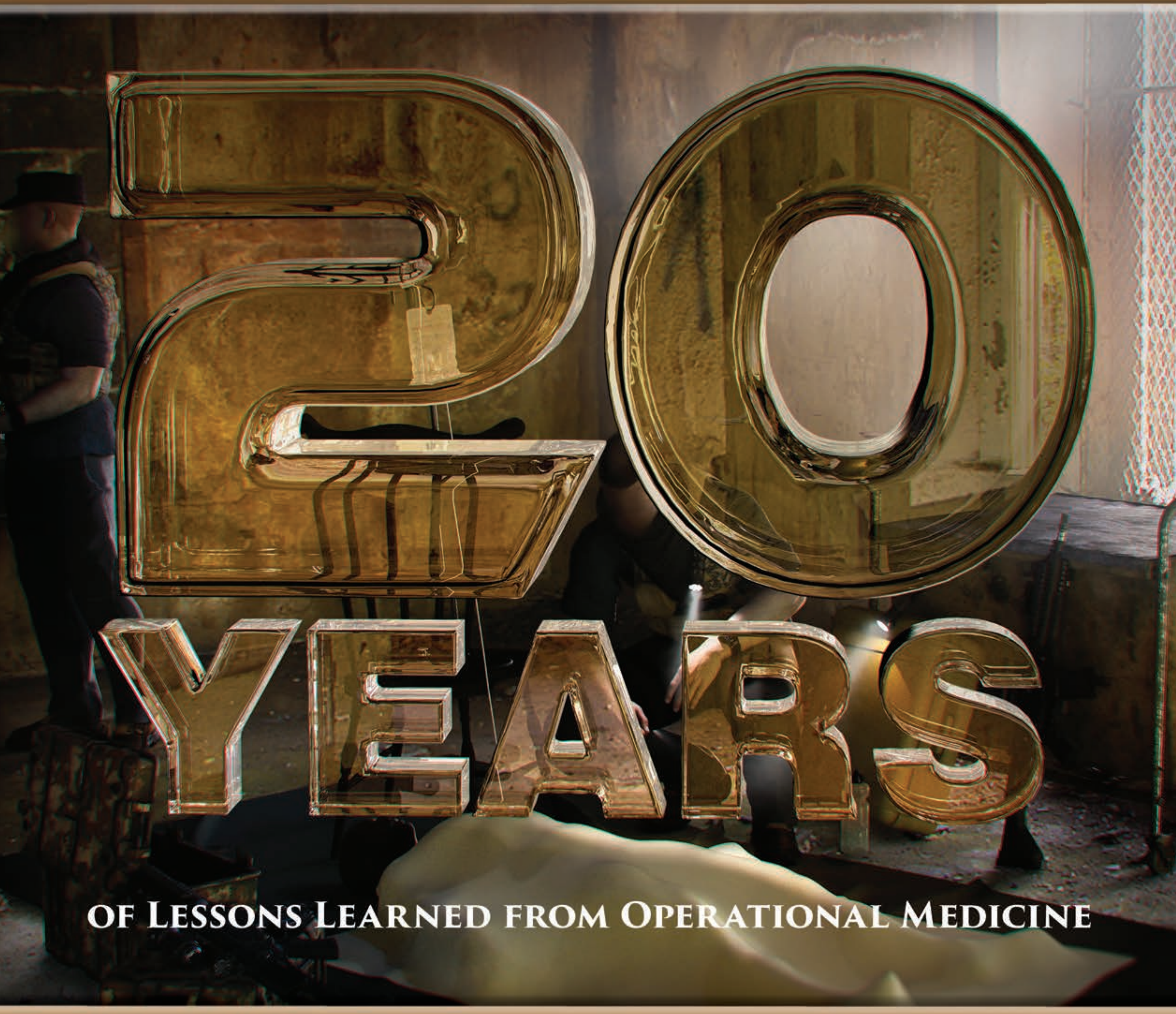

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