

Problems Affecting Alveolar Function

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Atelectasis;

Atelectasis, which is the term for collapse of alveoli, may occur from both internal or external factors. External causes of atelectasis are those that would prevent adequate chest expansion. Examples of this would be air in the pleural space, fluid in the pleural space, gastric distention and flail chest. These are the most commonly seen causes of atelectasis as a result of chest trauma.

When alveoli are collapsed the blood passing beside it in the pulmonary arteries does not pick up any oxygen with the blood returning to the left heart having a low PO₂. This effect is called SHUNT. If a large number of alveoli are collapsed then a large amount of the pulmonary circulation will return to the heart un-oxygenated leading to arterial hypoxemia. Any patient suspected of having significant atelectasis has significant hypoxemia until proven otherwise and does need oxygen.

1. Rib Fracture:

A simple rib fracture is a common thoracic injury causing the patient to become hypoxic due to pain associated from chest expansion. The pain will cause the patient to breath with shallow respirations and not inflate the lungs leading to progressive atelectasis which will make the patient at risk for developing pneumonia.

Rib fractures are caused by direct blows to the chest and most commonly involve the fifth through ninth ribs which are not protected by the shoulder girdle. Ribs are a ring and often break at more than one point. The principal symptom of rib fracture is localized pain to the site of injury with pain increasing on breathing, movement or coughing. there may be a deformity or bruising over the painful area with involved rib(s) being tender to palpation and possibly unstable. Assess for pneumothorax or hemothorax which can occur if the rib has penetrated the lung.

Treatments for rib fracture includes:

Administering oxygen

Splinting the injury with a hand or pillow and encouraging the patient to take deep breaths. Splinting the injured area can assist in relieving pain thus allowing patient to have deeper inspirations.

Follow SPEMS protocols for respiratory distress and/or major trauma.

2. Flail Chest:

Trauma to the chest may result in several ribs or the sternum or both being fractured leading to an unstable or flail chest. This results in a portion of the chest wall being unsupported and moving in a paradoxical fashion to normal movement. The injured area will expand or bulge out on expiration while collapsing on inspiration. The paradoxical movement may not be visualized at times but can be felt palpating the area. The collapse of the injured segment of the rib cage can lead to collapse and contusion of the lung thus leading to decreased levels of oxygenation of blood or shunting. The flail chest is often associated with pneumothorax indicating one should always check for evidence of a pneumothorax while assessing this patient.

Treatments for flail chest include:

Patent airway

Administer oxygen and assist ventilations with a BVM to prevent atelectasis. When assisting ventilations, observe closely for signs of pneumothorax since positive pressure can worsen a pneumothorax or result in a tension pneumothorax.

Treat tension pneumothorax immediately by decompressing the chest.

Stabilize the flail segment with a pillow or have the patient lay on the injured side if practical.

Monitor the cardiac rhythm as the chest trauma could include myocardial trauma as well.

Spinal Immobilization when needed due to mechanism of injury.

Follow SPEMS protocol(s) for major trauma.

3. Simple Pneumothorax:

A pneumothorax is presence of air within the pleural space. Air may enter the pleural space by a rupture of the lung or a sucking chest wound. Air in the pleural space compresses the lung beneath it, preventing adequate expansion of the lung resulting in atelectasis and shunting.

A simple pneumothorax can occur as a result of trauma causing the surface area of the lung to rupture. A spontaneous pneumothorax frequently is seen in young males who are tall and thin. The patient may complain of sudden sharp chest pain and shortness of breath after exerting themselves, coughing or flying in airplanes. Signs of a simple pneumothorax include decreased or absent breath sounds and hyper-resonance on the side of the collapsed lung. The trachea may also be deviated toward the side of the collapsed lung.

Management of a Simple Pneumothorax include:

Patent airway.

Administer oxygen, transport patient in position of comfort and watch for progressive respiratory distress or worsening of condition.

Be prepared to take aggressive action should patient began to show signs of tension pneumothorax and follow SPEMS protocols for respiratory distress.

4. Tension Pneumothorax

A tension pneumothorax is caused by a hole in the lung that allows air into the pleural cavity. the hole acts as a one way valve and does not allow air to escape. This action allows air pressure to build inside the pleural cavity pushing the mediastinum in the opposite direction. This will be evidenced by trachea deviation away from the affected area. Pressure on the opposite lung will squeeze that lung and compromise ventilation in that lung. The mediastinal cavity also holds the superior and inferior venae cavae and the pressure exerted can kink or compress these vessels which can decrease the blood flow to the right side of the heart. This can decrease the cardiac output and cause blood to back up into the systemic veins. This patient will show extreme dyspnea, restlessness and anxiety. The pulse will be weak and rapid and blood pressure can be low. Jugular vein distension can

be evident due to pressure on vena cava. Breath sounds will be diminished on the affected side with hyperresonance to percussion noted. The affected side can present more expanded than the normal side and moves less with breathing. Subcutaneous emphysema can be present. Severe cases can involve the chest, neck and face giving the patient a bloated appearance.

Tension pneumothorax is an extreme emergency and can lead to death within minutes, rapid assessment and treatment are needed immediately.

Management of Tension Pneumothorax:

Patent airway.

Administer high concentrate oxygen.

Decompress the affected chest

Follow SPEMS protocols for respiratory distress and/or major trauma.

5. Sucking Chest Wound

A sucking chest wound (open pneumothorax) is where air is drawn into the lung by negative intrapleural pressure during inhalation. The seriousness of the wound is increased by the size of the hole. Air entering the lungs through the hole rather than normal airway passages will compromise respiratory function. Management of the sucking chest wound is directed at sealing off the hole and supporting vital functions.

Management of Sucking Chest Wound:

Patent airway

Administer oxygen.

Cover the wound with an occlusive dressing. Watch for signs of tension pneumothorax to develop and should they appear lift a corner of the occlusive dressing allowing the air to escape, then reseal the wound.

Follow SPEMS protocol for respiratory distress and/or major trauma.

6. Hemothorax:

Hemothorax is the presence of blood in the pleural cavity. This often accompanies traumatic pneumothorax. Blood or fluid in the lungs prevent the lung from expanding, large amounts of blood in the lungs

leads to atelectasis. A small hemothorax < 300 ml of blood may cause minor symptoms and may not be detected in the field. Larger amounts of blood accumulating in the pleural space will lead to dyspnea due to compression of the lung. Massive hemothorax produces cyanosis, tightness in the chest and distension of the jugular veins. A massive hemothorax can lead to both hypotension from blood loss and compression of the vena cava and heart. The patient will show signs of shock such as pallor, cold and clammy skin, apprehension and a weak and rapid pulse. The trachea may deviate away from the side of the hemothorax with the affected side dull to percussion and absent breath sounds.

Management of Hemothorax:

Patent airway

High concentrate oxygen, assist ventilations if necessary

Follow SPEMS protocols for respiratory distress and major trauma.

Rapid transport

7. Traumatic Asphyxia:

Severe compression injuries to the chest can result in traumatic asphyxia. Impacting a steering wheel or similar type trauma can result in fractures of the ribs and sternum. The forcing of the sternum inward can exert sudden pressure on the heart with blood from the right side of the heart forced into the veins of the neck. This can lead to bleeding in subcutaneous tissue of the upper chest and neck. Signs of traumatic asphyxia are chest deformity usually with a flail segment, profound shock, cyanosis of the head, neck and shoulders; bloodshot, protruding eyes, swollen tongue and lips and bloody vomiting. Traumatic asphyxia will cause death quickly without proper management and even with good management, mortality rate is high.

Management of Traumatic Asphyxia:

Patent airway- intubate if possible

Administer high concentrate oxygen with bag valve mask.

Spinal immobilization

Follow SPEMS Major trauma protocols

Watch for tension pneumothorax or hemothorax.

Rapid transport

8. Pneumonia (Consolidation):

The alveoli become nonfunctional due to consolidation with pus which occurs in pneumonia. Similar to collapsed or fluid filled alveolus, the alveolus with consolidation does not participate in gas exchange. This again leads to SHUNT with hypoxia becoming a significant problem. Pneumonia is caused by a variety of bacterial, viral or fungal agents. Usually the patient reports several days of weakness, fever, and coughing that can lead to chest pain increased by the coughing. Elderly or chronic diseased patient's are more likely to pneumonia rather than healthy younger populations.

Patient's generally present quite ill. They may be febrile with a cough. Depending on the degree of consolidation he may exhibit moderate to severe respiratory distress. Rales and rhonchi will be evident upon auscultation with areas of the lungs dull to percussion.

Patient may have to be hospitalized for treatment of consolidation. Oxygen therapy is recommended and transport patient in position of comfort.

Management of Pneumonia

Administer oxygen

Follow SPEMS protocols for respiratory distress

9. Near Drowning

Drowning is the third leading cause of accidental death each year in the United States. There are at least 70,000 incidents of near drowning each year. Alcohol intoxication is a factor in almost half or the cases of adult drowning.

Near drowning generally follows the following sequence:

The victim goes underwater with water entering his mouth and nose, he begins to cough and gasp, swallowing considerable amounts of water. A small amount of water is aspirated into the larynx and trachea leading to laryngospasm which will seal off the airway, protecting it from further aspiration. This will cause the same affect as any airway obstruction, asphyxia which in turn causes the patient to lose consciousness. The progressive asphyxia will then cause the laryngeal muscles to relax, allowing the water to enter the lungs in massive quantities.

The pathophysiology of drowning will differ dependent as to the type of water the drowning occurs in. Due to osmosis, fresh water will pass through the alveoli into the bloodstream, diluting the blood, affecting blood chemistry and can lead to cardiac dysrhythmias. Salt water on the other hand will draw fluid across the alveoli causing pulmonary edema. A large amount of fluid could be drawn out into the lungs causing the patient to drown in his own interstitial fluid.

Resuscitation of the drowning victim begins with concern for the medic's own safety. Only qualified swimmers should rescue the patient from water. Upon first reaching patient the first priority should be to establish an airway and initiating ventilations. Always be aware of need for spinal immobilization in drownings. Once patient is removed from the water intubate as soon as possible as patient has a high risk of vomiting and aspiration. A nasogastric tube can be inserted to decompress the stomach. Should patient be in cardiac arrest, follow the appropriate protocol(s).

Management of Near Drowning

Do not enter water if you are not a qualified swimmer.

Patent airway- artificial ventilations as soon as possible.

Follow SPEMS protocols for near drowning.

DO NOT GIVE UP ON A DROWNING VICTIM, especially if patient has been submerged in cold water.

10. Toxic Inhalations:

Fatal burns can occur to the respiratory tract with little or no outward evidence. Inhalation of steam will likely cause thermal injuries to the mucosa of the lungs. Combustion of common products produce toxic elements that may cause interference of proper blood exchange in the alveoli. These causes include upper airway obstruction from edema, bronchospasm and chemical pulmonary edema. Any of these lead to SHUNTING.

Observe for facial burns, visualization of the mouth or throat for internal burns and auscultate for rales and wheezes. Edema of the upper respiratory tract can be a rapid onset with burns necessitating immediate intubation. Monitor any patient that has been involved in a fire or smoke inhalation closely for any change in status of the airway.

Management of Exposure of Toxic Inhalants

Remove victim from exposure environment
Patent airway--Intubate if needed
High Concentrate Oxygen, assist ventilations if needed
Follow SPEMS protocols for respiratory distress and /or burns.

Air exchange in the lungs at the alveoli are critical to life. Atelectasis occurs when the alveoli collapse and are not able to provide the gas exchange needed for life. Whether this is from an internal cause or an external cause the problem requires immediate intervention to prevent the SHUNT effect. All of the preceding situations can lead to SHUNTING. Proper diagnosis and treatment will make a positive difference in your patient's lives.

REFERENCES: Emergency Care In The Streets 3rd Edition by
Nancy L. Caroline, M.D.