# Chapter 29, Head and Spine Injuries

## 1. Introduction to Head and Spine Injuries

- This chapter focuses on **head and spine injuries** [1].
- Understanding this material helps manage trauma-related issues [2].
- It is crucial to recognize **life threats** from these injuries [3].
- Immediate **spinal stabilization** is essential [3].
- **Airway and breathing support** may also be needed [3].

## 2. Anatomy and Physiology of the Nervous System

| System | Components | Protection | Functions |
|---|---|---|---|
| Central Nervous | Brain, Spinal cord [16] | Skull, Bony spinal canal [11], Meninges | Controls body, Center of consciousness, Carries messages between brain and body [17] |
| Peripheral | 31 pairs of spinal nerves, 12 pairs of cranial nerves, Sensory nerves, Motor nerves, Connecting nerves [36] | None specified | Conducts impulses, Transports information directly to/from brain, Performs special functions [37] |

- The nervous system is a complex network of nerve cells [9].
- It includes the **brain, spinal cord, nerve fibers, and nerves** [10].
- The nervous system is well protected by bony structures [11].
- Serious injuries can damage the nervous system despite this protection [12].
- The central nervous system includes the brain and spinal cord [16].
  - The brain controls the body [17].
  - It is the center of consciousness [17].
  - The brain is divided into three major areas: **cerebrum, cerebellum, and**

**brainstem** [18].

- The cerebrum controls voluntary motor function and conscious thought [20].
- The cerebellum coordinates balance and body movements [22].
- The brain stem controls most functions necessary for life [23].
- This includes cardiac and respiratory systems [23].
- It is the best protected part of the central nervous system [24].

- The spinal cord carries messages between the brain and body [25].

- The central nervous system is protected by the **meninges** [27].
  - These are three layers of tissues [27].
  - The outer layer, **dura mater**, is a tough, fibrous sac [28].
  - The inner two layers, **arachnoid mater** and **pia mater**, contain blood vessels [29].
- **Cerebral spinal fluid (CSF)** is produced inside the brain [31].
  - It is produced in the third ventricle [32].
  - CSF acts primarily as a **shock absorber** [33].
  - Clear, watery CSF may leak from the nose, ears, or an open skull fracture if protective layers are penetrated [34].
- The peripheral nervous system has **spinal nerves** and **cranial nerves** [36].
  - Spinal nerves conduct impulses to and from the spinal cord [37].
  - Cranial nerves transport information directly to or from the brain [40].
  - Cranial nerves perform special functions in the head and face [41].
- There are two types of peripheral nerves: **sensory** and **motor** [42].
  - Sensory nerves carry information from the body to the brain [44].
  - Motor nerves carry information from the central nervous system to the muscles [45].
- Connecting nerves are found in the brain and spinal cord [46].
  - They connect sensory and motor nerves [46].
- The nervous system controls reflex activities, voluntary activities, and involuntary activities [48].
  - A **reflex arc** in the spinal cord allows simple messages to bypass the brain [49].
  - The **somatic nervous system** handles voluntary activities [52].
  - The **autonomic nervous system** handles involuntary functions [53].

- The autonomic system is divided into **sympathetic** and **parasympathetic** divisions [54].
- The sympathetic system reacts to stress with the **fight or flight response** [56].
- The parasympathetic system has opposite effects, such as slowing heart rate [57].
- These divisions balance each other for **homeostasis** [58].

## 3. Skeletal Structures Protecting the Nervous System

- The skeletal system includes the **skull** and the **spinal cord** [61].
- The skull is composed of **cranial** and **facial bones** [61].
  - The brain connects to the spinal cord through the **foramen magnum** [62].
  - Four major bones make up the cranium: occipital, temporal, parietal, and frontal [63].
  - The face is composed of 14 bones, including the maxilla, zygoma, mandible, nasal, and frontal [64].
- The spinal cord is the body's central supporting structure [66].
  - It has 33 vertebrae [67].
  - These are divided into five sections: cervical, thoracic, lumbar, sacral, and coccygeal [68].
  - The front part of each vertebrae is the vertebral body [70].
  - The back forms a bony arch [70].
  - The series of arches forms the **spinal canal** [71].
  - The spinal canal protects the spinal cord [71].
  - Vertebrae are connected by ligaments and separated by **intervertebral discs** [72].

## 4. Head Injuries: Types, Mechanisms, and Signs

| Aspect | Description |
| --- | --- |
| Definition | Traumatic insult to the head [74] |

| | |
|---|---|
| Impact | May injure soft tissue, bony structures, or the brain [74] accounts for over half of traumatic deaths [75] |
| Types | Closed head injury, Open head injury [78] |
| Mechanisms | Falls, Motor vehicle crashes, Assaults, Sports related incidents [81] |
| General Signs | Various signs listed in a table [83] |

- A head injury is a traumatic insult to the head [74].
- It can injure soft tissue, bony structures, or the brain [74].
- Head injuries account for over half of all traumatic deaths [75].
- Fatal injuries always involve the brain [76].
- Be aware of additional trauma the patient may have [77].
- There are generally two types of head injuries: **closed** and **open** [78].
- In closed head injuries, the brain is injured, but there is no opening [79].
- An open head injury has an opening to the outside world [80].
  - This is often caused by penetrating trauma [80].
  - Brain tissue may be exposed [80].
- Common mechanisms of injury include **falls** and **motor vehicle crashes** [81].
- Other mechanisms include assaults and sports incidents [82].
- General signs and symptoms are shown in a table [83].

## 5. Specific Types of Head Injuries

| Injury Type | Description | Key Characteristics / Signs |
|---|---|---|
| Scalp Lacerations | Minor or serious cuts to the scalp [84] | Can lead to significant blood loss, especially in children [84] May contribute to hypovolemia in multiple injuries [85] |
| Skull Fractures | Break in the skull bone [86] | May be open or closed [87] Result from significant force [86] |

| | | |
|---|---|---|
| Linear Skull Fracture | Accounts for 80% of skull fractures [90] | Often no physical signs [91] Diagnosed with radiographs [91] |
| Depressed Skull Fracture | High-energy direct trauma [92] | Bony fragments may injure the brain [93] Patients may have neurologic injury signs, like loss of consciousness [94] Most susceptible areas are frontal and parietal bones [93] |
| Basilar Skull Fracture | Associated with high-energy diffuse impact [95] | Extension of linear fractures to the base of the skull [96] Signs include CSF draining from ears, raccoon eyes, Battle signs [98] Diagnosed with CT [97] |
| Open Skull Fracture | Often associated with trauma to multiple systems [99] | Brain tissue may be exposed [100] High risk of bacterial infection [100] Very high mortality rate [100] |
| Traumatic Brain Injuries (TBI) | Traumatic insult to the brain [101] | Can cause physical, intellectual, emotional, social, vocational changes [101] Classified as primary (direct) or secondary (indirect) injury [101] |
| Primary Brain Injury | Direct injury from the impact [102] | Result from the initial impact [102] |
| Secondary Brain Injury | Indirect injury that increases primary injury severity [102] | Caused by cerebral edema, intracranial hemorrhage, increased ICP, cerebral ischemia, or infection [102] Hypoxia and hypotension are common causes [103] Can occur minutes to days later [105] Result from blunt or penetrating trauma [106] |
| Coup-Contrecoup Injury | Injury to front of brain from initial impact, then rear of brain from head movement [106] | Initial impact injures front brain, head movement injures rear brain [106] |

| | | |
|---|---|---|
| Cerebral Edema | Swelling of the brain [107] | May develop hours after injury [107] Low blood oxygen levels aggravate it [108] Monitor for seizure activity [109] |

- **Scalp lacerations** can be minor or serious [84].
  - Even small cuts can cause significant blood loss [84].
  - This is especially true in children [84].
  - Bleeding can contribute to hypovolemia in patients with multiple injuries [85].
- **Skull fractures** can result from significant force [86].
  - They may be open or closed [87].
  - Penetrating weapons frequently cause skull fractures [88].
  - Signs include head deformity or a visible crack [88].
  - **Raccoon eyes** (ecchymosis under the eyes) and **Battle sign** (ecchymosis behind the ear) are signs of skull fracture [88].
- **Linear skull fractures** are the most common [90].
  - They account for about 80% of skull fractures [90].
  - They often have no physical signs [91].
  - Radiographs are needed for diagnosis [91].
- **Depressed skull fractures** result from high-energy trauma with a blunt object [92].
  - Frontal and parietal bones are most susceptible [93].
  - Bony fragments can be driven into the brain [93].
  - Patients often show signs of neurologic injury [94].
  - Loss of consciousness is a common sign [94].
- **Basilar skull fractures** are associated with high-energy trauma [95].
  - They usually follow diffuse impact to the head [95].
  - These are often extensions of linear fractures [96].
  - Signs include CSF draining from the ears [98].
  - Raccoon eyes or Battle signs may also be present [98].
- **Open skull fractures** are often linked to trauma in multiple body systems [99].
  - Brain tissue may be exposed [100].
  - This greatly increases the risk of bacterial infection [100].
  - Open skull fractures have a very high mortality rate [100].

- **Traumatic brain injuries (TBIs)** are defined as traumatic insults to the brain [101].
  - They can cause physical, intellectual, emotional, social, and vocational changes [101].
  - TBIs are classified into two categories: **primary** and **secondary** injury [101].
  - **Primary injuries** are the direct result of the impact [102].
  - **Secondary injuries** increase the severity of the primary injury [102].
    - Causes include cerebral edema and intracranial hemorrhage [102].
    - Increased intracranial pressure (ICP) and cerebral ischemia can also cause them [102].
    - Infection is another possible cause [102].
    - **Hypoxia and hypotension** are the most common causes of secondary brain injury [103].
    - They significantly increase death and disability [104].
    - Secondary injuries can occur minutes to days after the initial injury [105].
    - They can result from blunt or penetrating trauma [106].
  - A **coup-contrecoup injury** involves injury to both the front and rear of the brain [106].
- **Cerebral edema** (brain swelling) may develop hours after injury [107].
  - Low blood oxygen levels make cerebral edema worse [108].
  - Monitor the patient for seizure activity with any head injury [109].

## 6. Intracranial Pressure and Hemorrhages

| Condition | Description | Signs and Symptoms | Key Characteristics |
| --- | --- | --- | --- |
| Increased Intracranial Pressure (ICP) | Accumulation of blood or swelling within the skull [109] | Abnormal respiratory patterns (ataxic, Cheyne-Stokes) [111] Decreased pulse rate [111] Headache, nausea, vomiting [111] Decreased alertness [111] Bradycardia [112] Sluggish/non-reactive pupils [112] Cerebral | Squeezes the brain against bony prominences [110] Can rapidly occur [109] |

| | | | |
|---|---|---|---|
| | | posturing [112] Widened blood pressure [112] | |
| Cushing's Reflex | Triad of symptoms indicating increased ICP [112] | Increased systolic blood pressure, Decreased pulse rate, Irregular respirations [113] | A symptom triad [112] |
| Intracranial Hemorrhage | Bleeding inside the skull [113] | Usually increases ICP [113] | Can occur between skull/dura mater, beneath dura mater/outside brain, or within brain tissues [114] |
| Epidural Hematoma | Blood accumulation between skull and dura mater [115] | Nearly always results from a blow causing linear fracture of temporal bone [115] Rapidly progressing symptoms [115] Immediate loss of consciousness [116] Lucid interval [117] Lapse back into unconsciousness [117] Fixed and dilated pupil on hematoma side [118] | Usually arterial bleeding (middle artery) [115] Death follows rapidly without surgery [118] |
| Subdural Hematoma | Blood accumulation beneath dura mater, outside brain [119] | Fluctuating level of consciousness [122] Slurred speech [123] Signs develop more gradually [121] Needs physician evaluation [123] | Usually results from falls or deceleration forces [120] More common than epidural hematomas [120] May or may not have skull fracture [120] Associated with venous bleed [121] |

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|---|---|---|---|
| Intracerebral Hematoma | Bleeding within the brain tissue [124] | Progression of increased ICP depends on other injuries, brain region, and size [126] High mortality rate [127] | Can follow penetrating injury or rapid deceleration [124] Many small ones associated with other brain injuries [125] High mortality even with surgery [127] |
| Subarachnoid Hemorrhage | Bleeding in the subarachnoid space where CSF circulates [127] | Bloody CSF [127] Signs of meningeal irritation (neck rigidity, headache) [127] Sudden severe headache [129] Signs of increased ICP as bleeding increases [130] | Often occurs in subarachnoid space [127] Causes include trauma or aneurysm rupture [128] Sudden severe cases usually result in death [131] Survivors often have permanent neurologic impairment [132] |

- Accumulation of blood or swelling within the skull can rapidly increase **intracranial pressure (ICP)** [109].
- Increased ICP squeezes the brain against the skull [110].
- Signs of increased ICP include:
  - Abnormal respiratory patterns (ataxic, Cheyne-Stokes) [111]
  - Decreased pulse rate [111]
  - Headache, nausea, vomiting [111]
  - Decreased alertness [111]
  - Bradycardia [112]
  - Sluggish or non-reactive pupils [112]
  - Cerebral posturing [112]
  - Increased or widened blood pressures [112]
- **Cushing's reflex** is a triad of symptoms indicating increased ICP [112].
  - It consists of **increased systolic blood pressure, decreased pulse rate, and irregular respirations** [113].
- **Intracranial hemorrhage** is bleeding inside the skull [113].

    - This usually increases ICP [113].
    - Bleeding can occur in different locations: between the skull and dura mater, beneath the dura mater but outside the brain, or within the brain tissue itself [114].
- An **epidural hematoma** is blood accumulation between the skull and dura mater [115].
    - It usually results from a blow to the head causing a linear fracture of the temporal bone [115].
    - It is nearly always due to **arterial bleeding** [115].
    - Symptoms progress rapidly [115].
    - The patient often loses consciousness immediately, followed by a brief **lucid interval**, then lapses back into unconsciousness [116].
    - The pupil on the side of the hematoma becomes fixed and dilated [118].
    - Death occurs rapidly without surgery [118].
- A **subdural hematoma** is blood accumulation beneath the dura mater, outside the brain [119].
    - It usually happens after falls or injuries with strong deceleration forces [120] .
    - It is more common than epidural hematomas [120].
    - It may or may not be associated with a skull fracture [120].
    - It is linked to a **venous bleed** [121].
    - Signs typically develop more gradually than with epidural hematomas [121].
    - The patient often has a fluctuating level of consciousness or slurred speech [122].
- An **intracerebral hematoma** involves bleeding within the brain itself [124].
    - It can occur after a penetrating head injury or rapid deceleration forces [124].
    - Many small, deep hemorrhages are associated with other brain injuries [125].
    - The progression of increased ICP depends on other injuries, the brain region, and the size of the hemorrhage [126].
    - Intracerebral hematomas have a high mortality rate [127].
    - This is true even if the hematoma is surgically removed [127].
- A **subarachnoid hemorrhage** is bleeding in the subarachnoid space [127].
    - This is where CSF circulates [127].

- It results in bloody CSF and signs of meningeal irritation [127].
- Neck rigidity or headache are signs of meningeal irritation [127].
- Common causes include trauma or a ruptured aneurysm [128].
- Patients report a sudden severe headache [129].
- As bleeding increases, signs of increased ICP appear [130].
- A sudden severe subarachnoid hemorrhage usually results in death [131].
- Survivors often have permanent neurologic impairment [132].

## 7. Concussions and Contusions

- A **concussion** is a blow to the head or face [133].
  - It is classified as a mild traumatic brain injury [133].
  - It is a closed injury [134].
  - There is temporary loss or alteration of brain function [134].
  - There is no demonstrable physical damage to the brain [134].
  - About 90% of patients with a concussion do not lose consciousness [135].
  - A patient may be confused or have **amnesia** [136].
  - **Retrograde amnesia** is the inability to remember events leading up to the injury [137].
  - **Anterograde amnesia** is the inability to remember the events of the injury [137].
  - Usually, a concussion lasts only a short time [138].
  - Ask about symptoms like dizziness, weakness, visual changes, or mood changes [138].
  - Additional signs include nausea, vomiting, ringing in the ear, slurred speech, and inability to focus [139].
  - Assume a patient with concussion signs has a more serious injury until proven otherwise [140].
- A **contusion** is bruising of the brain tissue [140].
  - It results from blunt trauma [140].
  - A contusion is far more serious than a concussion [141].
  - It involves physical injury to the brain tissue [142].
  - It may cause long-lasting or permanent damage [142].
  - Patients with a brain contusion may show all signs of a brain injury [143].

## 8. Non-Traumatic Brain Injuries

- Brain injuries can also come from medical conditions [144].
- These include blood clots or hemorrhages [144].
- Problems with blood vessels or high blood pressure can cause spontaneous bleeding [144].
- Signs and symptoms of a non-traumatic injury are often the same as traumatic brain injury [145].

## 9. Spinal Injuries: Mechanisms and Findings

- The cervical, thoracic, and lumbar spine can be injured in many ways [146].
- **Compression injuries** can result from a fall [147].
  - This is true regardless of how the patient landed [147].
  - Forces can compress the vertebrae bodies [148].
  - This can cause disc herniation and compression on the spinal cord [148].
  - Fragmentation into the spinal canal is possible [148].
- Motor vehicle crashes can **overextend or hyperflex** the cervical spine [149].
  - This can damage ligaments and joints [149].
- **Rotation flexion injuries** result from rapid acceleration forces [150].
- Any unnatural motion can result in a fracture or neurological deficit [151].
- **Hyperextension** occurs when the spine is pulled along its length [152].
  - This can cause fractures, ligament, and muscle injuries [152].
- When spine bones are altered by trauma, they can fracture or move [153].
  - Permanent damage may occur [154].
- Common findings include **pain and tenderness on palpation** [155].
- Take extra precautions when stabilizing the spine if these injuries are suspected [155].

## 10. Patient Assessment for Head and Spine Injuries

| Step | Focus | Key Actions |
| --- | --- | --- |

| | | |
|---|---|---|
| Recognizing MOI | Identify mechanisms suggestive of head or spinal injury [156] | Suspect injury in motor vehicle collisions (especially motorcycles, snowmobiles, ATVs), pedestrian/vehicle collisions, falls (>20 ft adult, >10 ft pediatric), blunt trauma, penetrating trauma to head/back/torso, rapid deceleration, hangings, axial loading, diving accidents [156] |
| Scene Size-up | Ensure scene safety and identify hazards [157] | Evaluate for hazards [157] Be prepared with standard precautions [157] Call for ALS early in MVC [157] Consider the mechanism of injury to predict likely injuries [158] |
| Primary Assessment | Identify and manage life-threatening concerns [160] | Focus on threats to circulation, airway, and breathing [161] Treat life threats immediately [161] Recognize critical patients quickly [162] Reduce on-scene time for critical patients [162] Increase survival chance or reduce damage for critical patients [162] |

- Always suspect a possible head or spinal cord injury with certain mechanisms of injury [156].
- Mechanisms suggesting injury include:
  - Motor vehicle collisions, especially motorcycles, snowmobiles, and ATVs [156]
  - Pedestrian or motor vehicle collisions [156]
  - Falls greater than 20 feet for adults or 10 feet for pediatrics [156]
  - Blunt trauma [156]
  - Penetrating trauma to the head, back, or torso [157]
  - Rapid deceleration injuries [157]
  - Hangings [157]
  - Axial loading injuries [157]
  - Diving accidents [157]
- During scene size-up, ensure the scene is safe [157].
- Evaluate the scene for hazards to your health, your team, or bystanders [157].
- Use appropriate standard precautions [157].

- Call for advanced life support (ALS) as soon as possible in motor vehicle crashes [157].
- Consider how the mechanism of injury might have produced the expected injuries [158].
- The **primary assessment** focuses on identifying and managing life-threatening concerns [160].
- Threats to circulation, airway, and breathing are life-threatening [161].
- They must be treated immediately [161].
- Reducing on-scene time and recognizing critical patients increases survival chances [162].
- This can also reduce irreversible damage [162].

## 11. Spinal Immobilization Considerations

- Be aware that any unnecessary patient movement can cause additional injuries [163].
- Assess the scene first to determine the risk of injury [164].
- Form a general impression of the patient based on their level of consciousness and chief complaint [164].
- Consider not using spinal restriction if the patient is clear-thinking [165].
  - This is also true if they have no neurological deficits or spinal pain/tenderness [165].
  - Consider this if there is no evidence of intoxication or other conditions masking spinal injury [165].
- The backboard is rigid and can place the patient in an incorrect position [166].
- Circulation to skin areas may be compromised [167].
- Some patients may have respiratory compromise laying flat [167].
- Minimize the time a patient is on a backboard [167].
- Apply a **cervical collar** after assessing airway and breathing [168].
- Provide necessary treatments before applying the collar [168].
- Once the cervical collar is on, do not move it unless it causes problems [169].
  - Problems include difficulty maintaining the airway [169].
  - Signs of increasing ICP are another reason to remove it [169].
- If the device must be removed, maintain manual stabilization of the cervical spine [170].

- Keep manual stabilization until the collar can be replaced [170].

## 12. Assessing for Signs and Symptoms

- Ask the responsive patient specific questions [171].
  - Ask what happened [171].
  - Ask where it hurts [171].
  - Ask if their neck or back hurts [171].
  - Ask if they can move their hands and feet [171].
  - Ask if they hit their head [171].
- Confused or slurred speech can indicate a head injury [171].
- Repetitive questioning or amnesia also suggest head injury in responsive patients [171].
- In trauma, assume a head injury until proven otherwise [172].
- Decreased blood glucose levels can mimic these symptoms [173].
- Patients with a decreased level of responsiveness should be considered to have a spinal cord injury [173].
- This consideration is based on their chief complaint [173].

## 13. Airway, Breathing, and Circulation Management

- If spinal injury is suspected, open and assess the airway [174].
- Manually hold the patient's head still while assessing the airway [175].
- Use the **jaw-thrust maneuver** to open the airway [176].
- If jaw-thrust is ineffective, the head-tilt, chin-lift is a last resort [177].
- Vomiting can occur in patients with a head injury [178].
- Irregular breathing, like Cheyne-Stokes, may result from increased ICP [179].
- Administer **high flow oxygen** to patients with head and spinal injuries [180].
- Pulse oximetry values should ideally be 95 or higher [181].
- They should not fall below 90 [181].
- Avoid hyperventilation (ventilating too fast or with too much force) [182].
- Use hyperventilation only when capnography is available [182].
- Ensure an end tidal CO2 between 30 to 35 during hyperventilation [182].
- A pulse that is too slow in a head injury patient can indicate a serious condition [183].

- A single episode of hypoperfusion can lead to significant brain damage or death [184].
- Assess for signs and symptoms of shock and treat appropriately [184].
- Control bleeding [185].

## 14. Transport Considerations

- The manner of transport is important for trauma patients [186].
- Keep several transport considerations in mind for head trauma patients [187].
- Patients with impaired airways, open head wounds, or abnormal vital signs may need **rapid extrication** [187].
- Patients who do not respond to painful stimuli also need rapid extrication and transport [187].
- Ensuring a patient's airway is paramount [188].
- Providing high flow oxygen is also paramount [188].
- There is a probability of vomiting and seizures [189].
- Suction should be readily available [189].
- A head trauma patient may deteriorate rapidly [190].
- They may require air medical transport [191].
- In supine patients, the head should be elevated 30 degrees if possible [192].
- This helps with ICP [192].
- Remember to maintain immobilization of the spine [193].

## 15. History Taking and Secondary Assessment

- Investigate the chief complaint during history taking [194].
- Obtain a medical history [194].
- Be alert for injury-specific signs and symptoms [194].
- Also look for any pertinent negatives [194].
- If the patient is not responsive, try to get history from other sources [195].
  - These include friends, family members, or medical identification [195].
  - Check cards in wallets [195].
- Make every attempt to get a **SAMPLE history** [196].
- In the secondary assessment, the ability to move extremities or feel sensations does not rule out spinal injury [196].

- Absence of pain also does not necessarily rule out spinal injury [196].
- Instruct the patient to keep still and not move their head or neck [197].
- Perform a physical exam, which can be systematic or focused [198].
- Perform a secondary assessment en route if time permits [199].
- Obtain a complete set of vital signs [200].
- Vital signs are essential in addition to hands-on assessment [200].
- Use monitoring devices to quantify oxygen and circulatory status [201].
- Maintain end tidal CO2 between 35 and 40 [201].
- Maintain an SPO2 above 94 [201].
- Use the **DCAP-BTLS exam** to examine the head, chest, abdomen, extremities, and back [202].
- Check perfusion, motor function, and sensation in all extremities before moving the patient [202].
- A decreased level of consciousness is the most reliable sign of head injury [203].
- Determine if there is decreased movement or numbness/tingling in extremities [203].
- Look for blood or CSF leaking from the ears, mouth, or nose [204].
- Also look for bruising around the eyes or behind the ears [204].
- Assess pupil size and reaction to light [204].
- Continue to monitor the pupils [204].
- Do not probe open scalp lacerations with a gloved finger [205].
  - This may push bone fragments into the brain [205].
- Do not remove an impaled object from an open head injury [205].

## 16. Neurologic and Spine Examination

| Examination Type | Assessment Focus | Techniques / Findings | Score/Scale |
| --- | --- | --- | --- |
| Neurologic Exam | Baseline assessment of consciousness levels [206] | Assess level of consciousness [206] Record fluctuating or deteriorating levels [208] | Glasgow Coma Scale (GCS) [206] Revised Trauma Score |

| | | | |
|---|---|---|---|
| | | | (RTS) if used [207] |
| Spine Exam | Inspect and palpate the spine, assess for impairment [209] | Inspect for DCAP-BTLS [209] Check extremities for circulation [209] Note the level of impairment [209] Palpate for pain or tenderness [210] Look for obvious deformity, numbness, weakness, tingling, soft tissue emergencies [211] Observe for obvious injuries to head/neck suggesting cervical spine injury [212] | None specified |

- Perform a baseline **neurologic examination** using the **Glasgow Coma Scale (GCS)** [206].
- If your jurisdiction uses the Revised Trauma Score (RTS), use GCS findings for RTS [207].
- Record levels of consciousness that fluctuate or deteriorate [208].
- The GCS categories are shown in a table [208].
- Perform a **spine exam** [209].
- Inspect for DCAP-BTLS [209].
- Check the extremities for circulation [209].
- If impairment is present, note the level [209].
- Pain or tenderness on palpation is a warning sign of possible spine injury [210].
- Other signs include obvious deformity [211].
- Numbness, weakness, or tingling of the extremities are also signs [211].
- Soft tissue emergencies in the spinal region may be present [211].
- Obvious injuries to the head or neck may indicate injury to the cervical spine [212].

## 17. Reassessment and Interventions

- Repeat the primary assessment during reassessment [213].
- Reassess signs and symptoms and the chief complaint [213].
- Recheck the patient's interventions [213].

- Reassess the patient's condition at least every five minutes [214].
- Rapid deterioration of neurologic signs after a head injury is a sign of expanding hematoma [215].
- It can also indicate rapidly progressing brain swelling [215].
- If CSF is present, cover the wound with sterile gauze [216].
- This prevents further contamination [216].
- Do not bandage it tightly [216].
- Your protocol should include administering high-flow O2 [217].
- Apply a cervical collar if indicated as part of spinal immobilization [217].
- Reassessment should occur as the patient is transported [218].
- Transport to an appropriate trauma facility [218].

## 18. Communication and Documentation

- Provide complete and detailed information to the destination facility [219].
- Advanced warning helps hospitals prepare for seriously injured patients [220].
- Describe the most serious problems found during assessment [220].
- More seriously injured patients should be documented [221].
- Document their vital signs every five minutes [221].
- For more stable patients, document vital signs every 15 minutes [222].
- You may be asked to testify as a witness [223].
- Be sure to properly document [223].

## 19. Emergency Care for Head Injuries

- There are three general principles for head injury emergency care [225].
- These principles protect and maintain critical functions of the central nervous system [225].
- You need to establish an adequate airway [226].
- Control bleeding [226].
- Provide adequate circulation to maintain cerebral perfusion [226].
- Assess the patient's baseline level of consciousness [227].
- Continuously monitor the level of consciousness [227].
- The most important step is establishing and maintaining an adequate airway [227].

- Once the airway is open, maintain the head and cervical spine in a neutral inline position [228].
- Keep this position until a cervical collar is placed [228].
- Also keep this position until the patient is secured on the backboard [228].
- Remove any foreign body secretions or vomit from the airway [230].
- Check ventilation after clearing the airway [230].
- Give supplemental oxygen to any patient with a suspected head injury [231].
- This is especially important for anyone having trouble breathing [231].
- Use a BVM to assist ventilations if the patient is breathing too slow or shallow [232].
- Placement of an airway device may be necessary [232].
- Consider calling for ALS if the patient's airway is compromised [233].
- Begin CPR if the patient is in cardiac arrest [234].
- Active blood loss can aggravate hypoxia [235].
- Bleeding inside the skull may cause ICP to rise to life-threatening levels [235].
- Bleeding from a scalp laceration can almost always be controlled with direct pressure [237].
- If a skull fracture is suspected, do not apply excessive pressure to the wound [238].
- If a dressing becomes soaked, do not remove it [239].
- Place a second dressing over the first [239].
- Shock is usually due to hypovolemia from bleeding from other injuries [240].
- Transport immediately to a trauma center [240].
- **Cushing's triad** indicates increased intracranial pressure [241].
  - It includes **increased blood pressure (hypertension)** [241].
  - It also includes **decreased heart rate (bradycardia)** [241].
  - Finally, it includes **irregular respirations** [242].
- If Cushing's triad continues, it is fatal [242].
- Manage shock [243].
- Administer oxygen [243].
- Ventilate as necessary [243].
- Avoid hyperventilation [243].

## 20. Emergency Care for Spinal Injuries

- Remember to follow standard precautions [245].
- Maintain the patient's airway while keeping the spine in the proper position [245].
- Assess respirations and give supplemental oxygen if needed [246].
- Manually manage the airway using the **jaw thrust maneuver** [246].
- Consider inserting an OPA [247].
- Have a suction unit available [247].
- Provide supplemental oxygen if needed [247].
- For spinal motion restriction of the cervical spine, immobilize the head and trunk [248].
- This prevents bone fragments from causing further damage [248].
- Even small movements can cause significant injury [249].
- Never force the head into a neutral position [250].
- Do not move the head further if the patient reports certain symptoms [250].
- These symptoms include muscle spasms [250].
- Increased pain, numbness, tingling, or weakness in arms/legs are also reasons not to move the head [250].
- A compromised airway or ventilations also mean not moving the head [250].
- In these situations, stabilize the patient in their current position [250].

## 21. Spinal Immobilization Devices and Techniques

- **Cervical collars** provide preliminary partial support [251].
- They should be applied to every patient with a possible spinal injury [252].
- This is based on mechanism of injury, history, or signs/symptoms [252].
- A rigid cervical collar must be the correct size to be effective [252].
- After manual head/neck stabilization, assess pulse, motor functions, and sensations in all extremities [253].
- Then assess the spinal cord area and neck [253].
- Maintain manual support until the patient is fully secured to the backboard or vacuum mattress [254].
- For supine patients, secure the patient to the **long backboard** [254].
- Procedures to move patients from the ground include a **four-person log roll** [255].

- You may also slide the patient onto the backboard or vacuum mattress [256].
- The **vacuum mattress** is an alternative to the long backboard [257].
- It molds to the body contours, reducing pressure points and providing comfort [257].
- It also provides thermal insulation [258].
- It is excellent for the elderly or patients with abnormal spinal curvature [259].
- Its thickness requires careful movement to maintain C-spine [260].
- It cannot be used for patients over 350 pounds [261].
- It cannot be used on spine sitting or standing patients [261].
- Patients can be moved onto it with a scoop stretcher or log roll [262].
- For sitting patients, use a **short board** or other extrication device [263].
- This restricts movement of the cervical and thoracic spine [263].
- Then secure the short backboard to the long backboard [263].
- Exceptions include dangerous situations requiring immediate access to others [264].
- Another exception is when injuries justify urgent removal [264].
- A standing patient should gently sit down [267].
- Then transfer them to a position where spinal motion restriction can be maintained [267].
- If mechanism or clinical signs suggest spinal injury, establish spinal motion restriction [268].
- Clinical indications include spinal tenderness or pain [269].
- Altered level of consciousness or neurologic deficits are indicators [269].
- Obvious anatomic deformity to the spine or high energy trauma in intoxicated patients are also indicators [269].
- Pain may be missed due to shock or attention on other painful areas [270].
- Assume spinal injury in all patients with a head injury [270].
- This is because manipulating an unstable cervical spine can cause permanent damage [270].
- Use manual inline stabilization or a cervical collar and long backboard [271].
- A **short backboard** is designed to immobilize the head, neck, and torso [274].
- It is used for non-critical seated patients with possible spinal injuries [275].
- **Long backboards** provide full body stabilization [276].
- They are used to immobilize patients found in any position [277].

## 22. Helmet Removal

- A well-fitting helmet should be left on if it prevents head movement [279].
  - This is true if there are no airway or breathing problems [279].
  - It should not interfere with airway/ventilation assessment and treatment [280].
  - You must be able to properly immobilize the spine [280].
- Remove the helmet if it is a full-face helmet [281].
- Remove it if it makes assessing or managing airway problems difficult [281].
- Remove it if removing the face guard is not possible to improve airway access [281].
- Remove it if it prevents proper spine immobilization [281].
- Also remove it if it allows excessive head movement [282].
- Remove the helmet if the patient is in cardiac arrest [282].
- The preferred removal method requires at least **two people** [283].
- The technique depends on the helmet type [284].
- You and your partner should not move at the same time [285].
- Consult medical control about the decision to remove the helmet [285].
- An alternate method allows removal with less force [287].
  - This reduces the likelihood of neck motion [287].
  - The disadvantage is that it is slightly more time consuming [288].
- Steps for the alternate method include removing the chin strap and face mask [289].
- Pop the jaw pads out of place [289].
- Place your finger inside the helmet during removal [289].
- One person controls the head by holding the jaw and occiput [289].
- Insert padding behind the occiput to prevent neck extension [290].
- The person at the chest is responsible for ensuring head and neck do not move [291].
- Small children may need extra padding for inline stabilization [292].

## 23. Review Questions and Conclusion

- Review questions cover key concepts from the chapter [294].

    - The central nervous system parts are cerebrum, cerebellum, brain stem [294].
    - Blood loss from scalp lacerations contributes to hypovolemic shock [296].
    - Immediate loss of consciousness followed by a lucid interval suggests an epidural hematoma [297].
    - A patient struck in the head who was briefly unconscious, has a headache and sees stars, and regained memory has a concussion [298].
    - No memory of events leading up to an accident is retrograde amnesia [300].
    - Memory of the actual event is anterograde amnesia [302].
    - A distraction injury to the cervical spine is likely from a hanging mechanism [303].
    - Manual stabilization of the head must be maintained until a patient with possible spinal injury is fully immobilized [304].
    - For a semi-conscious patient with face and head trauma, blood in the mouth, and snoring sounds, manually stabilize the head, log roll, and suction [305].
    - For an unconscious patient slumped over a steering wheel with head turned and neck flexed, manually stabilize and move into a neutral inline position [308].
    - Do not remove an injured football player's helmet if the face guard can be easily removed and there's no airway compromise [309].
- This concludes the lecture on head and spine injuries [310].