Fluid Management in Trauma

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Learning Objective: *To better understand the anesthesiologist's role in controlling life-threatening hemorrhage.*

Fluid resuscitation is a rapidly evolving area of trauma practice, particularly in early hemorrhagic shock (while the patient is still actively bleeding). The surgeons have brought new diagnostic and therapeutic options to the table, including FAST, angiography, and damage control techniques. What has anesthesia contributed?

I will briefly review the history and recent academic literature on early resuscitation, including the arguments for and against deliberate hypotensive management, early use of blood products, hypothermia, hypertonic resuscitation fluids, and pro-coagulants. The anesthesiologist plays a critical role in the application of each of these therapies and should be familiar with the evidence that supports their use.

I will conclude with a discussion of over-the-horizon approaches to hemorrhagic shock, including new diagnostic modalities, new treatment options, and new approaches to long-term resuscitation and prevention of organ system failure.

[Editors' note re "off-label" use: Dr. Dutton will discuss investigational and anecdotal use of dry fibrin sealant bandages, hemoglobin-based oxygen carriers, and recombinant FVIIa.]

Thursday, May 15, 2003

Simultaneous Afternoon Sessions — Session A —

New Dimensions in Trauma and Critical Care

Co-Chair: James G. Cain, MD
Co-Chair: Christopher M. Grande, MD, MPH

Sedation for the Critically Injured Trauma Patient: Precedex®, a Novel Alternative

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Learning Objective: *To provide an introduction to dexmedetomidine, a newly introduced alpha 2 blocking sedative-analgesic, and its use in critically ill trauma patients.*

Dexmedetomidine (Precedex®), a lipophilic imidazole derivative, selective alpha2 agonist (1300:1, a2:a1), is approved for use in initially intubated critically ill patients. Precedex® offers analgesia, sedation, inhibition of shivering, decreased sympathetic outflow, and decreased catecholamines without significantly decreasing respiratory drive. With this decrease in sympathetic outflow, mild to moderate hypotension and bradycardia may occur. Precedex® does not have a direct myocardial effect. A novel aspect of Precedex® is that, compared with an equal level of baseline sedation with standard agents, it allows easy arousability. This would be particularly advantageous in facilitating reproducible, serial neurologic examinations at will in patients with TBI while avoiding the drastic swings in sedation with volatile hemodynamics associated with the current propofol-based technique. Dexmedetomidine reduced propofol and morphine requirements and improved hemodynamic stability during bispectral (BIS) index-guided intensive care unit sedation. Additional benefits of Precedex® may be a modest decrease in cerebral blood flow, along with additional neuroprotective properties in its own right.

Bibliography

Hall JE, Uhrich TD, Barney JA, et al. Sedative, amnestic, and analgesic properties of small-dose dexmedetomidine infusions. *Anesth Analg* 2000; 90:699–705.
Housmans PR. Effect of dexmedetomidine on contractility, relaxation, and intracellular calcium transients of isolated ventricular myocardium. *Anesthesiology* 1990; 73:919–22.
Jolkkonen J, Puurunen K, Koistinaho J, et al. Neuroprotection by the alpha2-adrenoreceptor agonist, dexmedetomidine, in rat focal cerebral ischemia. *Eur J Pharmacol* 1999; 372:31–6.
Kuhmonen J, Pokorny J, Miettinen R, et al. Neuroprotective effects of dexmedetomidine in the gerbil hippocampus after transient global ischemia. *Anesthesiology* 1997; 87:371–7.
Prielipp RC, Wall MH, Tobin JR, et al. Dexmedetomidine-induced sedation in volunteers decreases regional and global blood flow. *Anesth Analg* 2002; 95:1052–9.
Takrouri MS, Seraj MA, Channa AB, et al. Dexmedetomidine in the intensive care unit: a study of hemodynamic changes. *Middle East J Anesthesiol* 2002;16:587–95.
Talke P, Li J, Jain U, et al. Effects of perioperative dexmedetomidine infusion in patients undergoing vascular surgery. The Study of Perioperative Ischemia Research Group. *Anesthesiology* 1995; 82:620–33.
Triltsch AE, Welte M, von Homeyer P, et al. Bispectral index-guided sedation with dexmedetomidine in intensive care: a prospective randomized, double blind, placebo-controlled phase II study. *Crit Care Med* 2002; 30:1007–14.
Venn RM, Bradshaw CJ, Spencer R, et al. Preliminary UK experience of dexmedetomidine, a novel agent for postoperative sedation in the intensive care unit. *Anaesthesia* 1999; 54:1136–42.
Venn RM, Bryant A, Hall GM, Grounds RM. Effects of dexmedetomidine on adrenocortical function, and the cardiovascular, endocrine and inflammatory responses in post-operative patients needing sedation in the intensive care unit. *Br J Anaesth* 2001; 86:650–6.
Venn RM, Hell J, Grounds RM. Respiratory effects of dexmedetomidine in the surgical patient requiring intensive care. *Crit Care* 2000; 4:302–8.

The Hazards of Nutraceuticals in the Management of the Trauma Patient

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Learning Objectives: *1) To outline the herbs and dietary supplements (nutraceuticals) that are most commonly used in the preoperative phase; 2) to discuss the various preparations in which these products are available; 3) to broadly cover the state of government regulation of these products; and 4) most importantly, to target some of the more important potential drug-nutraceutical interactions and hazards, particularly as they may relate to the care of the patient receiving anesthesia.*

Because of the paucity of government regulation regarding purity, contents, manufacturing, and health claims as well as pharmacologic and physiologic predictability, it is difficult to fund and perform double-blind, placebo-controlled studies on these products. For this reason, much of the material concerning potential hazards and adverse drug interactions is based on extrapolation, anecdote, and/or uncontrolled case studies on active ingredients that are not consistently available in the products that we purchase in our local pharmacies, grocery stores, and gyms.

SUMMARY OF POTENTIAL INTRAOPERATIVE COMPLICATIONS

Untoward cardiovascular effects	Ephedra Ginseng Licorice St. John's Wort (potential indirect effect) Vitamin E Triiodothyroacetic acid GBL, BD, GHB
Enhanced bleeding potential	Ginseng Ginkgo Ginger Garlic Feverfew Vitamin E
Potential for prolongation of anesthesia	Valerian Kava-kava St. John's Wort (anecedotal only)
Possible renal insufficiency or hepatotoxicity	Licorice (renal) Creatine (renal) Echinacea (hepatic) Kava-kava (hepatic)
Possible abnormal thyroid functions	Triiodothyroacetic acid Vitamin E
Potential for electrolyte disturbances	Goldenseal Licorice
Risk of decreased effectiveness of HIV protease inhibitors	St. John's Wort

SUMMARY OF INDIVIDUAL HERBS AND SUPPLEMENTS

Name	Common Uses	Potential Side Effects
Echinacea	Common cold, bronchitis	Possibly hepatotoxic. May decrease effectiveness of corticosteroids
Ephedra	Diet aid; antitussive	Death. Cardiovascular instability. Multiple drug interactions
Feverfew	Migraine prophylactic	May inhibit platelet activity and increase bleeding. Avoid use in pts on anticoagulants.
Garlic	Lipid & BP lowering; Antiplatelet, antioxidant, anithrombolytic qualities	May potentiate warfarin and increase bleeding; affects platelet aggregation.
Ginger	Antinauseant	May be a potent inhibitor of thromboxane synthetase and may increase bleeding time. Use with caution with warfarin.
Ginkgo	Circulatory stimulant	May enhance bleeding in pts on anticoagulant or antithrombotic therapy.
Ginseng	"Adaptogenic" Energy level enhancer Antioxidant	Avoid use with other stimulants—may experience tachycardia or hypertension. May increase bleeding, especially in patients on anticoagulant or antithrombotic therapies. Known to have anti-platelet properties.
Goldenseal	Diuretic; anti-inflammatory	Functions as aquaretic, not as diuretic; see no sodium excretion, just free water excretion. May worsen edema or hypertension.
Kava-kava	Anxiolytic	May potentiate barbiturates and prolong anesthesia.
Licorice	Gastric and duodenal ulcers	Glycyrrhizic acid in licorice may cause high blood pressure, low potassium, and edema. Contraindicated in renal insufficiency, liver conditions, hypertonia.
St. John's Wort	Mild to moderate depression Anxiety	May prolong effects of anesthesia (anecdotal only). May decrease effectiveness of all HIV protease inhibitors as well as all nonnucleoside reverse transcriptase inhibitors. May decrease blood levels of digoxin.
Valerian	Sedative	May potentiate barbiturates.

Triiodothy-roacetic acid	Diet aid	May cause heart attacks or strokes due to its potent thyroid hormone content. May also see abnormal thyroid function tests along with severe diarrhea, fatigue, lethargy, weight loss.
GHB, BD, GBL	Body building, weight loss aid, sleep inducement	Coma, seizures, vomiting, slowed breathing requiring intubation, slowed heart rate, or death. Being investigated as a treatment for narcolepsy. Implicated as a "date-rape" drug.
Vitamin E	Slow aging process Prevention of stroke and PE Promotes wound healing Effective against fibrocystic breast syndrome	May increase bleeding, especially when used with anticoagulant and/or anti-thrombotic drugs. May affect thyroid function in otherwise healthy patients. May enhance HTN in predisposed patients in doses greater than or equal to 400 IU/day.

Bibliography
1. McLeskey C, Meyer TA, Baisden CE, Gloyna DF, Roberson R. The incidence of herbal and seleted nutraceutical use in surgical patients. *Anesthesiology* 1999; 91(34):A1168.
2. Tsen LC, Segal S, Pothier M, Bader A. Alternative medicine use in presurgical patients. *Anesthesiology* 2000; 93(1):148–51.
3. Leak JA, Hogervorst SL, Roach P, Arbuckle R, Palmer L. *Anesthesiology* 2002; A-1129.
4. Eisenberg D, Davis RB, Ettner SL, Appel S, Wilkey S, Rompay M, Kessler RC. Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. JAMA 1998; 280:1569–75.
5. Leak JA. Herbal medicines: what do we need to know? ASA *Newsletter* 2000; 5(2):5–7,11.
6. Eisenberg DM, Kessler RC, Van Rompay M, Kaptchuk TJ, Wilkey SA, Appel S, Davis RB. Perceptions about complementary therapies relative to conventional therapies among adults who use both: results from a national survey. *Ann Intern Med* 2001; 135(5):344–51.
7. O'Hara MA, Kiefer D, Farrell K, Kemper K. A review of 12 commonly used medicinal herbs. Arch Fam Med 1998; 7:523–36.
8. Leak JA. Perioperative considerations in the management of the patient taking herbal medicines. *Current Opinion in Anaesthesiology* 2000; 13:321–5.
9. Miller HI, Longtin D. Death by dietary supplement. Policy Review 2000; 102:15–25.
10. American Society of Anesthesiologists. What you should know about your patients' use of herbal medicines. Pamphlet, American Society of Anesthesiologists, 520 N. Northwest Highway, Park Ridge, Illinois, 60068; 1999.
11. Gruenwald J, Brendler T, Jaenicke C. *PDR for Herbal Medicines*, ed. 2. Montvale: New Medical Economics Company; 2000, pp 469–74.
12. Leak JA. Herbal medicine: is it an alternative or an unknown? A brief review of popular herbs used by patients in a pain and symptom management practice setting. *Current Review of Pain* 1999; 226–36.
13. Durr D, Stieger B, Kullak, Ublick GA, Rentsch KM, Steinert HC, Meier PJ, Fattinger K. St. John's wort induces intestinal P-glycoprotein/MDR1 and intestinal and hepatic CYP3A4. *Clin Pharmacol Ther* 2000; 68:598–604.
14. US Food and Drug Administration, Medwatch, Important Message for Health Professionals. Report serious adverse events associated with dietary supplements containing GBL, GHB, BD. August 25, 1999.
15. Leak JA, Feather SM, DeMonte F. A case of multiple and significant postoperative bleeds in a single patient felt to be attributable to chronic preoperative *Panax ginseng use. Anesthesiology* 2001; 95(3):A-1134.

Controversies in Blunt Aortic Trauma

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Learning Objectives: *1) to review the incidence, pathophysiology, and diagnosis of blunt aortic injury and 2) to discuss the anesthetic considerations for patients with blunt aortic trauma.*

Cardiothoracic trauma includes injury to the chest wall, trachea, bronchus, lungs, pleura, thoracic great vessels, diaphragm, heart, and esophagus. The practical points of providing safe and efficient anesthesia for patients with blunt aortic trauma will be stressed.

The diagnosis of blunt aortic trauma should be suspected based on mechanism of injury and widened mediastinum on chest radiograph. .Aortic angiogram is the gold standard of diagnosis of aortic injury, although TEE may be an excellent alternative according to the experience in each institution, especially for the unstable patient. Chest computed tomography is rapid and noninvasive and may be the test of choice to confirm or rule out the existence of mediastinal widening.

The spectrum of blunt cardiac trauma ranges from asymptomatic myocardial contusion to cardiogenic shock, arrhythmias, free wall or septal wall rupture, valvular tears, and coronary artery thrombosis. Echocardiography is the diagnostic method of choice in patients with ECG abnormalities or unexplained cardiovascular instability following blunt chest trauma.

Major considerations for anesthetic management of patients undergoing aortic surgery include location and extent of aortic injury and timing of surgery. Delaying surgery is recommended in many instances for stabilization and workup of other injuries. Strict control of blood pressure with beta blockers and/or vasodilators is essential. Hemodynamic monitoring is recommended to optimize blood pressure, cardiac output, and tissue perfusion.

Ascending aorta and aortic arch tears require cardiopulmonary bypass and single lung anesthesia. Deep hypothermic circulatory arrest is often employed. Proximal descending aortic tears are usually done with clamp and sew techniques and one-lung anesthesia. Partial left heart bypass may be utilized. Maintenance of normoglycemia improves wound healing and reduces wound infection and death. Cerebrospinal fluid drainage is not routinely done. Risk factors for developing paraplegia after aortic surgery include duration of aortic cross clamping, intraoperative hypotension, and surgical technique.

A left-sided double-lumen tube is preferred for one-lung ventilation because of the high margin of safety and relative ease of deflating the left lung and providing CPAP to the atelectatic lung. Alternatively, a bronchial blocker technique may be employed. Fiberoptic bronchoscopy is routinely done to confirm proper position.

Postoperative complications after aortic repair include respiratory failure, stroke, pneumonia, renal failure, suture line failure, and paraplegia.

References
1. Duan Y, Smith CE. Anesthesia for major cardiothoracic trauma. In Wilson WC, Grande CM, Hoyt DB, eds. *Trauma: Resuscitation, Anesthesia, and Critical Care,* chapter 25, 2003, in press.
2. Van den Berghe G. Intensive insulin therapy in the critically ill patients. *N Engl J Med* 2001; 345(19):1359–67.
3. Orliaguet G, Ferjani M, Riou B. The heart in blunt trauma. *Anesthesiology* 2001; 95:544–8.

Web-Based Resources
1. Devitt JH. Blunt thoracic trauma: assessment, management, and anaesthesia. www.anesthesia.org/winterlude/wl95/wl95_4.html.
2. EAST guidelines for blunt aortic trauma management. www.east.org/tpg/chap8.pdf.
3. Pulmonary artery educational project: www.pacep.org/pages/start/ref.html?xin=accp.
4. ASA guidelines for PA catheters: www.asahq.org/publicationsandservices/pulm_artery.pdf.

What's New in Neurotrauma

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Learning Objectives:
- *To review the scientific basis of interesting developments*
- *To put these developments in clinical perspective*

These days, all of us are trying to practice evidence-based medicine. Unfortunately, there is a dearth of high quality research in the field of head injury management. This is unfortunate because mortality is still high. However, hospital outcome measurement following head injury is still crude compared to rehabilitation outcome measures. Attempts to link existing outcome registries have not been practical. Now is the time to reconsider how we assess outcome.

It is well known that hypoxia, hypotension, and combined hypoxia and hypertension are associated with poor outcome. The original data clearly demonstrate that perfusion is the crucial factor. But there is debate about how cerebral swelling should be managed. Many believe that protocol-driven management, which includes fluid and inotropes to raise mean arterial pressure, is useful. In Lund, an alternative approach is equally successful and treatment is directed mainly to reducing vasogenic oedema. Hypertonic saline has yet to find a clear role in the management of head injury.

Recent work has shown that blood glucose level in the first 24 hours after injury correlates more closely with outcome than even hypotension. Most doctors control blood sugar after head injury, but the evidence for benefit has been shown only in the general ICU population.

Hypothermia following head injury has failed to live up to its early promise. The reasons for this may include delays in inducing hypothermia, practical difficulties in measuring brain temperature, and faults in study design.

The successful management of spinal cord injury also depends on maintaining adequate perfusion. Much attention is still directed to preventing mechanical cord damage but there is a body of evidence suggesting that it would be better if more attention was given to perfusion. The value of steroids has been questioned. There is animal evidence to suggest that uncontrolled oxygen therapy may also be detrimental to the under-perfused spinal cord.

In order to improve outcome after neurotrauma, it is essential that high quality research is done. An example of this is the European CRASH trial. Many questions remain unanswered but better use of existing knowledge should be our current goal.

Further reading
1. Copes WS, Stark MM, Lanwick MM, et al. Linking data from national trauma and rehabilitation registry. *J Trauma* 1996; 40:428–36.
2. Rosner MJ, Rosner SD, Johnson AH. Cerebral perfusion pressure: management protocol and clinical results. *J Neurosurg* 1995; 83:949–62.
3. Eker C, Asgeirsson B, Grande P-O, et al. Improved outcome after severe head injury with a new therapy based on principles for brain volume regulation and preserved microcirculation. *Crit Care Med* 1998; 26:1881–86.
4. Walia S, Sutcliffe AJ. The relationship between blood glucose, mean arterial pressure and outcome after severe head injury. *Injury* 2002; 33:339–44.
5. Van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in critically ill patients. *N Engl J Med* 2001; 345:1359–67.
6. Qureshi AI, Suarez JI, Castro A, Bhardwaj A. Use of hypertonic saline/acetate infusion in treatment of cerebral edema in patients with head trauma: experience at a single center. *J Trauma* 1999; 47:659–65.
7. Clifton GL, Miller ER, Choi SC, et al. Lack of effect of induction of hypothermia after acute brain injury. *N Engl J Med* 2001; 344:556–63.
8. Perez-Pinzon MA, Alonso O, Kraydieh S, Dietrich WD. Induction of tolerance against traumatic brain injury by ischemic preconditioning. *Neuroreport* 1999; 10:2951–4.

Pathophysiological Processes Following Toxic Trauma

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Learning Objectives: *To present an approach toward the management of chemical and biological agent injuries, which is injury rather than agent specific.*

Toxic trauma is a term used to describe the injury caused by mass release of a variety of toxic agents. These may be drawn from the spectrum of chemical and biological warfare (CBW) agents or from the many industrial hazardous materials (HAZMAT). The term may also be used to include the longer-term organ failure consequences of serious infection.

Traditionally, the approach to the management of casualties from chemical agents has been antidote based, an approach that rests upon early identification of the noxious agent. While this is often possible in the military sphere, where sophisticated detection and monitoring systems are available, in civil life, such information may not be possible and treatment must then respond to presenting signs and symptoms. The concept of early life support in a toxic zone (TOXALS) introduced by ITACCS in 1996 has now been widely accepted and the new approach to CBW agent management is based upon life support coupled with appropriate antidote therapy where possible.

Consideration of the pathophysiological processes following toxic agent exposure provides a rational platform for prehospital and hospital clinical management. CBW agents can attack all systems of the body, including the central and peripheral nervous systems, the skin and epithelia, and particularly the respiratory system. The latter is vulnerable to attack from blockage of the airways through vesication and excess secretions, from failure of central control and peripheral neuromuscular transmission due to disruption of the cholinergic transmission system, and from the development of toxic pulmonary oedema. Certain classes of agent are clearly associated with different processes: nerve agents and neurotoxins have a direct effect on synaptic and neural transmission while the classic war gases such as phosgene and industrial agents such as methyl isocyanate have been demonstrated to cause mass toxic pulmonary edema. Vesicant agents such as mustard gas are now known to have effects at all levels of the respiratory tree apart from causing vesication of the dermis.

The explosion in research into the cholinergic transmission system that followed World War II led to a good understanding of the pathophysiology of acetylcholinesterase inhibition and the development of a range of antidotes that can be used in both military or civil exposure. There are valuable lessons to be learned from the management of pesticide poisoning, and the rational use of oximes has been reappraised. The interest in cholinergic mechanisms has been matched in recent years by work on the pathogenesis of toxic pulmonary edema and new treatment strategies have resulted. Work has focused on increasing cellular glutathione (GSH) levels as a means of preventing lipid–peroxidation induced pulmonary edema. There are suggestions that N-acetyl cysteine may provide protection by maintaining GSH levels and inhibiting production of inflammatory leukotrienes.

Further application of knowledge gained from normal clinical research into disease mechanisms is likely to have a continued beneficial effect on the management of the rarer circumstances of mass toxic trauma.

End Tidal CO2: From Airway to Cardiac Output

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Learning Objectives: *1) to review the physiology of CO2 production and excretion and 2) to describe the use of ETCO2 to monitor ventilation, tube placement, and indirect cardiac output.*

Principles. A capnometer projects filtered infrared light at a wavelength of 4.28 um across a sample chamber to a semiconductor detector. The detector generates an electrical signal inversely proportional to the light absorbed by CO2 in the sample chamber, which ultimately is translated into a capnometer value (CO2 concentration). Capnography is the real-time graphic depiction of CO2 concentration throughout the respiratory cycle.

Gas sampling may be by "sidestream" or "mainstream" technique. Mainstream technique incorporates the sensor into the ventilation circuit. Sidestream technique samples exchanged gases through a small branch tube from the ventilation circuit or breathing patient. Sidestream sampling is more susceptible to clogging with water or mucus and results in a slower response time compared with mainstream capnometry.

Applications. Carbon dioxide is a by-product of cellular metabolism, constantly produced in proportion to the cellular metabolic rate. Because CO2 is transported via the bloodstream for elimination by the lungs, measurement of end-tidal CO2 (ET CO2) may reflect the cellular metabolic rate, vascular system intactness, cardiac function, and ventilation. Capnometry and capnography enjoy widespread use in anesthesia and the ICU. Similar technology appears transferable to the emergency department and prehospital setting.

Decreased CO2 concentrations, detected by capnometry or capnography, are indicative of endotracheal tube disconnection, extubation, obstruction, or misplacement. ETCO2 was found more reliable than direct visualization, auscultation, or observation of chest wall motion. Capnometry/capnography can confirm esophageal intubation within one respiratory cycle, whereas pulse oximetry may not detect desaturation for several minutes in the pre-oxygenated patient. For these important reasons, capnometry is strongly advocated in the emergency department and prehospital arena, where physical diagnosis is difficult at best and patient motion increases the risk of endotracheal tube displacement.

Capnometry and capnography may be useful for assessing the effects of cardiopulmonary resuscitation (CPR). During cardiopulmonary arrest, CO2 is neither efficiently transported to, nor expired from the lungs, resulting in decreased ETCO2. A rising ETCO2 may be the first sign of improved patient status during CPR. CO2 concentrations as measured by capnometry have been shown to correlate well with coronary perfusion pressure during CPR. These data may suggest prognostic application of capnometry. Capnogram waveform analysis enhances the specificity of capnometric ETCO2 measurements. Baseline changes may indicate CO2 rebreathing, while slope changes may indicate resistance that occurs with endotracheal tube kinking or expiratory obstruction. "Staircase effects" in the capnogram descending limb may be seen in situations such as pneumothorax. These applications of capnography and capnometry are important in the emergency department and prehospital setting.

Recently a new dimension has been added with the introduction of noninvasive cardiac output. This system utilizes a CO2 Fick principle to simulate the equivalency of an O2 Fick application. Initially usable only on intubated patients, this has now been expanded to those spontaneously breathing. This system combines ETCO2, flow, and differential dead space rebreathing to non-invasively accomplish this.

Limitations. While highly accurate, in certain clinical situations the ability of capnometric measurement to estimate arterial CO2 tension (PaCO2) is hampered. In healthy patients with well-matched alveolar ventilation and perfusion, ET CO2 estimates PaCO2 within 2 or 3 mmHg. When expired gas is from poorly or nonperfused alveoli (ventilation-perfusion ratio, or V/Q, mismatching), ETCO2 underestimates PaCO2. V/Q mismatching has multiple etiologies, including body position changes, acute and chronic pulmonary disease, and adult respiratory distress syndrome. While absolute values of CO2 concentration may be inaccurate in these circumstances, trend information may remain valuable. Also, the arterial-alveolar CO2 difference may be calculated in these patients. The arterial-alveolar difference, a-ADCO2, is the difference between arterial CO2 and end tidal CO2 (ET CO2). Normally this difference is small (2–3 mmHg) in patients with normal physiology and without cardiovascular or pulmonary disease. The a-ADCO2 difference may be elevated due to incomplete emptying, shunt perfusion, or dead space ventilation.

In shunt perfusion, a particular lung unit is underventilated relative to the amount of perfusion (normal 5L blood flow to 4L ventilation). Here the a-ADCO2 difference will be slightly elevated in the range of 5 to10 mmHg. This small difference is related to the efficiency of the lung and the excellent diffusability of CO2.

In dead space ventilation, a particular lung unit is underperfused relative to the amount of ventilation. Dead space ventilation widens the a-ADCO2 much more than does shunt perfusion alone. This difference may be 10 to 20 mmHg or more. Further, dead space ventilation and shunt perfusion are not mutually exclusive and may both occur to some degree in the same patient.

Conclusion. Capnometry/capnography are of confirmed value in the hospital setting, and their applications continue to broaden. Situations unique to the out-of-hospital environment invite their rapid extrapolation to the prehospital setting. Their ultimate value will depend upon the training, level of understanding, and clinical acumen of emergency care providers. New application to allow noninvasive cardiac output will provide a viable alternative to invasive systems.

A New Approach to Monitoring Early Hemodynamic Performance: Transesophageal Echo Doppler Ultrasound

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Early resuscitation of severe trauma is first based on physical examination like heart rate and arterial blood pressure. These parameters are not accurate enough to give a reliable circulatory status of the patient. Therapeutic adjustments based on these clinical parameters are thus difficult to implement and control, even after an initial aggressive therapy. The outcoming of the Transesophageal Echo Doppler system, which is a new noninvasive or light invasive hemodynamic monitor, could lead to an interesting approach in the rapid management of severe trauma patients. Early detection of cardiocirculatory disorders and prompt adequate treatment in order to prevent serious complication like organ failure are required during the very first hours after trauma.

Transesophageal Echo Doppler monitoring is easy to use and reproducible. On the trauma field or in the emergency room, the rapid settlement of the TEE is a major asset which allows to obtain a hemodynamic profile in just a few minutes. Its logical first use gives the chance, in clinical practice, to adjust the therapy based on the displayed hemodynamic parameters: aortic blood flow, stroke volume in the aorta and total systemic vascular resistance of the aortic circuit.

- For severe head trauma patients with no active bleeding, in order to maintain a mean arterial blood pressure (MABP) of 90 mmHg and avoid a secondary cerebral ischemia, we highly suggest a continuous measurement of MABP. Thus, interpreting the arterial blood pressure data correlated to ABF, Sva and TSVRa, the therapy can be orientated either toward fluid loading or toward the use of catecholamines, i.e., when vascular resistances are low with a normal flow (neurogenic hypotension). In all cases, continuous monitoring and trends allow to assess a real time hemodynamic status and help to adjust treatment.
- For polytrauma patients (penetrating or blunt trauma), with an unstable hemodynamic condition, the arterial blood pressure and heart rate are useless in estimating the right amount of blood loss. Keeping in mind that treatment should not delay surgery, monitoring Sva and ABF will help guiding the vascular fluid loading. Increase of ABF or Sva will reflect more accurately efficacy of initial treatment than any increase of arterial blood pressure.

Another challenge provided by Transesophageal Echo Doppler is the possibility to determine factors able to predict occurrence of MOF. Continuous measurement of ABF and Sva as early as possible after the trauma could help to quantify early low flow and poor tissue perfusion states. Correlation betwin those variation and occurrence of MOF have to be determined.

Minimally invasive, hemodynamic monitoring using the Transesophageal Echo Doppler approach opens very enthusiastic perspectives. Earlier diagnosis and continuous monitoring of circulatory deficiencies must be very useful for the trauma physician to start adequate resuscitation and minimize tissue ischemia.

— Session B —

Disaster Management and Emergency Medicine
Co-Chair: Dario Gonzalez, MD, New York, New York, USA
Co-Chair: Andreas Thierbach, MD, Mainz, Germany

The International Chief Emergency Physician Training Course

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Learning Objectives: *To review the development, content, and importance of The International Chief Emergency Physician Training Course.*

Education and training are essential in handling major incidents and disasters. It is an obligation of any medical system to meet these challenges. Guidelines for education and training in disaster medicine have been proposed.[1]

The International Chief Emergency Physician Training course on Command Incident Management and Mass Casualty Disasters (ICEP) is one of the international courses with a well-established curriculum.

The first CEP course was set up in 1998 by The International Trauma Anesthesia and Critical Care Society (ITACCS) in cooperation with a group of leading chief emergency physicians in Mainz and based on experiences from national German CEP courses.[2]

The international faculty consists of experienced chief emergency physicians and experts in different fields from various parts of the world to cover all issues. Participants make up an international forum of physicians with experiences within prehospital care, trauma care, emergency medicine, and command incident management. This constellation facilitates international exchange of experiences and ideas.

The CEP course has an intensive 40 hours curriculum with lectures, discussions of case reports, excursions, and in-field training. Subjects include epidemiology of mass casualty incidents and disasters, responsibilities and duties of the CEP, command and control, triage concepts, personal protection and equipment, communication devices and techniques, evacuation and long-range transport, planning for mass gatherings, VIP protection, hostage situations, counter terrorism, HazMat, bio-threats and chemical warfare, medical relief, and media contact and management.

Lectures are interactive and most are accompanied by practical training sessions or tabletop discussions. Theory and practical training result in full-scale disaster exercises in cooperation with all local authorities.[3]

This international concept facilitates post-course exchange of knowledge and experiences based on the network established during the 5-day intensive curriculum of chief emergency physicians.

The ICEP courses are announced at www.ITACCS.com.

References

1. Handbook of Disaster Medicine International Society of Disaster Medicine 2000. Education and Training, pp 481–95.
2. Müller R, Lipp MDW. The First International Chief Emergency Physician Training Course. *TraumaCare* 1998; 8:29–30.
3. Thierbach AR, Lippert FK, Grande CM. The International Chief Emergency Physician Training Course on Command Incident Management and Mass Casualty Disasters. *TraumaCare*, in press.

The Effect of Select Drugs on Shock in the Trauma Patient

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"He takes a little white heart pill in the morning!"

Learning Objectives:

- *To understand the effects of prescribed medications, herbal supplements, and illicit drugs on the clinical presentation of shock.*
- *To review the effects of prescription medications and their potential influence on the assessment of trauma patients.*
- *To appreciate the risk of adverse drug reactions, especially in elderly patients with preexisting conditions.*

Many prescribed medications, over-the-counter drugs, social "drugs," and "herbal medicinals" may camouflage the clinical presentation of the shock syndrome in the trauma patient. For example, beta blockers may blunt the compensatory tachycardia in hypovolemia. Alcohol is a central nervous system depressant and vasodilator, potentially affecting Glasgow Coma Scale assessment or potentiating hypotension. A detailed history of prescribed medications, over-the-counter drugs, herbal supplements, and social "drug" activity must be sought if the "typical" presentation of shock is not consistent with the injury pattern or clinical appearance of the patient.

A working knowledge of the pharmacokinetics and pharmacodynamics of commonly prescribed medications and other drugs on various organ systems will aid the clinician in the overall assessment and management of the trauma patient.

Drugs used for the management of pre-existing disease may be solely or partially responsible for inciting cause of events leading to injury. Chief "culprits" are insulin and/or oral hypoglycemics, antihypertensives, and antiarrhythmics.

Many adverse drug effects may be treated expeditiously and effectively if it is recognized that the drug effect exists. For example, naloxone will reverse the effect of opiate-induced respiratory depression, and 50% dextrose in water will reverse hypoglycemia induced by insulin and oral hypoglycemics.

More than 35 million Americans are 65 years of age or older. There is a high incidence of diabetes mellitus and cardiovascular disease in the elderly. Many in this patient population are dependent on prescribed drugs for maintenance of health and, as a result, the elderly are more at risk for an adverse drug reaction.

Unfortunately, most herbal medications and supplements are not yet regulated by the Food and Drug Administration and may be purchased readily without prescription. Consumption of these "natural drugs" has increased significantly with the popularity of Internet sales and distribution.

Lessons Learned 911

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Learning Objectives:

1. *Student will be presented three core issues related to the problems associated with the 911 disaster.*
2. *The student will be presented with basic lessons learned from the discussed problems.*
3. *The student will be able to appreciate the need for pre-planning and policy development for disaster response.*

At 0845 on September 11, 2001, hijacked commercial airliners crashed into World Trade Center (WTC) Complex. This resulted in the collapse of the North and South Towers (each 110 stories). Fire Department City of New York (FDNY) and other New York City emergency responders initiated building evacuation, rescue, and fire suppression activities. The collapse of the towers killed 450 responders, including much of the top leadership of the Fire Department of New York City, who were operating within the towers as the on-scene incident command.

Incident Command Structure. The collapse and subsequent death of these key personnel resulted in a command void within the fire department. An effective command structure is essential to resolve four critical issues: scene control, event mitigation, resource coordination, and site safety.

The command structure did develop with time, but the delays encountered in reestablishing a command and control structure had significant operational, health, and safety consequences. The development of a cohesive incident command structure allowed the transition from victim rescue operations to body recovery operations and site mitigation.

Lessons Learned:

1. Fire command location must be based on the uniqueness of a disaster.
2. Coherent command authority is necessary to coordinate resources.
3. Incident command structure is necessary for the transition and development of a coordinated operational plan.

Hazard Analysis. The environment contained hazardous materials, such as jet fuel, battery acid, asbestos, lead paint, silica, explosives (munitions), radioactive debris, and products of combustion. Traditional site environmental risk-assessment activities had technical problems. The ever-present WTC dust was composed of silica (windows), concrete, smoke, cremated/shredded human remains, and unknown irritants. Its prolonged inhalation ultimately led to the "World Trade Center cough." Loss of the incident command and the nature of the event resulted in an overall poor personal protective equipment (PPE) compliance rate.

Efforts were made to qualitatively and quantitatively define the Ground Zero atmospheric environment. The environmental readings that were eventually obtained were confusing, contradictory, and difficult to correlate with human health risk analysis.

Lessons Learned:

1. Environmental data are difficult to interpret and quantify. Numbers in a vacuum only serve to confuse and alarm the public and emergency responders.
2. Policies for the appropriate use of PPE during disaster responses must be enforced.
3. Incident site hazard information must be collected rapidly and accurately.
4. Technologies that can provide rescuers real-time information about their environment (e.g., sampling and pluming models) are needed.

Volunteerism. Volunteerism after the WTC attack resulted in increased death rate for FDNY and police, due to the self-assignment by off duty personnel. Civilian volunteers arrived without appropriate protective equipment and worked in some of the most hazardous locations, outside the direction of the incident commander. Their presence added to the confusion and increased the safety and rescue responsibilities of the command structure. The massive outpouring of volunteer involvement in the response was heartwarming but became problematic.

Conclusion. The events surrounding September 11 posed unique challenges for the City of New York. Its uniqueness required emergency responders to assume new roles and responsibilities. The events surrounding large-scale disasters have a wide range of hazards. The more complicated the event, the greater the potential for multiple complex environmental threats. The World Trade Center incident began as an urgent response (days) and transitioned into a sustained recovery campaign (18 months).

There should be procedures in place to ensure 1) appropriate use of PPE, 2) timely and accurate hazard assessment, and 3) site management.

Organization of Medical Systems Under Repeat Terror Attacks

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From the start of the 'El-Aksa Intifada' on 29.09.2000 until 13.03.2003, Israel suffered 753 dead and 5,152 injuries from terror attacks. 523 of the dead and 3,844 of the injured were civilians. The incidents were bomb attacks in buses, hotels, and clubs and shooting at civilians' cars. After the first few attacks, the Israeli medical system began to change itself to deal with these terror incidents. The prehospital system, Magen David Adom (MDA), changed its way of working by adding on-call ambulances, creating a debriefing protocol after every incident, and building a feedback system with the hospitals. Emergency wards reviewed the trauma practice of their staff by using smart simulators in the 'National Medical Simulation Center', and the Israeli Trauma Association sent volunteers to help community hospitals get ready to deal with these injuries and to deal with mass casualties situations (MCS). The national MCS committee reviewed and updated MCS protocols to match the new situation. The army found new ways to prepare reserve physicians and medics in a short period of time for the new conditions at work. Out of all this, we built an international course for managing trauma systems and MCS.

Triage: Do We Need New Concepts?

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Learning Objectives:

1. *Participants will gain an understanding of the differences between traditional triage and triage of mass casualties when health care resources are exceeded.*
2. *Participants will become familiar with the indications for and methodology of Simple Triage and Rapid Treatment (START).*

The goal of standard triage is to identify the sickest patients who require the most immediate care. Clinicians expend the greatest resources on the most critical patients. However, in a situation in which health care resources are overwhelmed, patients will die if standard triage methods are applied. The focus of triage must shift from treating patients who are gravely ill or injured to "doing the most good for the most people."

There currently exists no single "correct" method of triage. Varying triage methods should be applied depending on the type or magnitude of the event. Is there a scene? Is the incident static, or are there likely to be additional casualties over time? Is there access to standard definitive medical care, or must patients be managed under austere field conditions or triaged to alternate care sites?

A common method for sorting multiple patients at a disaster scene is Simple Triage and Rapid Treatment (START). All patients who can walk are directed to move to a location away from the site. Next, patients are divided into green ("walking wounded"), yellow ("delayed"), red ("immediate"), and black ("deceased") groups, based on a quick assessment of respirations, pulse, and mental status. Assessment of each patient takes only seconds; the sole treatments performed are opening an airway or placing direct pressure on external hemorrhage.

Under conditions in which immediate transport to definitive care is unavailable, Secondary Assessment of Victim Endpoint (SAVE) triage may be used. SAVE assumes a local cadre of trained health care providers and decentralized equipment. Triage is a dynamic process and periodic patient reassessment is crucial.

Traditional triage methods presume a static event that occurs at a single point in time. However, in a catastrophic setting, there may be multiple pockets of casualties spread across a geographic region. Transportation and communication systems may be disrupted, EMS systems could be nonfunctional, and definitive care facilities could be unavailable. Traditional triage tags are inadequate for medical documentation during a dynamic event; secondary examinations and treatment will be necessary.

In non-military settings, mass casualty triage training is limited. Health care providers are taught to apply resources to the most critically ill or injured patients. It is challenging for a trained health care professional to allow a patient to die, even if this means saving many other lives. Fortunately, the capacity of the U.S. health care system has not been exceeded since the influenza pandemic of 1918. However, many current threats, including a massive earthquake, pandemic influenza, and some types of terrorist attacks would produce more casualties than could be treated. Surge capacity in the United States is currently lacking for such a situation; thus, new concepts in triage must be implemented.

References
1. Koenig KL, Schultz CH. Disaster medicine: advances in local catastrophic disaster response. *Acad Emerg Med* 1994; 1:133–6.
2. Schultz CH, Koenig KL, Noji EK. A medical disaster response to reduce immediate mortality following an earthquake. *N Engl J Med* 1996; 334(7):438–44.
3. Benson M, Koenig KL, Schultz CH. Disaster triage: START, then SAVE–a new method of dynamic triage for victims of a catastrophic earthquake. *Prehosp Disaster Med* 1996; 11(2):117–24.
4. Koenig KL, Dinerman N, Kuehl AE. Disaster nomenclature–a functional impact approach: the PICE system. *Acad Emerg Med* 1996; 3:723–7.
5. Schultz CH, Koenig KL, Noji E. Disaster planning and response. In Marx J, Hockberger R, Walls R, eds. *Rosen's Emergency Medicine*: *Concepts and Clinical Practice*, 5th edition. St. Louis, Mosby, 2002.

Databases for Storing Prehospital and Intrahospital Data
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Databases for Storing Pre-hospital and Intra-hospital Data

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Learning Objectives: *To understand the changing requirements for data collection in trauma care and to appreciate the influences affecting data accuracy.*

In a cost-constrained, evidence-based, and digitally competent world, data is precious. We need it to justify our actions and to point out improvements or pitfalls in care. Its very necessity creates a tension between unbiased accuracy and the desire to bolster our own practice. The more we are judged on our performance as demonstrated by the data, the higher the stakes become and the greater the need for transparency. These pressures are further confounded by the difficulty of recording real-time data in an emergency situation and the inherent uncertainty in the information at the time. Without cost constraints, we would employ extra scribes to record events while others deliver patient care or we would invest in labor-intensive media recordings with analytical replay to extract data.

Despite these conflicting constraints, many worthy data systems have been developed and they have played a pivotal role in trauma care. In its heyday, the Major Trauma Outcome Study (MTOS) allowed an overall comparison of mortality in different centres, adjusting for the variation in anatomical injury and physiological response using the TRISS methodology. Database development was relatively naïve at the time, leading to data structures that were somewhat clumsy and were extended 'by accretion' as extra variables were added piecemeal to the whole. In addition, the early focus was on pre-hospital and emergency department care, neglecting the important contribution of definitive care and rehabilitation to outcome (measured in terms of morbidity and disability rather than just mortality).

With the lessons we have learned and the seemingly limitless potential of new digital technology, we are developing new systems. We demand standardization and are keen to agree on universal data sets. Our greed for completeness haunts us as the list of variables grows ever larger and the problems of error, omission, and 'noise' remain with us. Commercial systems such as Collector(, while not inexpensive, have allowed professional software developers to enhance the way in which the data is handled. Over 200 centers worldwide have signed up to Collector's flexible system. The American College of Surgeons has developed its own system, offering the ability to import data from other commercial systems (including Collector). Its NTRACS(trauma registry, launched in 1992, and the associated national trauma data bank NTDB(offer national recognition, although only 20-25% of Level I-II trauma centers currently subscribe.

In Europe, the demand for unity and standardization is equally strong. After an international workshop coordinated by the Trauma Research and Audit Network (TARN), a European consensus on the minimum data set for trauma is being established, using the Delphi technique. TARN, the surviving UK sister of MTOS, has commissioned a new web-based data management system to facilitate remote input of and access to data. Although it incorporates new thinking on the generic nature of trauma data as the patient moves from one location to another (e.g. scene to ER to OR to ICU), other developments await the anticipated technological surge to allow real-time observations and decision-making to be incorporated into our trauma data systems.

Bibliography
American College of Surgeons Trauma Registry: http://www.facs.org/dept/trauma.
Dick WF, Baskett PJ, Grande C, et al. Recommendations for uniform reporting of data following major trauma – the Utstein style. B*r J Anaesth* 2000; 84:818–9.
Trauma Research and Audit Network: http://www.tarn.ac.uk.
Wynn A, Wise M, Wright MJ, et al. Accuracy of administrative and trauma registry databases. *J Trauma* 2001; 51:464–8.

— Session C —

Scientific Free Paper Presentations
Moderators: Enrico M. Camporesi, MD, Syracuse, New York; Adolph H. Giesecke, MD, Dallas, Texas; John K. Stene, MD, PhD, Hershey, Pennsylvania, USA

Battle Field Anaesthesia: How Different Is It?

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The provision of anesthesia and critical care is always a big challenge in trauma victims. It, however, becomes broadly redefined when working in field conditions due to inadequate logistic support and non-availability of optimal working conditions. This is exemplified while working in a combat zone trauma center.

Military anesthesia has been instrumental in providing care to the wounded since the discovery of anesthesia in 1846 and has made significant progress over the years. Each war and conflict has required anesthesiologists working in service hospitals to adapt to new challenges in different environments. This paper provides an insight into the working of a forward military trauma care center located in insurgency-rife Jammu and Kashmir sector. This part of India is at high altitude with extreme cold climate and high wind velocity. Besides the shelling, altitude, and cold, the area is heavily mined. The steep gradient and loose rocky surface make it prime avalanche territory.

The team comprises a single anesthesiologist and a surgeon with necessary ancillary staff. The main operation theatre is inside an underground bunker. We managed 767 casualties over a period of two and a half years (November 1999 to June 2002), out of which 587 patients underwent surgery. This included 209 splinter injuries, 191 gunshot wounds, 118 landmine injuries, and 69 grenade injuries.

A standardized protocol using the basics of trauma anesthesia was followed. Adequate wound treatment was given prime importance. Radical primary wound debridement and foreign body removal accounted for three fourths of the procedures. The choice of anesthesia was dependent on the site of involvement. DA was used for all 23% of cases and GA for 19%. The remaining cases were done under regional block anesthesia.

Military experience has shown that the presence of expert care in the vicinity of a forward post is a very big moral booster for troops employed in warfare. Prompt optimal care gives the trauma patient a chance to return to functional life. The future challenge for anesthesiologists involved in trauma care in an advance field surgical unit is to provide tertiary level care within the available resources and to minimize morbidity and mortality.

Cervical Spine Management in Unconscious Adult Trauma Patients: Survey of Practice in UK Specialist Centres

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Learning Objective: *To determine how the cervical spine is assessed before discontinuation of immobilisation in unconscious adult trauma patients in UK neurosurgical centres.*

Purpose of study: a) to establish if each unit had a written protocol or guidelines to screen for cervical spine injury, b) to determine the radiological screening tests used routinely in all unconscious patients, and c) to ascertain whether cervical spine immobilisation was normally continued until the patient regained consciousness and could be examined clinically.

Method Used. A postal questionnaire was sent to all neurosurgical centres in the United Kingdom. Follow-up telephone contact was made if a reply was not received within 6 weeks.

Results. 27 of 32 centres responded (84% response rate). The following results refer to the units from whom replies were received: 9% had written guidelines for the radiological screening tests used routinely in unconscious adults, 6% had a written policy for discontinuing immobilization, 56% of centres used fewer than three plain radiographs (over half of these centres did not use computed tomography [CT] routinely). CT scanning was used in 10 centres (37%). Two centres (7%) used dynamic fluoroscopy routinely. One centre used magnetic resonance imaging (MRI) routinely.

If all radiological investigations were normal, 44% of centres discontinued immobilisation before the patient was awake and could be assessed clinically.

Seven centres (26%) had experience in dynamic flexion-extension fluoroscopy. Three of these believed it was unsafe.

Conclusion. There is little consistency in how the cervical spine is assessed before the removal of immobilisation precautions in UK neurosurgical centres. Although the use of plain radiography is ubiquitous, there is wide variation in the number of films taken. Routine use of CT is surprisingly low for specialist centres dealing with unconscious trauma victims. Clinicians in these centres have little experience, and less faith, in the safety of dynamic fluoroscopy.

Clinically Relevant Hyperventilation of First Aid Providers Results from Artificial Ventilation

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Learning Objective: *To investigate the hypothesis that rescuer ventilating an apneic victim during basic life support (BLS) performing mouth-to-mouth or mouth-to-nose ventilation suffers from clinically relevant and statistically significant hyperventilation.*

Purpose of Study. The "Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care–International Consensus on Science" recommend a ventilation volume of 10 mL/kg body weight (equivalent to a tidal volume of 700 to 1000 mL) without the use of supplemental oxygen in adults during isolated respiratory arrest and two-rescuer cardiopulmonary resuscitation (CPR).[1] Additionally, a deep breath is recommended before each ventilation to increase the end-expiratory oxygen concentration of the air exhaled by the first aid provider.

Methods. To investigate the effects of these recommendations in healthy volunteers, test persons were asked to perform isolated artificial ventilation and two-rescuer CPR in a lung model connected with a BLS mannequin. The tidal volume was fixed to 800 mL. The breathing rate was set to 12/min for isolated respiratory arrest. In the two-rescuer cardiopulmonary resuscitation model, it depended primarily on the rate of chest compressions (set to 100/min). Therefore, a breathing rate between 8 and 9/min could be achieved by the test persons. End-tidal carbon dioxide, oxygen saturation (measured by pulse oximetry), and heart rate were recorded continuously. Capillary blood gas samples (including $capCO_2$) were collected before and after the ventilation periods.

Results. Clinically and statistically significant hyperventilation results in first aid providers performing artificial ventilation during isolated respiratory arrest[2] and two-rescuer CPR according to the Guidelines 2000. The ventilation was associated with a significant decrease in capillary and end-expiratory carbon dioxide pressure ($p < 0.001$) as well as with multiple symptoms of an acute hyperventilation syndrome (e.g., paresthesia, dizziness, and carpopedal spasms) in 75% of test persons. The main end-expiratory CO_2 decrease occurred during the first 2 minutes of ventilation, with a median decrease of 14 mmHg.

Conclusions. Artificial ventilation performed according to the Guidelines 2000 may cause injury to the health of the first aid provider. In order to minimize hyperventilation in the rescuer, the rescuer ventilating the victim should be replaced at regular intervals and the recommendation to take a deep breath before each ventilation should not be upheld any longer.

References
1. Guidelines 2000: Adult Basic Life Support Part 3; Supplement to *Circulation* 2000; 102(8):I-22–I-59.
2. Thierbach AR, Wolcke BB, Krummenauer F, Kunde M, Jänig C, Dick WF. Artificial ventilation for basic life support leads to hyperventilation in first aid providers. *Resuscitation*, in press.

The Statoil Search and Rescue Helicopter Service

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Learning Objective: *To describe and demonstrate the use of offshore stationed SAR helicopters in emergency situations at offshore oil installations.*

Oil companies operating in the North Sea and Norwegian Ocean are obliged to have their own medical aid and health service on board their platforms, even though a national coast guard service covers all the coast line. The quality of the service shall be comparable to onshore primary health care, and even requires the ability of qualified transportation of injured or critically ill patients.

Supplying oil installations with competent and immediate medical aid requires a helicopter based service. The low frequency of emergencies makes it possible to combine the service of ambulance transportation with tasks concerning surveillance of oil spills as well as search and rescue operations.

The crew consists of five members. The nurse on board is supposed to be able to handle emergency medical situations with the help of the rescue-man.

Statoil commenced the service at the Statfjord B platform in 1982. Since June 2001, the Statoil SAR operations include a new service based at the Heidrun platform in the Norwegian Ocean.

The method used is retrospective investigation of medical files and flight records.

The services in the Norwegian Ocean and the North Sea are demonstrated through pictures and tables. Descriptions of personal qualifications and equipment in use will be given. The main categories of tasks will be reviewed and discussed.

The efficiency of the service is demonstrated by referring a medical case, including serious trauma to extremities. First aid was given at the platform, and treatment was continued by the SAR nurse arriving at the installation. Scramble time and flight time was half the time compared with using an onshore based helicopter.

Results. Diagnoses are summarized and counts are reviewed for the year 2002. The counts show a total of 78 patients treated at Statfjord and 59 at the Heidrun services. Traumas counted for 22 and 12 of the cases, respectively. SAR operations, including hoisting from vessels, were performed in 6 and 2 cases each. In the other cases, the SAR helicopters where able to land on the helideck.

Fourteen percent of all treated patients were suggested to have an MI. In comparison, all traumas accounted for 25% of total. Major trauma counted for just 3 of these 34 cases, while the major part of traumas were distal fractures and soft tissue wounds. Counts show an increasing number of cases with coronary heart disease, while trauma cases are becoming fewer and less serious than in the early days of oil business offshore.

Conclusion. The combination of helicopter ambulance with a full SAR service in offshore industry is an appropriate way of gaining a high quality medical emergency service. Sharing the cost with company emergency tasks like sea-rescue and oil spill surveillance makes it beneficial to the oil companies. Combining these tasks gives an ambulance service at lower cost, higher quality, and shorter response time.

Stand-By Intra-Aortic Balloon Occlusion in the Prevention of Cardiac Arrest Prior to Definitive Treatment of Traumatic Hemorrhage

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Learning Objective: *To understand the strategies of initial treatment for the patients in hemorrhagic shock due to intra-abdominal hemorrhage or retroperitoneal hemorrhage.*

Purpose of Study. Hemorrhagic shock due to intra-abdominal hemorrhage or retroperitoneal hemorrhage caused by severe liver injury or pelvic fracture may cause cardiac arrest. How can we prevent cardiac arrest prior to adequate blood transfusion or definitive treatment such as transcutaneous arterial embolization (TAE), external fixation of the pelvis, or laparotomy? In the present study, we show the usefulness of the concept of stand-by intra-aortic balloon occlusion (IABO).

Methods. In the present study, a retrospective review of trauma patients, in whom IABO was considered appropriate, was conducted over a 3-year period. For the trauma patient, prior to the use of an IABO catheter, a 9Fr introducer or 18G catheter was inserted percutaneously so that emergency insertion of IABO would be possible. We defined this procedure as "stand-by IABO".

Results. We reviewed trauma patients with hemorrhagic shock (BP range, 50–94 mmHg) due to intra-abdominal hemorrhage or retroperitoneal hemorrhage at presentation and who were still fighting for life. Ten patients were considered to need or potentially need the use of IABO and in whom a 9Fr introducer or 18G catheter had been inserted. Among them, 7 patients were considered to need "stand-by IABO." Three patients were considered to need immediate IABO. Three of the 7 "stand-by IABO" patients were non-responders or transient responders to the initial bolus fluid resuscitation and required later inflation of the IABO balloon.

Conclusion. Stand-by intra-aortic balloon occlusion for preventing cardiac arrest prior to definitive treatment of traumatic hemorrhage appears to be a useful adjunct in some cases. We recommend preparing stand-by IABO for those patients whose initial vital signs are unstable and who would have intra-abdominal hemorrhage or retroperitoneal hemorrhage caused by severe liver injury or pelvic fracture, before their vital signs could deteriorate to the point where the femoral artery could not be palpated.

Mason's PU-92 Concept: Rapid Recognition and Treatment of the Crash Airway

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Learning Objective: *To understand how to rapidly recognize and treat the patient with a crash airway.*

Mason's PU-92 concept[1] was designed to assist with the rapid identification of the crash airway[2] by combining an assessment of the level of consciousness with the patient's SpO_2 level. The AVPU system specifies four levels of consciousness: 1) A (Alert) – signifying that the patient is alert; awake; responsive to voice; and oriented to person, time, and place; 2) V (responsive to a Voice) – signifying the patient responds to voice but is not fully oriented to person, time, or place; 3) P (responsive to a Pain) – signifying that the patient does not respond to voice but does respond to painful stimuli such as pressure to a nail-bed or the supraorbital nerve; and 4) U (Unresponsive) – signifying that the patient does not respond to verbal or painful stimuli. An AVPU score of 'P' or 'U' corresponds to a Glasgow Coma Scale score of <9 and indicates that the patient meets one of the criteria for intubation.[3] The other limb of the PU-92 concept recognizes the fact that pulse oximeters have an accuracy of +/- 2%. Therefore, to ensure the true oxygen saturation (SaO_2) is kept above 90%, rescuers are advised to attempt to maintain the indicated SpO_2 above 92%. This is important since the oxygen saturation of the blood drops precipitously when the SaO_2 level falls below 90%. Furthermore, hypercarbia secondary to hypoventilation exacerbates this decrease in SpO_2 by shifting the oxyhemoglobin dissociation curve to the right[4]. A "yes" answer to "PU ≤ 92?" following maximal efforts at ventilation with bag-valve mask ventilation + 100% oxygen indicates that a crash airway[2] exists.

Crash Airway. A crash airway is an infrequent occurrence but requires immediate recognition when it does occur. A crash airway patient is usually obtunded, often unstable physiologically, has an $SaO_2 \leq 90\%$, and is usually near death. When a crash airway[2] exists, the patient requires immediate improvement in ventilation and oxygenation. At this point, the practitioner has two choices: either attempt tracheal intubation one time or proceed directly to rescue ventilation. If the practitioner is skilled at tracheal intubation and believes the clinical situation will permit rapid intubation of the trachea, one attempt at oro-tracheal intubation with direct laryngoscopy may be attempted.[2] If tracheal intubation cannot be confirmed, the next step is to rapidly place a laryngeal mask airway or a Combitube (in patients taller than 4 feet). Alternatively, if it appears that the situation is not favorable for rapid intubation of the trachea because taking time to attempt even a rapid intubation might lessen the patient's chances of survival, one should proceed directly to rescue ventilation without attempting tracheal intubation. After placement of a Combitube or LMA temporizes the situation by sufficiently raising the SpO_2, tracheal intubation may then be attempted in a less hurried and safer fashion. Delays in commencing with rescue ventilation or cricothyrotomy if rescue ventilation options are ineffective or not available can lead to irreversible disability or death of the patient.

The Combitube and LMA are supraglottic airways and will only alleviate a supraglottic obstruction. Glottic and subglottic obstruction can be relieved only by using an endotracheal tube, TTJV, or surgical airway.[5] The Combitube is secured in the airway by maximal inflation of the oro-pharyngeal balloon.[6] The LMA can be secured by using a pre-manufactured tube holder-bite block apparatus[7] that will both secure the LMA and prevent tube occlusion from biting. Alternatively, the LMA can be secured with tape to prevent dislodgement and a rolled gauze bite block to prevent tube compression. The Combitube and laryngeal mask airway are currently recommended alternative airway devices by the American Heart Association, American Society of Anesthesiologists, and European Resuscitation Council.[2,3,6]

Aspiration Protection. Another benefit from use of the Combitube and LMA for rescue ventilation is the protection they offer from regurgitation and aspiration. In a multicenter trial using the LMA in CPR, the overall incidence of aspiration was <1%.8 The Combitube offers protection from aspiration similar to that of an endotracheal tube by effectively sealing the esophagus rather than the trachea, which thus provides a secure route of egress for stomach contents.[5,6,9] No reports of major aspiration with the Combitube have been reported.[5]

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. Walls RW. The emergency airway algorithms. In Walls RW, ed. *Manual of Emergency Airway Management*. Philadelphia: Lippincott Williams & Wilkins, 2000, pp 16–26.
3. Mackay CA et al. Association between the assessment of conscious level using the AVPU system and the Glasgow coma scale. *Pre-hospital Immediate Care* 2000; 4:17–9.
4. Weinberger SE, Drazen JM. Disturbances of respiratory function. In Braunwald E, Fauci A, Kasper D, et al, eds. *Harrison's Principles of Internal Medicine*, 15th ed. New York: McGraw-Hill, 2001, pp 1446–53.
5. Benumof JL. The ASA Difficult Airway Algorithm: new thoughts and considerations. In Hagberg CA, ed. *Handbook of Difficult Airway Management*. Philadelphia: Churchill Livingstone, 2000, 31–48.
6. Agro F, Frass M, Benumof JL, Krafft P. Current Status of the CombitubeTM: a review of the literature. *J Clin Anesth* 2002; 14:307–17.
7. Mason AM. Method of securing the laryngeal mask airway in pre-hospital care. *Pre-hospital Immediate Care* 1999; 3:167–9.
8. Baskett PJF (coordinator). The use of the laryngeal mask airway by nurses during cardiopulmonary resuscitation. Multicentre trial. *Anaesthesia* 1994; 49:3–7.
9 Urtubia R, Aguila C. New thoughts on the difficult airway. *Curr Opin Clin Exp Res* 2000; 2:61–7.

SLAM Emergency Airway Flowchart: Universal Considerations for the Emergency Airway

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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.

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

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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).

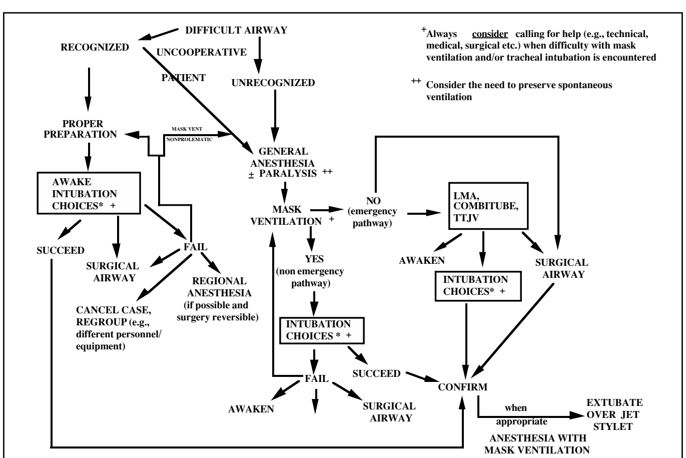

Figure 1. The ASA Difficult Airway Algorithm from References 1 and 2.
*Non-surgical tracheal intubation choices consist of laryngoscopy with a rigid laryngoscope blade (many types), blind orotracheal or nasotracheal technique, fiberoptic/stylet technique, retrograde technique, illuminating stylet, rigid 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

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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

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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.