ECOCARDIO
CHIRURGIA
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Shock cardiogeno: di cosa stiamo parlando

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Disclosure: none

DEFINITION — Shock is defined as a state of cellular and tissue hypoxia due to reduced oxygen delivery and/or increased oxygen consumption or inadequate oxygen utilization

Primary myocardial dysfunction resulting in the inability of the heart to maintain an adequate cardiac output (CO) with subsequent compromising of metabolic requirements

From: *Civetta et al (eds)* Critical Care

Basal Oxygen Consumption

- 80% of basal O2 consumption in the mitochondrion
- O2 reacts in the mitochondrion providing energy to form ATP
- Cytochrome aa3 has extremely high affinity for O2 (Km 1.5 mmHg)

Basal Oxygen Consumption

- 20% of O2 used extramitochondrial
- Extramitochondrial reactions have relatively low affinity for O2 (Km 10-15 mmHg)
- Relevance of the impairment of extramitochondrial pathways: more sensitive to oxygen deprivation

DEFINITION (1)

- Decreased cardiac output
- Evidence of tissue hypoxia
- Provided that we have an adequate intravascular volume

DEFINITION (2)

- Reduced CI (< 2.2 l/min/ m2)
- Sustained hypotension (BP < 90 mmHG or drop > 30 mmHG for > 30 min)
- WP > 18 mmHg

CARDIOGENIC SHOCK
Clinical Recognition

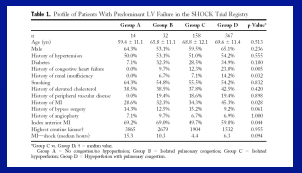


Table 1. Profile of Patients With Predominant LV Failure in the SHOCK Trial Registry

	Group A	Group B	Group C	Group D	p Value*
n	53	52	150	347	
Age (yr)	55.6 ± 11.1	65.8 ± 11.1	68.8 ± 12.1	69.6 ± 13.4	0.312
Male	64.3%	53.1%	59.5%	65.1%	0.236
History of hypertension	50.0%	53.1%	51.0%	54.2%	0.535
Diabetes	7.1%	32.3%	28.5%	34.9%	0.180
History of congestive heart failure	0.0%	9.7%	12.3%	23.8%	0.005
History of renal insufficiency	0.0%	6.7%	7.1%	14.2%	0.032
Smoking	64.3%	54.8%	55.5%	54.2%	0.832
History of elevated cholesterol	38.5%	38.5%	57.9%	42.5%	0.420
History of peripheral vascular disease	0.0%	19.4%	10.6%	15.6%	0.190
History of MI	28.6%	32.3%	34.3%	45.2%	0.028
History of bypass surgery	14.3%	12.5%	15.2%	9.2%	0.061
History of angioplasty	7.1%	9.7%	6.7%	6.9%	1.000
Index anterior MI	69.2%	69.0%	49.7%	59.8%	0.048
Highest creatine kinase†	3865	2679	1804	1532	0.955
MI—shock (median hours)	15.3	10.3	4.4	6.3	0.094

*Group C vs. Group D; † = median value.
Group A = No congestion/no hypoperfusion; Group B = Isolated pulmonary congestion; Group C = Isolated hypoperfusion; Group D = Hypoperfusion with pulmonary congestion.

- In the SHOCK trial: 64% of pts :

- Hypotension;
- Ineffective CO (tachycardia, altered mentation, oliguria , cold periphery)
- Pulmonary congestion

Menon V, et al. J Am Coll Cardiol 2000;36:1071–6.

GUSTO I study: 30 days mortality model importance of subjective signs

- Altered sensorium — Dying OR = 1.68
- Cold Clammy Skin — Dying OR = 1.68
- Oliguria — Dying OR = 2.25

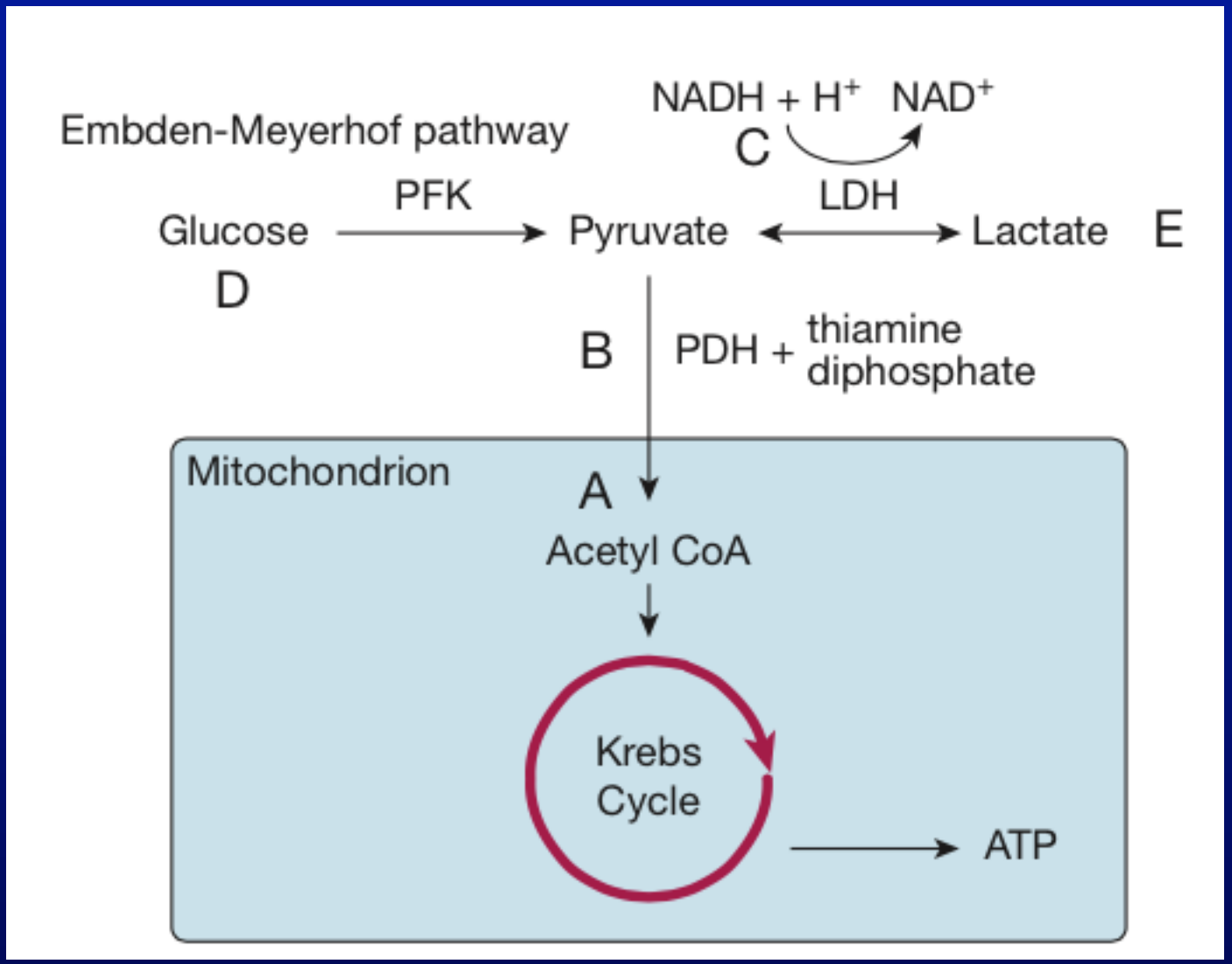
Independently of objective hemodynamics

From Hasdai D, et al. Cardiogenic shock complicating acute myocardial infarction: predictors of death. Am Heart J 1999;138:21–31.

DEFINITION (3)

- Poor tissue perfusion (cold clammy skin, altered sensorium, oligo-anuria)
- Hypotension
- Jugular vein fillings, rales

Lactate ?

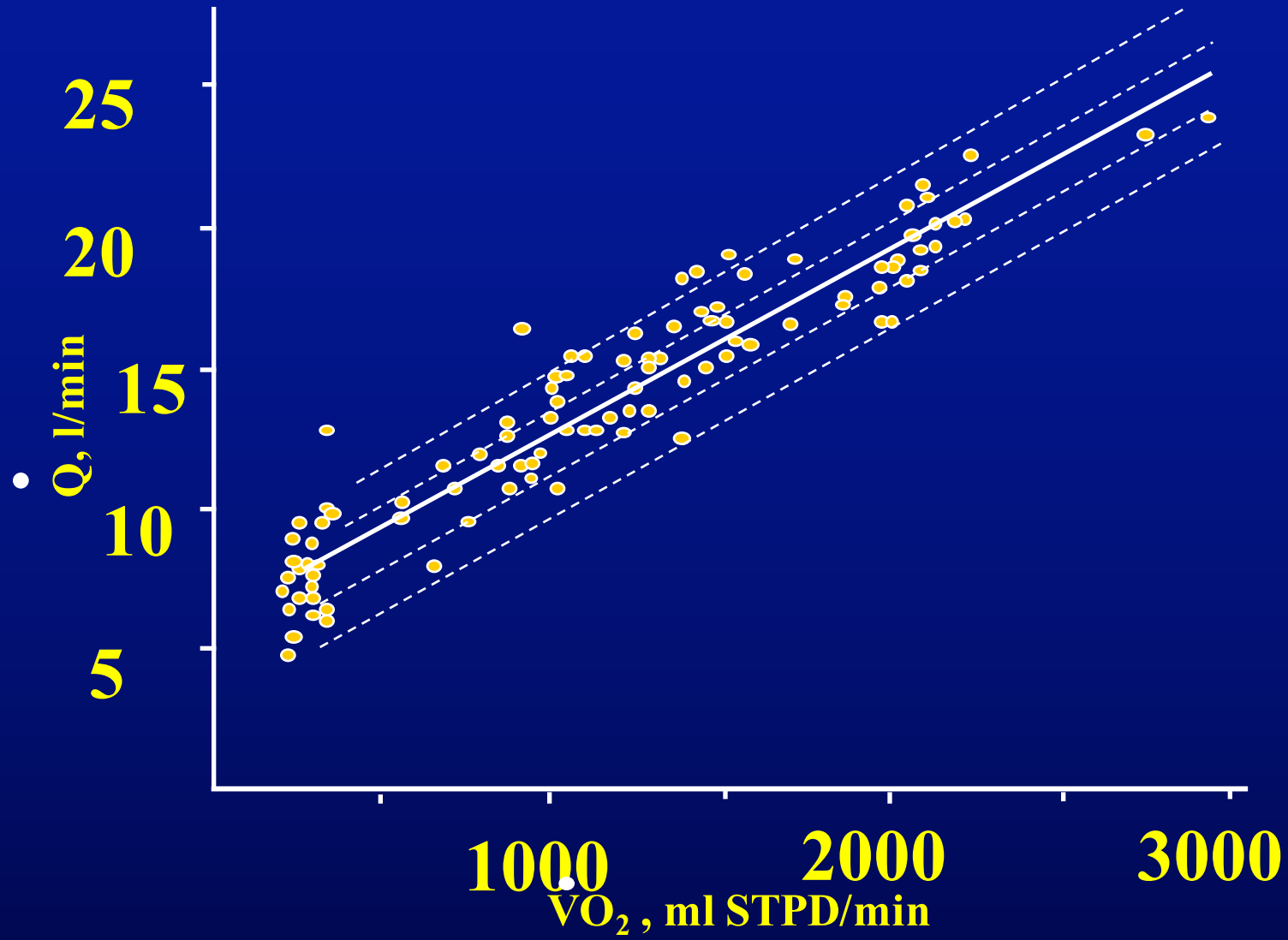

Embden-Meyerhof pathway
NADH + H+ NAD+
C
PFK
LDH
Glucose
Pyruvate
Lactate
E
D
B
PDH + thiamine diphosphate
Mitochondrion
A
Acetyl CoA
Krebs Cycle
ATP

Types and causes of lactic acidosis

Type A

- Due to hypoxia in tissues (most common)
- Hypoxia causes impaired oxidative phosphorylation and decreased ATP synthesis
- To survive, the cells switch to anaerobic glycolysis for ATP synthesis
- This produces lactate as a final product
- The amount of oxygen required to recover from oxygen deficiency is called oxygen debt

Relation between CO and oxygen uptake



Ekelund LG, *Circ res 1967; Suppl 20: 33*

Types and causes of lactic acidosis

- Type A is due to inadequate supply of oxygen to tissues in:
  - Myocardial infarction
  - Pulmonary embolism
  - Uncontrolled hemorrhage
  - Tissue hypoperfusion (shock, cardiac arrest, acute heart failure, etc.)
  - Anaerobic muscular exercise

Types and causes of lactic acidosis

Type B

- Due to disorders in carbohydrate metabolism
  - Congenital lactic acidosis is due to deficiency of pyruvate dehydrogenase enzyme
- Chronic hepatic disease accompanied by shock or bleeding
- Liver failure
- Drug intoxication

B2 (drugs/toxins)

- Biguanides
- Epinephrine, terbutaline, other adrenergic agonists
- Ethanol, methanol, ethylene glycol, propylene glycol
- Propofol
- Nitroprusside, inhaled nitric oxide
- Fructose
- Sorbitol
- Salicylates
- Acetaminophen
- Isoniazid
- Linezolid

Lactate clearance (Attanà Acute card Care 2012)

Lower 10% in 12 hrs =higher mortality

Main Cause

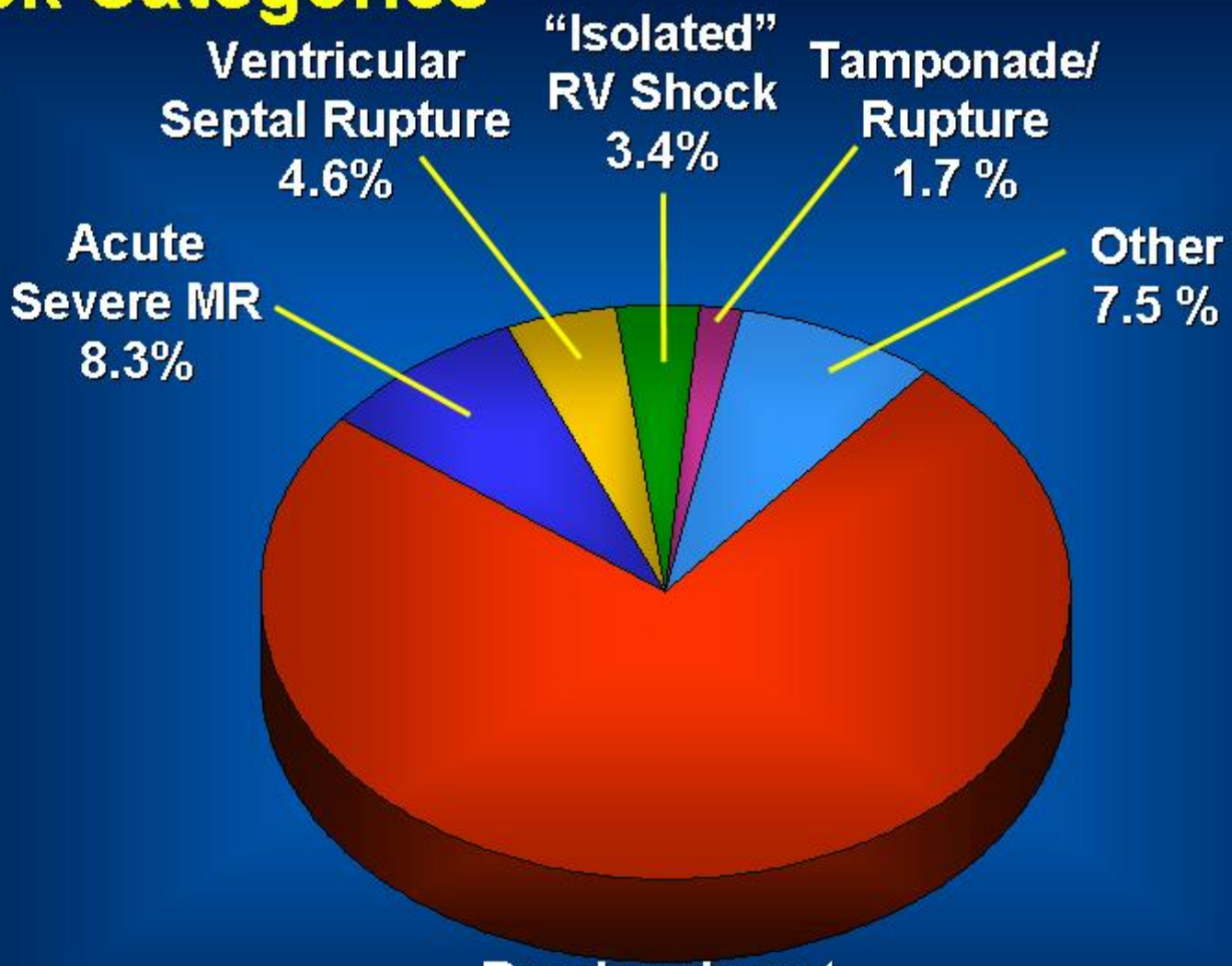
- Myocardial Infarction (MI)

Cardiogenic Shock Complicates 4.2-7.2 % of the MIs

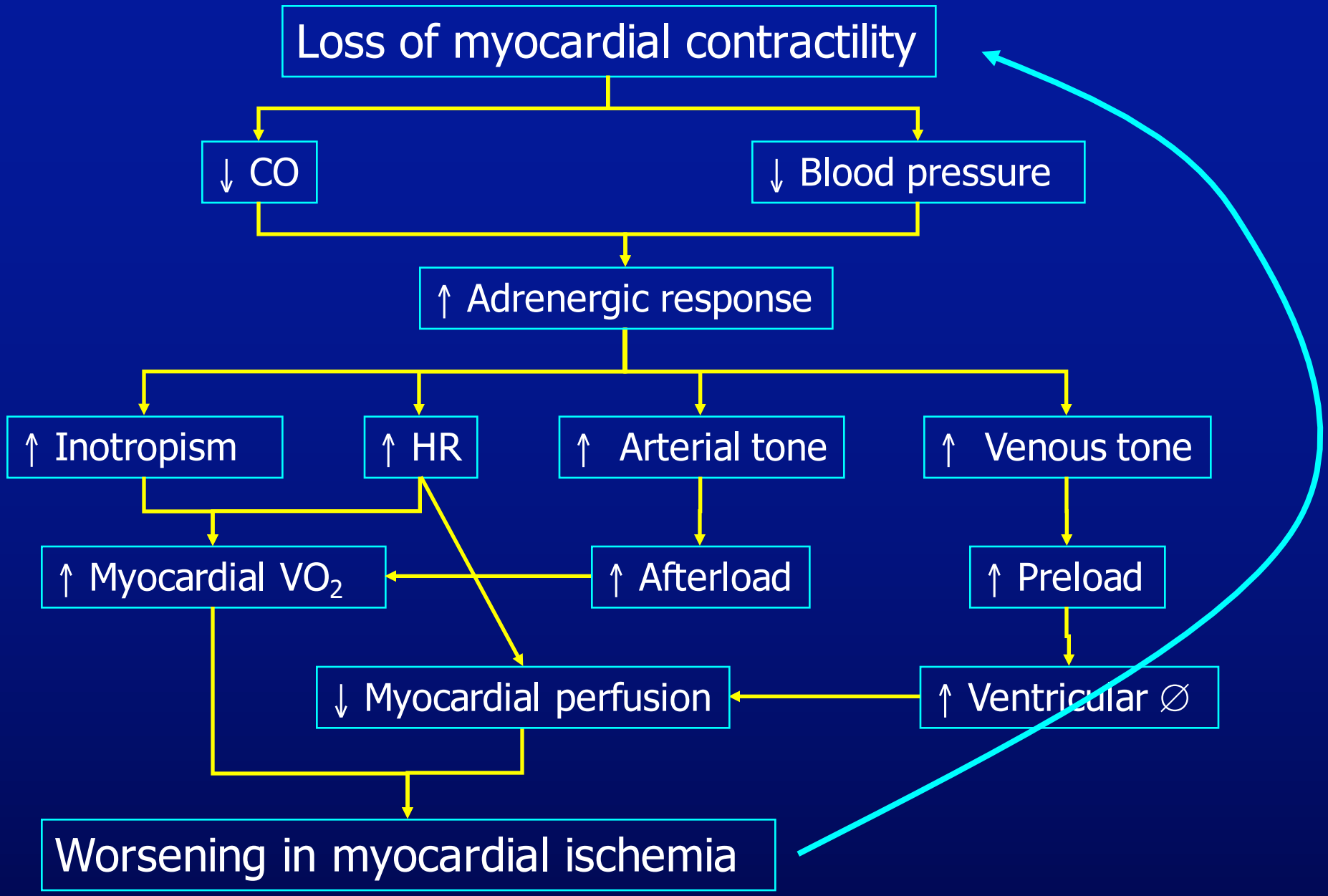
Leading cause of death (mortality rate ≈ 50%)

Usually develops for losses of tissue mass greater than 40 %

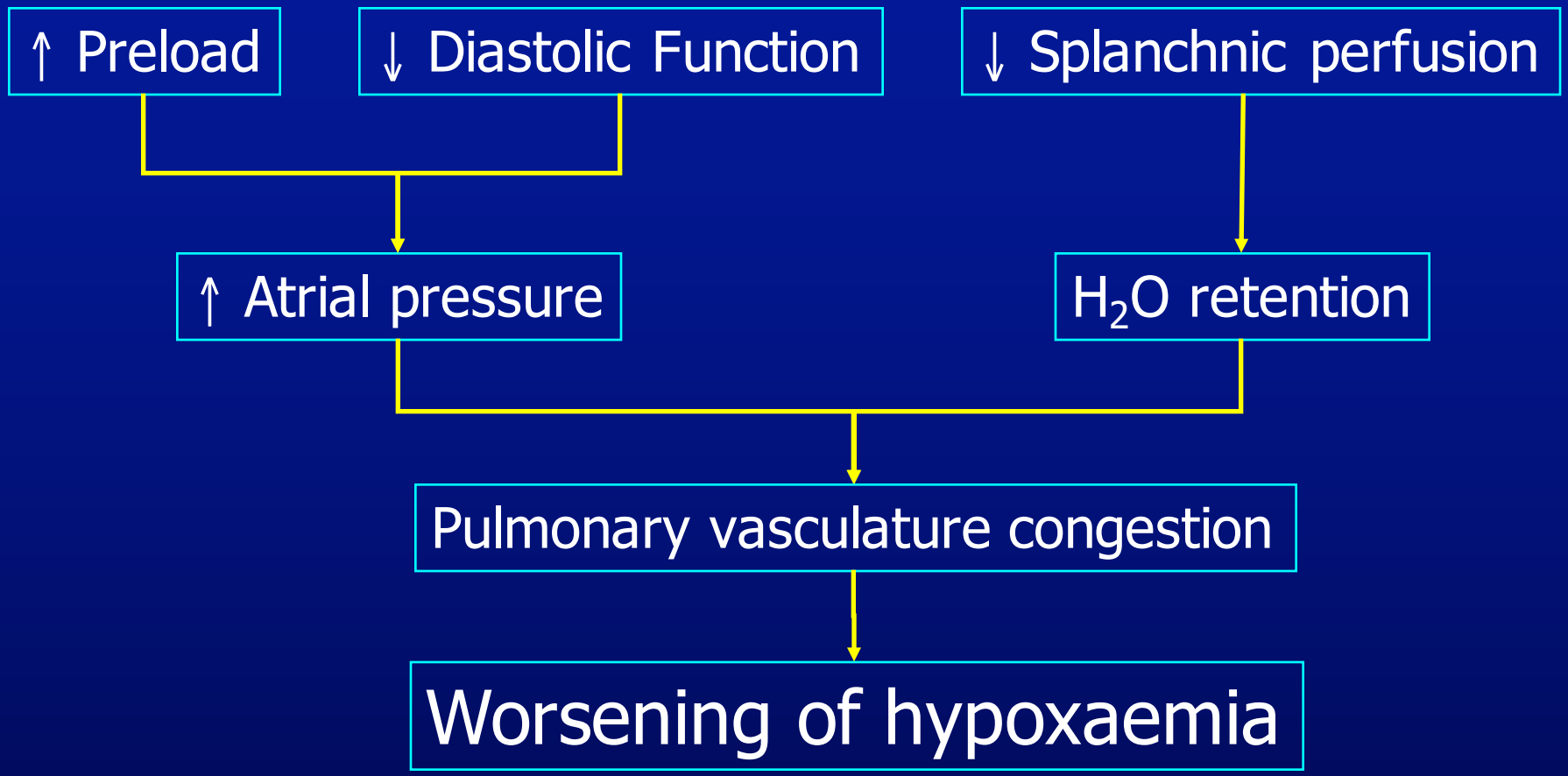
Shock Categories



Shock Registry
Hochman, JACC 36: 1063, 2000


Loss of myocardial contractility
↓ CO
↓ Blood pressure
↑ Adrenergic response
↑ Inotropism
↑ HR
↑ Arterial tone
↑ Venous tone
↑ Myocardial VO_2
↑ Afterload
↑ Preload
↓ Myocardial perfusion
↑ Ventricular ∅
Worsening in myocardial ischemia

In the lungs


↑ Preload
↓ Diastolic Function
↓ Splanchnic perfusion
↑ Atrial pressure
H_2O retention
Pulmonary vasculature congestion
Worsening of hypoxaemia

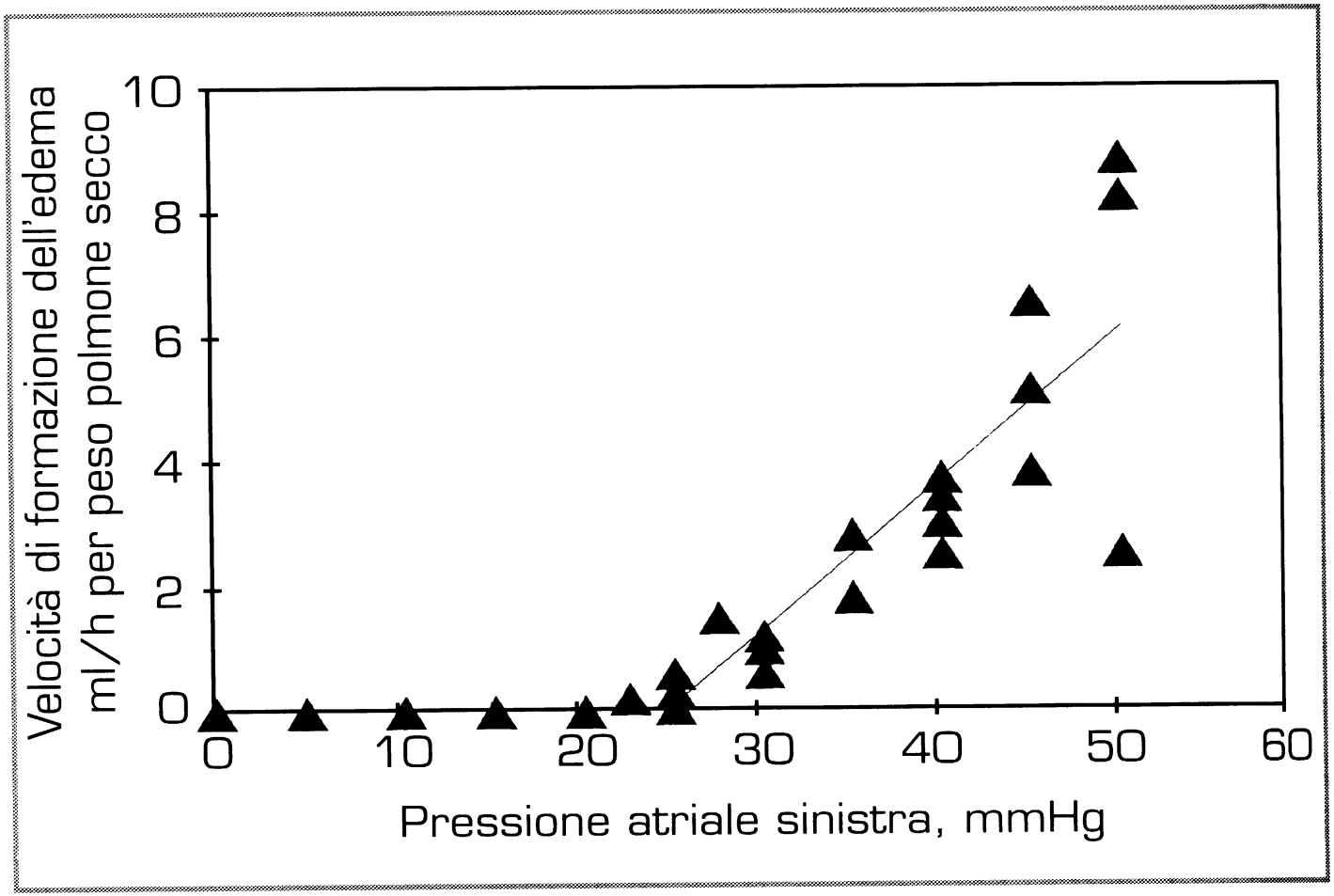
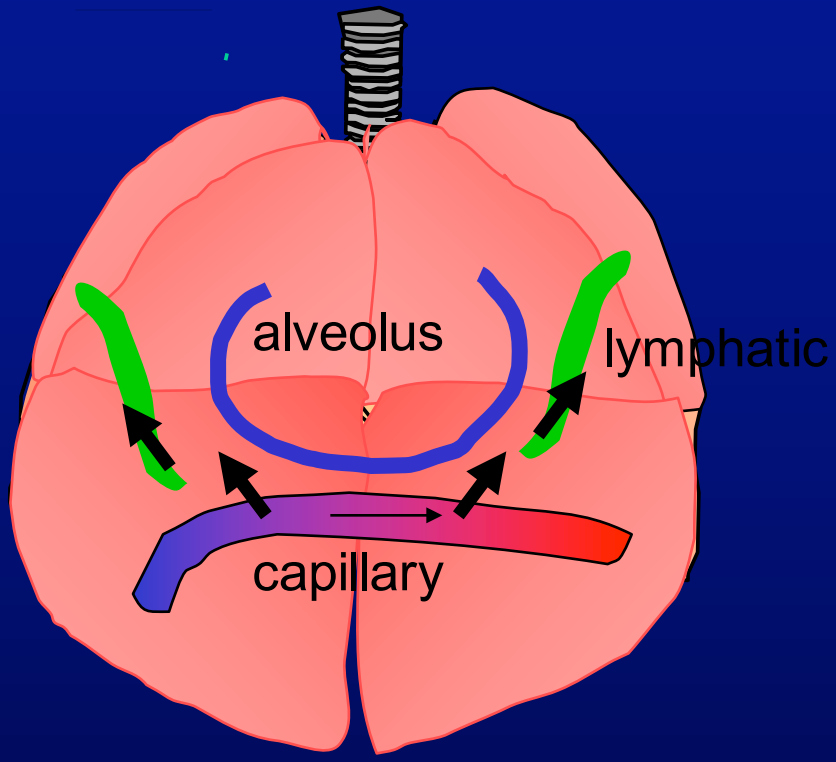


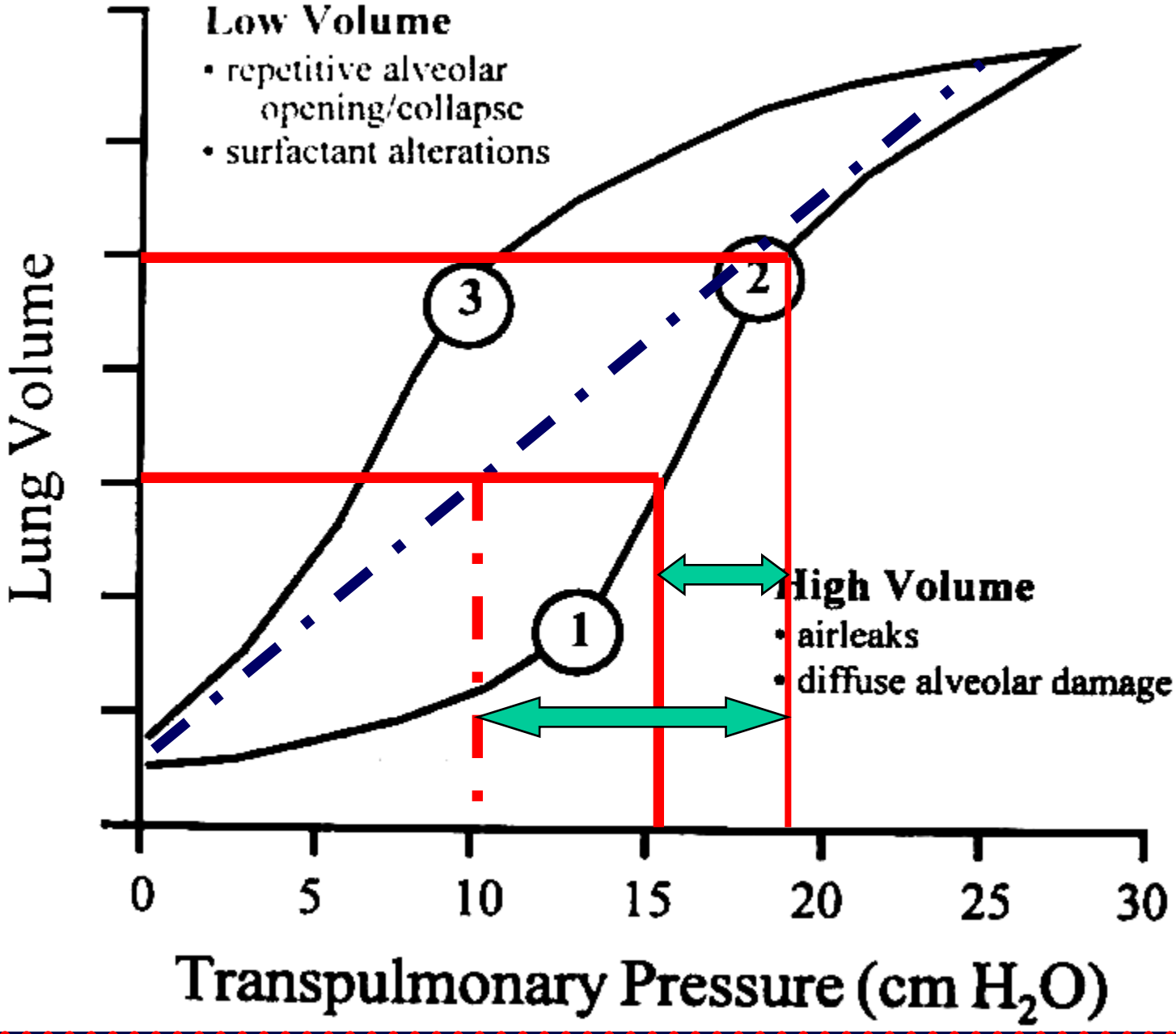
Figura 17.2 • *Sviluppo di edema polmonare quando la pressione atriale sinistra aumenta oltre i 25 mmHg circa. Al di sotto di questo valore critico, l'edema polmonare non si instaura. Da Guyton e Lindsey (7), per gentile concessione.*

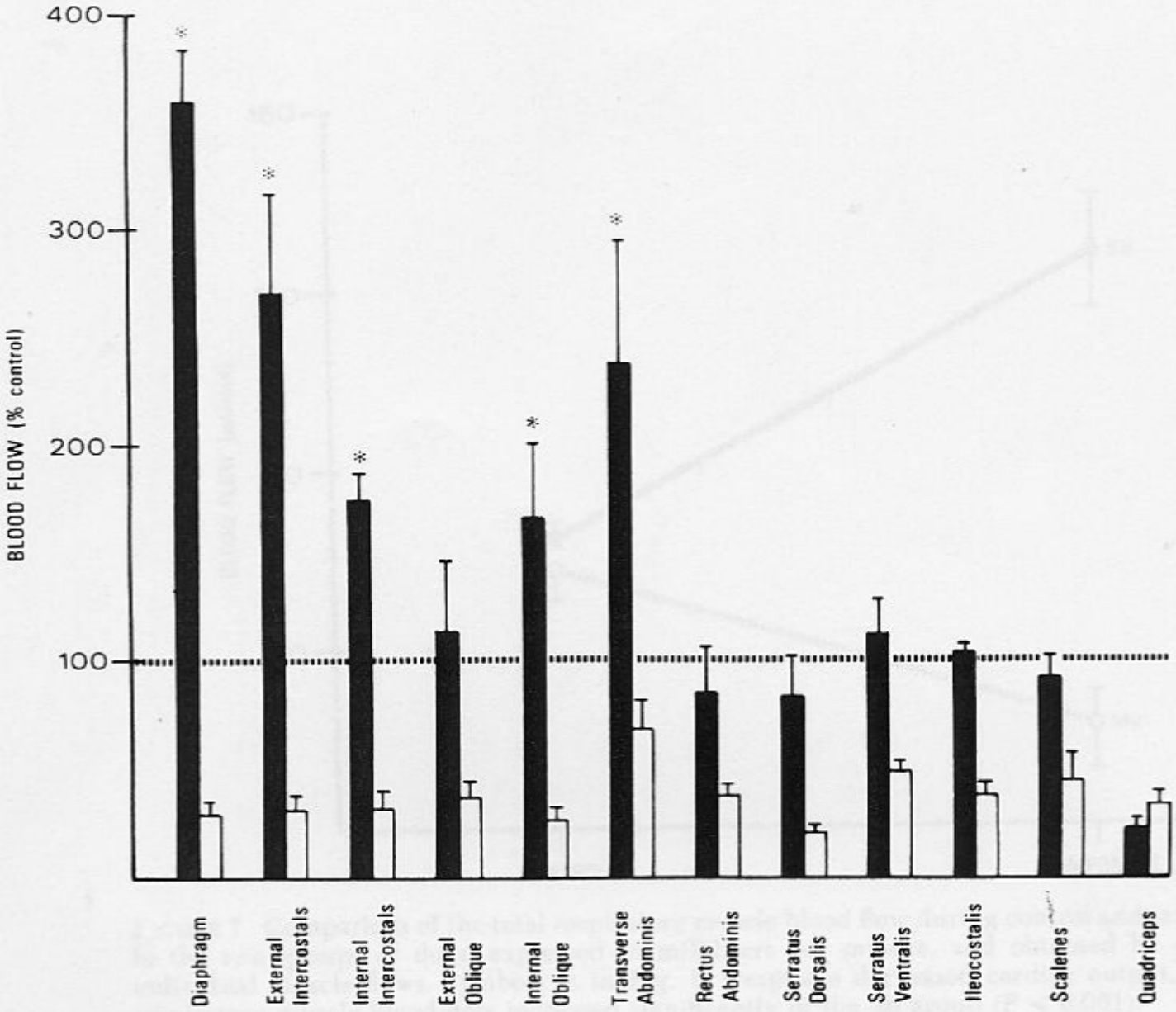
Capillary filtration determines lung water content



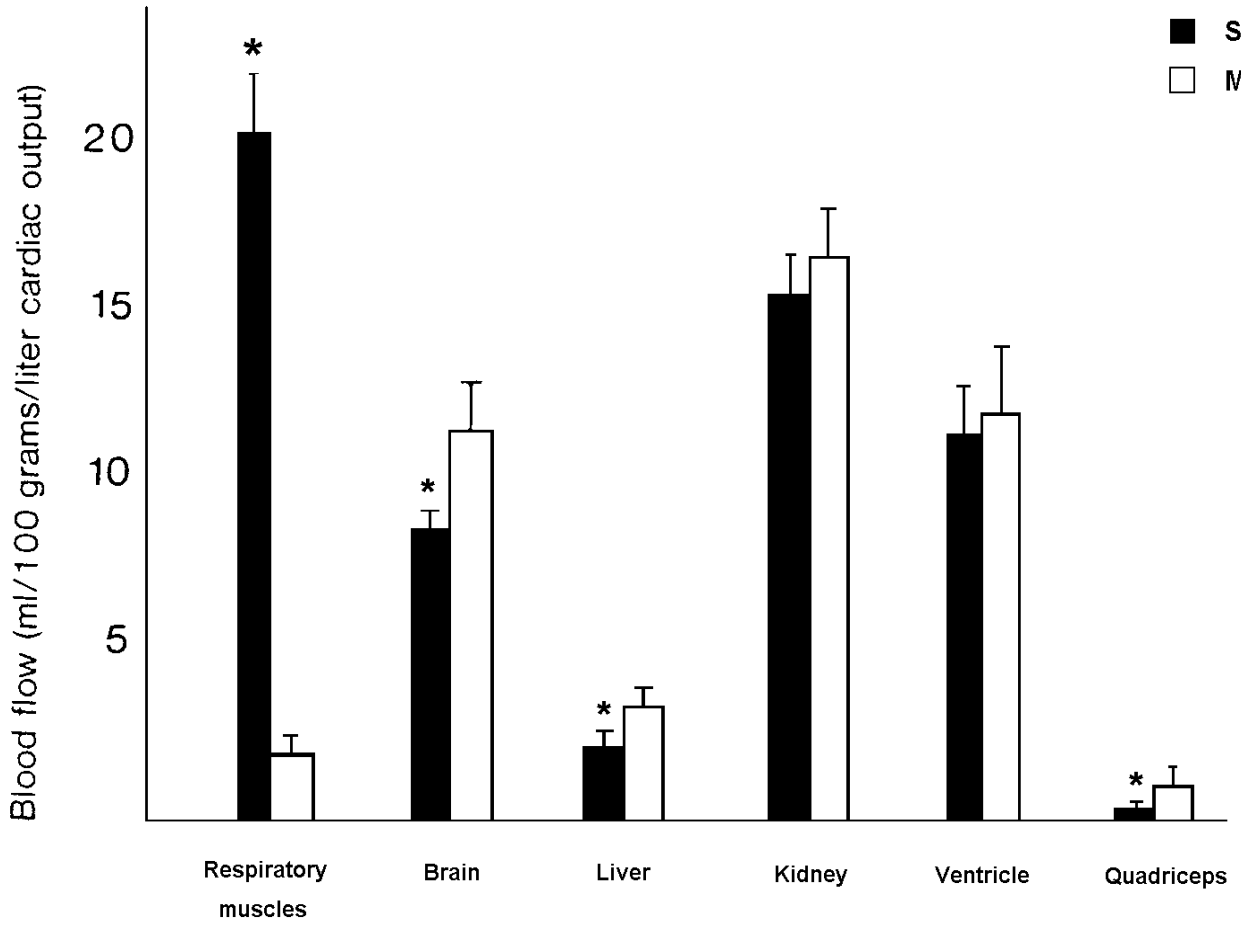
Consequences of interstitial fluid accumulation

- Increased lung weight
- Alveolar collapse
- Decreased FRC
- Decreased compliance


Low Volume
• repetitive alveolar opening/collapse
• surfactant alterations
3
2
1
High Volume
• airleaks
• diffuse alveolar damage
Lung Volume
0
5
10
15
20
25
30
Transpulmonary Pressure (cm H2O)

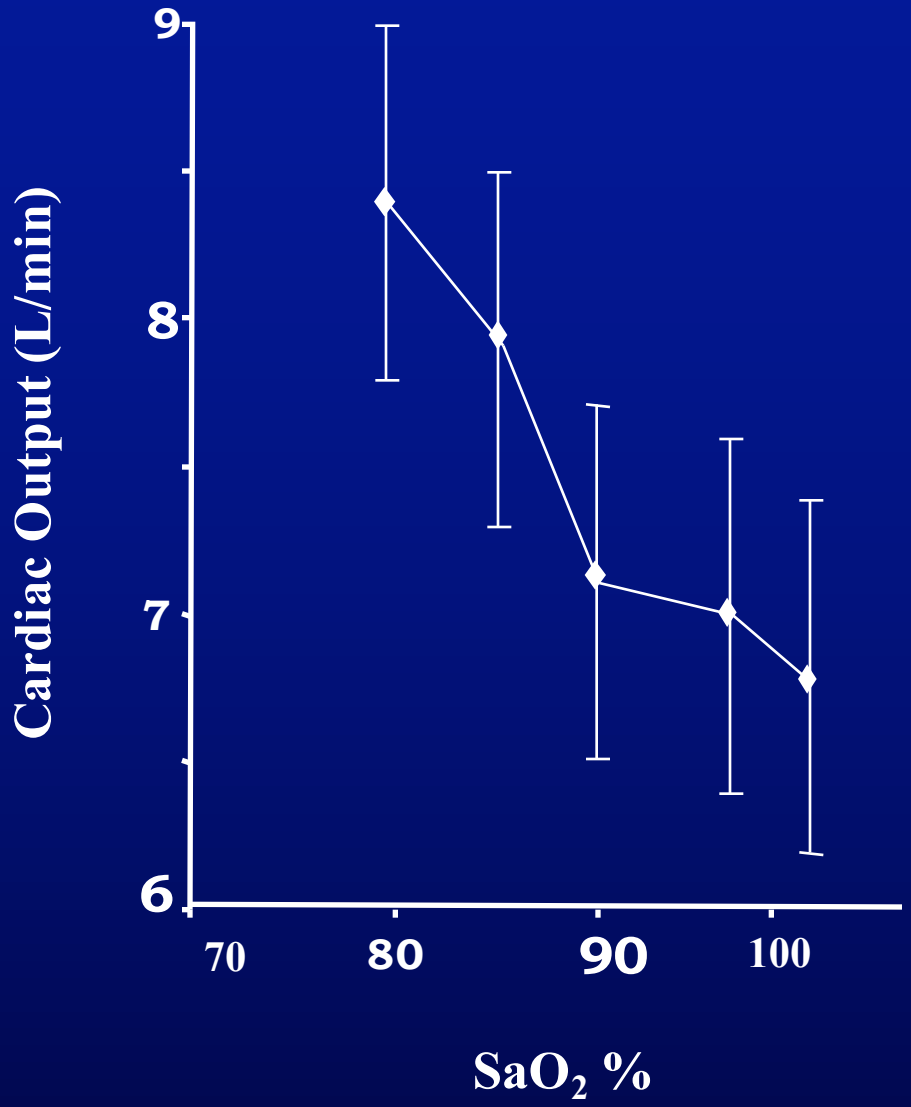


Viires et a. *J Clin Invest* 1983



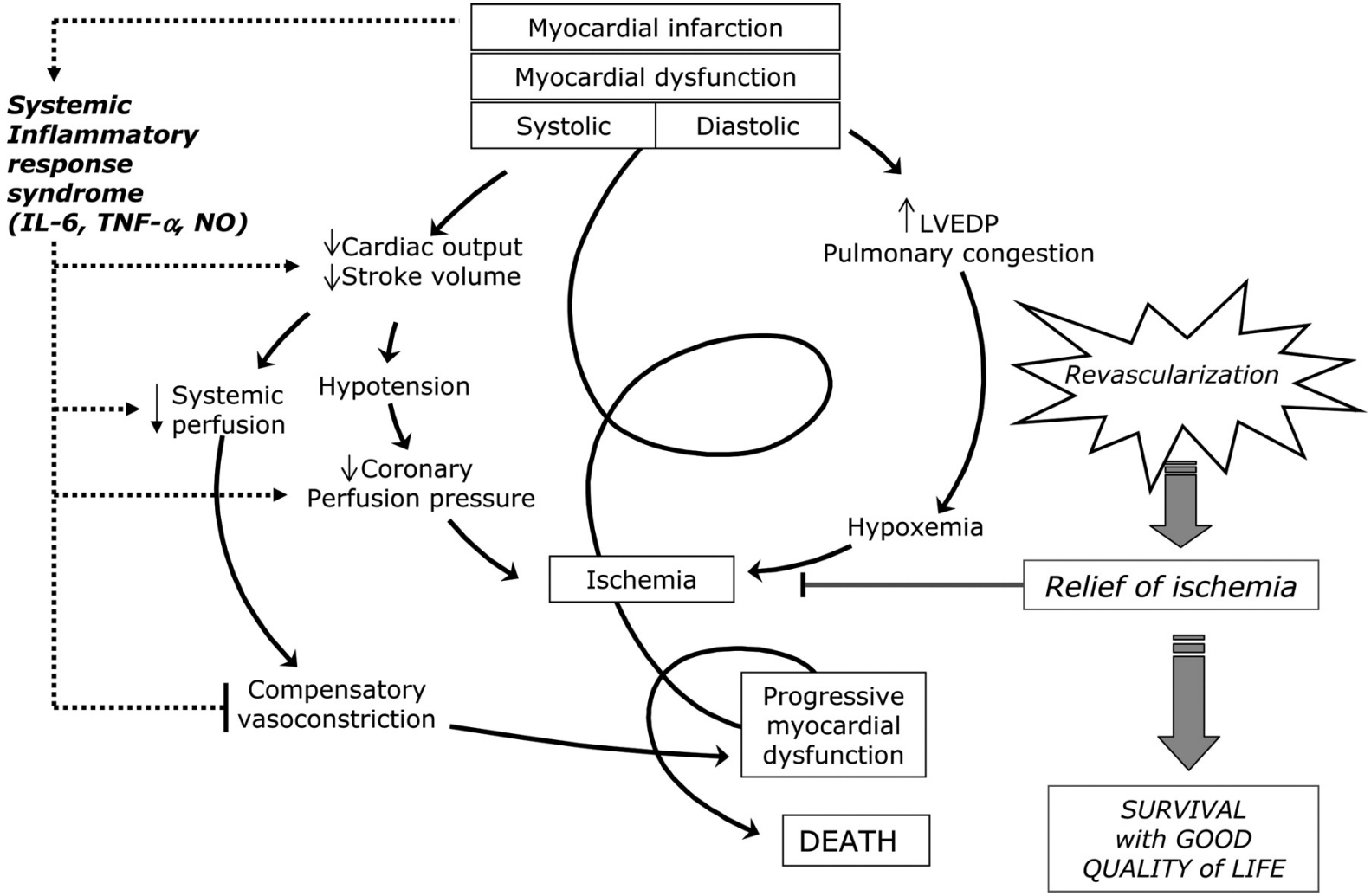
Viires et a. *J Clin Invest* 1983

Effect of Hypoxemia on Cardiac Output



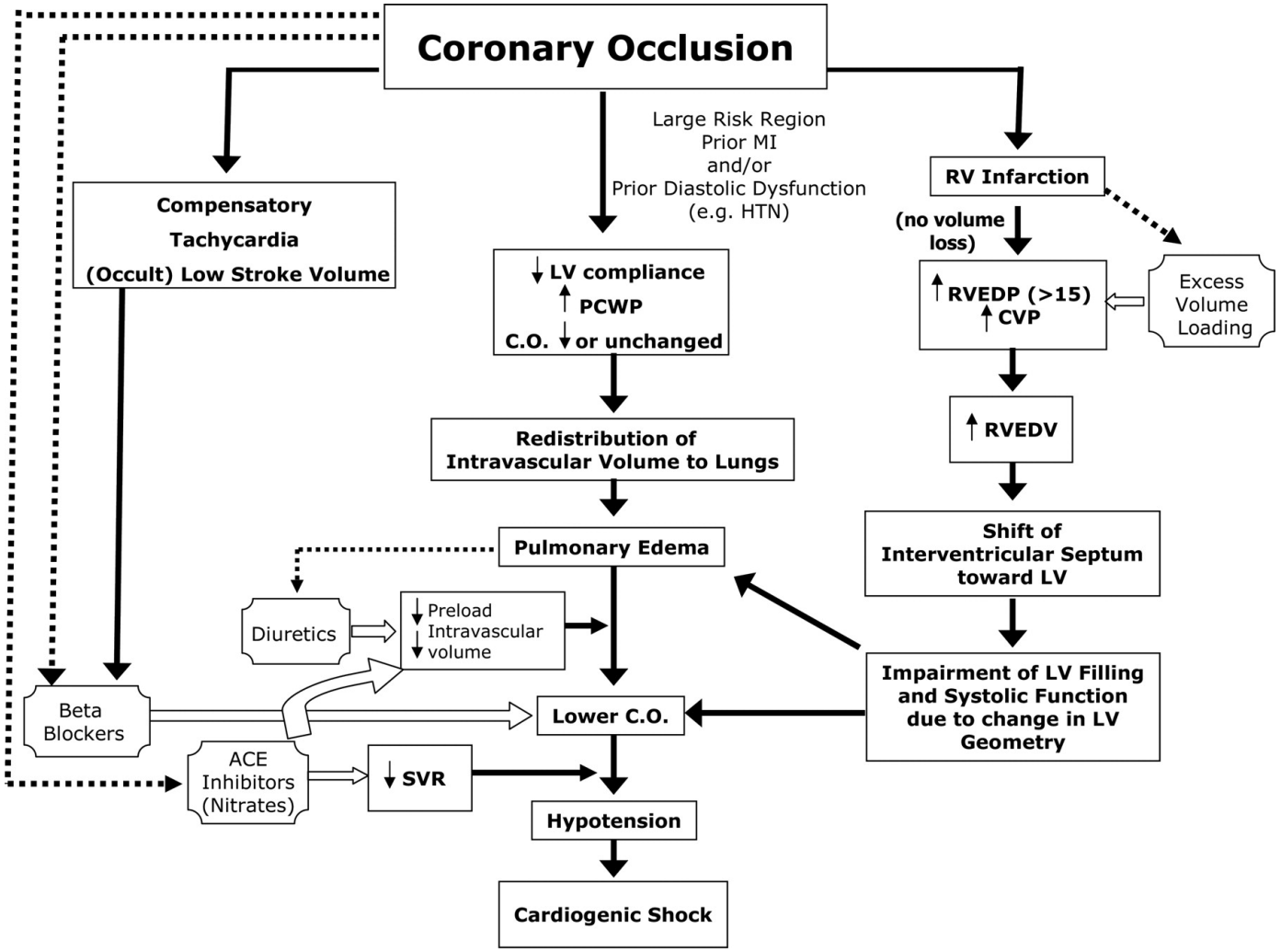
Phillips BA, *Chest 1988; 93: 471*

Figure 1. Current concept of CS pathophysiology.



Harmony R. Reynolds, and Judith S. Hochman Circulation. 2008;117:686-697

Figure 3. Iatrogenic shock.



Harmony R. Reynolds, and Judith S. Hochman Circulation. 2008;117:686-697

Take home message

Importance of clinical signs

Lactate as an index of tissue perfusion

Consequences on the myocardial perfusion

Effect on lung function

Discrepancy VO2/DO2 :it not the CO value the only determinant