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تبييض محاضرة

Shock



اللهم مددنا مع عندك إلى أوليائنا المستضعفين،
تلقيهم وتؤيهم وتداويهم وتحفظهم
وتنصرهم.



Done by :

الطب والجراحة
لجنة

Shock

ABORAJOOH EMAD AREF
MD, GENERAL SURGERY
GI AND MINIMALLY INVASIVE
SURGERY
IMRCS
JB AND AB1



Outline

- Definitions
- Types of Shock
- Resuscitation
- Management principles

Shock

- Circulatory failure leading to inadequate perfusion and delivery of oxygen to vital organs
- Blood Pressure is often used as an indirect estimator of tissue perfusion
- Oxygen delivery is an interaction of Cardiac Output, Blood Volume, Systemic Vascular Resistance

* pre shock state :
فریب جوانی -
young age
decompensation -
hypertension

not must to have
hypotension with shock
↓
عین نتیجہ مع
normal BP

Shock volume x HR
Vaso constriction (تنگی) ⇒ end stage of all type of shock
Vaso dilatation
Vaso constriction ⇒ 20%
Vaso dilatation ⇒ 20%
Vaso dilatation ⇒ only stage of septic shock

Hypotension

In Adults:

- systolic BP ≤ 90 mm Hg \Rightarrow hypotension
- mean arterial pressure ≤ 60 mm Hg
- \downarrow systolic BP > 40 mm Hg from the patient's baseline pressure

* اذا بزيه النقصان اكثر
فمن (2) عن baseline تبع
pt بنحكي انه hypotension

Ex: Pt في Baseline قيمه 160
اذا وصل 120 بنحكي انه hypo
ما بنحكي ليومل او 90

Pathophysiology (2)

- ATP production fails, the Na^+/K^+ pump fails resulting in the inability to correct the cell electronic potential.
- Cell swelling occurs leading to rupture and death.
- Oxidative Phosphorylation stops & anaerobic metabolism begins leading to lactic acid production.

Pathophysiology



Acidosis results from the accumulation of acid when during anaerobic metabolism the creation of ATP from ADP is slowed.

H^+ shift extracellularly and a metabolic acidosis develops

metabolism \rightarrow Aerobic: 38 ATP
 \rightarrow Anaerobic: 2 ATP
 \Rightarrow lead to acidosis (H^+)

\rightarrow Little

- O₂ Delivery** - volume of gaseous O₂ delivered to the LV/min.
- O₂ Consumption** - volume of gaseous O₂ which is actually used by the tissue/min.
- O₂ Demand** - volume of O₂ actually needed by the tissues to function in an aerobic manner

كم يحتاج O₂
لاستعمل
aerobic meta.

Demand $>$ consumption = anaerobic metabolism
 \downarrow
Low energy + H^+

Mixed Venous Oxygenation

→ to document shock state

- Used as a main marker of end organ perfusion and oxygen delivery
- True mixed venous is drawn from the pulmonary artery (mixing of venous blood from upper and lower body)
- Often sample will be drawn from central venous catheter (superior vena cava, R atrium)

central venous line (central vein)
 ① internal jugular MC
 ② subclavian (high risk for bleeding + pneumothorax)
 ③ femoral (ass. with infection)

Mixed Venous Oxygenation

- Normal oxygen saturation of venous blood 68% – 77%
- Low $S_{CV}O_2$** → mixed venous oxygenation
 - Tissues are extracting far more oxygen than usual, reflecting sub-optimal tissue perfusion (and oxygenation)
- Following trends of $S_{CV}O_2$ to guide resuscitation (fluids, RBC, inotropes, vasopressors)

shock state + inadequate resuscitation

→ mixed venous oxygenation

inotropic → increases contractility
 chronotropic → increase heart rate

Physiologic Determinants

- Global tissue perfusion is determined by:
- Cardiac output (CO)
 - CO = **Heart rate (HR)** times **Stroke Volume (SV)**
 - SV = function of **Preload, Afterload, Contractility**
- Systemic vascular resistance (SVR) → depend on preload
 - Variables: **Length, Inverse of Diameter, Viscosity**

* preload → venous return
 * Afterload → sys. vascular resistance

Cardiac Index Example

PATIENT A

- 60 yo male
- 50 kg
- CO = 4.0 L/min
- BSA = 1.86

CI = 2.2 L/min/m²

PATIENT B

- 60 yo male
- 150 kg
- CO = 4.0 L/min
- BSA = 2.64

CI = 1.5 L/min/m²

CO is the same

Body surface area

[مثلاً BSA أقل فالـ CI أقل]

Resuscitation Goals

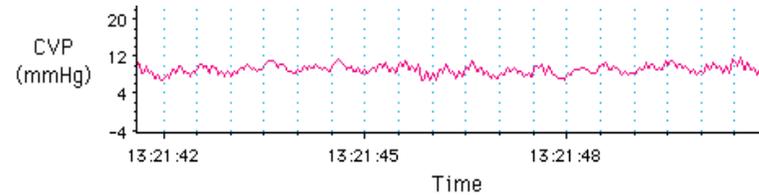
ملاحظه
صفحه 1

- CI = 4.5 L/min/m²
- Oxygen Delivery (DO₂I) = 600 mL/min/m²**
 - < 400 is bad sign
- Oxygen Consumption (VO₂I) = 170 mL/min/m²**
 - If VO₂I < 100 suggest tissues are not getting enough oxygen (نقص الأكسجين + كل dia)
- Maintain a **mean arterial pressure** of 60 (1/3 systolic + 2/3 diastolic)
- Keep O₂ sats > 92%, intubate if necessary

تقل الأكسجين
كل dia
* need for intubation → O₂ / consciousness level
ملاحظة: إذا كان المريض في غيبوبة أو لا يستطيع التنفس بشكل طبيعي، فسيحتاج إلى التنبيب.

CVP

- CVP of SVC at level of right atrium
- pre-load "assessment"
- normal 4 - 10 mm Hg



Pulmonary Artery Catheter

في وحدة العناية المركزة * in specialise center with cardiac surgery

ملاحظة
mixed venous oxygenation

A 5 - lumen Swan Ganz catheter has either an infusion port or a pacing port, allowing insertion of a transvenous pacing wire; usually color coded white.

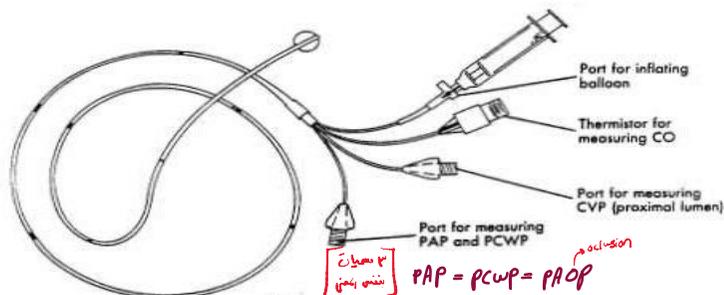
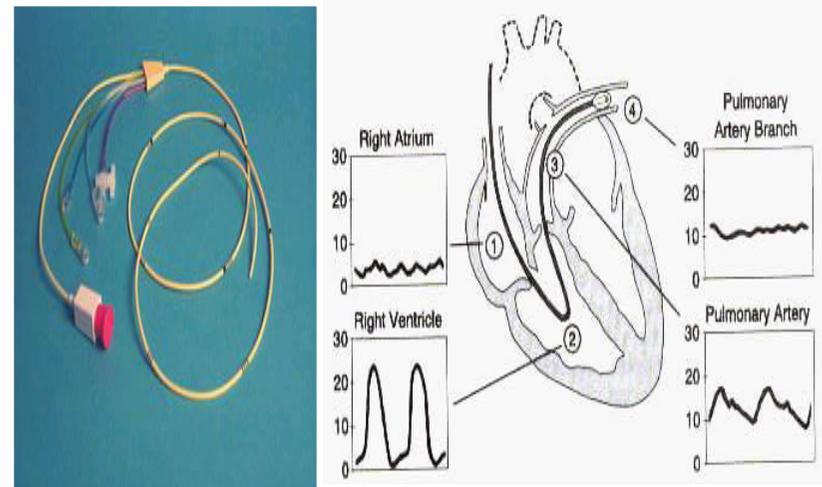
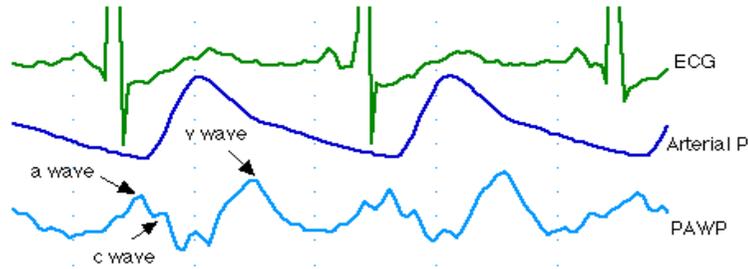


FIGURE 26-16 Four-lumen thermodilution pulmonary artery catheter for measuring cardiac output (CO), central venous pressure (CVP), pulmonary artery pressure (PAP), and pulmonary capillary wedge pressure (PCWP).



Waveform Analysis



- **A wave** - atrial systole
- **C wave** - tricuspid valve closure at ventricular systole
- **V wave** - venous filling of right atrium

Hemodynamic Calculations

$$CI = \frac{\text{Cardiac output (CO)}}{\text{body surface area (BSA)}}$$

Parameter	Normal
Cardiac Index (CI)	2.8 - 4.2
Stroke Volume Index (SVI)	30 - 65
Sys Vasc Resistance Index (SVRI)	1600 - 2400
Left Vent Stroke Work Index (LVSWI)	43 - 62

“SHOCK IS A SYMPTOM OF ITS CAUSE.”

		Pre-load	Pump Fn	After-load	Perfusion	
		PCWP JVP	CO	SVR	O2 Sat	TX
Hypovolemic	- Intravascular vol loss - hemorrhagic - fluid loss	↓	↓	↑	↓	Fluids
Cardiogenic	- Arrhythmia - AMI, valve failure - cardiomyopathy - pericarditis/PE	↑	↓	↑	↓	Dobutamine (5-20mcg/kg/min)
Distributive	Vasodilatory ↓ SVR - septic shock/SIRS/TSS - Anaphylaxis - neurogenic shock - Drug/toxin - Addisonian crisis	↓/-	↑	↓	-/↑	Norepi (neurogenic, septic) Epi (anaphylaxis) Phenyl (neurogenic) Dopamine
Obstructive	- Tension PTX - Tamponade - PE	↑	↓	-/↑	-/↓	Thoracostomy, pericardiocentesis

Types of Shock

- **HYPOVOLEMIC** External Bleeding / سرخوردگی
- **CARDIOGENIC** MI cause → MI / باطنی
- **DISTRIBUTIVE** (vasodilatory shock) / باطنی
septic shock / سرخوردگی
- **OBSTRUCTIVE** mostly it's surgical cause

bleeding in abdomen → in chest, in abdomen
 hypovolemic shock → 80% hypovolemic shock
 bleeding in abdomen → hypovolemic shock
 chest pain → MI, chest pain, hypotension, tachycardia
 abdominal shock → abdominal pain, hypotension, tachycardia
 cardiac exam → chest pain, hypotension, tachycardia
 neuro exam → hypotension, tachycardia
 skin exam → hypotension, tachycardia
 labs → hypotension, tachycardia
 imaging → hypotension, tachycardia

Common Features of Shock

- Hypotension (not an absolute requirement)
 - ◻ SBP < 90 mm Hg, not seen in "preshock"
- Cool skin
 - ◻ Vasoconstrictive mechanisms to redirect blood from periphery to vital organs
 - ◻ Exception is warm skin in early distrib. shock
- Oliguria (↓ kidney perfusion)
- Altered mental status (↓ brain perfusion)
- Metabolic acidosis

التهورين
 1 cc/kg/hour
 50 ← urine
 35 ← 70 urine

Work-up

- History to determine etiology
 - ◻ Bleeding (recent surgery, trauma, GI bleed)
 - ◻ Allergies or prior anaphylaxis
 - ◻ Sx consistent with pancreatitis, EtOH history
 - ◻ Hx of CAD, MI, current chest pain
- Physical examination
 - ◻ Mucous membranes, JVD, lung sounds, cardiac exam, abdomen, rectal (blood), neuro exam, skin (cold or warm)
- Labs/Tests directed toward suspected dx
 - Foot ultrasound

1

Hypovolemic Shock

Reduced circulating blood volume with secondary decreased cardiac output

- Causes
 - ◻ hemorrhage
 - ◻ vomiting
 - ◻ diarrhea
 - ◻ dehydration
 - ◻ third-space loss
 - ◻ burns
 - Signs
 - ◻ ↓ cardiac output
 - ◻ ↓ PAOP → Pulmonary artery occlusion pressure
 - ◻ ↑ SVR ↑ compensation
- burns, intestinal obstruction

Presentation of Hypovolemic Shock

- Hypotensive
- flat neck veins
- clear lungs → overworked / cardiac cause
- cool, cyanotic extremities
- evidence of bleeding?
 - ◻ Anticoagulant use
 - ◻ trauma, bruising
- oliguria

Cardiogenic Shock, intracardiac

- Myocardial Injury or Obstruction to Flow

- Arrhythmias
- valvular lesions
- AMI
- Severe CHF
- VSD
- Hypertrophic Cardiomyopathy

Signs

- ↓ cardiac output
- ↑ PAOP
- ↑ SVR
- ↓ left ventricular stroke work (LVSW)

Cardiogenic Shock, extracardiac (Obstructive)

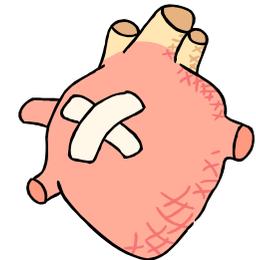
- Pulmonary Embolism → *sample, saddle embolus in trunk* → *hypertension! (obstructive)*
- Cardiac Tamponade → *تجمع سائلي / بطن كبير / Pericardial window*
- Tension Pneumothorax → *تفوق جدي / distended neck vein + mediastinal trachea* / *بطن / chest tube*
- Presentation will be according to underlying disease process.

Treatment

- Improve myocardial function, C.I. < 3.5 is a risk factor
- Catheterization if ongoing ischemia
- Fluids first guided by CVP & PAOP, then cautious pressors
- aortic DIASTOLIC pressures drives coronary perfusion (DBP-PAOP = Coronary Perfusion Pressure) **GOAL** - Coronary PP > 50 mm Hg
- If inotropes and vasopressors fail, intra-aortic balloon pump

Cardiogenic Shock

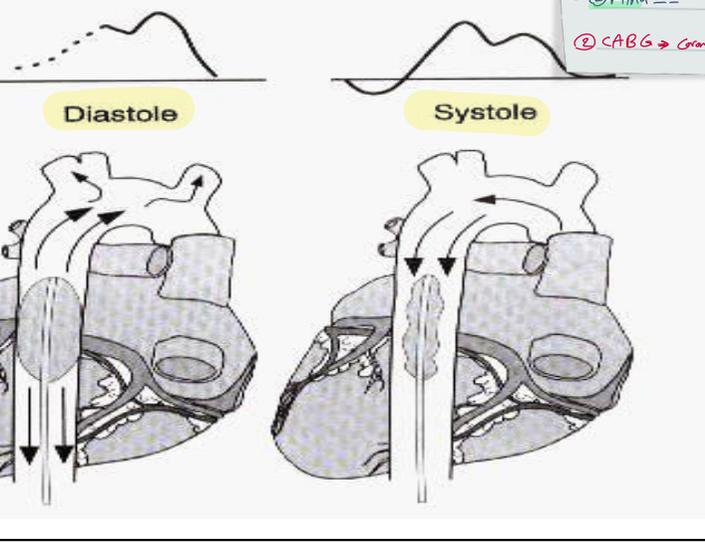
- Preload augmentation** - Consider Fluids
- Contractility**
 - dopamine
 - dobutamine
 - phosphodiesterase inhibitor
- Afterload reduction**
 - nitroglycerin
 - dobutamine



كل ال وسموم جسمي في قلوبنا ليقدرنا انقل

intra aortic balloon pump
 - allows blood to flow more easily into coronary arteries
 - during diastole -> يمنع الدم من ان يتدفق في الشرايين التاجية
 - during systole -> تمنع الدم من ان يتدفق في الشرايين التاجية

Cardiac surgery
 1) ACP -> aortic coronary Bypass
 2) LIMA (left internal mammary artery)
 3) CABG -> Coronary Artery Bypass graft



3 Distributive Shock

- Types
 - Sepsis
 - Anaphylactic
 - Acute adrenal insufficiency
 - Neurogenic
- Signs
 - ± cardiac output
 - ± PAOP
 - ↓ SVR

كل كائن حي يتحرك في ارضه
 immune response of the body (المناعة)
 decrease compliance lung fibrosis
 جزيئات في الدم

Management of Septic Shock

- Early goal directed therapy
- Identification of source of infection
- Broad Spectrum Antibiotics
- IV fluids
- Vasopressors
- Steroids ??
- Recombinant human activated protein C (Xygris)
- Bicarbonate if pH < 7.1

Definitions

- Infection**
 - Inflammatory response to microorganisms, or
 - Invasion of normally sterile tissues
- Systemic Inflammatory Response Syndrome (SIRS)**
 - T >38° C (100.4) or <36° C (96.8)
 - HR >90
 - RR >20 or pCO₂ <32mm Hg
 - WBC >12K or <4K or >10% Bands
- Sepsis**
 - Infection plus
 - ≥2 SIRS criteria
- Severe Sepsis**
 - Sepsis
 - Organ dysfunction
 - Hypoperfusion
 - Lactic acidosis
 - Oliguria
 - Altered mental status
- Septic shock**
 - Severe Sepsis
 - Hypotension despite fluid resuscitation
 - BP <90 or SBP decrease >40 mmHg
 - Inotropic or vasopressor agents
- Multiple Organ Dysfunction Syndrome (MODS)**
 - Altered organ function in an acutely ill patient
 - Homeostasis cannot be maintained without intervention

Bone RC et al. Chest. 1992;101:1644-55.

سوفيا
سوفيا score
اقيمت

- Systemic Inflammatory Response Syndrome (SIRS)
 - T >38°C (100.4) or <36°C (96.8)
 - HR >90
 - RR >20 or pCO₂ <32mm Hg
 - WBC >12K or <4K or >10% Bands

Table 1. Sequential Organ Failure Assessment Score

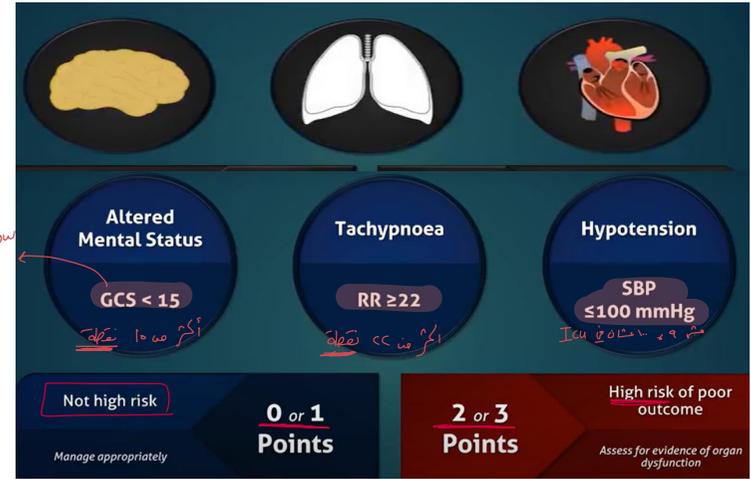
Variables	SOFA Score				
	0	1	2	3	4
Respiratory	PaO ₂ /FIO ₂ > 400 SpO ₂ /FIO ₂ > 302	PaO ₂ /FIO ₂ < 400 SpO ₂ /FIO ₂ < 302	PaO ₂ /FIO ₂ < 300 SpO ₂ /FIO ₂ < 221	PaO ₂ /FIO ₂ < 200 SpO ₂ /FIO ₂ < 142	PaO ₂ /FIO ₂ < 100 SpO ₂ /FIO ₂ < 67
Cardiovascular (doses in mcg/kg/min)	MAP ≥ 70 mm Hg	MAP ≥ 70 mm Hg	Dopamine ≤ 5 or ANY dobutamine	Dopamine > 5 Norepinephrine ≤ 0.1 Phenylephrine ≤ 0.8	Dopamine > 15 or Norepinephrine > 0.1 Phenylephrine > 0.8
Liver (bilirubin, mg/dL)	< 1.2	1.2-1.9	2.0-5.9	6.0-11.9	> 12
Renal (creatinine, mg/dL)	< 1.2	1.2-1.9	2.0-3.4	3.5-4.9	> 5.0
Coagulation (platelets x 10 ⁹ /mm ³)	≥ 150	< 150	< 100	< 50	< 20
Neurologic (GCS score)	15	13-14	10-12	6-9	< 6

According to Sepsis-3, a new (or presumed new) increase in SOFA score above baseline in the presence of infection makes the diagnosis of sepsis. Increasing SOFA scores are associated with incremental increases in mortality.

Abbreviations: GCS, Glasgow coma scale; FIO₂, fraction of inspired oxygen; MAP, mean arterial pressure; PaO₂, arterial oxygen pressure; SOFA, sequential organ failure assessment (score); SpO₂, oxygen saturation.

من صلاحيه
المرام

three ⊕ in sofa score



Glasgow
Coma
score

Steroid Use in Sepsis

- Refractory shock 200-300 mg/day of hydrocortisone in divided doses for 7 days
- ACTH test
- Once septic shock resolves, taper dose
- Add fludrocortisone 50 µg po q day

Sepsis → you have to treat the source

- Fluids
 - Correct the cause
 - Antibiotics
 - Debridement
- Vasopressors
 - Phenylephrine
 - Levophed

Main step to treat sepsis

• necrotizing fasciitis
• wafel gangrene

broad spectrum
ABs
+ culture

لا نعلم ما لطيف بعض ABs
عندنا لكن سوف نكتب

NA we have also depend to broad spectrum ABs
department 2. 2. 2.

EX → Penicillin + rifampin

ملاحظة: لا ننسى
العدوى الفطرية
في المرضى الذين
يستخدمون
المضادات الحيوية
الواسعة النطاق

Adrenal Crisis

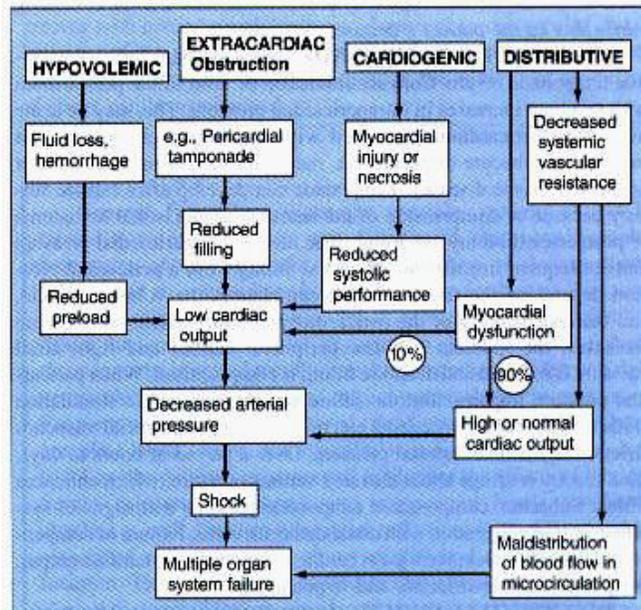
Distributive Shock

- **Causes**
 - Autoimmune adrenalitis
 - Adrenal apoplexy = B hemorrhage or infarct
 - heparin may predispose
- Steroids may be lifesaving in the patient who is unresponsive to fluids, inotropic, and vasopressor support.

Summary

Type	PAOP	C.O.	SVR
HYPOVOLEMIC	↓	↓	↑
CARDIOGENIC	↑	↓	↑
DISTRIBUTIVE	↓ or N	varies	↓
OBSTRUCTIVE	↑	↓	↑

س
شفت
عجان



köszönöm תודה! děkuji
 mahalo 고맙습니다
 thank you
 merci 谢谢 danke
 Ευχαριστώ شكرا
 どうもありがとう gracias

|| Vasopressors

- Assure adequate fluid volume
- Administer via CVL
- Do not use dopamine for renal protection
- Requires arterial line placement
- Vasopressin:
 - Refractory shock
 - Infusion rate 0.01 – 0.04 Units/min

|| Vasopressor Agents?

- Augments contractility, after preload established, thus improving cardiac output.
- Risk tachycardia and increased myocardial oxygen consumption if used too soon
- increased C.I. improves global perfusion

|| Vasopressors & Inotropic Agents

- Dopamine
- Norepinephrine
- Dobutamine
- Epinephrine
- Amrinone

|| Dopamine

- Low dose (0.5 - 2 $\mu\text{g}/\text{kg}/\text{min}$) = dopaminergic
- Moderate dose (3-10 $\mu\text{g}/\text{kg}/\text{min}$) = β -effects
- High dose (> 10 $\mu\text{g}/\text{kg}/\text{min}$) = α -effects
- SIDE EFFECTS
 - tachycardia
 - > 20 $\mu\text{g}/\text{kg}/\text{min}$ Δ to norepinephrine

|| Dobutamine

- β -agonist
- 5 - 20 $\mu\text{g}/\text{kg}/\text{min}$
- potent inotrope, variable chronotrope
- caution in hypotension (inadequate volume) may precipitate tachycardia or worsen hypotension

|| Norepinephrine

- Potent α -adrenergic vasopressor
- Some β -adrenergic, inotropic, chronotropic
- Dose 1 - 100 $\mu\text{g}/\text{min}$
- Unproven effect with low-dose dopamine to protect renal and mesenteric flow.

|| Epinephrine

- α - and β -adrenergic effects
- potent inotrope and chronotrope
- dose 1 - 10 $\mu\text{g}/\text{min}$
- increases myocardial oxygen consumption particularly in coronary heart disease

|| Amrinone

- Phosphodiesterase inhibitor, positive inotropic and vasodilatory effects
- increased cardiac stroke output without an increase in cardiac stroke work
- most often added with dobutamine as a second agent
- load dose = 0.75 -1.5 mg/kg \rightarrow 5 - 10 $\mu\text{g}/\text{kg}/\text{min}$ drip
- main side-effect - thrombocytopenia

Archives

38. All of the following decrease in hypovolemic shock except:

SVR

12. The best fluid replacement in case of class III hypovolemic shock is:

- a. Normal saline 0.9%
- b. Lactated Ringer
- c. **Blood and blood products**
- d. Glucose saline 0.9%
- e. Hypertonic saline 3%

2) A 30 year old male patient diagnosed to have obstructive shock one is false

Select one:

- a. Increased afterload.
- b. Decreased cardiac output.
- c. Increased pulmonary capillary pressure.
- d. Increased jugular venous pressure
- e. **Increased preload.**

15) When a patient is seen with stab wound of the neck that has injured the left vertebral artery. The most frequent clinical finding is:

- a. Hemiparesis.
- b. Hemiplegia.
- c. **Hemorrhagic shock.**
- d. Monocular blindness.
- e. Stable hematoma.

1. Three days after a myocardial infarction with cardiogenic shock, a 75-year-old man develops abdominal pain and distension. The abdomen is slightly tender with reduced bowel sounds. A plain abdominal X-ray shows distended small bowel without fluid levels. Blood tests reveal a metabolic acidosis. The most likely diagnosis is:

- a. perforated peptic ulcer
- b. **mesenteric ischaemia**
- c. pseudo-obstruction of the colon
- d. acute pancreatitis
- e. diverticulitis

55) not types of distributive shock :

- a. **Cardiac tamponade**

56) All are types of distributive shock except:

- a. **Tension pneumothorax**

Q12) The estimated blood loss in class III hypovolemic shock is:

- a. **1500-2000 cc blood.**
- b. 15-30% of total blood volume.
- c. More than 40% of total blood volume.
- d. 750-1500 cc blood.
- e. Less than 15% of total blood volume.

Q71) The most common source of gram-negative infection in a patient with septic shock is the:

- a. Biliary tract.
- b. Tracheobronchial tree.
- c. Small bowel.
- d. Colon.
- e. **Urinary tract??**

Q87) The anaphylactic shock is characterized by the following signs except:

- a. Hyperventilation.
- b. Hypotension.
- c. Tachycardia.
- d. **Pale cold extremities.**
- e. Oliguria.

1. The estimated blood loss in class II hypovolemic shock is :

- a. **750 - 1500 ml**
- b. 1500 – 2000 ml
- c. More than 3000 ml
- d. Less than 750 ml
- e. 2000- 3000 ml

Q100) When a patient is seen with stab wound of the neck that has injured the left vertebral artery. The most frequent clinical finding is:

- a. Hemiparesis.
- b. Hemiplegia.
- c. **Hemorrhagic shock.**
- d. Monocular blindness.
- e. Stable hematoma.

21. Shock is best described as :

- a. **Inadequate tissue perfusion to vital organs**
- b. **Inadequate tissue perfusion and oxygen delivery to vital organs**
- c. Systolic blood pressure less than 90 mmHg
- d. Mean arterial pressure less than 60 mmHg
- e. Central venous pressure less than 8 mmHg

65. Blood loss of 1000 ml can cause which class of hypovolemic shock:

- a. Class I
- b. **Class II**
- c. Class III
- d. Class IV
- e. Class V

44. Patient with history of bleeding per rectum ب اجی signs of shock:

- Resuscitation, draw blood for cross match, colonoscopy

100. about causes of cardiogenic shock

57. All of the following are true about shock intrauma patient except:-

- A. Any patient who is cool and tachycardic is in shock until proved otherwise.
- B. Any shocked patient is considered hypovolaemic on the initial examination.
- C. Consider non-haemorrhagic shock in injury above the diaphragm.
- D. Initial normal BP and haematocrite does not exclude shock.
- E. **The initial I.V. fluid administration of choice is Dextran\40**

83. The usual early complications of acute pancreatitis is:

- a. Hyperglycemia
- b. **Hypovolemia Shock**
- c. ARDS
- d. Hypocalcemia
- e. **Renal failure**

34-All of the following are true about shock in trauma patient except:-

- A-Any patient who is cool and tachycardic is in shock until proved otherwise.
- B-Any shocked patient is considered hypovolaemic on the initial examination.
- C-Consider non-haemorrhagic shock in injury above the diaphragm.
- D-Initial normal BP and haematocrite does not exclude shock.
- * **E-The presence of shock in an injured does not demand the immediate presence of a qualified surgeon.**

5-All of the following signs of different classes of shock are correct except :-

- * **A-CLASS I : Tachycardia + Low diastolic pressure.**
- B-CLASS II : Tachycardia + Narrow pulse pressure.
- C-CLASS III : All signs of shock ; Low BP, Tachycardia, High resp rate, Low urinary