

JULIUSZ JAKUBASZKO

***FLUID THERAPY
IN TRAUMA***

***Chair of Emergency Medicine,
Wroclaw University of Medicine,
Wroclaw, Poland***



**Polskie Towarzystwo
Medycyny Ratunkowej**

**Polish Society for
Emergency Medicine**



Early signs of hemorrhagic shock

- ***Visible blood loss or long- bone fracture***
- ***Anxiety, lethargy, coma***
- ***Pallor, diaphoresis, decreased skin turgor***
- ***Hypotension (with narrowed pulse pressure)***
- ***Tachycardia***
- ***Nonfunctioning pulse oximeter***
- ***Decreased ETCO₂***

Estimation of blood volume deficit in trauma

<i>Unilateral hemothorax</i>	<i>3000 ml</i>
<i>Hemoperitoneum</i>	<i>2000 – 5000 ml</i>
<i>Pelvic fracture</i>	<i>1500 – 2000 ml</i>
<i>Femur fracture</i>	<i>800 – 1200 ml</i>
<i>Tibia fracture</i>	<i>350 – 650 ml</i>
<i>Small fracture sites</i>	<i>100 – 500 ml</i>

Most common regions of bleeding in hemorrhagic shock

<i>Location</i>	<i>Cause</i>	<i>Diagnostic Approach</i>
<i>Chest</i>	<i>Pulmonary injury, Intercostal arteries, Great vessels</i>	<i>physical examination, chest RTG, CT, chest tube output</i>
<i>Abdomen</i>	<i>Solid organ injury, Mesentery</i>	<i>FAST, CT, DPL</i>

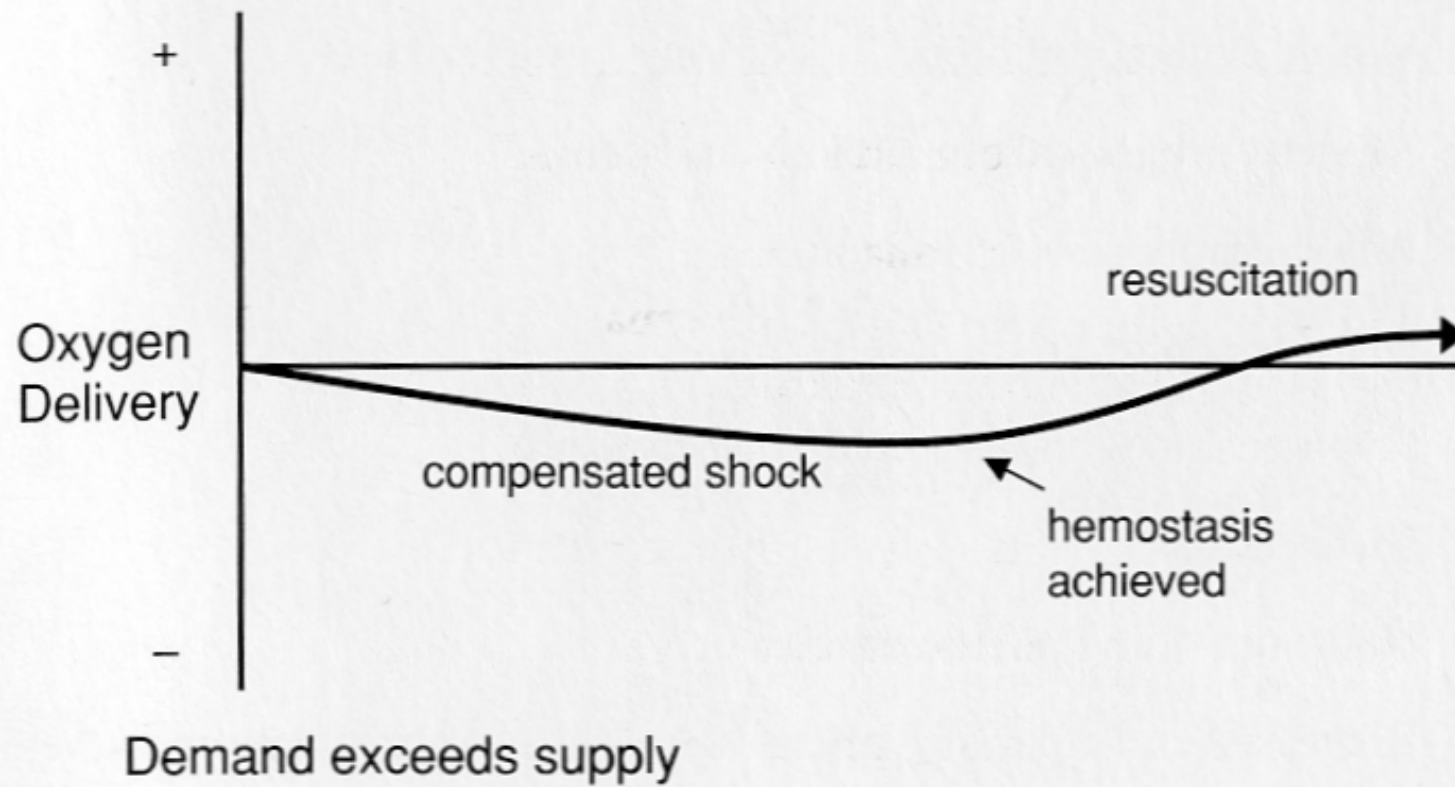
Most common regions of bleeding in hemorrhagic shock

<i>Location</i>	<i>Cause</i>	<i>Diagnostic Approach</i>
<i>Retoperitoneum</i>	<i>Post.pelvic fracture; Renal aortic, vena, Caval injury</i>	<i>pelvic instability, pelvic RTG, CT</i>
<i>Thighs</i>	<i>Femur fracture</i>	<i>physical examin., direct RTG</i>
<i>“The street”</i>	<i>Scalp fracture, Open fracture, Massive soft tissue wounds</i>	<i>physical examin.</i>

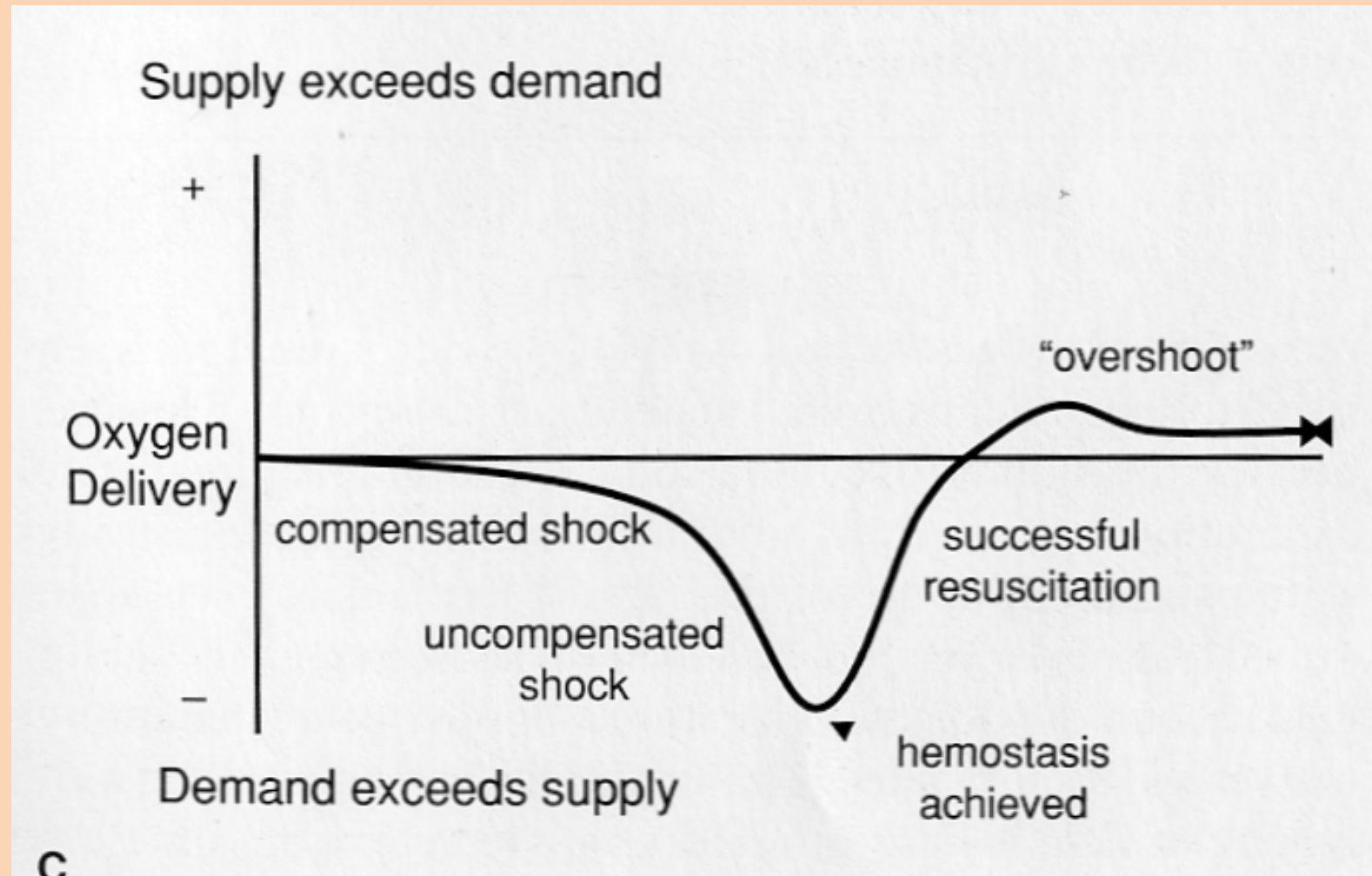
Classification of hypovolemic shock based on response to fluid bolus

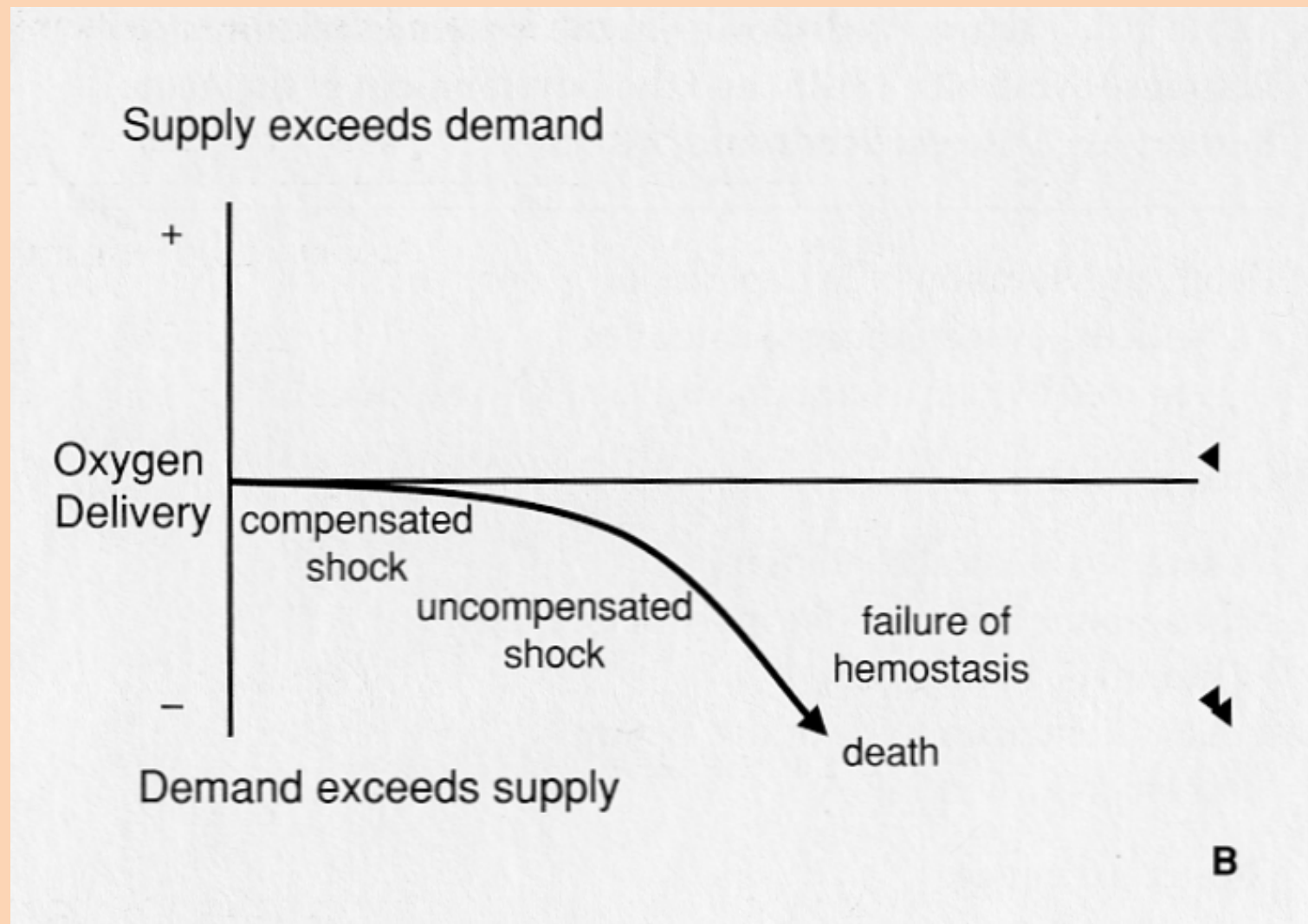
	<i>Response to 500ml crystalloids</i>	<i>Clinical implication</i>
<i>Responder</i>	<i>increased and sustained improvement BP</i>	<i>not actively bleeding, do not require transfusion</i>
<i>Transient responder</i>	<i>increased BP but recurrent hypotension</i>	<i>actively bleeding, consider early transfusion</i>
<i>Nonresponder</i>	<i>no improvement</i>	<i>likely active bleeding, severe hypoperfusion, rule out: - tension pneumothorax, - cardiac tamponade, - spinal cord injury, immediate transfusion (early plasma and platelets)</i>

Supply exceeds demand

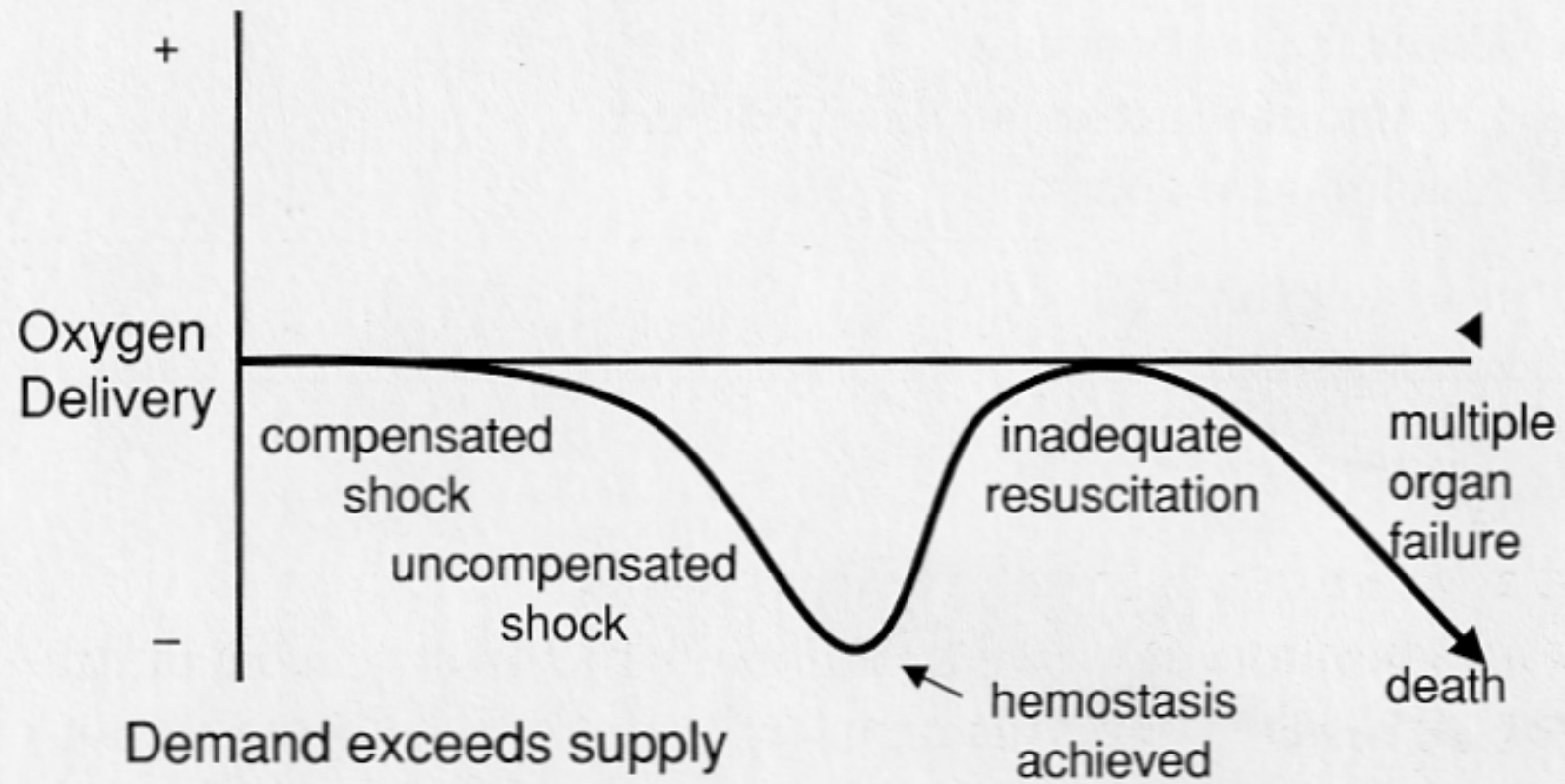


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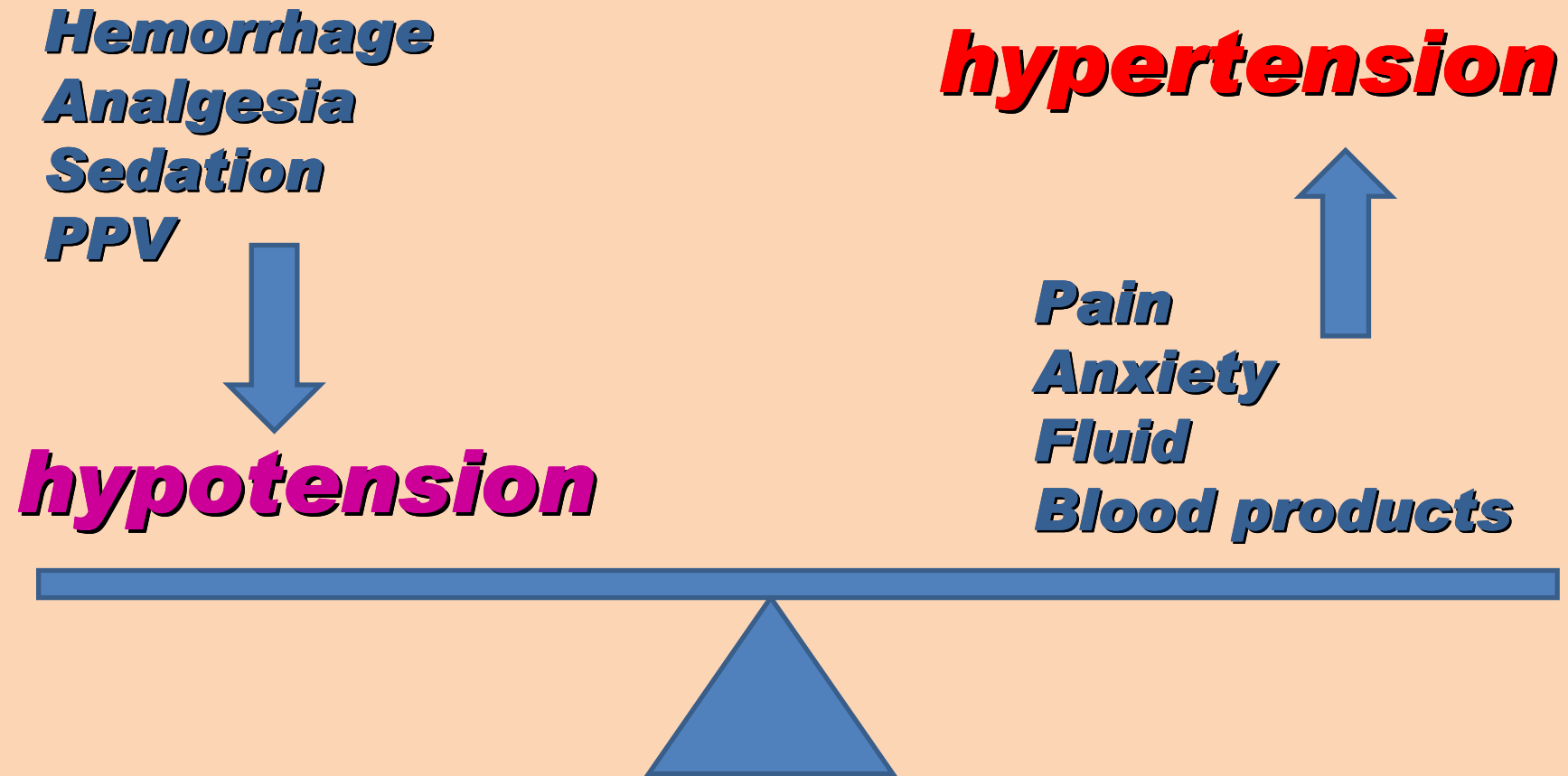


Supply exceeds demand



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Hemodynamic balance in hemorrhagic trauma



Routine Monitoring of Severely Injured

- ***ECG***
- ***CVP (central venous catheter)***
- ***IBP (arterial line)***
- ***Stroke Volume (hemodynamic monitoring)***
- ***Pulse Oximetry***
- ***Capnography***
- ***Central Temperature***
- ***Urine Output***
- ***POC (laboratory studies : ABG, Hgb, Ht, Electrolytes, Coagulation paramet.,serum lactate)***

Future monitoring of hemorrhagic shock

- ***Mixed venous oxygen saturation***
- ***Gastric tonometry (?)***
- ***Sublingual CO₂ concentration***
- ***Infra-red tissue oximetry***

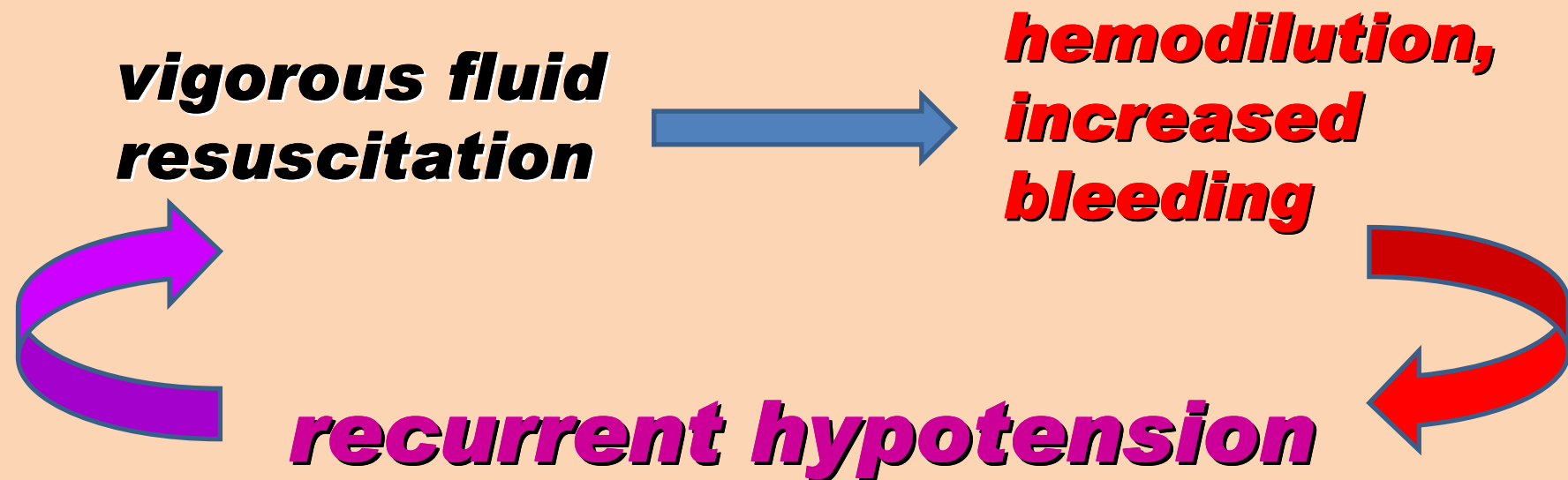
Priority in Trauma Management

- ***restore and maintain
organ perfusion***
- ***restore and maintain
oxygenation above critical level***

best achieved by

- ***stopping the bleeding***
- ***repleting intravascular volume***

Rapid crystalloid infusion in active hemorrhage ?



Immediate fluid resuscitation ?

Disadvantages

- ***Decreased blood viscosity***
- ***Blowout of hemostatic plug***
- ***Dilution of coagulation factors***
- ***Increased blood loss***
- ***Delayed transport to definitive care***

Delayed fluid resuscitation ?

Benefits

- ***Faster transfer to hospital facilities***
- ***Avoidance of recurrent bleeding and hypotension***

Fluid Options for Trauma Hemorrhage

Isotonic Crystalloids

pro

contra

**0,9%
saline**

***compatible
with blood***

***dilutes blood components,
hyperchloremic metabolic
acidosis***

**Lactate
Ringer's**

***physiologic
electrolyte
mix***

***dilutes blood composition,
may clot blood (contains
calcium)***

Fluid Options for Trauma Hemorrhage

Colloids

pro

contra

5% Albumin

***rapid volume
expansion***

***may results endothelial
swelling, no proved
benefit***

***High MW
Hetastarch***

***rapid volume
expansion***

***coagulopathy, platelet
dysfunction***

***Low MW
Hetastarch***

***rapid volume
expansion,
less
coagulopathy***

no proved benefit

Fluid Options for Trauma Hemorrhage

Hypertonic saline

pro

***rapid volume
expansion,
restores
intravascular
volume,
decreases ICP,
improved
outcomes in TBI***

contra

***rapid increase BP
may exacerbate
bleeding, dilutes
blood composition***

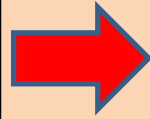
Fluid Options for Trauma Hemorrhage

	<i>pro</i>	<i>contra</i>
<i>Red blood cells</i>	<i>rapid volume expansion, increased oxygen delivery</i>	<i>limited resource, cross-matching requ., viral transmission</i>
<i>Plasma</i>	<i>rapid volume expansion, clotting factor replacement</i>	<i>limited resource, cross-matching requ., viral transmission</i>
<i>Fresh whole blood</i>	<i>rapid volume expansion, increased oxygen delivery, includes factors and platelets,</i>	<i>limited resource, cross-matching requ., long time for viral testing</i>

Donation

**Fresh Whole
Blood
500ml:**

**Hematocrit
45%
Factor activity
100%
Platelets
250,000/mcl**



**RBC:
355ml**

**Hematocrit
55%**

**Plasma:
275ml**

**Factor
activity
80%**

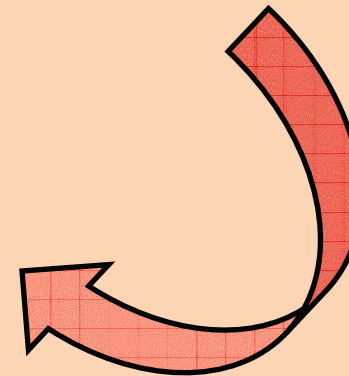
**Platelets:
50ml**

5.5×10^{10}

Transfusion

660ml:

**Hematocrit
29%
Factor activity
65%
Platelets
88,000/mcl**



Fluid Resuscitation Strategy

a s a p

before the point of uncompensated shock

possible immediate

localization and correction source of bleeding

continuous

***support patient's physiology
(not normalization)***

Fluid Resuscitation Strategy

slow crystalloid infusion

controlled hypotension (SBP 90mmHg)

preserve blood composition

as soon as deficits identified:

O neg.RBC, plasma, platelets

Fluid Resuscitation Strategy

actively bleeding transient responder in ED

Fresh Whole Blood

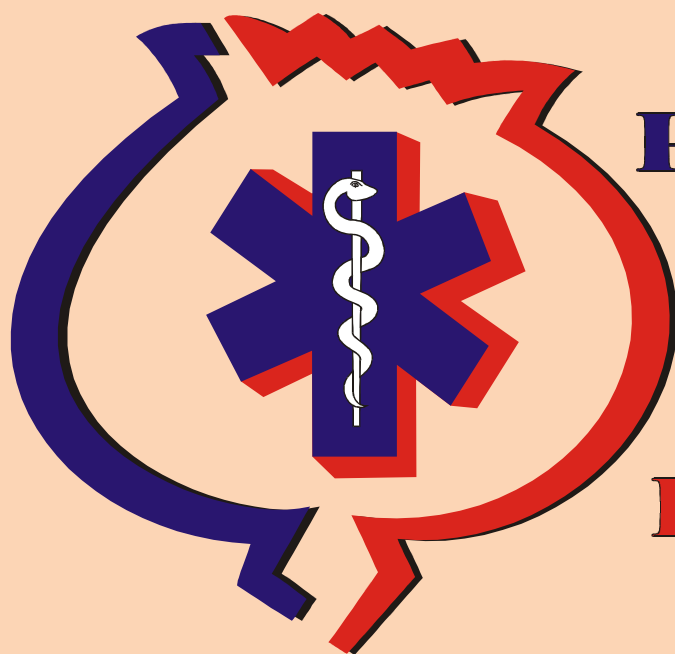
Massive Transfusion Protocol:

- ***red blood cells, thawed fresh plasma, platelet pool***
- ***“jump start” to coagulation : cryoprecipitate, Factor VII a, bicarbonate, calcium***

avoid

hypothermia, hypocalcemia, hyperkalemia, hyperglycemia

The Best Course - RAPID HEMOSTASIS



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Thank you for your attention