



الطب والجراحة لجنة

Shock

dr.Emad Abo Rajoooh

Done by:
Bayan Mahmoud
Rana Khattab
Corrected by:
Haneen Al-azzah

Shock :

Circulatory failure leading to inadequate **for aerobic metabolism** perfusion and delivery of oxygen to vital organs. (**mainly the brain**)

Blood Pressure is often used as an indirect estimator of tissue perfusion .
not must to have hypotension, could happen with normal BP.

Oxygen delivery is an interaction of Cardiac Output, Blood Volume, Systemic Vascular Resistance.

after 4 minutes Irreversible brain damage . Pre Shock Stage : normal pation , then sudden decompensation and hypotension, esp. young age .

Vasoconstriction = lowering temperature expt in early stage of septic shock (warm shock VD.)

Hypotension :

In Adults:

- ☐ systolic BP ≤ 90 mm Hg
- ☐ mean arterial pressure ≤ 60 mm Hg
- ☐ decrease systolic BP > 40 mm Hg from the patient's baseline pressure

decrease blood pressure more than 40 from base line (ex. Baseline is 160 \rightarrow 120 is hypotension.

Pathophysiology :

$\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}_i + \text{H}^+ + \text{Energy}$

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

- 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
- O_2 Delivery- volume of gaseous O_2 delivered to the LV/min.
- O_2 Consumption- volume of gaseous O_2 which is actually used by the tissue/min.
- O_2 Demand- volume of O_2 actually needed by the tissues to function in an aerobic manner

Demand $>$ consumption = anaerobic metabolism **law energy + H^+**

Mixed Venous Oxygenation :

- 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 on three main veins (internal jugular (mc, safe) , Subclavian (bleeding , pnemothorax risk) , femoral (infection risk)

- Normal oxygen saturation of venous blood 68% – 77%
- **Low SCVO₂ mixed venous oxygenation shock state + inadequate resuscitation**
 - Tissues are extracting far more oxygen than usual, reflecting sub-optimal tissue perfusion (and oxygenation)
- Following trends of SCVO₂ to guide resuscitation (fluids, RBC, inotropes, vasopressors)

Physiologic Determinants:

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

Cardiac Index Example : →

vital signs (O₂Sat, Temp. , BP
RR , HR) ****

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

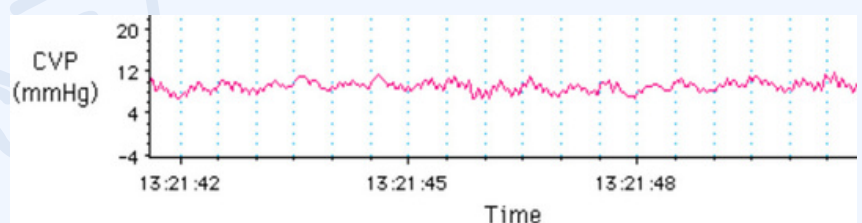
CI = 1.5 L/min/m²

Resuscitation Goals :

- 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
- Maintain a mean arterial pressure of 60 (1/3 systolic + 2/3 diastolic)
- **Keep O₂ sats >92%, intubate if neccesary (need for intubation depend on 1. O₂ (if less than 92 , conscious level)**

CVP :

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



Pulmonary Artery Catheter :

(to measure mixed venous oxygenation)
in special centres
with cardiac surgery
not on ICU

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.

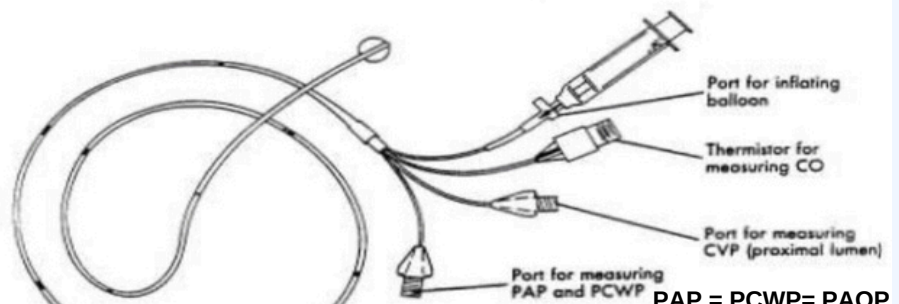
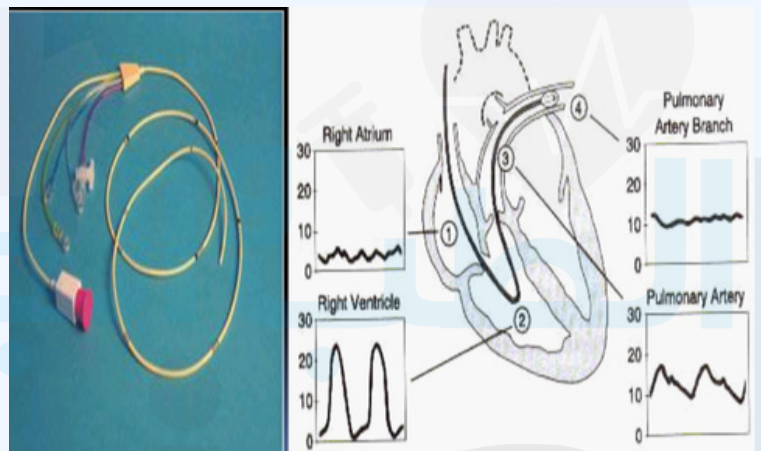
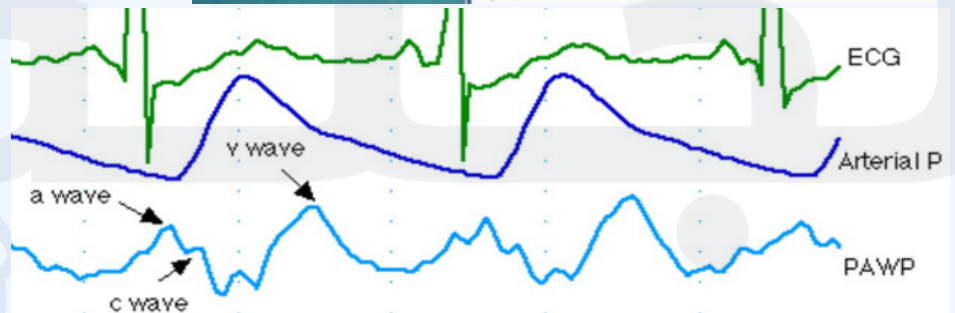


FIGURE 26-16 Four-lumen thermodilution pulmonary artery catheter for measuring cardiac output (CO), central venous pressure (CVP), pulmonary artery pressure (PAP), and pulmonary capillary wedge pressure (PCWP).



Waveform Analysis

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



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

Hemodynamic Calculations

$$CI = CaoP / \text{body surface area}$$

“SHOCK IS A SYMPTOM OF ITS CAUSE”

Types of Shock

- HYPOVOLEMIC (external bleeding) جراحة
- CARDIOGENIC (mc cause MI) باطني
- DISTRIBUTIVE (VD in Septic shock) جراحة + باطني
- OBSTRUCTIVE (mostly sugecal cause)

all types cone with VC. Except Distributive one

Common Features of Shock

- Hypotension (not an absolute requirement) not on all types
 - SBP < 90mm 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)
urine (.5 cc /kg / hour)
- Altered mental status (↓ brain perfusion)
- Metabolic acidosis

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

Hypovolemic Shock

Reduced circulating blood volume with secondary decreased cardiac output

Like : burn , Ints. Obstruction , peritonitis

Causes

- hemorrhage
- vomiting
- diarrhea
- dehydration
- third-space loss
- burns

Signs

- ↓ cardiac output
- ↓ PAOP
- ↑ SVR
- As compensation

Presentation of Hypovolemic Shock

- Hypotensive
- flat neck veins
- clear lungs **non cardiogenic or overloaded causes**
- cool, cyanotic extremities
- evidence of bleeding?
 - ☐ Anticoagulant use
 - ☐ trauma, bruising
- oliguria

neurological Shock: loss of SVR → hypotension

Classes of Hypovolemic Shock

Start as tachycardia and hypotension
 بنعطي RBCs
 Fresh frozen plasma

	Class I	Class II	Class III	Class IV
Blood Loss	< 750	750-1500	1500-2000	> 2000
% Blood Vol.	< 15%	15 – 30%	30 – 40%	> 40%
Pulse	< 100	> 100	> 120	> 140
Blood Pressure	Normal	Normal	Decreased	Decreased
Pulse Pressure	Normal	Decreased	Decreased	Decreased
Resp. Rate	14 – 20	20 – 30	30 – 40	> 40
UOP	> 30	20 – 30	5 – 15	negligible
Mental Status	sl. Anxious	mildly anx	confused	lethargic
Fluid	crystalloid	crystalloid	blood	blood

for trauma patient : crystalloid fluid (LR , NS) .

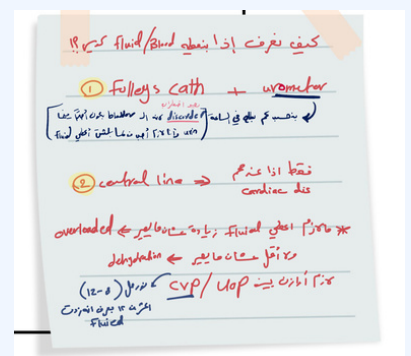
all leads to other as cycle

SHOCK/HYPOVOLEMIA

- FLUIDS... FLUIDS... FLUIDS...
- BLOOD & PRODUCTS TRANSFUSION
- CORRECT
 - ☐ ACIDOSIS
 - ☐ COAGULOPATHY
 - ☐ HYPOTHERMIA

Initial Resuscitation :

- CVP: 8- 12 mm Hg (HF or MI)
- MAP ☐ 65 mm Hg
- UOP ☐ 0.5 cc/kg/hr **monitor by follas catheter.**
 اللي بطلع اول ما نركبها لا يحسب لانه موجو في bladder من قبل
- Mixed venous Oxygen Sat ☐ 70%
- Consider:
 - ☐ Transfusion to Hb ☐ 10
 - ☐ Dobutamine up to 20 ☐ g/kg/min



Treatment

- Reverse hypovolemia vs. hemorrhage control
- Crystalloid vs. Colloid
- Pressors

Cardiogenic Shock, intracardiac

- Myocardial Injury or Obstruction to Flow

Hypovolemic shock treatment:

- **ABCs**
(Airway, Breathing, Circulation) For any sick patient
- **Control any bleeding**
- **Establish 2 large bore IVs¹ or central line**
- **Colloid solution** Contain protein particles that exert oncotic pressure and cause fluid to remain in the intravascular.
- **Crystalloids²**
Normal saline or Lactate Ringers.
For resuscitation and blood is way better than fluids
- **PRBCs³** (Packed RBCs)
O negative or cross matched
(Are red blood cells that have been separated for blood transfusion)
- **Arrange definitive treatment**

falling fown and open fracture
with external wound bleeding

: الضغط /80

Approch ABCDE

tow large pores cannula maybe
grey

tow peripheral lines
crystalloid

if you guss massive transfusions
(free fresh plasma + RBCs +
feeding

we measure : CBC , Urea ,
Electrolytes , blood group ,
creatinine

- 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 **not simple/ saddle embolus in trunk : come hypotension**
- Tx : metalyse (fibrinolytic) .**
- Cardiac Tamponade **fluid accumulation/ trauma/ we do cardiac window**
- Tension Pneumothorax **air in pleural cavity: distended vein / mediastinal and tracheal deviation : we do 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

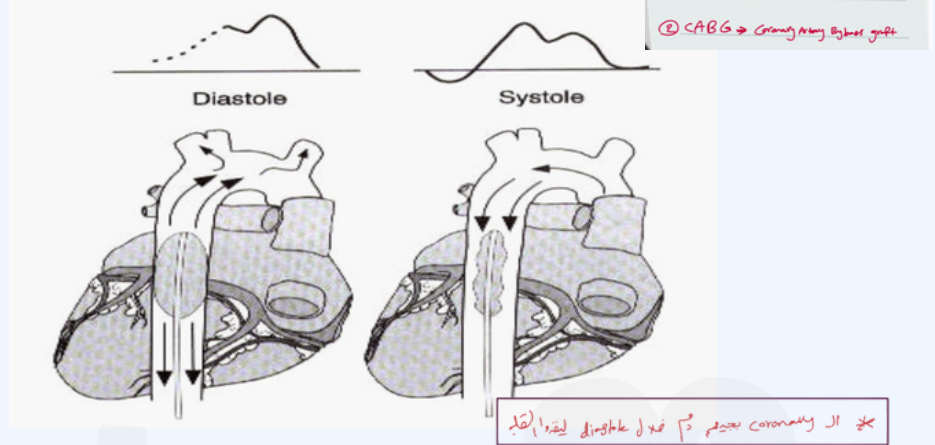
Cardiogenic Shock

- Preload augmentation- Consider Fluids
- Contractility
 - dopamine
 - dobutamine

- phosphodiesterase inhibitor
- Afterload reduction
- nitroglycerin
- dobutamine

Intra-Aortic Balloon Pump

→ used after CABG to increase time and pressure of cardiac perfusion during diastole



Distributive Shock

- Types
 - Sepsis
 - Anaphylactic
 - Acute adrenal insufficiency
 - Neurogenic
- Signs
 - \pm cardiac output
 - \pm PAOP
 - decreased SVR

* intra aortic balloon pump
Therapeutic
allows blood to flow more easily into
coronary arteries [تتمثل الفائدة في زيادة
التي تدفق الدم إلى الشرايين التاجية
من خلال زيادة الضغط في الشرايين التاجية
أثناء الراحة القلبية]

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.

Box 1. SIRS (Systemic Inflammatory Response Syndrome)

Two or more of:

Temperature $>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$

Heart rate $>90/\text{min}$

Respiratory rate $>20/\text{min}$ or $\text{Paco}_2 <32 \text{ mm Hg}$ (4.3 kPa)

White blood cell count $>12\,000/\text{mm}^3$ or $<4000/\text{mm}^3$ or $>10\%$ immature bands

To know the parameters:

RR
coagulation profile
liver
CVS (map)
GCS

parameters اشى ال الدكتور حكا اهم

Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score^a

System	0	1	2	3	4
Respiration					
$\text{Pao}_2/\text{Fio}_2$, mm Hg (kPa)	≥ 400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
Coagulation					
Platelets, $\times 10^3/\mu\text{L}$	≥ 150	<150	<100	<50	<20
Liver					
Bilirubin, mg/dL ($\mu\text{mol/L}$)	<1.2 (20)	1.2-1.9 (20-32)	2.0-5.9 (33-101)	6.0-11.9 (102-204)	>12.0 (204)
Cardiovascular	MAP ≥ 70 mm Hg	MAP <70 mm Hg	Dopamine <5 or dobutamine (any dose) ^b	Dopamine 5.1-15 or epinephrine ≤ 0.1 or norepinephrine ≤ 0.1 ^b	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1 ^b
Central nervous system					
Glasgow Coma Scale score ^c	15	13-14	10-12	6-9	<6
Renal					
Creatinine, mg/dL ($\mu\text{mol/L}$)	<1.2 (110)	1.2-1.9 (110-170)	2.0-3.4 (171-299)	3.5-4.9 (300-440)	>5.0 (440)
Urine output, mL/d				<500	<200

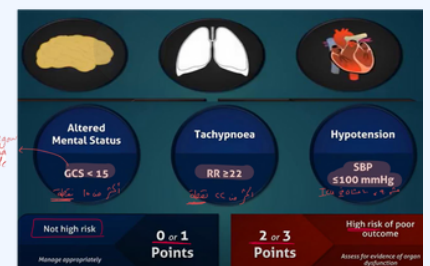
Abbreviations: Fio_2 , fraction of inspired oxygen; MAP, mean arterial pressure; Pao_2 , partial pressure of oxygen.
^a Adapted from Vincent et al.²⁷
^b Catecholamine doses are given as $\mu\text{g/kg/min}$ for at least 1 hour.
^c Glasgow Coma Scale scores range from 3-15; higher score indicates better neurological function.

qSOFA (Quick SOFA) Criteria

For patient in coma

Three + in coma score

- Respiratory rate $\geq 22/\text{min}$
- Altered mentation
- Systolic blood pressure $\leq 100 \text{ mm Hg}$



Terms and Definitions

- Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection.
- Organ dysfunction can be identified as an acute change in total SOFA score ≥ 2 points consequent to the infection.
- Septic shock is a subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality.
- Patients with septic shock can be identified with a clinical construct of sepsis with persisting hypotension requiring vasopressors to maintain MAP $\geq 65 \text{ mm Hg}$ and having a serum lactate level $>2 \text{ mmol/L}$ (18 mg/dL) despite adequate volume resuscitation. With these criteria, hospital mortality is in excess of 40%

Steroid Use in Sepsis

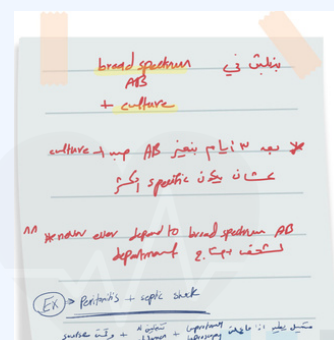
- Refractory shock 200-300 mg/day of hydrocortisone in divided doses for 7 days
- ACTH test
- Once septic shock resolves, taper dose
- Add fludrocortisone 50 µg po q day

Sepsis (You have to treat the source)

- Fluids
- Correct the cause

- Necrotizing fasciitis
- wet gangrene

- Antibiotics
- Debridement
- **Vasopressors**
 - ☐ Phenylephrine
 - ☐ Levophed

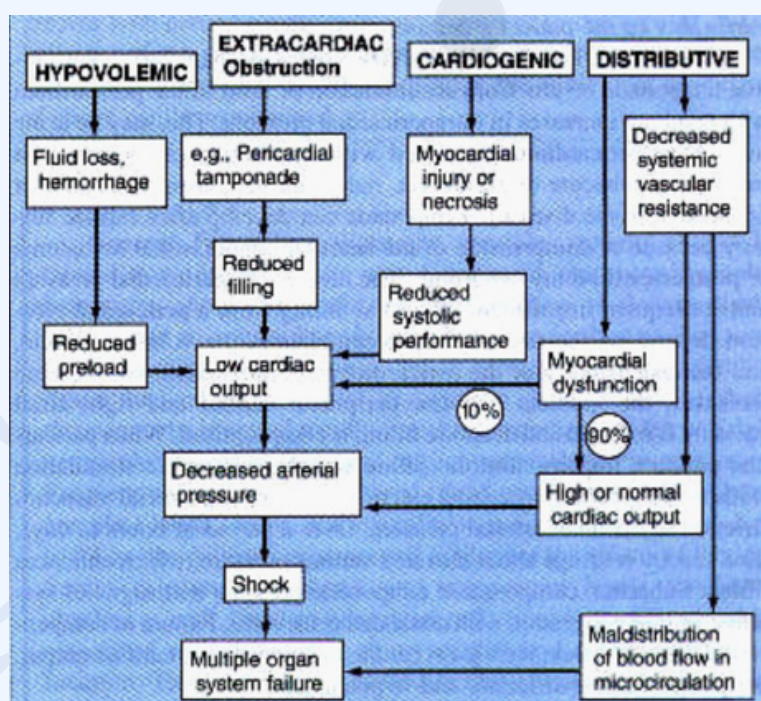


Adrenal Crisis Distributive Shock

- 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	↑	↓	↑



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 $\mu\text{g/kg/min}$) = dopaminergic
- Moderate dose (3-10 $\mu\text{g/kg/min}$) = β -effects
- High dose (> 10 $\mu\text{g/kg/min}$) = α -effects

SIDE EFFECTS

tachycardia

> 20 $\mu\text{g/kg/min}$ Δ to norepinephrine

- β -agonist
- 5 - 20 $\mu\text{g/kg/min}$
- 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

Archive :

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 Output, Deteriorated level of consciousness .
- D-CLASS IV : Mental status is markedly depressed.
- E-More than 50 % Blood loss : Comatose , No BP or pulse.

Answer:A

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 haematocrit does not exclude shock.
- E-bloodThe presence of shock in an injured does not demand the immediate presence of a qualified surgeon.

Answer:E

57.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 haematocrit does not exclude shock.
- E. The initial I.V. fluid administration of choice is Dextran\40

Answer:E

16.The cause of death in established tetanus is:

- A. Septic shock
- B. Heart failure
- C. Renal failure
- D. Respiratory failure
- E. Pulmonary embolism

Answer: D

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.

Answer:E

All of the following decrease in hypovolemic shock except: SVR

patient with severe hypovolemic shock all of the following are common clinical features, EXCEPT:

- A. Tachycardia
- B. Sweating
- C. Hyperpyrexia
- D. Pallor
- E. Hypotension

Answer:C

The most important step in the early management of extensive burns is: (повтор)

- A. Prevention of burn shock by giving i.v. fluids and analgesics

Patient with hemorrhagic shock, the best i.v. solution to be given until blood is at hand is:

- A. G/W 5%
- B. G/W 10%
- C. Ringer's lactate
- D. Albumin
- E. Aminoacid solution

Answer: C

first to be managed in multi-injured patient is:

- A. Shock
- B. Intracranial hematoma
- C. Respiratory problems
- D. Open fracture of long bones
- E. Crushed contaminated wounds

Answer:C

.Patient with cholecystitis admitted to hospital and given IV antibiotic started to have tachypnea and palpitation and marked erythema around the canula Dx:

- A. Anaphylaxis
- B. septic shock

Answer:A

Patient with history of bleeding per rectum: come with of shock

- Resuscitation, draw blood for cross match, colonoscopy

usual early complications of acute pancreatitis is:

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

Answer: B

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

Answer: B