

Medical Mission Planning

Tactical Mgmt of UW Casualties in SOF

Tactical Medicine

Combat Trauma Mgmt.
Wisdom

Tactical Trauma: Pearls of

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Tactical Management of Urban Warfare Casualties in Special Operations

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Table Of Contents

Panelists	Error! Bookmark not defined.
Table Of Contents.....	Error! Bookmark not defined.
Editor’s Summary of Key Points and Research Issues	Error! Bookmark not defined.
Introduction	Error! Bookmark not defined.
Overview OF THE BATTLE OF MOGADISHU	19
Scenario 1 - Fast Rope Casualty during Assault	25
MANAGEMENT PLAN.....	27
DISCUSSION	29
Scenario 2 – First Helicopter Crash	33
MANAGEMENT PLAN.....	34
DISCUSSION	38
Scenario 3 – Second Helicopter Crash	39
MANAGEMENT PLAN.....	41
DISCUSSION	46
Scenario 4 – RPG Explosion in Vehicle	48
MANAGEMENT PLAN.....	49
DISCUSSION	54
Scenario 5 – First Assault Team Rescue Element Casualties	58
MANAGEMENT PLAN.....	59
DISCUSSION	62
Scenario 6 – Second Assault Team Rescue Element Casualties.....	66
MANAGEMENT PLAN.....	66

DISCUSSION	71
Scenario 7 – Helicopter Hit by RPG Round	76
MANAGEMENT PLAN.....	76
DISCUSSION	80
Scenario 8 – QRF Casualty in an Exposed Location	82
DISCUSSION	89
Scenario 9 – Chest Wound in the Rescue Convoy	93
MANAGEMENT PLAN.....	93
DISCUSSION	97
Concluding Remarks.....	103

Editor's Summary of Key Points and Research Issues

1. An operation that is planned and initiated as humanitarian/civic mission may rapidly evolve into a combat action.
2. Many of the decisions regarding the management of casualties in Mogadishu had important tactical implications. Instruction in tactical medicine should be added to training courses for small-unit mission commanders and their senior enlisted leadership.
3. Helicopter evacuation of casualties in Mogadishu was not feasible because of the threat of RPG fire and a lack of adequate landing zones due to the narrow streets. Vehicle evacuation was difficult because of roadblocks, ambushes, and RPG fire. A specialized vehicle is needed to evacuate casualties from urban environments. This vehicle must:
 - a. Offer reliable protection from small-arms fire.
 - b. Be hardened as feasible against RPG fire.
 - c. Be able to negotiate roadblocks
 - d. Be able to provide fire support for the casualties and rescuers.

The Israeli Merkava vehicle was suggested as being possibly suitable for this task, but other armored vehicles might suffice as well.

4. The number of hostile combatants can increase very quickly in the urban environment as a result of recruitment from the urban population. In addition, fire and maneuver is difficult for ground forces with casualties. These two factors may result in overrun situations for friendly units sustaining casualties, with the entire unit being killed or captured as a result. Fixed-wing air gunfire support is essential if successful evacuation of casualties is to be reliably accomplished in the urban environment.
5. There was a prolonged (15 hour) delay to evacuation for most of the casualties injured in Mogadishu. Plans for managing combat trauma on the battlefield should take the probability of such delays into account.

6. The Ben Taub study found that aggressive prehospital fluid resuscitation of hemorrhagic shock resulting from penetrating trauma to the chest or abdomen produced a greater mortality than KVO fluids only. There was, however, a clear consensus in the panel that should a casualty with uncontrolled hemorrhage have mental status changes or become unconscious (blood pressure of 50 systolic or less), he should be given enough fluid to resuscitate him to the point where his mentation improves (systolic blood pressure of 70 or above.) Additional animal research is needed to optimize fluid resuscitation strategy in this circumstance. Panel members stressed the importance of not trying to aggressively administer IV fluids with the goal of achieving "normal" blood pressure in casualties with penetrating truncal injuries.
7. Optimum care of casualties may be in direct conflict with maximum prosecution of the mission in the urban warfare environment. The impact of delays to evacuation on the expected outcome of specific injuries is a critical element of information for small-unit commanders responsible for making tactical decisions after casualties have been sustained by his unit. This should be addressed as a high-priority research effort.
8. Several casualties died as a result of hemorrhage from superficial but non-extremity bleeding sites where tourniquets could not be used. Attempts to maintain direct pressure on a hemorrhage site may be complicated by multiple bleeding sites and/or the need to return fire. A hemostatic dressing such as that now being developed by the Army Medical Research and Materiel Command would be an invaluable asset in such cases and is the best chance that such casualties have for survival. This project should be a top priority for research and procurement funding.
9. The prolonged (15 hour) delay to evacuation for most of the casualties in Mogadishu serves to emphasize that the results of civilian prehospital fluid resuscitation studies (in which the delay to arrival at the hospital is usually 15 minutes or less) may not be applicable to the combat environment.
10. Treatment of casualties on SOF missions involves a combination of good medicine and good tactics. Controlled, prospective human studies that address the entire spectrum of issues peculiar to battlefield trauma care are not likely to ever be accomplished. Optimum guidance for combat medical personnel on these issues will require a combination of combat-appropriate animal studies and consensus opinion from focused expert consideration of these issues. In general, interventions of questionable value should not be undertaken when they entail significant additional risk to mission personnel or the mission itself.

11. The femoral artery bleeding described in Scenario 7 was stopped with an improvised tourniquet. Many SOF operators are unhappy with the U.S. military standard issue tourniquets and stressed the need for improvements which can be put on one-handed and which can reliably stop arterial bleeding. This should be a top priority for research funding.

12. Hespan has the potential advantage of being retained in the intravascular space longer than Lactated Ringer's. A majority of the panel felt that Hespan is a better choice than Lactated Ringers for the treatment of hypovolemic shock resulting from controlled hemorrhage in combat casualties who may experience delays to surgery beyond those seen in civilian trauma studies.

13. The participants in the Mogadishu action were in the field for up to 15 hours in almost 100 degree heat with only two canteens (2 quarts) of water, adding dehydration as a significant stressor in this operation. The impact of this level of dehydration on the management of hypovolemic shock has not been well studied. Additional research is needed in this area.

14. Although Hespan has the potential advantage of being better retained in the intravascular space, Lactated Ringer's wider distribution might make it a better choice than or a necessary addition to Hespan in patients who are both dehydrated and suffering from hemorrhagic shock. Additional animal research is needed in this area.

15. The best bet for improvement in prehospital fluid alternatives for combat casualties was felt to be a *hypertonic saline/colloid combination*. *Continued efforts to obtain FDA approval for this type of fluid should be undertaken*. Additional animal research is needed to evaluate the efficacy of these solutions as compared to Lactated Ringers, normal saline, hypertonic saline and Hespan. These studies should address the delayed surgery and dehydration that will often be present in combat and should use both controlled and uncontrolled hemorrhage models.

16. Casualties who are unconscious from falls may have both a closed-head injury and bleeding from intrathoracic or intra-abdominal injuries. The optimum fluid resuscitation strategy for these patients has not been determined. Hespan offers a theoretical advantage in these patients in that it is retained in the intravascular space and may contribute less to cerebral edema than crystalloids. The importance of maintaining cerebral perfusion pressure (avoiding hypotension) in casualties with closed-head injuries was emphasized.

17. Not all individuals injured in combat need IV fluid resuscitation. Combat medical personnel should not generally initiate fluid resuscitation

in individuals who are not in shock in order to: (1) minimize interference with combatants who can continue to participate in the engagement; (2) conserve limited IV fluid supplies; and (3) attend to casualties with more severe wounds. All significantly injured patients should, however, have a saline lock started when tactically feasible in anticipation of the possible need for subsequent IV fluids, analgesia, or antibiotics.

18. Even with optimal care in civilian trauma centers, trauma patients who present with systolic blood pressures below 90 mmHg as a result of trauma have a survival rate of only approximately 50%. The presence of hemorrhagic shock on the battlefield is a grave prognostic sign.

19. The prolonged delay to surgery in Mogadishu and the reported high incidence of subsequent infectious complications emphasizes the need for antibiotics to be administered to casualties as soon as possible. Cefoxitin was felt to be a good choice by the panel, although ceftriaxone was suggested as an alternative. Ceftriaxone was noted to be more expensive and to have a narrower range of antibiotic coverage than cefoxitin, but it does offer the advantage of once-a-day dosing in prolonged evacuation situations.

20. The antibiotic coverage and absorption after oral dosing of the fluoroquinolones is excellent. Use of a fluoroquinolone taken by mouth with a small amount of water in a combat setting may be helpful in reducing combat medical equipment weight and treatment complexity. Animal research is needed in this area.

21. Preliminary research data in a pig model from the U.S. Army Institute of Surgical Research has shown that needle thoracostomy with a 14-gauge needle is as successful as a chest tube in relieving a tension pneumothorax and that the therapeutic benefit persists for at least four hours.

22. If a casualty has a chest wound, but is having no severe or increasing difficulty with his breathing, there is no need to do either a needle thoracostomy or to insert a chest tube emergently. The theoretical advantage of expediting hemostasis in lung parenchymal wounds will not be realized unless suction is applied to the chest tube. This type of suction is not available on the battlefield. Use of a chest tube without suction has been shown in animal studies at the Army Institute of Surgical Research to be unsuccessful in re-expanding lungs with a pneumothorax following penetrating chest trauma.

23. If a casualty has a chest wound, and develops increasingly severe respiratory difficulty, needle thoracostomy should be performed. If this is not successful in relieving the respiratory distress, there are additional measures that may be considered: (1) inserting a second needle at the 5th

intercostal space at the anterior axillary line on the wounded side of the chest; (2) inserting a chest tube in the injured side of the chest; (3) simply making a chest-tube sized hole in the chest if the corpsman, PJ, or medic is not carrying a chest tube; or (4) inserting a needle on the other side of the chest if the clinical findings suggest a *contralateral tension pneumothorax*.

24. The patency of a needle or catheter inserted to relieve a tension pneumothorax can be checked by observing the attached Heimlich valve for the passage of air. If air is seen to be moving through the valve, then it may be assumed to be functioning.

25. Multiple panel members noted that they routinely give up to 20 mg of morphine IV to myocardial infarction patients in the Emergency Department without producing respiratory depression or marked mental status changes.

26. The fire provided by casualties whose wounds are relatively minor may be very important in maintaining fire superiority, but there are a number of reasons that combat casualties might have an altered mental status. Among these are stress or panic reactions to the wound, a head injury, hemorrhagic shock, and analgesic medications. Casualties who have an altered state of consciousness from any cause should be disarmed immediately. The decision regarding disarming casualties must be individualized for each casualty and situation. Training in this aspect of tactical decision making should be added to combat medical training programs for both combat medical personnel and small-unit leaders.

27. SOF combat medical personnel who carry morphine should also carry naloxone and be trained in its use.

28. The armored floor mats from the helicopter at the first crash site were removed from the aircraft and used to provide cover for the crew and the CSAR team. This is an excellent innovation and should be incorporated into training for all individuals who might be rendering assistance at helicopter crash sites in a combat environment in the future.

29. Where transportation for evacuation or maneuvering is not readily available, the urban environment may provide many vehicles of opportunity that can be commandeered. Training and appropriate technology to take advantage of these opportunities should be provided.

30. At the two helicopter crash sites, there were large numbers of hostiles who converged on the crash sites, knowing that the crew was injured and vulnerable. Improved area denial techniques need to be identified or developed for this type of situation in the future. These area denial

techniques must be designed to keep hostile forces out but allow access to friendly rescuing forces.

31. Non-lethal technologies designed to incapacitate an enemy but not result in fatalities are often suggested as being useful in urban warfare environments. Given the cost and the complexity of employing such weapons rapidly when needed in urban warfare, forces may be better served by increased carriage and application of conventional ordnance.

32. Currently only Combat Search and Rescue Teams carry equipment designed to free casualties trapped in airframes after crashes. This equipment may need to be used by other groups in the absence of the CSAR team. Positioning this equipment in aircraft or vehicles or making it available through other means is necessary if future casualty scenarios that entail trapped crash or wreck victims are to be managed effectively.

33. When a rescuer is approaching a helicopter crash site, he should take the following steps: (1) immediately assess for the possibility of fire or explosion; (2) be aware of the possibility of ambush or booby traps if the crash site may have been under hostile control; (3) attempt to establish verbal communications with survivors before approaching the crash so that they will not mistake rescuers for hostile forces; and (4) establish crash site security before beginning rescue attempts.

34. There were two dead pilots trapped inside the first helicopter crash. It was extremely difficult to remove them from the wreckage, causing a delay in tactical maneuvering. Current Special Operations doctrine dictates that neither the wounded nor the dead are to be left behind. How do we deal with the next fatalities trapped in a crashed helicopter? If immediate evacuation had been available, should everyone have been evacuated, everyone have stayed, or something in between?

35. Providing adequate gunfire support in Mogadishu was problematic because of the presence of buildings that provided cover adequate to protect hostile forces from 7.62 caliber fire. Future urban warfare gunfire support plans should incorporate provision for weapons capable of building penetration.

36. Traditional triage considerations may need to be rethought for in-flight aircraft casualty scenarios. Scenario 7 contained an aircraft with two severely injured individuals, a runaway minigun, and a dazed pilot. The panel member discussing this scenario pointed out that the primary consideration in managing in-flight aviation casualties should be to ensure that the aircraft remains in the air, even though this might entail treating even relatively lesser injuries in the pilot before attending to other crew or passenger injuries.

37. Tactical medicine should be taught to all pilots and aircrew members so that they can deal most effectively with injuries sustained while in flight.

38. If an aircraft is disabled, has casualties aboard, and must make an emergency landing, the immediate action should be to arrange for the CSAR aircraft or any other aircraft that might be available to land in a nearby location. After an emergent transfer of personnel, the second helicopter should destroy the disabled aircraft, if possible, before departing.

39. If an aircraft is disabled, has casualties aboard, and is about to make an emergency landing, it is generally more important to ensure that all personnel, including the casualties, are prepared for a crash landing than to render medical care.

40. If a pilot is injured and in significant pain, the potential detrimental effects of narcotic analgesic medications must be weighed against those resulting from the pain. Intravenous or intramuscular ketorolac might be a good alternative in this scenario despite its potential adverse effects on platelet function. Another possibility is simply to withhold analgesic medications until after the aircraft has landed.

41. Urban warfare casualties should generally be moved to the best tactical location as quickly as possible before treatment for their injuries is undertaken.

42. Urban warfare may result in blunt trauma casualties from fast-rope injuries, falls, and motor vehicle accidents. Casualties with possible spinal cord injuries from these mechanisms may need to be moved to cover before long spine boards and C-collars are available. Improvised spine boards may be fashioned from doors or other available materials. If these substitutes are not readily available, and the risk of hostile fire injury to the casualty requires immediate movement, the casualty may be grabbed by the shoulders of his uniform, the head stabilized by the forearms, and the casualty dragged along the ground to cover. Avoid maneuvers like the shoulder carry in these casualties if possible.

43. Retrieval of casualties from open areas was often complicated by intense small arms fire in Mogadishu. Improved casualty retrieval and area denial methods to include smoke, diversions, custom-made or field-expedient casualty retrieval devices (such a length of line with a snap link), pursuit deterrent munitions, use of vehicles for cover, and improved gunfire support plans for the urban environment need to be developed and employed.

44. There were no advocates on the panel for attempting CPR in the tactical setting for individuals in cardiac arrest as a result of penetrating or blast trauma.
45. Imposition of casualties at various points in the mission should be a routine part of rehearsals and training for SOF missions. It is important to consider not only how the casualty's injuries should be treated, but also the tactical implications of the casualty upon the ongoing mission.
46. The presence of hearing loss (tympanic membrane rupture) as a result of blast injury should alert the treating medic or corpsman to the possibility of blast injury to the gastrointestinal tract or lungs.
47. Because of potential prolonged delays prior to evacuation in the urban environment, consideration should be given to preparing prepackaged replenishment medical supplies, water, and ammunition that could be air-dropped to trapped units in future engagements.
48. Urban warfare with combatants riding in motor vehicles may result in significant numbers of individuals with blast trauma. The pathophysiology and management of blast trauma (to include blast lung, arterial gas embolism, and late sepsis from gastrointestinal rupture) should be included in combat medical training courses.
49. For casualties with penetrating head trauma, there is little data to show that care rendered in the prehospital environment (beyond stopping any significant external bleeding that may be present) is reliably effective in improving outcome.
50. Unconscious casualties should be transported in a lateral decubitus position if possible. This position offers more protection to the airway than the supine position.
51. Pneumatic splints can be used to construct a field-expedient cervical spine collar.
52. A number of the panelists suggested that MAST trousers, although not routinely carried in the combat medical pack, have a place in SOF. They may be carried in mobility or evacuation assets and used to help manage exsanguinating hemorrhage in the pelvis and groin area. Hemorrhage in these areas may be of increasing concern in the future, since they are outside of the area protected by body armor.
53. The importance of frequent reassessment of casualties was emphasized.

54. Body armor is heavy to carry and hot to wear, but panel members identified at least three individuals whose lives were saved in Mogadishu by wearing it. It's continued use was strongly endorsed by panel members.

55. Some panel members advocated ketamine as a possible alternative to morphine, while others voiced concerns about the hallucinations and hypersalivation that this medication may induce. Ketamine was thought by some to be very useful in the event that it becomes necessary to perform an emergency amputation to remove a victim from a crash or building rubble.

56. Intraosseous infusion devices were felt to be good alternatives to IVs for fluid resuscitation in patients where IV access is difficult to obtain.

57. The medic should give consideration to what will be done with both his weapon and that of the casualty when presented with a wounded individual who is still under effective hostile fire and who requires emergent movement to cover.

58. The time required to perform interventions on combat casualties may result in additional injuries to the casualty, the combat medic or corpsman, or the other members of their unit. This underscores the need to do only those things that have been shown to be beneficial. Despite this pressing need for outcome-based management protocols, the Department of Defense is prohibited by law from performing or funding any human research in which full, informed consent is not obtained before entry into the study. This effectively prohibits the DOD from doing any human research in the area of prehospital trauma. The FDA and the Department of Health and Human Services are not similarly constrained. This prohibition should be removed. Without this change, the ability of the DOD to improve care for combat casualties will be unnecessarily compromised.

Introduction

CAPT Frank Butler, MC, USN.

It is a pleasure to welcome you to our Workshop on the Tactical Management of Urban Warfare Casualties in Special Operations. This workshop is brought to you courtesy of the U.S. Special Operations Command Biomedical R&D Program.

Before we start, I would like to thank some of the people who have helped to organize our program today. The first is April Porter of the Casualty Care Research Center who is our workshop coordinator. The second is LTC Dale Hamilton from the Special Operations Medical Association (SOMA) who has been gracious enough to allow us to incorporate this workshop as part of the annual SOMA meeting this year. I would also like to thank Colonel Steve Yevich, the U.S. Special Operations Command Surgeon, and my fellow members of the USSOCOM Biomedical Initiatives Steering Committee for their continued support of this series of workshops.

I would like to give you a little insight into the origin of these workshops. In the Special Operations world, if we need a new weapon, we don't go down to the local department store and look in the sporting goods section for a rifle. When we need a new boat for maritime operations, we don't go down to the marina and buy a fishing boat. For many years, however, we were using trauma management guidelines taken directly from the civilian sector without evaluating their suitability for the SOF tactical combat environment.

In 1993, we began a research project to re-evaluate our prehospital combat trauma management strategies. This effort resulted in the paper "Tactical Combat Casualty Care in Special Operations" that was published in Military Medicine in 1996. This project was very much a SOF community effort; many of the physicians, corpsmen, medics and pararescuemen in the audience today contributed to the development of the combat trauma protocol that was published.

The paper presented a new approach for managing combat trauma and proposed a step-by-step protocol for dealing with such casualties. The protocol divides prehospital trauma care into three phases: Care Under Fire, Tactical Field Care and Casualty Evacuation (CASEVAC) Care. This phased approach is necessary because combat medical personnel have to decide not only what care to provide, but when to provide it.

It would be fair to say that a number of the recommendations that came out in the proposed new protocol were a bit controversial. One of these was the use of tourniquets. Tourniquets are in disfavor in civilian trauma protocols, but combat trauma authorities like Colonel Ron Bellamy emphasize that the number one

cause of preventable death on the battlefield is exsanguination from extremity hemorrhage. These are letters to mothers, fathers, and wives that should not have to be written. In the paper, then, there is a recommendation that all SOF operators on combat missions have a suitable tourniquet readily available in a standard location on their battle gear and be trained in its use.

Civil War history buffs will recall that General Albert Sidney Johnston was one of the leading Confederate generals. He was killed in action at Shiloh on 7 April 1862. Before the battle, his surgeon, Dr. David Yandell, directed that everyone in the Confederate force have a tourniquet and be trained in its use. During the battle, General Johnston sustained a gunshot wound to the knee during the battle with an injury to his popliteal artery. He went on to bleed to death despite having a tourniquet in his pocket.

For those of you in the audience who are combat medics, do the soldiers or sailors in your units carry tourniquets in a designated location? Are they trained in their use? Could this same type of needless fatality happen to someone in your unit during their next battle?

There were other things in the paper that were quite different from civilian protocols: Hespan instead of Lactated Ringer's (LR) for fluid resuscitation; IV fluids only for those trauma patients who really need them; delayed fluid resuscitation for uncontrolled hemorrhage; IV instead of intramuscular analgesia; and no CPR for casualties who are in cardiac arrest on the battlefield from penetrating or blast trauma.

Having these concepts published in the peer-reviewed literature was an important step, but no one ever had their life saved on the battlefield by a paper published in a medical journal unless somebody acts on the recommendations it contains. That means that one has to take the time and effort to transition them into use - not necessarily an easy thing to do. I want to take a minute to describe where we are with this transition effort at present.

In January of 1997, CAPT Steve Giebner, Master Chief Andy Knoch, and I briefed Admiral Richards on this issue. In April 1997, at the Admiral's direction, the Tactical Combat Casualty Care guidelines contained in the paper became the standard of care in Naval Special Warfare. The British military and the Israeli Defense Force now also use many of these same concepts. The US Air Force Pararescue Medications and Procedures Manual incorporates some, although not all, of them. In August 1998, the Marine Corps Combat Development Command (MCCDC) convened an advisory panel to look at the issue of trauma training for Navy corpsmen serving with the Marines. The panel recommended that the TCCC guidelines be added to the combat trauma curriculum at the Field Medical Services School. That recommendation has gone to the commanding general at MCCDC and is currently being implemented.

In addition, thanks to Colonel Yevich, CAPT Greg Adkisson at the Defense Medical Readiness Training Institute, and Dr. Norman McSwain of Tulane University, there was an opportunity to provide input on this topic to the Pre-Hospital Trauma Life Support (PHTLS) Manual. The latest edition includes, for the first time, a military medicine chapter. This chapter contains the same Tactical Combat Casualty Care guidelines proposed in the paper. The back cover of the PHTLS Manual states that the contents of the Manual are endorsed by Committee on Trauma of the American College of Surgeons and the National Association of EMTs. As far as I know, the TCCC concepts are the only set of combat trauma guidelines that have ever received this dual endorsement.

This is progress. Unfortunately, however, casualty scenarios in Special Operations usually entail both a medical problem and a tactical problem. If your generic trauma management plan does not work for the specific tactical context in which the injury occurs, then for a SEAL corpsman or an Army Special Forces 18-Delta medic or an Air Force pararescueman (PJ), it just doesn't work. What is required is a scenario-based approach. We need to take a particular casualty, put it into a tactical context, and then figure out how to solve the problems such that we get the best possible outcome for both the man and the mission. This is what we are here to do today.

Since no one individual can adequately address all of the issues that the tactical management of these casualties entails, we have developed the concept of TCCC workshops. We convene SOF combat medical personnel, SOF physicians, SOF mission commanders, and invited medical subject matter experts to address a number of specific casualty scenarios. This is the sixth workshop in our series. The first was on the Tactical Management of Diving Casualties in Special Operations, held in Anchorage in 1996 in collaboration with the Undersea and Hyperbaric Medical Society (UHMS). We covered 15 difficult diving casualties. The workshop report has now been published by the UHMS and is included in the 1998 Special Operations Computer-Assisted Medical Reference System (SOCAMRS). This is a set of 3 CD-ROM disks produced by USSOCOM and distributed annually to SOF physicians and combat medical personnel.

The second workshop was on the Tactical Management of Wilderness Casualties in Special Operations. This was held in 1997 in collaboration with the Wilderness Medical Society, who devoted an entire issue of their journal "Wilderness and Environmental Medicine" to the workshop proceedings.

The other three workshops have been on the management of radiation casualties, chemical weapons casualties and biological weapons casualties. The proceedings from these workshops are in the process of being edited.

There are several points that I would like to emphasize. Much of the material that you see covered in these workshops is not taught in medical school, ATLS, or

EMT courses. The best options for treating casualties in SOF tactical scenarios have to be developed by the people in this room. We have to realize that no one group of medical providers has all of the answers. We need a team effort come up with good plans for these scenarios.

It is also very important that we consider scenario-based management plans advisory rather than directive in nature because it is unlikely that anyone will encounter a casualty scenario in future combat that exactly reproduces one of our workshop scenarios. Our combat medical people are going to have to improvise and think on their feet, and that is exactly what we want them to do. We need to get away from the JCAHO mentality. JCAHO (the Joint Commission on Accreditation of Hospitals) is a process whereby a hospital is inspected to ensure that it is in compliance with a long list of inspection criteria. These criteria must be met in the most minute detail. That approach may suffice to get your hospital through a JCAHO inspection, but it is a recipe for disaster on the battlefield. There are many people who might disagree with this approach to things. Fortunately, I know one individual who does agree with it, and most of the people in this room work for him. In his vision statement. General Schoomaker, the Commander-in-Chief of the U.S. Special Operations Command, emphasizes that we have to "train people how to think, not just what to think." Ladies and gentlemen, that is what we plan to do here today.

This workshop on the Tactical Management of Urban Warfare Casualties in Special Operations differs slightly from previous workshops in which we used mostly hypothetical scenarios. Every casualty that is going to be discussed today is an actual casualty scenario from the battle of Mogadishu in Somalia in 1993. Before we begin, I want to establish three major ground rules. First, our security personnel have screened all of these scenarios to ensure that they contain no classified information. They have emphasized that we should not mention the names of specific SOF units engaged in the battle and we will observe that recommendation. Second, we will not mention the names of the casualties, even though they may be known to some of you. Third, we will not discuss the care that was actually rendered. We are not here to second-guess the combat medics who were out there in the field. What we want to do have our panel and audience look at the scenario, discuss the management options, and try to decide which ones are the most appropriate for the situation described.

In addition to our distinguished panel, we have an incredibly experienced and capable audience. We are counting on a lot of participation from you today. We will ask each panelist to present his scenario and tell us how he would approach it. Then we are going to open the floor for comments from the rest of the panel followed by questions and comments from the audience.

I would like to acknowledge the presence of two members of our panel who were actual participants in the Battle of the Black Sea in Mogadishu, CAPT Eric Olson and 2LT Bob Mabry. These individuals would probably prefer that I not go into

detail regarding their actions during the engagement in this forum. Suffice it to say that we are all honored by their presence. Now, before we start considering the nine scenarios, we are going to be given an overview of the tactical situation in Mogadishu by 2LT Mabry.

Overview

2LT Bob Mabry MS, USAR.

Good morning. I am Second Lieutenant Bob Mabry, a 4th year medical student at the Uniformed Services University of the Health Sciences. Five years ago, on the 3rd of October 1993, I was SFC Bob Mabry, a Special Forces medic, assigned to Task Force Ranger as a part of the Combat Search and Rescue Team. I am going to speak for a few minutes about the Battle of the Black Sea. With this in mind, I wish to say up front that many aspects of the operation remain classified, so I have prepared my comments directly from several open sources in the media, including: the Philadelphia Inquirer's "Blackhawk Down" series; a Time magazine article, "Anatomy of a Firefight"; and the PBS special, "Ambush in Mogadishu". If any of you participated in the operation or are privy to its details, you may recognize some inconsistencies. I am also going to refrain from mentioning specific units and individual's names. No classified information was used to prepare this presentation.

What I hope to do over the next twenty minutes is to give you a sense of what the tactical situation on the battlefield was like on 3 October. I also want to "put you on the ground in Mogadishu". At the risk of being overly melodramatic, over the next few minutes, I want you to be able to close your eyes and smell the aviation fuel mixed with the third-world stench of human waste, charcoal, and rotten fruit. I want you to smell the stink of sweat and blood mixed with gunpowder and burning tires. I want you to be able to hear the roar of helicopters overhead, mixed with the distinctive sound of AK-47 rounds and the whoosh of rocket-propelled grenades (RPG's) as they go past. I want you to hear the deafening echo of continuous gunfire along narrow, confined streets mixed with the screams of "Medic" and "I'm hit" from the dying and wounded. I want you to see buddies to your left and right being hit and to feel the bullets passing by, sometimes through your clothing and equipment, and I want you to understand the effect that that has on your concentration and psyche.

Sunday, 3 October, 1993 was another day in the hangar. Task Force Ranger (TFR) had been in country for about 5 weeks. People were reading, writing letters, doing PT or at the beach catching some rays. At about one o'clock in the afternoon, TFR began receiving intelligence reports that two of Aidid's top lieutenants would be meeting later that afternoon at the Olympic Hotel close to the notorious Bakara Market, in the heart of an Aidid-controlled area known as the Black Sea. Over the next hour, this intelligence was confirmed and "GET IT ON" echoed throughout the hanger. Everyone dressed out and loaded the aircraft and vehicles in just a few minutes, as this ritual was repeated with daily profile flights and with 6 previous missions, all of which had gone smoothly.

The mission was to follow a standard template that was simple and well

rehearsed. An assault force of about 90 soldiers, riding on more than a dozen Special Operations helicopters, would swoop down on the target, air landing or fast roping if needed. One group would assault the target building and the other would establish blocking positions around the perimeter. Meanwhile, a 50-man ground convoy of trucks and armored Humvees, with 50-caliber machine guns and Mark 19 grenade launchers, would make its way through the city and arrive shortly after the air assault. The air-assault force and any prisoners or wounded would then be loaded onto the ground convoy vehicles for extraction. A command and control helicopter and a Combat Search and Rescue (CSAR) bird would orbit overhead. The CSAR package, with 2 Air Force pararescuemen (PJ's), a Ranger medic, and a squad of Rangers with litters and cutting tools were on call to respond as needed. All together about 170 men would take part in the operation.

At 3:30 in the afternoon, the pilot of the lead Blackhawk helicopter gave the code word and the assault force lifted off, out over the ocean and along the Somali coast. Meanwhile, the ground convoy departed from the airfield. Ten minutes later, the assaulters are inserted by helicopter and begin to storm the target building. Moments afterward, the Blackhawks inserted the perimeter security team into their blocking positions. In the brownout of flying dust and debris created by the rotor wash, a Ranger falls forty feet from a Blackhawk, sustaining a closed head injury, a femur fracture and a broken arm. Unconscious, one eye swollen shut, and bleeding from the nose and mouth, he is the first casualty.

Twenty minutes later, the assault force has secured the target building and has captured more than twenty prisoners, flex-tied them, and is waiting to load them onto the trucks. By now, the convoy and blocking positions are receiving sporadic fire. The Ranger Commander is informed about the soldier who fell. The medic tells him the casualty's injuries are critical, and the decision is made to evacuate him. Three of the Humvees are sent back to the airfield with the injured Ranger. As they make their way back through the city, they encounter gunfire from every direction; from rooftops, doorways and alleys. The 50-cal gunner in one of the vehicles is hit in the head. Blood and gray matter are splattered over his fellow Rangers and the interior of the Humvee. He is the dead by the time they reach the hanger.

Back at the objective, as the prisoners are being loaded, the volume of fire increases, armed and hostile crowds are beginning to gather. In the sky above, the helicopters are under steady fire from RPG's. The Aviation commander would comment later that "the fire never stopped " and that in 10 minutes one Blackhawk was fired upon 10-15 times. At 4:10 in the afternoon, 40 minutes after the operation began, an RPG finds its mark and Super 61, one of the Blackhawks, is hit. The RPG hit the tail boom and Super 61 begins to spin in a slow, wide arc until it crashes, nose first and on its left side, in a narrow Mogadishu alley with a loud "crumping" sound. The two pilots are killed on impact. Amazingly, the 6 soldiers riding in back survive. Four of them quickly

pour out of the right side door and begin to secure the area. They were under fire moments later. One of the survivors engages the Somalis rapidly, taking well-aimed shots, and killing perhaps 10 of them before he goes down, mortally wounded, hit in the pelvis and abdomen. One of his comrades comes to his aid and is shot through the shoulder. Then, amazingly, a helicopter lands in the middle of the road next to the crash site, its rotor blades just a few feet from the Somali houses. The ranger shot in the shoulder, with the help of the co-pilot, loads his dying comrade into the back while the pilot fires with his sidearm at the advancing gunmen. The other Rangers stay with the downed helo and wave the bird off.

Moments after the helo lifts off, the 15-man CSAR team fast-ropes into the crash site. As the last two men are on the rope, the CSAR bird is hit in the tail with an RPG. It lurches slightly, but holds its position until the ropes are clear and then limps back to the airfield, spewing smoke and fluid, to land safely.

Back at the objective, everyone who saw and heard the crash knew that things had just changed dramatically. One of the Ranger platoon leaders within sight of the crash began to move his men forward on foot to the site. The Ranger commander, now with 3 vehicles lost to CASEVAC and one five-ton truck disabled from a direct hit with an RPG, began to move his convoy to the crash site. As soon as they rounded the corner from the objective, they were met with a hail of fire. Gunfire and RPGs were coming from all directions. The Command and Control helicopter spotted Somalis setting up roadblocks to slow the convoy. Groups of armed Somalis would run on foot a block over and parallel to the convoy in what was in effect a moving ambush. The Command and Control bird tried to vector the convoy away from the crowds and the gathering gunmen and toward the downed Blackhawk, but this only resulted in the convoy wandering for about an hour under intense fire in a maze of unfamiliar streets and alleys. Ten minutes after Super 61 went down, while the convoy searches for the first crash site, yet another Blackhawk is hit by an RPG and crashes about a mile from the first crash site. The convoy is then instructed to recover the personnel from the first crash and then move to the second crash site. Crowds of angry Somalis gather and advance on the convoy when it stops to pick up wounded or to turn around. Medics run alongside at stops to provide what treatment they can for the injured. Gunmen use women and children as shields. Some are armed and are fired on. Bullets hit the vehicles constantly. Rangers are hit, many more than once. Bullets graze equipment and clothing; many are stopped by helmets and body armor. Several more RPG's find the convoy. One five-ton truck driver is hit in the chest. The RPG does not explode, but will later be discovered by a doctor who takes off the Ranger's body armor and sees the fins from the unexploded round sticking out of his chest. Another RPG hits the side of a Humvee. The blast tears one of the Rangers almost in half at the pelvis. He is mortally wounded, yet will live for another 12 hours. After an hour of intense fire, the decision is made to return to the airfield. At this point, there are more dead and wounded in the convoy than at the crash sites.

At the second crash site, the bird went in hard but remained upright. It had crashed in a rabbit warren of Somali huts and shanties. There is no place to set a helo down close to the downed aircraft, so one of the Blackhawks orbits overhead providing support with its minigun. Another RPG finds its mark and hits the bird, the blast taking the leg of the gunner. Since the CSAR team is committed to the first crash site, a pair of Rangers jumps from a hovering Blackhawk and moves through the shanties to assist the crew. They pull the pilot from the wreckage and hold the Somalis at bay for almost an hour. Then, low on ammo and under deafening barrage of Somali fire, the two Rangers and the co-pilot are killed, and the pilot captured.

Back at the first crash site, the CSAR team works to secure the crash and to extricate the dead and wounded. They have been under constant fire since they fast-roped in. The PJ's move forward to remove the bodies and a Ranger medic sets up a casualty collection point (CCP) behind the protection of the downed helo. Anticipating quick evacuation, the casualties were not moved into the protection of a nearby Somali house. A short while after infiltration, the body of the first pilot is freed. He is obviously dead. Moments later, the senior PJ limps back to the CCP cursing. "Rat bastards shot me". He then assumes control of the CCP and the Ranger medic moves forward to assist in the aircraft. While moving up to the nose of the aircraft, a grenade flies over the wall and lands in the narrow alley where he and some of the Ranger security element are clustered. There was no place to go. They ducked, turned away, closed their eyes, and gritted their teeth. Nothing happens; it is a dud. Before they could breath a sigh of relief another grenade flies over the wall and lands only several feet from them. It is not a dud; it explodes up and out and misses everyone. "Get some grenades over that wall" someone yells. Seconds later, 3 or 4 grenades fly over the wall and explode in rapid succession. Rounds continuously hit the aircraft, the walls of the narrow alley, and the ground around the security team. At the nose of the aircraft, one Ranger is hit in the chest and falls backward. He looks down, sees that the bullet has been stopped by his Kevlar body armor, and then continues to return fire.

Meanwhile, the second PJ has discovered a crew chief buried under the debris in the cargo area of the downed helo. He calls to the other medic for help. The army medic tries to dig under to nose of the aircraft but cannot get in, so he takes a deep breath, scrambles up the nose of the Blackhawk and jumps in from the top. Seeing him enter the aircraft, silhouetted against the sky, the Somalis respond with an intense volley at the downed aircraft. Inside, there is a hail of bullets that lasts a few seconds. One of the medics is grazed in the face, the other on the hand and the crew chief has his some of fingers shot off. Otherwise they are unhurt. The three of them look at each other in amazement. "Wait a minute" one medic says, and takes up the Blackhawk's armored floorboards and places them in the fore and aft section of aircraft. Now, somewhat protected, they place the wounded crew chief on a litter and dig a hole under the aircraft to get him out. While they work, the armored floorboards take hits, are knocked over, and then

put up again.

Back out in the street, the wounded are stacking up. The floorboards from the aircraft and blocks of rubble from the wall smashed by the helicopter are quickly stacked up for cover. The medics work quickly to assess and stabilize the casualties. By now, members of the SAR team are getting hit. The fire has not let up. A radio call comes from across the intersection; "We have wounded across the street," says the CSAR Team Commander. The PJ and the Army medic look at each other. "I'll go," the PJ volunteers and jumps up and runs across the street. Moments later he is back saying, "I need some IV fluids; I have a casualty who is bleeding a lot." He then makes his way back through the fire across the street for a third time.

During this time, some of the blocking force and assaulters from the target building have made their way to the crash site, taking wounded and dead of their own on the way there. The perimeter is slowly expanded, but the narrow streets and alleys are still a funnel for bullets. By the time the CSAR team realizes they are going to be there for a while, they cannot move. Two attempts are made to move casualties inside but each time the CSAR team takes more wounded. A Ranger platoon leader tells a CSAR medic "We have got to get these wounded inside." The medic agrees but tells him, "We just got two people shot trying it. It will get dark soon; we'll try it then." As darkness falls, the volume of fire decreases and the wounded are moved inside with no further casualties taken.

As night falls, about 100 men are spread out around the crash site; medics work through the night on the wounded. In the building next to the helo there are 12 wounded. These include a crew chief with a suspected pelvic fracture and amputated fingers, a Ranger with a gunshot wound and severe leg fracture, and another Ranger with multiple facial fractures who had been injured in the crash. There are also half a dozen or so with assorted gunshot wounds, shrapnel wounds and fractures of the extremities. Across the street, the other PJ has four wounded. One is shot in the pelvis and testicle and is bleeding heavily. A short distance away, another medic works tirelessly to save a Ranger shot in the groin, but the bleeding cannot be stopped and he will die during the night. Medical supplies run low. IV fluids and morphine are used up in a few hours. Some supplies are recovered from the crash. In the middle of the night, a helo hovers over the site and drops a re-supply bundle. Soldiers on the helo are shot, but the supplies make it in.

While the medics work, the men at the first crash site listen to the radio and hear that a relief column is being put together. Earlier that day, shortly after the gravity of the situation was realized, the 10th Mountain's Quick Reaction Force (QRF) was summoned to the airfield and briefed on the situation. At 1830, a company of the QRF in Humvees and 5-ton trucks moves toward the first crash site. They encounter a vicious ambush at the K-4 circle and are forced back to the airfield. At the crash site they hear the QRF is enroute, then, moments later, they hear

several minutes of intense fire to the south, followed by a report of the QRF being ambushed and turning back. The mission commanders realize that more firepower is needed, so they work feverishly to assemble a second convoy of four Pakistani tanks, two companies of QRF, 32 Malaysian Armored Personnel Carriers (APC's) and about a dozen each Humvees and trucks. All available personnel were rounded up; cooks, the lightly wounded, support personnel, and staff from the task force would all go out with the second convoy.

At about 2330 hours, the second convoy departs the airfield. It splits off into two elements at the Pakistani checkpoint. One element moves to the first crash site and the other to the second. Shortly thereafter, the lead APC in the second crash site element takes a wrong turn and is hit by an RPG. The rocket decapitates the Malaysian driver and disables the APC. Several soldiers from the 10th Mountain are shot recovering the wounded. They then continue on to the second crash site where no Americans are found.

The other element advances to the first crash site and links up with the members of Task Force Ranger at about 0200. It takes several hours to load all of the wounded into the vehicles. Meanwhile, the CSAR team continues to work on extricating the last pilot's body from the wreckage of the Blackhawk. At dawn, the pilot is finally freed and to the surprise and chagrin of many at the first crash site, they find out the APC's are so full of wounded that they will have to run alongside them on foot for exfiltration.

So, shortly after dawn on the 4th of October, two long columns of men are stretched along each side of the street near the downed helo. Many of the men had no idea that there were that many of them there. Most have spent the night right next to each other without ever realizing that their buddies were so close. These two columns run, house to house, street to street, using the APC's for cover. This run is later to be called the "Mogadishu Marathon." While they move, they encounter sporadic fire. Helicopters provide fire support directly overhead, just as they have done all night. Expended brass and links rain down on them as they move. Walls and buildings crumble close by as the tanks and helos suppress the Somali fire, which increased after dawn broke. After about 2 miles, the force links up with elements of the QRF and loads onto vehicles. Many drink water for the first time in many hours.

The QRF then moves out in two groups, one to the Pakistani Stadium, the other to the New Port. They encounter sporadic fire from snipers along the way, but nothing like the day before. As one group arrives at the New Port, two medics prepare to take care of the wounded, although one of them could not hear. During the Marathon he ran by a wall, just as an RPG round exploded and his eardrums were ruptured. No casualties arrive at the New Port, however, and the TFR members are ferried back to the hanger by Blackhawk.

The second group arrives at the Pakistani Stadium with the wounded. The scene

is surreal. Vehicles are splattered with blood and gore. Body parts and the dead are stacked in the back of the Humvees. The dead are covered with ponchos. Here medics and Task Force doctors began to treat and triage the flood of wounded, sending patients to the 46th Combat Support Hospital close by, where three surgeons, working without rest for more than 36 hours, would stabilize them for evacuation to Germany. At the Pakistani Stadium, Rangers learn for the first time about buddies who are dead or wounded. They learn that the crew of Super 61 and the two sergeants who went in after them are still missing.

By the time everyone returns to the Hanger, they meet the first wave going out on MEDEVAC at the nearby Air Force MEDEVAC staging area. Everyone reloads ammo. The medics repack their nearly empty aid bags. People eat and try to sleep knowing that at any moment they may have to go back out for the missing crew. Many task force members, although exhausted from almost 15 hours of continuous fighting, cannot sleep. The sound of gunfire and the whoosh of RPG's still rings in their ears. Then, by that afternoon, CNN shows films of American bodies being dragged through the streets of Mogadishu. The anger in the hanger is palpable. But a follow-on mission never comes. Over the next few days they learn that the pilot of Super 61 is still alive, to be released seventeen days later, but that his crew and the brave sergeants who went to their rescue did not make it.

This would bring the total killed on 3/4 October to 19. The total wounded requiring medical evacuation from Somalia was 59 and the total lightly wounded and returned to duty was 49. The estimates of Somali dead ranged from 350 to 500, with up to 1000 wounded. This action represents the largest, most intense firefight for U.S forces since Vietnam and has had a lasting effect on US foreign policy in the conduct of operations other than war.

A few days later, a memorial service was held at the hangar for the Task Force Ranger members who fell in combat. The Task Force commander read a passage from Shakespeare's King Henry V, where the king addressed his men the day before going into battle. I will share those words with you now.

"Whosoever does not have the stomach for this fight, let him depart. Give him money to speed his departure, since we do not wish to die in that man's company. For whosoever lives past this day and comes home safely will rouse himself every year on this day, show his neighbors his scars, and tell embellished stories of all the great feats of battle. These stories he will teach to his sons and from this day until the end of the world, we shall be remembered. We few, we happy few, we band of brothers. For whosoever shall shed his blood with me today shall be my brother, and those men afraid to go will think themselves as lesser men to hear how we fought and died together."

That concludes my comments. I hope I have succeeded in putting you there, and I hope what I have said will set the stage for the scenarios to follow. Hopefully, by

the end of the day, you will have learned something from this battle that will help improve the care that we give to the soldiers, sailors and airmen of the Special Operations community in the future battles that are sure to come. Thank you.

Scenario 1

Fast-Rope Casualty

LCDR Jeff Timby

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- 16-man Ranger element designated as perimeter security team
- Assault team, perimeter security team, and prisoners to be picked up by a 12-vehicle ground convoy
- 70 foot fast-rope insertion from helicopter
- Ranger misses rope and falls
- Unconscious on the ground
- Bleeding from the mouth and ears
- Several hundred hostile Somalis in disorganized crowds
- Sporadic fire from numerous gunmen in crowds

Preliminary Comments:

In falls from height, the height of a fall is the most important predictor of the extent of injury that a person will sustain. The surface of impact is also important. Hard surfaces such as macadam or cement produce more severe injuries than soft surfaces such as mud, swamps, or water. The angle of impact is another important factor. In a fall from 20 feet or less, the angle of impact is largely dependent upon the angle from which the casualty began descent. From a greater height, the center of mass for the body is a better predictor of the attitude at impact. Since the center of mass for the human body is the upper thorax, the position at impact will likely be a swan dive-type approach. Back packs, parachutes, weapons, and other carried gear will affect the center of mass and body angle during prolonged descent. Consideration must also be given to such

factors as wind drag and whether the fall is free or broken. The age and fitness of the casualty may be also important considerations.

The height of the fall affects the velocity at impact. Human free-fall acceleration is approximately 20 miles per hour for every second of descent. An individual who falls from 70 feet will descend for approximately 2-1/2 seconds and impact at a speed of approximately 50 miles per hour. If the fall were from a much greater height, the terminal velocity would be approximately 130 miles per hour.

Pertinent to the care of a fall victim from a given height is the type of injuries anticipated as a result of falls from that height. Steadman (1989) described a high proportion of visceral injuries when patients fell 6.1 meters or more. Lau (1988) reported that Injury Severity Scores (ISS) can be correlated with the height of a fall. This can be used to corroborate the reported mechanism of the fall with the type and severity of injuries encountered.

Kragh (1995) reported on 170 injuries to Army Rangers sustained during fast-roping over a 55-month period. Most of the injuries were from controlled descents. A controlled descent is defined as one with a descent rate of 10 to 15 feet per second, whereas an uncontrolled descent is defined as one with a descent rate of greater than 15 feet per second. One percent of the 170 injured Rangers had closed head injuries, 2% had thoracolumbar spine fractures, 3% had chest or abdominal contusions, 2% had pelvic fractures and 2% had femur fractures.

Richter (1996) described 101 patients who fell from an average of 7.2 meters. In this study, 83% had thoracic or thoracolumbar spine fractures, 21% had chest contusions, 30% had pelvic fractures, and 27% had closed head injuries.

Velhamos (1997) reported on 187 patients with falls ranging from 5 to 70 feet. Only three patients in this study experienced falls greater than 40 feet. Despite the relatively low heights, 20% of the patients suffered spinal fractures, with 4% having neurologic deficits. Although 6% of the patients had significant abdominal trauma, vascular injuries were infrequent with less than 1% having a ruptured thoracic aorta or retroperitoneal bleed.

Warner (1986) examined the pathophysiology of injuries related to falls. He states "mortality from a six-story fall onto a hard surface such as concrete is almost 100% for adults." Risser (1996) also found that death usually results when the fall is more than five stories. The average story height for a standard high-rise building ranges from 10 to 12 feet. The scenario here has a 70-foot (6 to 7 story) fall onto a hard-packed urban street. The studies mentioned therefore predict a critical, if not moribund, physical condition for this Ranger as his care is initiated.

The critical issues in this scenario are whether or not the Ranger fell the entire 70-foot distance to the road surface, whether the fall was unbroken, and how

hard the surface on which he impacted was. In the worst case responses for these questions, the likelihood of survival is poor, even if the casualty were being treated immediately in a modern urban medical center. In a combat scenario, the probability of survival is reduced even further.

Prior to outlining a combat casualty care plan, several assumptions will be made about this casualty. Given the height of the fall, it has to be assumed that the casualty has multiple injuries that individually or collectively equate to a high probability of death. Since he is unconscious at the time of evaluation, it is assumed that he has a severe closed head injury. Coma is defined as the inability to obey commands, utter words, and open the eyes. A Glasgow Coma Scale (GCS) score of 8 or less is a generally accepted quantitative definition of coma. The bleeding from the ears likely represents a basilar skull fracture. Blood in the mouth suggests either maxillofacial fractures or pharyngeal trauma that will complicate airway control. Whenever there is a closed head injury, consider cervical spine fractures. Based on the height of the fall and the likely body angle at impact, the thoracolumbar region from T11 to L1 is also at high risk for fracture. Occult hemorrhage from a hemothorax, hemoperitoneum, and pelvic or long bone fractures is also likely and may contribute to morbidity and mortality.

The initial assessment is critical. Witnesses to the fall must help establish whether he fell the entire 70 feet and whether the fall was unbroken. Prolonged Tactical Field Care is the presumption. Survival for the severely injured casualty in this environment is poor, as the ability to provide life-saving interventions is very limited.

MANAGEMENT PLAN

Care Under Fire

1. Return fire as required. The principle objective in this situation is to keep your casualty from sustaining further injuries and to keep yourself from becoming a casualty.

2. Answer the following questions:

Is he alive? Resuscitation of trauma-related cardiopulmonary arrest is not indicated.

Is he apneic? If so, insert an oral or nasopharyngeal airway.

Is the mechanism of injury survivable? If not, treat expectantly.

Is there life-threatening extremity hemorrhage? If so, apply a tourniquet.

Is there an associated spine injury? If so, try to limit further injury during transport to cover. Use of a poncho or pack with head stabilization should be considered to drag the Ranger to cover.

Tactical Field Care

1. The history offers little conclusive data regarding the extent of the injuries sustained. The known facts include:

The Ranger is unconscious with a GCS less than 8.

The Ranger is bleeding from his mouth and ears, suggesting maxillofacial fracture, pharyngeal injury, and/or basilar skull fracture.

The Ranger fell from a height that is anticipated to result in multiple trauma.

2. Airway control is of paramount importance in closed-head injury patients, particularly if the GCS is less than 8. Blood in the oropharynx interferes with airflow and a definitive airway is warranted. The best airway that can be placed quickly and securely, still enabling the provider to render care to other individuals or return fire as necessary, is a cricothyroidotomy using either a #6.0 cuffed tracheostomy or a standard endotracheal tube cut to appropriate length. Nasotracheal tubes are contraindicated with suspected maxillofacial or basilar skull fractures. Orotracheal tubes can be safely placed in patients with suspected cervical spine fractures in a controlled setting, but performing this procedure in a tactical urban warfare setting may be too hazardous. I do not feel that orotracheal intubation is the best way to secure the airway in this casualty. I also do not believe that a laryngeal mask airway or esophageal-laryngeal combitube has any utility in tactical field care.
3. Casualties with a severe closed-head injury are at high risk for transient respiratory arrest. However, in this environment, it is not possible to provide prolonged respiratory support or supplemental oxygen. Hypoxemia adversely affects outcome in severe closed-head injury and hypercapnea will exacerbate elevated intracranial pressure (ICP). Inability to maintain oxygenation and spontaneous ventilation portends poor outcome.
4. Other factors that may compromise oxygenation and ventilation in this casualty include chest contusion, tension pneumothorax, massive hemothorax, and diaphragmatic rupture. Of those, the most important and most reversible is a tension pneumothorax. Needle thoracostomy is indicated if tension pneumothorax is suspected clinically.
5. Recognize that, after a 70-foot fall, this casualty may be in shock from uncontrolled bleeding in the chest, abdomen, or pelvis. Support of the

intravascular volume with Hespan or other IV fluids should be performed. With a severe head injury, cerebral perfusion pressure is critically important. In a controlled setting, the target cerebral perfusion pressure is greater than 70mmHg. In a tactical field care environment, the cerebral perfusion pressure is unknown. Maintenance of a pressure of 100mmHg by palpation or using a readily palpable pulse in combination a heart rate of 100 beats per minute or less are two possibly helpful clinical parameters to monitor. Normalization of blood pressure may exacerbate uncontrolled hemorrhage from abdominal, chest, or pelvic sources. Allocation of resuscitation fluids to a casualty with limited survivability should be carefully considered.

6. Assess for spinal cord injuries and secure on a litter or other solid support if possible.
7. Maintain core body temperature. Remove outer garments only as necessary to facilitate care.

CASEVAC Care.

1. Re-evaluate ABCs. Assure a secure airway, oxygenate and ventilate.
2. Re-evaluate the neurologic status frequently. During air or ground transportation, mechanical hyperventilation and mannitol should be given if signs of elevated ICP are present.
3. If a needle thoracostomy was performed to decompress a tension pneumothorax, then conversion to a tube thoracostomy is necessary at some point.
4. Maintain cerebral perfusion pressure by fluid resuscitating with Hespan or Lactated Ringers to a mean arterial pressure greater than 70mmHg despite the possible presence of uncontrolled hemorrhage. Cerebral perfusion pressures less than 70mmHg are associated with a poor outcome.

Additional Considerations

1. In the future, we need to consider other resuscitation fluids such as hypertonic saline, hypertonic saline/colloid combinations, or other blood substitutes as a means of improving the survival of patients with closed-head injury and shock.

References

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3. Kragh et al: Military Medicine 1995; 160: 277-279
4. Velhamos et al: World J Surg 1997; 21: 816-821
5. Warner ey al: Ann Emerg Med 1986; 15: 1088-1093
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DISCUSSION

CAPT Butler: One of the things that makes these scenarios difficult is that your unit cannot move if you have to stop and care for this individual. It would be interesting to hear Captain Olson's thoughts about better ways to carry out evacuations in urban environments.

CAPT Olson: First, I would add a bullet to the first slide that talked about factors affecting the injury. Include how the Ranger is dressed, what he is carrying, and how his load is configured on his body. These could act as significant factors that affect the injuries sustained and I think there are many ways to dress for success in how the Ranger configures himself, knowing that fast roping is part of the mission.

In every scenario, there is a larger mission that the Commander has to execute and I think one of the primary responsibilities of anybody providing medical care is to not hinder the execution of the larger mission.

CAPT Eric Olson

In every scenario, there is a larger mission that the Commander has to execute and I think one of the primary responsibilities of anybody providing medical care is to not hinder the execution of the larger mission. In this case, an intersection of two hard-packed dirt roads was carefully selected as a blocking position and the Rangers, after inserting by fast rope, were to move to a specific corner of that intersection and establish a blocking position. The corner was closer to the target than the rest of the intersection, and therefore the treatment of this particular patient would have been in the middle of the field of fire that the blocking force was supposed to set up. There was absolutely no time to render care at the location of the fall, even though the entire scene was obscured by a dust brown-out from the helicopter rotor wash for a period of several seconds after the injury. The first guy on the scene had a primary responsibility to grab the casualty by the collar, web gear, or hair and to get him to the corner of the intersection where the Rangers had established their defensive position before giving any real care. Whatever seconds are lost in doing that is the price that everyone has to pay in order to contribute to the execution of the larger mission.

CAPT Butler: Considering the difficulties that the convoys and helicopters had, should we be planning to use different evacuation assets in the next urban conflict?

CAPT Olson: This was a carefully planned evacuation given the assets that were available at the time. You can fast-rope in, but you cannot fast-rope out. It is easy to put people into an urban environment by helicopter but very difficult to remove them. The Little Birds that were able to land in selected intersections

were really the exception. In this case, there was a convoy of Rangers at the ready as part of the mission plan to evacuate the hostile forces who were being captured, and everybody who went in by helicopter was coming out as part of that convoy. The responsibility, then, was to move this particular Ranger who was injured to the collection point for pick-up by vehicle. There was a lot of argument about whether or not the correct vehicles were used and whether or not they were positioned in the correct place as they waited for evacuation. In this particular case, a ground movement out of the target area was required and was planned for, and it was simply a matter of getting this Ranger to the collection point a block away.

LTC Holcomb: I am a general surgeon and take care of a number of trauma patients. There has been a lot of discussion about hypotensive resuscitation, levels of resuscitation, and resuscitation end points. The bottom line is, for the type of resuscitation combat medics will be doing in the field, there are lots of guesses and hunches but there is no definitive information available. I think it is pretty clear that you cannot apply hypotensive resuscitation to head injury patients with what we know right now, and I would like to re-emphasize that. If you leave him hypotensive, you are going to make whatever head injury he has a lot worse. I would like to invite discussion about that.

Dr. Champion: In fact, the mortality rate goes up from about 20 to 50 percent if you add hypotension to a head injury.

LTC Holcomb: There is information on hypotensive resuscitation for penetrating injuries, and I would practice that to some extent, but not for head injuries. We are constantly having to think about what can we do better next time or what device could we put in the hands of a medic to enable him to do a better job. I think that it would be very useful to develop something that would enable the medic to determine the urgency for evacuation. Prototype devices that do this exist in research environments, but they are not out in the field yet. These devices may assist in making diagnoses for disorders that occur in parts of the body that the corpsmen or medic cannot see, such as within the brain, chest, abdomen and pelvis.

CDR Lowe: When I was a civilian ER doctor, I always thought about witnessed cardiac arrest, but I never thought much about witnessed exsanguination. If someone goes into witnessed shock, and it is due to internal injuries, they are not going to do very well. Most of the people we see in shock have been delayed for the minutes to hours it took to get them to us. We should emphasize to our combat medical personnel that, if a casualty has suffered this type of a fall and quickly goes into profound shock, that casualty is probably not going to do very well, no matter what we do for him.

Dr. Champion: If you define shock as a blood pressure of less than 90, then the mortality of shock patients arriving in trauma centers in the United States is 50 percent, (1) and about 60 percent of those die within the first half hour.

LTC Anderson: My sense from looking at the literature is that there is a dearth of solid, outcome-based evidence on a lot of these points being discussed. Houswald produced an article that showed that there is no difference in spinal outcomes if you compare Malaysia, where they grab people and throw them in the back of a pickup truck to take them to the hospital, and places where they use a backboard with a Philadelphia collar. Rather than expose our medics to hostile fire to accomplish treatments of uncertain value, we should perform outcome-based research. I do not think that this can necessarily be done in a randomized, controlled study, but I think we can compare populations where things are done differently.

You should also pay attention to critical incident stress debriefing. If you have a medic who grabs a guy by the web gear, hauls him back to cover, and then the patient turns out to be quadraplegic afterwards, you have to make sure that the medic knows that he may not have caused that quadriplegia. In fact, the patient was likely to have been quadriplegic before he was hauled back, and the medic probably saved his life.

CAPT Butler: I think that your comment about outcome-based treatment is very important and I would like to add several additional points.

First, if we are going to ask one of our combat medics to undertake a medical treatment in the middle of a firefight, then we need to be as sure as possible that the benefit resulting from this treatment is going to be worth the risk to the medic and the other members of the team.

Second, the DOD is prohibited from performing or funding any human research that entails the use of people who have not signed an informed consent. So, as a result, the DOD cannot fund any studies on prehospital trauma. The FDA is not so constrained. Health and Human Services is not so constrained. Why is the DOD not able to fund the type of research that will provide the possibility of outcome-based decisions for our medics and corpsmen and PJs?

The third point concerns the question of using Hespan instead of Lactated Ringers. One bad thing about resuscitating somebody with a closed head injury who may also have concurrent hypovolemic shock with Lactated Ringer's, is that 80% of the Lactated Ringer's is not going to be in the intravascular space after an hour. It is going to be in the interstitial space, where it might possibly contribute to increased intracranial pressure. This provides at least a theoretical advantage for using Hespan in patients with concurrent closed head injuries and hypovolemia.

LTC Cloonan: The point was made that it may be appropriate to do a surgical airway on this particular patient, and I would like to address that. The American College of Surgeons took that approach for a long time in their ATLS course. You will recall that it was felt that, if there was a C-spine injury, then orotracheal intubation would put that patient at risk and their initial recommendation had been to go with the surgical airway. That changed based on a number of studies that showed that orotracheal intubation done with due concern for the potential for C-spine injury had a relatively low risk of converting an unstable injury into a cord injury. This, coupled with recognition of the risks inherent in doing an emergent surgical airway, was why the ACS went to their recommendation to go with orotracheal intubation. For the prehospital care scenario that we are talking about, it would be my recommendation that an attempt at orotracheal intubation, with due regard for the potential for C-spine injury, should be made.

MAJ White: We have the benefit of hindsight here, but I think that this casualty drove the train for a lot of what happened later in the conflict. I do not remember from reading the scenario whether the casualty was hypotensive or not. I submit that, if he was hypotensive from a fall with a closed-head injury of that severity, we need to give the medic permission to do nothing. The combination of an exsanguinating hypovolemia from a fall plus a significant head injury is going to be fatal. If he was not hypotensive, you still have to win the firefight first, get yourself to safety and move expeditiously. I would say to just use an ET tube and, if the guy continues to breathe on his own, great. Hespan can be used to support his blood pressure if it falls later, but if he is hypotensive and has massive head injury, we need do nothing at first.

LTC Hagmann: This issue of expectant patients has been brought up several times and although I certainly cannot disagree with Dr. White on any factual statistical basis, you have to remember that this is the first casualty. There is no way for the medic to know when treating this casualty that there are 15 hours of hell coming. He is the only US casualty in the entire group at this point. Here we have a mission where the Force Commander has prisoners and he is being asked to decide which is more important, the prisoners or a casualty who is very severely wounded and is probably not going to make it. The rule is that you should concentrate on force protection first. What actually happened in the scenario seems to be more in keeping with what we would all advocate if this were the only casualty without knowing that there are other casualties coming.

MAJ White: I think the line officers want us to make that call for them. If there were no neurosurgical support at the Combat Support Hospital that the casualty was going back to, then there is not much that can be done for him there. If there is any doubt, establish communications and say, "Hey, this is what I have" and ask the surgeons what they think.

CAPT Butler: Thanks for the comment and, just to re-emphasize the point, the primary information that the Commander needs from the medic in this scenario is

reasonably accurate information about the casualty's chances of survival and how those chances will be affected by evacuation delays.

If we are going to ask one of our combat medics to undertake a medical treatment in the middle of a firefight, then we need to be as sure as possible that the benefit resulting from this treatment is going to be worth the risk to the medic and the other members of the team.

CAPT Frank Butler

References:

1. Heckbert SR, Vedder NB, Hoffman W, et al: Outcome after hemorrhagic shock in trauma patients. J Trauma 1998; 45: 545-549

Scenario 2

First Helicopter Crash

Dr. Edward Otten

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Location 600 yards northeast of target building
- Helicopter laying on its side in an alley with cockpit jammed into a wall
- Rotor separated from wreckage
- No fire (flames) in the crashed helicopter
- Wingman providing fire support
- Two wounded crew members previously evacuated
- 15 man Combat Search and Rescue team fast-ropes in for rescue
- Taking fire from several directions
- Hole in nearby wall from the crash
- Pilot - Dead, crushed on impact, trapped in helicopter
- Co-pilot - Dead, 3 rounds in back, 1 in neck
- Ranger One - Facial fractures from crash
- Ranger Two - Blunt trauma to back from crash
- Crew Chief - Dazed and disoriented from crash, two fingers shot off during evacuation from helicopter
- CSAR Team Pararescueman One - Grazing GSW to face and arm
- CSAR Team Medic - Grazing GSW to hand

- CSAR Team Pararescueman Two - GSW to calf, unable to do patient care

Preliminary Comments:

The overview that we heard earlier is almost identical to an incident described in a book by Bernard Fall called "Street Without Joy" that took place about 40 years ago in a jungle in South Vietnam. A group was sent into the jungle and was ambushed. A relief column was sent but it too was ambushed and bogged down in a killing zone for a couple of days. The incident resulted in a lot of casualties and led to the eventual collapse of the French in Indochina. Unfortunately one thing that this and other incidents have shown us is that we learn very little from history. We keep making the same mistakes, not just in tactics, but also in the way that we respond to trauma and to medical emergencies.

As 2LT Mabry mentioned, the battle of Mogadishu resulted in the largest number of U.S. casualties in any fire fight since Vietnam. By the year 2025, 80 percent of the people in the world are going to be living in cities and there are going to be 60 cities in the world that have over 8 million people in them. The Marine Corps is spending a lot of time working on tactics in urban terrain, and I have a feeling that, in the future, we are going to spend a lot more time fighting in cities than over hedgerows and rice paddies. We have an enormous amount of combat experience gathered here today, but we need to make this experience available to others so that we do not keep making the same mistakes.

When I went to Vietnam in 1967, I was given a book called "Lessons Learned" to read, and it was supposed to teach me what to do. Unfortunately, it was not much use because it raised more questions than it answered and, of course, there was no one who could answer them for me. Here today, you have a great opportunity to ask questions, so that you can come away with a lot more information and knowledge about what to do in these kinds of medical situations.

I think a problem that we often run into is that, although we have the best technology in the world, as we saw during Desert Storm, technology is not always the answer to everything. Good tactics can often overcome inferior technology. We saw this in Vietnam where the most technologically advanced country in the world came up short against one of the least technologically advanced countries.

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CAPT Mel Otten

MANAGEMENT PLAN

Care Under Fire

1. Do not go to medical priorities until the tactical priorities are taken care of. If possible, return fire and get out of the killing zone. Get to cover and triage if the intensity of the fire decreases. If the intensity of the hostile fire is sustained, the primary responsibility is for everyone, including medical personnel, to return fire.
2. Casualties should administer self-aid or buddy care if the fire does not diminish. A casualty can put a tourniquet on his own leg if he has to.
3. The casualties with back and leg injuries may need to be dragged or carried.
4. The first triage priority is Ranger One, who was shot in the face. Make sure his airway is not compromised. If it is, it has to be cleared.
5. PJ One is shot in the face and hand with grazing wounds. If a grazing wound means he has an abrasion or a laceration or something like that, that should not be a problem as long as the airway is not compromised. Sometimes, however, a grazing wound from a high-velocity round can cause significant damage and lead to death, so the wounds have to be assessed. If the mandible has been blown away and there are airway problems, we have to get that under control. If the entire lower face or mandible is gone, you can pull the tongue forward. You can get an ET tube in the trachea pretty easily, but then someone is going to have to manage it, and that is very labor intensive.
6. The crew chief is disoriented and has to be led to cover. Take his weapon away if he is confused to the point that he cannot identify friend from foe. He has some fingers blown away, so the bleeding from his hand should be controlled.
7. The medic who has been injured needs to get to cover. If his hand is okay, he needs to return fire and then re-evaluate the patients.

8. Ranger Two has a back injury. Find out if he can move or not. Is he paralyzed from the waist down because he has a spinal fracture? Can he walk, crawl or be dragged?
9. Control bleeding for PJ 2.
10. Pilot - no treatment.
11. Co-pilot - no treatment.

Tactical Field Care

1. Constantly re-evaluate the casualties as their condition will change. I remember a soldier in Vietnam who was shot in the chest. I went over, put on a plastic bag and a field dressing, wrapped his poncho around him, laid him on his side and did everything by the book. However he started getting tachycardic, started sweating, and his respiratory rate increased. I did not know what was going on. One of the more senior medics ran over and ripped the bandage off and I heard a big gush of air. I had taken a sucking chest wound and converted it into a tension pneumothorax through my stupidity. I had never heard of a tension pneumothorax before. All I knew was how to treat a sucking chest wound, and that is what I did. The advice I got from the senior medic was "Keep an eye on the patient. If you see him getting worse, re-evaluate him. Start over from "ABC." That is what we all have to learn to do in combat.
2. We do not know if PJ No. 2 has a through-and-through injury or if bone is involved. Look at the wound. If you see only one wound, then it is usually not through and through. However, you can get a grazing wound that looks just like a single wound, but it is usually a lot larger than a single bullet wound. If he has fat globules coming out of the wound, then the bone has been involved. That's an easy way to identify a fracture without x-rays. You then have to make sure that the extremity is splinted. If he puts stress on the fracture fragments by trying to walk, he is going to cause more damage and probably more bleeding. Bleeding can usually be controlled with direct pressure, but if a larger vessel was hit by the round, he is going to need a proximal tourniquet.
3. Treat the back pain in Ranger Two. If this is a blunt injury, he may have a transverse process fracture and may be in severe pain, so give him some morphine and diazepam. Diazepam works much better than morphine for relieving muscle spasm and it does not cause as much respiratory depression. I probably would not give this guy morphine. We do not want him unconscious; we just want to stop his back spasms so he can walk and fire his weapon and do his job.

4. If the crew chief is disoriented from the head injury, you may need to observe him carefully so that he does not wander away or injure his own troops.

CASEVAC Care.

1. Helicopters are a great way to get people out, but the landing area has to be safe and there is not much treatment you can provide on a helicopter.
2. Attempting to contact and join the nearby ground units should be considered, although communication is difficult in urban terrain.
3. If you cannot call in your own vehicles, try to commandeer vehicles off the streets to transport your wounded.

If you cannot call in your own vehicles, try to commandeer vehicles off the streets to transport your wounded.

CAPT Mel Otten

Equipment Considerations

1. Before any mission, you should have an idea of what kind of supplies you might need in case you cannot get back out in a hurry. Ammo, water and fuel obviously are the three most important things. Other resupply items include batteries for your radios, medical supplies, and rations.
2. Consider taking eye protection to guard against flying debris.
3. A poncho is a great way to carry people around.
4. In an urban environment, there should be all kinds of material around that can be commandeered, such as vehicles or even weapons and ammo.

Additional Considerations

1. Getting to cover is extremely important. These guys were smart to pull out the floor plates from the helicopter and build themselves a bunker. The cover available in an urban environment is usually much better than in open terrain. You can build up rubble and make yourself a place to fight from..
2. One of the important things that must be learned is that medical people are also combatants and they have to be able to fight. When I was a Commanding Officer of a Marine support unit I made my nurses, corpsmen

and doctors all qualify with all their weapons and take hand-to-hand combat even though they said, "What do we need this for?" I said, "You have to learn how to fight because you have to be able to defend yourself and your patient. In an emergency, you are all combatants."

3. It is difficult sometimes to remember that this is not a hospital and it is not civilian life. This is combat, where you have to conserve the fighting strength of the unit. The mission comes first. It is hard for medical people to do that, because the serious things always attract your eye. This is where training comes in. Instinct tells you to go to the worst guy and take care of him. Training tells you what your mission is. In a combat situation, you are going to have minimal personnel, equipment, and supplies with which to care for the casualties. The goal of triage is to do the most good for the most casualties. There are essentially three categories in triage. Those who are going to die no matter what you do; those who are going to live no matter what you do; and those who are going to live only if you do something and do it right now. The first two groups you can leave alone at first, even though it is a hard thing to do. If you have a guy with his legs blown off, and a head injury, and he is gurgling in his own vomit, you may think "I have got to take care of this guy right now or he is going to die". Well, you are absolutely right, he is going to die. If you have somebody else with a gunshot wound to the upper arm, and who is bleeding out, if you do not stop that bleeding, that soldier is going to die. If you do stop the bleeding, he might not die. He is the person who has to get priority care, since he is the one who is going to live only if you do something, and do it now.

There are essentially three categories in triage. Those who are going to die no matter what you do; those who are going to live no matter what you do; and those who are going to live only if you do something and do it right now.

CAPT Mel Otten

4. Combat medic rules. On my first day in Vietnam, a sergeant took me aside and said, "Forget what you learned in medic school. I am going to tell you what you need to survive over here. The first rule is never to go into a zeroed-in position." The corollary to this obviously is to get out of the zeroed-in position and to get your casualty out also. If somebody just got shot by a sniper, and you go over there and try to grab him and drag him to cover, you are going to get shot by the sniper, too. If the casualty is conscious, get him to crawl to cover.
5. Rule two is: "Always disarm the patient if there is any doubt about his ability to use his weapon effectively." Disarm patients who are in shock, who are hypoxic, who have a head injury or who have just gotten morphine. If someone has been shot in the leg and has a tourniquet on it and the bleeding

is controlled, then he can still be an asset to his unit and help to return fire or operate a radio.

6. Attempting to resuscitate a patient in cardiac arrest from blunt trauma is futile even in the best of circumstances. Do not even think about doing CPR. This may be difficult to face, since this is your buddy that you were talking to 2 minutes ago. That is the worst thing about combat. You cannot train for that. You can train to keep going in the face of adversity, but you cannot train to see your buddies get hurt or killed.
7. Everyone in the military should learn First Aid to be able to care for their buddy or themselves, since the medic may be the first one to get shot. When I was a medic, they used to give us little aid bags to carry around. It did not take long for the Viet Cong to figure out who the medic was. Put the medical equipment in something that is not so conspicuous.
8. People who have traumatic amputations from explosions, mines or booby traps often have bleeding. However, as a result of retraction and contraction of blood vessels, the bleeding is usually minimal and endorphins kick in. I have had casualties with one or both feet blown off who did not even realize they were injured. They kept trying to walk and could not understand why they could not. In the heat of battle, a casualty may not even realize he has been shot.
9. There are lots of ways to move people, including on a poncho, on a poncho liner, or by grabbing them by their web gear, but these techniques need to be practiced.
10. It is very difficult to carry casualties over rough terrain. You need six people to carry someone any distance and they wear down fairly rapidly, which then reduces their ability to fight. So, if you can get any form of mechanized transport, use it.

Forget what you learned in medic school.... The first rule is never to go into a zeroed-in position.

CAPT Mel Otten

11. Fire support in urban terrain. Direct fire weapons are much more reliable for putting rounds on target than indirect fire weapons and you waste less ammo. The new Predator and Javelin shoulder-fired high-explosive rockets can be used against air targets, bunkers, armor, and buildings. The way to clear an objective is to fire one of these weapons in there and the objective will be cleared without a lot of collateral damage. We always have to consider collateral damage in an urban area. Artillery can help to clear a city, but there is usually not much left of it when you get there. What is left are the bad guys

in bunkered-in positions that the artillery did not touch, and you still have to fight from room to room and street to street.

12. Be aware of a problem with backblast inside buildings, especially with the older LAWs (Light Anti-tank Weapon) and other shoulder-fired rockets. The new Predators and Javelins are supposed to have less backblast so that you can use them in a building. The last thing you want to do is fire your LAW inside a building at a vehicle going down the street and end up bringing the whole building down on top of your head.

Always disarm the patient if there is any doubt about his ability to use his weapon effectively. Disarm patients who are in shock, who are hypoxic, who have a head injury or who have just gotten morphine.

CAPT Mel Otten

DISCUSSION

CAPT BUTLER: Thank you, Doctor Otten. Let's move on to our next scenario since it also involves a helicopter crash and then we can discuss both scenarios together.

Scenario 3

Second Helicopter Crash

Dr. Craig Llewellyn MD, MPH, COL, MC, USA (Retired)

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Assault team, perimeter security team, and prisoners to be picked up by a 12-vehicle ground convoy
- Blackhawk flying air cover for raid shot down by RPG round
- Second Blackhawk flying support over crash site
- Hit in tail rotor by RPG round
- Rotor comes apart - rapid spin to right - flat crash
- Crash site one mile away from the first crash
- No search and rescue team available
- Somali crowd moving into site
- Two additional Rangers inserted to help
- Pilot - Open right femur fracture, transient loss of consciousness, back pain
- Co-pilot - Left tibia fracture, back pain, pinned in his seat
- Crew Member One - Blood all over trousers, talking but confused
- Crew Member Two - "Severely injured"

Preliminary Comments:

This conference today is a logical outgrowth of a movement to focus on scenario-based care that has now been going on for about 10 years. When Captain Butler first talked to me about the project that led to the paper that he and Dr. Hagmann and Ensign George Butler published, I emphasized that a tactical scenario has to be stated in such a way that it forces people to speak about a specific set of circumstances. Otherwise you are going to have people saying, "In my ER" or "In my trauma center, we do this."

Now, this is not the end of the process. The process has to continue with input from the audience. There may, however, be difficulty in doing that because of the expectations that people bring with them. What I mean by that is that you may come to this forum expecting that the panel is going to tell you how it is and how it should be for the future. Those of you in the room who are combat medics, however, are viewed by the National Registry of EMTs, and by a variety of other groups, as the best-trained medics in the country, and perhaps in the world. That puts an enormous responsibility on you for continuous professional growth and means that you have to read things and discuss them in order to try to figure out what you think the data mean. Do not just let us pontificate to you about it. Your

input has been missing from many arenas, and I hope we can extend and expand what LTC Cloonan has begun at JSOMTC where the Mogadishu raid is now a part of the curriculum.

We ran a similar exercise to this during the conference on Military Medicine at the Maryland Shock Trauma Center entitled "Surgery for Victims of Conflict". We benefited enormously from interaction with our colleagues in the UK who described their Special Forces Trauma Course. I hope that some of them are going to raise issues and ask questions today, because not everything they will hear today fits in with the way they do business at the present time.

One thing to remember is that, in this kind of scenario, there is no point carping about whether or not you know enough about the patients because, if you are the medic on the ground, this is the kind of situation you have to deal with. You often do not have all the information you think you need. It is not a bad way to exercise, so that you do not expect that you are going to have access to full information.

What I am going to try to do is paint a picture of what it might have looked like to the two rescuers in this scenario. As far as I know, I do not have a medic on the ground there to think about. I have two Rangers who came in after a helicopter crashed. The other thing that might be of some interest to the guys who are being inserted is that this helicopter crashed a mile from where all the rest of the action is going down. So, there is no intelligence about what is happening on the ground. Are there armed people in the area? We know that there is a crowd moving into the site. We know that there is no search and rescue team available, but other than that, we do not know anything.

The next thing we are presented with is that it would be very difficult for the people arriving on the ground to determine in a short period of time who is alive and who is not and what, in fact, has happened to them. Now, what I would like to do is comment briefly on one approach to this, which might be called the ATLS approach.

You would immediately think in terms of A, B, C, D and E (airway, breathing, circulation, disability, and exposure). The casualty with the open femur fracture would probably get some attention early on, particularly if I was told that there is also life-threatening hemorrhage associated with that open fracture. The other individual that would probably get a fair amount of attention is Crew Member Two, the "severely injured" casualty. What do you see when you approach this severely injured person? Multiple holes in a vest and an unconscious person and no gross hemorrhage observable? So, you do not know if the holes have gone all the way through and, of course, you are not going to take the vest off at this point to check that out. You do not know if he is unconscious because of the penetrating wound or because of the helicopter crash, and it is irrelevant at this point. If we were doing this from an ATLS standpoint, then we would be thinking

about bleeding control and getting the traction splint on for the first casualty. In the secondary survey, we would try to determine what his mental status was, including a Glasgow coma score, which would be inappropriate in this kind of setting at this time.

A comment on the guy pinned in his seat. I do not know how many of you are also EMTs and practice extractions from vehicles. In civilian trauma extractions, you can usually count on people showing up who have the Jaws of Life or something to haul, move or tear vehicles apart. That is probably not going to happen in this kind of setting, and what would be extraordinarily important is for you to have some idea of what the crew compartment looks like, so that you might have some idea of what could hang this guy up. Now, clearly, if the whole roof has collapsed on him, and that is why he is pinned in his seat, that is a little bit different than the more common reasons that people are trapped in their seats, such as when they get hung up on harnesses. Their feet could also get tangled in pedals and a number of things of that type. Try to draw some parallels between what you might be thinking of if you were trying to apply EMS, ATLS and PHTLS in the streets of the US, as opposed to the setting in this scenario.

My point here is that before Care Under Fire begins, remember that you have a two-person rescue unit that came in. Even if there is a medic with them, the first thing is to assess the tactical situation. Is there hostile fire or a potential source of it? Is cover available near where the helicopter went down? You have to assume that since it rotated in, that there is at least a cleared space that was large enough for the helicopter to settle down into. Is there any kind of fire or explosion hazard? From what I have been able to learn, the principal explosion hazard would probably be the self-sealing fuel cells, but there may also be munitions and explosives on board. The helicopter would be unlikely to blow up like you see in the movies unless ammunition or other explosives that were inside happened to be hit, but those are all things to consider. You need to consider them even more strongly if there is fire and smoke coming out of the helicopter.

Another thing about the tactical situation is that you should approach the helicopter with care because a smart enemy would leave somebody alive inside who could make noise and call for help in the hope of luring more rescuers into the area. The quick thing to do while you are still outside this helicopter and before any care is rendered would be to see who can respond verbally and whether or not their verbal response is appropriate. Somebody in there might be able to tell you how many people were on the helicopter and where they are at the present time. You know that when you have a large casualty situation, you first ask all those people who are ambulatory to "come to me" so that you can sort out quickly who the people are that need immediate care. Casualties who can walk may be able help themselves or other casualties. Your main concerns at this point have to be surveillance of the area, being prepared to return fire and then finding out if anybody has appropriate arms to help with defense of the area while you try to do more for the casualties. Another important consideration in the

two-man Ranger team that came in is which of the two is in charge and will be making the decisions about where you go.

All of the above factors have to be considered and dealt with before you get to Care Under Fire.

MANAGEMENT PLAN

Care Under Fire

1. The priority is to return fire and to ensure personnel are as safe as possible. ATLS "ABC's" are inappropriate when you are under fire.

Tactical Field Care

1. For Tactical Field Care, keep in mind that you do not want to get involved in providing extensive medical care because you may revert back to the Care Under Fire stage in a very short period of time.
2. If there were no incoming fire or imminent danger, then I would consider checking the airway, breathing, and circulation early on.
3. There is no mention in the scenario of how much the Pilot is bleeding from his open femur fracture. I will assume that he has a life-threatening hemorrhage. A tourniquet or direct pressure should be applied immediately, but here the bleeding point is not one where you can get a tourniquet on. The question, then, is how effective would direct pressure be while you are trying to move this casualty? Unfortunately the answer is - not very effective, so do not agonize over that. Do not think about splinting or traction or anything like that until you are extricated and under cover.
4. The main thing with the Co-pilot is to try to figure out a way to extricate him in a relatively short period of time. Maybe one person could crawl underneath to see if he has a foot or leg caught. Check his harnesses to see if he could be freed by just cutting those. At this point he is just saying that his leg hurts, so you have to figure that he might be ambulatory. He probably is not going to run, but unless he has a severe malrotation or something of that sort, he can probably move himself.
5. The Crew Member One has bloody pants. You don't know where the blood came from. It could have come from the Pilot who had the hemorrhage. It could have come from the other crew member who is unconscious and who has multiple penetrating wounds. What about his chest and abdomen? You cannot tell yet because you haven't taken his vest off.

6. The first crew member is confused. Anyone who has an altered mental status should be disarmed, and that may not be an easy thing to do. It does not matter if the mental status is altered because of stress in the aftermath of surviving the accident, because of having blood all over him, because of a head injury or because of something that you do for him such as giving him morphine. You cannot trust this individual to behave in a responsible way with a firearm even if you have known him for a long period of time. What criteria should be used in deciding which of the wounded should be allowed to continue to return fire and which should be disarmed? Disarm anyone that you are uncertain about until you can assess their ability to help you defend your position
7. Someone has to make a tactical decision at this point about whether to leave the helicopter for other cover or to remain near it and try to utilize its armor for defensive purposes.
8. At this point, you can probably assume that the airways of the Pilot, Co-pilot and Crew Member Number One, are all okay since they are able to talk.
9. If there is a casualty who is not responsive to verbal stimuli, see if he responds to pain.
10. Crew Member Number Two is described as "severely injured." I will assume that he is unconscious and has snoring respirations. Position him appropriately and consider placing at least a nasopharyngeal airway because of the sonorous respirations. Assume further that respirations are 32, shallow and irregular. Since this casualty is unconscious, consider the possibility that he has a closed-head injury. We should try to make sure that whatever oxygen he is able to move is being distributed to his brain. I would consider the possibility of a tension pneumothorax in light of the respiratory distress and do a needle thoracostomy on the appropriate side in the second intercostal space anteriorly if his clinical state indicates.
11. Circulation. The pilot has hemorrhage from his thigh wound. It can be now controlled by direct pressure. Assume that his heart rate is 138 and the radial pulse is weak. At this point, he is still alert and oriented, but he has had transient loss of consciousness. We do not know for how long. We do not know if he is now in a lucid interval with a subdural hematoma developing. Hespan might do some good if this were the case. It might increase perfusion pressure to the brain and, at the same time, pull some fluid back in from the interstitial space, although this is debatable. Also, with an open femur fracture, you have to do something for this soldier's pain.
12. Crew Member Number Two has no visible bleeding. He does have a rapid pulse, but his radial pulse is palpable bilaterally. At the moment, it is probably okay not to do anything other than perhaps establish IV access, because if he

wakes up and becomes combative, you may need to be able to give him something to control him again.

13. Next consider things like "Does the pilot need a traction splint for his femoral fracture?" I have never been taught how to improvise a traction splint. I have heard people describe doing it under a variety of conditions, and I do not doubt that it can be done. My guess is that, without a lot of practice, it is unreasonable to expect that medics or rescuers are going to be able to do this very well in this scenario. Consequently, the fact that you are in an urban environment, where there may be pieces of board and so forth around, does not necessarily mean that you are any better off. I am not proposing that traction splints should be issued or carried. The chances are very good that the best you are going to be able to do under these conditions is to use the other leg to stabilize the broken one and to try to get some traction on it by pulling to provide a certain amount of relief.
14. For the Co-pilot, there are a variety of ways that you can improvise a splint for a tibial fracture. You could even use the flight manuals from the cabin. The reasons to splint the tibial fracture are that you may increase his mobility and probably also decrease his pain. Be sure, if you ever have to straighten a tibial fracture, that you turn the leg back the way it broke and not all the rest of the way around.
15. Crew Member Number One has blood all over the front of his pants and we still do not know where it came from. He needs to be calmed down and his mental status assessed to make sure that he did not also have a transient loss of consciousness due to a closed head injury.
16. Try to get oral fluids into the people who can take them. Assume that they were dehydrated when this event occurred. Assume, also, that fluids mean you are doing something for them, and they think that you are doing something for them.
17. With respect to freeing the trapped casualty, you could try to use an improvised lever, but you are probably not going to be carrying shears or saws.
18. Should care be rendered prior to moving casualties who are trapped in the aircraft to whatever cover is available? The only thing to do, if it could be done without reducing your ability to move them and with covering fire, is to apply direct pressure on a potentially life-threatening hemorrhage. If you use direct pressure, however, how are you going to maintain it when you move them? If the bleeding site is not amenable to a tourniquet, move the casualty to cover as quickly as possible and then use direct pressure.

CASEVAC Care.

1. Helicopter CASEVAC may not be feasible in this kind of urban warfare scenario.
2. Based on the Israeli experience, the only way that you are going to extricate a force that is pinned down in this type of urban environment is with armor. There are tanks that have been specially designed for casualty evacuation, like the Israeli Merkava, where the back opens up so you can load the wounded soldiers, and they need to be available for future urban engagements.

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COL Craig Llewellyn

Equipment Considerations

1. An event such as this crash does suggest that every helicopter ought to be equipped with gear that would allow you to extricate the crew if they become trapped in the wreckage.
2. There are lots of good ways to move casualties using field-expedient devices. I'll bet that none of the Rangers had a poncho with them. You don't have to have ponchos; you could have something smaller. We used to cut the tops off of jungle hammocks. They roll up rather small and can be used for a variety of purposes, such as wrapping around a casualty and hoisting him up to a helicopter. Some people might say that if the casualty is really badly injured, such as the casualty who had his pelvis crushed, that you should not do that. One of the advantages to doing this, however, is that you would get him off the mind of the Ground Commander. The helicopter does not have to be there for very long to accomplish this.
3. Another thing that was done in Vietnam was to hook people into an extraction rope that was then pulled slowly up into the helicopter, or alternatively, allowed them to be extracted just hanging on the rope.

Additional Considerations

1. Never, never underestimate what the "bad guys" can do to you. I would suggest that the mere fact that at least seven operations had been successfully conducted using the same tactics before this incident occurred had to make people somewhat sanguine about their ability to do this without great risk. Since this incident, it has been established that the events in Mogadishu were not being made up as they went along. The militia had, in

fact, been coached over a period of months by people that Osama bin Laden's group had brought in from Afghanistan.

2. This is asymmetrical conflict. You have to be a fool to fight fair in any situation like this, and you have to be a fool to expect that the other guys are going to fight fair.
3. In the planning process for this mission, some consideration might have been given to what to do in the event of the force became pinned down. You should be aware of rallying points that you can head for. That is what the Israelis used in Southern Lebanon during urban combat back in 1982. They had small surgical teams that were attached to battalions and actually were moved down to the company level in a number of places. Their forward surgical teams were pushed to rallying points within the operating area, since they realized how difficult it is to evacuate people any distance in an urban terrain.
4. Remember that not all urban environments are the same in the same way that not all jungles are the same and not all deserts are the same. You have to be prepared to adapt to the environment you find yourself in.
5. Are there defensive techniques that could be used when extracting injured people? Of course, but is this a medical question? No, it is not. This is a tactical call, but it should be practiced in such a way that combat medical personnel are going to be comfortable and knowledgeable about what might be done. In Vietnam, even the surgeon had grenades, and part of his job was, when directed, to pull pins and drop them behind as they were running like hell and being chased. The point is that you cannot separate what you are going to do medically under these conditions from what tactical doctrine, standard operating procedures and battle drills dictate. One of the hardest things, in my experience, is to get Special Ops or civilian SWAT teams to practice disengagement and man-down drills and things of that type in a realistic way. In Vietnam, because of the kinds of operations we were running, it was standard operating procedure for people to carry a 30-foot length of static line with snap links on either end hooked into your gear. It could be thrown out to another person in the team who was down for whatever reason and who was being covered by fire in such a way that the best chance you had for extricating him was to get some cord out and haul him back in. These are the types of things that you have to be thinking about in advance.
6. If you are going to be doing air operations, you also need to familiarize yourself with what breaks the easiest in the aircraft, and also with things like how to release and unpin seats in case you have to extract people.

An event such as this crash does suggest that every helicopter ought to be equipped with gear that would allow you to extricate the crew if they become trapped in the wreckage.

COL Craig Llewellyn

DISCUSSION

Dr. Hull: With reference to femoral fractures, I think you made a number of very valid points. With blunt injuries, it is exceedingly rare to have significant damage to the femoral artery. If you do, and you have an open fracture with the femoral artery spurting out of the wound, then I think the chances of survival in that situation are very low. Direct pressure there is probably not going to be effective, but the vast majority of femoral fractures are associated with muscle injury and bleeding from the bone ends. In that situation, the ideal is to get them out to length and get traction on. If this is not possible, just strapping the legs together will be effective in many cases, and it will certainly slow the bleeding down to the point where you can replace fluid rapidly enough to keep up with blood loss. UK forces happen to deploy with traction splints, but it is not always possible to do that, and if you cannot, I think simply strapping the legs together is very reasonable and effective in the majority of cases.

Cpt Mosley: I want to talk about CASEVAC and the urban environment, because one of the things we have been working on in the 160th is using the MH-6 Little Bird aircraft as a CASEVAC platform. We strap collapsible Stokes litters in the back of the helicopter and they are taken out by the pilot in a CASEVAC scenario.

CAPT Butler: We said that we were not going to talk about the care that was actually rendered in the scenarios, but we should talk about the outcome of Scenario Three, which was that the crash site was overrun and everyone was killed, except the pilot, who was taken captive. In the urban environment, the medical plan has to address how you buy yourself enough time to deal with casualties in potential overrun situations. I would be interested to hear Captain Olson's comments about area denial techniques so that we may be able to find ways to help prevent repeats of this scenario in the future.

CAPT Olson: This situation was extremely desperate. What has been described as the 15-man CSAR team for this operation had already been inserted at the first helicopter crash site. There was no way to put assistance directly onto this crash site. After the insertion, the fast-ropes were released to the ground and there were no other fast-ropes in this helicopter that could be used by anyone else. Therefore, the helicopter with the two Rangers who requested to be inserted at the crash site had to find a location where they could come close enough to the ground so that the Rangers could jump out to render assistance.

The environment there was a shanty town. This was a central part of Mogadishu that over time had been invaded by squatters and built up with temporary shelters. Consequently, rotor wash was blowing the roofs off buildings. There were no streets, alleyways or sidewalks - just a jumbled maze of temporary structures. The helicopter crashed into the middle of this maze. The two Rangers were inserted between 100 and 150 meters away. The fire fight was already in

progress, and they had to fight their way into the crash site. There was no good way to put other people in on top of them and there was no good way to get people out because of the environment. The only realistic way to CASEVAC in this situation would have been to move back to the same area into which the Rangers had been inserted 100 to 150 meters away and to try to bring a helicopter in skids down or close enough to throw the guys into it - the old Vietnam kind of MEDEVAC concept.

In the urban environment, the medical plan has to address how you buy yourself enough time to deal with casualties in potential overrun situations.

CAPT Frank Butler

In the meantime, they were surrounded by all sorts of fire. It was coming from every direction. There was no place to move to. The best place to be was in the protection of the armored helicopter, using the helicopter-mounted weapons and the armor that was available for protection.

In terms of rendering assistance - it was tough. The first rescue convoy that was briefed earlier was designated to go to that location, but it got turned around at K4 Circle and had its own casualties. Other convoys that were sent out were stopped at every intersection and received fire and finally had to turn back to the airfield. There was probably an hour where there was no good knowledge of what was happening at this site. The RPG threat was real. In fact, this was now the fourth helicopter that had been hit by an RPG. One had been hit the day before and then three this day. So, the helicopters could not go hovering low over a site to try to find out what was going on. This was also not an environment in which you would bring a Little Bird in to insert troops, because then you would have two helicopters down at that site, not one. The only real means of rendering assistance would have been to fast rope in large numbers of people, who were not available, or to render some sort of ground support, which was attempted but failed.

There were more non-ambulatory than ambulatory wounded, and they just could not get the numbers in to get those people out to the safe site. So, I do not have a good answer for you about what should have been done. I think that there was a lot of controversy and a lot of discussion later about the value of AC-130 gun ships across this whole scenario. My own opinion is that, at the first crash site, an AC-130 would have been ineffective because of the density of helicopters at the site and the inability to fire through helicopters at ground targets. At the second crash site, however, an AC-130 may have been useful in defining a perimeter around that crash site and keeping the Somalis out of it.

In terms of other area denial methods, I think that smoke would have been useful, and it would have reduced the precision of the Somali fire. I am not sure that it was all that precise to begin with, but there were certainly large volumes of

it, and some of that would have been misdirected had the site been obscured by smoke. That would have been a holding tactic while waiting for nightfall and the massing of the larger rescue force to get to the scene. In that case, it would have required denial for a period of 6 or 7 hours in order to protect a very small force on the scene. So, I do not have an answer. I would like to know what one is.

Let me say something about the development of an armored ambulance for urban warfare and whether or not that is useful. Ultimately, it was the tanks and the Malaysian APCs that got out and brought most of the casualties back. At the second crash site, a rapidly responsive armored ambulance force with good protective cover and escort might have been useful, but I think the situation there was really resolved in the first 20 minutes, and that was probably not enough time to get a ground force to the scene.

At the second crash site, however, an AC-130 may have been useful in defining a perimeter around that crash site and keeping the Somalis out of it.

CAPT Eric Olson

Scenario 4

RPG Explosion in Vehicle

Dr. Howard R. Champion, FRCS (Edin.), FACS

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Assault team, perimeter security team, and prisoners to be picked up by 12-vehicle ground convoy
- Blackhawk flying air cover for raid shot down by RPG round
- Ground convoy searching for first crash site to assist
- Prisoners loaded and under guard
- Not enough room on trucks - troops running alongside
- Rangers sitting in crowded Humvee
- "Raining RPGs" - one hits Humvee - dense black smoke
- 3 Rangers blown out of back of vehicle
- Ranger One - GSW to thighs of both legs previously/ RPG blew off the back half of his left thigh/Tumbled about 10 yards/Legs were a "mass of blood and gore"/Stood up and tried to walk/Run over by "friendly" 5-ton truck
- Ranger Two - Shrapnel to left forearm/Fractured bone/Severed tendon/Fractured hand/ Wasn't bleeding much/ Could still shoot
- Ranger Three - Left arm bloody/Boots on fire
- Ranger Four - Blood rapidly staining his trousers/Kept shooting/Difficulty breathing
- Ranger Five - "Practically torn in half"/Grenade passed through his lower body/Pelvis largely missing/Alert and "very much alive"

Preliminary Comments:

At the outset, let me say that this is not a simple scenario. I hope that the complete lack of controversy emanating from the audience will not persist because some of these issues we are discussing are quite controversial. In this scenario, there are five casualties but there is a big disparity between the least injured and the most severely injured.

In preparing this scenario, I was asked to consider certain questions. Did everybody need an IV? The answer is no. Which casualties need emergent IV fluid resuscitation? And if you undertake fluid resuscitation with Lactated Ringer's, how much should be administered? The relevance of Ringer's Lactate to the treatment of severe exsanguinating hemorrhagic shock certainly needs to be restudied.

What is the maximum amount of IV morphine that we can give these casualties? I noticed that COL Llewellyn mentioned that he was going to disarm everybody in his scenario and that he did not like people to be handling their weapons after receiving morphine. I am going to disagree with him on that, particularly in this sort of environment. I would like to hear some debate about that and about how much morphine we should give these casualties.

Considering the absence of penetrating trauma in the casualty who is short of breath, we want to consider the possibility of barotrauma. Is this likely in this environment, and if yes, so what? Assuming a delay of 12 hours prior to surgical care of these casualties, how would IV antibiotics be expected to affect the outcome? You heard earlier from Norman McSwain that they should get antibiotics. We do not know quite how that is going to affect the outcome, but certainly under these circumstances, if you can get around to giving antibiotics, it is probably a good thing. Whether outcome studies have been done or not to document it in this sort of environment, I do not really know.

Then there is this issue of non-survivable injuries such as the Ranger with half of the body blown away, but still talking. Put yourself in the place of a 20 year-old who is watching someone die while he is talking to him. How do you handle this and how do you prioritize the management of that individual versus the care of the other casualties?

Assume that Ranger One had a potentially life-threatening hemorrhage in his distal thigh and that a tourniquet was applied. How long could the tourniquet be left in place? Are you going to save his life but lose his limb? With respect to the thigh wound, if it is pulsating red blood, then that is arterial bleeding. If the mean arterial pressure is above 70 mmHg, the bleeding is usually going to continue despite a pressure bandage. You therefore need to keep direct pressure on it or use a tourniquet. If it is venous bleeding, a good pressure bandage may well stop it. If you were going to be there for 12 hours, it would be nice to try to salvage the limb. If you have a tourniquet applied constantly to the femoral artery for that amount of time, you are going to lose everything distal to it. It would be nice to be

a little bit more surgically precise about the site of bleeding. If you can apply pressure or a clamp (assuming that you can see the point of bleeding), then I would recommend doing those things. If you cannot do that, then you have to put the tourniquet back on. You may have to save the guy's life at the expense of the lower limb, and he will probably thank you for that.

MANAGEMENT PLAN

Care Under Fire

1. Ranger One needs help. He has bilateral gunshot wounds to his thighs. We envision a big chunk of the posterior thigh scalloped out with a raw bleeding wound as a result of his injury.
2. Ranger Two is okay for now. He is the guy with the shrapnel wound to the left forearm. He has a broken bone, but he's not going to die from it. He has some bleeding around the tendon, but he is okay. That can be managed with a dressing.
3. For Ranger Three, with his boots on fire, the question is what is causing the fire. Is it gasoline from the Humvee or is it some phosphorous-based agent? The treatment of those is somewhat different. I imagine that this probably would not be a phosphorous-based agent. You should be able to get a fire extinguisher to cover the flames and put this out. Taking the boots off would be a reasonable thing to do, and you should not end up with burned feet if you did that quickly enough. He could probably do that himself.
4. Ranger Four could be in trouble and needs some assistance. He is short of breath, but with no penetrating injury to the chest. He is still shooting, but he has a rapidly developing blood stain on his trousers, the source of which we do not yet know.
5. Ranger Five was described as being practically torn in half by a grenade that passed through his lower body, although he is alert and very much alive. Now, if that is true, then he probably merits expectant care, and priority attention should be given to the other wounded. However, you need to verify that this casualty has half of his pelvis missing, that he is bleeding, and that he is going to die. If this is so, then the best thing to do is comfort him, give him morphine and get somebody to be with him. It is a very difficult to confront, especially when casualty is still chatting to you, but he is going to die under these circumstances.
6. So the priorities here are to go to Rangers One and Four and to control their hemorrhages.

7. Everybody is talking to you, so everybody has an open airway, although we have some concern about Ranger Four because he is a bit breathless, and we might need to consider that he has a blast overpressure injury to his lungs.
8. Get someone to help Ranger Three with the hand injury.

Tactical Field Care

1. Try to exchange Ranger One's tourniquet, if one has been applied, for a pressure dressing. This is where John Holcomb's fibrin impregnated bandage would be wonderful. If we can get that out into the field, this is the place for a fibrin-impregnated bandage, big raw wounds. It would be a significant advance in hemorrhage control, probably the most significant advance in the past 80 years.
2. Morphine for Ranger Five. He is the gentleman we might be treating expectantly and you may have to give up to 25 to 30 milligrams. I know the usual dose is only 5 milligrams. Again, I have been interpreting this a bit; "practically torn in half" needs to be verified. In this tactical environment, if you have a large gaping wound and useless legs, a pulse greater than 150, and feces in the wound, these would be the sorts of things that would make me think that this casualty is not going to survive. He can keep talking until his systolic blood pressure goes down to the region of 50 to 60. Put an IV up on him, so you can give him lots of morphine on a continuous basis. Other people might think differently.
3. Ranger Four needs continued pressure control of the hemorrhage, if you can find out where it is. Presumably, if the blood is on his trousers, it is coming from somewhere underneath them. Lie him down on a stretcher if you have one. Observe for respiratory distress. I am a bit confused about respiratory distress under these circumstances. If he has real respiratory distress, that is not good. If he has a blast injury to his lungs, it is certainly not advisable to give him lots of Ringer's Lactate.
4. Ranger Two, the arm injury, needs dressings and splints, but no IV and no morphine unless he complains of pain. Give him antibiotics if you can get around to it. Let him keep his weapon.
5. Ranger Three - the arm needs dressings and a splint but no IV and no morphine. He may be able to walk if he can move in those boots that were burnt. Let him keep his weapon. Sit Rangers Two and Three in the back of the transport when you are able to move out.
6. Ranger One has the potential to be a catastrophe. There is a little bit of leeway in interpreting this scenario. I do not know exactly what happened to

him, but he stood up after getting gunshot wounds in his legs. Although it is quite possible to stand up with fractures, particularly some that are not severely displaced, it is more likely that most of his injuries were in the soft tissue. Then a 5-ton truck comes barreling down and does something to him. If it runs over his head, chest, abdomen or pelvis, he is probably going to die. If it runs over his legs, he probably has fractured femurs. Let us assume that they are compound comminuted, and he may or may not have an associated pelvic fracture. Notwithstanding that, his hemorrhage has gone from being fairly minor and visible to possibly very significant and not visible. His probability of survival beyond the period of 6 hours is decreasing. He needs an IV started and he needs to be monitored closely.

7. Assessment of Ranger Four, the one with bleeding under his trousers: he has a shrapnel wound to his groin, his pulse is rapid, and the location is too high for a tourniquet. He may be able to apply direct pressure himself and stop the bleeding. It is a very good sign that he is not in shock if he can keep pressure on there. If he cannot keep the pressure on, somebody can help him. Perhaps one of the other wounded individuals can keep pressure on with his uninjured arm to make sure that he does not exsanguinate. There is very little you can do to quell the bleeding in this location other than to apply pressure. As the location is too high for a tourniquet, this brings us to the question of the use of MAST trousers. You heard what Norman McSwain said this morning. I happen to agree with him. John Holcomb tells me that they are developing the pelvic component of the shock trousers, so you could wrap those around the pelvis and put a big wad of dressing underneath and put direct pressure on a pelvic or groin wound like that. That might be helpful, but he still needs to be observed.
8. Ranger Four also has labored breathing. That can be brought on by severe shock or is he just scared? I would be. Is it barotrauma? It may be, but so what? What are you going to do about it? Is it a shrapnel embolus? All sorts of things can go through your mind if you have time to think. I am not sure what I would be able to do for barotrauma under these circumstances, given the fact that it takes time to appear and it requires very specific treatment which is probably not available.

CASEVAC Care.

1. Not applicable

Equipment Considerations

1. Not applicable

Most individuals with wounds do not need IV fluids. Only 5 to 7 percent of those injured in Vietnam had abnormal vital signs....If the pulse is less than

120 and the casualty is still talking to you, then generally speaking, he does not need emergent IV fluids.

Dr. Howard Champion

Additional Considerations

1. IV morphine. If you are in this environment I think every bit of firepower is helpful. Three to 5 milligrams of IV morphine takes effect very, very quickly. If the casualty then says, "My pain is better; I feel okay," I would give him his weapon and tell him to point it in the right direction. Craig Llewellyn and I might like to debate that, but there is unlikely to be severe respiratory or CNS depression in a big, healthy guy with pain until 25 to 30 milligrams has been given. So, I would say that under certain circumstances, giving somebody something that is easily titratable, like IV morphine, and enabling them to return fire would be well worth considering.
2. IV fluids. This IV fluid issue is really an irritating one. Most individuals with wounds do not need IV fluids. Only 5 to 7 percent of those injured in Vietnam had abnormal vital signs. In civilian environments as well, probably one of the most overused and useless bits of treatment is an IV. A young person will tolerate substantial blood loss (up to 20 to 30 percent) without any adverse effects. If the pulse is less than 120 and the casualty is still talking to you, then generally speaking, he does not need emergent IV fluids.
3. In terms of what fluid to give in the IV, we have used Ringer's Lactate for 50 years. It is time for a change. There is no doubt about it. Five years from now we will not be giving people Ringer's Lactate. We may be giving people Hespan. We probably will be giving people a hypertonic crystalloid such as hypertonic saline mixed with a small amount of colloid. The advantage of these fluids is that they have been shown to improve the outcome of head injury. They have been shown to improve the outcome of shock states. They vasodilate the patients instead of vasoconstricting them. They use extracellular fluid to expand the intravascular fluid, and they enable us to get medications into the circulation and into target organs such as the brain and heart. My bet is that a hypertonic crystalloid/colloid mixture, which some people are already using in Europe is probably where we are going to be when we have all this unraveled. Certainly Ringer's Lactate is not appropriate and Hespan gets us to a half way point. What we are aiming for is the therapeutic end point of either a systolic blood pressure in the range of 70 or 80mmHg (at least above 50) or a pulse rate of less than 110-120.
4. Just to put the final nail in the coffin for Ringer's Lactate - only one-third of it stays in the circulation. You do not need any transfusion with a hematocrit of 20 to 25%. We take people of 65 and 70 years of age through open heart surgery and do not transfuse them with a hematocrit of 25%. Now, here you

are thinking of giving blood or fluids to young people whose hematocrit could comfortably go down to 20 without harm. Five is bad. Twenty-five is just fine. Fifty percent hemodilution is non-damaging.

5. Respiratory difficulty makes you think of pneumothorax. Hemoptysis would be a bad sign. Restrict the IV fluid. Give morphine which is a pulmonary vasodilator, if it gets bad. Treat pneumothorax, if it is diagnosed. I do not know how many of you have actually diagnosed a pneumothorax in the field. I have tremendous difficulty in an emergency department or in a trauma area picking up a pneumothorax that is not a tension pneumothorax and immediately premorbid. Diagnosing the subtle signs of a pneumothorax is not easy. So, if you have possible signs of a tension pneumothorax, I am all in favor of sticking a needle in the chest and relieving anything there. You are not going to kill anybody doing that, but you will kill somebody if you do not relieve a tension pneumothorax. COL Ron Bellamy's data show that 3 to 5 percent of the patients in the Vietnam database had a pneumothorax.
6. A torso wound may be unfixable if it entails a lot of hemorrhage. Basically, anybody who is hit in the bottom half of the torso with an RPG is not going to do well.
7. We need to provide decision rules and these should be very simple for the tactical environment. Here you have to consider both whether or not you can get the casualties out at all and, if so, how long it is going to take to get them to definitive medical care. I have examined some data in various databases that I have access to. I have about half a million injured patients on these databases. I can go in and pull out ten or eleven thousand gunshot wounds between the ages of 15 and 30 and look at those patients in shock. I can tell you that if you get the best of care in trauma centers in the United States after coming in with a blood pressure of 90 or less, you have a one in two chance of dying. So, in a resource-constrained hostile environment, the mortality of severe shock in this patient population is going to be close to 70 or 80 percent. Some of the times to death in these databases just reflect the fact that some physicians are pretty slow at figuring out that the patient is dead. Essentially, as somebody said this morning, if you are in cardiac arrest from trauma, that is it. If you have a blood pressure that is not measurable, if you cannot feel a carotid pulse and so forth, then you have a one in four chance of survival with optimum care. That is in a hospital, not in a field environment. The point is that, even if you have somebody who is in shock, if you can keep the blood pressure above 50, keep him talking, and give him enough fluids without overdoing it so that you restart the bleeding and dislodge the clot, they may be okay. You can probably go 6 or 8 hours tweaking them along if you can maintain a decent blood pressure.
8. Therapeutic end point is quite important. I looked at it just for pulse rate, because not all of you carry your blood pressure cuff and

sphygmomanometer into the combat zone. It is reasonable to look at pulse rate as an indicator of time to death. You know if your pulse rate is over 120, you have some chance of dying, but you probably have while to go. This is from civilian data, but decision rules based on some very simple measurements like this might help individuals in the field make some of the tough decisions that have to be made in the tactical environment.

I can tell you that if you get the best of care in trauma centers in the United States after coming in with a blood pressure of 90 or less, you have a one in two chance of dying... If you have a blood pressure that is not measurable, if you cannot feel a carotid pulse and so forth, then you have a one in four chance of survival with optimum care. That is in a hospital, not in a field environment.

Dr. Howard Champion

DISCUSSION

Dr. Otten: I just have a comment about blast injuries. They are very difficult to diagnose and even more difficult to treat. Casualties that you think have a pulmonary blast injury do become a priority for triage. From data that comes out of pub bombings in Northern Ireland, it has been noted that people who do not have tympanic membrane injuries do not have associated blast injuries. This is because the overpressure that is needed to rupture the tympanic membrane is about 15 psi, but the amount of overpressure needed to rupture a bleb or the alveoli in your lung is about 30 psi. So, if the casualty can hear normally and his tympanic membraness are okay, he probably does not have pulmonary or intestinal blast injury.

Dr. Champion: That is a very good point. Maybe you could comment on the history here. This is an outside blast. In a building, inside confined walls, I would have expected blast lung to be more of a concern. Outside, however, even in a Humvee, the mechanism of injury makes me put blast lung fairly low as a priority for consideration.

Dr. Otten: Right. The blast wave actually travels fastest through solid objects. People who are on board ships and close to the bulkheads when they have a blast outside are more likely to be injured than if they are a couple of feet away. It is the same inside a building. If you are near a wall, the blast that hits you from the front then bounces off the wall and hits you coming back, too. So, you get hit with the blast twice.

If you are in the water, the amount of blast injury is greater as well, because the blast wave travels faster in water, and you get a spalling effect (changes in the speed of the blast wave when travelling from one density to another that result in a tearing of membranes at the interface) as well as a water hammer effect (movement of a column of water by a blast that strikes an object in it's path). If you are up against the side of the vehicle and there is a blast outside, you are very likely to be hurt by the blast wave. If you are away from the side of the side of the vehicle you are less likely to be hurt.

Dr. Hull: You said that you wanted controversy. My interpretation of the data from Northern Ireland about blast lung and tympanic membrane rupture is slightly different. If you have tympanic membrane rupture, you are certainly at risk of having blast lung. However, if you have no tympanic membrane injury, you cannot rule out blast lung because the position of the head will determine what overpressure gets into the ear whereas the chest is exposed all the way around. You cannot rule out blast lung in people who have intact tympanic membranes, although you can certainly have a high index of suspicion in those who have had them burst.

Dr. Otten: Right, you cannot totally rule it out

Dr. Champion: Is there anything useful you can do? If you stretch your brain to make the diagnosis here in this tactical environment, what is the answer to "so what?" Can you do anything useful for it?

CAPT Butler: If, in fact, you make the diagnosis of pulmonary barotrauma with arterial gas embolism, there are a couple of things that you could possibly do. One is to put the casualty in the horizontal position, just as you would for an individual with a gas embolism that results from diving. You would want to put him on 100 percent oxygen when it becomes available. One of the things that we hope to look at in our research program is the use of lidocaine to treat pulmonary barotrauma with secondary arterial gas embolism. Lidocaine does not magically makes the bubbles go away, but it may reduce secondary damage to the endothelium from the bubbles.

Dr. Hull: Could I make comment on that as well? We are not necessarily talking about gas embolism here. What we are talking about is fairly mild breakdown of the pulmonary alveolar membrane with hemoptysis. So, we are basically getting blood in the alveoli rather than gas in the blood. Now, for those patients, the last thing you want to do to is lie them down. You would be much better off sitting them up.

Dr. Champion: With a bit of morphine in their IV. It is probably about the only thing you can do. If you have your stethoscope and it all goes quiet, you can listen for the crepitations.

CAPT Butler: Just to respond to that, I would agree with what you have said if your primary concern is with the patient's pulmonary status, and you are thinking that he has a contused lung. If he were to have hemiplegia or loss of consciousness to suggest neurological injury from a gas embolism, then you would do the other things that I mentioned.

Dr. Champion: Oxygen is a very expensive thing to carry around. We were charged a couple of years ago to do a complete literature research on the value of oxygen in trauma. I know you find it in the back of every ambulance and that it is routinely used in shock patients, but. there is no data that demonstrates a benefit from the routine use of oxygen in trauma patients. You can do it if you feel like it, but it is no more justified than the use of prehospital IV fluid resuscitation in patients who are not in significant shock.

LTC Holcomb: Dr. Champion, do you think it is possible that only one patient out of all the casualties in the Humvee would have a blast overpressure injury? I do not think so. If you have someone in respiratory distress, why would you not put a needle into his chest as a presumptive treatment for a tension pneumothorax?

Dr. Champion: I thought I mentioned that I would put a needle into anybody that I thought might have a tension pneumothorax.

LTC Holcomb: I asked the question because I think it is worth emphasizing, and I wanted you to emphasize it again. The things that you can do on the battlefield for chest injuries are very few, be it blast overpressure, pulmonary embolus, or whatever. The one lifesaving thing that you can do, however, is to put that IV catheter in the chest of a casualty with a tension pneumothorax.

Dr. Champion: I completely agree with you. In fact, I have been having a debate with LTC Cloonan about putting chest tubes in these folks as well, because I think that would be very useful on certain chest injuries. I think he is coming around to my point of view.

Dr. Llewellyn: I have a comment on blast overpressure injury. There is an Israeli report that documents that, of 3 people in a fairly small space, one of them had blast overpressure injury and the other two did not. I think the real issue is the pulmonary contusion one. Not infrequently, this takes some time to develop. If, in fact, you are going to have these casualties on your hands for an extended period of time, the worst thing you could do is give them Ringer's Lactate. That may make the blast lung much worse.

Unfortunately, I cannot sustain a controversy with Howard about the morphine. What I said was that after giving somebody morphine, I want to take his weapon away. I also want to take away grenades and any other ordnance as well. Now, if I have the opportunity to observe this individual and better evaluate his mental status, then I might modify the decision. If I have to have a rule of thumb, however, it is going to be that if I am doing anything that could potentially alter the mental status of an individual, then I have to observe him for a while. Having had to use morphine on myself one night in Vietnam, I am also aware of the fact that, even when you are making a conscious effort to avoid letting it affect your judgement, it can.

CAPT Johnson: I have a question that I would like to pose to the panel. When do you need to convert a needle thoracostomy to a tube thoracostomy in this scenario? These casualties are going to be there for a while. Do you wait for increasing respiratory distress before you put a chest tube in, or do you replace the needle with a tube as soon as feasible?

LTC Cloonan: I think John Holcomb ought to answer that question because he's doing the research .

LTC Holcomb: I have reviewed the needle thoracostomy data back to World War II, and there is not a lot. There are two questions: (1) how well does it work; and (2) how long does it work for? We are in the process of doing an animal protocol right now because these questions are not adequately answered by retrospective human studies. Needle thoracostomy with a 14 gauge needle works very well to relieve a tension pneumothorax initially, and it works for at least 4 hours in animals.

Needle thoracostomy with a 14 gauge needle works very well to relieve a tension pneumothorax initially, and it works for at least 4 hours in animals.

LTC John Holcomb

There are a couple of additional questions. What do you hook it up to? How do you hook the Heimlich valve up? Do you need a Heimlich valve or not? Is the needle okay just by itself? That's the long answer to your question. The short one is that it will work for at least 4 hours in pigs.

CAPT Johnson: I was reviewing this literature to provide guidance to my medics. It says that you do not necessarily need a chest tube at all, just to make a hole in the side of the chest and leave it open, like an anatomical flap. What do you think about that?

LTC Holcomb: What I think is that, if you do either a chest tube or a needle thoracostomy, in the field, the lung does not re-expand because you do not have positive pressure from above or suction from below. The lung stays collapsed. We have good evidence for that. So, all you are really doing is converting the tension pneumothorax to a simple pneumothorax, but by relieving the tension component, you will save the soldier's life. That is what I am telling the medics. You just have to watch the casualty to make sure the tension component does not come back.

LTC Cloonan: I would like to ask a specific question about that. I took a look at the literature because, as Dr. Champion mentioned, we have had a discussion going about chest tubes. It is worthwhile to ask some very fundamental questions, such as "Why do we put in a chest tube at all?" I mean, people do okay when they drop a lung. Is there really any physiological benefit to putting in a chest tube? The bottom line is that the studies seem to show that if you re-expand the lung, it helps to control the hemorrhage.

One of the things that has been brought up was that, if you had massive bleeding in the chest, was it a good thing to clamp the chest tube? In fact, the study said that clamping the chest tube makes you feel better because you do not see the blood gushing out of the chest, but actually the patients do not do better. The question is, if you do not have the ability to re-expand the lung by hooking it up to suction in the field, is there any real advantage to putting a chest tube in? Is it not better to just make sure that there is no tension pneumothorax. This can be done by simply putting in a needle or using one or the other devices that are available.

If you do either a chest tube or a needle thoracostomy, in the field, the lung does not re-expand because you do not have positive pressure from above or suction from below. The lung stays collapsed.

LTC John Holcomb

Scenario 5

First Assault Team Rescue Element Casualties

Dr. Norman McSwain

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Blackhawk flying air cover for raid shot down
- Ranger element from target house maneuvering to assist
- Rangers come under heavy fire from hostile crowds
- Moving along from house to house for cover
- Ranger One - GSW head/Blood spurting from wound
- Ranger Two - GSW to neck
- Ranger Three (M60 man) - GSW to right arm
- Ranger Four - GSW to right arm
- Ranger Five - GSW to groin with severe bleeding/Proximal femur fracture/Missing testicle

Preliminary Comments:

Of the casualties in this scenario, one individual has a gunshot wound to the head and blood is spurting out, but the scenario does not give us the anatomy involved. There are two main issues to consider: (1) the brain could be injured and the blood is coming from a deep wound or (2) it is a scalp wound with a major artery injury that does not involve the brain. These two possibilities will affect how you would handle and triage the patient and what you are able to do.

The second casualty has a gunshot wound to the neck, but again the anatomy involved is unknown. There are three anatomical regions in the neck to think about. The first region is something that is lateral to or posterior to any major

structure. Therefore it is an unimportant wound and can be treated like any other wound that involves only muscle and skin. The second area is where it is in proximity to a major structure, but has not produced any major anatomical or physiological defects at this point and the patient is stable. The third area is when there are hard signs of major anatomical structural injury, such as airway compromise (e.g. a hole in the trachea with air leaking to the outside or an expanding hematoma).

There are the two casualties with gunshot wounds to the arm, but again we do not know how much blood they are losing. There are two possibilities to consider. Either the patient is bleeding a lot, needs a tourniquet and, therefore, may lose the function of that arm, or the individual is not bleeding a lot and can still use his weapon and/or provide some kind of help to others.

The fifth individual has a gunshot wound to the proximal femur and you could identify immediately that it is going to be very difficult to get a tourniquet on this area to control the hemorrhage. You will have to control it with direct pressure. The patient is bleeding severely and missing a testicle and although missing a testicle is not of major consequence in the middle of a firefight, it certainly can be a major consequence to the individual later.

MANAGEMENT PLAN

Care Under Fire

1. For Ranger One, if the injury is external to the skull, pressure will take care of the hemorrhage. Take care not to put too much pressure on the wound if there is damage to the bone, or you may push the bone fragments down into the brain. If the round has gone through the skull and the bleeding is coming from inside the skull, no amount of direct pressure is going to solve that problem. Assume that Ranger One is unconscious. Is he unconscious because the round has gone through the skull or because he has lost so much blood? Either way, he is likely to be in the expectant category and this would drop him to the bottom of your triage list.
2. For the gunshot wound to the neck of Ranger Two, consider which zone it is in. Is the patient bleeding a lot? Can the patient control his own hemorrhage or do you have to use another Ranger to control it?
3. Rangers Three and Four have gunshot wounds to the arms. If there is no major hemorrhage or bony involvement, simply putting a dressing on the wounds or applying a tourniquet may be sufficient to ensure that they can continue to fight and help defend your position.
4. Ranger Five has a groin wound that is hemorrhaging. Direct pressure on the groin wound will stop the hemorrhage, but if somebody other than the patient

has to apply the pressure, it will mean that you have lost another soldier from the fight. Whether or not you could afford to lose another person to apply the direct pressure is something that needs to be discussed.

5. Do we want to start an IV on Rangers Two, Three, and Four, or do we want to just use a saline lock on them? We are not presented with their level of consciousness, but that is something that you need to think about. Do you need to start an IV on these casualties in the Care under Fire situation? Probably not.

Should we give these casualties antibiotics? The answer to that is absolutely "yes"...The earlier you can get antibiotics to a combat casualty with penetrating trauma, the better.

Dr. Norman McSwain

Tactical Field Care

1. Ranger One is unconscious and bleeding but is he unconscious because there is bleeding or unconscious because of his head injury? If he is unconscious because he has had major blood loss, then it means that he has lost at least half of his blood volume, and in this kind of an environment, you are not going to be able to replace it. If he is unconscious because the round has gone through the brain, that is probably going to put him into the expectant category. The third alternative is that he is unconscious due to airway obstruction, which can be remedied unless he requires ventilatory support. He has to be assessed to ensure that it is not just a loss of the airway causing his unconsciousness.
2. Is Hespan going to be beneficial to Ranger One? Hespan may improve the blood flow to the brain and that would be beneficial. You have to ask yourself "Can this patient survive for the amount of time that you going to be with him in this area?" If not, you may be better off saving the Hespan for another patient who has a better chance of survival.
3. Antibiotics. Should we give these casualties antibiotics? The answer to that is absolutely yes. The reason is that when you give a patient antibiotics and he develops a hematoma, that hematoma will have antibiotics in it, which will reduce bacterial growth and suppress abscess formation in the area. The earlier you can get antibiotics to a combat casualty with penetrating trauma, the better.
4. Hemorrhage control can be maintained for both the head and the neck injuries by direct pressure if it is worth the loss of another Ranger or two Rangers to achieve that. In the Tactical Field Care phase, under cover, it is worth it but in the Care under Fire situation it is probably not.

5. Consider whether or not you need to start any IV's. You have to ask yourself "What benefit is it going to provide?" If it is not going to provide any benefit, then do not do it. This will be determined by how the patient presents. When resuscitating a casualty with IV fluids, you have to ensure that you do not do something that makes them lose blood at a faster rate. One problem is that if you dilute the blood by giving IV fluids such as Ringer's Lactate or Hespan while he is still bleeding, the additional fluid will reduce the hematocrit. As he continues to bleed, the total red cell mass continues to drop, and his condition will deteriorate.

CASEVAC Care.

1. Not applicable

Equipment Considerations

1. None

Additional Considerations

1. Most material about managing head injuries and improving blood flow to the brain in head injury situations comes from the blunt trauma literature. You have to be very careful as you read the literature or listen to people speaking to you from a podium. You have to ask yourself if the information is pertinent to the environment in which you are working. If you are talking about improving oxygenation and cerebral blood flow in a patient with a brain injury, a lot depends on whether that brain injury is secondary to penetrating trauma or blunt trauma. That is going to determine whether you are going to place the casualty in the treatment category or the expectant category.
2. How hard are you going to try to resuscitate a casualty such as Ranger One who is unconscious with a gunshot wound to the head in this kind of an environment? Obviously, in the environment you are working in here, you cannot have much in the way of airway management. You cannot put an endotracheal tube in this patient. A tracheostomy is not going to be of much benefit, because in order to ventilate a patient like this, you are going to have to have more advanced equipment than will be available in the field.
3. What about IV fluids in a tactical situation? Under normal circumstances, you need about 30 cc's of PO fluids per kilogram per day and that equates to the 2 liters of fluid that would be carried in canteens. By the end of the day, even in a normal maintenance situation you would be running out of fluids. In a scenario such as this, however, there is a high temperature, (90 degrees or more) and folks are working pretty hard. Their water requirements are going to be much higher and dehydration may be a major problem.

4. Think about the physiology of IV fluids. Hespan is a volume expander. It stays in the vascular system for a while. It also sucks fluids out of the interstitial space and puts it in the cardiovascular space. That creates a deficit in the interstitial space which has to be resupplied. If we do not resupply that relatively soon, especially if there is additional blood loss, then the patient is going to start to get in trouble.
5. If you have a casualty who has a full load of 5 liters of blood in his cardiovascular space, but who then has an injury wound and loses a significant portion of this blood, his blood pressure will drop and the bleeding will hopefully slow down. It may be appropriate to leave him at that lower blood flow and blood pressure state. Based on the Bernoulli principle, the amount of blood loss is based on the differential between the pressure inside and outside the vessel. Putting more pressure outside the vessel, such as with a pneumatic anti-shock garment or with hand pressure or with an Ace bandage will stop the blood flow coming out from the hole in the vessel because it will decrease the pressure differential. You can decrease the differential by simply lowering the pressure or allowing the pressure to be lowered inside the vessel.
6. I am sure all of you are familiar with the article that came out of Houston several years ago identifying that the pneumatic anti-shock garment does not work because it increases blood pressure and therefore increases blood loss in areas that are not covered by the pneumatic anti-shock garment. I am sure you are also all familiar with the subsequent material that also came out of Houston that purported to show that IV fluids in the prehospital environment not only do not work, but actually increase the mortality rate. These two articles, that have been touted as proving that IV fluids and MAST trousers do not work, do not prove anything. Neither of them proves those points. Go back and read the articles and make your own decisions. Look at the results yourself - don't base your management of a patient on somebody else's interpretation.
7. There is an interesting paper that Dr. Holcomb sent to me several months ago. It came from a military publication in 1949 and reported that there was a higher survival in patients that arrived at the hospital with lower blood pressures than in patients whose blood pressure was raised artificially with IV fluids. (1)
8. There was an interesting paper that was published in the Journal of the American College of Surgeons this month. It came out of Madigan Hospital and was about the optimal end point for fluid resuscitation. That is probably a mean arterial pressure of about 60 mmHg, at least in the prehospital phase, before the casualties get to the operating room.

References

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DISCUSSION

CAPT Butler: Thank you very much, Doctor McSwain. Comments or questions?

Dr. Llewellyn: I enjoyed the presentation a lot. I think that it is important to point out that when you are doing Care Under Fire and have somebody with a through-and-through head wound, the best thing to do initially is to ignore them. You do not have to consider them expectant or anything else, as they will declare themselves over a period of time. There is excellent data to support this from Andre Salazar's Vietnam head injury studies and from data from the United Kingdom and the United States in follow-ups to World War II injuries. These studies indicate that there is virtually nothing you can do in the immediate period after through-and-through head wounding to help the casualty. In fact, unconscious patients, if they remain stable, tend to travel extraordinarily well, and you can make the situation worse by trying to fool around with them in any way. This became standard procedure by the end of World War II but had to be relearned in Korea. I am not sure it was ever relearned in Vietnam because, unfortunately, we could get helicopters in too fast and people were convinced that the more IVs you could get into people, the better off they would be. Of course, we never gathered any data.

In the Care under Fire phase, I think the issue of triage is probably unimportant. You should treat whoever you can get to at a very minimal level. In my opinion, this just means that if there is obvious gross hemorrhage, you try to get somebody to control it. Declaring people expectant, unless the head is separated from the body, is not something to spend time on or agonize over at this stage. Another thing to remember is that when you talk about shifting to the Tactical Field Care Phase, you need to be aware that the situation could change back rapidly to one where you are again under effective incoming fire. Therefore, you cannot commit yourself to Tactical Field Care unless you are in a place where the tactical leader can be sure that you are fairly secure and will stay that way for a while.

I think that it is important to point out that when you are doing Care Under Fire and have somebody with a through-and-through head wound, the best thing to do initially is to ignore them....there is virtually nothing you can do in the immediate period after through-and-through head wounding to help the casualty.

COL Craig Llewellyn

The last comment I would make is that we do not know much about the two guys with arm wounds. To me, they are extraordinarily important because, if you can immobilize them and get some kind of dressing on, they may be able to do things to help you care for the other casualties. The immobilization should not be

ignored and may consist simply of tying the arm down to the vest. You do not have to worry initially about splinting.

LTC Cloonan: I agree with everything Dr. Llewellyn said, but I would add that the one thing that you can do for the unconscious casualties that could potentially improve their outcome is to make sure that you turn them on their side. Placing them in a lateral decubitus position to help keep their airway open could really enhance their chances of survival because it may prevent them from developing an airway obstruction. There were a number of patients who died from airway obstruction in World War II while being transported on their backs. This led to the Surgeon General's recommendation that unconscious patients be transported lying on their side.

There were a number of casualties who died from airway obstruction in World War II while being transported on their backs. This led to the Surgeon General's recommendation that unconscious patients be transported lying on their side.

LTC Cliff Cloonan

I would like to make a quick comment about back injuries. The one study that people keep going back to is the one by Josh Vayer and Ron Bellamy that looked at whether cervical spine immobilization would be of benefit in penetrating injury. Everybody needs to understand that that study looked at penetrating injury. In several of the scenarios that we have seen today, however, the mechanism of injury was blunt trauma from falls or helicopter crashes. You must all understand that the risk of cervical and other spinal injuries is very real in these situations. While I am not telling you to carry a backboard into that environment, maybe a C collar would add some benefit. At a minimum, you ought to be aware that there is at least a distinct possibility of C-spine damage, and when you move the patient, you ought to do so with an understanding that that is a potential problem.

Dr. Otten: I want to make a point about head injuries. Statistics from the Crimean War show that the percentage of people who died with head injuries then was about the same as it is today, and that was over 150 years ago. So things have not changed much for head injuries resulting from penetrating trauma, except for the use of the helmet. Helmets can make a big difference, and the statistics from Desert Storm show that most head injuries occurred below the level of the helmet. The helmet did a good job of protecting the area that it covered, so maybe we need to make bigger helmets.

I think there is a role for protecting the cervical spine, especially with blunt trauma. Instead of carrying a C-collar, you can carry SAM splints which you can turn into a C-collar and which work as well as any other C-collar. Because of weight considerations, everything you carry should have more than one use. If you have a regular Philadelphia collar, that is about all you can use it for, but if

you have a SAM splint or something similar to that, you can use it for lots of different things.

SGT Miller: We hear a lot of talk about anti-shock garments. Where do they and where don't they play a part? In our tactical setting, they are used not so much for trauma and autotransfusion during class III shock, but for pelvic stabilization and attempts to tamponade something like a common iliac or femoral vessel hemorrhage..

CAPT Butler: Sergeant Miller, do you carry MAST trousers into the field?

SGT Miller: In some situations we do, because we are different from SEAL teams and 18- Deltas in regard to medic loads. We go both heavy and light assault. Some of the vehicles that we have can bring them in. So, we do have them available and use them in some situations for those purposes that I mentioned.

Dr. McSwain: I am a very strong proponent of that and have been for a long time.

Dr. Hagmann: Let us finish with the MAST garment. I think we need to emphasize what Doctor McSwain was saying earlier. Ranger Five has a gunshot wound to the groin that is exsanguinating. As Dr. McSwain pointed out, unless you are willing to dedicate an individual to holding pressure on that wound, it may be a fatal injury. The MAST garment could give you pelvic stabilization and tamponade in this circumstance.

I think that the point that we made in the Tactical Combat Casualty Care article is that the MAST garment is not a tactically useful device for most combat medical personnel because the size and weight was too large in relation to its benefit. This does not imply that the device is without some benefits, particularly when your next echelon of support is a vehicle that can support the weight. I think that is an important distinction to make.

SGT Miller: I think it would also be worth talking about the fluid resuscitation protocols that you have come up with, because we have incorporated utilization of Hespan over normal saline. Let's say you have a casualty with penetrating trauma to the abdomen and bleeding is uncontrolled. When would you fluid resuscitate this casualty? When would you stop? We know he is probably not going to live as we get below a systolic blood pressure of 60 or 50 mmHg. Should we fluid resuscitate this casualty with normal saline at that point?

CAPT Butler: I would first like to comment on the issue of dehydration. With Hespan, you pull fluid into the vascular space from the interstitial space. You might therefore be considered to be increasing the dehydration in the interstitial space. However, if you think about it, before he got shot he was dehydrated, and

yet he was still fighting and functioning well. Dehydration alone did not incapacitate the Rangers in Mogadishu. On the other hand, if you have a Ranger in hypovolemic shock after losing several liters of blood, now you have someone who may die. So, assuming that you are able to stop the bleeding, are you willing to trade making the interstitial space slightly more dehydrated in order to restore the intravascular volume? As far as I know, that is a question that has not been well answered in the literature, especially in the setting of long delays to definitive surgery. We are hoping to answer these questions with future research efforts. In the meantime, the physiology seems to dictate that you would go with Hespan instead of crystalloid in casualties with combined hypovolemic shock and dehydration because the decreased intravascular volume is more of a problem than the decreased volume in the interstitial space. This is an area where appropriate animal studies are badly needed.

Dehydration alone did not incapacitate the Rangers in Mogadishu....the physiology seems to dictate that you would go with Hespan instead of crystalloid in casualties with combined hypovolemic shock and dehydration because the decreased intravascular volume is more of a problem than the decreased volume in the interstitial space. This is an area where appropriate animal studies are badly needed.

CAPT Frank Butler

The second part of the question is also important, and we need to throw that out to the trauma surgeons here. If you have a casualty who is shot in the chest or abdomen and has uncontrolled bleeding, is there a point at which you would treat them with fluid resuscitation?

Dr. McSwain: If they become unconscious, they have probably lost enough blood volume that they are not going to survive even if you bring their blood pressure back up. They are continuing to bleed from the site of injury. That does not mean that you shouldn't try, and that is one of the benefits of a pneumatic anti-shock garment; it provides abdominal compression to control hemorrhage.

On the other side of it is the matter of when can you get this casualty back to an operating room. That will play an important part in what you are going to do for that casualty and also how much Hespan you have and do you need to use that Hespan on somebody else?

Dr. Champion: I am going to show you some figures on this that gives you the probability of survival for certain blood pressures and the minutes you have to live. There is no doubt, to answer CAPT Butler's question specifically, that, if you are unconscious from bleeding in the abdomen, you require fluid resuscitation. That means your blood pressure has gone down to about 40 to 45 systolic. Your therapeutic goal is to give enough volume to allow adequate cerebral perfusion. You may or may not be successful, but to ask the question "Should you treat

them?" - the answer is yes, and your therapeutic end point is to keep mentation going. That is the only therapeutic end point, and that can be achieved with a systolic blood pressure of 60 to 70 millimeters of mercury.

Scenario 6

Second Assault Team Rescue Element Casualties

LTC John Holcomb

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Blackhawk flying air cover for raid shot down
- Ranger element from target house maneuvering to assist
- About a block from crash site
- Rangers come under heavy fire from hostile crowds
- Moving along from house to house for cover
- Ranger One - GSW upper thigh and abdomen/Severed femoral artery/Gaping hole in upper leg with blood everywhere
- Ranger Two - GSW foot
- Ranger Three - GSW groin/Round through buttock and into pelvis/One testicle blown off/ Blood pumping out from wound

MANAGEMENT PLAN

Care under Fire

1. We have talked about some of the tactical issues already. I would drag the casualties to a safe spot, such as behind a wall or behind some kind of armor. "Safe spot" is obviously a relative term.
2. There is not much you can do at this stage other than to stop any major hemorrhage if possible. If you cannot get a tourniquet on, then try any means possible to stop the bleeding (Kerlex, Ace wraps, standard Army or military dressing or the Israeli dressing).

3. Talk to the casualty. Not only is that reassuring for him, but it also gives you an indication of his level of cerebral perfusion.

Tactical Field Care

1. Do a quick airway and breathing check.
2. See if the casualties are talking. If not, figure out why not and attempt a quick airway.
3. Start a single saline lock on all three casualties, because if they have a blood pressure and still have accessible veins, this is the time to get into them. It can be hard to start IVs, no matter how experienced you are, when a patient is in severe shock. Don't start two large-bore IVs as ATLS recommends. I don't think that applies in this situation.

If the hemorrhage is under control and the casualty's mental status is okay, then I would not give any IV fluids, no matter what his blood pressure is.

LTC John Holcomb

4. If the hemorrhage is under control and the casualty's mental status is okay, then I would not give any IV fluids, no matter what his blood pressure is. There is no human combat data to support this, but for combat casualties who are still in the field and still under fire, that's what I would do.
5. If the hemorrhage is controlled, but the patient is not talking, then I would give 500cc of Hespan. Is Hespan the best thing to give? Maybe not, but Hespan is in my ruck. I also carry some Lactated Ringer's because I am not sure exactly which way to go. There is no question you get more bang for your buck with Hespan than with Lactated Ringer's, but it may not be the best thing to give to dehydrated patients. There is absolutely nothing in the literature about giving Hespan to dehydrated casualties, nor is there any research going on right now that I am aware of, despite our efforts to bring this issue to the attention of the research community.
6. What do you do about fluid resuscitation in a casualty who has hemorrhaged and who is unresponsive and does not have a palpable pulse? Do you give him a bag of Hespan? I probably would. If he responds, then you are golden, because that would suggest that he is no longer bleeding. This will then give you some time to work on other casualties. What do you do if the casualty does not respond to the initial 500cc bolus of Hespan and you suspect that he has ongoing bleeding from the chest, abdomen or pelvis? Do you give him another bag when you have other casualties that may need that Hespan? Probably yes, if the tactical and medical situations allow. Do you give more than 1000cc? I don't think so. It is important to establish a 1000cc maximum

on IV fluids in uncontrolled hemorrhage as a rule of thumb, so that the medics who are taking care of patients under fire don't have to make those decisions on their own, in the dark, under fire, and with three or four buddies lying around bleeding. That is what I would do in those situations, but I would like to hear what everyone else thinks about it.

7. Give antibiotics up front and as soon as reasonably possible. There is fairly decent data to show that it is beneficial to give antibiotics as soon as possible, either in the field or after the casualties arrive at the hospital, because they may not get to the operating room for up to 24 hours.
8. Control pain, splint fractures, reassess injuries.

It is important to establish a 1000cc maximum on IV fluids in uncontrolled hemorrhage as a rule of thumb, so that the medics who are taking care of patients under fire don't have to make this decision on their own, in the dark, under fire, and with three or four buddies lying around bleeding.

LTC John Hlocomb

9. If tourniquets have been put on, I would try to remove them at this point. I do not know of good data concerning the timing of tourniquet removal so that you will avoid both ischemic injury to the extremity and the danger of rebleeding. I would ask for comments from the audience on this.. As far as I can tell from the orthopedic literature, if you get the tourniquet off within 2 hours, you are probably not going to have significant muscle and nerve damage distal to the tourniquet site. You might not only have stopped the bleeding but might also have saved the leg. However, clearly the most important thing is to stop the bleeding and save the casualty's life.

CASEVAC Care.

1. Recheck all previous interventions.
2. Look for things that have failed. If you put in a needle to decompress a tension pneumothorax, make sure it is still working and that it isn't clotted.
3. Evacuation order is based upon level of response. A casualty who does not respond to 2 bags of Hespan should probably be the last individual to evacuate, because he is probably continuing to bleed. You are most likely not going to be able to do much to save him.
4. Try to remove tourniquets if possible.
5. Monitor blood pressures.

6. Start patients, particularly ones with chest injuries, on oxygen as needed.

Wear body armor. I talked to three guys whose lives were saved by body armor in Mogadishu.

LTC John Holcomb

Equipment Considerations

1. Wear body armor. I talked to three guys whose lives were saved by body armor in Mogadishu. It is hot and heavy, but carry it and wear it. There is no question that it decreased our killed in action in Somalia.
2. There are about 10 different ways of getting an airway in, but if you read CAPT Butler's paper and the other pertinent literature, you will realize that it is unlikely that you are going to be putting too many airways in people. There are just not that many casualties who need a cricothyroidotomy or an endotracheal tube. I have pared down the number of airway aids that I carry, and I fill up the extra space with equipment to stop bleeding.
3. I would take a 14-gauge needle for needle thoracentesis. It works as well, if not better than, other devices designed exclusively for needle thoracostomy. The 14-gauge needle can also be used for IV access. I would also ask everyone to look at their Heimlich valve/needle thoracostomy connection. Most of the medics know (but most of the docs do not) that these two things are not meant to go together. The Heimlich valve was not made to fit onto the end of a needle. Until you actually try to make the connection, you do not necessarily realize that. You have to have a tube in between, and you need to be prepared for that.
4. Hemorrhage control equipment (kerlix, ace wraps, battle dressings, cravats), saline locks, the right IV fluids, are all critically important.

If a casualty has hemorrhage from a site that is not accessible to direct pressure or a tourniquet, but which may be achieving hemostasis through formation of a clot, you can raise the blood pressure too high with your fluid resuscitation and blow that clot right off.

LTC John Holcomb

Additional Considerations

1. Can the casualties be moved? Of course, they can be moved, because they have to be moved. Might you lose some casualties by moving them if they are tenuous? Yes. Would they be lost if you left them there? Yes. I would get them to cover as soon as possible. Captain Olson talked about using armored vehicles. His comments carry a lot more weight than mine and I would agree with them.
2. I made the point that the data to support my decisions regarding what IV resuscitation fluids I would carry in my rucksack is somewhat sketchy. There are lots of opportunities for research in this area. Unfortunately, the guys who decide where the research funding goes are not in this room, nor have they really listened to the right questions from the operators. They are often not interested in those questions. They are more interested in doing what they want to do and I can say that because I work in a research lab.
3. The use of clamps to stop the bleeding in the groin and tourniquets to stop the bleeding in the upper leg may be frowned upon, but if the casualty is bleeding to death and that is all you have, I would use them. I tell every medic that I work with that, if you can just bring me a live casualty, we can fix almost anything that you might have done incorrectly while trying to keep him that way.
4. With respect to "popping the clot" - if a casualty has hemorrhage from a site that is not accessible to direct pressure or a tourniquet, but which may be achieving hemostasis through formation of a clot, you can raise the blood pressure too high with your fluid resuscitation and blow that clot right off. If you have an injury that has stopped bleeding, there is an optimal level to which you should restore his blood pressure. If you go beyond that level, I think you may blow the clot off. It is up to the researchers to figure out what that level is.
5. How long can a patient stay hypotensive and still do well 3 to 5 days later? Hypotensive resuscitation makes sense. It was done for thousands of casualties in World War II in the shock tents. It was very clear to those surgeons that, in an injured patient, if you raised the systolic pressure above 80mmHg before you achieved definitive hemostasis, you increased the bleeding. This is well-documented in books from World War II. The important research question is 'How long can a patient stay hypotensive?'
6. What is the best IV fluid to use for resuscitation? I agree with some of the other panelists. It will probably eventually turn out to be a combination of colloid and hypertonic saline.
7. The distinction between controlled and uncontrolled hemorrhage is really important for fluid resuscitation. If the casualty has an extremity injury, and you can put your hand on the wound and stop the bleeding, then resuscitate

him. Make his blood pressure come up a little bit. If he has an abdominal, chest or pelvic wound, you cannot definitively control the bleeding, so you want to leave his blood pressure a bit lower so that you do not pop the clot off.

8. If he has a head injury, I would reiterate that you need to resuscitate him back to a normal blood pressure.
9. One thing that I think that we do not pay enough attention to is hydration. When we go to the field, sometimes for 12 hours or more in 90-degree heat, we do not carry a lot of water. There is quite a bit of data available about the amount of fluid that you can lose through sweating and it is considerable. However, when you are wearing body armor and getting shot at and running from point to point, you are likely to lose even more than the literature would indicate. You might have to drink 10 liters or more to replace fluid losses in a scenario like Mogadishu, even in soldiers who are not wounded. This degree of dehydration is quite significant. The therapeutic implications of combining hemorrhagic shock and severe dehydration in humans are not known.

If you have a soldier who starts out dehydrated and then he gets shot and loses a lot of blood, what do you do with that individual? I can tell you from the animal literature that with equal blood losses, the mortality goes up 30 percent in dehydrated animals as compared to controls.

LTC John Holcomb

10. If you have a soldier who starts out dehydrated and then he gets shot and loses a lot of blood, what do you do with that individual? I can tell you from the animal literature that with equal blood losses, the mortality goes up 30 percent in dehydrated animals as compared to controls. So, not only do you have soldiers who may be making bad decisions because they are 15 percent dehydrated, but they are more likely to die if wounded and to die faster. There is lots of information about rehydration with LR and normal saline. There is none on Hespan. Obviously, we need to know that answer.
11. Pain control. There are people who use ketamine instead of morphine. It relieves pain, does not cause mental status changes, and does not cause cardiac or respiratory depression. It is something the U.S. military has not embraced. It is a very useful drug in the operating room for sick patients if you do not want to drop their blood pressure. At this time, it is not a controlled substance. It works just as well IM as IV and almost as quickly. It is easy to titrate. I think it is something we should consider for our combat medics. I think some individuals here have given ketamine for pain control in the field and I would like them to comment on that.

12. IV or IM antibiotics - does it matter which? Probably not, but it is important to make sure that the casualties have antibiotic coverage. The wounds that we saw in Somalia were not treated with antibiotics in the field and had a very high rate of infection.

It is important to make sure that the casualties have antibiotic coverage. The wounds that we saw in Somalia were not treated with antibiotics in the field and had a very high rate of infection.

LTC John Holcomb

DISCUSSION

Dr. Zafren: I have a comment about ketamine, which I use quite frequently in the emergency department. I wonder how it would work in a noisy environment because I notice that it works better when things are quiet. The other thing you can do with ketamine, especially in adults, is to give a little bit of benzodiazepine with it. There seem to be fewer side effects such as hallucinations if you use diazepam or lorazepam in conjunction with it

Dr. Llewellyn: I cannot tell you how happy I am to see you emphasizing dehydration. In Vietnam, we saw strange things happening with Special Forces patrols, even with soldiers on their second or third tours. When they were out for more than 4 or 5 days, they not infrequently would call fire in on themselves or not show up for air drops. I spent a fair amount of time going on operations just to find out what happened. The reason turned out to be that nobody drank water. Checking urine specific gravities on these individuals confirmed the dehydration. I realized that even I was doing the same thing and not drinking enough.

Forcing hydration, making it an NCO's responsibility, writing it into the operational plan, making sure that fluids are available and drunk are all things that we try to stress to our medical students. We put them in a stress-filled situation and we monitor them when they are squad leaders to see if they are doing this with their squads in the field.

This issue is one of the things that enhanced our credibility with the tactical law enforcement organizations that we work with. They initially did not emphasize hydration at all. It has to be emphasized and re-emphasized. You cannot afford to have operations go bad because people are dehydrated and heat stressed.

The other thing I would like to ask about is the relationship between increasing intracranial pressure, systemic blood pressure, and survival in penetrating head trauma. The importance of intracranial pressure monitoring and maintaining the systemic blood pressure is often stressed for closed head trauma, but I have not seen any data for penetrating head trauma.

LTC Holcomb: The penetrating head injury data that I am familiar with is mostly from Dr. Kerry in Louisiana. If you get a transcranial wound or a midline wound, you are dead. If you get a tangential wound, which a number of head wounds are, you have a significant chance of survival with a good outcome. Now, good outcome to a neurosurgeon and good outcome to the rest of us are sometimes two different things. You must look at what the neurosurgeon says is good, and determine if the patient is walking and talking and interacting with people.

The area at risk in the brain is called the ischemic penumbra. This is not that area of brain tissue that is already dead, but the area that may be salvageable around it. If you leave the casualty hypoxic and hypotensive, the tissue in this

area is going to die. If you keep them well-oxygenated and keep their blood pressure up, the ischemic penumbra may recover.

Dr. Llewellyn: But as I recall, Kerry does not have data on resuscitation.

LTC Holcomb: Correct.

CAPT Chaloner: My experience with war injury has been in the civilian setting with Medicine sans Frontier in Angola and Sri Lanka and with the Halo Trust, which is a mine-clearing charity in Afghanistan, Angola and Mozambique. Last November, there was an International Committee of the Red Cross Conference in Geneva on the pre-hospital management of war wounded and there were a few points that came out of that meeting that may be relevant. First, it is clear that in these circumstances, "E" for environment comes before "A" for airway. My suggestion about this Mogadishu scenario is that your medics probably constituted 10 percent of your fire power. In my view, I would just drag the casualties under hard cover, ignore them, and get on with putting rounds down on the enemy.

Second, there was a clear consensus of both military and civilian physicians in agreement with what LTC Holcomb said about the use of minimal airway equipment. Most casualties on the battlefield who will tolerate an endotracheal tube are going to die. It is not worth your spending time and effort trying to change that situation.

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CAPT Chaloner

The use of hypotensive resuscitation, with the presence of a palpable radial pulse as an end point of resuscitation, was very strongly endorsed by virtually everybody. This included military physicians, the civilian trauma world, and physicians with vast field experience working with the Red Cross and Medicine sans Frontier under very difficult conditions.

The next thing is the issue of tourniquets. In my view, under these circumstances, the military operation is absolutely key. From my own experiences in working with patients who have suffered blast amputations from land mines, often you can put the tourniquet on, put a pressure dressing on the wound, and then an hour later take the tourniquet down, and the bleeding has stopped. It is anecdotal, but I am convinced that this approach allows a clot to form at the bleeding site and bleeding to be controlled.

Finally, a point about the use of ketamine. I have used ketamine extensively in the field for anesthesia and analgesia, for setting fractures, reducing dislocations and repairing rectal prolapses in children in refugee camps. I regard it as an excellent drug, and Doctor Mike England can testify that we once did a laparotomy under ketamine on a child who had blown himself up with a grenade. We had absolutely no problem whatsoever, and I recommend it to you all.

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CAPT Chaloner

LTC Holcomb: Could you address the issue of using ketamine in a soldier with a painful wound, such as a femur fracture, that you would like to be able to have continue firing his weapon?

CAPT. Chaloner: That I am not so sure about. I would be quite happy in this situation to give him some morphine and let him carry on firing, but ketamine does produce a sort of dissociative state. As one of the panel has already said, it is best given with a little bit of benzodiazepene if you want to keep a lid on the hallucinations. I would not suggest that somebody continue to retain their weapon after that combination.

MAJ White: With reference to ketamine and the statement that it is not a controlled substance, I know that within my command, it is absolutely a controlled substance. The FDA is still looking at it as far as I know, but it is a drug with abuse potential because of its hallucinogenic effects. It is related to PCP. It is not a medication I would give to somebody if I wanted them to use a firearm. I expect that the FDA is probably going to move to put it on a schedule soon, just like narcotics and amphetamines.

With reference to antibiotics and wounds, you have orthopedic data, but I would like to see other wound data as well. The only wounds I am familiar with are wounds caused by bites, and antibiotics in that setting do not seem to make a difference.

...there are no data for much of what we do. If you are thinking about evidence-based data for the combat environment, there just is very little available.

CAPT Mel Otten

Dr. Otten: Dr. Holcomb brought up the fact that there are no data for much of what we do. If you are thinking about evidence-based data for the combat environment, there just is very little available. As someone just mentioned, you have to use your experience. Unfortunately, experience is sometimes based on bad judgment, since you have to make some mistakes before you develop enough experience to have good judgment. I think that we are trying to capture some of each other's experience in forums such as this workshop..

The surgical or trauma literature is not suddenly going to come out with a paper saying that this is the last word on what you should do to save lives. You have to take the responsibility for what you do based on your experience, your knowledge, anecdotal cases, and what you think the literature says. You take the risk, and you take the responsibility. If the casualty lives, you are a hero. If he dies, you are the goat. That is what we do on a daily basis in the Emergency Department and that is what you have to do when you are out there, too. I think Dr. Holcomb is right on. You have to do what you think is best based on what you know and your experience.

2LT Mabry: Just anecdotally again, from the patients in Somalia, there were quite a number with gunshot wounds who had associated fractures and delayed evacuation. Many of those casualties had pretty significant infectious complications and interference with union and healing of those wounds.

CAPT Butler: Did any of those casualties get antibiotics in the field?

2LT Mabry: There were a couple of cases. I have not tracked down the exact ones who got antibiotics yet. On longer patrols, I usually carry antibiotics, but I did not in this particular instance.

LTC Holcomb: In civilian trauma centers, if we do not get an open fracture to the Operating Room within 6 hours that falls out on your trauma registry and, more importantly, infections are increased. I want to reiterate that some of these casualties were in the field for 12 hours after wounding, came to the 46th Combat Support Hospital, and then lay in the hospital for another 24 hours before they went to the Operating Room for surgical debridement and repair.

I think that there is good evidence that the use of antibiotics in open fractures decrease infectious complications. The environment that we work in, not only in the field, but also in third world hospitals, is not the same as in the U.S. These casualties are not going to get surgical debridement and repair in 6 hours unless they are the only casualty that day. So, I would highly recommend antibiotics as early as possible.

CAPT Butler: Granted that there is not much data that addresses many of our specific situations. However, both the NATO War Surgery Manual and Medical Letter Recommendations call for the use of antibiotics if there is going to be a

long delay to surgery, if there is suspected intraperitoneal injury with the potential for sepsis from penetrating bowel trauma, or for open fractures. That is a fairly well-accepted recommendation, even though, as you say, there are not many controlled studies that have been done in the battlefield environment to demonstrate its efficacy in reducing infectious complications.

CDR Jaegger: I am a staff anesthesiologist, and I have had some experience using ketamine. It is very useful, but I would not use it for procedures in a situation where you need silence, because in addition to the hallucinations, there is a lot of vocalizing that they are not able to control coming out from the ketamine. We are starting to use it more, and I recommend that you keep an eye on the anesthesia literature. We are using it in smaller doses as an adjunct to analgesia; because of its function as an n-methyl-d-aspartate (NMDA) receptor antagonist, 10 to 20 milligrams will help to block pain pathways in a manner different from opiate receptors. Its use helps to decrease the total narcotic requirement and decreases the potential for respiratory depression.

2LT Mabry: Are you using that alone or in combination?

CDR Jaegger: In combination. Another agent that is being used more and more frequently is magnesium sulfate. One to two grams IV has fairly minimal cardiovascular effects and it also is an NMDA receptor antagonist. The NMDA receptor is another one of the glutamate-type activated receptors that is important for long-term potentiation of pain. It has a number of other functions, but one of them is an analgesic pathway.

The only other comment I would make is about applying tourniquets. I think they are obviously appropriate but the caution I would offer from personal experience is that when you take them off, you need to be prepared to fluid resuscitate and treat hypotension. That may not always be easy to do in the situations we are talking about. If I had a choice of leaving the tourniquet on in the field or taking it off, I think I would leave it on unless I was in a position to aggressively undertake this fluid resuscitation.

LTC Hagmann: We have been having discussions about the use of ketamine in the Special Operations community for well over 5 years. The problem we have that our colleagues in the UK do not have is that, with our medical system, the interspecialty turf battle is one of the major limitations to our use of ketamine in the prehospital environment. It was hard enough for us to be able to get diazepam into the medics' hands. Getting ketamine to them will be another political battle that we will have to fight and we need the support of our anesthesia colleagues.

I use ketamine in the controlled environment of an emergency department, but in about one in five cases that I use it, I have to do a quality review with the

anesthesiologist. We always bring up the same literature and the outcome is always the same - that it was appropriate to use the ketamine.

SGT Miller: During Care under Fire, an individual gets a tourniquet on, let us say, the upper thigh. In the CASEVAC phase, if I wanted to take the tourniquet off, would there be any renal problems that I would have to deal with on a long flight?

Also, if you look at SOF operators and medics across the board, they are moving towards Kerlex and Ace wraps to control hemorrhage. The Israeli dressing has been mentioned. Although it is not FDA approved, it is the best of both worlds and can be turned into a tourniquet as well. I would like to see if we could get that into the hands of our medics.

LTC Holcomb: The Israeli dressing is basically a manufactured Kerlex or Ace wrap combined with a little plastic stick. It works just like Kerlex and an Ace Wrap. You have to be very careful not to make it into a tourniquet accidentally and that's a problem. The majority of casualties do not need tourniquets. However, when you do need a tourniquet, it could be life saving.

CDR Frosolone: We talked about IV fluid resuscitation. Can anybody give us an update on the technique of interosseous infusion in prehospital combat trauma care?

LTC Holcomb: Sternal or tibial interosseous infusion devices make excellent sense in this environment. It is certainly quicker than doing a cut-down or trying to start IVs on patients whose blood pressure is 70 or below. A sternal interosseous system only takes seconds to put in.

CDR Frosolone: Yes, you just pull the T-shirt up and fire it.

LTC Holcomb: Unless they have body armor there.

CDR Frosolone: The Israelis have a spring-powered one that goes into the tibia.

Audience Member: I think the intraosseous system is something that everyone in SOF should be looking at. I can tell you that, at my command, we are buying them.

Dr. Caulkins: It is bothersome to me as an anesthesiologist to hear a bunch of surgeons saying that the airway does not need attention. I know you guys do not mean to ignore this important aspect of care.

We just finished a tourniquet study using 18-Delta medics. We found that the Israeli tourniquet was a nice combination of bandage and pressure dressing. It did not, however, reliably eliminate the distal pulse in our study.

At the Walter Reed Army Institute of Research, we have looked at a number of different tourniquet systems. It appears that a ratchet technique is the best arrangement. The tourniquet systems available now will not work, even if you have somebody else putting it on, unless you have a windlass. A windlass technique is very difficult to use on yourself if you are trying to put the tourniquet on one-handed, as you may well have to.

With respect to the intraosseous infusion techniques, we just finished a study looking at the Israeli bone injection gun, the Fast device made by Pynq Medical, the Sur-fast made by Cook Critical Care, and the Jamshidi sternal bone marrow needle. From those studies, it looks like the 18-Deltas and corpsmen can reliably use all of those devices. They are very easy to teach and all of them worked well. There was no one particular device that was felt to be overall better than the others, but certain devices have more desirable features.

The Fast is a sternal injection gun and is a little bit large. If you have room in your ruck, it is a great device to use. Where you have limited space to carry an intraosseous device, the Sur-fast system, which is a hand-driven model with a single handle, gives you the ability to carry 10 or 12 needles in the same volume and weight that you would need to carry any of the other devices.

LTC Holcomb: I think the answer to Sgt Miller's question about releasing tourniquets and renal failure is that nobody really knows. I would try to get the tourniquet off within 2 hours. If the bleeding starts, put it back on. If the bleeding does not start back up, I would judiciously give some fluids, because you know releasing the tourniquet is going to release potassium and lactic acid into the circulation with potential harmful side effects.

Scenario 7

Helicopter Hit by RPG Round

LTC Robert Allen

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- In Blackhawk helicopter trying to cover helo crash site
- Flying at 300 foot altitude
- Left door gunner with 6 barrel M-134 minigun
- Hit in hand by ground fire
- Another crew member takes over mini-gun
- RPG round impacts under right door gunner
- Windshields all blown out
- Smoke filling aircraft
- Right minigun not functioning
- Left minigun without a gunner and firing uncontrolled
- Pilot - Transiently unconscious/Now becoming alert
- Co-pilot - Unconscious/Lying forward on helicopter controls
- Crew Member - Leg blown off/Lying in puddle of his own blood/Femoral bleeding

MANAGEMENT PLAN

Care Under Fire

1. The first priority in a casualty scenario involving an aircraft in flight is to try to keep the aircraft in the air or, if it cannot stay in the air, to control the crash as much as possible. If you crash in an uncontrolled manner, everyone on board who is already injured is going to be more severely injured or killed, and the people on board who are minimally injured could very well die as a result of the crash.

The first priority in a casualty scenario involving an aircraft in flight is to try to keep the aircraft in the air or, if it cannot stay in the air, to control the crash as much as possible.

LTC Rob Allen

2. Get the unconscious Co-pilot off the controls. He is lying forward and is probably pushing the controls forward, which may make the aircraft harder to

control. Reach over the back, grab him by the shoulder, pull him back, and once you get him back into position, lock his harness. Years ago, part of the pre-combat checklist was to lock the pilot and co-pilot's harness so this would not happen. If there is a problem with his harness, you may have to hold him back in that position because, if you let go, he will just flop forward over the controls again. You may have to tie him in that position. If he remains unconscious, you will need to get him out of that seat, but that is something you are going to have to deal with a little bit later. For now, steady the stick and try to get the aircraft under some semblance of control.

3. Wake up the Pilot if possible. The aircraft has all the windows blown out so there is plenty of fresh air coming into that cockpit. Hopefully that will help to keep him awake, but if that does not work, reach over, grab him, shake him, yell at him, do whatever it takes to try to get the aircraft back under his control. Get the aircraft pointed towards a safe emergency site if you can. Remember to try to keep that runaway door gun pointed in a safe direction away from your own troops and other aircraft.
4. Next, you have to get the door gun shut down. Keep that left door gun firing in a direction that it is not going to hurt anybody on the ground or shoot your wingman down. The gun mounts that we have at least on the 60-Golf aircraft are designed such that the gun cannot fire up into the rotor disk or fire back into the tail or nose of the aircraft. However, the gun has been damaged, so the mount could be damaged. An M-134 mini gun is a six-barrel, rotating gatling gun, and it is run by electrical power. Since the gun is fired electrically, hit the master arm switch and turn it (and every other piece of electrically powered weaponry in the aircraft) off. If you cannot reach the master arm switch, pop the circuit breaker for it. You could also pull the cannon plug or cut the power line with your knife. Another thing you can do is to jam your knife into the ammo feed. I do not, however, recommend jamming a knife in the rotating barrels because they will probably take your arm off. An alternative is to point the gun in a safe direction until it runs out of ammunition. At 4000 rounds per minute, that is not going to take too long.
5. Once it has been assured that the aircraft is not going to have a bad meeting with gravity, get a tourniquet on the leg of the crew member who has the traumatic amputation, since he has a femoral bleed. This could be done by one of the other crew members while you are trying to take care of the pilots up front. It could also be done by the casualty himself. There are many precedents for people having extremities blown off who put tourniquets on and save their own lives. If the Crew Member is alert, you may just need to remind him that he has a tourniquet in his pocket and to use it.
6. For the Co-pilot who is unconscious, the only thing I might do at this point is to put a nasal trumpet in him and assess for any obvious injury. Make sure he is not bleeding anywhere and, if possible, get him out of the seat. If he is

unconscious, sooner or later he is going to do one of two things. He will either go into a deeper state of unconsciousness, or he will wake up. If he starts to wake up, he may start flailing around and hit something that you do not want him to hit, so he needs to be taken out of the seat. In the Air Force 60s, you can hit a couple of pins and drop the seat back. You then grab the casualty and drag him back. The problem is that there is a lot of equipment such as ammo cans in the back of a Blackhawk and they might get in the way. Also, you cannot drop the seat back in some aircraft.

7. Assess the injury to the Pilot. What caused him to become unconscious? Was it a momentary blackout because of a concussion? Is he likely to become unconscious again? Is he able to control the aircraft? Remember he is the one in control of this aircraft and has everyone's life in his hands.

Tactical Field Care

1. Until the aircraft is out of danger from flak and appears to be flyable to base or some other safe site, you need to limit your care to keeping the pilot awake and providing any care needed to assist with controlling the aircraft.
2. Contact other aircraft and figure out a safe heading to avoid any other known flak traps. One of the dirty tricks they used on the rescue helicopters in Vietnam was to fire at them from one location in order to drive them into a flak trap. This is where escort aircraft may come in handy. They can be orbiting above, keeping an eye on the ground situation and vectoring you in a safe direction. If they can be spared from the current tactical mission, they could provide an escort to base and a ready CSAR capability. If a dedicated CSAR bird is available, you could also use it to escort your aircraft out of there, if it can be spared from the tactical situation.
3. Continue the casualty care in the back of the aircraft.
4. Put a pressure dressing on the casualty with the leg wound and assess the injury to the co-pilot. Would I remove the tourniquet at this point? Probably not. I would leave the tourniquet on and put a pressure dressing on the wound.
5. Your subsequent actions are going to be based on how long it's going to take to get this aircraft to a relatively safe area.

CASEVAC Care

1. There are many variables to consider. What is the degree of injury to the pilot and to the aircraft? Is the pilot capable of continuing to fly this aircraft for the next 15 or 20 minutes? Is the aircraft so badly damaged that it is going to go down in 5 minutes no matter what you do or are you going to be able to

continue to fly it to safety? What is your distance and time to appropriate medical care? What is the distance and time to a safe landing zone? What medical supplies are on board?

2. In this scenario, the flight time to a safe area where medical care was available was measured in minutes. Some scenarios could involve a 3 or 4-hour flight, with one or two aerial re-fuelings. So, should the aircraft land in a safe zone? If you have a significant distance to travel, this might be the best option. Land the CSAR aircraft first, then land the mishap aircraft, transfer the wounded, get a new pilot. If the aircraft is too badly damaged to continue safe flight, transfer the uninjured crew and destroy it on site.
3. If the aircraft is able to continue on without landing, the crew man with the amputation continues to get a pressure dressing. You can start a saline lock to use for IV pain control. Do you fluid resuscitate this casualty? It depends on his vital signs. His bleeding is controlled, so we are probably not in a situation where you are going to bring his blood pressure up and possibly blow a clot off, although that is a possibility. At least the bleeding is in an area that is pretty obvious, so if the increase in blood pressure does blow the clot off, you would know about it very quickly.
4. What is the likelihood that this crew is dehydrated? Having flown search and rescue in the Mojave Desert for 4 years, I can tell you that after 2-1/2 of hours flying at relatively low altitudes in a Huey in a hot environment, everyone in the aircraft was pretty badly dehydrated, and that was without wearing body armor. So, yes, these guys are probably pretty dehydrated. What do you do in terms of giving these guys fluids? Do you go with Hespan? Do you combine Hespan with a little normal saline? I don't think anybody knows. What I do in a case like that is to consult my grandfather's ghost, which is to say that I make it up as I go along. In this case, I would probably give him a bit of normal saline and a bit of Hespan.
5. The pilot has to remain alert to fly the aircraft. One of the questions specifically asked for this scenario was "If the pilot is in a significant amount of pain, should he be given morphine to decrease his pain in the hope that he could then fly the aircraft better?" The idea of a pilot flying an aircraft after having been given significant opiates bothers me quite a bit. He may be in pain, but he may just have to bite the bullet, because he should not be given morphine.
6. One thing that could conceivably be done if the equipment and expertise was on board and he has an extremity injury causing the pain is to do a local block. Another possibility is to use injectable ketorolac, although some people are not very fond of this medication, since it does not seem to work all that well for traumatic wounds like this. There are also some theoretical problems associated with ketorolac decreasing platelet aggregation, although the

literature shows that there is more of a problem with anticoagulation from giving Ringer's Lactate than ketorolac.

7. There are some other problems to think about. What if you cannot keep the aircraft in the air? What if you have a crash landing coming up? A controlled crash landing means the aircraft stays relatively upright, and you can exit a somewhat intact aircraft. A crash landing means that the aircraft is going to roll over or do something along those lines. To prepare for a crash landing, strap everybody down, preferably in seats. Especially on the Blackhawk, it is much better to be in a seat if you are going to hit the ground hard rather than to be sitting on the floor. Secure any loose gear or dump it over the side, except for weapons and ammunition because you might need those after you hit the ground.
8. When you hit the ground, take the wounded with you when you leave the wreckage.

Equipment Considerations

1. Not Applicable

Additional Considerations

1. Not Applicable

DISCUSSION

CAPT Butler: Excellent presentation, Dr. Allen. When you start to look at casualties in the aviation environment, there are quite a few additional things to consider. Any comments from the audience? There is a lot of new information here.

Cpt Johnson: This is an excellent example of why flight surgeons need to get more stick time. The primary concern is getting the aircraft back on the ground safely. I want to reiterate that when something like this happens to an aircraft in flight, everybody on that aircraft becomes a crew member. You need to be looking outside for a safe landing zone. In this scenario, the only safe landing zone was the air field and fortunately they got there.

LTC Allen: Just to add to that, the first thing that I learned as a flight surgeon flying combat rescue was that there is no such thing as a passenger on a combat aircraft.

CAPT Butler: Thank you. Before we move on to our next scenario, Dr. Llewellyn has asked if he can make a few comments.

Dr. Llewellyn: I cannot tell you how delighted I am to be a member of the panel but, also, having been in the SOF community for a long time, at the quality of the exchange and discussion within this meeting.

There was a recognition within the SOF medical community during the Eighties, and maybe all the way back to the Sixties, when I was running the old 18-Delta school, that it was not good enough to be using only civilian knowledge bases in our medical instruction. We trained people very well, but we also created myths and some of those myths have persisted. It is absolutely crazy to presume that if your medic training has involved a goat lab that you are prepared to open one of your team member's bellies if there is no opportunity to get him to surgery.

Now, why would I talk about this here? Our service Medical Departments have real problems in recognizing that there is something different about Special Operations Forces medicine. What is so gratifying is to not only see the physicians here with a fair amount to contribute but also to see the interest on the part of the enlisted medics.

If you cannot define the knowledge that is the basis for your practice, then you are left with making it up as you go along. I cannot tell you how delighted I was when Captain Frank Butler came to me and asked if our department would be interested in participating in the sort of research project that we are involved with today. CAPT Butler came up with funding, initially from the Naval Special Warfare Command and then from SOCOM, to look at what the knowledge base was and how to make it better. He had made common cause with LTC John

Hagmann, our medical director at the Combat Casualty Research Center. LTC Hagmann had the benefit of having been invited to participate with UK Special Forces in the development of their trauma course. They did a literature review and then obtained review and comment from both Special Operations combat medical personnel and medical subject matter experts before publishing their paper. CAPT Butler and LTC Hagmann subsequently realized that using specific scenarios and casualties that might be expected in SOF was the critical next step. This has become an ongoing process, a living document, and not something set into stone, which is a problem that we have had in the past.

What CAPT Butler and LTC Hagmann have done is provide in the United States not only the basis for us to educate and evaluate ourselves, but also to find common ground on which we can engage people like Howard Champion, who is an international trauma expert. Without a program and forum like this for us to focus on, it is difficult to ensure that information on combat trauma management strategies and current technologies are shared in both directions.

I would like to invite CAPT Butler and LTC Hagmann to step forward to be presented with a token of our appreciation of their efforts. I will read one but mention both names. For Captain Frank K. Butler and Lieutenant Colonel John H. Hagmann: "In appreciation for your vision, dedication and leadership in planing the first Combat Casualty Research Center forum. Your contributions to SOF medicine in general and the Special Operations Medical Association in particular are immeasurable. 1998."

CAPT Butler: Thank you, Colonel Llewellyn. If I could just emphasize a point I made at the start of the morning, if this particular project has been successful, it is because it has been a community effort in SOF medicine. One of the first things that I learned when I got into a SEAL platoon was that you don't plan the operation without talking to your Chief and Leading Petty Officer. That approach carried over into this particular effort, except that this time we had to ask not only the combat medical personnel for their input, but also a great many of our medical colleagues. It is an honor to accept this award on behalf of everyone who had a hand in this effort. Thanks very much.

LTC Hagmann: I cannot say it any better than that.

Scenario 8

Quick Reaction Force Casualty in an Exposed Location

LTC Cliff Cloonan

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Two Blackhawk helicopters flying air cover for the raid shot down
- Quick Reaction Force convoy on rescue effort
- About a block from first crash site
- Heavy Somali small arms and RPG fire
- Five-ton trucks and Humvees in a convoy
- Lead elements split from remainder of column by attack
- Troops dismount to take cover
- Vehicles turn around - now on other side of street
- Troops have to run across street to get to trucks
- QRF casualty lying in the middle of the street - GSW chest and shoulder/Unable to crawl to safety
- Hostile forces laying down heavy denial fire

Preliminary Comments:

At the Joint Special Operations Medical Training Center, we do a Mogadishu raid exercise. If anyone is interested in getting more information on that, I would be happy to send you a copy. For further information, there is also an absolutely outstanding web site about Mogadishu that the Philadelphia Inquirer has that takes you all through the particulars. Type "Blackhawk Down" on your Internet search engine. The author of that series is Mark Bowden, and he also has a book

by the same name that is going to be coming out sometime this year. There is also an excellent book called "Fire in the Street: The Battle for Hue" by Eric Hamill. It describes the hazards of casualty recovery in a fire zone. I would also recommend a book called "The Death of Stonewall Jackson." This book describes the wounding of General A. P. Hill and how a number of other people were killed and wounded while attempting to move the General off of the battlefield.

At this point, I would like to read the questions that were put to me on this scenario, and then give you my recommendations. I will avoid answering any of the tactical questions because I do not view myself as an expert in the area of tactics. I will confine myself to medical comments.

Question 1. Is there any medical care that should be rendered between the time that a medic reaches the casualty and the time that he reaches the cover of the structures at the side of the road? Under the circumstances, you would probably be ill-advised to attempt to render any aid until you got to cover. To attempt to do so would put both the rescuer and the patient at further risk.

Question 2. Is there a better way to retrieve the casualty in this situation than to have the medic run out and bring him back? This was particularly interesting to me because we currently have three small business initiatives that are addressing the concept of a combat casualty recovery device. This would be a device that could be carried into the field by combat medical personnel to use for the express purpose of recovering casualties under fire while minimizing the danger to the rescuer.

The impulse to rush out and rescue the casualty immediately should be strongly resisted in order to reduce the risk to both the rescuers and the casualty. If possible, some form of cover or diversionary tactic could be used. There are a number of options that should be considered. First is the use of obscurants. I think they should be carried and used wherever possible. Smoke, for example, could be used in combination with suppressive fire. Next is the use of vehicles to screen the casualty during recovery attempts. This was done successfully several times during the battle of Hue, and it was also done during the Mogadishu raid. Five-ton trucks and Humvees offer limited small arms protection and little protection from RPGs, but they have sometimes been quite effective, and they are certainly better than trying to rush out there with no cover at all.

Another thing that you might do is to think about this scenario when you are doing your medical planning and putting your kits together. You might want to include some line with a D-ring on the end of it. This can be thrown out to the casualty and he can hopefully clip it into his equipment and then be dragged back to cover.

Question 3. Should the medic attempt to fire while running to retrieve the casualty or should he not fire in an attempt to maximize speed? That depends on the specific circumstances of the scenario.

Question 4. What should the medic do with his weapon and the casualty's weapon after reaching the casualty and preparing to transport him to cover? I am not the most qualified person to answer this, but I have spoken to some experienced combat medics about it. They tell me that they worry a lot about what to do with the casualty's weapon. In circumstances like Mogadishu, if you do not police the casualty's weapon, it will be used by the enemy against you. In fact, one individual made the comment that, in some circumstances, he was more worried about recovering the weapon than he was about recovering the casualty.

Question 5. What is the best technique for moving the casualty to cover in this particular setting? What if the medic weighs 140 pounds and the casualty weighs 220 pounds? Again, this is very situation and environment-specific, but I do think that it is a perfect example of where realistic training is absolutely critical.

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LTC Cliff Cloonan

When we do our casualty training, often what we do is to find the lightest guy in the unit and have him play the casualty. What you probably ought to do is just draw straws because that is the way wounding is on the battlefield. The time to figure out that carrying a 220-pound casualty is a difficult thing to do is not when you are in the heat of battle. You probably should have tried various methods beforehand to find out what works for you and, probably more importantly, to find out what doesn't work. If you weigh 140 pounds and the casualty weighs 220 pounds and there is incoming fire, even if you rush out there, you may not be able to pull him to safety without help. You might want to wait until help is available before exposing yourself to fire.

Question 6. Once the casualty has been moved to the cover of the building at the side of the street, would you now undertake the more extensive treatment spelled out in the Tactical Field Care phase or would you continue to consider yourself in the Care under Fire phase?

I would say that once the immediate threat of further injury from hostile fire has been reduced to a minimum level, the casualties ought to be taken care of in order of priority. I would re-emphasize some of the comments that have been made earlier today. If a casualty has a penetrating chest wound and there is any suspicion at all that he may have a tension pneumothorax, I would go ahead and

put a needle in his chest. If he has a penetrating chest injury, he almost certainly has a pneumothorax already, so it is not like you are going to cause a pneumothorax in this circumstance. It takes very little time and equipment to do. If the airway is clear and any exsanguinating external hemorrhage has been controlled, then the other tasks are less critical and can wait until a later time.

Question 7. Assume that the casualty is having no severe or increasing difficulty with his breathing. What is the degree of urgency for performing needle thoracostomy or putting in the chest tube?

It is virtually certain that, if you have a casualty with a penetrating chest injury, he already has a hemopneumothorax, and therefore any risk from putting in a needle is extremely low. It can be performed quickly with minimal equipment.

We talked a little bit about the need for a chest tube. From looking at the literature, it appears that the primary reason for putting in a chest tube is to re-expand the lung, which helps to control intrathoracic bleeding. However, if you do not have the ability to apply suction and re-expand the lung, then you are not going to control the bleeding by putting in a chest tube. Since you are not able to control the bleeding, the only other thing you can effectively treat is a tension pneumothorax. Since this can be treated with a needle, I am not sure that there is any urgency to put in a chest tube.

One of my British colleagues was telling me about an incident in Desert Storm where someone survived a gunshot wound to the liver. He had a hemopneumothorax from a chest wound as well. He survived and walked out of Iraq and did perfectly fine until he was taken care of by medical personnel from another country. They proceeded to put a chest tube into his liver. First of all, he probably did not need the chest tube, having survived long enough to walk out of Kuwait. Second, it would have been nice, if they were going to put a chest tube in, to put it in the right place. So, I do worry about the risks associated with chest tube insertion.

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LTC Cliff Cloonan

Question 8: Comment on the use of morphine in this casualty. In casualties who are at risk of hypovolemic shock or who have respiratory difficulty, how should pain control be achieved on the battlefield?

I like morphine. I personally do not think that 10 milligrams of morphine significantly alters mental status. I would generally feel comfortable letting

casualties keep their weapon until you got up to higher doses of morphine. In addition, I think that if a casualty is in a lot of pain, he will probably be distracted by that pain. This may cause problems with him using his weapon as well.

Only about one-fifth of combat casualties have significant pain, so don't give pain medication unless the casualty is really complaining of pain. Those who do have significant pain are mostly casualties with long-bone fractures or abdominal wounds. If morphine is given, it ought to be given intravenously. This is one of the primary indications for putting a saline lock in casualties - so that you can give them pain medications and possibly antibiotics.

Morphine really should not be given IM. If you have a hypovolemic patient, particularly if he is hypothermic, and you give him IM morphine, it does not get well-absorbed out of the muscle. Then somebody else gives him some more, and that does not get absorbed either. Finally, he gets back to a warm tent, gets fluid resuscitated, and develops a morphine overdose because he absorbs a depot of morphine that you put into the muscle. I would give morphine in 3 to 4-milligram IV boluses titrated as necessary to relieve the pain. If you are giving morphine, you ought to have **naloxone** available also.

Question 9: Assuming that this casualty has no decrease in mental status, would you initiate fluid resuscitation and, if so, what fluid would you use and how much would you administer?

Let me just make a general observation that, within the medical community, there are some things that we really get into arguments about. My observation has been that the things that we get into the biggest arguments over are those things where there are no good scientific data to provide a definitive answer. I would submit to you that it is the things that we do not argue about at all that are really important.

So, do not argue with me about fluids. I have looked through the data and this argument about crystalloids and colloids has been going on for 50 years. Frankly, I don't think it really matters much.

I think it is clear that you can reduce the weight of your medical equipment by carrying colloids. If it is really critical for you to watch your equipment weight, and if you know that all you are going to be treating is hemorrhage, then carry Hespan. I think we will start to use less and less IV fluid for casualties on the battlefield as we recognize the benefits of hypotensive resuscitation. We will probably use more IV fluid to treat dehydration, and I would carry normal saline to treat dehydration.

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LTC Cliff Cloonan

With head injuries, the question has come up about maintaining cerebral perfusion. I have not seen any studies on Hespan and head injury. There are theoretical advantages for using colloids in head injury patients. The only studies that I have seen have been with hypertonic saline. They do show improved survival in trauma patients with head injuries who are given 7 percent hypertonic saline and dextran.

The most important comment on this whole issue of fluids is that you absolutely have to control all controllable hemorrhage. If you are taking any time away from doing that to start an IV, you are missing the boat. The patient will do a lot better with his own red cells in his body than with any external fluid you are going to give him. Another thing that we ought to look at is autotransfusion, particularly for chest wounds. That's something we haven't talked about much. John Holcomb will tell you that whole blood is a miraculous fluid, and if you have it for a casualty who is in shock, it is the fluid of choice. Hespan, on the other hand, is pretty expensive and less available in the system. You may have some trouble getting it, particularly if you are linked up with conventional forces.

Question 10: Assume the casualty becomes unresponsive, raising the possibility of hypovolemic shock. Would you withhold fluid resuscitation because of the uncontrolled hemorrhage?

The first thing I would say is, if the patient is unresponsive as a result of hemorrhagic shock, then he has a very bad prognosis. It means that his systolic pressure, the perfusion pressure, has dropped low enough that he is not perfusing his brain. That is very bad and, in the field, there is not a whole lot you can do for it. I would say, "Search for other causes of the unconsciousness." If his hypotension is due to a tension pneumothorax, that you can treat.

You should not overlook the possibility that it may be a head injury that is causing your patient to have an altered mental status. Do not simply assume that the altered mental status is due to hemorrhagic shock.

In terms of fluid resuscitation volume, if you have a casualty who is unconscious from hemorrhagic shock, I would give a 500cc bolus of normal saline and see what that did. You could substitute 200cc of Hespan if you want.

Question 11: Helicopter evacuation of the casualties was very difficult in Mogadishu because of crowds, roadblocks, RPGs and ambushes. What changes need to be made in CASEVAC plans for urban warfare in the future to address these problems?

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LTC Cliff Cloonan

I am not going to answer this completely because to do so goes beyond the scope of my personal expertise. I think it is a question that needs to be answered, however. In order to be able to answer this question adequately, you need to understand the unit's standard operating procedures, its mission, what organic and attached medical support they have, and what evacuation assets they have.

Helicopter evacuation in an urban environment is extremely difficult, if not impossible. Vertical extraction may be reasonable. If you are going to do that, you need to have the equipment and training for it.

A lot of the suggestions that arise from Mogadishu revolve around making sure that we have armored vehicles in this type of environment. The Chechens did a very good job against Russian armor in that city, however, so armor may not always be sufficient. One of the Malaysian APCs in Mogadishu was taken out by a rocket-propelled grenade. Armored vehicles in the city have to maneuver in very close spaces. A small squad can disrupt armored vehicles in an urban environment. So, I don't know if more armor is necessarily a complete solution.

Another important point about evacuation in an urban environment is that you need to train to do it. You need to train people to go up and down stairs and maneuver in buildings with casualties. I do not think that we do enough of this type of training.

Because of all of these problems with evacuation, it may be appropriate to put some higher levels of resuscitative surgical care far forward, maybe even into the urban environment. It was mentioned earlier today that the Israelis used this sort

of forward resuscitative support in Lebanon. There are problems with that as well, but if you cannot get the patient out to the surgeons, maybe you are going to have to come up with a way to get the surgeons in to the patients.

Question 12: Assuming a delay of 6 hours prior to surgical care for this casualty, how would IV antibiotics be expected to affect the outcome?

The most important thing for any wound is good wound care. I would never say that antibiotics are a substitute for good wound care, but let's assume that the casualty is going to get good wound care.

I have reviewed the literature and, if antibiotics are going to have any benefit at all, they need to be given very early after wounding, probably within 30 to 60 minutes. Surgeons often use antibiotics prophylactically before surgery. You have to reach adequate levels of antibiotics in the tissues and that takes a period of time, so the sooner we can give them, the better. This is what we are starting to teach at the JSOMTC. The Tactical Combat Casualty Care in Special Operations paper recommended cefoxitin, 2 grams IV. That is a perfectly reasonable choice which provides good antibiotic coverage. We used that down in Panama for abdominal injuries.

Another good choice which I personally like is ceftriaxone. It has a long half life and good penetration into the tissues. It penetrates the central nervous system well. If you have somebody with a head or a spinal cord injury, ceftriaxone is a good choice. It will last for up to 12 to 24 hours.

The British did something I thought was particularly interesting in the Falklands. I heard that the guideline was that, if a soldier received an abdominal gunshot wound, the treatment for that in far forward areas was to give him a rectal metronidazole suppository. That may be a good idea, since it does not require you to put an IV in. I am just thinking, however, about the soldier out there who has an abdominal gunshot wound, and the first thing the medic does is to come up and take his pants down. Metronidazole has good coverage for the bacteria encountered in penetrating abdominal trauma and it is well-absorbed rectally, but I am not sure how well the suppository route would be received by the troops.

The last thing that I would like to say concerns the issue of someone being pinned in wreckage, either dead or alive. I think it is worthwhile having our medics carry a gigli bone saw in the field. It does not take up much space. If the casualty is dead, a scalpel and a gigli bone saw will allow you to amputate his leg and get the rest of his body out in short order. I have talked with Lieutenant Mabry about that, and he agrees that it would be a good thing for medics to carry, particularly the Air Force PJs since they often have to deal with people pinned in wreckage.

If the person is alive, then it raises the question of doing an amputation in somebody who has not been anesthetized. Personally I think ketamine has a relatively low risk profile, although I know the anesthesiologists may disagree. It may be the best option in a scenario where you have someone trapped in wreckage, to give enough ketamine to achieve sufficient anesthesia to allow a SOF combat medic to amputate the trapped extremity. In the event that your position is getting overrun or the aircraft is on fire and you have got to get the casualty out, that may be an appropriate thing for SOF combat medical personnel to do. That concludes my comments.

DISCUSSION

Dr. Otten: I have a couple of comments. The first is about the rescue saw. I know some Ranger units carry gasoline-powered saws that have carbide-tip blades on them that can cut through chain link fences, floors, roofs, concrete, and steel. You could certainly cut somebody out of an aircraft with one of those if you had to.

The other thing is that I recall, during the Tet offensive in 1968, we had a battle in Can Tho at the university, and there were lots of casualties. We had an M113 armored personnel carrier that was designated the medic track. We used to roll it out and get it between the fire and the casualty. The ramp was let down and the medic reached out and pulled the casualty in. Inside there was light and suction. There were cots to put the casualties on and IV equipment. I do not know if the M113 is used anymore, but at the time, it worked great, even though it did not have the greatest armor in the world. If you improve its armor, it certainly could do the job of going out and getting between the fire and the casualty and helping to get them under cover.

CAPT Olson: I do not believe the M113 will stand up against an RPG.

Dr. Otten: With improved armor, it might.

CAPT Olson: Right, but the real challenge here was the close-range RPGs across the intersections. This raises the larger issue of a Commander's planning about where to position the full range of medical assets and when to bring the medical capability to the fight. With regard to the medic running into the street to pull out the casualty, I would not send the medic. I would keep the medic under cover and send a Ranger buddy or somebody else out into the street to pull the casualty to cover. Most of these incidents happen while crossing or moving down streets, and there is often somebody closer to the casualty than the medic. In my view, it is up to that guy to grab the casualty and bring him under cover.

CAPT Butler: I would like to follow up on the thought about how to protect the individual who is trying to rescue the casualty. One of the things that you hear a lot about these days is non-lethal weapons designed for use in the urban environment, so that you can control crowds by disabling them without causing permanent damage. There is a lot of research into these technologies currently. The question that this scenario and the crash scenarios brings up is, "Do we want *non-lethal* technology or do we want *more lethal* technology to cover our forces in casualty situations that occur in urban environments?"

CAPT. Olson: I would say that non-lethal weapons are not really a good concept for us to focus on. I think that what we have not said openly here is that the scenarios in Mogadishu and in many urban environments are not carefully planned and deliberately executed against known targets with quality

intelligence. These were targets that were on the move, on the fly, quickly planned, executed by means of deviation from a template that had been trained against extensively but with variations on the template for each of the operations. The non-lethal technologies and devices that I am aware of all require some sort of a more deliberate employment. You have to have the right time, the right place, and the right opportunity to use them. In the meantime, they would take up space in the rucksack and weight on the web belt that is much better devoted to ammunition.

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CAPT Eric Olson

CAPT Chalonor: I wanted to mention something that I omitted before about using ketamine in the field. It is not risk free. It is advantageous, obviously, from the point of view of not inducing hypotension. Something that I think is underrated by the occasional user, however, and particularly the non-anesthetist in less than ideal situations, is the degree to which it provokes hypersalivation. That can be a significant problem if that fluid then drips down onto the cords. You can end up with laryngospasm and pulmonary edema from inspiration against a closed glottis very quickly. This is something that I have encountered once, and it certainly induced a reflex tachycardia in me. Ideally, you want to use it conjunction with something to dry up the secretions, or if you don't have a drying agent available, make sure that the head is tilted so that the saliva goes onto the trousers and not onto the vocal cords.

LTC Hagmann: That is a very good point. I think we may have overstated the case for ketamine in some ways, but clearly it has its place in the operational environment. In England, I know they have used it in emergency prehospital amputations. Also in St Louis, some 20 years ago, a bridge collapsed and ketamine was used in some of the amputations there. So, it has been used in the prehospital environment, but relatively rarely. It has benefits and drawbacks that we have to be more cognizant of if we are ever going to try to employ it operationally.

We have mentioned morphine and diazepam, and various analgesic techniques several times today. My experience with these drugs is that, if you just use morphine or just use diazepam or just use ketamine, it still allows the patient to remain relatively lucid and able to cooperate. We routinely give cardiac patients coming in with myocardial infarctions 20 milligrams of morphine, and they are conversant enough to give us a very good history. It is the mixing of analgesic medications that is most likely to cause CNS and respiratory depression. We can

consider all of these medications for use in the prehospital environment, but we should avoid using them in combination.

We routinely give cardiac patients coming in with myocardial infarctions 20 milligrams of morphine, and they are conversant enough to give us a very good history.

LTC John Haggmann

HMCS Beske: With regard to antibiotic therapy, suppose we have a unit going out on a direct action mission with a high probability of taking casualties. Would it be reasonable to pre-dose everybody with an antibiotic prior to going to the field?

LTC Cloonan: It depends on what the mission profile and the probability of taking casualties is. Antibiotics might be a good idea prophylactically if you thought the probability of taking casualties was very high.

Another thing to mention about using medications before combat operations is that aspirin permanently poisons platelets. If you think you may be in combat, do not have your operators take aspirin because you are going to have additional difficulty with controlling hemorrhage in those individuals. The other non-steroidals do that to a lesser extent, but they only do it for the period of time that you are actually taking them whereas aspirin does it permanently. That is why we use aspirin for patients with cardiac problems.

LTC Haggmann: The Norwegians have, for some years on certain missions, pre-cannulated a vein and put a heparin lock on it. As you know, it is particularly difficult to start an IV in somebody who has just come out of very cold water. We discussed that idea several times within small units in the United States. The problem was that this action was viewed as displaying a defeatist mentality. The objection to it was not that they did not want to have an IV put in, but that they did not want to have the mentality that they were going to go into a situation where they might need to have an IV. I mention that because we may have the same sort of cultural bias against the use of prophylactic antibiotics.

CAPT Butler: The practice of doing pre-mission IVs would not survive the first occasion on which it interfered with anything SEALs were doing operationally. This is especially true when you consider the evidence that indicates that you really do not need emergent IV fluid resuscitation all that often. There is time to get antibiotics in once you are out of the kill zone and have a chance to regroup and collect your thoughts.

MAJ England: I want to thank LTC Cloonan for raising the issue of which antibiotic to use. Throughout this morning we have said, "Give antibiotics" but which one? I have to agree with LTC Cloonan that ceftriaxone strikes me as being a very good antibiotic for several reasons. It has good tissue availability

and once-daily dosing. At the moment, we are looking very carefully at prolonged field care of casualties for several days and, in that situation, once-daily dosing is very advantageous.

In the UK Special Forces, we do not routinely issue ketamine. If we decide in advance that, for a particular situation that it may be good to use, we would actually send the medics away to be trained under an anesthetist for a period of time in how to use it properly.

CAPT Butler: I mentioned before that the Tactical Combat Casualty Care project was a community effort. When we did the first draft of the paper, we had ceftriaxone as the antibiotic of choice for all of the reasons that have been mentioned. When we presented our proposed protocol to the medical department at Naval Special Warfare Group One, the Senior Medical Officer there, LCDR Loch Noyes argued that cefoxitin was a better choice because: (1) the anaerobic coverage is better, which is very important for abdominal wounds with the potential for contamination with gut flora; (2) the cost for ceftriaxone is approximately \$35 a dose compared to \$6 a dose for cefoxitin; and (3) cefoxitin is the medication recommended for prophylactic therapy for abdominal wounds in both the Medical Letter and the NATO War Surgery Manual. The same points were made by CAPT John Perciballi, our Chief of Surgery at the Naval Hospital Pensacola. Either medication can be given IM if necessary. Based primarily on the input of these two individuals and concurrence by our subsequent reviewers, we changed our recommendation as the best single antibiotic for SOF corpsmen and medics to carry on combat missions to cefoxitin. The once-daily dosing remains an advantage of using ceftriaxone.

LTC Cloonan: Actually, when I was in Panama, we used both ceftriaxone and cefoxitin. If you had an abdominal injury, you got cefoxitin. If you had any other injury you got ceftriaxone.

Advantages of cefoxitin over ceftriaxone for combat trauma:

(1) The anaerobic coverage is better, which is very important for abdominal wounds with the potential for contamination with gut flora; (2) the cost for ceftriaxone is approximately \$35 a dose compared to \$6 a dose for cefoxitin; and (3) cefoxitin is the medication recommended for prophylactic therapy for abdominal wounds in both the Medical Letter and the NATO War Surgery Manual.

CAPT John Perciballi/CDR Loch Noyes

LTC Allen: I have a comment concerning the extrication of trapped casualties from crash sites. We have developed a kit that is man-portable (if not man-packable) that contains a hydraulic generator, jaws-of-life, ryobi saw and air-

powered lift bags. It is a light-to-medium weight extrication unit, but it is quite effective and it will tear a Blackhawk apart with no problem at all.

Dr. Llewellyn: I have not heard any response from our colleagues across the sea about the metronidazole suppository. I am not so curious about the suppository, but I am interested in whether anybody still thinks that metronidazole has a specific role for penetrating abdominal wounds.

LTC Cloonan: The information that I found in the literature suggests that it has good anaerobic coverage and is a good drug for penetrating abdominal trauma, but the primary reason that I think it would be used is because it lends itself well to being given as a suppository.

LTC HAGMANN: One of the other drugs that has been mentioned for gut wounds is oral ciprofloxacin. You get levels equivalent to those you get with IV ciprofloxacin. If it is given as an oral medication, it is much easier to carry and administer, but there is no literature to support the use of an oral medication for an abdominal wound.

LTC Hull: The question about rectal antibiotics and fluids is one that has always embarrassed us in the UK because it should never have happened. One of the medical officers who deployed with the Falklands Task Force was, I think, misled by an anesthetist who should have known better, and briefed a whole battalion that they could give IV fluids per rectum.

That does not work for a number of reasons, but mainly because the rectal blood supply in someone who is in shock is not good enough to allow adequate absorption to occur. I had not previously heard about the metronidazole suppositories, although that might be slightly more feasible. The reason we continue to use metronidazole in the UK is because, for most operations, we still have penicillin as our first-line antibiotic to be given by autojet within an hour of wounding. For someone who has an abdominal wound, you clearly have to add something to that to offer the sort of coverage necessary. That is why we still use metronidazole.

Scenario 9

Chest Wound in the Rescue Convoy

Dr. Ken Zafren

- Hostile and well-armed (AK-47s, RPGs) urban environment
- Building assault to capture members of a hostile clan
- Blackhawk helicopter flying air cover for raid shot down by RPG round
- Quick Reaction Force convoy engaged in rescue effort
- Several hundred hostile Somalis in disorganized crowds
- Taking fire from numerous gunmen in crowds
- RPG hits armored personnel carrier in Quick Reaction Force
- Troops move inside house for shelter
- QRF casualty - GSW leg/GSW chest
- Casualty develops increasingly severe difficulty with his breathing

MANAGEMENT PLAN

Care Under Fire

1. Prior to getting the casualty to a safe location, try to stop any accessible major hemorrhage. That may be something that the casualty can do for himself.

Tactical Field Care

1. Assume that any life-threatening bleeding has been controlled by a tourniquet.

2. If he is having difficulty breathing, at least that means that he is breathing and that his airway is clear.
3. We want to relieve the respiratory distress. What causes respiratory distress in someone with a gunshot wound to the chest? This casualty probably has a pneumothorax or a hemothorax. If he has severe respiratory distress, the main thing to be concerned about is a tension pneumothorax. So, do a needle thoracostomy on the side of the injury. How do you diagnose a pneumothorax in the field? You listen and percuss the chest, although this may be difficult if rounds are going off. Do you look for a shift of the trachea? No, I think that type of thing is difficult to appreciate in any environment, including the emergency department. I would not do that because it is going to delay the treatment and possibly mislead you.
4. What happens if the respiratory difficulty persists? I would also consider a needle thoracostomy on the other side if the clinical findings suggest a contralateral tension pneumothorax.
5. If that doesn't work, you can put more than one needle in on each side. It sounds pretty simple, but I have seen people give up after putting only one needle in each side. There is no reason to give up. Put another needle in if you really think there is a tension pneumothorax.
6. What about the location of the needles? I had always been taught that the preferred site is the second or third intercostal space in the midclavicular line. Recently, however, I heard a lecture that said that the fourth or fifth intercostal space in the anterior axillary line should be the preferred site because there are fewer important things there and you are going to put a chest tube in at that location anyway later on. So, you might do it there. I don't know if there is a single right answer. Most of the time when there is controversy over something, it means that either alternative will work equally well or equally poorly and that we have not found the definitive right answer.
7. What happens if a needle thoracostomy is unsuccessful and the patient continues to develop increasing respiratory difficulty? I would accept a certain amount of respiratory distress in this situation, but if the patient is in extremis, as he would be if there were an unrelieved tension pneumothorax, I would consider putting in a chest tube. If you don't have a chest tube in your rucksack, maybe you just want to make a big hole in the chest.
8. With a tension pneumothorax, you are most likely to see respiratory distress before shock, although they might come quickly one after the other. This scenario clearly suggests to me the possibility of a tension pneumothorax.
9. We know that the airway is clear. We will say that the respiratory distress is finally relieved and so now we go back and look at that leg wound. See what

happens when the tourniquet is removed and if the bleeding can be controlled with direct pressure. If a tourniquet was not put on because the wound was not bleeding that much, this would be the time to control the bleeding with direct pressure.

10. What are the indications for Hespan in this scenario? I would go with the recommendations about using decreased mental status as a marker for shock. If the patient is in shock and you have controlled the bleeding, that is where I would use Hespan. There is a caveat to that in this scenario because, if this casualty is in shock from uncontrolled bleeding in his chest, you might reconsider whether you want to give the Hespan.
11. Dress the wounds.
12. Check for additional wounds.
13. Now we come to the issue of morphine sulfate. I had the same questions presented to me that Scenario 8 had about what you would do about morphine. My experience is pretty much the same. We give people 20 milligrams of morphine when they are having heart attacks, and they are still generally lucid and coherent. I would have no hesitation about giving someone 5 to 10 milligrams of morphine, possibly a little bit more, in the field and then giving back the weapon that I have taken away from him if I needed him to use it. Again, re-evaluate the patient. If he is not lucid after the morphine, do not give him back the weapon.
14. If the patient is in shock, he probably does not need morphine. You are treating pain with the morphine and if he is shock, then he is probably not having much pain.
15. You might want to splint the leg wound, especially if there is a possible underlying fracture
16. Giving 2 grams of IV cefoxitin is certainly beneficial.

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DR. Ken Zafren

CASEVAC Care.

1. It is possible that you did not have all the supplies you needed during the previous phases of care. In the CASEVAC phase, pick up what you were previously not able to do.
2. The other presenters have talked about what a chest tube actually does, and I would submit that there are some reasons why you might not want to put a chest tube in until you can definitively manage it. One issue we talked about is clamping the chest tube. My indication for clamping the chest tube in the emergency department is that the cell saver is not ready yet. It is also conceivable that you have some intrathoracic bleeding tamponaded and when you put the chest tube in, you have more bleeding than you are ready to control. So, I think I would go with what seemed to be the consensus earlier, that a chest tube is not absolutely necessary as long as your needle thoracostomy is still working. Ideally you want to wait until the patient can be managed in a much more definitive manner before you put in the chest tube.

Equipment Considerations

1. Eighteen gauge is pretty small bore for a needle thoracostomy. I would recommend a 14 or a 12 gauge, but you can do it with an 18. The advantage of a catheter over a needle is that you do not have the needle sticking out of the patient's chest. You can tape down the catheter. It is flexible and more likely to stay in and do the job.
2. What do you need to do a chest tube insertion? If you read the emergency medicine and surgical literature, you might think that you need an awful lot of stuff on a chest tube tray, but much of what you often find on the tray is just in the way. What is the minimum that you need to put in a chest tube? I think probably a scalpel blade, something to do a blunt dissection with, a large hemostat or scissors, and some kind of tube. If the patient is conscious, a local anesthetic and syringe and needle to administer it with would be greatly appreciated.

Additional Considerations

1. The emergency physicians in the panel and audience who have gone through their boards know that, when you do a scenario for your oral examination, the examiner looks for the critical actions that must be accomplished. I tried to identify what the critical actions in this particular casualty are, and there are really only two - relieve the severe respiratory distress and control the bleeding.
2. I would like to mention something else that we talked about earlier. Is what we are doing evidence-based? There was a paper by Callahan in the Annals of Emergency Medicine a number of months ago, in which he reviewed all of the pre-hospital emergency care data from about 3000 studies. There were

less than one dozen that were prospective, controlled studies, the ones that carry the most weight. Does that mean that everything we do in prehospital care is worthless? He said yes, but it was just to get people's dander up and get them responding to what he said. Another point - if you look at some of the "good" studies, they addressed questions such as, "Is intravenous morphine sulfate better than intravenous normal saline for pain control?" You really don't need a prospective, controlled study to answer that question for you. So, there were even fewer good, prospective, controlled studies than he said. We know that a lot of the things that our prehospital people do are helping patients, but it is unlikely that we will ever be able to do double-blind, controlled studies on all of them. Almost everything that they do now is so entrenched that no one would want to do a study on it because they would feel that the control group was getting disadvantageous treatment.

We know that a lot of the things that our prehospital people do are helping patients, but it is unlikely that we will ever be able to do double-blind, controlled studies on all of them. Almost everything that they do now is so entrenched that no one would want to do a study on it because they would feel that the control group was getting disadvantageous treatment.

Dr. Ken Zafren

DISCUSSION

MAJ White: With regard to putting multiple needles into the chest, I think it is probably a good idea if one did not work to try again, but I think that after two or three needles on each side, a chest tube is a waste of time. The medic may not carry it in his rucksack anyway.

I think you overlooked the fact that this casualty was in an APC that was hit and disabled by an RPG before he tumbled into the street and got shot twice. Maybe the gunshot wound to the chest is only part of the problem. He may have a blast lung injury that you are not going to be able to help by putting more holes in his chest. Doing less is better in some cases.

Dr. Zafren: That is a good point. From what we have heard previously, though, there is not much you can do about a blast injury. I should have emphasized that I do not just stick the needles in haphazardly. You have to reassess after each one and think about the other possibilities as to what could be wrong with him. Whether you can do anything about some of those other possibilities, though, is another issue.

LTC Holcomb: I would like to comment on the issue of clamping chest tubes. If you decide to put one in and blood comes pouring out, then what? When I was a junior surgery resident, I put a chest tube in a patient, lots of blood came out, and the patient started doing very poorly. I clamped the chest tube, but he went on to die. As stated in an article recently published in the Journal of Trauma, it does no good to clamp chest tubes if the patient is becoming hypotensive and blood is coming out. (1)

We spent a lot of time on tension pneumothorax. That's because, if that's what the soldier has, you can save his life with a needle. So, I think it is worth spending time on.

LTC. Hagmann: We have had several chest tube scenarios, and one issue has been brought up a couple of times, but was breezed over. Several of you have said, "Re-inflating the lung is probably the only way that you are going to be able to control some types of hemorrhage within the thoracic cavity short of a surgical intervention," and indeed, it does work. The literature is there. For trauma to the lung parenchyma, re-inflating the lung does help to stop that bleeding. It is not simply a question of whether or not the casualty has a tension pneumothorax. If he is bleeding from that lung wound, not putting in a chest tube can allow a slow bleed to continue. I recently took care of a patient who, 4 hours after a stab wound to the chest, presented with a liter and a half of blood in his chest. Once his chest tube was put in, he stopped bleeding.

Dr. Zafren: That is an excellent point, but as was pointed out before, some of that hemostatic effect is thought to be due to either positive pressure ventilation or suction on the chest tube, neither of which you can provide in the field.

Dr. Hagmann: That is actually a research question that CAPT Butler needs to write down because the question has not been answered. If you put a Heimlich valve (or some reasonable representation of a Heimlich valve) on a chest tube, do the excursions of the chest give you enough re-inflation and negative pressure to re-inflate the lung? If you look at the old literature, when they first started putting in chest tubes, all they used was some sort of one-way valve device and they seemed to have pretty good results.

Dr. Zafren: And, if you do not have a one-way valve, you can improvise one from the finger of a surgical glove. It is not too hard to do.

LTC Holcomb: In pigs, you can put a scope in the chest while they are still alive, and spontaneously breathing with a needle in their chest hooked to a Heimlich valve, and the lung does not re-expand. This has been shown with about 20 consecutive animals. So, Doctor Hagmann, your question is a good one, and the answer is that the lung does not re-expand. Talk about the plastic catheter that is in the chest being displaced by the re-expanding lung is mistaken because the lung does not re-expand in the absence of suction.

LTC Hagmann: Was that a needle or a chest tube that was put in?

LTC Holcomb: Either one. The lung does not re-expand when you only relieve the tension pneumothorax. The lung re-expands by two mechanisms. You blow it up by positive pressure or you suck it up by putting your chest tube on suction, and obviously neither one of those is available on the battlefield.

Cpt Johnson: My type of environment is a little bit different. I reviewed the literature prior to coming here because I wanted to give definitive guidance to my medics on what to do when they receive a patient who has a needle thoracostomy and a long, 4-hour plus evacuation time on a helicopter. Now that we have the refueling probes on helicopters, you can fly almost indefinitely. So, what are you going to do? You cannot hear breath sounds well. You have pulse oximetry and you can palpate his pulse, but that is about it. My guidance to the medics is that, if it is a long evacuation time, a casualty with a chest wound needs a more definitive decompression of the chest. From what I have seen in the literature and have learned from practical experience, a 14-gauge needle clots frequently. Also, you may have other patients in that helicopter to be concerned about, so if you can do a more definitive treatment for that patient so that you do not have to worry about him as much, I think that is a good thing. One study in Air Medical Transport in the UK had paramedics and nurses do chest tubes in the field, although they had short evacuation times. What they found was that there was actually no difference in the morbidity and mortality of

those patients. So, if I gain the advantage of not having to worry so much about that 14-gauge needle clotting by putting the chest tube in, that is of some benefit. What does the panel think of that?

Dr. Zafren: That is the other shortcoming of almost all our prehospital studies. It is like the fluid resuscitation data. They are all very short transport times, usually less than 15 minutes. There is not much about 4-hour transport times.

LTC Cloonan: I posed this question to Cook Catheters, a company that makes a device that is intended to be used in patients who come into the emergency department with spontaneous pneumothorax. Whereas traditionally we have had to admit these patients to the hospital for re-expansion of the lung with a chest tube, Cook Catheters now makes a very flexible catheter that can be put in, and the patient can be discharged with it in place. That would seem to be ideal for the kind of scenario we are considering here. However, a problem with it is that the cost is somewhere up around \$200. Remember also that you have to be careful when you try to take the results obtained from one population and then say that the same results would be obtained from another population or under different circumstances. The Cook Catheter is, however, relatively easy to use, relatively low risk, and maybe a little bit safer and quicker to do than trying to put in a standard chest tube.

COL Serfustini: I am sure that this audience is aware that approximately 85 percent of wounds and injuries in the field are going to have some orthopedic component. If you look at the morbidity from the orthopedic wounds from any exercise in the last 10 or 12 years, you will see that, of the penetrating joint injuries that were treated expeditiously with splinting, every single one of those injured was boarded out of the service. The Marines have looked at urban warfare extensively, and the casualty rates that were seen in Mogadishu are probably relatively low compared to some of the casualty rates that may be incurred in future operations. We need to have some sort of locator mechanism that will tell us (1) where the casualty is and (2) whether that casualty is alive or dead.

SGT Miller: I think that sometimes we forget that this is about the medic on the ground and how he detects or understands a pneumothorax. I train our medics to consider just whether or not the casualty has penetrating chest injury, whether or not there is unilateral chest movement, and whether or not there is increasing respiratory distress. If the answer is yes, then that casualty is getting needed. It doesn't matter if he does not have jugular vein distension because he could be hypovolemic. It also does not matter whether or not he has tracheal deviation. If he has the three things I mentioned, he is getting needed.

Dr. Zafren: I would agree with you, and that is why I took the approach that I did.

MAJ White: Two questions for Dr. Holcomb. You said that Heimlich valves do not appear to re-expand the lung without suction. Can you use some kind of hand suction like a syringe to pull the air out and re-expand the lung? The second question is, is it merely the weight of the blood pushing against the lung that prevents re-expansion or will air alone do the same thing?

LTC Holcomb: The answer to the first question is that you cannot hook anything up to the Heimlich valve that is going to bring the lung up because of the way that little floater valve is in there. Air comes out, but you cannot apply pressure through that thing. So, you would have to suck on the needle that you put in. That would be kind of tedious, I think. I have looked through the 91 Bravo and 91 Charlie and other medic manuals. Some of them describe three-way stopcocks and sucking air out. That is kind of crazy. You are not going to do that. I agree with Sergeant Miller. You look at the mechanism of injury. If you have holes in the chest and you have tachycardia and respiratory distress and the casualty is not doing well, put a needle in.

I think that sometimes we forget that this is about the medic on the ground and how he detects or understands a pneumothorax. I train our medics to consider just whether or not the casualty has penetrating chest injury, whether or not there is unilateral chest movement, and whether or not there is increasing respiratory distress. If the answer is yes, then that casualty is getting needed.

SFC Bob Miller

For the second question, the lung collapses because you have positive intrathoracic pressure throughout the respiratory cycle - it is not just the blood present in the thoracic cavity. I guess that, if you could get the soldier to Valsalva, you might possibly be able to blow the lung up and do something for hemostasis, but I can tell you that on 20 consecutive animals it did not come up.

You also have the ambu bag. If you had a bag valve mask set up and a compliant patient, you could try to blow the lung up. But as somebody said earlier, if you can do that to a soldier in the field, he is probably already dead.

If there were just one casualty, and you were able to work on him exclusively, I would try lots of things. If you have a lot of casualties, I would probably needle him and move on. I think that someone asked how long that would last for? What he is really asking is, "Can I put it in and forget it and move on? How closely must the needle thoracostomy be observed?" If you hook it up to a Heimlich valve, as long as it has air going through it, then the needle thoracostomy is patent. If there is no air movement, it means the tube is clotted. This has been seen in animals, and the tension immediately redevelops. It is amazing that the needle thoracostomy does not clot more frequently, because we have blood in the chest and it is coming out through there.

Dr. Lowe: For 20 years, we have tried to reinforce that the definition of a tension pneumothorax is increasing respiratory distress in the face of hemodynamic instability. I have never had pointy things stuck in my chest, but I expect that that alone gives you some amount of respiratory distress. I do not think we want to give the message that everybody who gets shot or stabbed in the chest needs to have six or eight needles stuck in their chest until they feel better, because they are not going to feel completely better. The thing you are looking for is to correct their hemodynamic instability. They are still going to be short of breath. Bullets do that.

The second thing is that it is wrong to say that putting a chest tube in cannot do any damage. There are cases where chest tubes have been inserted into lungs or even liver tissue. I understand what everybody is saying, but I would rather that the corpsmen pay attention to the casualty's respirations and feel his pulse. If he is becoming worse, then do second needle thoracostomy instead of trying to put in a chest tube. I would not like to have to treat a liver wound in addition to of the chest wound.

Dr. Nelson: I would ask that when you look at research results that you keep in mind that, if we are transloading to a Talon or a Shadow, (Ed. note: Fixed wing aircraft) we may be going up several thousand feet, not necessarily staying at ground level. A needle or catheter may not work as well in at altitude. For the Talon and Shadow community, they may need to insert a chest tube, even though the needle is perfectly successful at ground level.

COL Bagian: From previous comments, it seemed that our original ground rules were that we were not going to use chest tubes for tactical reasons in the field. I think it is different during CASEVAC. If you wind up having the casualty at altitude, you may have to worry about an evolving tension pneumothorax that you did not have before.

Dr. Llewellyn: I would just like to reinforce what Doctor Bagian was saying. CAPT Butler and LTC Hagmann's paper clearly identified different stages of care, and they also alluded to the fact that there is a responsibility for the SOF physicians, if they are going to be using aircraft for CASEVAC, to train teams and equip them appropriately.

Most of what we have discussed has to be put aside once you get into the CASEVAC setting. I think it is a great thing that, at the end of day, people have started to ask these kinds of questions, because there is no reason why doctors or medics on a Combat Casualty Transport Team could not take the time to do endotracheal intubations. You ought to have people in the CASEVAC phase who are doing chest tubes a lot more frequently than the combat medical personnel on the ground. On the aircraft, there is no reason why you cannot have the kind of suction that is required to re-inflate the lung, etc. I think that is a whole separate topic.

The other thing that I wanted to comment on is that somebody pointed out that we have spent most of the day dealing with what is in general a very small percentage of all the casualties that occur on the battlefield. Let us not forget that the highest percentages of penetrating wounds are caused by fragments and not by gunshot wounds. As Ron Bellamy and a variety of other people have shown, the majority of those whose integument is penetrated are going to do very well, thank you very much, no matter what we do to or for them. At the other end of the spectrum, there will be casualties that you cannot do anything for. There is a small fraction of the casualties, maybe 7 to 15 percent or so, whose lives may depend on the life-saving interventions of our combat medical personnel. We sometimes still have difficulty identifying this group. I doubt that Personal Status Monitors (PSMs) are ever going to help us with that. All of the PSMs that I have seen so far, I would not trust. Another thing to consider is that a technology that allows you to find your casualty when you have lost him could also be used against you. If the bad guys can find out where you are by sending out a signal that causes your position to be revealed, they may be the ones who show up instead of an evacuation team.

As Ron Bellamy and a variety of other people have shown, the majority of those whose integument is penetrated in combat are going to do very well, thank you very much, no matter what we do to or for them. At the other end of the spectrum, there will be casualties that you cannot do anything for. There is a small fraction of the casualties, maybe 7 to 15 percent or so, whose lives may depend on the life-saving interventions of our combat medical personnel.

COL Craig Llewellyn

LTC Hagmann: I think that, in every presentation, there has been at least one reference to the fact that data and cases and experience are often lacking for the type of medicine that we do. This is probably our biggest problem in SOF medicine. The community is very fragmented. The operations we do are usually small and often classified. The numbers are scattered over a large time and space so that the ability to accumulate statistics the way the civilian community does just does not exist for us. That is our weakness. One way of addressing that is to look very closely at the experience and the cases that we do have, even if it is only 100 cases or so.

We hope that, in the future, the Medical R&D commands will be willing to support the archiving of medical statistics from battles involving U.S. forces, so that this data can be analyzed and the medical lessons learned extracted. That is one technique of getting access to data.

The other way is to look at what you, the operators and the medics in this field, have actually done during operations in the past. Dr. Holcomb and I would like to ask that if, you have actually done any needle thoracostomies, tourniquet

applications, cricothyroidotomies or chest tube insertions, that you write down which ones and how many you have done. Dr. Holcomb and I will follow up with you later to get additional information so that we can begin to develop a database.

Mr. Leitch: Somebody earlier alluded to the Marine Corps and their work in urban warfare. I was a co-author of a study on urban warfare casualty rates and patterns that looked at 50 year's worth of urban warfare. Having listened to the proceedings today, I know that this particular operation fits perfectly into what has gone before. One of the major lessons from the urban warfare study was that almost all technology fails you at some point. It does not matter who the hell you are. Technology failed in Mogadishu from the helicopter down to the armored ambulance. Every technology fails you, and you are down to moving casualties by carrying them. That is a major issue for us all because how many of us have ever carried a Cliff Cloonan (Editor's note: Dr. Cloonan is 6'2" and about 225 pounds) under fire? And we may have to. Certainly one of the major lessons that came out of the previous study was that, almost invariably, you have to fight for casualties and often you have to leave them to die. If you don't, you will end up with more casualties. All of these issues have come out today and I would like to support John Hagmann's suggestion that this become a major study in the future.

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Concluding Remarks

CAPT Butler

I think it would be fitting to end with an observation drawn from Colonel Bellamy's writings and lectures. If, during the next war, you could do only two things, namely (1) put a tourniquet on and (2) relieve a tension pneumothorax, then you can probably avoid between 70 and 90 percent of all the preventable deaths on the battlefield. So, as we talk about all the courses and training open available to our physicians and combat medical personnel, let us never lose sight of those two simple yet very important things that can be done.

We have heard a lot of talk about evidence-based medicine. I think it is important to do that where we can, but in the world where many of the people in this room live and operate, we have to deal with a combination of medicine and tactics that the medical literature will never be able to address adequately. You have to be smart. You have to use your good judgment. You have to do what your particular situation calls for. Evidence-based medicine is a good goal, but you are probably going to save more lives with smart tactics than evidence-based medicine.

I would like to thank the panel for a superb job in presenting the scenarios and the audience members for their participation in the discussions. If anyone has any ideas or suggestions for scenarios for future workshops, we would be grateful to hear them. I encourage each of you to identify and document difficult scenarios that you may have encountered in your professional life so that they can be considered for inclusion in future workshops.

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