Shock

István Lőrincz MD, PhD
Division of Emergency Medicine, Institute of Internal Medicine, University of Debrecen
Shock is a medical emergency in which the organs and tissues of the body are not receiving an adequate flow of blood. This deprives the organs and tissues of oxygen (carried in the blood) and allows the buildup of waste products. Shock can result in serious damage or even death.
Definition

• Inadequate oxygen delivery to meet metabolic demands

• Results in global tissue hypoperfusion and metabolic acidosis

• Shock can occur **WITH A NORMAL BLOOD PRESSURE** and **HYPOTENSION CAN OCCUR WITHOUT SHOCK**
Shock is a clinical condition characterized by failure to adequately perfuse and oxygenate vital organs.

Clinically, shock is recognized by:

- Hypotension
- Altered consciousness and/or fainting
- Poor peripheral perfusion
- Oliguria
- Tachypnoea
Stages of Shock

• **Initial stage** - tissues are under perfused, decreased CO, increased anaerobic metabolism, lactic acid is building

• **Compensatory stage** - Reversible. SNS activated by low CO, attempting to compensate for the decrease tissue perfusion.

• **Progressive stage** - Failing compensatory mechanisms: profound vasoconstriction from the SNS → ISCHEMIA. Lactic acid production is high → metabolic acidosis

• **Irreversible or refractory stage** - Cellular necrosis and Multiple Organ Dysfunction Syndrome may occur → DEATH IS IMMINENT!!!!
Clinically

- Hemorrhage
- Fluid loss
- Myocardial or valvular disease
- Anaphylaxis
- Neurogenic impulses
- Sepsis

- Hypovolemia → Heart failure → Vasodilatation

SYMPTOMS OF SHOCK:
- Severe hypotension
- Cold, clammy skin
- Edema
- Thrombosis
- Hemorrhage
- Somnolence, coma
- Oliguria
- Dyspnea
- GI bleeding

- Cell anoxia → Decreased cardiac output → Hypoperfusion of tissue

- Cytokines (TNF, IL-1)
- Acidosis

- Shock

- Renal failure
- Lung failure (ARDS)
- Gastrointestinal lesions

- Death due to cardiorespiratory failure
- Paralytic ileus
The Shock Cycle

- Shock
- Hypotension
  - ↓ Preload
  - ↓ Intravascular volume
  - ↑ Membrane permeability
  - ↓ Myocardial contractility
  - Cellular hypoxia
  - Anaerobic metabolism

Metabolic by-products:
- lactic acid
- myocardial depressant factor
- endogenous catecholamines
- adenine nucleotides
Categories of Shock

• HYPOVOLEMIC
• CARDIOGENIC
• DISTRIBUTIVE
• OBSTRUCTIVE
## Categories of Shock

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<td>No Change - in neurogenic shock</td>
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- **BaroRc**: Baroreceptor response
- **SVR**: Systemic vascular resistance
Shock syndrome

Cardiogen
- Myogen
- Rhythm disturbances
- Non-cardiac
  - AMI
  - CMP
  - papill. muscl.
  - Myocarditis
  - Toxic myocard
  - pancreatitis
  - Aneurysm ruptzre
  - Sept. rupt
  - TdP
  - VF, VT
  - III. AV
  - PSVT
  - PE
  - Pericardial tamponade
  - Tension PTX
  - Pericarditis

Hypovolemic
- Blood loss
- Plasma
- Fluid
  - External
  - Internal
  - bleeding
  - Dehidration
  - exsiccosis
  - vomitus
  - ileus
  - etc
  - Renal:
  - DM
  - Addison
  - Bakterium
  - Mycosis
  - Virus
  - Endotoxin
  - Burns

Distributive
- Septic
- Neurogen
- Anaphylaxis
  - Drugs
  - Bites, Food
  - Blood-transfusion

Vasoconstriction

Vasodilatation
• **Hypotension** Generally considered to be systolic BP <90mmHg, but values may be higher in young, fit or previously hypertensive pts. Associated tachycardia (>100/min) is common, but may not be present in pts with cardiac or neurological causes or in those taking β-blockers. A few pts with haemorrhagic shock have a paradoxical bradycardia.

• **Altered consciousness and/or fainting** (especially on standing or sitting up) may result from cerebral perfusion.

• **Poor peripheral perfusion** Cool peripheries, clammy/sweaty skin, pallor, capillary return, but note that in the early phase of endotoxic septic shock there may be vasodilatation with warm peripheries.

• **Oliguria** renal perfusion with urine output <50ml/hr.

• **Tachypnoea**.
Management of shock

**Shock Screening Criteria**
- Hypotension: SBP < 90, MAP < 60 and one or more of the following:
  - Anxiety, apathy, agitation, coma or lethargy
  - Cool extremities or skin mottling
  - Respirations ≥ 20 bpm
  - Oliguria < 30 cc/hour
  - Lactic acid > 2.0 or BE ≤ -5 mmol/L
  - Temperature ≤ 36°C

**Exclusion Criteria**
- Trauma as cause of shock
- Acute MI as cause of shock
- Patients who are not candidates for aggressive treatment by advanced directive, or pre-existing diagnosis
- Patients in critical care units already receiving ACLS therapy

**Fluid Bolus**
- 1000 cc for ER patients
- 500 cc for floor patients

**Screening Criteria still met and Exclusion Criteria do not apply**
- CALL SHOCK ALERT
- Notify Primary MD

**Shock team, cart, lab panel, and ICU bed activated**

**Patient In Shock**

**Initiate 600 cc Fluid Increments**
- (2) 16 gauge IV or central line
- Up to 2000 cc per protocol

**Respiratory Support**
- SaO₂ > 92
- Decrease work of breathing
- Early intubation

**Goals:**
- MAP ≥ 70
- Decreased work of breathing
- Improve skin or peripheral perfusion

**Goals Not Met:**
- Continue Fluid Challenge Protocol
- Start Dopamine or Levophed MAP ≤ 70
- Add Dobutamine if MAP > 70

**Rapid Transfer**
- ICU or OR

**Goals not met or Increase in pressor requirement or deteriorating oxygenation**
- Intubate and consider placing PA catheter
- Additional Goals:
  - SvO₂ ≥ 60
  - SaO₂ > 92
  - Transfusen to Hb 10
  - Dobutamine

**Hypovolemic Shock Transfusion and Coag Factor Protocols**
**Septic Shock and Antibiotic Protocols**
**Cardiogenic Shock Protocol**
**Anaphylactic Shock Protocol**
**Shock Screening Criteria**

**Hypotension** SBP<90, MAP<60 and one or more of the following:

- Anxiety, apathy, agitation, coma or lethargy
- Cool extremities or skin mottling

**Normotension** with three or more of the following:

- Respirations > 20 bpm
- Oliguria < 30 cc/hour
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- Trauma as cause of shock
- Acute MI as cause of shock
- Patients who are not candidates for aggressive treatment by advanced directive, or pre-existing diagnosis
- Patients in critical care units already receiving ACLS therapy

---

**Fluid Bolus**

- 1000 cc for ER patients
- 250 cc for floor patients

**Screening Criteria still met and Exclusion Criteria do not apply**

**CALL SHOCK ALERT**

**Notify Primary MD**

**Shock team**

- Cart, lab panel, and ICU bed activated

---

**PATIENT IN SHOCK**

---

**Initiate 500 cc Fluid Increments**

- (2) 16 gauge IV or central line
- Up to 2000 cc per protocol

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Rapid Transfer
ICU or OR

Goals not met or increase in pressor requirement or deteriorating oxygenation
Intubate and consider placing PA catheter

Additional Goals:
- SvO₂ ≥ 60
- SaO₂ ≥ 92
- Transfuse to Hb 10
- Dobutamine
- Cardiac Index
  - ≥ 2.5 (cardiogenic)
  - ≥ 2.7 (hypovolemic)
  - ≥ 3.0 (septic and anaphylactic)

Hypovolemic Shock
Transfusion and Coag Factor Protocols

Septic Shock and Antibiotic Protocols

Cardiogenic Shock Protocol

Anaphylactic Shock Protocol
Traditional classification of types of shock is artificial - mixed aetiologies are common.

**Hypovolaemic shock**
- Blood loss
- Fluid loss/redistribution

**Cardiogenic shock**
- Primary:
- Secondary:

**Distributive shock**
- Septic shock
- Anaphylactic shock
- Neurogenic shock

**Other causes**
These include poisoning and Addison's disease
Classification of shock

Hypovolaemic shock
- Blood loss: trauma, gastrointestinal (GI) bleed (haematemesis, melaena) ruptured abdominal aortic aneurysm, ruptured ectopic pregnancy.
- Fluid loss/redistribution ('third spacing'): burns, GI losses (vomiting, diarrhoea), pancreatitis, sepsis.

Cardiogenic shock
- Primary: myocardial infarction (MI), arrhythmias, valve dysfunction, myocarditis.
- Secondary: cardiac tamponade, massive pulmonary embolus, tension pneumothorax.
Classification of shock

Hypovolaemic shock
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Cardiogenic shock
- **Primary**: myocardial infarction (MI), arrhythmias, valve dysfunction, myocarditis.
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Hypovolaemic shock

Inadequate circulation volume. Causes: **fluid loss; haemorrhage, salt and water loss, sepsis, burns, etc.**

A poor venous return to the heart will decrease the stroke volume and cardiac output. The patient will attempt to compensate by tachycardia and increased systemic vascular resistance (SVR).

Despite normal BP, organs are poorly perfused due to a reduction in blood flow.
Hypovolemic Shock

• **Treatment:**
  - **Oxygen**
  - **Supine position**
  - **Monitors**
  - **IV access**
  - **Fluid replacement**
  - **Pressor support (rarely needed)**
  - **Correct underlying cause**
Hypovolemic Shock

• Fluid replacement:
  • Hypovolemia:
    • Isotonic crystalloids
    • Colloids
  • Hemorrhage:
    • Whole blood
    • Packed RBCs
    • Isotonic Crystalloids
Hypovolemic Shock

- **Caveat:**
  - If shock due to trauma, and bleeding cannot be controlled, give only enough small fluid boluses to maintain radial pulse (SBP ≈ 80 mm Hg).
  - If bleeding can be controlled, control bleeding and administer enough fluid or blood to restore normal blood pressure.
Classification of shock

Hypovolaemic shock
• **Blood loss**: trauma, gastrointestinal (GI) bleed (haematemesis, melaena) ruptured abdominal aortic aneurysm, ruptured ectopic pregnancy.
• **Fluid loss/redistribution** (‘third spacing’): burns, GI losses (vomiting, diarrhoea), pancreatitis, sepsis.

Cardiogenic shock
• **Primary**: myocardial infarction (MI), arrhythmias, valve dysfunction, myocarditis.
• **Secondary**: cardiac tamponade, massive pulmonary embolus, tension pneumothorax.
The patient will have a poor cardiac output and will therefore attempt to maintain a BP by increasing SVR. BP can be low, normal or high, but organ perfusion is compromised, peripheries are cold and the patient is prone to pulmonary oedema. Early ECHOardiography is important to assess contractility, valve function and exclude significant pericardial effusion.
Cardiogenic shock

- Myocardial Dysfunction
  - Systolic
  - Diastolic

- Cardiac output ↓
- Stroke Volume ↓
- Hypotension
- Systemic perfusion ↓
- Coronary perfusion pressure ↓
- Compensatory vasoconstriction; fluid retention
- LVEDP ↑
- Pulmonary congestion
- Hypoxemia
- Ischemia
- Progressive Myocardial Dysfunction
- Death
Cardiogenic Shock

**Treatment:**

- **Oxygen**
- **Monitors**
- **Nitrates (if possible)**
- **Morphine or fentanyl**
- **Pressor support** (dopamine or dobutamine)
- **If no pulmonary edema, consider small fluid boluses**
- **IABP**
- **Definitive therapy** (fibrinolytic therapy, PTCA, CABG, ventricular assist device, cardiac transplant)
Management of cardiogenic shock
Management of cardiogenic shock
DISTRIBUTIVE SHOCK

Septic shock: More common at the extremes of age, in pts with DM, renal/hepatic failure and the immunocompromised (HIV infect., malignancy, post-splenectomy, steroid th.). Note that fever, rigors and white cell count (WCC) may not be present. Organisms responsible include Gram +ve and -ve, especially Staph. Aureus, Strep. pneumoniae, N meningitidis, coliforms including enterococci and Bacteroides (especially in pts with intra-abdominal emergencies, such as ruptured diverticular abscess). In the immunocompromised, Pseudomonas, viruses, and fungi may cause septic shock.

Anaphylactic shock:

Neurogenic shock:

Other: These include poisoning (p.183) and Addison's disease.
Classification of shock

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Anaphylactic shock:

Neurogenic shock:

Other: These include poisoning (p.183) and Addison's disease.
Peripheral vasodilatation and subsequent maldistribution of blood flow. This leads to a relative hypovolaemia. (There is more space in which to put the same volume of fluid).

Common examples of this type being septic, anaphylactic and neurogenic shock.
Septic Shock

• **Treatment:**
  - Airway and ventilatory management
  - Oxygenation
  - IV fluids (crystalloids)
  - Pressor support (dopamine, norepinephrine)
  - Empiric antibiotics
  - Removal of source of infection
  - NaHCO$_3$?
  - Steroids?
  - Anti-endotoxin antibodies
Anaphylactic Shock

**Treatment:**

- Airway (have low threshold for early intubation)
- Oxygenation and ventilation
- Epinephrine (IV, IM, Subcutaneously)
- IV Fluids (crystalloids)
- Antihistamines
  - Benadryl, Zantac
- Steroids
- Beta agonists
- Aminophylline
- Pressor support (dopamine, dobutamine or epinephrine)
Adrenal Crisis  Distributive Shock

• **Causes**
  • Autoimmune adrenalitis
  • Adrenal apoplexy = Brain hemorrhage or infarct
  • heparin may predispose

• **Steroids**

  may be lifesaving in the patient who is unresponsive to fluids, inotropic, and vasopressor support. Which one?
Classification of shock

Caused by extra-cardiac obstruction to blood flow. For example, in pulmonary embolism, aortic stenosis, pericardial effusion and tension pneumothorax. As a result of the low CO the pt will be tachycardic and have an ↑ in SVR to compensate. The pt becomes cold and shut down. They may demonstrate raised JVP and venous congestion of the face and body due to the obstruction.
Obstructive Shock

• Causes
  • Cardiac Tamponade
  • Tension Pneumothorax
  • Massive Pulmonary Embolus

• Signs
  • ↓ cardiac output (CO)
  • ↑ PAOP (PCWP)
  • ↑ SVR
DISTRIBUTIVE SHOCK

Septic shock: More common at the extremes of age, in pts with DM, renal/hepatic failure and the immunocompromised (HIV infect., malignancy, post-splenectomy, steroid th.). Note that fever, rigors and ↑ white cell count (WCC) may not be present.

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Anaphylactic shock:

Neurogenic shock:

Other: These include poisoning (p.183) and Addison's disease.
Classification of shock

Neurogenic shock occurs when there is **damage to the spinal cord** and a subsequent loss of the sympathetic tone. Features of this shock are hypotension, bradycardia, warm peripheries, venous pooling and sometimes priapism.

Please note that bradycardia is an important feature of this shock; if hypotension and tachycardia are present, e.g. in an RTA victim, look for other causes of shock like external or internal haemorrhage.
Neurogenic shock

- Interruption in the CNS connections with the periphery (spinal cord injury).
- Form of distributive shock.
Neurogenic shock

- Spinal cord injury
- Spinal anesthetic
Neurogenic shock
Neurogenic Shock

• **Treatment:**
  - ABCDE
  - Fluid resuscitation with crystalloid
  - PA catheter helpful in preventing overhydration.
  - Look for other causes of hypotension
  - Consider vasopressor support with dopamine or dobutamine
  - Transfer patient to regional spine center
# Haemodynamic monitoring

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<th>C.O.</th>
<th>SVR</th>
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Management of shock

**Historical Features**

- Trauma?
- Pregnant?
- Acute abdominal pain?
- Vomiting or Diarrhea?
- Hematochezia or hematemesis?
- Fever? Focus of infection?
- Chest pain?
Management of shock

Investigation and treatment should occur simultaneously.

Get senior help immediately.

- Address the priorities - ABC.
- Give high flow O2 by mask.
- Secure adequate venous access and take blood for FBC, U&E, glucose, liver function tests (LFTs), lactate, coagulation screen, and if appropriate blood cultures.
- Monitor vital signs, including pulse, BP, SpO2, respiratory rate.
- Check ABG.
- Monitor ECG and obtain 12-lead ECG and CXR.
Management of shock

- Insert a urinary catheter and monitor urine output hourly.
- For shock associated with effective circulating blood volume, give IV crystalloid (0.9% saline) 20ML/kg as bolus, Give further IV fluids including colloid ± blood (aim for haematocrit (Hct) >30%) according to aetiology and clinical response (and in particular, pulse, BP, central venous pressure (CVP), and urine output). Use caution with IV fluid infusion in shock related to cardiogenic causes, and in ruptured or dissecting aortic aneurysm.
Management of shock

- Look for, and treat specifically, the cause(s) of the shock. Echocardiography, USS, CT, and/or surgical intervention may be required.

Specific treatments include:

**Laparotomy:** ruptured abdominal aortic aneurysm, splenic and/or liver trauma, ruptured ectopic pregnancy, intra-abdominal sepsis.

**Thrombolysis/angioplasty:** MI.

**Thrombolysis:** PE.

**Pericardiocentesis/cardiac surgery:** cardiac tamponade, aortic valve dysfunction.

**Antidotes:** for certain poisons.
Management of shock

**Antibiotics:** sepsis. The choice of antibiotic will depend upon the perceived cause and local policies (eg. ceftriaxone for meningococcal disease). Where there is no obvious source, empirical combination therapy is advised (eg. co-amoxiclav + gentamicin + metronidazole). Obtain specialist microbiological advice early, especially in neutropaenic / immunocompromised patients.

- **Inotropic and vasoactive therapy**, assisted ventilation, and invasive monitoring (including arterial and CVP lines) are often needed as part of goal directed therapy. Get specialist ICU help early.
Management of shock

Shock and/or MAP < 60 mm Hg

Airway
- Δ mental status
- Intubation and mechanical ventilation
  - Hypovolemic shock
    - 2 (14-16 g) IV’s or cordis/central line
    - Elevate legs
    - 2-3 liters NS over 10-20 min
    - PRBC if bleeding
    - Continue NS/PRBC until shock resolves
    - Surgical consult if bleeding
    - Maintenance fluids
  - Septic shock
    - 2-3 liters NS over 10-30 min Persistent shock?
    - No
    - Maintenance fluids
    - Dopa to MAP > 60
    - Levo if refractory
    - ADH if refractory to Levo and consider “stress-dose” steroids even if ACTH stim is normal
    - Continue fluid boluses until:
      - shock resolves or
      - ↑CVP, S3, rales, and ↓PO2, then insert RHC
  - Obstructive shock
    - Specific Rx:
      - PE - thrombolysis if not contraindicated
      - Pneumothorax – chest tube
      - Tamponade – pericardial tap
      - Constriction – pericardial stripping
    - Maintenance fluids
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    - Continue fluid boluses until:
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      - If persistent shock, consider IABP and cardiac catheterization

Circulation
- IV, arterial access, Foley catheter, EKG, NG tube
- Stratify based on Diagnostic Algorithm for Hypotension
  - Respiratory distress, hypoxemia, ↑ PCO2
  - Intubation and mechanical ventilation
  - Right ventricular MI
  - See Acute myocardial infarction
    - Maintenance fluids
    - Consider RHC to optimize CO with fluids**
    - Dobutamine
    - What is the systolic BP?
    - < 70
      - Levo
      - Dopa + Dobut
    - 70-100
      - Dobut + NTG or NTP
    - >100 (mm DBP)
      - Levo
      - Dopa + Dobut
      - Dobut + NTG or NTP

Breathing
- Intubation and mechanical ventilation
Management of shock

Shock and/or MAP < 60 mm Hg

- Airway
  - Δ mental status
    - Intubation and mechanical ventilation

- Circulation
  - IV, arterial access, Foley catheter, EKG, NG tube
  - Stratify based on Diagnostic Algorithm for Hypotension

- Breathing
  - Respiratory distress, hypoxemia, ↑ PCO2
  - Intubation and mechanical ventilation

- Hypovolemic shock
- Septic shock
- Obstructive shock
- Right ventricular MI
- Cardiogenic shock
Management of shock

Hypovolemic shock
- 2 (14-16 g) IV's or cordis/central line
- Elevate legs
- 2-3 liters NS over 10-20 min
- PRBC if bleeding
  - Continue NS/PRBC until shock resolves
  - Surgical consult if bleeding
  - Maintenance fluids

Septic shock
- 2-3 liters NS over 10-30 min
- Persistent shock?
  - No
  - Yes

Obstructive shock
- 200 – 500 ml NS over 10-20 min
- Persistent shock?
  - Yes
  - No

Right ventricular MI
- See Acute myocardial infarction
- 1-2 liters NS / 20 min
- Persistent shock?
  - No
  - Yes

Cardiogenic shock
- If no CHF present:
  - 100-500 ml NS/10 min

Maintenance fluids

Dopa to MAP > 60
- Levo if refractory
- ADH if refractory to Levo and consider “stress-dose” steroids even if ACTH stim is normal
- Continue fluid boluses until:
  - shock resolves or
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Specific Rx:
- PE- thrombolysis if not contraindicated
- Pneumothorax – chest tube
- Tamponade – pericardial tap
- Constriction – pericardial stripping

Maintenance fluids

Consider RHC to guide therapy

What is the systolic BP?

If persistent shock, consider IABP and cardiac catheterization

Levo

Dopa + Dobut

Dobut + NTG or NTP
# Principles of shock management

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<td>Optimise fluid</td>
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<tr>
<td>Replace Hb, if low</td>
</tr>
<tr>
<td>Use vasopressors to improve BP e.g. septic shock</td>
</tr>
<tr>
<td>Use inotrope to improve contractility if required e.g. dobutamine for cardiogenic shock</td>
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<td>Adrenaline is a vasopressor/inotrope and can be used if cause of shock is unknown</td>
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<td>Vasodilators are also used to reduce afterload and offload the heart in cardiogenic shock</td>
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<tr>
<td>Reduce oxygen demand</td>
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<td>Call for HELP sooner rather than later if you are unsure</td>
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<td>Adhere to your local ICU policy for inotrope/vasopressor dilutions</td>
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THANK YOU!