tions such as airway assessment; oxygenation and ventilation; aspiration prophylaxis; cervical spine protection; and confirmation of tracheal intubation. However, it differs from other algorithms in the presentation of the six limbs, i.e., 1) first responder limb for providers who generally do not possess tracheal intubation skills and may or may not have rescue ventilation skills; 2) nonintubation technique limb, which allows the provider to opt out of using tracheal intubation if the situation dictates and to either continue with a nonrebreathing mask or bag-valve mask ventilation or proceed with a minimally invasive technique such as Combitube, COPA, Easy Tube, King LT or LMA; 3) rescue ventilation limb, which provides for rapid insertion of a Combitube or LMA or LMA-Fastrach in the presence of a crash airway or failed airway situation; 4) difficult intubation limb, which provides options for facilitating a difficult intubation; 5) RSI limb, which focuses on appropriate use of rapid sequence intubation; and 6) cricothyrotomy limb for application if rescue ventilation fails.

The flowchart assists in improving oxygenation and ventilation regardless of the provider's skill level. Other contributions include use of limiting intubation attempts to avoid traumatizing the airway or creating a "cannot ventilate–cannot intubate";[6] "Mason's PU-92 Concept" for rapid recognition of the crash airway[1]; maxims and special considerations to facilitate airway safety; technique adjustment if adequate oxygenation is not being attained or maintained; clear criteria for application of rescue ventilation to treat a failed or crash airway; criteria for application of cricothyrotomy; and near-failsafe devices in all locations to confirm tracheal intubation. Use of color to show safe blocks, danger blocks, decision blocks, consideration blocks, and action blocks aids in instruction and acquisition of information.

Conclusions. A flowchart has been developed that can be used by all practitioners involved in emergency airway management. It provides a platform for teaching critical decision-making skills to diverse practitioners. It is hoped that a tool can be developed to measure its effect on providers' ability to apply critical decision-making skills effectively in emergency airway management. The flowchart is germane to that common area of emergency airway management where the diverse fields of anesthesiology, emergency medicine, and prehospital care coincide.

References

1. Mason AM. The Laryngeal Mask Airway (LMA) & Intubating Laryngeal Mask Airway (ILMA) in Prehospital Trauma Care. Presentation at the Royal College of Anaesthetists, London, May 13, 2002.
2. ASA Task Force on Management of the Difficult Airway. *Anesthesiology* 1993; 78:597.
3. Gabbott DA. Management of the airway and ventilation during resuscitation. *Br J Anaesth* 1997; 79:159–71.
4. Walls RW. The emergency airway algorithms. In Walls RW, ed. Manual of Emergency Airway Management. Philadelphia: *Lippincott Williams & Wilkins,* 2000, pp 16–26.
5. Smith CE, Grande CM, Wayne MA, et al. ITACCS Rapid Sequence Intubation (RSI) in Trauma [poster]. 10th ATACCS. Baltimore, May 1997.
6. Benumof JL. The ASA Difficult Airway Algorithm: new thoughts and considerations. In Hagberg CA, ed. *Handbook of Difficult Airway Management.* Philadelphia: Churchill Livingstone, 2000, pp 31–48.

Friday, May 16, 2003

Simultaneous Morning Sessions

— Session A —

Trauma Airway Management

Chair: Andreas Thierbach, MD, Mainz, Germany

The ASA Difficult Airway Algorithm As It Pertains to Trauma Patients

William C. Wilson, MD
University of California, San Diego School of Medicine, San Diego, California, USA

Learning Objectives: *1) to review the ASA difficult airway (DA) algorithm, 2) to recognize that most of the important elements of the algorithm apply equally well to the elective setting and the emergency trauma setting, and 3) to identify special considerations and solutions related to trauma airway situations.*

Pre-induction Airway Evaluation. The ASA DA Algorithm (Figure 1) begins with recognition of airway difficulty. Whenever the patient is recognized to have a difficult airway (and the patient is stable and cooperative), the clinician should secure the airway awake.

Awake Limb of the ASA Algorithm. The ASA DA algorithm does not endorse any particular airway technique. However, it does emphasize that the patient must be properly prepared (both mentally and physically) for an awake technique, and the physician must ensure continuation of spontaneous ventilation and adequacy of O_2 saturation.

Stopping to Come Back Another Day (Seldom an Option with Trauma). If awake intubation techniques fail, one can, and should, consider stopping, maintaining spontaneous ventilation, allowing the patient to recover from topicalization or sedatives and resume management later with a better plan (other equipment/personnel). However, stopping is seldom an option when managing the emergency trauma airway.

Anesthetized or Uncooperative Patient Limb of ASA Algorithm. There are three common conditions when the need arises to intubate the trachea of an unconscious or anesthetized patient with a DA: 1) The clinician fails to recognize a difficult airway in preoperative evaluation prior to the induction of anesthesia. 2) The DA patient who is already unconscious prior to being assessed by the trauma anesthesiologist. 3) The patient has an obvious DA but is hemodynamically unstable (i.e., following trauma) or absolutely refuses to cooperate with an awake intubation (child, or mentally retarded, or drugged or head-injured adult). Once the patient is anesthetized or is rendered apneic or presents comatose and the trachea cannot be intubated, O_2-enriched mask ventilation is attempted. If adequate, a number of intubation techniques may be employed. Techniques allowing continuous ventilation during airway manipulations are favored over those requiring an interruption of mask ventilation (e.g., fiberoptic bronchoscope, via an LMA or an airway intubating mask, with self-sealing diaphragm). Alternatively, techniques requiring a cessation of ventilation (at least temporarily) can be employed (these techniques are relatively contraindicated for patients with large right-to-left transpulmonary shunt or decreased FRC).

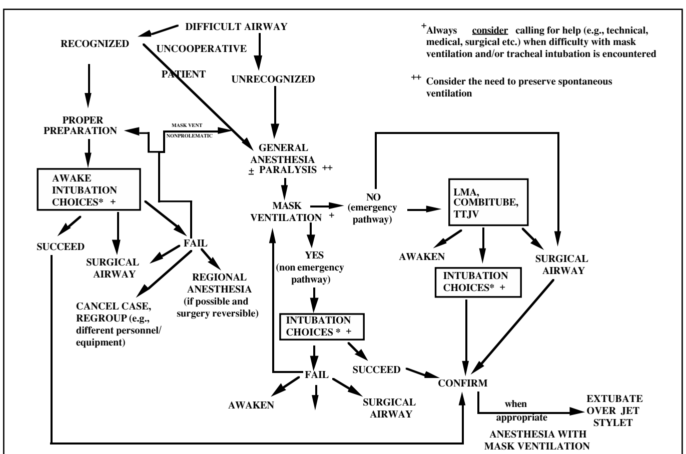


Figure 1. The ASA Difficult Airway Algorithm from References 1 and 2.
*Non-surgical tracheal intubation choices consist of laryngoscopy with a rigid laryngoscope blade (many types), blind orotracheal or nasotracheal technique, fiberoptic/stylet technique, retrograde technique, illuminating stylet, rigid bronchoscope, percutaneous dilational tracheal entry. See Reference 2 for a complete discussion of these TI choices.

Three Emergency Airway Aides (LMA , Combitube, and TTJV) Assist the Cannot Intubate/Cannot Ventilate Patient. When confronted with this type of patient, three alternative ventilation methods should be considered (Combitube, LMA, TTJV). Once ventilation is established with one of these methods, other more definitive (and time-consuming) techniques of airway management may be considered.

Confirmation of Endotracheal Tube Position. Immediately after the patient's trachea is intubated, one must confirm endotracheal tube position with end tidal CO_2 measurement. If end tidal CO_2 measurement is unavailable, the Wee's esophageal detector device is reasonably reliable (close to 100% sensitive and specific).

Extubation or Endotracheal Tube Change of the Difficult Airway. If the conditions that caused the airway to be difficult to intubate still exist at the time of extubation, or if new DA conditions exist (e.g., airway edema, Halo), then the trachea should be extubated over an airway exchange catheter and/or with the assistance of a fiberoptic bronchoscope.

References

1. Benumof JL. Laryngeal mask airway and the ASA difficult airway algorithm.. *Anesthesiology* 1996; 84:686-99.
2. Wilson WC, Benumof JL. Pathophysiology evaluation and treatment of the difficult airway. *Anesthesiol Clin North Am* 1998; 16(1):29-75.

Controversies and Obstacles to Airway Training for Paramedics

Adolph H. Giesecke, MD
Retired Jenkins Professor and Former Chairman, Anesthesiology and Pain Management
Univeristy of Texas Southwestern Medical School, Dallas, Texas, USA

Medical doctors, paramedics, and educators all agree that paramedics should be taught management of the airway. Curriculum should include evaluation of the airway and breathing, airway-clearing maneuvers, bag and mask ventilation, oral and nasal airway insertion, and endotracheal intubation. Teaching methods should include lectures, teaching movies, manikin practice, and experience in an operating room supervised by an anesthesiologist or nurse anesthetist. Most programs require a minimum of five supervised intubations before the course is complete. The supervised OR experience improves the successful attempts in the field from 50% to 95%.

The supervised OR experience carries proven benefits to the paramedic and to the patients, but it is becoming less and less available over the nation. One by one hospitals, anesthesiologists, and nurse anesthetists have withdrawn from offering this valuable training to paramedics. The reasons offered include fear of liability, advice of liability insurance carriers, problems with informed consent and increasing use of the LMA in routine surgery.

I don't have magic bullets to propose to solve the problem, except to strongly repeat the time honored argument, "When you have your cardiac arrest, what level of success will you accept from your paramedic: 50% or 95%?" Anesthesiologists and nurse anesthetists must continue to offer this training. Insurance companies must accept the minimal risk associated with this training, and we must all work on the problem of informed consent. We must also carefully evaluate the use of the LMA and Combitube as rescue airways in emergency medical services.

Airway Management with Penetrating Neck Trauma

Vance E. Shearer, MD
Associate Professor, Department of Anesthesiology and Pain Management; University of Texas Southwestern Medical Center at Dallas; Dallas, Texas, USA

Learning Objectives: *1) To understand the need for an individualized approach to patients with penetrating neck injuries, 2) to appreciate the indications for and utility of fiberoptic bronchoscopy and retrograde intubation in the management of penetrating neck trauma, 3) to understand the need for topical anesthesia during bronchoscopy, 4) to realize the dangers associated with blind intubation and direct laryngoscopy during the management of penetrating neck trauma, and 5) to recognize the situations in which creation of a surgical airway is warranted.*

The airway can be distorted significantly by a penetrating neck injury. Standard management algorithms do not adequately cover the establishment of a secure airway in patients with this type of injury. Until prospective studies are completed, the best technique for intubation remains controversial; meanwhile, each patient's airway must be approached on an individual basis.

Fiberoptic Bronchoscopy. Awake and spontaneously breathing patients can usually maintain a patent airway. Spontaneous ventilation avoids the potential complications of positive pressure ventilation, e.g., barotrauma or disruption of an injured trachea. Intubation over a fiberoptic bronchoscope (FOB) has the advantages of both an awake, spontaneously breathing patient and the ability to examine the airway distal to the glottis. In the absence of significant bleeding, a tracheal wound can be identified and the ETT cuff placed distal to the injury. If the wound is sufficiently large or is at the level of the cricoid ring, then the intubation can be aborted and a tracheostomy with local anesthesia performed. Few anesthesia providers possess proficiency in awake bronchoscopy under emergency conditions; therefore, alternative methods of securing an airway may be necessary.

For an awake FOB technique, the airway must be anesthetized to avoid coughing, gagging, and vomiting. Transtracheal injection of local anesthetic is probably best avoided in the management of penetrating neck injuries, because it tends to cause significant coughing. Administration of a mixture of 4% lidocaine with sterile water through a nebulizer appears to decrease coughing and gagging during subsequent topicalization of the airway and provides adequate tolerance of the ETT. Others have reported that gargling with viscous lidocaine followed by spraying 4% lidocaine through the suction port of an advancing FOB is effective and efficient. However, we refrain from the use of viscous lidocaine for fear of dislodging tamponaded hemorrhage. Whatever technique of topicalization is utilized, it is important that the airway is anesthetized adequately. Topicalization of the airway can take 5 to 20 minutes, which may be too long for some patients, and will not be effective in patients with significant bleeding or secretions.

Blind Intubation. Blind attempts at endotracheal intubation are contraindicated because they may worsen existing injury, leading to airway obstruction or passage of the ETT into a false passage. An awake patient may cough, buck, or vomit during the attempt, causing loss of the airway. The sympathetic response in an awake patient may increase heart rate and blood pressure, overcoming hemostasis and causing an expanding hematoma to distort the airway.

Direct Laryngoscopy. Direct laryngoscopy after rapid sequence induction (RSI) has a high success rate. However, it is a blind procedure after the ETT passes the glottic opening. Since there is a small potential for blindly placing the ETT through a tracheal wound, initial breaths should be administered softly until the ETT is confirmed to be in the trachea by continuously expired end-tidal CO_2.

Fiberoptic-Assisted Direct Laryngoscopy. Although direct laryngoscopy has a high success rate, the author suggests combining FOB or the Shikani Seeing Stylet with direct laryngoscopy to decrease the possibility of blindly placing the ETT through a tracheal wound. This technique involves RSI, with placement of the FOB (preloaded with an ETT) through the vocal cords under direct laryngoscopy. The addition of the FOB allows intubation and inspection of the trachea and helps ensure the ETT cuff is distal to a tracheal injury. The FOB may also stent the airway during ETT passage, thereby avoiding additional trauma to the trachea. The Shikani Seeing Stylet is also ideal for visualizing the airway during intubation. Oxygen can be insufflated through the FOB's suction port or the stylet's side port.

Although the author recommends direct laryngoscopy, especially combined with fiberoptics, the problem is to identify and predict those patients who will be impossible to intubate and will require a surgical airway as the primary choice. Therefore, each patient's injuries must be evaluated and managed on an individual basis.

Retrograde Intubation. Retrograde intubation has been successful in patients with severe maxillofacial injuries and therefore may be especially useful with a Zone III pharyngeal injury. In experienced hands, this technique can be performed rapidly and is especially useful with airway hemorrhage. However, excessive upper airway tissue destruction and edema may prevent passage of the ETT into the trachea. Much of this procedure is blind and may dislodge a previously tamponaded hematoma, causing massive bleeding.

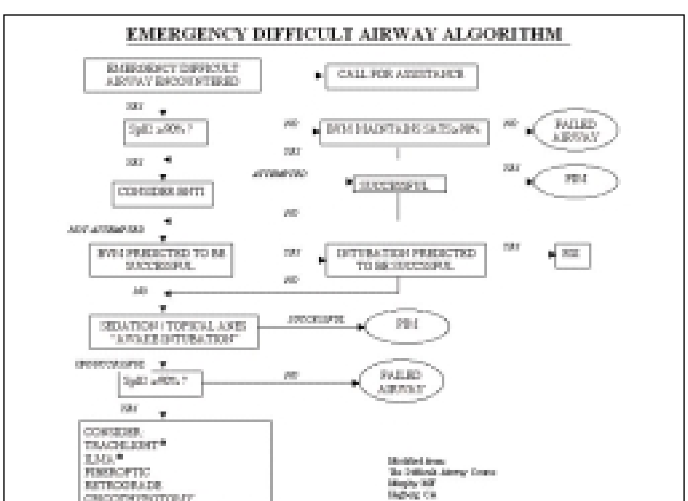
Surgical Airway. Creation of a surgical airway is the best first choice in some situations:

- Failure to intubate
- Cricoid ring injury
- Significant laryngeal injury
- Excessive hemorrhage
- Significant tracheal deviation
- Trauma-induced airway obstruction
- Quadriplegia
- Significant upper airway tissue edema and destruction

The Difficult and Failed Airway in the Trauma Patient

Jeffrey M. Berman, MD
University of North Carolina, Chapel Hill, North Carolina, USA

Learning Objectives: *1) To identify the difficult airway in the trauma patient, 2) recognize when an intubation failure has occurred, 3) to utilize specific algorithms, 4) to develop personal strategies for emergency airway management.*



Expectations. As anesthesia providers, we are called upon to provide airway management in any area of our hospital where the need arises, including critical care units and the emergency department. Often the circumstances are chaotic and the environment difficult. Moreover, we can be confronted with an obviously difficult airway–facial trauma, airway edema or hemorrhage, hematoma of the neck, or other anatomic abnormality. Nevertheless, the expectation is that we will secure the airway in a timely manner while simultaneously maintaining oxygenation. Though this should always be our goal, it ought be recognized that it is sometimes an unrealistic expectation.

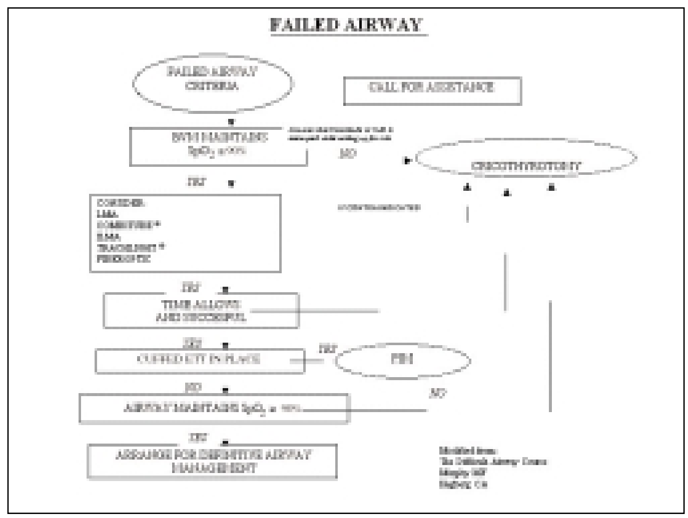
Airway Evaluation. The need and value of an adequate and accurate airway exam cannot be overstated. Predicting a difficult airway can and often averts catastrophic loss of airway control. Careful attention should be paid to predictors of difficult bag-valve mask ventilation as well as those stigmata that might predict difficulty for tracheal intubation.

The Emergency Difficult Airway Algorithm. Developed by Murphy, Hagberg, Walls, et al, it specifically deals with the emergent difficult setting. It is a binary decision tree specifically designed for use in emergency situations outside the elective anesthesia setting. It seamlessly couples with the Failed Airway Algorithm.

Predicted Difficult Airway. It is universally held that the best approach is to secure the airway with the patient awake. In the stable and cooperative trauma patient, this may not be problematic. However, in the unconscious and/or unstable patient, management becomes far more urgent and difficult often because of declining cardiovascular and/or respiratory status.

Unpredicted Difficult Airway. This situation can easily degenerate very quickly, especially if bag-valve mask ventilation is impossible or difficult. If SPO_2 can be maintained above 90%, more options are available. However, if SPO_2 falls below 90%, time to assure adequate oxygenation becomes critical and the options for doing so become fewer. In this situation, one must have the confidence and ability to perform a needle cricothyrotomy or employ a commercial cricothyrotomy kit in short order.

The Failed Airway. Recognition that the situation has become extremely time critical and preparations for a surgical airway must be made. Initiation of this algorithm is triggered by inability to maintain SPO_2 greater than 90% by bag-valve ventilation after attempt(s) at tracheal intubation.



The Role of the Combitube (ETC) and the EasyTube (EzT)

Andreas R. Thierbach, MD
Consultant Anesthesiologist, University of Mainz, Mainz, Germany

Learning Objectives: *To discuss the function, uses, advantages, and disadvantages of the Combitube and to introduce an enhancement of the ETC, the EasyTube.*

The ETC is a double-lumen tube that is introduced blindly into the mouth, combining the functions of an esophageal obturator airway (EOA) and a conventional endotracheal airway. It is manufactured in two sizes: Combitube 37 F SA (=small adult) and Combitube 41 F.

The device is designed to ventilate the lungs, whether the distal end enters the esophagus or the trachea. The longer channel has an open distal end, and the other channel has a blind end with multiple small openings at supraglottic level. There is a small-volume distal cuff and a large-volume proximal cuff designed to obliterate the hypopharynx. If the long tube enters the esophagus (as it does in the majority of cases), the patient is ventilated through the small openings above the glottic level. The tidal volume is directed toward the glottis and is prevented from passing elsewhere by the inflated distal and hypopharyngeal cuffs. If the tube enters the trachea, ventilation is performed via the open distal channel.

The ETC has been used successfully as an artificial airway during cardiorespiratory arrest. The device has also been evaluated for use by ICU nurses and by paramedics in the prehospital setting. The ETC is an effective substitute for tracheal intubation in cases where there is a lack of expertise or familiarity in endotracheal intubation, or there is an inability to intubate caused by difficult anatomy, or when patients are trapped in unusual positions.

A disadvantage of the ETC is that suctioning of the trachea is impossible in the esophageal position. Complications of the device include lacerations of the pharynx and hypopharynx, esophageal or tracheal perforation, and the inability to provide adequate ventilation. The Combitube is, however, contraindicated in the following circumstances: patients shorter than 4 feet; patients with intact gag reflexes irrespective of their level of consciousness; patients with known esophageal pathology; patients who have ingested caustic substances; and patients with obstruction of the upper airways, e.g., foreign bodies and tumors.

Since May 2003, the so-called EasyTube (EzT) has been available on the European market. The device will be available on the U.S. market in 2003. It represents a further development of the ETC. Major advantages of the EasyTube include a special double-lumen design, including a tip resembling a standard endotracheal tube. This tip facilitates tracheal intubation, but still enables ventilation when positioned in the esophagus. Furthermore, the trachea is accessible in the esophageal and endotracheal position of the tip of the tube. The large volume proximal cuff is made of Neoprene; therefore, the device is suitable for patients allergic to latex.

The EzT is available in two sizes (41 and 27 Fr), making the device applicable for patients from a height of 90 cm on.

SLAM Emergency Airway Flowchart: Universal Considerations for the Emergency Airway

James M. Rich, MA, CRNA
Baylor University Medical Center, Dallas, TX, USA

Learning Objective: *To understand the need for acquisition of critical decision-making skills to effectively deal with a wide range of emergency airway situations.*

Purpose of Work. The purpose of the work was 1) to collate and organize current information on emergency airway management in a single flowchart that provides a clear strategy for effectively dealing with emergency airway situations that occur in and out of the hospital; 2) to teach rapid recognition and treatment of a "crash" or "failed" airway; 3) to assist practitioners in developing critical decision making skills for emergency airway management. Although it can be applied in the operating room, it was primarily developed for providers outside the operating room and hospital.

Method Used. A literature review was used to collect current peer-reviewed information on emergency airway management.

Results. Material was drawn from peer reviewed sources[1–5] to develop a single "all-in-one" flowchart that provides a clear strategy for dealing with a wide array of emergency airway situations. It is similar to other flowcharts in its coverage of common airway considerations such as airway assessment; oxygenation and ventilation; aspiration prophylaxis; cervical spine protection; and confirmation of tracheal intubation. However, it differs from other algorithms in the presentation of the six limbs, i.e., 1) first responder limb for providers who generally do not possess tracheal intubation skills and may or may not have rescue ventilation skills; 2) nonintubation technique limb, which allows the provider to opt out of using tracheal intubation if the situation dictates and to either continue with a nonrebreathing mask or bag-valve mask ventilation or proceed with a minimally invasive technique such as Combitube, COPA, Easy Tube, King LT or LMA; 3) rescue ventilation limb, which provides for rapid insertion of a Combitube or LMA or LMA-Fastrach in the presence of a crash airway or failed airway situation; 4) difficult intubation limb, which provides options for facilitating a difficult intubation; 5) RSI limb, which focuses on appropriate use of rapid sequence intubation; and 6) cricothyrotomy limb for application if rescue ventilation fails.

The flowchart assists in improving oxygenation and ventilation regardless of the provider's skill level. Other contributions include use of limiting intubation attempts to avoid traumatizing the airway or creating a "cannot ventilate–cannot intubate";[6] "Mason's PU-92 Concept" for rapid recognition of the crash airway[1]; maxims and special considerations to facilitate airway safety; technique adjustment if adequate oxygenation is not being attained or maintained; clear criteria for application of rescue ventilation to treat a failed or crash airway; criteria for application of cricothyrotomy; and near-failsafe devices in all locations to confirm tracheal intubation. Use of color to show safe blocks, danger blocks, decision blocks, consideration blocks, and action blocks aids in instruction and acquisition of information.

Conclusions. A flowchart has been developed that can be used by all practitioners involved in emergency airway management. It provides a platform for teaching critical decision-making skills to diverse practitioners. It is hoped that a tool can be developed to measure its effect on providers' ability to apply critical decision-making skills effectively in emergency airway management. The flowchart is germane to that common area of emergency airway management where the diverse fields of anesthesiology, emergency medicine, and prehospital care coincide.

References

1. Mason AM. The Laryngeal Mask Airway (LMA) & Intubating Laryngeal Mask Airway (ILMA) in Prehospital Trauma Care. Presentation at the Royal College of Anaesthetists, London, May 13, 2002.
2. ASA Task Force on Management of the Difficult Airway. *Anesthesiology* 1993; 78:597.
3. Gabbott DA. Management of the airway and ventilation during resuscitation. *Br J Anaesth* 1997; 79:159–71.
4. Walls RW. The emergency airway algorithms. In Walls RW, ed. Manual of Emergency Airway Management. Philadelphia: *Lippincott Williams & Wilkins,* 2000, pp 16–26.
5. Smith CE, Grande CM, Wayne MA, et al. ITACCS Rapid Sequence Intubation (RSI) in Trauma [poster]. 10th ATACCS. Baltimore, May 1997.
6. Benumof JL. The ASA Difficult Airway Algorithm: new thoughts and considerations. In Hagberg CA, ed. *Handbook of Difficult Airway Management.* Philadelphia: Churchill Livingstone, 2000, pp 31–48.

Flexible Fiberoptic Intubation

Freddy Lippert, MD
Trauma Center and Major Incident Command Centre, H:S Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark

Learning Objectives. *To understand 1) the need for a more prominent role of fiberoptic endotracheal intubation (FOI) in difficult airway management, 2) to know the indications and limitations for the use of FOI, and 3) to realize the need for acquiring the necessary skills and experience during daily practice of non-emergency situations.*

Difficult Airway Management. Airway management of the severely traumatized patient is often a challenge. The aim is to establish a secure airway. The ASA difficult airway algorithm provides various proposals for safe and simple procedures for solving difficult airway management. However, the flexible fiberoptic facilitated endotracheal intubation is down the line in the ASA algorithm, and the surgical airway is an early consideration in the advanced trauma life support (ATLS) airway algorithm.

Fiberoptic Intubation. Various techniques have being developed. For a safe, awake FOI technique, the airway must be anesthetized sufficiently to avoid coughing, gagging, and vomiting. Various techniques have been described but time consumption might be a limitation. In the conscious patient, transtracheal injection of local anesthetic is easy, simple, and effective. Subsequent topicalization of the airway provides further tolerance of the fiberoptic scope, and additional spraying of lignocaine through the suction port of an advancing fiberoptic scope is effective and efficient.

Advantages. The FOI is a simple, non-traumatic technique, superb to most other technique in the hands of the experienced person. The FOI can be used for solving most of the challenges presented in difficult airway management of trauma patients. In case of a suspected difficult airway in a spontaneously breathing patient, the fiberoptic approach reveals the problem, thereby avoiding an emergency "cannot intubate situation". The cervical spine can be protected and movements of the C-spine minimized in case of suspected C-spine injuries. Injury to the airway and penetrating neck injuries can be handled with care and diagnosed early. Hemodynamic stability is preserved during FOI with topical anesthesia. FOI provides an immediate and precise confirmation of endotracheal tube position.

Disadvantages. The major disadvantage of FOI is that, like all other emergency techniques, proper use requires skills and prior experience with the equipment and the procedure. FOI is more time consuming than successful first-time conventional direct laryngoscopy. Interruption of mask ventilation might be necessary in the apneic patient. Bleeding in the upper airway is another problem making FOI more difficult or impossible. Other limitations include the relatively high costs and vulnerability of fiberoptic scopes, the immediate availability of equipment, and cleaning and maintenance of equipment.

Conclusion. Direct laryngoscopy after rapid sequence induction is usually the first approach. However, the recognition of a possible difficult airway is the main issue. If possible, keep the patient awake and spontaneously breathing. FOI should be considered early if skills are available. Nasotracheal intubation is often easier and permitted even in trauma patients, however, with the risk of bleeding making visualization difficult. Establishing a surgical airway is not always simple and easy; the FOI is a qualified alternative. Skills end experiences should be obtained during non-emergency situations

The challenge is to predict and identify the patients in whom conventional intubation is not possible or very difficult and those who will require a surgical airway as the primary choice. Prospective studies need to demonstrate the future role of FOI in emergency care.

Recommended Literature

Ovassapian A. Fiberoptic Endoscopy and the Difficult Airway, 2nd edition. Philadelphia, Lippincott-Raven, 1996.

— Session B —

Critical Care in the Age of Terrorism

Chair: Maureen McCunn, MD, Baltimore, Maryland

Trauma Care Around the World: How We Are Different and How We Are the Same

Maureen McCunn, MD
Medical Director, Neurotrauma Critical Care; Physician Director, Continuous Renal Replacement Therapies; R Adams Cowley Shock Trauma Center
University of Maryland, Baltimore, Maryland, and
Graduate Candidate, Johns Hopkins University, School of Advanced International Studies, Washington, DC, USA

Trauma . . . "the neglected disease of modern society" . . .

Learning Objective: *To review differences in trauma care in various countries and to highlight cultural differences.*

Injury is a major public health problem in the United States, developed countries, and developing nations. Blunt trauma due to vehicular craches, industrial equipment, and falls occurs across all economic strata, in addition to blast and crush injuries that may be seen in war-ravaged environments. Penetrating injuries from gunshot wounds, stabs, or landmines occur not only in combatants but more and more commonly in civilians. All populations are affected by this growing burden of injury.

While published data garnered from studies of the epidemiology of injury and violence around the world are increasing, there are few to no data concerning how we can effectively intervene to implement policies or to change ineffective practices surrounding these issues. What is acceptable in any given society may not be effective in another due to social, cultural, or religious differences. Trauma care in various cultures may demand multiple paradigms as a result of these differences.

Background and Significance. The World Health Organization (WHO) estimates that injury accounts for 16% of all disease worldwide.[1] The leading causes of death for both men and women between the ages of 15 and 44 years are injury related, and by 2020, injuries will be the third leading cause of death and disability in the world.[2] Interpersonal violence and war-related mortality account for approximately 5 million deaths. Based on 2000 data, 91% of homicides occur in low- and middle-income countries.[3]

One of every ten Americans was treated for an injury in an emergency department in 2000.[4] Injury is also an increasingly significant health problem in most low-income countries. However, few studies have investigated the epidemiology of injury patterns and even fewer address strategies for injury prevention. Furthermore, there are no published data that investigate the impact that social customs, religion, or cultural differences may have on trauma care.

In today's less-developed countries, infectious diseases remain the leading cause of death, but this trend is decreasing and trauma is causing more and more deaths. According to the WHO report concerning the global burden of disease, road traffic craches are predicted to be the leading cause of death in the world by 2020.[5] Fifty percent of injured victims die at the scene in some countries. The preventable death rate (PDR) is about 25% in Poland, 30% in Greece, 37% in Italy, and 43% to 62% in the United Kingdom. In the United States, the PDR dropped from 13% to 7% due to better and more efficient systems of trauma care.[6] Unfortunately, there are very little data with regard to traumatic injury in developing nations.

Recent Developments. Progress in the organization and the delivery of trauma care has resulted in decreased mortality. These improvements include the following:

- More rapid prehospital transport
- Increased capabilities for prehospital care/training
- Growth of emergency medicine as a specialty
- Development of trauma surgery as a specialty
- Advanced Trauma Life Support (ATLS) course
- Development/certification of trauma centers

Unfortunately, many of these changes have not reached developing nations.

Differences in Trauma Care. Previous queries into trauma system effectiveness in the United States and Canada concluded that studies assessing efficacy of care rely on hospital deaths as the primary indicator of success or failure.[7] But many patients in developing nations are not even treated for their injuries[8,9] so hospital deaths may not be an indication of true morbidity or mortality from traumatic injury. A cluster survey of household interviews has shown that many injuries and deaths in poor nations are not captured by hospital data.[10]

Mortality from trauma may be directly correlated with gross national product,[11] such that mortality declines with increasing economic level. Implementation of low-cost improvements in prehospital trauma care in a developing nation has been shown to decrease mortality during transport by 50%, with only a 16% required increase in the ambulance service budget.[12] Another difference in patterns of injury in developing nations involves urban versus rural trauma.[13] Prevention strategies need to differ from those in developed countries and may need to target nonmedical providers (private citizens) to show a difference.

Despite these recently published statistics, and an increasing recognition of injury as a major public health problem worldwide, limited attention and resources have been paid to this topic. This lack of attention is most notable in low-income countries. International forums to define the global burden of injury and to make recommendations regarding specific actions required of governments, individual researchers, and donor agencies are only lately forthcoming.[14,15]

This dilemma is made more difficult when injuries resulting from conflict are taken into account. The face of modern wars has changed dramatically; the target is no longer the destruction of the opposing army, but rather the destabilization of the opponent's political, social, cultural, and psychological infrastructure.[16] Civilians have been the major targets in recent wars (Afghanistan, Lebanon, Kosovo, the Persian Gulf) and account for more than 80% of those killed and wounded. This represents a further burden on the effective delivery of trauma care and resources utilized. Today, warfare is the leading cause of traumatic deaths in the world.

Cultural Sensitivity. Problems identified in the chain of trauma care (from injury through hospital discharge and rehabilitation) do not include weak links associated with ethnic prejudices, religious differences, cultural norms, or gender issues. It is known that there are social and cultural disparities in substance abuse,[17,18] in decisions regarding end-of-life care,[19] and in functional status measurements of health-related outcomes.[20] Studies documenting the presence of racial, ethnic, and socioeconomic disparities in health care have outpaced articles that describe effective strategies to eliminate disparities.[21] Education in the area of cultural competence, defined as a set of skills that allows an individual to increase his/her understanding of cultural differences and similarities within, among, and between groups, is virtually nil.[22,23]

Jean Jacques Rosseau makes the all-important point, in The Social Contract (1762), that "the history, character, habits, religion, economic base and education of each people must be taken into account before setting up machinery."

Eye to the Future. While technological advances and a more precise understanding of the pathophysiology of trauma have led to significant improvements in trauma care in many developed nations, there has been little attention paid to the majority of civilization. Trauma systems are only as effective as their ability to be accessed/utilized. We must focus on developing effectual programs to improve care and quality of life throughout the world.

References

1. World Health Organization. Injury: *A Leading Cause of the Global Burden of Disease.* Geneva: World Health Organization, 1999.
2. Murray CJL, Lopez AD. *The Global Burden of Disease.* Cambridge, Massachusetts: Harvard University Press, 1996.
3. Krug EG, Dahlberg LL, Mercy JA, et al (eds). *World Report on Violence and Health.* Geneva, World Heath Organization, 2002.
4. Centers for Disease Control Data.
5. Krug EG, Sharma GK, Lozano R: The global burden of injuries. *Am J Public Health* 2000; 90(4): 523–6.
6. Bielecki K. Trauma care for the year 2000. *Przegiad Ledarski* 2000; 57:S127–8.
7. Mann NC, Mullins RJ, MacKenzie EJ, et al. Systematic review of published evidence regarding trauma system effectiveness. *J Trauma* 1999; 47:S25–33.
8. Mock CN, nii-Amon-Kotei D, Maier RV. Low utilization of formal medical services by injured persons in a developing nation: health service data underestimate the importance of trauma. *J Trauma* 1997; 42:504–511.
9. Mock CN, Forjuoh SN, Rivara FP. Epidemiology of transport-related injuries in Ghana. *Accid Anal and Prev* 1999; 31:359–370.
10. Mock CN, Abantanga F, Cummings P, et al. Incidence and outcome of injury in Ghana: a community-based survey. *Bull World Health Organ* 1999; 77:955–64.
11. Mock CN, Jurkovich GJ, nii-Amon-Kotei D, et al. Trauma mortality patterns in three nations are different economic levels: implications for global trauma system development. *J Trauma* 1998; 44:804–12.
12. Arreola-Risa C, Mock CN, Lojero-Wheatly L, et al. Low-cost improvements in prehospital trauma care in a Latin American city. *J Trauma* 2000; 48:119–24.
13. Mock CN, Forjuoh SN, Rivara FP. Epidemiology of transport-related injuries in Ghana. *Accid Anal Prev* 1999; 31:359–70.
14. Forjuoh SN, Zwi AB, Mock CN. Injury control in Africa: getting governments to do more. *Trop Med Int Health* 1998; 3:349–56.
15. World Health Organization and The Bone and Joint Decade. The burden of musculoskeletal conditions at the start of the new millennium: Scientific Group Meeting, Geneva, January 2000.
16. Aboutanos MB, Baker SP. Wartime civilian injuries: epidemiology and intervention strategies. *J Trauma* 1997; 43:719–25.
17. Leischow SJ, Ranger-Moore J, Lawrence D. Addressing social and cultural disparities in tobacco use. *Addic Behav* 2000; 25:821–31.
18. Rossow I. Alcohol and homicide: a cross-cultural comparison of the relationship in 14 European countries. *Addic* 2001; 96:S77–9.
19. Vincent JL. Cultural differences in end-of-life care. *Crit Care Med* 2001; 29:S52–5.
20. Custers JW, Hoijtink H, van der Net J, et al. Cultural differences in functional status measurement: analyses of person fit according to the Rasch model. *Qual Lif Res* 2000; 9:571–8.
21. Horowitz CR, Davis MH, Palermo AS, et al. Approaches to eliminating sociocultural disparities in health. *Min Heal Today* 2001; 2:33–43.
22. Nunez AE: Transforming cultural competence into cross-cultural efficacy in women's health education. *Acad Med* 2000; 75:1071–80.
23. Mesquita B: Emotions in collectivist and individualist contexts. *J Pers Soc Psychol* 2001; 80:68–74.

Wartime Civilian Injuries. An Epidemiological Shift in Terrorism and Complex Disasters

Michel B. Aboutanos, MD, MPH
Medical College of Virginia Hospitals, Virginia Commonwealth University. Richmond, Virginia, USA

Learning Objectives:

1. *The audience should understand the recent trends in world violence in terms of terrorist activities and armed conflicts.*
2. *The audience should understand the risk factors leading to increase morbidity and mortality in armed conflicts and terrorist events*
3. *The audience should understand the implication of blast injuries in terms of prevention, response, and trauma and critical care management.*

Background. Two forms of world violence, international terrorism and major armed conflicts, have escalated exponentially in the post-world wars era. Since 1945, 160 wars and armed conflicts resulted in an estimated 22 millions deaths and over 60 million injuries. Between 1990 and 2000, 56 different major armed conflicts in 44 different locations were recorded, with 25 conflicts still active in 2000.[1,2] Similarly, since 1968 over 14,000 international terrorist attacks have taken place throughout the world.[3,4]

Purpose. To delineate the characteristics of the recent armed conflicts and the significant terrorist incidents in terms of demographics, method of wounding, causes of injury, risk factors, and the implications for the trauma and critical care communities.

Methods. An extensive review of governmental documents and published experiences dealing with wartime injuries and prominent international terrorist incidents from 1961 to 2001. Specific trends in demographics, etiologies, and methods of wounding were delineated along with the contributing risk factors.

Results. A total of 392 terrorist incidents were reviewed, accounting for 27,312 casualties and 5,682 deaths. Seventy percent of all terrorist incidents were against civilian targets, which constituted 92% of all casualties. Bombings were the most frequent terrorist events (44%) and accounted for 74% (20,221) of all casualties and over 90% of all deaths. Similar results were observed in recent wars. Civilians were the major targets in recent armed conflicts and accounted for most of the killed and wounded (80%–90%). A shift toward more powerful explosive devices (artillery shells and mines) was also noted. Whereas noncivilian victims (army, paramilitary, government agents) were mainly male and restricted to the 21- to 40-year-old age group in both armed conflicts and terrorist incidents, civilian victims were of all ages and both genders. The risk factors for lethal injuries identified in both wartime and terrorist incidents were similar and included 1) the intentional targeting of civilians, 2) the confinement of a large number of people in a single area (bomb shelters and hospitals in the armed conflicts, transportation vehicles such as buses and commercial airplanes in the terrorist incidents), 3) personal and environmental vulnerability of the targeted victims, and 4) the exponential increase in firepower and lethality of modern explosives. These factors also lead to higher mortality rates among critically injured survivors due to the enormous number of wounded from secondary blast injuries that can overwhelm triage, treatment, and resource/personnel allocation.

Conclusion. In both wartime and terrorist incidents, civilians are now the primary targets. An epidemiological shift in the demographics of the victims and lethality of injuries corresponds to the shift in targeting of civilians and the methods of fatal wounding. The implications to international aid agencies and to the trauma and critical care communities in terms of prevention strategies, targeted preparation, and medical response are highly significant.

References

1. Seybolt TB. Major armed conflicts. SIPRI Yearbook 2001. Armaments, *Disarmaments and International Security*. Oxford: Oxford University Press, 2001.
2. Wallensteen P, Sollenberg M. Armed Conflict, 1989–98. *Journal of Peace Research* 36(5):593, 1999.
3. Federal Bureau of Investigation. *Terrorism in the United States.* Washington, DC: FBI, 1999.
4. U.S. Department of State. *Patterns of Global Terrorism*, 1999.

Suicide Bombings in Israel: Injuries Never Seen Before

Itamar Ashkenazi, MD, and Ricardo Alfici, MD
Surgery B, Hillel Yaffe Medical Center PO Box 169, Hadera, Israel 38100

In the past two years, victims from 38 terrorist incidents were treated in Hillel Yaffe Medical Center. Of these, 16 were bomb attacks that resulted in mass casualties. Our experience will be presented. Special emphasis will be given to injuries never reported before in the medical literature. The diagnostic and therapeutic challenge, together with the implications upon treatment, will be discussed. These new presentations of injury represent an introduction to a new phase in the ingenuity of perpetrating injury in suicide bombings.

Rapid Evacuation and Transport of the Critically Injured Patient

William Beninati, MD, Air Force Coalition for Sustainment of Trauma and Readiness Skills/R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA
Todd Carter, MD, Office of the Air Force Surgeon General, Washington, DC, USA
Gregory Rupert, RN, Wilford Hall Medical Center, San Antonio, Texas, USA
James H. Henderson, MD, Wilford Hall Medical Center, San Antonio, Texas, USA

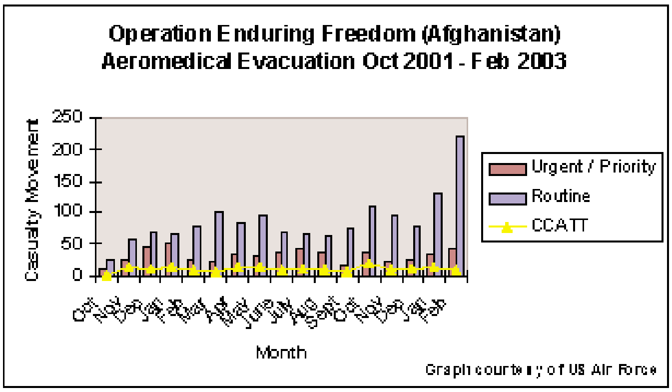
Learning Objectives

1. *To describe the US Air Force Aeromedical Evacuation System for transporting casualties.*
2. *To comprehend the clinical capabilities that can be reasonably be provided during long-range air transport.*
3. *To explain the technological limitations to care during long-range air transport.*
4. *To explain the USAF Critical Care Air Transport Team experience with evacuation of casualties across a spectrum of settings from peacetime healthcare to combat.*

The United States Air Force (USAF) maintains an Aeromedical Evacuation System (AES) designed to operate across a broad spectrum of activities from peacetime healthcare to combat support. This system is flexible and scalable, and can accommodate a range from single-patient to mass casualty evacuation. To provide for the care of casualties who have been stabilized by ground-based medical teams, but who remain critically ill or injured, the USAF developed Critical Care Air Transport Teams (CCATT). The CCATT capability permits the use of small, highly capable, ground-based resuscitative teams without imbedded post-resuscitative care. Such teams can be rapidly inserted with minimal impact on limited airlift resources, relying on the AES to provide post-resuscitation/post-surgical care.

Methods. The AES uses opportune cargo aircraft staffed by dedicated aeromedical evacuation (AE) crews consisting of flight nurses and technicians. Patients with imminent loss of life, limb, or vision are designated urgent or priority for rapid evacuation; a subset of these casualties are critically ill. For transport of critically ill patients, the AE crews oversee the conduct of the mission to include flight safety, loading and unloading, and access to oxygen and electricity. Direct care of critical patients is provided by CCATT. A CCATT consists of a critical care physician, critical care nurse, and respiratory therapist equipped with appropriate supplies and portable, battery-operated medical equipment. This equipment includes mechanical ventilators, physiologic monitors, a pacemaker/defibrillator, multi-channel infusion pumps, and a laboratory analyzer. This personnel and equipment package provides the majority of capability available in a hospital-based intensive care unit. A training pipeline has been developed for team members, which includes clinical qualification, basic aeromedical training, evacuation exercises, as well as operational and clinical sustainment training.

Results. The USAF CCATTs have safely transported critically ill and injured patients in settings that include peacetime health care, disaster response, terrorist attacks, peacekeeping operations, and combat. Transport times have been as long as 20 hours. Specific missions will be discussed to demonstrate the flexibility, clinical capabilities, and limitations of this system. In the early phase of Operation Enduring Freedom in Afghanistan, initial casualty care was provided by forward surgical teams with limited capacity for sustained critical care post-damage control. This care was provided in the air by the AES. In the first 17 months of this operation, CCATTs transported 172 critical casualties (see graph), representing 12% of total casualties moved. There was no peri-transport morbidity or mortality.



Discussion. The CCATT model demonstrates a highly successful balance of small size, portability, and robust clinical capability. This model has proven flexible across a broad range of settings. This model for rapid evacuation of stabilized casualties can be adapted to civilian disaster response and to novel situations that may arise.

Organization of Nurses Working with Terror Victims in the Emergency Department and on the Wards

Gila Hyams, RN, MA
Rambam Medical Center, Haifa, Israel

Over the past two years, Israel has been hit by a wave of terror attacks, mostly bomb explosions, amidst the civilian population. The large number of events has brought about an improvement in the organization of every link in the chain of survival.

Organizing a hospital to deal with a mass casualty situation (MCS) is a very complicated affair. It includes organizing the physical space, the equipment, and the manpower. In manpower, the largest group is the nurses. A variety of subjects must be dealt with: 1) knowledge/medical skills, 2) recruiting of nursing staff, 3) organization in the admitting sites, and 4) preparation of wards.

This means that every nurse in an MCS should know what to do, where to do it, and how to do it. To achieve this end, a complex process of preparedness must occur in a continuing fashion. The tools to achieve this goal are lectures, computer lessons, drills, and, above all, writing detailed standing orders for each and every situation. With our experience in recent terror attacks, we will describe the benefits and drawbacks of each tool in preparing the nursing staff to deal successfully with an MCS.

In addition, we will discuss new protocols that we have adopted for a 'limited' MCS, with training of teams, nurses and physicians together, at a medical simulation center and debriefing of teams after every event.

Damage Control Surgery: Principles of Care for Critical Injury

Thomas Scalea, MD, FACS
Physician in Chief, R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA

Learning Objectives: *To understand the conditions that warrant damage control surgery and the procedures associated with this approach to the stabilization of severely injured patients.*

Damage control applies standard principles differently in critically injured patients. Damage control is divided into phases. Phase 1 occurs in the emergency department. Patients who present in extremis should undergo rapid evaluation with limited radiographs ascertaining the location of cavitary blood loss. This should take less than 15 minutes and the patient taken directly to the operating room. The damage control operation should be tailored to stop named bleeding and control gross contamination. Expendable organs (the spleen) should be resected. Major vascular injuries should be repaired, or temporarized by intraluminal shunting. Non-expendable organs (the liver) should have major bleeding controlled and non-surgical bleeding packed. Gastrointestinal injuries should be ligated or resected without anastamosis. Once major blood loss is controlled, the patient should be packed and temporarily closed.

Exsanguinating hemorrhage often leads to hypothermia acidosis and coagulopathy. Further operation perpetuates this cycle. Thus, early selection is important. This may be based on either anatomic criteria (multiple visceral injuries, major vascular injury) or physiologic criteria (acidosis, blood product requirements).

The patient should then be taken to the ICU. Cardiovascular function is optimized generally using invasively derived hemodynamic parameters. Respiratory function should be optimized, often using pressure limited ventilatory strategies. Most importantly, coagulopathy must be reversed and normal temperature restored.

Adjunctive hemostasis can be obtained using angiographic embolization. This technique is most helpful with central liver injuries, bleeding deep in the pelvis or adjacent to the great vessels. Strong consideration for re-operation should be given for ongoing transfusion requirements or inability to normalize lactate.

When homeostasis is restored, the patient should be returned to the operating room for re-exploration. The patient is unpacked and residual bleeding dealt with. Careful inspection should be made for injuries missed at initial laparotomy. Gastrointestinal integrity can be reconstituted.

Occasionally, it is possible to close the fascia primarily at this point. Temporary closure can be effected in a number of ways, such as mobilization of skin flaps or bridging the fascial defect with absorbable mesh. If mesh is used, this can be skin grafted in about 2 weeks. Delayed abdominal wall reconstruction can be accomplished at 6 months when all intra-abdominal inflammation has subsided.

Damage control can also be utilized elsewhere in the body, especially in polytrauma patients with long-bone fractures. While the advantages of early fracture fixation are clear, definitive fixation can be time consuming and risks considerable blood loss. Temporary external fixation provides the advantages of fracture stabilization without blood loss or time in the operating room. When the patient is stable, the intra-medullary techniques can be used to gain final fracture stabilization.

Damage control involves utilizing standard trauma principles in a slightly different way when dealing with the most critically ill patients. It is a philosophy of care, not a technique, and is applicable to a large number of critically ill patients.

— Session C—

Trauma Education, Simulation, and Patient Safety

Co-Chair: James G. Cain, MD Pittsburgh, Pennsylvania, and West Virginia University, Morgantown, West Virginia, USA

Co-Chair: Michael J.A. Parr, MB BS MRCP FRCA FANZCA, FJFICM, University of New South Wales, Sydney, NSW

Human Crisis Simulation for Rural Medical Education

James Gordon Cain, MD
Allegheny General Hospital, Pittsburgh, Pennsylvania, USA, and West Virginia University, Morgantown, West Virginia, USA

Learning Objective: *To provide an introduction to simulation as a means to extend resources in providing trauma education in a rural setting.*

Rural areas present unique challenges in providing trauma services and educating practitioners in acute care. Rural populations have experienced unique patterns of trauma since medieval times. Thirty percent of the United States' population is rural, yet 70% of all trauma fatalities occur in that population. The reasons for increased risk are multifactorial. Poverty and unemployment are higher. Hazardous occupations are more common. More than half of all fatal motor vehicle collisions occur on rural roads and involve local residents. Rural patients are more frequently aged, chronically ill, or disabled (congenital or acquired), increasing the likelihood of death from less severe injuries. Trauma is the number one cause of childhood death. Mortality from rural pediatric trauma is approximately twice that of urban pediatric trauma.

A major impediment for the rural trauma patient is access to adequate health care. It is difficult to attract and retain physicians of any description to rural areas. Economic pressures limit physician staffing of rural emergency departments. Rural settings benefit from innovations improving acute care management, such as medical simulation.

Medical simulation's roots are vested in aviation, a standard, accepted tool for pilot education, evaluation, and reproduction of critical events. Similar to flying, anesthesiology requires vigilance while multitasking in the face of distracters. In 1986, the VA Palo Alto HSC/Stanford University Center for Crisis Management Training in Health Care extrapolated technology from aviation to medicine and anesthesia. Medical simulation now includes critical care, trauma, and emergency medicine and may decrease morbidity related to critical events. Most major simulation centers worldwide have developed simulation programs focusing on the dynamics of Crisis Resource Management (CRM). CRM is resource intensive and requires expenditures for the simulator, physical plant, personnel, and support staff required to produce complete operating room, emergency department, or critical care simulations. Institutions unable to muster such resources may feel unable to participate.

The West Virginia University Human Crisis Simulation Program developed a successful, heavily utilized center with a modicum of resources in a rural setting. Simulation allows stretching of educational resources. Simulation offers rural medical trainees and practitioners a safe and effective environment in which to learn appropriate actions and procedures in acute care situations. The West Virginia Human Crisis Simulation Program is located in a recently renovated 700-square-foot facility near clinical areas and includes a simulator room, control room, and physician office. The simulator is used extensively to introduce anesthesia residents to anesthesia and acute care medicine and for multidisciplinary education, medical student education, and continuing medical education. Videotaped simulations may be used to educate juries, judges, and attorneys in medical malpractice trials. Media coverage expounding the benefits of simulation in medicine and its potential to decrease the likelihood for serious errors provided welcome favorable publicity and enhanced public relations. Future uses for the simulator include multidisciplinary research, modeling work environment for new technologies, videoconferencing with statewide CME capability, and professional evaluations and certifications. The curriculum is unique in its application of tertiary care and Level 1 trauma skills to a rural population.

The Role of Microsimulators in Training Trauma Professionals

Ulrik Juul Christensen, MD
Sophus Medical A/S, Copenhagen, Denmark

Learning Objective: *To provide an overview of the background for the use of microsimulators (PC-based simulators) in medical education in general and in trauma education in particular.*

Background. Medical microsimulators are PC-based simulators that can be used for training the cognitive aspects of handling patients in a low-risk, instructor-less, and easily accessible environment. The debriefing after simulation sessions is just as important for microsimulation as in full-scale (also known as macrosimulation) simulation with manikins and instructors involved. In order to use microsimulators for self-directed learning and optimally for distance learning, the simulators should have as advanced technology for debriefing as possible in order to provide qualified feedback on the performance in the virtual simulators.

Most microsimulators are designed to supplement the existing education based on lectures, reading, classroom teaching, and optimally large numbers of hands-on practice in safe environments such as full-scale simulators, task trainers, and simulated patients (actors). The philosophy is that microsimulators in the same way as chess computers (i.e., microsimulators for chess playing) can provide the learning access to a vast amount of more or less seldom cases that can be dealt with dynamically. This aspect becomes particularly more important if the learners have limited access to "real" cases where they can be taught in an apprenticeship manner.

The issue of access to only a very limited number of clinically challenging problems (and consequently the lack of cognitive and psychomotor practice) is evident in the case of the training of the US Army Combat Medics (the so-called 91W program). The 91W program is a condensed 16-week course, with the first part being a standard EMT-B education. Due to a variety of reasons, with some being quite obvious during peacetime, the equivalent of clinical encounters, bedside learning, and clinical sessions is very limited. Therefore, the US Army decided to train to up to 8000 each year with extensive use of full-scale human patient simulators, a variety of task trainers such as IV arms and CPR manikins, and finally days in a simulated battlefield with both portable simulators and humans with wound make up.

The US Army is now introducing microsimulation as a integrated part of the training of the army combat medics in order to achieve a number of benefits: a) to strengthen the cognitive training by focusing more on deep learning (by doing!) rather than more superficial learning types that can be the result of classroom teaching only, b) to use less intensive time during practical exercises for more self-directed learning, and c) to free resources during the practical exercises in order to increase the instructor-to-student ratio during psychomotor and field training exercises. The military microsimulators are based on systems used in prehospital and inhospital care as well as by the Red Cross in many countries for training in First Aid (in the military environment the target for the latter technology is the equivalent of First Aid – called Self Aid and Buddy Aid). The immediate implementation of the military microsimulators will be at the combat medic level, but the technology has been developed to be scaled up and down to be used for all group of personnel from emergency physicians to EMT-Bs, combat medics, and nurses. The majority of the cases will focus on trauma care, but a large number of cases will also be aimed at the EMT-B education, including ALS and other aspects of acute medicine as well as several cases aimed at CBRNE (chemical, biological, radiation, nuclear, explosions) related patients.

Rapid Preparation of Reserve Military Medical Teams Using Advanced Patient Simulators

Guy Lin,1 Yahav Oron,[1] Ron Ben-Abraham,1 Dafna Barsuk,[2] Haim Berkenstadt,[2] Amitai Ziv,[2] Amir Blumenfeld1
[1]IDF-Medical Corps Trauma Branch and the [2]National Medical Simulation Center (M.S.R.), Chaim Sheba Medical Center, Tel-Hashomer, Israel

Learning Objectives: *To discuss the advantages of the use of advanced patient simulators in the training of reserve medical personnal.*

Primary prehospital medical treatment for trauma casualties has unique features in the military setting. The environment is sometimes hostile, and tactical situations together with the feasibility of evacuation are major considerations. Most of our reserve medical teams are not working routinely in this environment. In many debriefings, we recognize gaps in patients' evaluation, diagnosis of deterioration in the patient respiratory or hemodynamic condition after the initial treatment, and need for rapid evacuation. We believed that training with advanced patient simulators could improve these tasks.

Many reserve medical teams were recruited for the medical support of the "Defensive Shield" operation (April 2002). The reserve teams were composed of physicians having all kinds of expertise and medics having various non-medical professions. A questionnaire revealed that 72% of reserve staff rarely treat trauma patients. Forty-seven percent define themselves as not good enough in trauma management. Moreover, reserve forces are usually trained for a high-intensity conflict, being prepared for prolonged evacuation time, and are not accustomed to the nearness of trauma centers to the battle zone.

Every military physician has ATLS certification. Complementary training is usually done by traditional methods such as simple manikins and living animal models. These models fit for technical skills and familiarity with the equipment, and less for diagnosis and decision-making. Team training is usually done by "fake" patients with less attention to individual performance. Advanced patient simulators give the opportunity to integrate all these skills.

Recruitment of reserve medical teams for medical support of battle zones adjacent to medical centers creates a need to assimilate rapid diagnosis and decision making (which interventions are more important than time?), together with refreshment of the critical skills of airway management and chest decompression.

During a 3-week period, 75 teams (90 physicians and 352 medics) were trained by advanced patient simulators in the Israeli Center for Medical Simulation (a collaboration of military and civilian systems).

We developed a scenario-based training adapted to specific missions. The basic program included an airway station (Airman manikin), head injury with difficulties in endotracheal inbtubation (Sim Man manikin), penetrating chest injury causing tension pneumothorax and hemorrhagic shock (Meti manikin), a multi-trauma pediatric patient (Pediasim Meti manikin), and a multi-casualty event. Video-screened debriefing was conducted by experienced ATLS instructors.

Feedback of trainees revealed overwhelming satisfaction. Reality of scenarios was evaluated as high by 95% of trainees. Eighty-seven percent said they are more ready for decision making in the care of combat casualties. Seventy-three percent felt they increased their knowledge and improved their skills.

Twelve trained medical teams have treated major trauma patients during the operation. They reported great contribution of advanced simulators training to the care of their patients: improved individual performance, self-confidence, and staff coordination.

Conclusion. Scenario-based training using HPS should be a leading system in the qualification of military medical teams. Rapid preparation for combat casualties care is feasible. This method of treatment should be developed, and the next step will be constructing a study for objective validation.

Selected References

Ali J, Adam R, Josa D, et al. Effects of basic pre-hospital trauma life support program on cognitive and trauma management skills. *World J Surg* 1998; 1192–6.
Ali J, Adam R, Pierre I, et al. Comparison of performance two years after the old and new (interactive) ATLS courses. *J Surg Res* 2001; 97:71–5.
Ali J, Cohen RJ, Gana TJ, Al-Bedah KF. Effects of ATLS program on medical students' performance in simulated trauma patient management. *J Trauma* 1998; 44:588–91.
Ali J, Gana TJ, Howard N. Trauma mannequin assessment of management skills of surgical residents after ATLS training. *J Surg Res* 2000; 93:197–200.
Bond FB, Kostenbader M, McCarthy JF. Pre-hospital and hospital-based health care providers experience with a human patient simulator. *Prehospital Emerg Care* 2001; 5:284–7.
Blumenfeld A, Abraham RB, Stein M, et al. Cognitive knowledge decline after ATLS courses. *J Trauma* 1998; 44:513–6.
Devitt JH, Kurrek MM, Cohen MM, Cleave-Hogg D. The validity of performance assessment using simulation. *Anesthesiology* 2001; 95:36–42.
Issenberg SB, Megaghic WC, Hart IR, et al. Simulation technology for health care professional skills training and assessment. *JAMA* 1999; 282:861–6.
Ziv A, Small S, Wolpe P, Patient safety and simulation based medical education. *Med Tech* 2000; 22:489–95.

Drills: Are They the Best Way to Prepare for a Mass Casualty Situation?

Moshe Michaelson, MD
Trauma Unit, Rambam Medical Center, Haifa, Israel

Learning Objective: *To compare the types of drills available for training participants to respond to a mass casualty situation.*

The key to success in a mass casualty situation (MCS) is to be prepared. The first step in preparedness is writing detailed standing orders. Standing orders should provide answers to all the problems that may arise during this difficult situation. However, writing standing orders is only part of the solution. A bigger task is to disseminate the information to all participants. There are a few tools to help us in this undertaking, and drills are one of the best. We discuss the types of drills available, with emphasis on the role each drill plays in achieving the goal of preparing the system to deal with an MCS. Attention is paid to cost-benefits and the ability of a single hospital to organize drills without outside help. At the end of the presentation, it will be clear whether drills are the best way to prepare for an MCS.

Friday, May 16, 2003

Simultaneous Afternoon Sessions

— Session A —

Update on New Drugs, Equipment, and Techniques in Trauma Care
Chair: Charles E. Smith, MD, FRCPC, Cleveland, Ohio, USA

What's New in Pulse Oximetry

Steven J. Barker, PhD, MD
Professor and Head, Department of Anesthesiology
University of Arizona, Tucson, Arizona, USA

Learning Objectives: *This lecture will promote a better understanding of 1) how pulse oximeters work, 2) what they can and cannot measure, 3) the application of pulse oximetry to care of the trauma patient, and 4) current and expected new developments in the technology.*

This lecture will review the theoretical background and recent developments in pulse oximetry, with emphasis on its use in trauma patients. The relationship of pulse oximetry to other monitors of patient oxygenation will be explored through a review of the physiology of oxygen transport. Clinical applications will be used to show both the value and the limitations of saturation monitoring.

Recent developments in pulse oximetry have been aimed chiefly at improving accuracy and reliability in the presence of various signal artifacts. These sources of error include patient motion, hypovolemia, shock, dyshemoglobinemias, and venous pulsations. Each of these artifacts and their potential remedies will be discussed in the context of the trauma patient.

Capnography in Trauma

Steven J. Barker, PhD, MD
Professor and Head, Department of Anesthesiology
University of Arizona, Tucson, Arizona, USA

Learning Objectives: *This lecture will provide a better understanding of the mechanisms of CO_2 transport from the body, the relationship between arterial and end-tidal CO_2 tensions, and the use of the capnogram as a diagnostic tool. The attendee will be able to identify various abnormal capnogram shapes and use these to initiate and monitor treatment.*

Capnography, the measurement of respiratory carbon dioxide, is effectively a minimum standard of care for general anesthesia. It is particularly important in the trauma patient, because the capnogram provides information not only about ventilation, but also about circulation and metabolism. This lecture will review the physiology of carbon dioxide transport, using this background as a guide to the interpretation of expired CO_2. The reasons for the difference between end-tidal and arterial carbon dioxide tensions will be discussed in detail, to show how this difference can be used as an important diagnostic tool.

We shall also review some basic capnogram waveforms and their clinical interpretation. This waveform can provide valuable diagnostic information, and it can also be used to monitor the progress of therapeutic interventions. We will see how the capnograph can even be used to measure the effectiveness of chest compressions during CPR. Unlike the pulse oximeter, which provides data on only one patient variable (arterial oxygenation), the capnograph provides an indication of metabolism, circulation, and ventilation simultaneously.

Neuromuscular Relaxant Pharmacology: An Update

Charles E. Smith, MD, FRCPC
Department of Anesthesia, MetroHealth Medical Center, Case Western Reserve University, Cleveland, Ohio, USA

Learning Objective: *To discuss the scientific basis for choosing a neuromuscular relaxant for trauma patients.*

Non-depolarizing relaxants bind to the acetylcholine (Ach) receptor at the post junctional nicotinic receptor and competitively prevent binding of Ach to the receptor. The ion channel is closed and no