Clin Orthop Relat Res (2013) 471:2755–2759
DOI 10.1007/s11999-013-3012-9

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

SYMPOSIUM: TSCHERNE FESTSCHRIFT

The Classic

Review Article: Traffic Accidents

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Abstract This Classic Article is a translation of the original work by Prof. Harald Tscherne, Der Straßenunfall [Traffic Accidents]. An accompanying biographical sketch of Prof. Tscherne is available at DOI 10.1007/s11999-013-3011-x. An online version of the original German article is available as supplemental material. The Classic Article is reproduced with permission from Brüder Hollinek & Co. GesmbH, Purkersdorf, Austria. The original article was published in *Wien Med Wochenschr.* 1966;116:105–108. (Translated by Dr. Roman Pfeifer.)

Lecture delivered on the occasion of "Training courses for practical medicine" of the Medical Association for Stiermark in 1964 Judenburg, Wagna, Rottenmann, Leoben.

Electronic supplementary material The online version of this article (doi:10.1007/s11999-013-3012-9) contains supplementary material, which is available to authorized users.

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Road traffic leads to 75,000 deaths and some 1.7 million injured each year in Europe. The alarming fact is that the number of victims increases by 5% per year. Road traffic injuries are particularly common in young and healthy people.

Numerous studies have demonstrated that 15% to 25% of traffic fatalities are preventable. Most of these patients die of shock or pulmonary aspiration. In fact, 1/3 of road traffic fatalities die at the injury site, and another 1/3 die during the transportation to the hospital. Moreover, 1/6 of patients die within the first 24 hours after hospital admission (Mayrhofer).

The application of new research findings in resuscitation and intensive care medicine have improved the survival of severely injured patients. Initially, appropriate first aid can mean the difference between patient's survival and death. The main concern is to maintain oxygen supply to the brain. Absent or insufficient oxygenation over 3 to 8 minutes can cause irreversible damage to the central nervous system with subsequent death or serious complications if the patient survives. Treatment of life-threatening conditions should be performed first and not stabilization of fractures or treatment of minor injuries. Today, more than 80% of severely injured patients are unconsciousness and asphyxic at the time of admission. Treatment of shock at the injury site or during the transport is uncommon. Precipitous transport of unstable severely injured trauma patients, even for short distances, should be avoided. According to Akerlund the risk of an accident in speeding ambulances is 20 times higher than that of taxi drivers.

Despite the fact that numerous publications have been published within the few last years, it is justified to focus the general attention on the importance of first aid at the injury site and during patient transport. "Extended first aid" means appropriate and optimal treatment of injured patients on injury site and during ambulance transport by physicians or surgeons. In order to give an overview of emergency procedures, a schematic diagram has been elaborated for teaching purpose (Fig. 1). This diagram

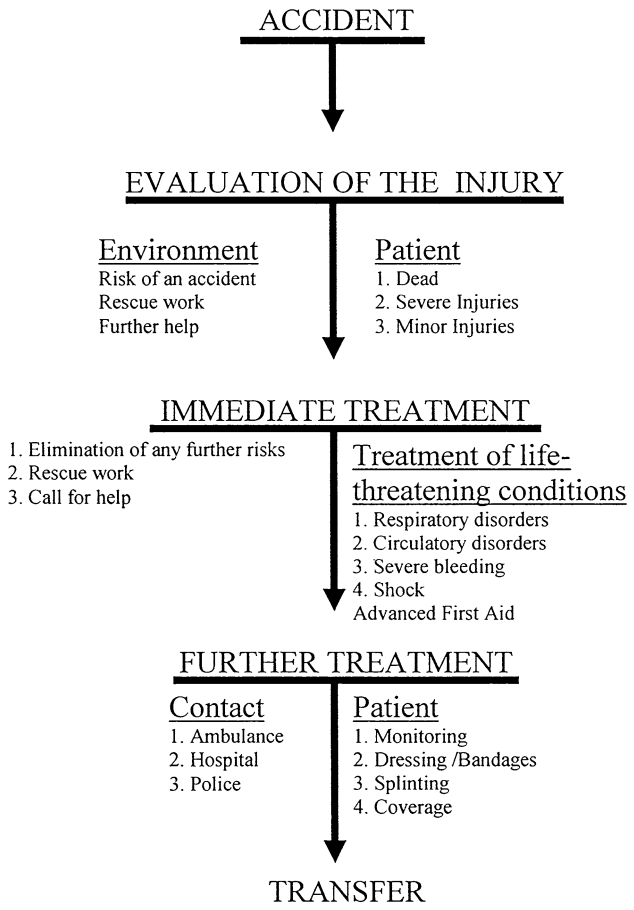

Fig. 1 A schematic diagram of emergency procedures for teaching purposes is shown.

shows three main requirements that must be considered when performing first aid: injury evaluation, immediate life-saving treatment, further treatment.

Injury Evaluation

Rapid and adequate evaluation on injury site is often very difficult; nonetheless, this is the main requirement for success. The environment should be observed for the following points: 1. Is there a further risk of accident (eg, frozen road, limited visibility)? 2. Is there a need for rescue work (eg, burning vehicle)? 3. Do I need help?

The determination of whether the patient is severely injured or has minor injuries is of importance when the number of trauma victims is high. Patients with high chance of survival should be treated first.

Immediate Life-Saving Treatment

Once the accident situation is assessed, it is important to follow emergency procedures to eliminate risk factors for further injuries. Life-saving procedures must be initiated at the injury site. Life-threatening conditions are: respiratory failure, circulatory disturbance, bleeding and shock. In the initial treatment of these conditions, the causes of these life-threatening conditions (external versus internal injury or brain injury) are not of importance.

Respiratory Failure

Respiratory function must be assessed first. How are the skin color, breathing rate and breathing sounds? Snoring or stertorous respiration in combination with cyanosis is associated with obstruction of airways by blood, mucus, tongue or foreign objects. The supine patient is at risk for airway obstruction from tongue. The presence of irregular or forced breathing, gasping respiration, or even breathing arrest should be cause for alarm. In case of respiratory dysfunction the airways are initially cleared and patient stabilized in recovery position. Artificial respiration should be initiated if needed.

In unconscious patients with adequate breathing, foreign bodies are removed from the oral cavity and the patient is placed in recovery position.[1] Head tilt chin lift technique is used to ensure open airway in unconscious individuals. Shoulder and pelvis girdle must be turned simultaneously to avoid spinal torsion. The recovery position can be applied in patients with suspected spine injuries and while transport to the hospital. If asphyxia is present, the head tilt chin lift maneuver is used to open the airways. In majority of cases this position improved the respiratory situation.

In patients with respiratory failure, the rescuer can open the airway using the already mentioned head tilt chin lift maneuver. In the majority of cases, this technique ensures normal breathing. In presence of apnea or persistent respiratory insufficiency, immediate artificial respiration is advocated. Today manual methods of respiration (Schäfer, Silvester, Holger-Nielsen) are not recommended. Instead, more effective artificial respiration is used. It can be performed as mouth-to-mouth, mouth-to-nose, and mouth-to-mouth and nose in infants. This respiration can be performed not only in a supine position, but also in any other body position. One hand holds the forehead of the trauma victim and the other hand is placed on chin pressing the mandible against maxilla. Thereafter, the patient can be ventilated by mouth or nose. Normal respiratory rate must be maintained. For hygienic reasons a gauze bandage or tissue is placed between the patient and rescuer. Patient should be ventilated with 2/3 of cycle being expiratory breathing. In infants lower ventilation pressure is used.

[1] Editor's note: The "recovery position" is used for people who are unconscious but breathing. The patient is on the lateral side with locked arms and legs to maintain the position.

In case of adequate position (head tilt lift chin) and open airways this technique is less exhausting in comparison to manual respiration strategies.

Airway support can be effectively provided by face mask in combination with oropharyngeal airways (eg, Mayo or Safar airway). Endotracheal intubation on injury site is recommended but it requires experience. A Safar airway appears to be more useful in that situation and fits in every pocket. Respiratory resuscitation is more effective with ventilation masks. The Ambu bag (bag valve mask) is widely known and simple in practice. Air is delivered through the mask in to the patients if airways are free and the mask is properly sealed around patient face.

It is not always possible to keep the airway free (eg, laryngeal injury). Conicotomy can be in such case a life saving procedure. The incision is made into the ligamentum conicum between thyroid and cricoid cartilage and can be performed on injury site if needed. A horizontal incision is made into the skin and ligament using a scalpel or pocket knife. Next, the wound is kept open with a clamp and a tube can be inserted into the trachea.

Circulatory Disturbance

Post-traumatic circulatory arrest is always dramatic. The main reasons for cardiac arrest following accidents are: hypoxia due to obstruction of airways, severe bleeding, shock, and thorax trauma or neck injuries. This life-threatening condition is characterized by the absence of the pulse and heart sounds, hypotension, cyanotic skin color, wide pupils and apnea or gasping. In such a situation it is difficult to determine whether the patient is dead or alive. Repeated measurements of the pulse rate, blood pressure and auscultation of heart sounds is time consuming and usually unhelpful. Indirect heart massage restores the circulation of the patient and should be immediately initiated at the injury site. In contrast to artificial respiration the cardiopulmonary resuscitation is performed in supine position with a resuscitation board under patient's thorax. The rescuer compresses the chest on the lower portion of sternum at a rate of least 60 to 80 per minute. Thereby, the heart is compressed between the sternum and spine leading to blood flow toward the large efferent heart vessels. External heart massage is usually combined with artificial respiration. Otherwise, it is less effective. If the rescuer is alone on injury site, the resuscitation is initiated with artificial respiration followed by combined cardiopulmonary resuscitation. A compression to ventilation ratio of 5 to 1 should be maintained.

In case of cardiac arrest, survival of the patient can be achieved if immediate cardiopulmonary resuscitation is started and multiple rescuers are present. We have considerable experience with external heart massage. Thereby, persistent heart activity and measureable blood pressure can be maintained. However, the presence of cerebral anoxia for more than 3 minutes is associated with lethal outcome.

Bleeding

Bleeding due to transaction of large vessels leads to death in a short period of time. In case of severe bleeding digital compression is applied to pressure points in combination with direct pressure to the wound until the bleeding stops. Elastic bandages or tourniquets are used on upper arm or thigh to maintain pressure. These should be left on the wound for no more than 1 ½ hours. The time point when dressing has been applied to the wound must be recorded. In persistent bleeding or head, neck or thorax wounds bleeding can be stopped with the exertion of direct pressure and tamponade over the wounds. Clamping of bleeding vessels with clamps should not be permitted due to vascular wall injuries and associated difficult vascular reconstruction. In minor arterial or venous bleeding compression bandage and elevation of the wounded limb is sufficient.

Shock

Both hemorrhagic and neurogenic shock are characterized by reduced circulating blood volume. In such situations the circulation in non-vital organs is reduced to maintain tissue perfusion in the heart and brain. This "centralization of blood circulation" is known to have narrow margin. Circulatory shock can become irreversible at any time. Therefore, early treatment of the shock is critical.

Clinical signs of shock are: paleness, sweaty and cold skin, tachycardia, hypotension, shallow breathing, wide pupils, nausea, thirst, agitation, apathy or unconsciousness. Patients with a blood pressure below 100 mm Hg and a heart rate over 100 beats per minute have probably lost more than 30 % of the total blood volume. Every patient in a shock state must be considered as a severely exsanguinated patient.

Hemorrhagic shock is treated by elevation of pelvis and lower extremities and leg wrapping with elastic bandages. This allows the mobilization of circulation blood volume and increases the perfusion of vital organs. The administration of blood products (red blood cells or blood substitutes) is without a doubt effective shock treatment. Nowadays, every rescue vehicle must contain blood replacement products (such as blood protein, Rheomakrodex, and Hämaccel). Pain management is achieved with intravenous administration of 50 mg of Dolantin and 10 mg of Vilan. The time of administration, drug dose, and clinical condition of the abdomen should be noted. The elimination

of pain-related shock condition is of importance; however, pain medication can mask evidence of further injuries.

Oxygen therapy is always indicated. Patients in shock should be covered by blankets to prevent hypothermia. However, re-warming can result in widening of blood vessels and abrupt worsening of shock.

Vasoactive drugs and catecholamines are administered to patients in case of hypovolemia and tachycardia. Drop of blood pressure below 70 mmHg and elevation of the heart rate over 140 beats per minute indicate a possible blood loss of about 50 % of total blood volume (Allgöwer). The failure of blood pressure to increase despite adequate transfusion is an indication for intravenous administration of catecholamines (4 amp. Adrenor in combination with 500 ml of blood replacement) and adrenocortical hormones (75-100 mg of Prednisolone). Of great importance is volume replacement therapy. As long as the blood pressure is below 100 mmHg without jugular vein distention, there is no danger of volume overload. In patients with clinical signs of arrhythmia and cardiac decompensation additional treatment with digitalis is recommended.

Further Treatment and Transport

After immediate life-saving treatment and stabilization of the patient, minor injuries can be addressed. Suspected fractures should be splinted and wounds dressed. Thereafter, emergency transfer is initiated. Continuous monitoring allows early identification and treatment of breathing dysfunction, circulatory disorders or worsening of the shock.

Particular Injuries

Cranial Injuries

Craniocerebral trauma is common in patients with road traffic injuries. As mentioned above, in these patients shock and respiratory management are the main treatment aims. In fact, some patients may die due to shock or aspiration rather than to the initial cranial injury. Of critical importance for further evaluation and treatment is the documentation of the initial neurological status. In patients with open brain injury the wound should be covered with sterile dressing. In case of severe venous bleeding, bring the patient into a sitting position in order to reduce intra-cranial venous pressure.

Spine Injuries

These injuries are frequently missed, especially in patients with additional craniocerebral trauma. Careful patient positioning is of immense importance. Excessive movement can result in secondary fragment dislocations and spinal cord injury. Patient with suspected spine injury must be aligned in supine position. Lifting and turning is performed under simultaneous support of the thorax, spine and leg by at least two rescuers. In case of respiratory failure patients can be placed in recovery position.

In suspected cervical spine injuries patient's neck should be aligned in neutral position and stabilized by wrapped blankets. Axial extension of the head can be advantageous. Moreover, careful and deliberate transfer of the patient is required to avoid further injuries. The documentation of initial neurological status is important in order to distinguish whether neurological symptoms (eg, transverse spinal cord syndrome) were initially present on injury site or have developed later.

Thoracic Injury

Open pneumothorax, tension pneumothorax, and flail chest are thoracic injuries that need immediate treatment on injury site. The severity of an open thorax depends on the size of the chest wall defect. Small defects are characterized by foaming blood at the thorax and ex-and inspiratory whistle sounds in combination with respiratory and circulatory dysfunctions. The open pneumothorax should be closed as soon as possible and converted to closed pneumothorax. Prompt airtight closing of the defect improves the threatening situation. Adhesive wound plaster or other airtight occlusive dressing made from plastic, latex, or gauze can be used. The patient must be positioned on the affected side to stabilize the thoracic wall. Breathing or cardiac arrest may occur and has to be treated immediately.

Multiple rib fractures result in mobilization of chest segments and present a clinical situation comparable with open pneumothorax. The presence of paradoxical breathing and paradoxical chest motion is life-threatening condition and should be treated with compression bandage applied under expiration. In addition, patient is placed on injured site to stabilize the thoracic wall.

Finally, thoracic injuries can lead to pneumothorax or tension pneumothorax. The clinical picture is characterized by jugular vein distention and reduced motion of the affected thorax side. Rib fractures in combination with skin emphysema are also frequently present. Chest percussion reveals hyperresonant sounds. Pulmonary auscultation may show different findings: breathing sounds may be diminished or loud with bronchial sounds. The shift of mediastinum (movement of the heart apex beat, heart sounds on unusual site) confirms the diagnosis. The insertion of intravenous cannula into the second or third rip space in the mid-clavicular line results in immediate decompression and improves the clinical situation. Puncture of pleura can be repeated while transfer to the clinic if clinical symptoms appear again.

Conclusion

Initial treatment (the first few hours or even minutes) determines the destiny of a severely injured patient. Adequate first-aid substantially improves the outcome of trauma patients. We developed a schema in order to demonstrate reasonable treatment strategy. Special attention is placed on treatment of life-threatening conditions: adequate patient positions, elimination of respiratory and circulatory disorders, treatment of severe bleeding, shock management, closure of open pneumothorax, et cetera. In case of emergency, every surgeon and physician should use modern resuscitation methods. This required high personal dedication and commitment on duty.