Burn Pain Management: A Paradigm for Aggressive Pain Control Following Major Trauma

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Learning objectives: *The purpose of this presentation is to use burn pain–possibly the most intense and problematic example of post-traumatic pain–as an illustration for aggressive pain management, emphasizing 1) regular and recorded pain assessment, 2) targeting of analgesic techniques to specific types of pain, 3) anxiolysis as an analgesic adjunct to opioid therapy, and 4) awareness of new or novel analgesic therapies.*

Post-burn pain is an extreme example of post-traumatic pain, both in its intensity and its duration. Because significant attention has been focused on the nature of burn pain management (both pharmacologic and nonpharmacologic), it serves as a potential paradigm for the treatment of other types of post-traumatic pain that accompany major, non-burn trauma. This presentation will focus on four specific areas: pain assessment, targeted analgesia, anxiolysis as an analgesic adjunct, and novel analgesic therapies.

Pain Assessment. A wide variety of pain assessment tools currently exist that have been validated (i.e., they yield accurate and reproducible results in the intended population) in the clinical setting, and are applicable to a wide variety of specific age ranges and cognitive abilities.[1] Regardless of which assessment or measurement technique is used, the consistent use of a pain assessment tool on a daily basis provides two tangible benefits to both patients and staff: 1) accurate assessment of patient pain and efficacy of the current analgesic plan and 2) simplified communication of pain and analgesia issues among care staff. These benefits are maximized when pain assessment occurs regularly (i.e., on daily rounds), when both background pain and procedural pain are assessed, and when results are recorded in the medical record or bedside chart so that all burn care staff are aware of the level of pain, recent changes in pain, or the effects of recent analgesic interventions.

Tailoring Analgesic Regimens to Clinical Needs. Because burn pain is variable in its degree and time course, reliance on a single analgesic regimen is unreliable at best, and unsuccessful at worst. Conversely, the diverse spectrum of burn patients (adults vs children, large burns vs small, intensive care unit nursing vs ward care, inhalation injury vs not) makes the routine individualization of analgesic plans overwhelming and impractical. One clinically practical solution to this dilemma is to determine an analgesic regimen for each individual patient based upon two broad categories: 1) the clinical need for analgesia and 2) the limitations imposed by the patient or by clinical facilities–and then individualize analgesic therapy within guidelines established by the institution:

Clinical Need for Analgesia	Patient or Facility Limitations
– Background pain	– IV access or not
– Procedural pain	– Intubated or not
– Breakthrough pain	– Monitoring needs
– Postoperative pain	– Drug tolerance

The first step is to address background, procedural, breakthrough, and postoperative pain needs separately, and then to consider individual drug choices based upon patient or facility limitations. To reinforce this type of approach to analgesic management, particularly in centers where housestaff physicians and/or nursing staff may rotate or change frequently, the establishment of succinct yet detailed institutional guidelines may help physicians and nurses choose and administer specific analgesics.[2] To maximize simplicity and utility, it is recommended that such guidelines be safe and effective over a broad range of ages, be explicit in their dosing recommendations, have a limited formulary to maximize staff familiarity, and allow the bedside nurse to evaluate efficacy and safety continuously.[2]

Anxiolysis and Procedural Burn Pain. Current aggressive therapies for cutaneous burns, together with the intense and unremitting qualities of background and wound care pain, make burn care an experience that is likely to engender anxiety in a large proportion of adult and pediatric patients. It is also recognized that anxiety can exacerbate acute pain, and has led to the common practice in U.S. burn centers of using anxiolytic drugs in combination with opioid analgesics. Intuitively, this practice seems particularly useful in premedicating patients for wound care, due to the anticipatory anxiety experienced by these patients prior to and during debridement. Benzodiazepine therapy improves postoperative pain scores in non-burn settings, and it has been reported that low-dose benzodiazepine administration significantly reduces procedural pain during burn wound care.[3] It appears that the patients most likely to benefit from this therapy are not those with high trait (premorbid) anxiety, but rather those with high state (at the time of the procedure) anxiety or with high baseline pain scores. Other non-pharmacologic anxiolysis techniques (e.g., hypnosis, behavioral therapy) should also be considered, as discussed elsewhere in this course.

New and/or Novel Pharmacologic Analgesic Techniques. Analgesic options, once limited to intramuscular opioids administered on a PRN basis, are now diverse, with new therapies introduced regularly. Clinicians should be aware of new/novel therapies, whether they are new analgesic pharmacologies (dexmedetomidine), new uses of old analgesic pharmacologies (intranasal ketamine), or new nonpharmacologic technologies (virtual reality analgesia).

References

1. Marvin JA. Pain assessment versus measurement. *J Burn Care Rehabil* 1995; 16:348–57.
2. Sheridan RL, Hinson M, Nackel A, et al. Development of a pediatric burn pain and anxiety management program. *J Burn Care Rehabil* 1997; 18:455-9.
3. Patterson DR, Ptacek JT, Carrougher GJ, Sharar SR. Lorazepam as an adjunct to opioid analgesics in the treatment of burn pain. *Pain* 1997; 72:367–74.
4. Hoffman HG, Patterson DR, Carrougher GJ, Sharar SR. The effectiveness of virtual reality based pain control with multiple treatments. *Clin J Pain* 2001; 17:229–35.

[*Editors' note: In this abstract, intranasal ketamine administration is described as a potential new use of an existing pharmacology. The drug delivery system for such administration is currently under development.*]

Post-Traumatic Chronic Pain–Does It Slow Rehabilitation and Increase Costs? And, If So, What Can We Do to Prevent It?

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[abstract not available]

— Session 1C —

Prehospital Trauma Care–The Weak Link in the Trauma Chain of Survival?

Does Bystander Trauma Care Save Lives or Just Make Things Worse?

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Learning objectives: *1) to understand the history of the development of first-aid courses and application principles, 2) to review accepted basic life support measures for various injuries and medical conditions, and 3) to reveal the need for research into the value of administering first aid at the scene of injury versus initiating immediate transport of trauma victims to a medical facility.*

First Aid History in Norway. The Norwegian system of rescuing injured or lost people, at sea or land, is by tradition based on volunteer rescue preparedness organizations. These organizations are also responsible for providing the majority of first aid courses, where laypersons are educated in basic life support.

The Norwegian Red Cross was founded 1865. The relief work carried out ranges from caring for the elderly, a prison visitor service, international aid, working with AIDS and volunteer rescue groups. The Red Cross Rescue Corps (founded 1932) has 15.000 members and emergency standby at 335 locations. First aid education has been a main activity throughout its history.[1]

The Norwegian Women Public Health Association was founded in 1896. The main activities were education of nurses and public health issues, such as work against tuberculosis and rheumatism; supporting the mentally disabled; and providing information on psychiatric disorders. First aid education was a main topic during the Second World War and in the 1950s.[2]

The Norwegian Peoples Aid was founded in 1932. The organization is a major contributor in international aid, sponsoring projects against the landmine problem, organizing volunteer rescue corps, and providing first aid training and emergency standby at public gatherings.

Norwegian Air Ambulance was established in 1978. The organization has 800.000 members and is a major contributor to emergency medical research and education. Its founder, Dr. Jens Moe, was the inventor of the modern Norwegian air ambulance concept. Norwegian Air Ambulance is now responsible for helicopter operations and/or medical operations at 11 air ambulance bases.

First Aid Education, Recommendations, and Legislation in Norway. First aid training is obligatory for all school pupils in Norway. It is not mandatory for obtaining a driving license. Personnel performing their obligatory military training will receive good knowledge of first aid, but today less than 40% of the male population actually completes military training. Humanitarian and volunteer organizations are the main contributors to public first aid education.

All Norwegian citizens have, by statutory law, a general duty to assist and help a person whose life is in danger. The Road Traffic Law instructs a driver to stop and give help at the scene of a traffic accident.

First aid recommendations in Norway are given by the *Norwegian First Aid Council* (member organizations: Norwegian Peoples Aid, Directorate for Civil Defence and Emergency Planning, Norwegian Red Cross, Norwegian Resuscitation Council, Norwegian Defence Force, and Norwegian Air Ambulance) and the *Norwegian Resuscitation Council*.

Epidemiology of Unintentional Injury in Norway. Unintentional injury will cause 1.700 deaths per year in Norway. Of these, 300 will result from road accidents. Half of the victims will be under 40 year of age. According to the Norwegian Institute of Public Health's injury register for the year 1994, more than 400.000 injuries were treated in hospitals or outpatient emergency rooms. 60.000 patients were admitted for hospital treatment. The total cost of treatment was estimated to NOK 1,7 billion.[3]

Modern First Aid Development. Research into modern external cardiopulmonary resuscitation (CPR) and basic life support (BSL) without equipment started in the 1950s.

The efficacy of airway control (for coma) by backward tilt of the head, mouth-to-mouth ventilation (for apnoea), and emergency artificial circulation with external cardiac (chest) compressions established the basis in this development.

Life-supporting first aid (LFSA) was introduced in the 1960s by Safar and Laerdal[4,5]: "A few simple measures, which are crucial to make a difference for the patient's immediate survival."

Bystander Trauma Care: Definition, Medical Literature and Scientific Evidence, International Recommendations. The European Resuscitation Council (ERC) and American Heart Association (AHA) Task Force on First Aid have given the following definition: "First aid is assessment and interventions that can be performed by a bystander with minimal equipment until appropriate medical personnel arrive." They also state, "Education in first aid should be universal: everyone can learn first aid and everyone should."

The International Trauma Anesthesia and Critical Care Society (ITACCS) Working Group on Bystander Trauma Care states in their first report[6]: "Bystander trauma care is almost nonexistent as far as the medical literature is concerned….The recommendations given in (first aid) training manuals and books are not based on scientific studies (however, that does not mean the recommendations are incorrect)".

The ERC/AHA task force[7] states, "Most of the evidence supporting the value of first aid assessment and management was found to be in the categories; astute clinical observations, extrapolations from other data sources and common sense."

Eisenburger and Safar gave the following recommendations[8]: "Life Supporting First Aid measures are mostly psychomotor skills, acquisition depends mainly on practice and repetition. There is a need for utmost simplicity of what and how to teach, training programs should be community based and include the media. Certification is not needed. Case registries are needed for the ongoing evaluation."

The ITACCS Working Group did not find any major differences in first aid recommendations in Europe, North America, and Australia. In most countries, first aid education includes these topics (example from first aid courses offered by St. Johns Ambulance and BBC [a Web-based interactive first-aid course]): action at the scene of an accident (personal safety), caring for an unconscious casualty, carrying out cardiopulmonary resuscitation (CPR), dealing with choking, dealing with serious bleeding, treating shock, treating burns and scalds, responding to a heart attack, responding to poisoning, and responding to drowning.

Specific Evidence-Based BLS and First-Aid Interventions (ERC/AHA 2000 Guidelines[9]). Therapeutic interventions are classified as follows: class I, excellent; class IIa, good to very good; class IIb, fair to good; class indeterminate; and class III, unacceptable.

Burns. Immediately cool the burn with cold–but not ice-cold–water (class IIa). Beneficial effects: pain relief, reduced formation of oedema, reduced infection rates, reduced depth of injury and more rapid healing, reduced need for grafting, and reduced mortality. The

recommendations are built on scientific support from a large number of observational clinical studies and controlled animal experiments. No results are available from randomly controlled trials. Animal experiments have shown that excessive cooling with ice water results in hypothermia and increased mortality rates.

Haemorrhage. To control any active bleeding, apply direct pressure with the flat portion of your fingers or the palm of your hand over a sterile dressing or clean pad (class IIb). If bleeding is from an extremity, elevate the extremity above the level of the heart (class IIb). In case of severe bleeding from an extremity, apply arterial pressure. In case of severe bleeding from the upper extremity, apply pressure to the brachial artery or in case of severe bleeding from the lower extremity, apply pressure to the femoral artery (recommendation class indeterminate).

The use of *tourniquets* is controversial. Their use by first aid providers often causes venous occlusion and increases the haemorrhage. Complications reported are bleeding, soft tissue injury, nerve and vascular injury, and paralysis. Tourniquets should be used only as a last resort for massive haemorrhage not controlled by other methods and only by skilled persons.

Head Trauma. First aid responders should gather information on the mechanism of injury, alteration in mental status, and the presence and duration of unconsciousness; remove the victim if the location is dangerous; assess the need for and provide CPR if needed; assess victim's risk of vomiting and ability to protect the airway; assess and control bleeding; maintain the victim's body temperature; and stabilize the cervical spine in high-risk situations (unclassified).

Spinal Cord Injuries. First aid responders should suspect an unstable spine or spinal cord injury under the following circumstances (recommendation class indeterminate): injury was caused by force sufficient to result in loss of consciousness; injury occurred on the upper part of the body, especially the head and neck; injury resulted in altered mental status; or there is evidence of drug or alcohol intoxication.

If spinal cord injury is suspected, the first-aid provider should not allow the victim to move in any direction. The care provider should immobilize the victim's head, neck, and trunk if CPR is required; open the airway with jaw thrust; and support the head, neck, and trunk if movement is necessary.

A recent Cochrane review of the effect of spinal immobilisation for trauma patients has this conclusion[10]: "The effect of spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients remains uncertain." "Airway obstruction is a major cause of preventable death in trauma patients…, the possibility that immobilisation may increase mortality and morbidity cannot be excluded."

Musculoskeletal Trauma. The aim of first aid for soft-tissue sprains and contusions, ligament and tendon strains, and fractures (class IIa) is to decrease haemorrhage, oedema, and pain. Application of ice reduces pain and duration of disability. Application of ice should be limited to 20 minutes, to prevent cold injury to the skin. Body temperature should be maintained.

Hypothermia. Initial therapy (unclassified): Remove wet garments, protect against heat loss and wind chill, maintain horizontal position, and avoid rough movement and excess activity.

Modification of BLS: The BLS rescuer should assess breathing and, later, pulse for a period of 30 to 45 seconds to confirm respiratory arrest, pulseless cardiac arrest, or bradycardia profound enough to require CPR.

BLS for Cardiac Arrest Associated with Trauma. The BLS provider should perform a primary survey of the trauma patient, including assessment of responsiveness, establishment of a patent airway, and assessment of breathing. When multisystem trauma or isolated head or neck trauma is present, the spine should be immobilized; the airway opened using jaw thrust; and the mouth cleared of blood, vomitus, and secretions.

When providing artificial ventilation, the cervical spine should be immobilized and breaths delivered slowly to reduce danger of gastric inflation/regurgitation. If the patient has no signs of circulation, chest compressions should be provided and an AED applied if available.

External haemorrhage should be stopped by applying external compression. The victim should be kept warm. (All recommendations are unclassified.)

Foreign-Body Airway Obstruction (FBAO). The incidence of FBAO as a cause of death is 1.2/100.000.

The Heimlich maneuver (subdiaphragmatic abdominal thrusts or abdominal thrusts) for relief of FBAO was introduced in 1974.[11] Other suggested manoeuvres consist of back blows and chest thrusts.

Adult victim (>8 years of age) and child victim (1 to 8 years of age): Lay rescuers are not taught the sequence for management of FBAO for unresponsive adults and children (class IIb). They should activate the EMS system and perform the sequence of CPR (the untrained rescuer should get instructions from EMS dispatcher). For the responsive adult and child, most resuscitation councils recommend the Heimlich maneuver to be used only by the trained rescuer, for relief of FBAO.

Infant victim (newborn to 1 year of age): The responsive infant with signs of complete FBAO should be given a combination of back blows and chest thrusts. If the infant becomes unresponsive, perform CPR. Look for the obstructing object each time the airway is opened.

There are several reports of complications of the Heimlich maneuver. Mesenteric laceration, contusion and intraperitoneal bleeding,[12] gastric rupture,[13] pharyngeal obstruction,[14] and surgical emphysema.[15] Several authors advocate that victims who receive the Heimlich maneuver should be evaluated and that all patients receiving the maneuver should be examined by an experienced physician to rule out any life-threatening complications.[16,17]

Transportation of Trauma Patients. Most resuscitation councils and first aid organizations will advise the lay first-aid provider to stay on scene and wait for the EMS personnel to arrive, and not to start transport of victim to hospital by private cars or other non-ambulance vehicles. This topic has not received much attention in medical literature, with one exception.

Demetriades et al compared two groups of trauma patients transported to a large, urban, academic level 1 trauma center (Los Angeles, USA).[18] Severely injured patients transported by paramedics (EMS group) were compared with those transported by friends, relatives, bystanders, or police (non-EMS group). The investigation included 4856 EMS patients and 926 non-EMS patients. The crude mortality rate was 9,3% in the EMS group and 4,0% in the non-EMS group (relative risk 2,32; $P<0.001$). Adjusted mortality rate in the subgroup with ISS >15 was found to be 28,8% in the EMS-group and 17,9% in the non-EMS group ($P<0.001$).

Factors that explain the significant difference in survival rates are not identified. Several years after the publication of this interesting study, there is still a need for further investigation of this aspect of bystander trauma care.

Bystander Willingness to Provide First Aid. Almost half of Americans have concerns about stopping at a crash scene.[19] Reasons not to stop include lack of knowledge of how to help, fear for personal safety, and worry about being sued. There are also unrealistic expectations about EMS response times.

Lester et al surveyed postally 800 lay CPR trainees 4 years after training.[20] Eighty percent expressed willingness to perform full CPR on casualties who were unknown to them, but this fell to 40% if facial blood was present and 48% if the victim was a gay man.

The Iowa Bystander Trauma Care program trained citizens to provide initial care at the scene of a motor vehicle crash.[21] One hundred twenty EMT instructors trained more than 2,000 citizen bystanders. Immediately after the training program, participants were more likely to provide assistance ($P<0.001$), and understand the sequence of actions to be performed at the scene of a crash and how to prioritise the information provided to 911 ($P<0.05$).

The ITACCS Working Group commented on a report on public first aid training[22]: "First aid training seems to be effective, if only in giving participants confidence to start some meaningful actions."

First Aid Kits. Recommendations about first aid kits are available for commercial airlines[23] and for travel use.[24,25] National first aid and resuscitation councils have developed their own guidelines for contents of first aid kits, but are all focusing on the fact that BLS can be provided without equipment.

In one study the value of medical packs was questioned. The medical pack used by the British Army was proven unsuitable to treat 40% of cadets who attended medical treatment during annual camp.[26]

Conclusion. First aid recommendations are in general not based on scientific evidence but built on "astute clinical observations, extrapolations from other data sources and common sense." The ITACCS Working Group on Bystander Trauma Care found no major difference in national first aid recommendations from countries in Europe, from North America, or from Australia. There are no conclusive data on quality or effect of first aid intervention. Data from the Vienna Bystander Care Study will give us some more information on this topic.[27]

Do We Make Things Worse? Complications related to first aid procedures have been reported. Several reports describe complications after Heimlich maneuvre for relief of FBAO. Tourniquets can cause harm and often, when applied by first aid providers, increase rather than decrease haemorrhage. Additional spinal cord injuries from movement of the spinal column in connection with BLS and first aid procedures has been a major concern for first aid providers from the 1960s and are still given a lot of attention. On the other hand, fear of causing additional injury must not stop the first aid provider from attempting life-saving BLS interventions. We do not know the frequency of complications related to bystander trauma care or layperson first-aid interventions, and we do not know the result of giving no first-aid intervention at all, in cases where complications are reported.

Do We Save Lives? We have good reason to believe so. In many reported cases, BLS performed by lay bystanders definitively was identified as the key intervention for survival of the victim.

Challenges. The international first-aid community has several challenges on its efforts to establish evidence-based first aid and bystander trauma care. There is a need for international standardization of basic first aid and trauma care recommendations. Trauma and resuscitation registers will be vital in ongoing quality development. Research programmes, including randomised controlled trials, must be encouraged. The public must be offered first aid training programs at the community level. Media and the Internet should be included.

References

1. Florelius S. Håndbok for Røde Kors hjelpekorps. *Norges Røde Kors* 1937, 1957.
2. Semb H. Førstehjelpsboken. Norske Kvinners Sanitetsforening. 1951, 1954.
3. Kopjar B, Guldvog B, Wiik J. Medisinske behandlingskostnader for skader i Norge. *Tidsskr Nor Lægeforen* 1996; 116(4):512–62.
4. Safar P. An Introduction to Resuscitation Medicine. Guidelines by WFSA. Stavanger: Laerdal, 1968.
5. Laerdal A. Emergency First Aid in Road Accidents. First Aid Manual. Stavanger: Laerdal Medical, 1965.
6. Mauritz W. ITACCS: Working Group on Bystander Trauma Care: First Report. *TraumaCare* 1999; 9(2):61–6.
7. International Guidelines 2000 for CPR and ECC, part 5: new guidelines for first aid. *Resuscitation* 2000; 46:93–102.
8. Eisenburger P, Safar P. Life supporting first aid training of the public – review and recommendations. *Resuscitation* 1999; 41(1):3–18.
9. ERC/AHA. International Guidelines 2000 for CPR and ECC: a consensus on science. *Resuscitation* 2000; 46(1-3):3–15 and *Circulation* 2000; 102(8 suppl):I1-11.
10. Kwan I et al (The WHO Pre-Hospital Trauma Care Steering Committee). Spinal immobilisation for trauma patients (Cochrane Review). The Cochrane Library, 1, 2002.
11. Heimlich HJ. A life-saving maneuver to prevent food-choking. *JAMA* 1975; 234:398–401.
12. Wolf DA. Heimlich trauma: a violent maneuver. *Am J Forensic Med Pathol* 2001; 22(1):65–7.
13. Bintz M. Gastric rupture after the Heimlich maneuver. *J Trauma* 1996; 40:159–60.
14. Anderson S. Prolonged pharyngeal obstruction [letter]. *Anaesthesia* 1999; 54:308–9.
15. Nowitz A. An interesting complication of the Heimlich manouver. *Resuscitation* 1998; 39(1-2):129–31.
16. Tung PH. Gastric rupture after Heimlich maneuver and CPR. *Hepatogastroenterology* 2001; 48(37):109–11.
17. Majumdar A. Gastric rupture secondary to successful Heimlich maneuvre. *Postgrad Med J* 1998; 74(876):609–10.
18. Demetriades D et al. Paramedic vs private transportation of trauma patients: effect on outcome. *Arch Surg* 1996; 131(2):133–8.
19. National Highway Traffic Safety Administration: 1996 Motor vehicle occupant safety survey. *Ann Emerg Med* 1998; 518–9.
20. Lester CA. Lay CPR trainees: retraining, confidence and willingness to attempt resuscitation 4 years after training. *Resuscitation* 2000; 45(2):77–82.
21. Peterson TD. Bystander trauma care training in Iowa. *Prehosp Emerg Care* 1999;3(3):225-30.
22. Steele JA. The effects of first aid training on public awareness of the management of a seriously injured patient. *J R Soc Health* 1994; 114:67.
23. FAA. Proposed rule for AEDs and inflight medical kits. *Aviat Space Environ Med* 2000; 71(10):1072.
24. Tessier D. First aid kits for travellers. *Med Trop* 1997; 57:473.
25. Steven Pray W. Preparing a first aid kit for home or travel. U.S. Pharmacist 2002; 27(2).
26. Nguyen-Van-Tam JS, Madeley RJ. Do cadet force units need a dedicated medical pack? *J R Army Med Corps* 1995, 141:83–6.
27. Unpublished data. Courtesy of Professor W. Mauritz, Vienna, Austria.

What All Medical Personnel Must Know About Extrication and the Care of Entrapped Patients

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Learning objectives:

- *Recognizing a systematic approach for extrication of entrapped patients.*
- *Awareness of special techniques and instruments in pre/hospital trauma care for entrapped patients.*

Hospital care is different from prehospital care in many ways. Although the basic knowledge and skills must be acquired in the hospital, in the prehospital situation the rescuer must deal with a wide spectrum of different problems. Especially when the patient is trapped and immediate access is not possible or when urgent medical interventions have to be done

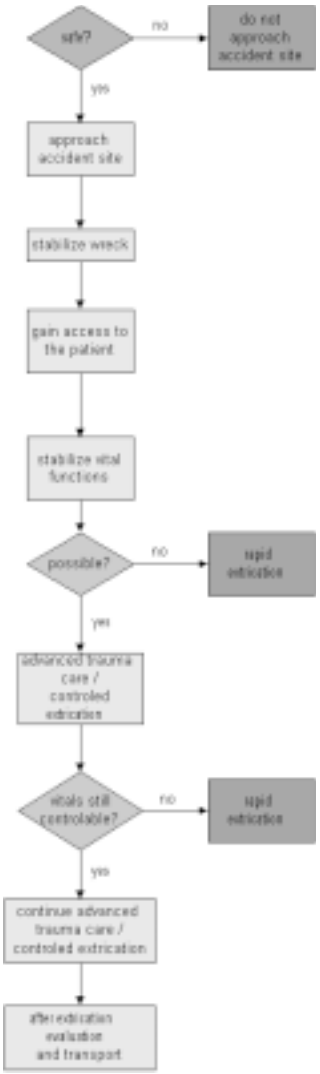
in confined spaces under much than less optimal conditions, the rescuer need to offer more than standard skills that are in general sufficient for the hospital situation.

Another characteristic feature is that medical personnel have to work in cooperation with many other kinds of personnel at the accident site: rescue teams, fire fighters, police, other ambulance personnel, commanders of various disciplines, salvage companies, etc. This means that people should be able to cope with many other kinds of people, each with interests and cultures, even under stressful conditions. In an ideal situation, people should be selected not only for medical qualities but also for their behaviour under stress and their behaviour toward other people.

Rescue of entrapped patients is complicated and working with so many others has the potential to make the situation even more complicated; therefore, it is of utmost importance that all are working by a common approach (see figure). When fire fighters, rescuers, and medical personnel are working according to the same strategy, communication between all the disciplines present will be more effective, scene time will be shorter, and at the end, medical care will be optimal.

For example, airway management in the hospital, in the operating theatre, can be difficult sometimes. In contrast, airway management in entrapped patients is almost always difficult and seldom easy. Besides, the access to the patient's head is not always possible from above the patient. For that reason, intubation should not only be possible from the top of the patient's head, but also from the side or even in front of the patient's head (face-to-face intubation). In principle, the patient should have the airway secured, even under difficult conditions, as soon as possible. Waiting until the patient has been extricated in total before the airway has been secured is unacceptable.

Another example is ventilation. Especially when intubation is not possible, mask ventilation is an alternative. Mask ventilation, however, has been shown to have a high potential of insufficiency when performed by a single rescuer. In trauma patients, where the extension of the neck is not possible when cervical spine injury is suspected, mask ventilation is almost impossible to perform adequately by one single person. When the patient is posturing because of head injury, the situation is really critical. Only with proper airway management, using the right techniques and special resuscitators/ventilators, making it possible to keep the airway open by both hands and meanwhile ventilating the patient in a safe and effective way, the patient will survive without unnecessary harm.



Conclusion. Medical care for entrapped patients is a real challenge to all rescuers. Special skills and special medical equipment are necessary in combination with a cooperative attitude. All rescuers should work following the same protocol, indicating which procedures should be executed by whom and when. Special multidisciplinary training should be obligatory for all rescue team members before they will be exposed to entrapped patients.

Bibliography

Ersson A, Gonzalez D, Rutten F. The entrapped patient. In Soreide E, Grande CM, eds. *Prehospital Trauma Care.* Basel, Marcel Dekker, 2001, pp 471–528.

Is the PHTLS® Spinal Immobilization Training Old-Fashioned and Dangerous?

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Learning objective: *To appreciate the possible adverse effects of spinal immobilization of trauma patients.*

Current protocols for spinal immobilization emanate from the ATLS® and PHTLS® protocols. Although some modifications have been made recently, these protocols still have a conservative profile, leading to prolonged and sometimes unnecessary immobilization.

Present data question the traditional approach for being costly, time-consuming, unnecessary, and even dangerous. The whole concept of spinal immobilization has been argued to be of no value in a fairly recent cohort study of different trauma systems. This study has been criticised and does have a lot of serious confounders, but it still raises the important question of the scientific base for the concept of spinal immobilization. This base seems poor, as a recent review by Cochrane Library failed to find solid scientific material to evaluate the benefit of spinal immobilization of trauma patients. Thus, its effect on neurologic injury and spinal stability and adverse effects in trauma patients remain uncertain. Increased mortality and morbidity due to the immobilization cannot be excluded.

Implementation and validation of clinical spinal clearance protocols (SCP) have led to a reduction in the use of x-ray and of prolonged intrahospital immobilization. The implementation of these protocols in the prehospital setting has not turned out to be very successful in order to minimise the use of full immobilization, although the sensitivity has been reported as high as 99%. Furthermore, evaluations of the prehospital use of SCP have shown significant disagreement concerning the need for spinal immobilization between EMS crews and ED physicians. The morbidity reported includes risks of iatrogenic pain, skin ulcerations, aspirations, respiratory compromise, raised ICP, as well as potential harmful movements during ambulance transports.

The scientific base and clinical relevance of these adverse effects are questioned, although experimental data have shown raised ICP, restricted respiration, and possible harmful neck movements when patients have been transported fully immobilised. Long immobilization times have also been reported to cause pressure ulcerations and pain.

In light of the apparent lack of solid data, it is understandable that most trauma patients still end up being immobilized, since the alternative of missing a spinal injury would be disastrous and unacceptable.

This presentation discusses the rationale for spinal immobilization in the light of available data on indications and adverse effects.

Bibliography

Kwan I, Bunn F, Roberts I, on behalf of the WHO Pre-Hospital Trauma Care Steering Committee. Spinal immobilization for trauma patients (Cochrane Review). In: *The Cochrane Library* (1) 2002. Oxford:Update software.

Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker M. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. *N Engl J Med* 2000; 343:94–9.

Stroh G, Braude D. Can out-of-hospital cervical spine clearance protocol identify all patients with injuries? An argument for selective immobilization. *Ann Emerg Med* 2001; 37(6):609–15.

Hankins DG, Rivera-Rivera EJ, Ornato JP, Swor R, BlackwellT, Domeier RM. Spinal immobilization in the field. *Prebosp Emerg Care* 2001; 5:88–93.

Hauswald M, Ong G, Tandberg D, Omar Z. Out-of-hospital spinal immobilization: its effect on neurologic injury. *Acad Emerg Med* 1998; 5:214–9.

Meldon SW, Brant TA, Cydulka RK, Collins TE, Shade BR. Out-of-hospital cervical spine clerence: agreement between emergency medical technicians and emergency physicians. *J Trauma* 1998; 45(6):1058–61.

Physicians in Prehospital Care Contribute to Improved Survival in Severely Injured Patients

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Learning objective: *To evaluate the effect of an anesthesiologist-staffed mobile emergency care service in regard to mortality of severely injured patients.*

Background. During the years 1996 and 1997, the trauma care system, both out-of-hospital and in-hospital, was reorganized and improved in Aarhus. A Mobile Emergency Care Unit (MECU) staffed with an anaesthesiologist and a paramedic working in a rendezvous model was introduced. The MECU is dispatched to the most severe cases and always together with an ordinary ambulance. The population in the area is 330.000 inhabitants, and there is one trauma center at the university hospital. The purpose of this study was to evaluate the effect on mortality before and after the changes in organization.

Methods. Study periods before were 1994–1995 and immediately before the MECU, 1.10.96–31.3.97; after period was 1998–2000. Since 1998 we have had a consecutive trauma registry. The study group was severely injured patients (defined as Injury Severity Score [ISS] >15). In case of insufficient data to calculate ISS, we included patients who died. Mortality: number of patients who died on scene or during the hospital stay. Data are from pre-hospital and in-hospital registries. Statistics: (^{2}-test.

Results. In 1994–1995, there were 132 patients with ISS >15; 65 of these died and there were four other deaths, corresponding to a total mortality of 51%. In the period immediately before the MECU, mortality was 45%; 20 of 44 patients with ISS >15 died. In the second period (1998–2000), there were 220 patients with ISS >15, and 59 of these patients died within 6 months. Other 17 patients died, corresponding to a total mortality of 32%. This was significantly lower than 1994–1995 ($P<0.001$). Age, sex, and ISS distribution seemed similar during the periods, and further statistical analysis is going on. After introduction of MECU, a major part of the severely injured patients (43%) were underwent endotracheal intubation in the pre-hospital phase of care, and the majority of these received analgesics and sedatives on scene. Ambulance personnel do not perform endotracheal intubation.

Conclusion. The improved trauma care system, including the physician-staffed Mobile Emergency Care Unit, contributed to increased survival among severely injured patients. Key medical interventions were pre-hospital intubation and analgesia and sedation performed by the MECU.

Prehospital Intubation in Trauma Patients – An Over-Rated Intervention? (Pro)

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[abstract not available]

Prehospital Intubation in Trauma Patients — An Over-rated Intervention? (Con)

Frédéric Adnet
Bobigny Cedex, France

[abstract not available]

Prehospital Controlled Ventilation–How Controlled Is It?

Matthias Helm
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[abstract not available]

The Effect of Prehospital Care on Outcome in Patients with Severe Head Injury

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Learning objective: *To assess the effect of including doctors in the prehospital care of head-injured people in regard to on-scene time and mortality rate.*

Introduction. The role of prehospital trauma care and the effect of prehospital airway

management are not clear. This study evaluated the impact of prehospital trauma care with emergency medical doctors (EMD) on the mortality from severe head injury and determined whether it is associated with longer on-scene times.

Methods. A 36-month prospective study of severely head-injured patients who received ATLS and were transported by EMD to Teaching Hospital, Maribor. We evaluated all patients with severe head injury 3 years before and 3 years after the beginning of the prehospital care with EMD.

Results. See table below.

Patients	ATLS (EMD)	BLS (RN)	*P*
Age	43,5± 18,8	41,4± 16,5	0,86*
Sex (M/F)	30/12	29/9	0,87#
On-scene time (min)	21± 9	19± 8	0,78*
IV line (Y/N)	42/0	15/23	<0,05#
Analgesia, anaesthesia, relaxation (Y/N)	40/2	2/36	<0,05#
Intubation (Y/N)	40/2	4/34	<0,05#
Mechanical ventilation (Y/N)	36/6	0/38	<0,05#
Mortality–first hour (Y/N)	2/40 (5%)	12/26 (35,8%)	<0,05#
Hospital mortality (Y/N)	13/29 (30,9%)	21/17 (55,2%)	<0,05#

* Student's t test; # Chi-square test

Conclusion. ATLS procedures can be performed by emergency medical doctors on severely head-injured patients without significantly prolonged on-scene time. After starting prehospital trauma care employing EMD, there was a decrease in the deaths occurring before hospital admission and a reduction in the severe head injury mortality rate.

References

1. Eckstein M, Chan L, Schneir A, et al. Effect of prehospital advanced life support on outcomes of major trauma patients. *J Trauma* 2000; 48:643–8.
2. Hussain LM, Redmond AD. Are pre-hospital deaths from accidental injury preventable? *BJM* 1994; 308:1077–80.

Prehospital End-Tidal Carbon Dioxide and Outcome in Major Trauma

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Learning objectives: *To assess the value of end-tidal carbon dioxide concentration in predicting patient outcome after major trauma.*

Introduction. End-tidal carbon dioxide ($P_{ET}CO_2$) concentration reflects cardiac output when measured at an appropriate minute volume. $P_{ET}CO_2$ levels correlate both with outcome following 45–90 minutes of hospital resuscitation of trauma patients[1] and when measured after 20 minutes of prehospital advanced cardiac life support following non-traumatic cardiac arrest.[2] The predictive value of prehospital $P_{ET}CO_2$ concentration in survival from major trauma has not been examined. We retrospectively examined the predictive value of $P_{ET}CO_2$ and outcome in major trauma following prehospital advanced trauma life support.

Materials and Methods. Records were examined of patients with major blunt trauma treated by a doctor from the Helicopter Emergency Medical Service over a 4-year period (1998–2001). 191 patients were identified with major trauma requiring prehospital intubation at the roadside and in whom prehospital $P_{ET}CO_2$ had been recorded. Patients were ventilated at a minute volume appropriate to their weight (10 ml/kg/min). Initial $P_{ET}CO_2$ and $P_{ET}CO_2$ at 20 minutes after endotracheal intubation was recorded, together with survival to discharge.

Results. Outcome was related to $P_{ET}CO_2$. Mean $P_{ET}CO_2$ at 20 min post-intubation was 4.13 kPa in survivors and 3.51 kPa in non-survivors (95% CI of difference between means from 0.32 to 0.92 kPa). The difference between groups was highly significant (Mann-Whitney U test; $P<0.0001$). A ROC curve (Fig. 1) shows that $P_{ET}CO_2$ at 20 min ($P<0.001$) is a better predictor of outcome than at 0 min ($P=0.02$). Median ISS in survivors was 20.0 and in non-survivors was 41.0.

Discussion. $P_{ET}CO_2$ at 20 min predicts outcome from major trauma. Only 5% patients with $P_{ET}CO_2$ <3.25 kPa survived to discharge. $P_{ET}CO_2$ at 0 min is a poorer predictor, presumably because increased $P_{ET}CO_2$ secondary to airway obstruction is not an indicator of cardiac output.

References

1. Wilson RF, Tyburski JG, Kubinec SM, et al. Intraoperative end-tidal carbon dioxide levels and derived calculations correlated with outcome in trauma patients. *J Trauma* 1996; 41:606–11.
2. Levine RL, Wayne MA, Miller CC. End-tidal carbon dioxide and outcome of out-of-hospital cardiac arrest. *N Engl J Med* 1997; 337:301–6.

Moderated Poster Discussion

"Seat Belt Syndrome" In Children

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The term "seat belt syndrome" was first used by Garrett and Braunstein in 1962 to describe a distinctive pattern of injuries resulting from the use of lap belts in car crashes. The syndrome describes intestinal injury with concomitant spinal injury. We report two children presenting with this pattern of injuries treated in Ullevaal University Hospital.

Case 1: A 12-year-old boy was transferred to our hospital a few hours after a high-speed car crash. He had been a rear-seat passenger restrained with a lap belt. At the referring hospital a computed tomography (CT) scan showed disruption of the anterior abdominal musculature with herniation of bowel into the subcutaneous space. In addition, a severe diaphragmatic tear with the left kidney displaced in the left thoracic cavity was noted. The vertebral column was incompletely examined initially. After transferral, an abbreviated laparotomy was performed with a second-look operation performed the next day.

Non-viable small bowel and colon were resected, as was the left kidney. The diaphragmatic tear was repaired. Three enterostomies were constructed. A Chance fracture of L2 was diagnosed and treated conservatively. Closures of the enterostomies were performed after 6 weeks and 3 months, respectively. After 8 months, the patient was fully recovered.

Case 2: A 13-year-old girl was involved in a car crash while wearing an adult back-seat lap belt. On admission she complained of abdominal pain and was paraplegic. Physical examination revealed lap belt ecchymosis. An x-ray revealed a burst-fracture of L3. A CT scan showed no sign of intraabdominal injury. The L3 fracture was stabilized operatively. The patient developed abdominal distension a few hours later and was referred to our hospital. Repeated CT scan showed free intraperitoneal fluid and air. Exploration of the abdomen revealed massive contamination with a proximal jejunal perforation and necrosis of the transverse colon. Bowel resections and construction of three enterostomies were performed. The jejunostomy was closed at day 11, the colostomies after 6 weeks. The patient remained permanently paraplegic but otherwise recovered uneventfully.

"Seat belt syndrome" refers to the spectrum of injuries associated with lap belt restraints. Children wearing lap belts are at risk of a "lap belt complex." Both diagnosis and treatment present a challenge. Most important is to remember the typical combination of injury to intestinal organs and spine in these patients.

Traumatic Abdominal Wall Hernia in Children

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Traumatic abdominal wall hernia (TAWH) remains an unusual clinical entity despite the increased incidence of blunt trauma. In children, very few cases have been reported. Recognition of these hernias is of importance since they may be associated with significant intraabdominal injuries, as in the two cases of TAWH in children presented herein.

Case 1: A 12-year-old boy was a rear-seat passenger wearing two-point fixation in a motor vehicle crash. He presented to the local hospital complaining of severe abdominal pain; abdominal ecchymosis was present. A computed tomography (CT) scan revealed a large defect of the lower anterior abdominal wall with herniation of small bowel into the subcutaneous tissue, rupture of the left diaphragm, displacement of the left kidney into the left hemithorax, and bilateral haemothorax. He was transferred to our hospital and immediately after arrival the rupture of the left diaphragm was sutured; the left kidney and parts of small intestine and colon were resected. A second-look laparotomy was performed the next day and additional non-viable bowel segments were resected and three enterostomies were constructed. He had a complicated postoperative course. A Chance fracture of L2 without neurological impairment was treated conservatively. The enterostomies were closed 6 weeks and 3 months after the injury, respectively. He received parenteral nutrition for 5 months. One year after the accident he has regained normal activity with no signs of reccurence of hernia.

Case 2: An 8-year-old boy fell from a tree. He was admitted to an outside hospital, where he presented with abdominal pain and a bulge in the upper left abdominal quadrant. A CT scan revealed a defect in this region, with loops of small bowel in the subcutaneous tissue. A surgical exploration was performed and the hernia was repaired. The following day the patient deteriorated and was transferred to our hospital. At relaparotomy two litres of bile-stained fluid was evacuated and a jejunal perforation near the ligament of Treitz was closed by two layers of interrupted suture. Postoperatively he developed acute respiratory distress syndrome and a hemorrhagic peptic ulcer. Three months later he had regained normal activity with no signs of recurrence of hernia.

Building a Trauma System: The Rambam Medical Center Experience

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Rambam Medical Center is a 900-bed level one trauma center. The Emergency Room at RMC treats 45,000 trauma patients yearly, of whom 3,300 are hospitalized. Organizing a trauma unit is the easy part. Building a trauma team is more difficult. Our team consists of two general surgeons and two nurses. The surgeon is responsible for the trauma patient. It is very difficult to teach physicians and nurses to work as a team, and it took much practice and issuing of specific protocols and standing orders to achieve teamwork. A dedicated physician, preferably a surgeon, should be found to head the trauma unit and build the trauma center. Completion of an A.T.L.S. course is a vital step. A trauma unit has two major components: the admitting area and the team work. Our Trauma Unit consists of three identical bays, each containing a trolley with a monitor and a respirator, and all equipment is within easy reach. Having a well-equipped, well-operating trauma unit does not make a hospital a trauma center. Commitment and dedication do. The commitment must come from the hospital administration. Trauma takes priority, particularly in the operating rooms, intensive care units, and CT unit and in manpower.

The trauma nurse coordinator is the second most important position in the team. She is the crucial link between the patient, family, and multidisciplinary team. Her main task is to build a quality assurance system (QAS). Our QAS consists of a video camera in the admitting area, which records treatment of trauma patients and is reviewed later.

A trauma center does not make a trauma system. A trauma system ensures that all trauma victims receive the best treatment available. Our first task was to embrace the pre-hospital care providers. We began monthly meetings with paramedics, updating their knowledge in trauma and discussing their difficult cases. We also provide written feedback reports on every trauma patient. We developed special transfer documents and send written feedback reports for every patient transferred from other hospitals (700 annually). Our *Quality Assurance in Trauma* Committee meets weekly, while the *Trauma Forum* is a monthly gathering of people involved in trauma treatment, who discuss problems and issue standing orders.

Medial Meniscus Interpositon in a Proximal Tibial Physeal Fracture: A Case Report and Review of the Literature

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Proximal tibial fractures are rare in children. The majority of these injuries are treated conservatively.2 We report a case of minimally displaced proximal tibial fracture in an 11-year-old child. We would have normally treated this fracture conservatively but the presence of massive haemarthrosis and considerable pain made us proceed for examination under anaesthetic/arthroscopy under general anaesthetic. During examination under anaesthetic, no instability could be detected. On screening, the fracture was not reducible. This prompted us to proceed to arthroscopy. At arthroscopy, the medial meniscus was not visualised as expected and this made us wonder whether this could be trapped at the fracture site. A small medial arthrotomy showed the meniscus trapped at the fracture site without any avulsion in the anterior or posterior horns. The fractures easily reduced once the meniscus was levered out. We submit radiographs, intra-operative pictures, and post- reduction pictures of this interesting injury.