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Trauma pathology

Management of multiple trauma patients

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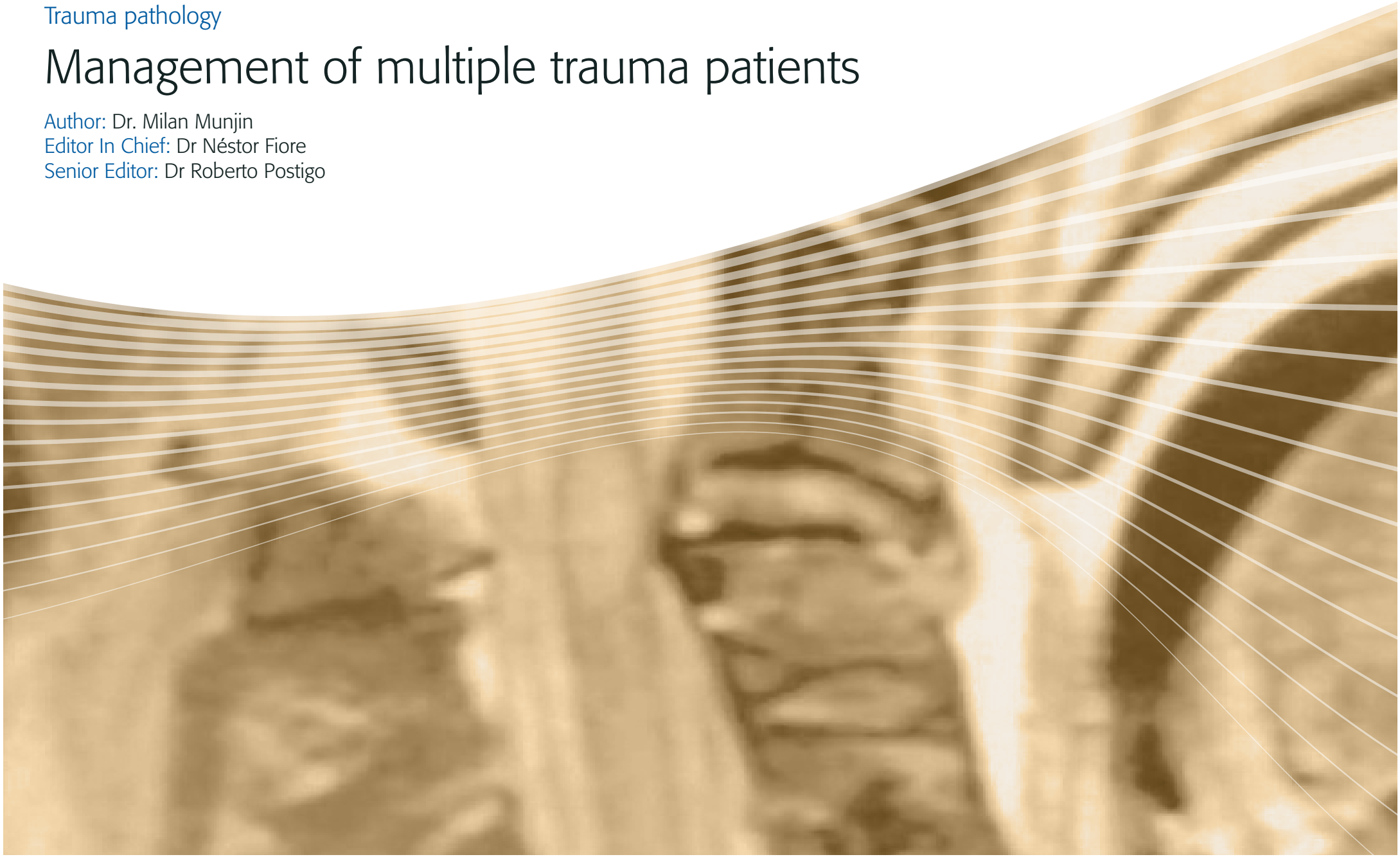

OBJECTIVES

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Trauma pathology

Management of multiple trauma patients

- To provide an introductory explanation of the problems involved with the management of polytrauma patients.
- To describe how to manage these patients in the prehospital and hospital phases.
- To identify the priorities when attending polytrauma patients.
- To describe the current approach to managing spinal cord traumas and shock in polytrauma patients.

CONTENTS

1. INTRODUCTION

Overview

A significant reduction in morbidity, mortality and disability rates due to such injuries can only be achieved through an organized trauma attention system that considers the needs of rescue, transfer and standardized hospital treatment, accompanied by a systematic approach to assessment and management.

- Trauma injuries are the leading cause of death in the population aged 5 to 38. In general, they are the third most frequent cause of death, after cardiovascular diseases and cancer.
- Spinal cord injuries affect 14,000 people a year in North America. The incidence in Canada is 64 new cases per 100,000 inhabitants every year. The majority of the cases involve the cervical vertebrae.
- In the Hospital del Trabajador in Santiago (HTS), Chile, the annual rate studied during 2005 was 10.8 cases per year.

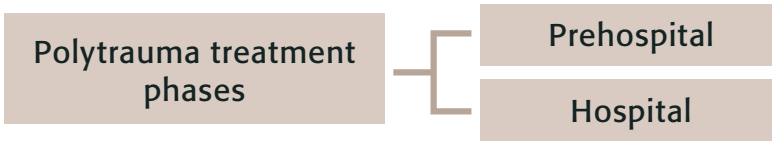
The most frequent injury is a displaced fracture of the mid cervical spine. Patients who suffer damage to the spinal cord at this level face devastating consequences, definitive disability, with a wide impact on families and society.

According to data from the HTS, the first year's cost of treating a spine and/or spinal cord trauma (SSCT) with quadriplegia can ascend to 1 million dollars and between 500,000 and 1,000,000 for paraplegia.

The treatment of patients with SSCT has not been standardized. There are no guidelines, nor is treatment coherent within the same institution, from one center to another or between centers in the same geographical region. Treatment strategies usually depend on the experience of the health service institutions or providers, training of the health professionals and the resources available in each hospital. Management can have a strong effect on the results in these patients, so doctors across the world make a huge effort to offer the "best and most appropriate treatment".

Based on experience in the HTS and a review of the relevant literature, the following guidelines are recommended for the diagnostic study, classification, management timeline and recording of these cases.

The treatment consists of two phases:



2. PREHOSPITAL PHASE

Overview

- The correct identification of the magnitude and mechanism of the trauma plus its anatomofunctional effects mean that accident victims can be categorized.
- Establishing the individual and relative severity facilitates selection of transfer priorities.
- The initial stabilization and immobilization helps to limit any aggravation of the injury.
- Depending on the distance to and resources of the medical center, indicate the type of center to which the patient shall be taken and the chosen route/ transport.

Four aspects need to be considered in the prehospital phase: rescue, triage, stabilization and transfer.

Rescue

The rescue team should operate in an appropriately equipped vehicle which is suited to the location, distance and circumstances of the accident. The personnel must be trained to recognize the situations that they may have to face at the scene of the accident and quickly establish the important facts:

- number of injured parties
- severity
- potential risk of complications
- number of fatalities

Whenever there is a fatality, it should be presumed that the accident involved a high amount of energy transfer and there is likely to be other severely injured victims. These facts have to be reported to the hospital or communication center immediately, they will organize any additional resources that may be required (basic and advanced rescue equipment, medicines, etc.).

If there are injured parties trapped in a vehicle or crushed by an avalanche or rubble then necessary measures must be taken to rescue them rapidly, but also efficiently.

The cervical spine should be protected with a stiff collar and the patient's body mobilized but without moving the spinal column, laying the patient on either a short or long spine board, depending on the situation (in the case of rapid extraction, immobilization is only carried out on a long board).

In this phase, attention should be directed to vital emergencies in order to control hemorrhage and pain:

- Maintain a clear airway.
- Cover penetrating thoracic injuries with dressings or compress packs.
- Constrain copious external hemorrhages with bandaging and manual compression.
- Provisionally align and immobilize any unstable fractures or displaced fractures.

Each area should use a rescue, coordination and transport system appropriate for the local situation.

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ll actions performed should comply with the principle of avoiding aggravation of existing injuries or provoking new ones.

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Triage

The classification recommended by the American College of Surgeons Committee On Trauma (ACS-COT) considers the use of physiological and anatomical parameters, indicating those patients that require priority attention. If there is only one trauma victim, once the steps above have been completed the patient is ready to be transferred to the hospital where they shall receive their complete and definitive attention. If the accident involves multiple victims then triage will be necessary (triage is a French word, commonly used in trauma departments, meaning to classify patients according to the category or characteristics of their injuries).

> In function of the characteristics of their injuries, the trauma patient should be transferred as directly and immediately as possible, by the most appropriate means, to the hospital where they shall receive definitive care. Triage becomes necessary whenever the resources available for on-site emergency services, or for transferring the trauma patient from the accident scene, are below requirements.

Priority is given to severely polytraumatized victims with recoverable injuries, followed by those with moderate to severe trauma, and then mild traumas. Finally, individuals in an agonal state or fatalities should then be attended.

Physiological and anatomical factors are considered in this prioritization, as well as an algorithm used for the stratification.

Physiological Factors

These predict the severity of the patient's overall state and correlate with the rates of morbidity and mortality:

Glasgow coma scale	**< 13**
Systolic blood pressure	**< 90**
Respiratory rate	**< 10 or > 29**

Anatomical Factors

The presence of one or more of these injuries are indicative of a high mortality rate:

- penetrating injury in the following areas:
  - chest
  - head
  - abdomen
  - neck
  - groin
- 2 or more proximal fractures of long bones in the limbs
- fracture of pelvis (unstable)
- chest trauma (unstable thorax)
- traumatic brain injury (TBI) with impaired consciousness and/or signs of lateralization
- compound or depressed fracture of cranium
- traumatic amputations above the hand and/or ankle
- crushing, stripping or severe injury to the extremities
- combinations of burns across 15% of the body surface and those associated with injuries to the face or airway
- evidence of a severe impact in a motor vehicle accident or fall from a height of over 3 meters
- overturning with the occupant ejected from the vehicle
- pedestrian struck at a speed of more than 32 km/h
- motorbike accidents at a speed of more than 30 km/h
- In addition to this list are extreme ages and concomitant morbid factors (known cardiovascular or respiratory diseases).

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Physiological Factors

The following algorithm helps to understand the decision-making process used to classify patients.

Triage decision-making algorithm

STEP 1

Measure vital signs and level of consciousness

- GCS < 14 or RF < 10 or
- BP < 90 or Revised TS < 11
- Pediatric TS < 9

STEP 2

YES

- Admitted to the trauma center
- Trauma team alerted

NO

Evaluate anatomical injury

- Unstable thorax
- 2 or more proximal fractures of long bones
- Proximal amputation of wrist or ankle
- Any penetrating trauma of head neck, trunk or limbs proximal to the elbow and knee
- Compound or depressed fracture of cranium
- Paralysis of extremities
- Pelvic fractures (unstable)
- Combination of trauma and burns
- Major burns
- Traumatic brain injury (TBI) with impaired consciousness and/or signs of lateralization
- Crushing, stripping or severe injury to the extremities

STEP 3

YES

- Admitted to the trauma center
- Trauma team alerted

NO

Evaluate mechanism of injury and evidence of high energy

- Expulsion from vehicle
- Death of passengers in the same compartment
- Pedestrian struck by vehicle
- High velocity automobile collision
- Deformity of automobile > 50 cm
- Motorbike collision > 32 km/h or driver-motorbike separation
- Rescue time > 6 min
- Overturning, passenger not using a safety device
- Automobile-pedestrian impact at velocity > 8 km/h
- Initial velocity > 60 km/h
- Compartment intrusion > 30 cm

STEP 4

YES

- Admitted to the trauma center
- Trauma team alerted

NO

Evaluate the medical condition

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Stabilization

Based on the distance and time required to reach the hospital of definitive care, oxygenate the patient and prepare a venous catheter to receive volume.

The following conditions should also be ensured:

- establish a clear airway
- immobilization of the cervical spine
- blockage of thoracic injuries (with gauze)
- control of external hemorrhages (with compression pads)
- immobilization (splints)

> No time should be wasted on these activities if the accident is only a short distance away, with the exception of administering oxygen.

All of the information about the accident (often provided by family and witnesses), the treatment administered and the changes observed during the trauma patient's evolution must be entered on a clear record sheet, in order, legibly and then delivered to the doctor upon arrival at the hospital.

Patient Transfer

Frequent radio communication between the rescue team and the hospital base with the medical personnel will facilitate the transmission of management instructions that can benefit the patient during their transfer, while also allowing the resuscitation team to prepare for their arrival.

When work is based on rescue protocols, specific centers with insufficient facilities can be discarded and the trauma patient can be taken directly to a better equipped specialized center. The most effective means of transport could also include aerial rescue. In recent years, aerial transfer has proved to be a fast and safe mode of transport which effectively decreases the mortality of trauma patients by significantly reducing the time between the accident and definitive treatment.

Transfer Conditions

The transfer must be rapid and expertly executed. The accident victim must be treated and monitored at all times. They should never be left alone.

> Measures that are applied at the scene of the accident must be monitored and corrected, if necessary, at all times.

- Eliminate the general contamination from injuries and protect them with sterile dressings or clean healing elements.
- If during the journey the patient presents significant hemodynamic deterioration and the transfer distance or time is relatively long, assess the appropriateness of inserting one or two intravenous lines with 14 or 16 gauge trocar and start volume replacement.
- If the patient is vomiting they should be turned as a single unit, with or without the spinal boards, to prevent aspiration of the vomit into the upper airways.
- Conditions for immobilizing the limbs should be observed at all times.
- The following factors must be monitored and corrected at all times:
- position
- traction
- pulse palpitation
- If inflatable immobilization splints are used it is important to check that they are always at the correct level of inflation, remembering that this changes when going from hot to cold environments or if in the mountains or a helicopter compared to sea level.

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These measures must be completed without losing any time. The patient should not be admitted to the hospital during the layover stop and, generally speaking, delays for diagnostic examinations, or any therapies that are not related to the patient's stabilization, are unjustified.

Stops for Intermediate Stabilization

If the patient's condition worsens, or the distance and/or time required for the transfer to the definitive hospital are very long, a temporary stop at a nearby hospital could be necessary.

- The only permissible reasons for such a stop are:
- To ensure that the airway is kept clear and oxygenated.
- To place or adjust a cervical collar.
- To insert 2 peripheral intravenous lines and start volume replacement.
- To provisionally align, retract, and immobilize any severely deformed osteoarticular injuries of the extremities.
- To perform any procedures which are above the capacities of the rescue personnel (pleural drainage, for example).

A hospital that will provide definitive care for trauma patients must have the appropriate physical and human resources operating at full efficiency 24 hours a day:

- laboratory
- blood bank
- diagnostic imaging equipment
- surgery
- intensive care unit
- group of specifically trained health professionals

For this last point it is worth highlighting the integrated multidisciplinary medical teams that participate simultaneously or successively to resolve the serious problems of polytrauma patients.

Summary:

PREHOSPITAL PHASE

The following actions are considered essential during the provision of prehospital attention:

- Maintaining a clear airway and ventilation.
- Controlling external hemorrhages.
- Suitably immobilizing the patient.

It is important to reduce the time spent at the scene of the accident, with a view to a rapid and effective transfer to the most appropriate and best equipped center for integral treatment.

The polytrauma victim should be identified and the severity of their condition assessed. Based on the ACS-COT criteria, the patient should be transferred to the hospital as quick as possible, where they will receive efficient medical attention, both emergency and definitive.

This transfer must be carried out efficiently, safely and with communication with the corresponding center according to the severity of the victim's condition. This is the only way to reduce the morbidity rate, the recovery time, level of disability and the death rate in such patients.

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3. HOSPITAL PHASE

Overview

The hospital phase is organized to receive patients in distinct, suitably equipped areas corresponding to their severity (a resuscitation room in the most serious of cases). Furthermore, rapid coordination with the laboratory, X-ray and imaging services, the blood bank and other support services is essential for the correct management of polytrauma patients

Immediate deaths (approximately 50% of cases)

They occur at the scene of the accident or immediately afterwards due to lacerations in the following areas:

- brain
- spinal cord
- large vessels
- brain stem
- heart
- etc.

Early deaths (approximately 30% of cases)

Deaths between 3 and 4 hours after the accident. Causes could be the following:

- major intracranial hemorrhages
- severe thoracic and/or abdominal injuries

They are considered as deaths that can be prevented by modern surgical procedures, if they are treated promptly in centers equipped with the necessary resources.
This group is crucial; they are capable of attaining much higher survival rates when treated appropriately.

Late deaths

Those which occur days or weeks after the trauma and, in 80% of cases, are caused by sepsis and/or multiple organ system failure.

Triage in Hospital Phase

This refers to the classification of trauma patients based on treatment necessities, depending on the severity of injuries and resources available in the center receiving the patients.

> Triage can be applied to multi-victim accidents when the number of patients and severity of their injuries do not exceed the capacities of the center which receives them for treatment. Patients whose condition is life-threatening and those with multiple traumas are treated first.

In the case of a disaster or massive accident, the number of patients can significantly exceed the capacities of a given center and its personnel. In such events, patients with the highest chance of survival and who require the least expenditure of equipment, supplies, time and personnel will take priority.

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Managing Polytraumatized Patients

The most popular system throughout the world, called ATLS, was developed by the American College of Surgeons. Its approach focuses on the issues of immediate aid and classifying priorities.

Initial Evaluation

The initial examination should include the following attributes:

- Be quick, accurate and efficient, covering all vital signs.
- Take no longer than 2 minutes.
- Aim to identify any injuries that endanger the patient's life and/or limbs if they are not treated immediately.

> It is essential that the examination follows an organized, step-by-step procedure, even when faced with multiple injuries, otherwise critical lesions may go unnoticed while less severe injuries could incorrectly be considered as priorities.

The severity of injuries is assessed and then, from that information, treatment priorities determined. An experienced medical first responder should need just a few seconds to classify a patient into one of the following states:

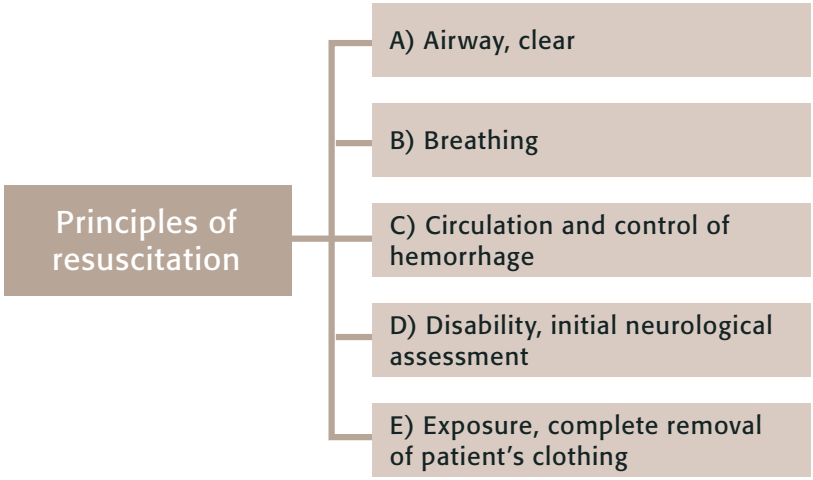
- dead or in a state of agony
- in shock with compromised vital signs (airway)
- stable or unstable

This is achieved via a fast examination of the airway, pulse, level of consciousness, peripheral perfusion, neck veins, respiration and circulation, among other signs.

Resuscitation

Resuscitation is usually carried out at the same time as the initial evaluation because any life-threatening injuries must be treated as soon as they are identified.

The methodology can be organized according to the ABC of resuscitation (airway, breathing and circulation), with the addition of the principles for D and E (disability and exposure).



Resuscitation must be led and coordinated by an experienced individual.

A. Airway, clear (with the cervical spine under control)

Nasogastric or orotracheal intubation should be carried out when there is clear evidence of respiratory compromise. However, until confirmed otherwise, the cervical spine should be presumed fractured in all unconscious patients with cranial and/or severe facial trauma.

The presence of any cervical spine fractures is assessed via a lateral X-ray which must provide an image of C1 to C7. Meanwhile, the cervical column must be kept in an aligned position by immobilizing it with a semi-rigid neck collar and avoiding hyperextension during resuscitation procedures, especially in the case of orotracheal intubation.

It must be noted that a lateral cervical X-ray does not eliminate all possible injuries to this region of the spine, although it does provide some reassurance that an existing injury will not be provoked or worsened when performing maneuvers. If in doubt, and based on clinical judgment, immobilization procedures must be followed until an appropriate X-ray study is completed and until neurological and/or orthopedic assessments rule out any cervical spine injuries.

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Protecting the cervical spine and spinal cord constitute the essential principles of polytrauma patient management

It is important to remember that injuries to the cervical spine should be assumed in all polytrauma patients, especially if they have signs of impaired consciousness and/or blunt force trauma to the face and clavicular regions.

If attempts to ensure a clear airway (nasal or oral) fail within approximately 60 seconds and it is impossible to ventilate with an oxygen mask, a cricothyrotomy through the cricotracheal membrane must be considered to allow passage for a No. 5 or No. 6 endotracheal tube. A tracheotomy should be the procedure chosen to be performed in surgery, preferably. A constant oxygen supply is always required.

B. Breathing

Corresponds to traumas that anatomically occur below the level of the larynx. It consists of assessing the following points:

- thoracic respiratory excursion and air exchange
- stability of the thoracic wall or paradoxical mobility
- respiration rate
- pulmonary auscultation

Feel for the position of the trachea and determine whether there is subcutaneous emphysema. The presence of any of the following symptoms indicates the need for assisted ventilation:

- stridor
- cyanosis
- anxiety
- intercostal retraction
- use of accessory respiratory muscles
- polypnea, RR greater than 30 per minute
- bradypnea, RR less than 12 per minute which is a sign of imminent respiratory collapse

Pneumothorax can be a significant complication. The following types can be considered:

Tension pneumothorax	Requires immediate draining (needle aspiration). If there is air, a pleural drainage tube should be inserted.
Open pneumothorax (with traumatopnea)	The opening must be closed and a pleural tube inserted.

The correct ventilation and oxygenation of the trauma patient requires an air supply that delivers the necessary volume and concentration of oxygen (10 to 12 liters per minute, at concentrations of up to 85% or more). This cannot be achieved with a common nasal cannula or mask. Therefore, it is important to use a mask that can supply a known oxygen concentration or a rebreather mask.

A pulse oximeter is a good complement to help monitor the correct management of airway control maneuvers and the efficacy of those maneuvers. The device measures, by colorimetry, the saturation of peripheral oxygen and hemoglobin, but it does not measure the ventilation rate or partial pressure of oxygen in blood. A clear airway and correct ventilation, with oxygen administered in sufficient quantities, should give oximetry readings of over 90%.

C. Circulation and control of hemorrhages

Circulatory status is established from the following parameters:

- pulse
- blood pressure
- skin temperature
- perspiration
- distal pulses of extremities
- capillary refill time (2 seconds in normovolemic patients)
- heart beat
- status of neck veins
- electrocardiogram (ECG)

The following clinical observations can provide important information about the patient's hemodynamic condition in just a few seconds:

- level of consciousness
- skin color
- appearance of skin
- pulse

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However, the effects of hypovolemia on blood pressure appear later, manifesting upon the depletion of the compensation mechanisms which the body resorts to ensure blood perfusion to the most vital organs (heart, brain, kidneys).

If there is bleeding, actions should be rapid and the following measures must be taken:

- Identify and control exsanguinating, arterial and venous hemorrhages.
- Consider direct compression on the bleeding vessel or injury until definitive treatment can be performed.
- A tourniquet should only be considered on traumatic amputations.
- Avoid uncontrolled hemostasis (vascular and neurological damage).

Hypovolemia is the primary cause of shock. It is therefore important to search for hidden hemorrhages on the thorax, abdomen and pelvis (retroperitoneum). A traumatic brain injury (TBI) in itself does not cause shock.

Shock caused by a spinal cord injury should be ruled out by checking for mobility in the toes, by evaluating the osteotendinous reflexes and degree of anal sphincter tone.

If neck veins are distended, then the following clinical conditions must be ruled out:

- tension pneumothorax
- cardiac tamponade (if in doubt, a pericardiocentesis via substernal pericardiocentesis should be performed to provide temporary drainage of a hemopericardium while the patient is being taken
- to surgery)
- myocardial contusion
- myocardial infarction
- air embolism

In the case of hypovolemia, a venous line is required, if possible with two wide peripheral lines (No. 14 or No. 16), whether percutaneously or by stripping (surgical canalization). It is best placed in the lower limbs when there is severe thoracic injury, and in the upper limbs if there are abdominal injuries

A blood sample should also be taken for analysis of the following parameters:

- classification
- arterial gases
- routine blood chemistry:
- hematocrit
- hemoglobin
- uremia
- glycemia
- electrolytes
- amylasemia
- coagulation tests
- calcemia
- etc.

Volume replacement should be aggressive, using a balanced saline solution (Ringer's lactate solution or a physiological saline solution). Between 2 and 3 liters should be administered within 10 to 20 seconds whenever there is hemodynamic compromise. Afterwards, if hemodynamic instability persists, continue with blood. Remember that the volume of crystalloids needs to be 3 to 4 times greater than the estimated volume of blood loss. For example: 500 mL of blood loss requires 1,500 to 2,000 mL of saline solution. Ideally hematocrit should be maintained between 30 to 35%, which are appropriate levels for oxygen transport and provides optimal viscosity.

The time periods required to complete multi-section computed tomography have reduced, while the advantages of specificity and sensitivity remain, in addition to the ability to perform vascular studies (angiograph) by using a dual contrast media: digestive and intravenous.

If more than 3 liters are replaced without recovering hemodynamic stability then surgery to control the bleeding as much as possible must be considered, as long as the point of hemorrhage has been localized.

An abdominal ultrasound directed at the four quadrants (Eco-fast), the pleural cavities and the pericardium is capable of delivering rapid, early information to help detect hidden bleeding in these areas. As it is non-invasive, it can be carried out at and/or taken to the side of the patient, then repeated sequentially without altering their baseline condition.

Emphasis should be placed on appropriate and early control of any origins of bleeding, it is more important than volume replacement which could lead to increased bleeding by interfering with the body's own compensation mechanisms that respond to control the situation

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D. Disability, initial neurological assessment

Neurological status is established via a rapid examination of the following parameters:

- level of consciousness (alert, responsive to spoken words and pain, or without any response)
- pupil size and reaction
- movement of limbs, spontaneous or provoked
- signs of lateralization
- records of estimated level of spinal cord injury, if suspected

The Glasgow coma scale (GCS) is a rapid, simple method used to determine a patient's level of consciousness. Furthermore, it is predictive of the patient's evolution with respect to their neurological impairment, particularly considering the best motor response

The Glasgow coma scale considers three items:

Characteristic	Score
How the patient opens the eyes	
Spontaneously	4
When spoken to	3
In response to pain	2
Does not open the eyes	1
What the motor response is like	
Responds adequately	6
Localizes stimulation	5
Withdraws from stimulation	4
Responds in flexion	3
Responds in extension	2
Does not move	1
What the verbal response is	
Speaks coherently	5
Speech is confusing	4
Utters inappropriate words	3
Produces incomprehensible sounds	2
Does not talk or make any sounds whatsoever	1

It is extremely useful for classifying the severity of a traumatic brain injury (TBI) into the following levels

TBI 0
Minimal trauma.
TBI I
Mild trauma: ■ Glasgow score of 13-15. ■ With or without fractures. ■ Loss of consciousness < 5 min. ■ Complete recovery.
TBI II
Moderate trauma ■ Glasgow score of 9-13. ■ Intracranial injuries.
TBI III
Moderate trauma ■ Glasgow score of 8 <.

It must be remembered that impaired consciousness, in conjunction with a traumatic brain injury (TBI), can be due to any of the following causes:

- hypoxemia
- hypovolemia
- drugs
- alcohol

The priority in a trauma patient with an altered level of consciousness is based on identifying and treating the anoxia and shock.

Once the level of consciousness is established, it is important to identify and treat the brain injury (hyperventilation, mannitol is indicated for rapidly progressing symptoms), once other possibles causative factors have been discounted (hypoglycemia, alcohol, narcotics or other drugs).

Despite having applied all aspects of brain injury management, very quick and unexpected deterioration is still possible. This possibility can be minimized by a frequent reevaluation capable of detecting early signs of change. It may be necessary to perform the primary assessment again and confirm that the airway remains clear, with correct ventilation and oxygenation, and that there is sufficient cerebral perfusion. A neurosurgeon should also be consulted, in order to obtain their expert opinion and so they may guide actual, or any additional, treatments, transfer procedures or other actions.

Exposure, complete removal of patient's clothing
This step is obligatory, to allow an appropriate and complete anterior and posterior examination, mobilizing the patient in a block if a spinal injury is suspected.

Once this is done, it is imperative to cover the trauma patient with warm blankets or activate external heating devices in the emergency service to prevent the possibility of hypothermia. Any intravenous fluids should also be warmed prior to administration.

E. Exposure, complete removal of patient's clothing

This step is obligatory, to allow an appropriate and complete anterior and posterior examination, mobilizing the patient in a block if a spinal injury is suspected.

Once this is done, it is imperative to cover the trauma patient with warm blankets or activate external heating devices in the emergency service to prevent the possibility of hypothermia. Any intravenous fluids should also be warmed prior to administration.

> The most important aspect is the patient's body temperature, not the comfort of the personnel caring for them.

Complements to the Initial Evaluation and Resuscitation

Once a clear airway and ventilation have been established and ensured, proceed to complete the initial resuscitation by fulfilling the following points:

- When necessary, administer supplementary oxygen. Monitor with a pulse oximeter that affords continuous observation of the pulse and oxygen saturation. Do not measure the partial pressure of oxygen, nor that of carbon dioxide.
- The presence of arrhythmia and changes to the ST segment of the electrocardiogram can be signs of cardiac contusion and so it is important to bear heart monitoring in mind. Pulseless electrical activity (formerly known as electromechanical dissociation) can indicate cardiac tamponade, tension pneumothorax or severe hypovolemia. In the event of bradycardia, aberrant conduction and premature extrasystoles, one should immediately suspect hypoxia and hypoperfusion. Extreme hypothermia can also be a cause of arrhythmias.
- Catheterization of the bladder is indicated, except when a tear in the posterior urethra is suspected (if there is blood in the meatus, incapacity to urinate, a floating prostate was discovered during the rectal examination or a displaced pelvic fracture). If such a tear is suspected, perform a urethrography for confirmation/elimination. Urinary flow should also be monitored and a urine sample sent to determine the presence of hematuria.
- An attempt should also be made to stabilize closed fractures of long bones to prevent potentially greater hemorrhaging.
- The nasogastric intubation is used to investigate gastric bleeding and emptying, and to prevent pulmonary aspiration. Exercise precaution when there is a fracture, or one is suspected, at the base of the cranium, which could compromise the cribriform plate of the ethmoids. In such cases, intubation could alternatively be placed orogastrically.

Obtain an anteroposterior X-ray of the thorax and pelvis, with the patient either seated or stood up, as early as possible. These studies are the most important as they can provide information about the following situations:

- location of the endotracheal tube
- occupation of the thoracic cavity:
  - pleural
  - mediastinal
  - pericardia
  - of the diaphragm
  - abdominal
  - etc.
- pelvis: presence and type of fractures

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Definitive Treatment

Once the clinical evaluation is complete, imaging studies are required to attain an acceptable level of diagnostic certainty

X-Rays

This technique has been replaced by full-body computed tomography (where available) for the emergency assessment upon admission and resuscitation of patients with suspected spine or spinal cord injuries (Hadley et al., 2002; Harris and Sethi, 2006).

> Considering X-rays, it is established that the cervical spine trauma series (anteroposterior, lateral and C1-C2) is the recommended standard for evaluation of the cervical spine in symptomatic patients.

This should be complemented by computed tomography in order to define the suspicious areas more precisely, attaining clear views of the occipitocervical and cervicothoracic areas of transition.

The cervical collar can be withdrawn for a normal X-ray series of the cervical spine (including CT supplements, if they are necessary) or, equally, for a normal magnetic resonance imaging study (MRI).

However, for unconscious patients, the cervical spine should remain immobilized until the results of the normal cervical spine X-ray imaging studies have been obtained, including the supplementary CT or MRI scans, as necessary.

Post-Operative Computed Tomography

Simple X-rays of the vertebral column are not required in the initial evaluation if there are more advanced imaging diagnosis methods available (Brown, Antevil, Sise and Sack, 2005).

Recent studies confirm the benefits of full-body CT in the detection of visceral abdominal injuries, as well as bone injuries in the pelvis and/or vertebral column.

Evidence indicates that multi-section CT scans of the spine identify 99.3% of vertebral fractures in polytraumatized patients. The cases which go undiagnosed are minor injuries or those which do not require treatment.

Magnetic Resonance Imaging (MRI)

MRI is the imaging technique that provides the most sensitive analysis of soft tissues. As such, MRI scans of the spine provide the clearest image of the neurological structures, ligaments and discs.

MRI is of most use in those patients whose simple X-rays or CT scans do not explain their clinical symptoms. In cases of neurological compromise with no evidence of structural damage in either X-rays or CT scans (SIWORA), MRI can provide extremely valuable diagnostic information.

Vaccaro and Eck (2010) reported that 25% of patients with thoracic or cervical injuries and neurological deficit in the initial examination had their preliminary treatment modified after obtaining the MRI results. The same study revealed that MRIs did not affect the treatment plan for neurological intact patients.

MRI can facilitate valuable information about ligaments and discs, without the risks implied in dynamic flexo-extension studies.

Summary:

HOSPITAL PHASE

Systematic evaluation, based on protocols with established assessment algorithms, resuscitation procedures, clinical, neurological and imaging diagnostics, helps to guarantee homogeneous management of cases, with appropriate, timely and complete staging of the traumatic injuries.

4. MANAGING SPINAL CORD INJURIES AND SHOCK IN POLYTRAUMATIZED PATIENTS

Administration of corticoids is only recommended for 24 hours in incomplete injuries, starting in the first 8 hours of evolution, in preparation for surgical decompression and stabilization

Spinal Cord Injury (SCI)

The administration of corticosteroids helps to prevent secondary damage. There is insufficient evidence to propose treatment standards or guidelines about how to proceed with treatment (Bracken et al., 1990).

spinal cord injury. However, it should only be used when the potential benefits outweigh any potential damage.

Methylprednisolone administration has not been approved as a standard treatment, nor can it even be considered a recommended treatment. There is only weak evidence, possibly from isolated cases, to support the drug's efficacy and effect.

In the strictest of senses, the 24 hours of methylprednisolone administration should really be considered for use in clinical experimentation. Forty-eight hours of therapy is not recommended. This conclusions are important to consider when designing any future trials and also in a legal context (Hurlbert, 2000).

In patients with a partial injury, corticoids could increase the therapeutic window until definitive decompression and stabilization can be achieved. This cannot be confirmed with IB level evidence alone; nevertheless, recent work of Fehlings supports this line of action (Fehlings et al., 2008).

The initial dose of methylprednisolone in bolus via intravenous is 30 mg/kg and should be maintained at a rate of 5.4 mg/kg/h for the next 23 hours.

1. Keep adequate oxygenation pO2 100%, so as to keep spinal cord well oxygenated.
2. Keep Median Arterial Preassure over 70 mmHg, to ensure irrigation to the spinal cord
3. Sooner reduction and stabilization of the fracture, specially if incomplete cord lesion.

Shock

Patients who suffer a spinal cord injury (SCI) generally fall into the category of polytrauma patients. Therefore, these patients have 2 potential causes of hemodynamic compromise:

- hypovolemia
- neurogenic shock (loss of vasomotor tone primarily manifesting as hypotension and bradycardia)

Recommendations for volume replenishment therapy are to maintain an average blood pressure of between 80 and 100 mm Hg. If this is insufficient then treatment with beta- agonists, such as dopamine or dobutamine, should be initiated. The use of alpha-agonists, such as adrenaline, should be avoided because they can increase and directly affect the cardiac afterload (Fehlings et al., 2008).

Hypoxemia can worsen the prognosis for a cord injury. Higher injuries, above C6, with interruption of the sympathetic chain generally present with hypotension and bradycardia. This condition is called neurogenic shock and leads to other problems in perfusion to the spinal cord.

Summary:

MANAGING SPINAL CORD INJURIES AND SHOCK IN POLYTRAUMATIZED PATIENTS

The use of corticoids to manage cord injuries, which was a standard treatment for over a decade, is currently under review. The ability to differentiate hypovolemic shock from neurogenic shock is vital in the decision to focus on either volume replacement or drug therapy.

5. SPINAL SURGERY: TREATMENT TIMELINE

Overview

Immediate surgery has several advantages and is not associated with any further deterioration of neurological status.

Time in intensive care is shortened for those patients who are surgically stabilized early on. Consequently, the rate of pneumonia is lower, as are the costs of care.

The most notable difference is observed in patients with a thoracic fracture. They also present a reduced number of days in which they require assisted ventilation (Croce, Bee, Pritchard, Miller and Fabian, 2001).

Treatment Principles

Immediate surgery has several advantages and is not associated with any further deterioration of neurological status.

Time in intensive care is shortened for those patients who are surgically stabilized early on. Consequently, the rate of pneumonia is lower, as are the costs of care.

The most notable difference is observed in patients with a thoracic fracture. They also present a reduced number of days in which they require assisted ventilation (Croce, Bee, Pritchard, Miller and Fabian, 2001).

In general, the principles of surgical treatment are as follows:

- reduction of spinal injury
- direct or indirect decompression of neural elements
- stabilization of damaged segments, avoiding the need for external immobilization
- minimal sacrifice of intact spinal segments
- facilitation of early rehabilitation

In the specific case of the cervical column, reduction using halo traction meets the first objective, but it does not stabilize the segment. The definitive stability must be guaranteed as soon as physiological conditions permit and the technical equipment and personnel are available.

The best surgical procedure is that which realigns, decompresses and fixes the spinal column, generating a suitable environment for revascularization and repair.

Articular dislocations must be reduced and fractures of long bones stabilized with external fixation. This could be concomitant with placing the patient in the supine position.

The technique used must be adapted to the different regions:
occipitocervical

- C1-C2
- lower cervical
- cervicothoracic
- thoracic
- thoracolumbar
- lower lumbar
- sacral

Each of these regions has its own characteristics and skeletal importance that imply varying levels of stabilization.

Summary:

SPINAL SURGERY: TREATMENT TIMELINE

Surgery should be undertaken after completing the imaging studies and ruling out the possibility of an intracranial expansive lesion and intracranial hypertension, which would take priority. Similarly, according to the ATLS system, a thoraco-abdominal study should be completed previously..

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