灌流功能評估

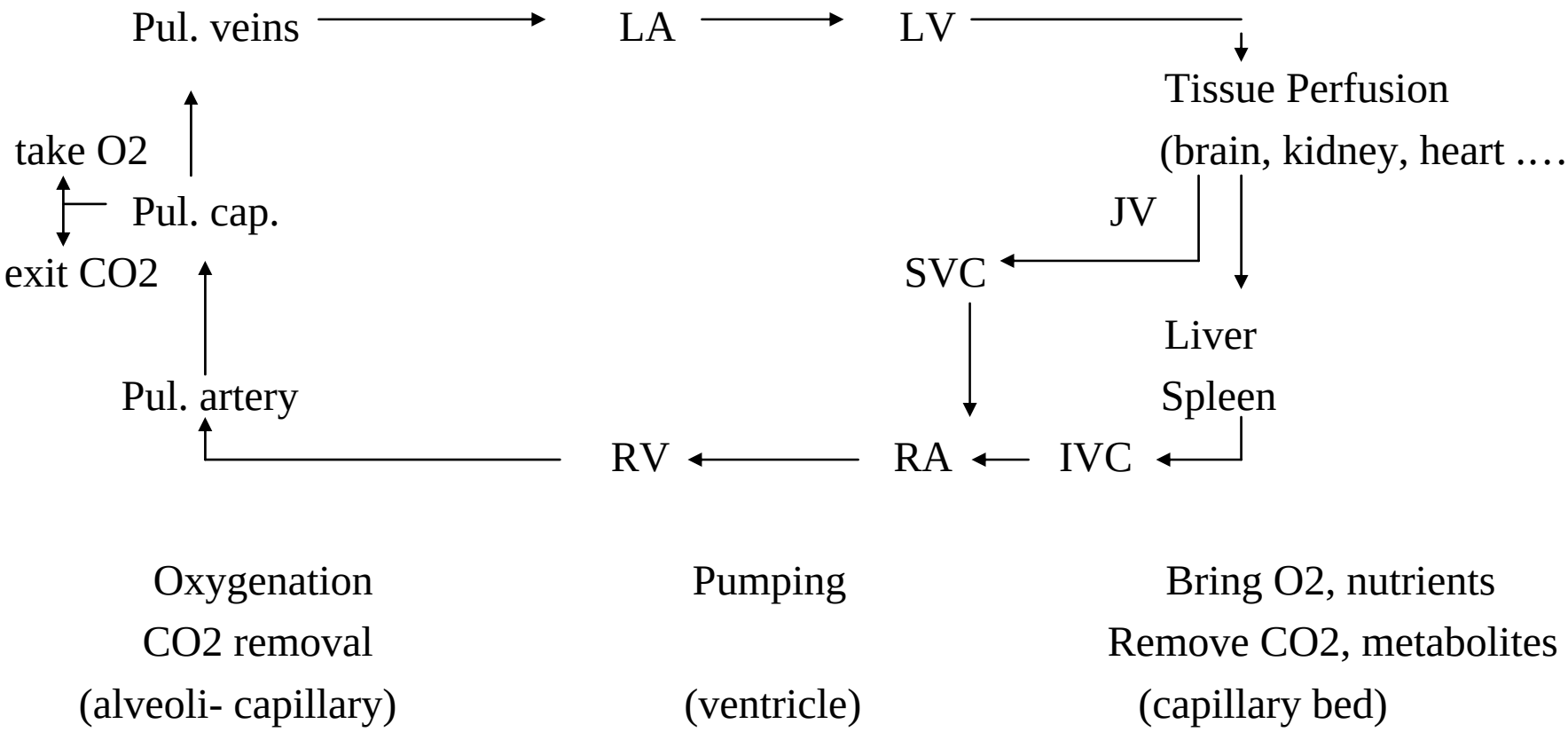
臨床數據判讀與護理意涵課程

邱艷芬教授

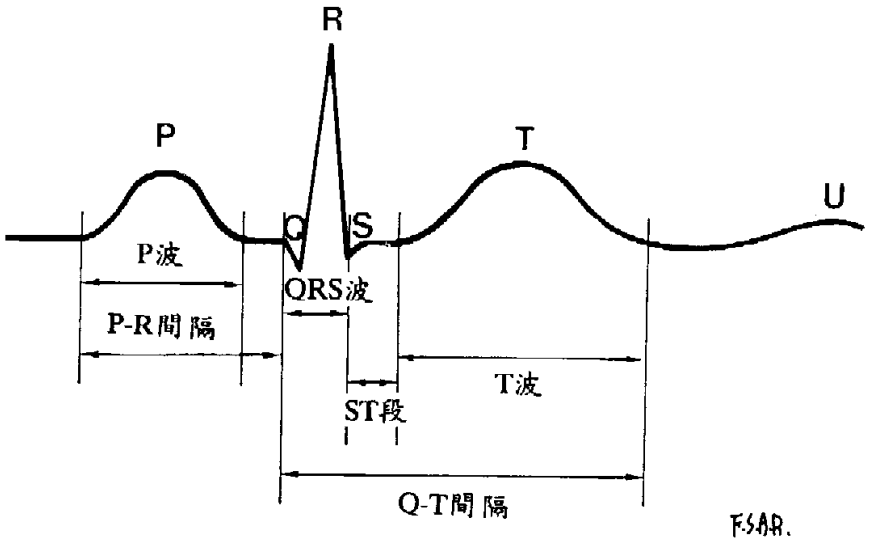
循環功能的評估

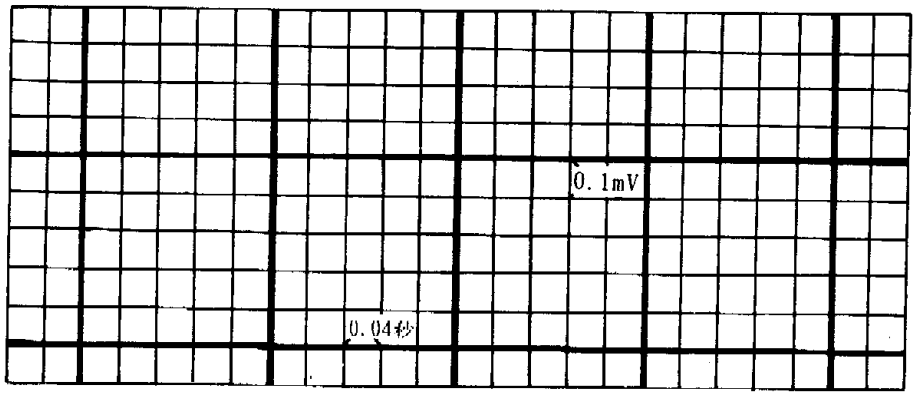
- 循環功能主要為組織灌流
- 決定組織灌流之三主要因素：
  - Blood volume：CVP
  - Cardiac pumping：SBP
  - Vascular tone：DBP
- 評估血量、心臟、與動脈、靜脈、微血管
- 評估血壓

心臟功能與組織灌流


Pul. veins
LA
LV
Tissue Perfusion
(brain, kidney, heart ….
take O2
Pul. cap.
exit CO2
JV
SVC
Liver
Spleen
Pul. artery
RV
RA
IVC
Oxygenation
CO2 removal
(alveoli- capillary)
Pumping
(ventricle)
Bring O2, nutrients
Remove CO2, metabolites
(capillary bed)

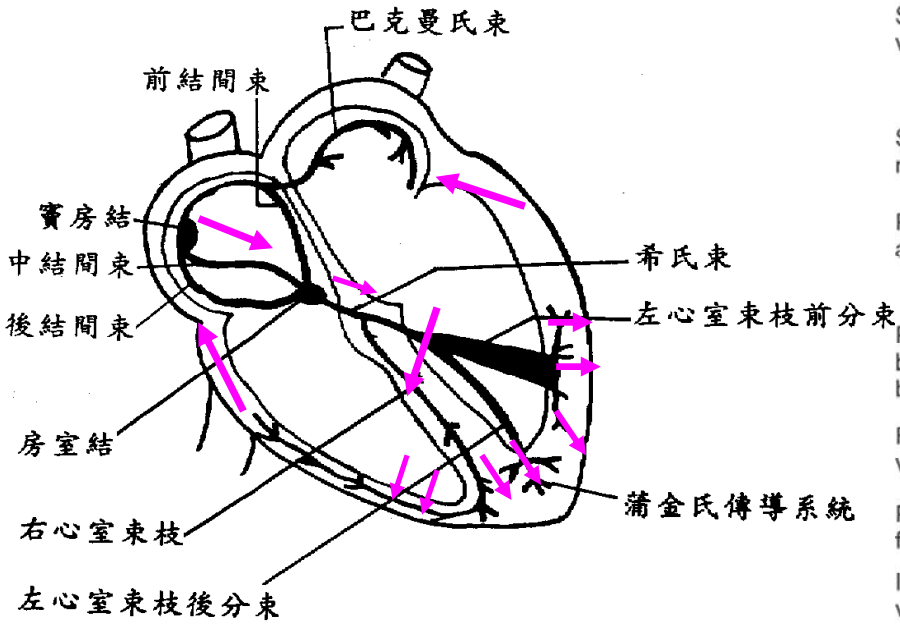
EKG information





- Pacing maker
- Arrhythmia
- 心房肥大
- 心室肥大
- Ischemia
- Injury
- Infarction

心電傳導方向



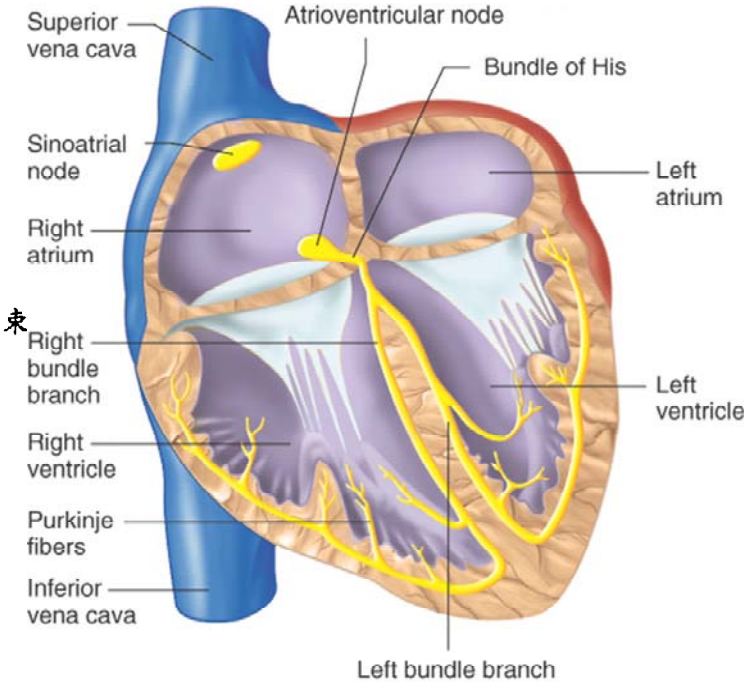
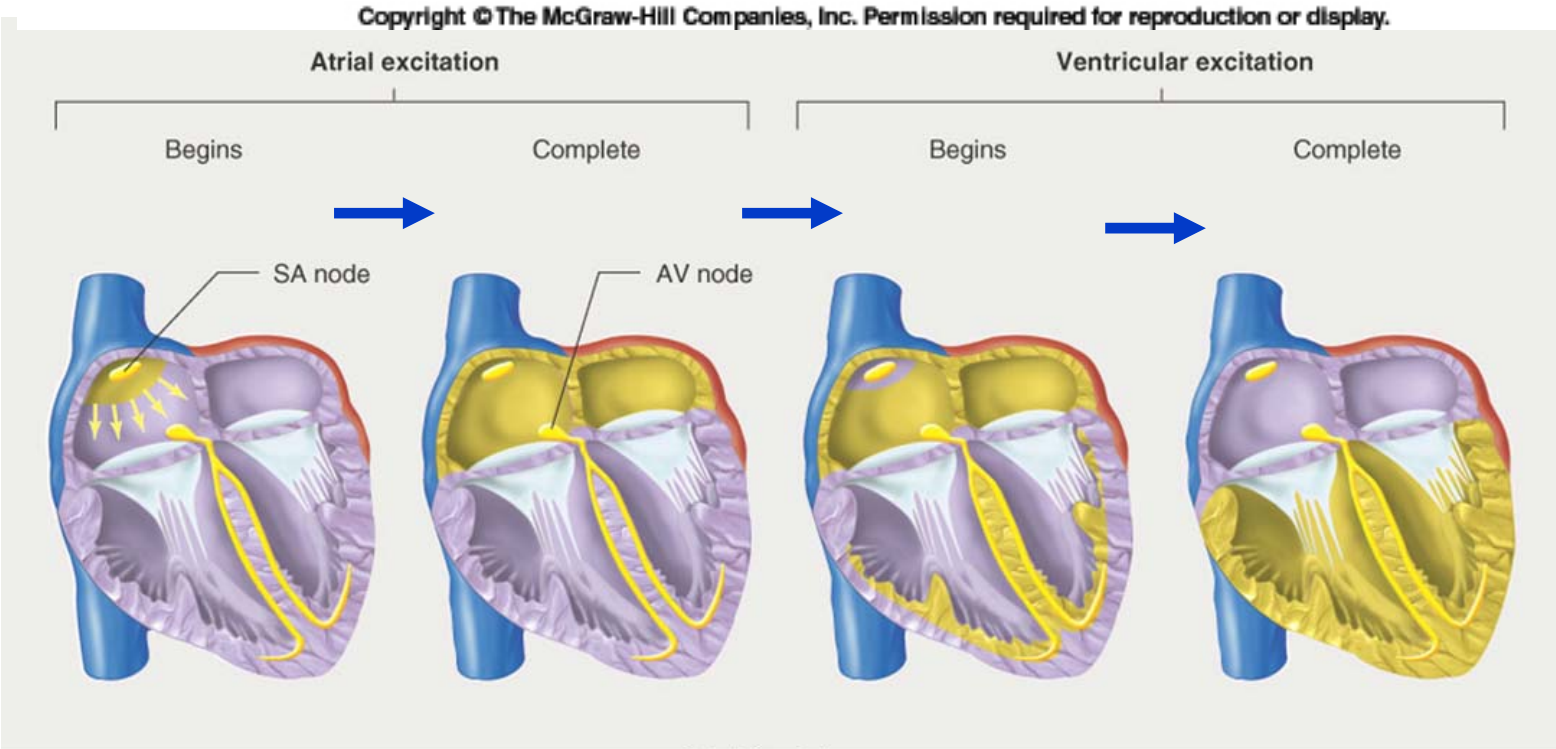


圖1-4　心臟之電傳導系統

心房心室去極化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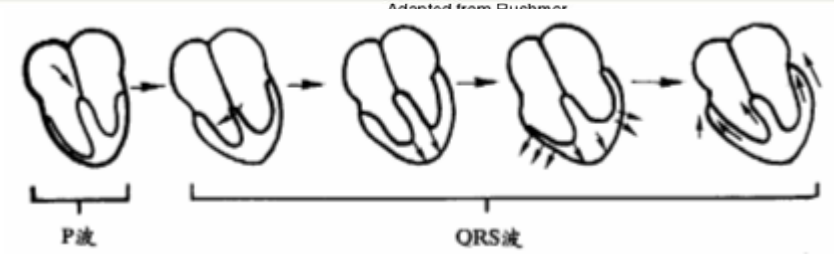
Atrial excitation
Ventricular excitation
Begins
Complete
Begins
Complete
SA node
AV node


P波
QRS波

EKG 波形與意義

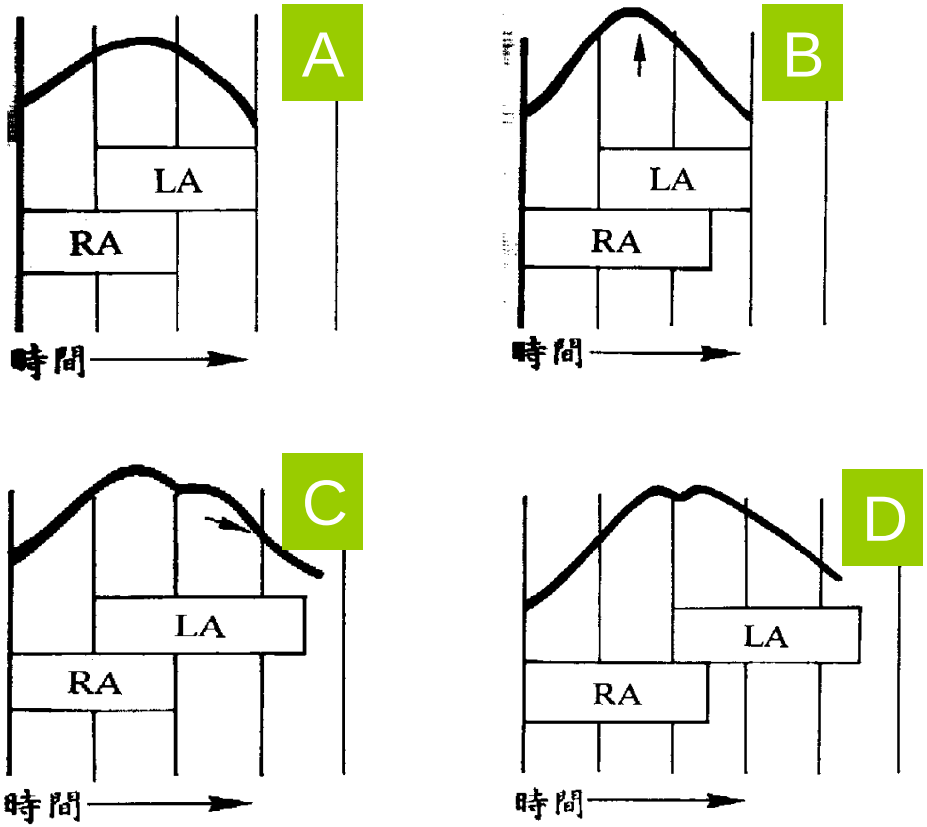
波形	意　義	正常圖型
P波	心房去極化	向上圓型＜3小格
QRS波	心室去極化	瘦高型＜3小格
ST段	心室再極化	等平線上
T波	心室再極化	向上

心房變大

- P波型的變異

P波變高：右心房肥大

P波變寬：左心房肥大



A：正常心房去極化

B：右心房肥大

C：左心房肥大

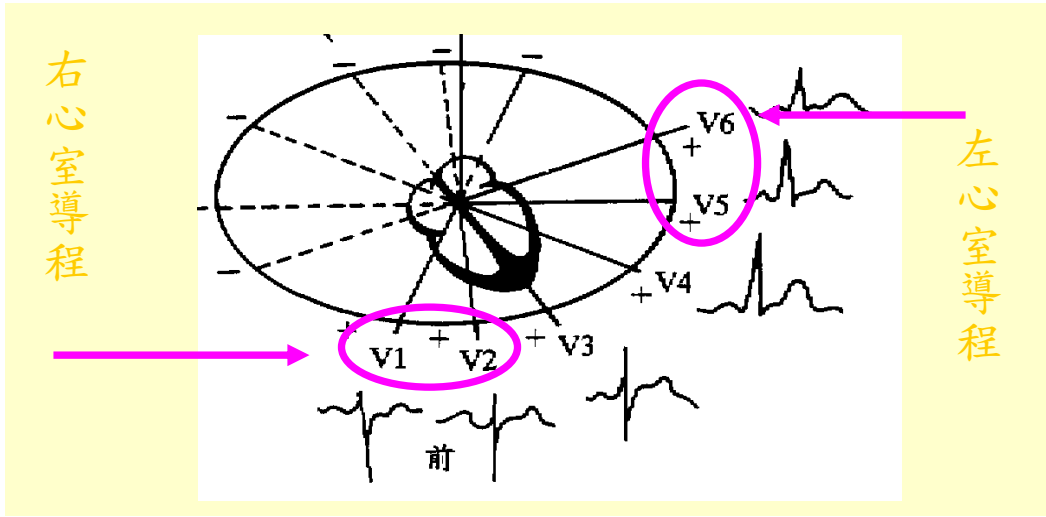
D：左右心房均肥大

心室變大

- QRS波的變異

右心室肥大：
V1.V2出現向上波
V5.V6出現向下波

左心室肥大：
V1.V2→S波加深
V5.V6→R波加高



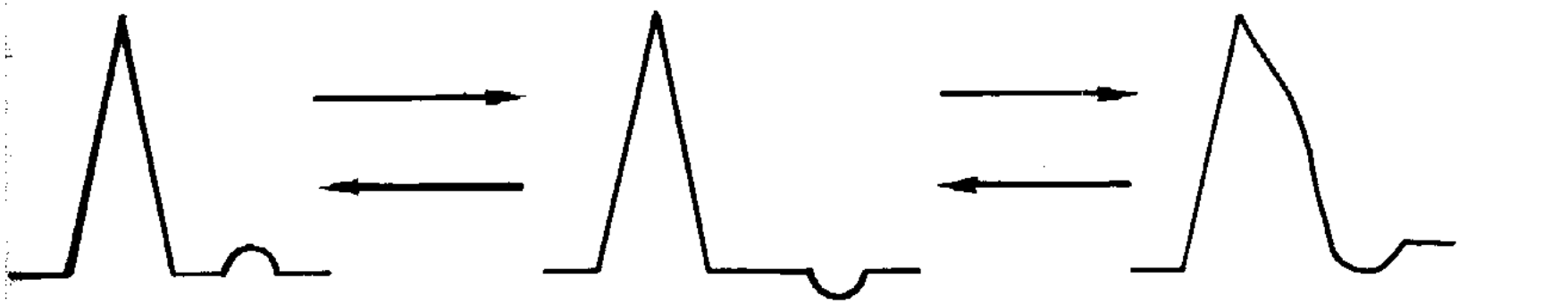
心肌去極化的節律

Named by pacing foci

- Sinus rhythm
- Atrial rhythm
- Junctional rhythm
- Ventricular rhythm
- Pacemaker rhythm

心肌缺氧的變化

- ST與T波的變異
  - ST波：心肌受傷時上升，心肌疲累時下降
  - T波：缺氧時出現向下倒立

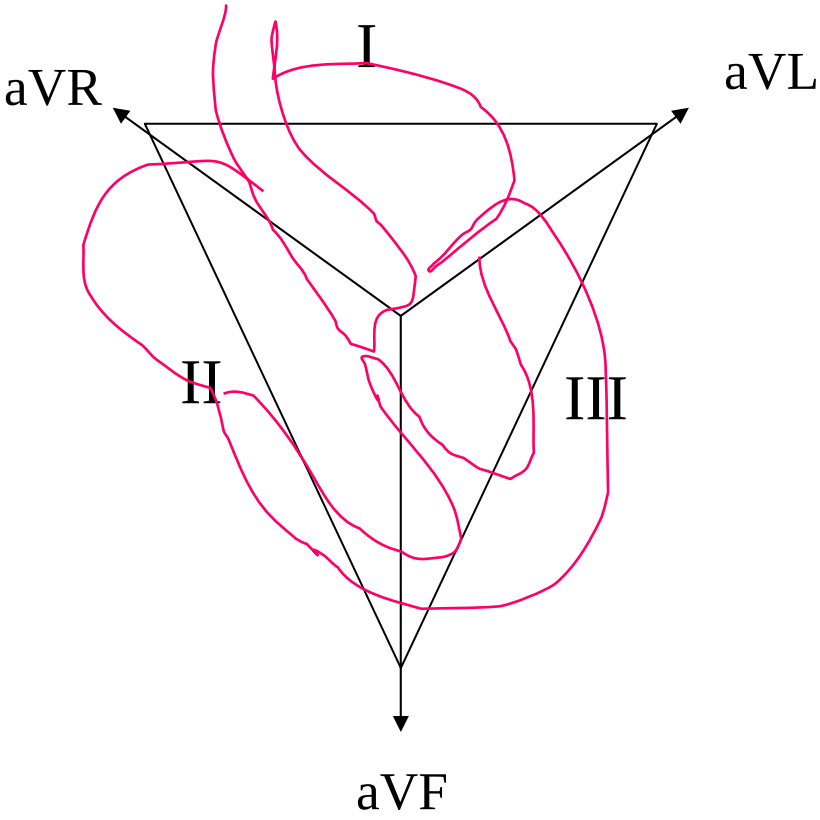


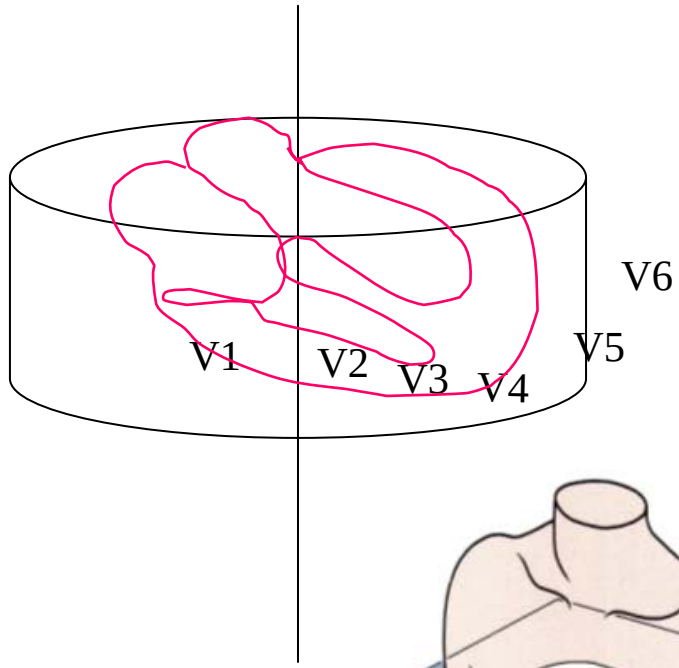
(A)正常心肌，心電圖ST段平T波正立

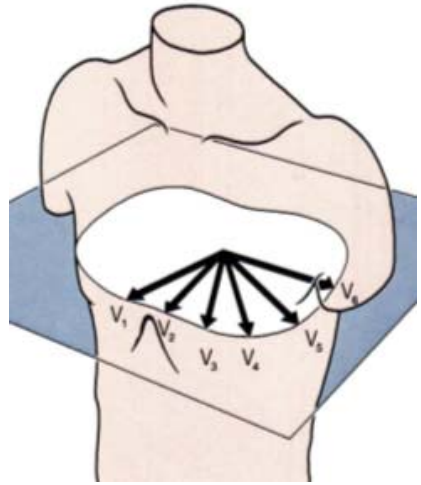
(B)缺氧心肌，心電圖首先出現T波倒立

(C)心肌缺氧至損傷程度，ST段上升T波倒立

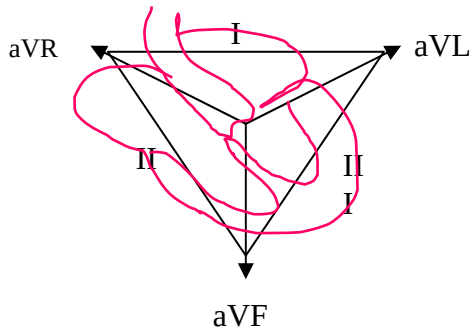
從十二導程心電圖推知心肌梗塞的部位

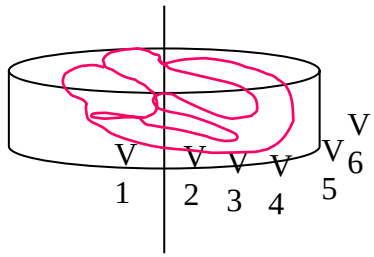






梗塞區的判斷





- 右心室的梗塞應會在I、II、avF、與V1、V2上反映
- 左心室之梗塞應會在I、III、avL、avF、與V4、V5、V6上反映
- 前壁與心中膈的梗塞可自I、V2、V3、V4上反映
- 胸前導程(V1-6)上有變化之導程越多，梗塞範圍越大。

心律不整嚴重度判斷

- 是否引起 BP drop
  - MBP<70 affect brain
  - MBP<60 affect heart
  - MBP<50 affect kidney
- 致死性心律不整
  - ventricular tachycardia
  - ventricular flutter
  - ventricular fibrilization
- 危險性心律不整

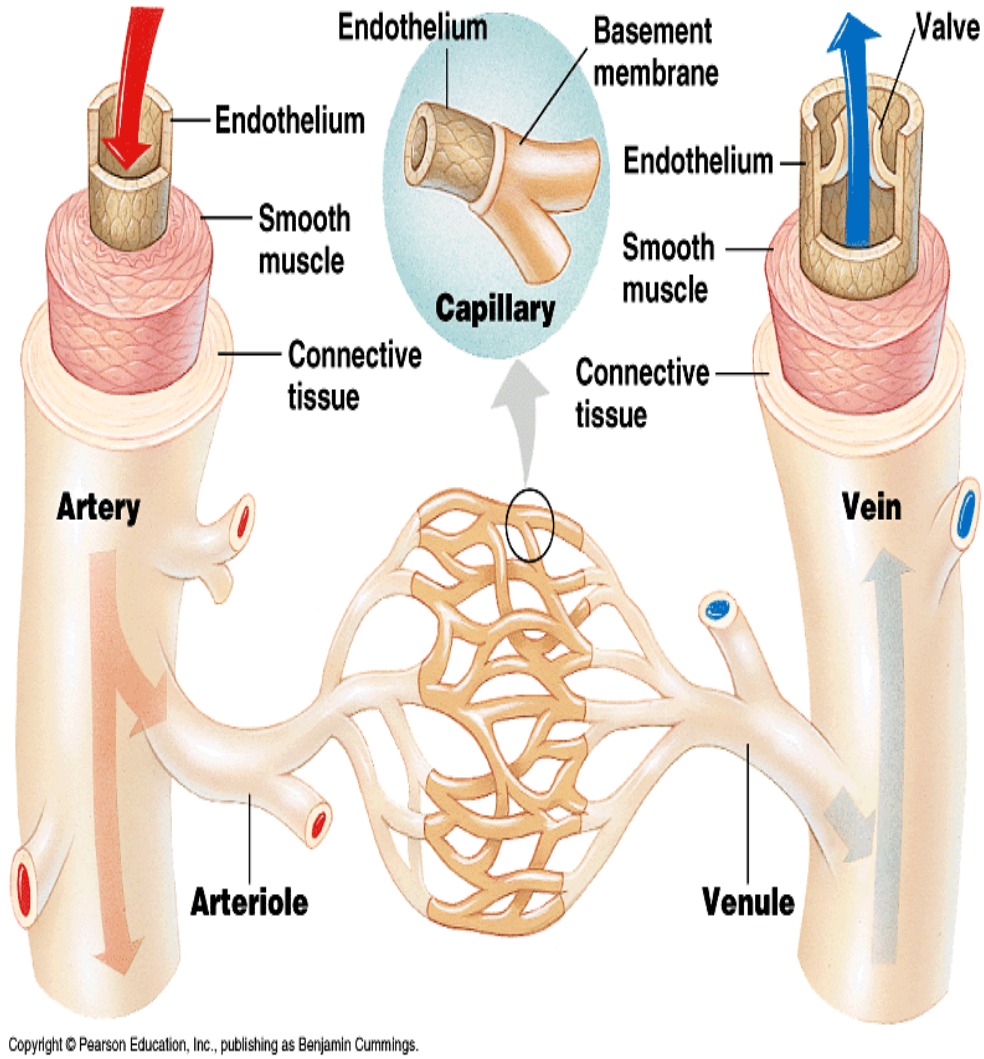
危險性心律不整

常為致死性心律不整的前兆

- VPCs
  - Frequent VPC：＞6次/分。
  - paired PVC（成對出現Couplet）、triplet PVC（成串出現 **Triplet**又稱short run VT ）
  - Bigeminy(每兩個正常心電圖及有一個VPC) 、Trigeminy(每三個正常心電圖即有一個VPC)
  - Multifocal: VPC型態不一
  - R-on-T
- AVB
  - CAVB
  - 2 AVB type II
- AF with RVR, Af with RVR

Vascular physiology

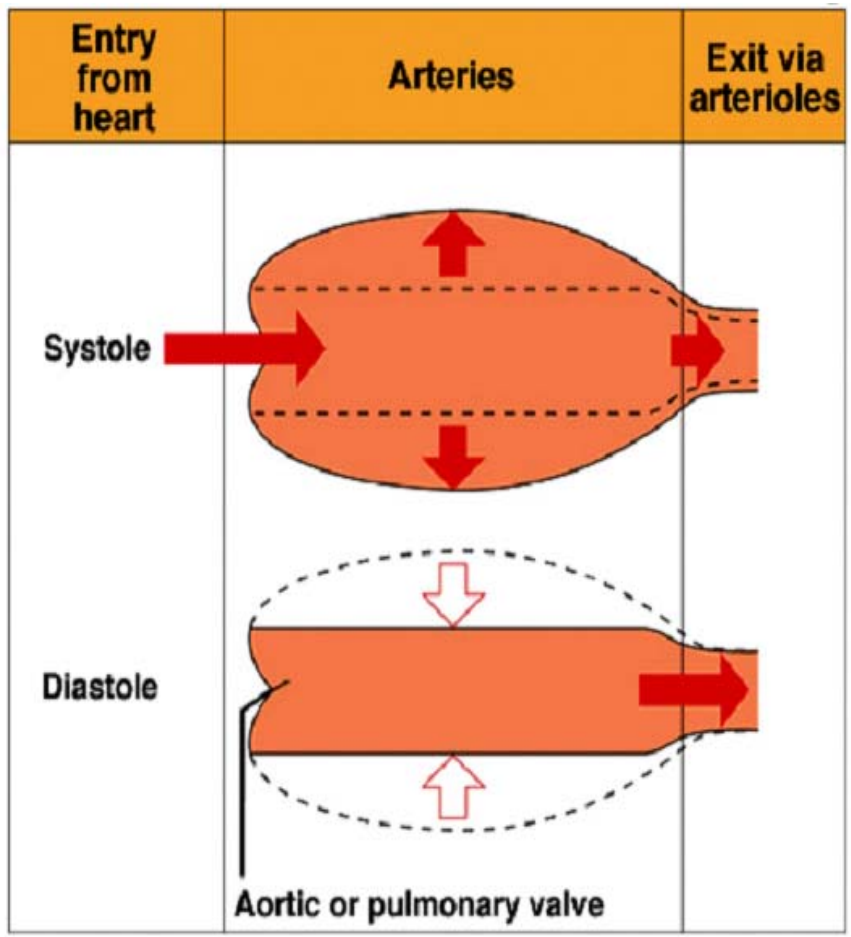
- Artery
  - 管道
  - Vascular tone
- Veins
  - 管道
  - Vascular tone
- Capillary
  - 交換場所
  - permeability



The vascular tone

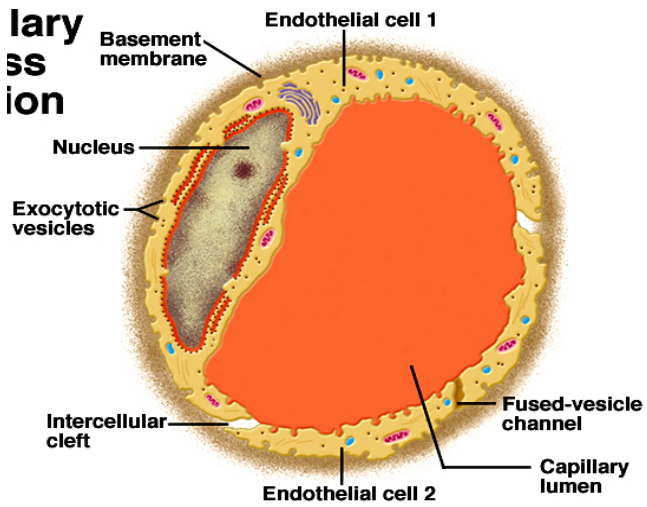
The blood contained in a single heart contraction (the stroke volume) stretches out the arteries,

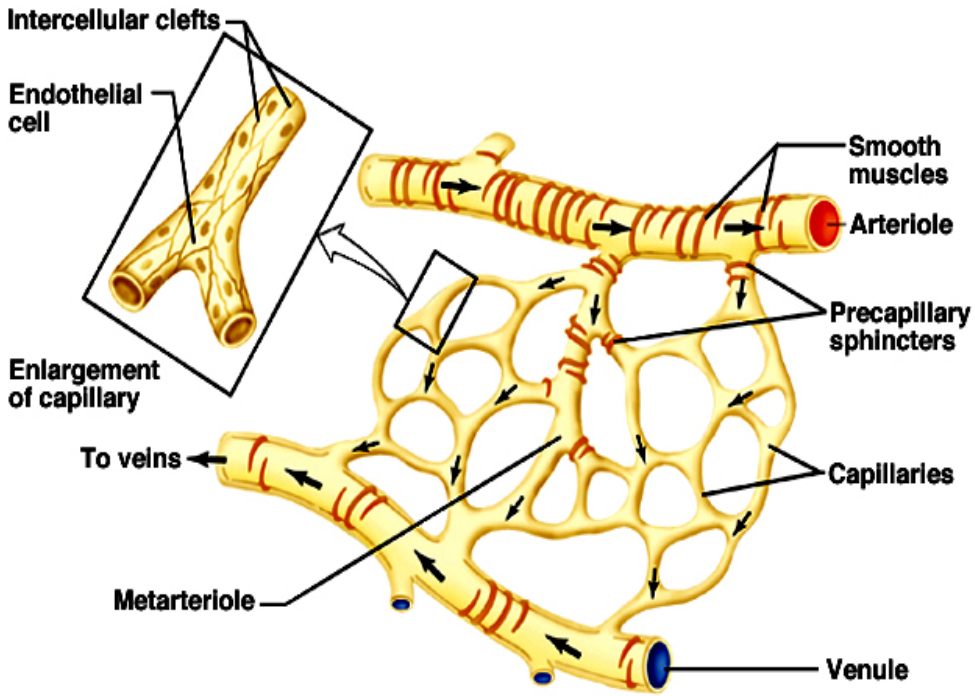
so that their elasticity continues to "squeeze" on the blood, keeping it moving during diastole.



The permeability nature of capillary

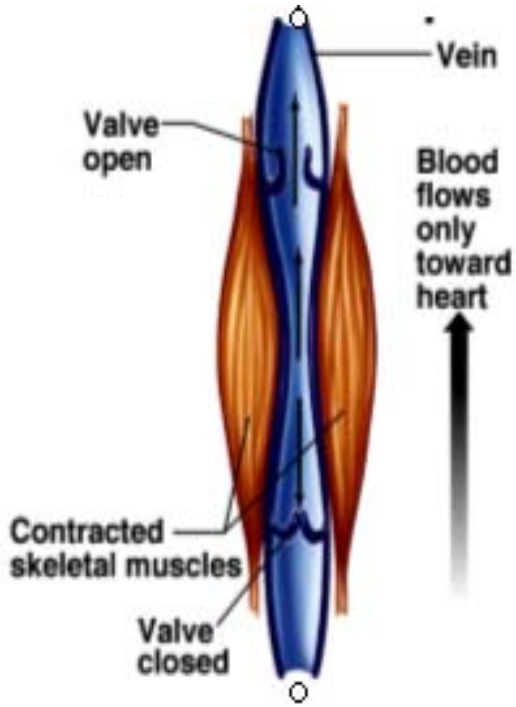
- **Capillary walls are a single endothelial cell in thickness. Intercellular clefts assist the exchange.**





Venous return

- At rest, most of the blood volume is in the veins.
- Sympathetically mediated venoconstriction can substantially increase venous return to the heart.
- Venous flow is assisted by “skeletal muscle squeeze”
- working in combination with one-way valves.



週邊循環

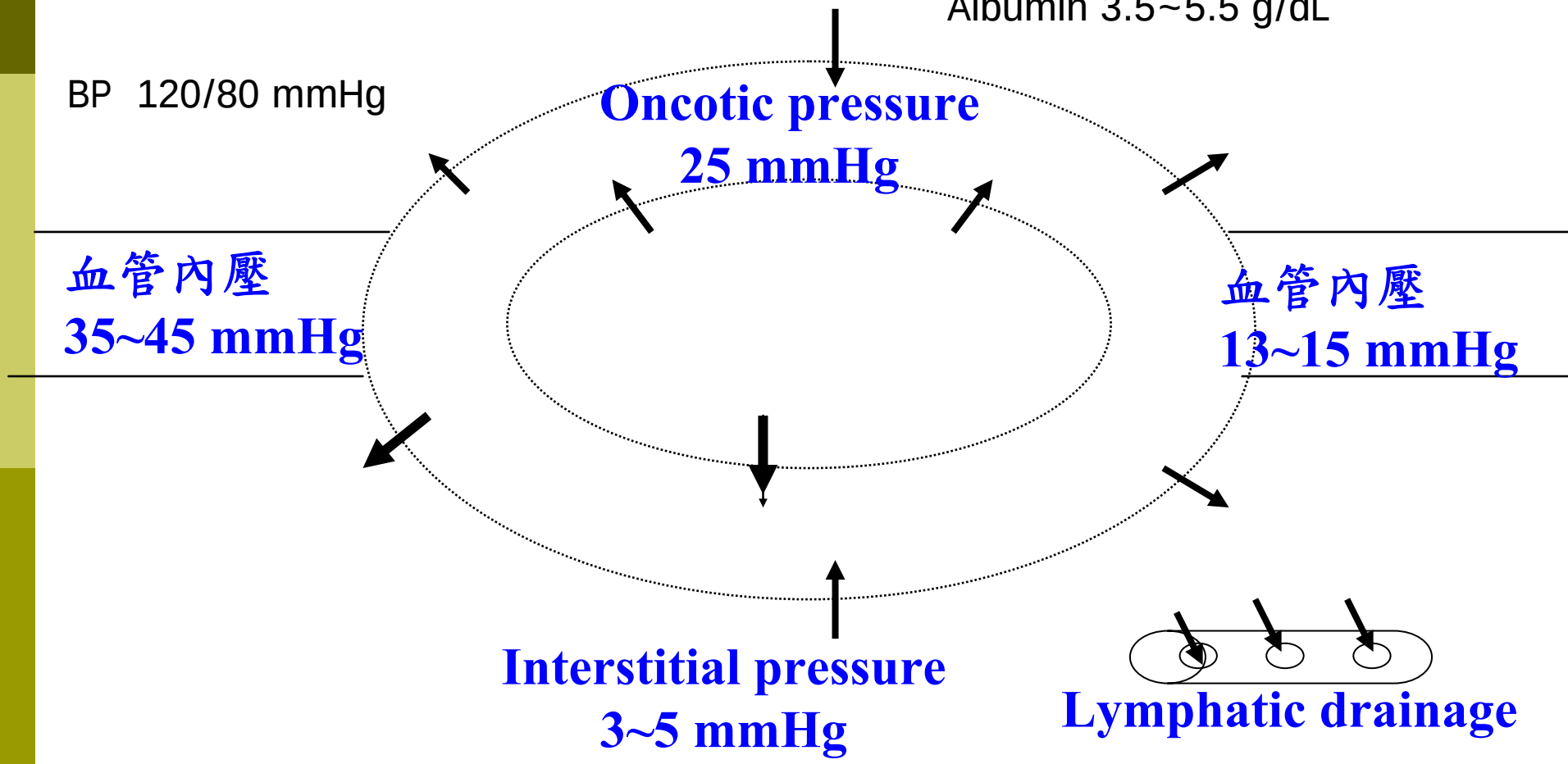
- 動脈循環
  - 不良時：冰涼、蒼白、脈搏弱
- 靜脈循環
  - 不良時：發紺、腫脹
- 微血管循環
  - 不良時：回填度不佳、水腫
  - 回填度不佳：動脈收縮

Change of skin color and temperature

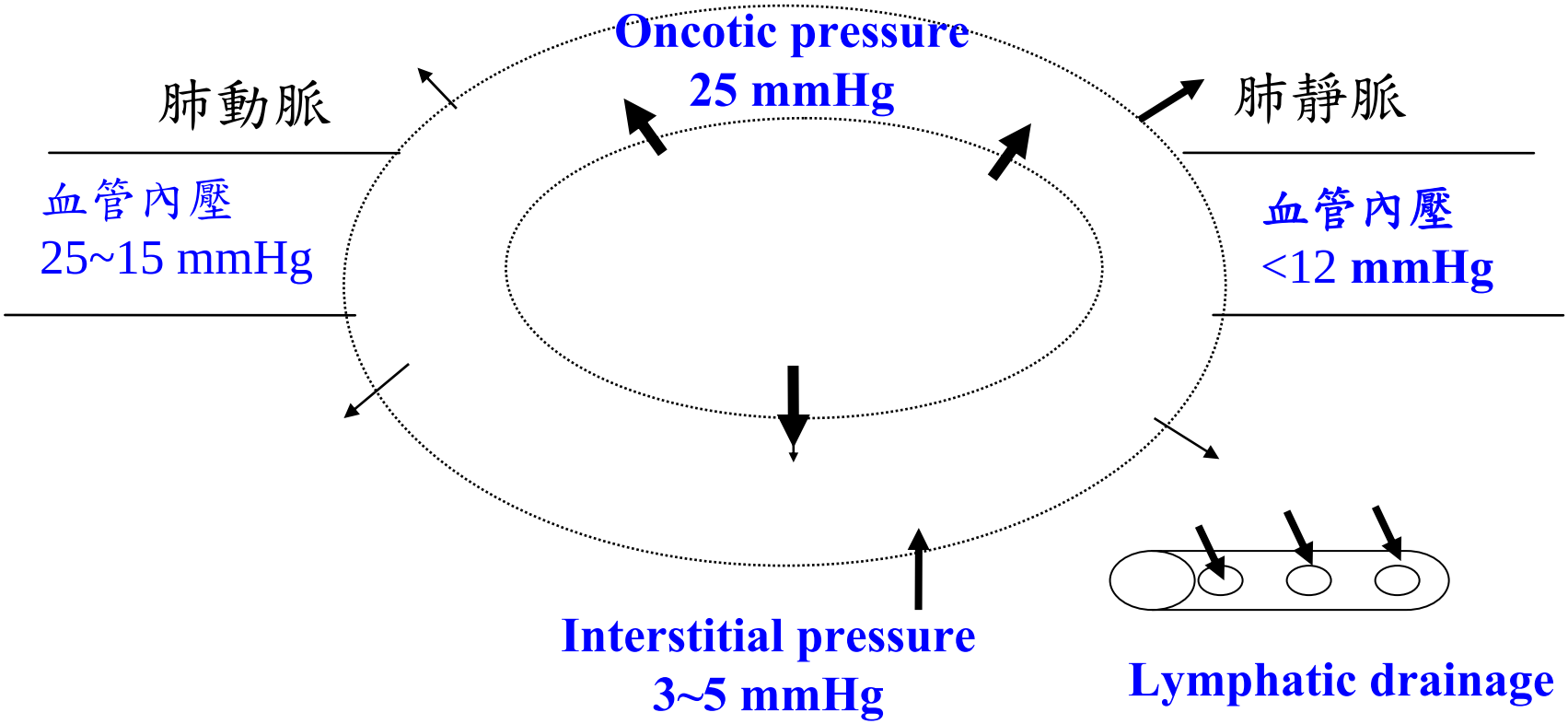
- in cardiac failure：
  - affect arterial flow first, then venous flow
  - pink, warm ➔ pale cold ➔cyanosis, cold

- in compartment syndrom：
  - affect venous flow first, then arteial flow；
  - **pink, warm ➔ cyanotic, warm ➔ cyanotic, cold**

週邊水腫原理


Albumin 3.5~5.5 g/dL
BP 120/80 mmHg
Oncotic pressure
25 mmHg
血管內壓
35~45 mmHg
血管內壓
13~15 mmHg
Interstitial pressure
3~5 mmHg
Lymphatic drainage

肺水腫原理


Oncotic pressure
25 mmHg
肺動脈
血管內壓
25~15 mmHg
肺靜脈
血管內壓
<12 mmHg
Interstitial pressure
3~5 mmHg
Lymphatic drainage

Perfusion pressure

- Determined by
  - Volume pumped out by heart
  - Vascular tone
- Measured by
  - **MBP = 1/3 SBP + 2/3 DBP**
  - **Pulse pressure = SBP – DBP**
  - **Perfusion pressure = BP_{in}-BP_{out}**

評估的徵象:blood pressure

- perfusion pressure(灌流壓)：
  - 將血液推往前之力量
- systemic perfusion pressure(系統性灌流壓):
  - MBP-CVP
- cerebral perfusion pressure (腦灌流壓) :
  - MBP-ICP (50 mmHg, in injured brain > 70 mmHg)
- myocardial perfusion pressure (心肌灌流壓) :
  - DBP-CVP (>50 mmHg)
- glumerular filtration pressure (腎濾過壓) :
  - MBP-膠質滲透壓-鮑式囊內壓

Hypertension emergrncy

- Hypertensive encephalophathy:
  - MBP >150 mmHg，超過cerebral autoregulation引起vasospasm、ischemia、edema、hemorrhage→seizure
- Malignant hypertension:
  - DBP>130mmHg，快速引起end organ damage
    - LV hypertrophy, LV failure,溶血性貧血, hematuria、proteinuria, 視乳突水腫
  - Threaten to life:
    - S/S:

Hypotension

inadequate perfusion to organ

MBP< 70mmHg	to	brain
MBP< 60mmHg	to	heart
MBP< 50mmHg	to	kidney

反映組織灌流不足的徵象

-- impaired functions of the perfused organ

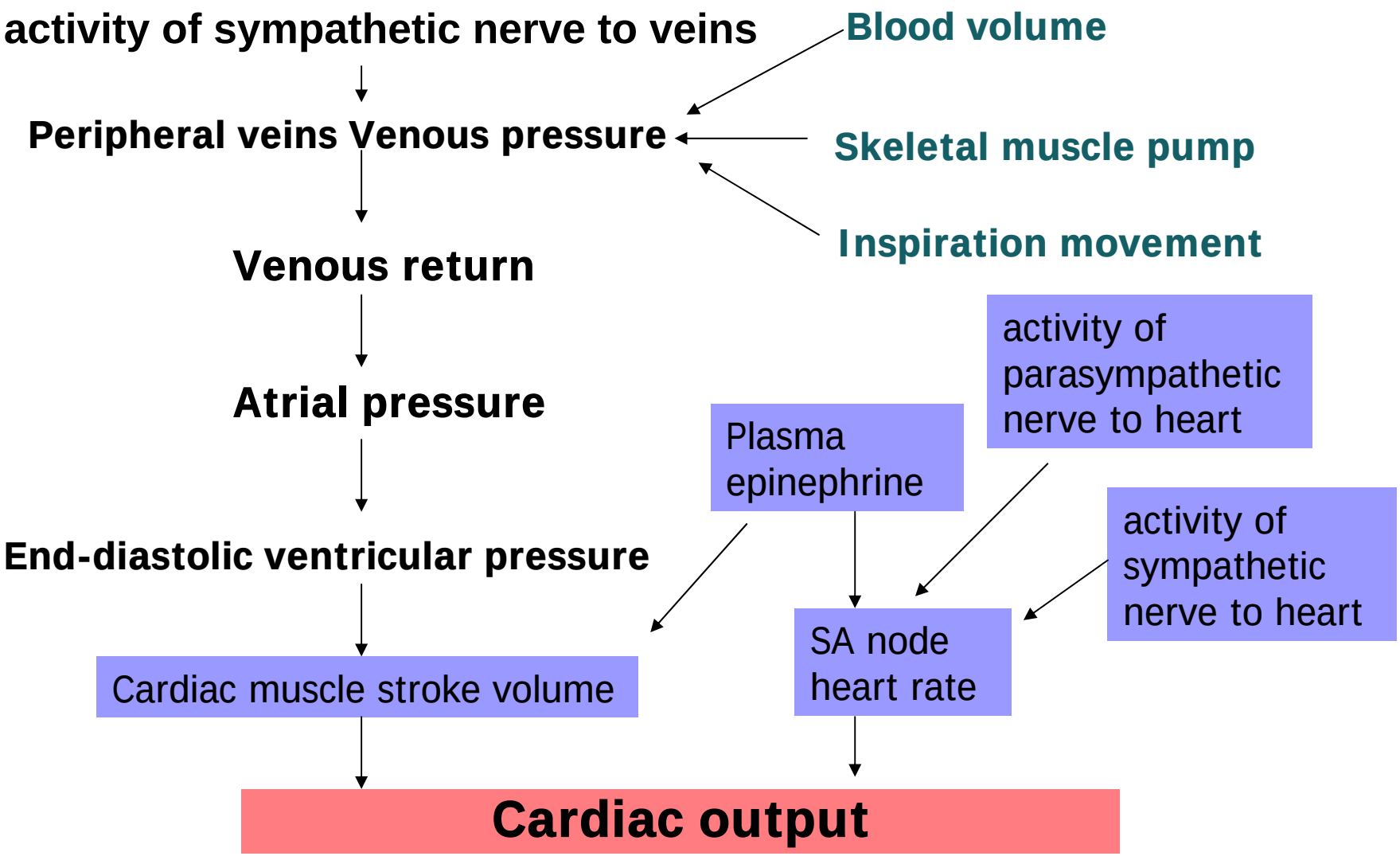
- Brain: change of LOC
- Kidney: decrease U/O
- Heart: myocardial ischemia，
- Lung: poor oxygenation results in vascular constriction
- Liver: in congestion，心源性肝小葉壞死
- GI track: ischemic
- Limbs:pale and cold, thread pulse, poor capillary refilling

EFFECT OF AUTOMONIC SYSTEM

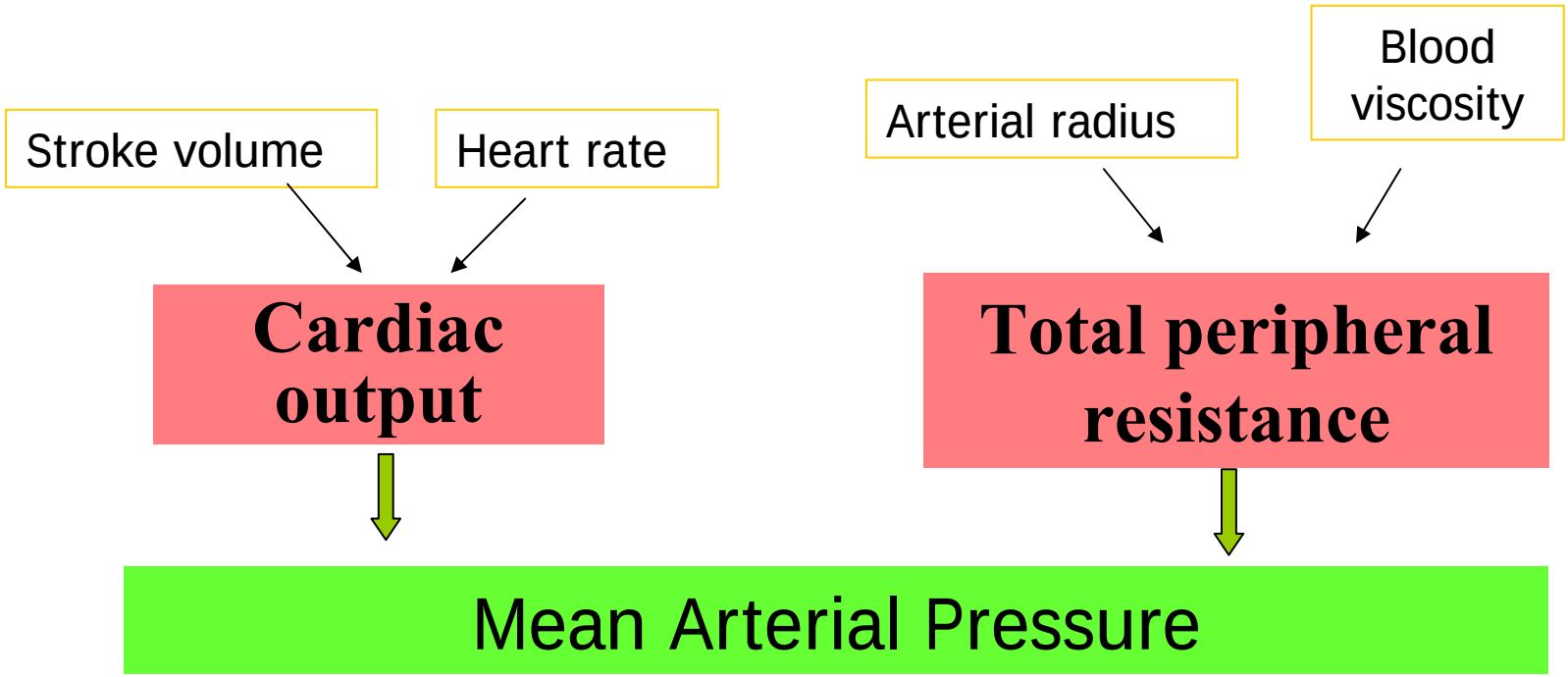
	SYMPATHETIC	PARA-SYMPATHETIC
SA node	↑ Heart rate	↓heart rate
AV node	↑conduction	↓conduction
Atrial muscle	↑contractility	↓contractility
Ventricular muscle	↑contractility	No significant effect

- **Sympathetic stimulation**
  - **α1: arterial vasoconstriction**
  - **α2: venous vasoconstriction**
  - **β: vasodilation**

Factors determine cardiac output



A summary of dynamic changes in MAP and TPR.



MBP=Cardiac output X Total peripheral resistance

Hemodynamic measures

- Cardiac output (CO)
  - CO=SV x HR
  - Normal CO: 4 to 8 L/min
- Cardiac index (CI)
  - cardiac output divided by the body surface area.
  - Normal cardiac index: 2.5 to 4 L/min/m2
- Central venous pressure (CVP)
  - Normal CVP: 2 to 8 mm Hg .
- Preload
  - the volume of blood in the ventricle at the end of diastole.
  - also called the left ventricular end-diastolic pressure.
  - Clinically, the preload is measured as the pulmonary artery occlusive pressure or the "wedge" pressure.

Hemodynamic measures(續)

- Afterload
  - the amount of work the ventricles must overcome to eject blood
  - referred to as systemic vascular resistance (SVR).
  - SVR = [(MAP - CVP)/CO] x 80.
  - Normal SVR : 800 ~ 1200 dynes/sec/cm-5
- Stroke volume (SV)
  - Normal stroke volume is 60 to 80 ml/beat.
- Pulmonary artery pressure (PAP)
  - Normal values : Systolic PAP: 15 to 30 mm Hg, Diastolic PAP: 8 to 15 mm Hg, Mean PAP: 10 to 20 mm Hg
- Pulmonary artery occlusive pressure (PAOP)
  - called the wedge pressure.
  - Normal pulmonary artery occlusive pressure is 8 to 15 mm Hg

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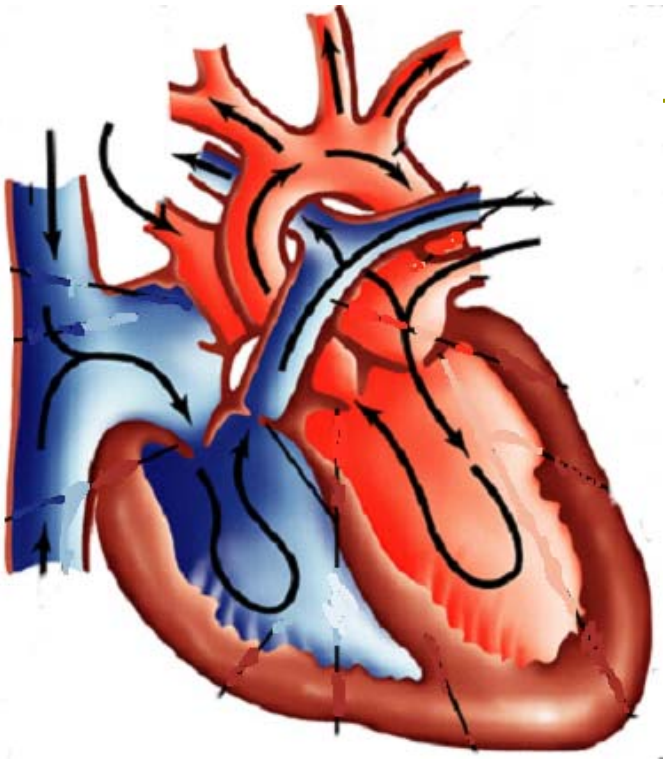

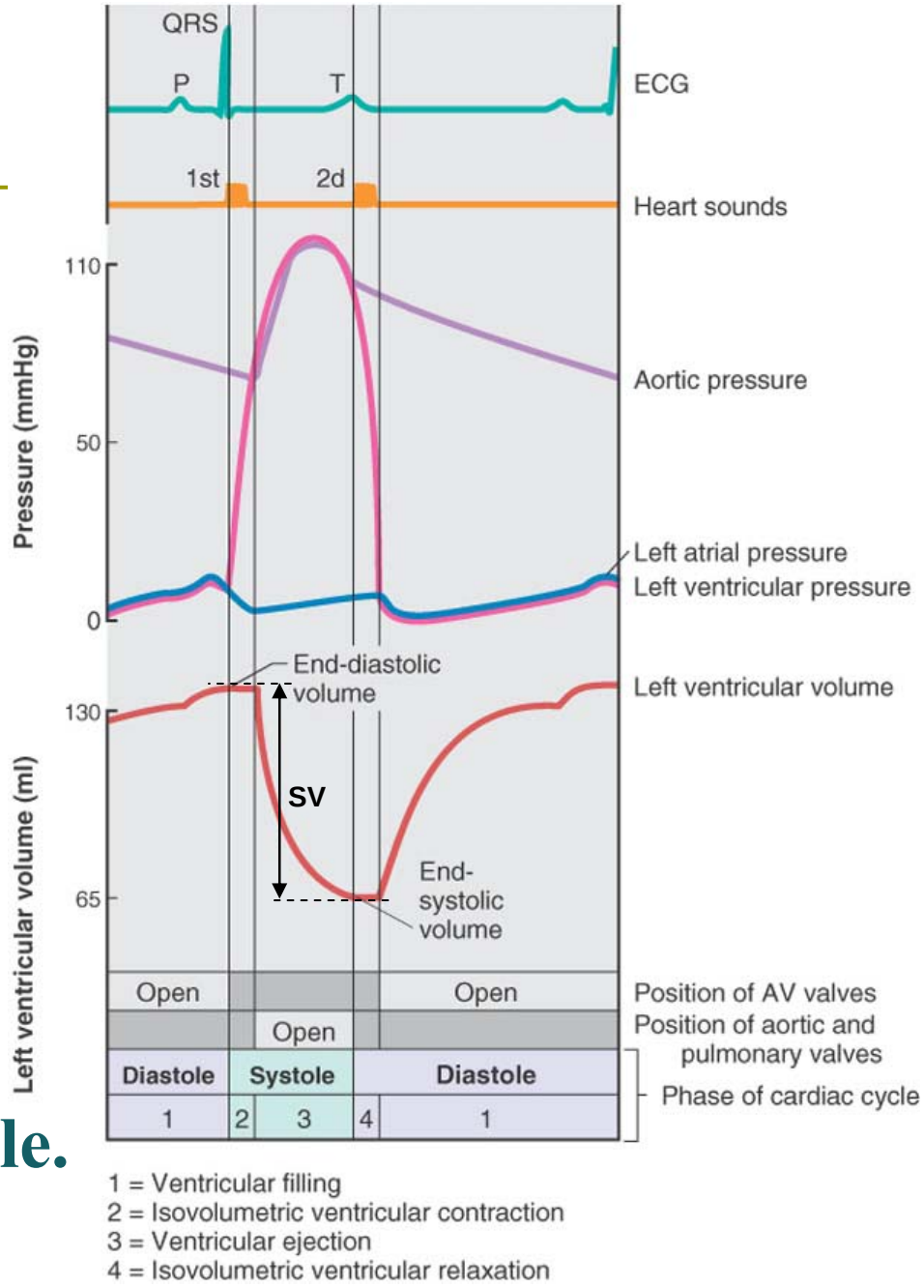

Pressure and volume changes in the left heart during a contraction cycle.

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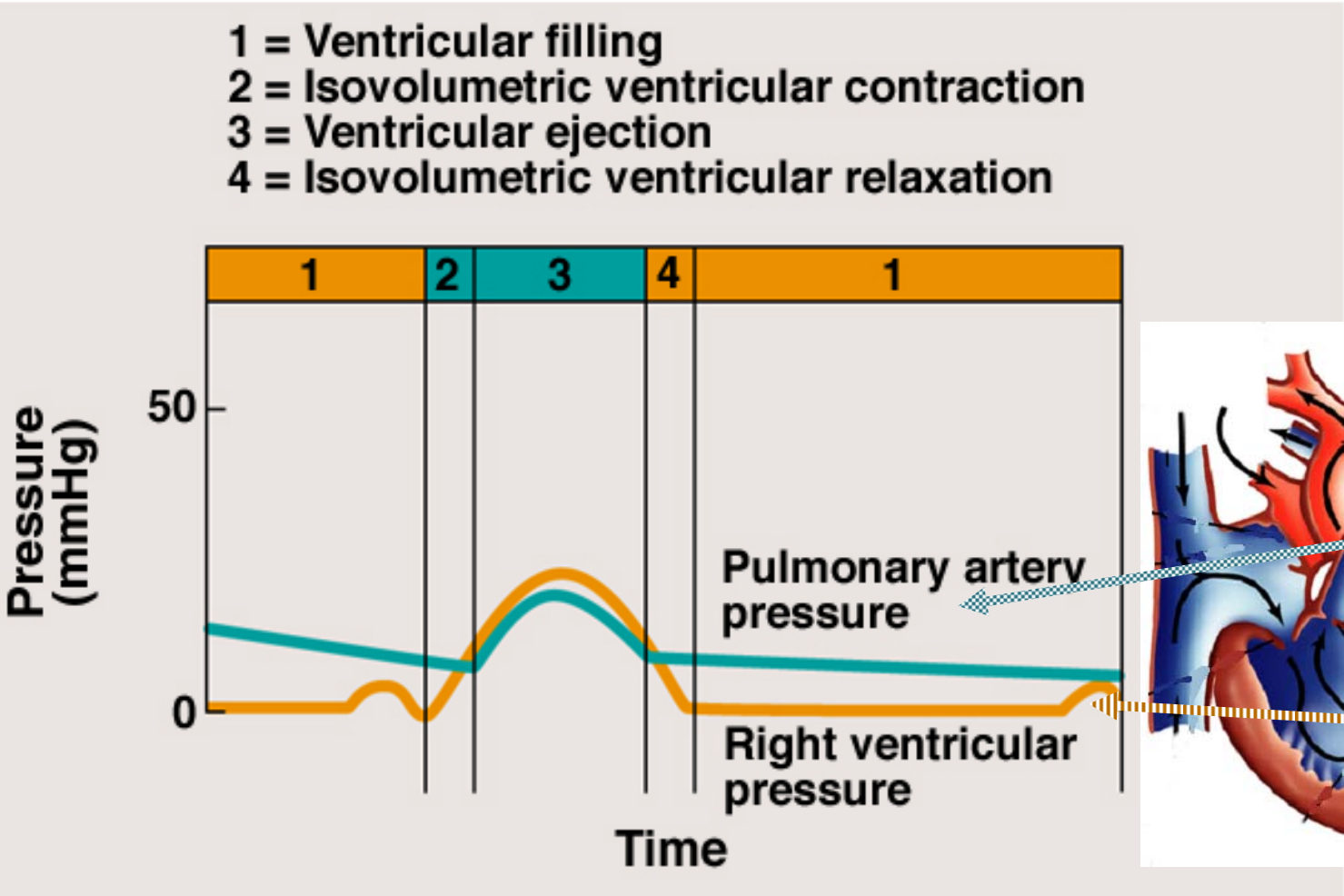
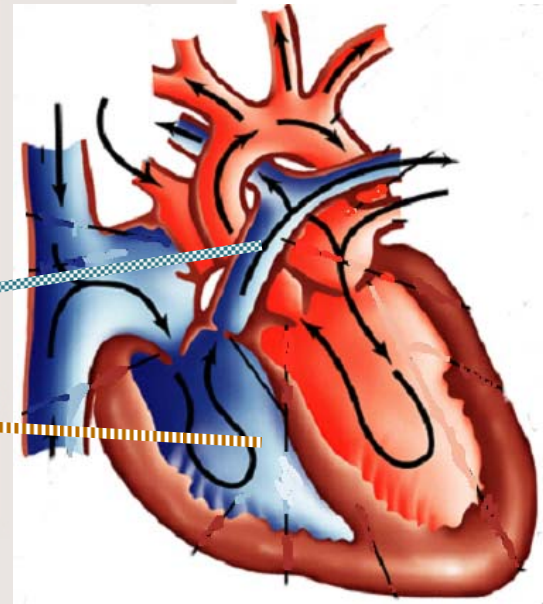
Pulmonary Circulation Pressure





Pressure changes in the right heart during a contraction cycle.

S-G catheter

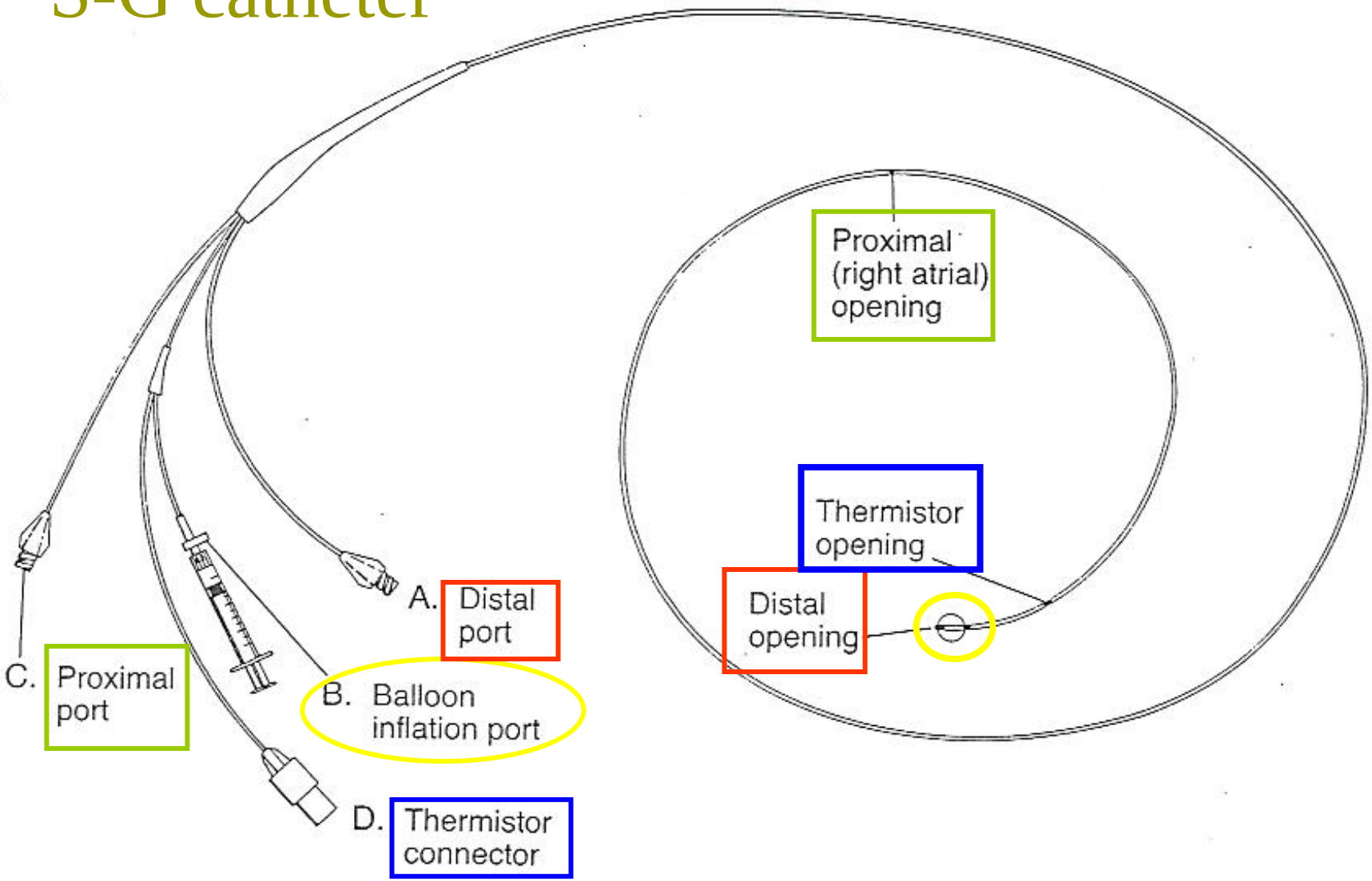
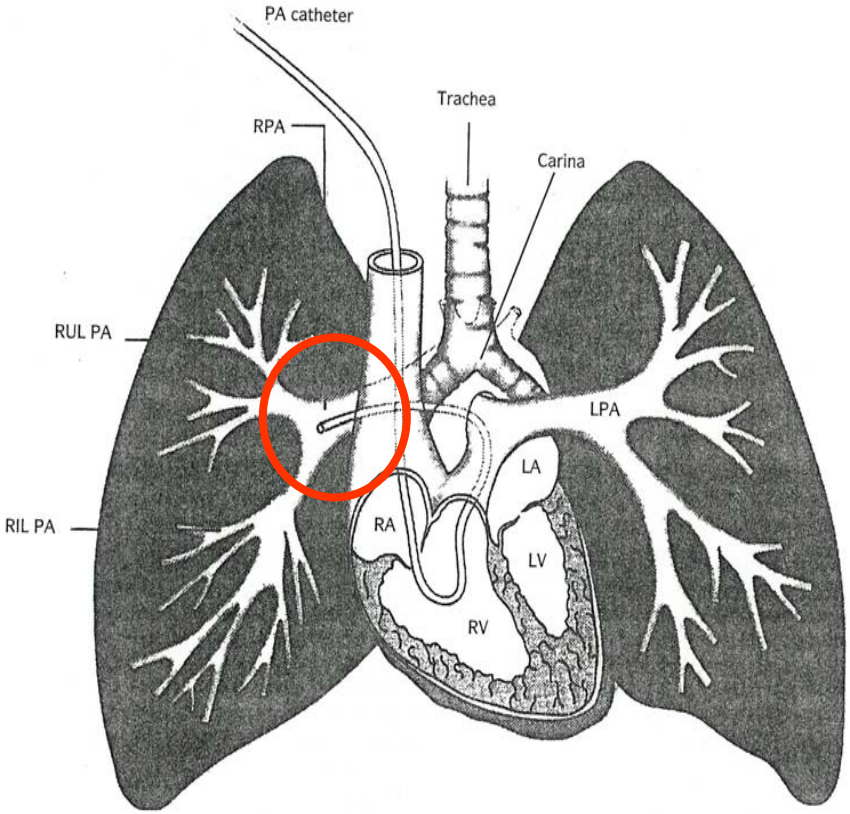
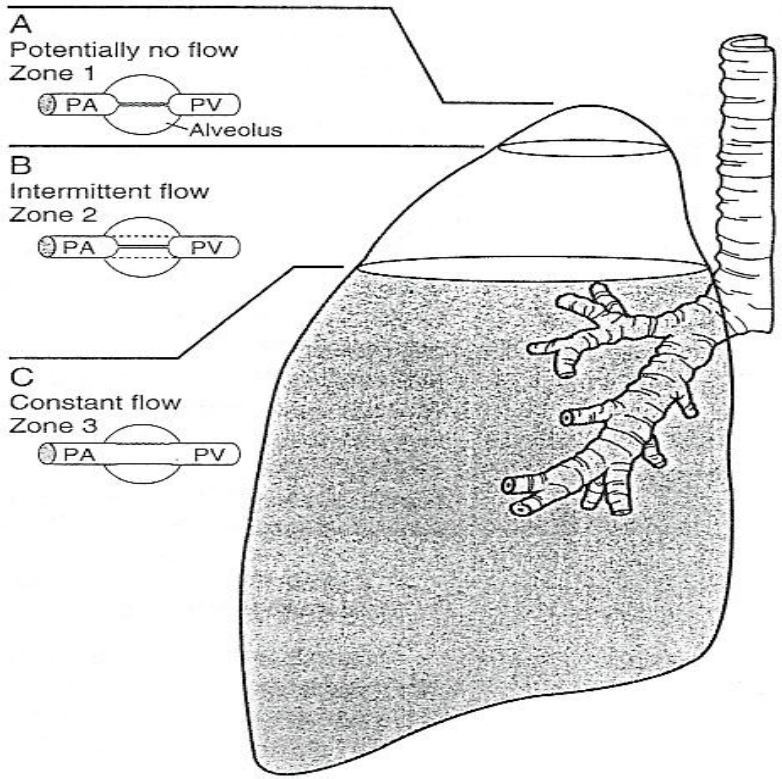
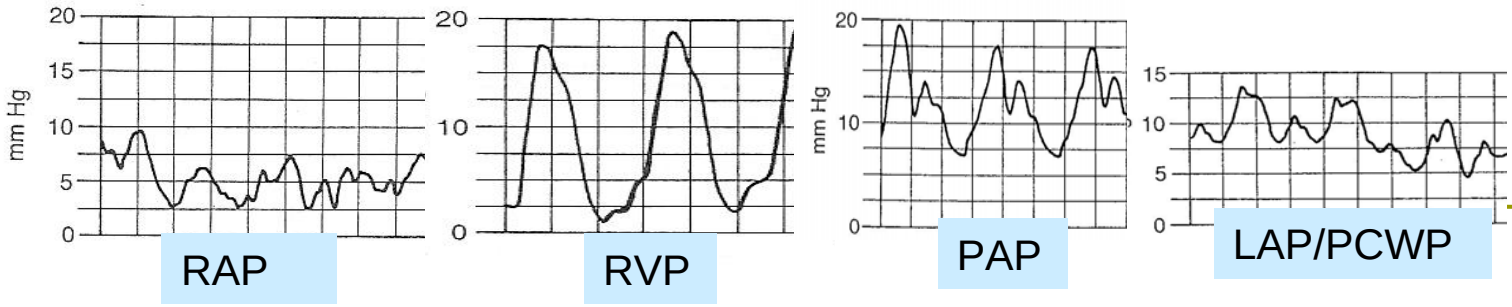


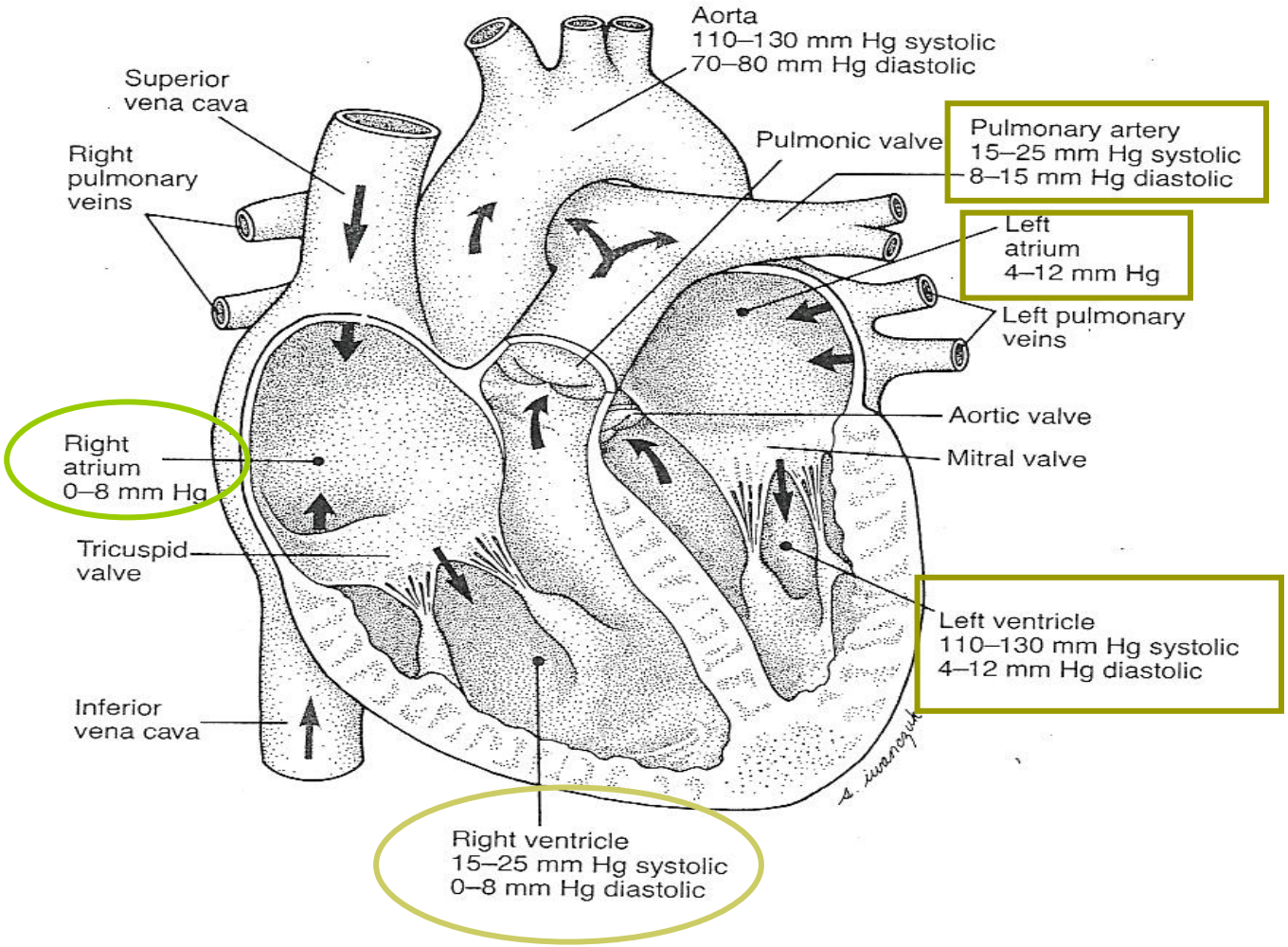
Figure 10–1 The #7 French quadruple lumen, thermodilution pulmonary artery catheter.

The position of SG






mm Hg
20
15
10
5
0
RAP
RVP
PAP
LAP/PCWP


Aorta
110–130 mm Hg systolic
70–80 mm Hg diastolic
Superior vena cava
Right pulmonary veins
Pulmonic valve
Pulmonary artery
15–25 mm Hg systolic
8–15 mm Hg diastolic
Left atrium
4–12 mm Hg
Left pulmonary veins
Aortic valve
Mitral valve
Right atrium
0–8 mm Hg
Tricuspid valve
Left ventricle
110–130 mm Hg systolic
4–12 mm Hg diastolic
Inferior vena cava
Right ventricle
15–25 mm Hg systolic
0–8 mm Hg diastolic

Correct IABP Timing

A = One complete cardiac cycle

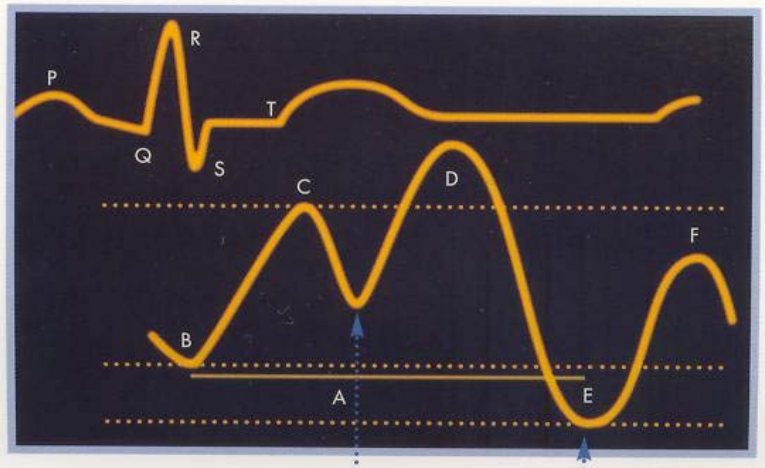
B = Unassisted aortic end diastolic pressure

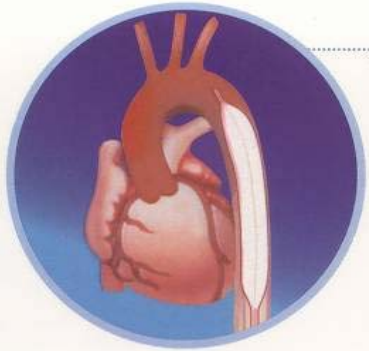
C = Unassisted systolic pressure

D = Diastolic augmentation

E = Reduced aortic end diastolic pressure

F = Reduced systolic pressure



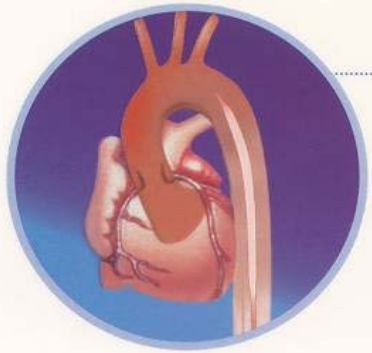


INFLATION

At the onset of diastole, IAB inflation occurs, giving rise to sharp "V" on arterial waveform.

Effect:

- Increased coronary perfusion



DEFLATION

Occurs at end of diastole prior to systole resulting in reduction of aortic end-diastolic and systolic pressures.

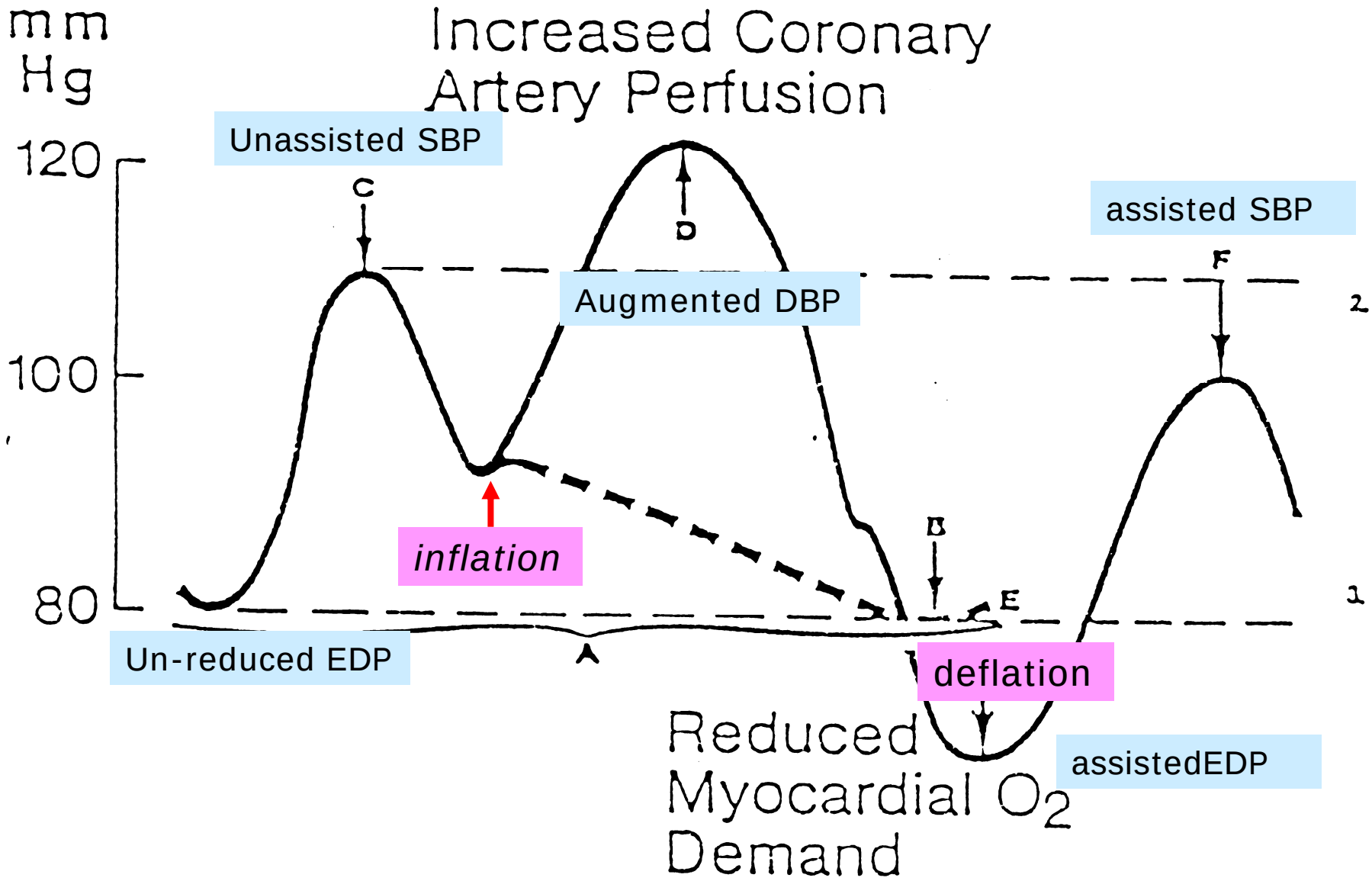
Effects:

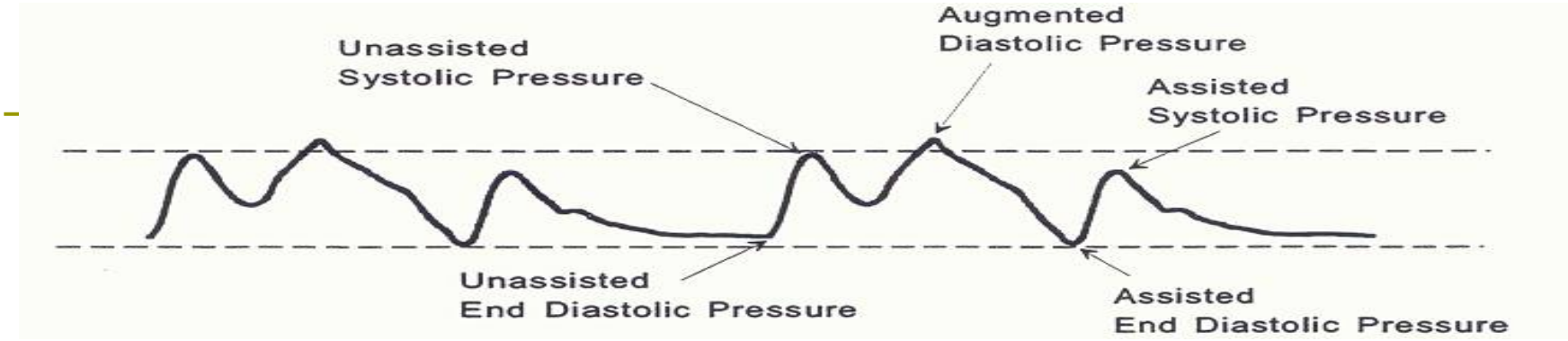
- Decreased afterload
- Decreased cardiac work
- Decreased myocardial oxygen consumption
- Increased cardiac output

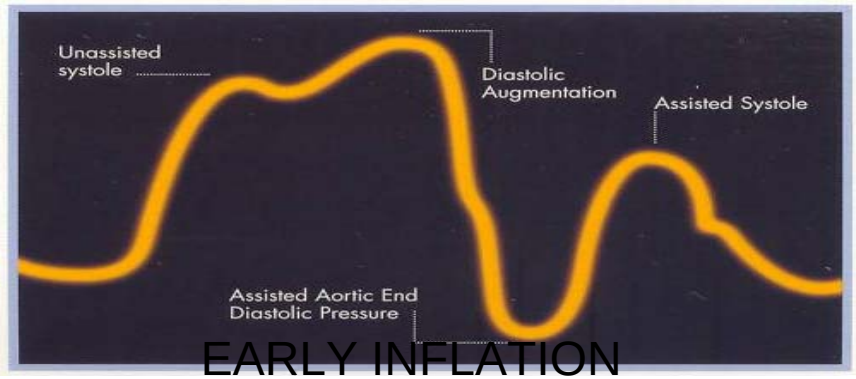
Please Note:

- R-Wave deflation may provide more effective support for patients experiencing arrhythmias

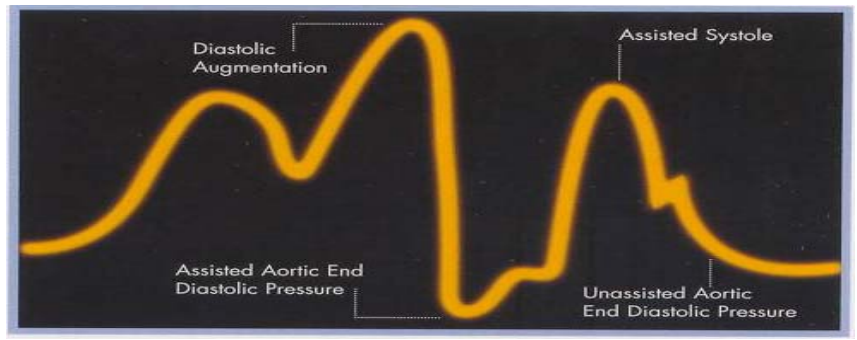
Benefits of IABP



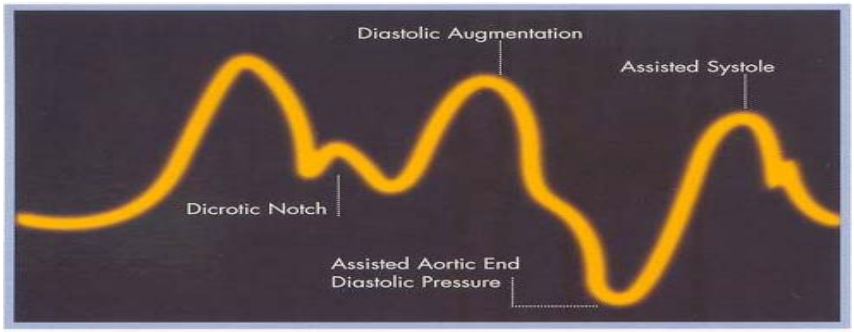




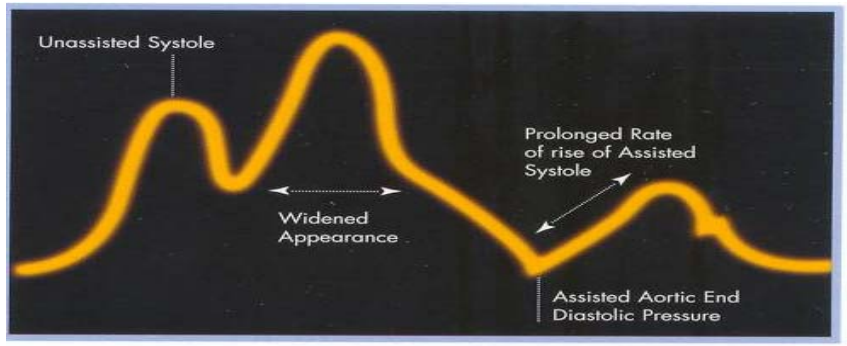
EARLY INFLATION



EARLY DEFLATION

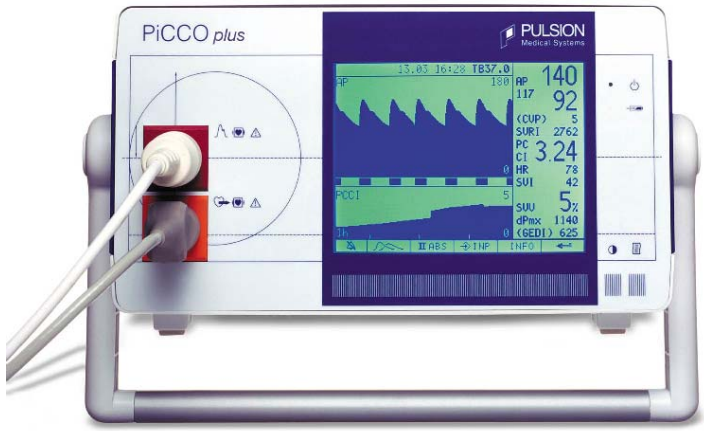


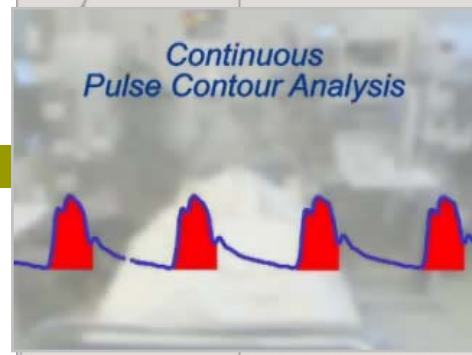
LATE INFLATION



LATE DEFLATION

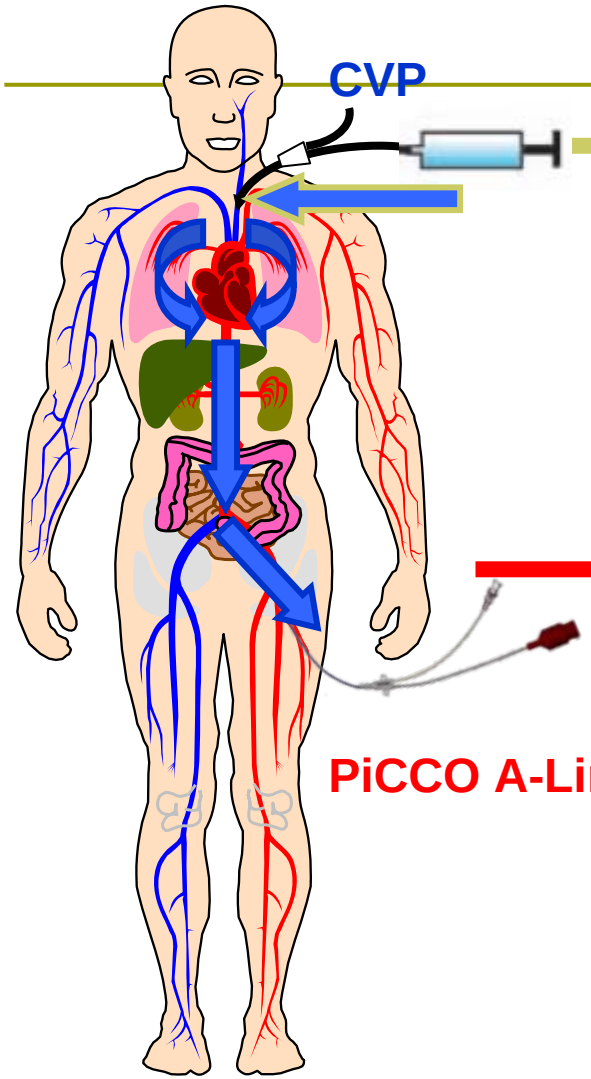
Pulse Contour Cardiac Output
PiCCO *plus*

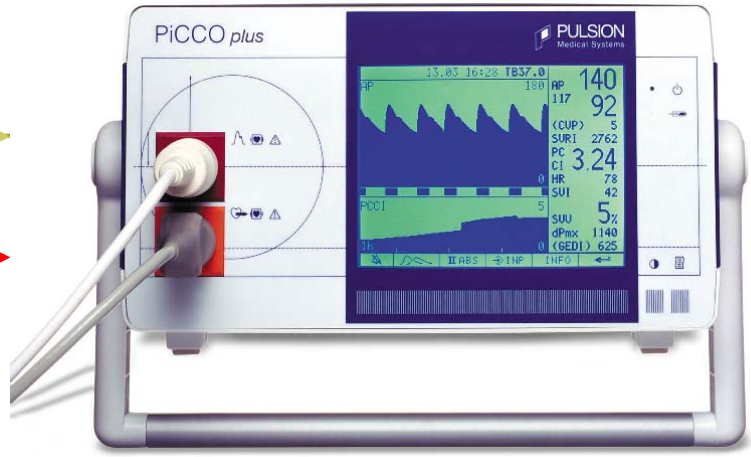




心肺容積監視器

- PiCCO ➡心肺容積量+連續血流動力學評估
- PiCCO利用經肺式熱稀釋法和脈搏曲線分析法結合計算求得胸內血容積量(Preload)、肺血管外水容積量和測量心臟功能(C.O.、Afterload、Contractility)的監視系統
- 所獲得之參數可直接使用於臨床診斷和治療。





經肺式溫度稀釋法 Transpulmonary thermodilution

- ❑CV端注入冰水(<8℃)或室溫水(<24 ℃)
- ❑PiCCO動脈熱稀釋導管測量

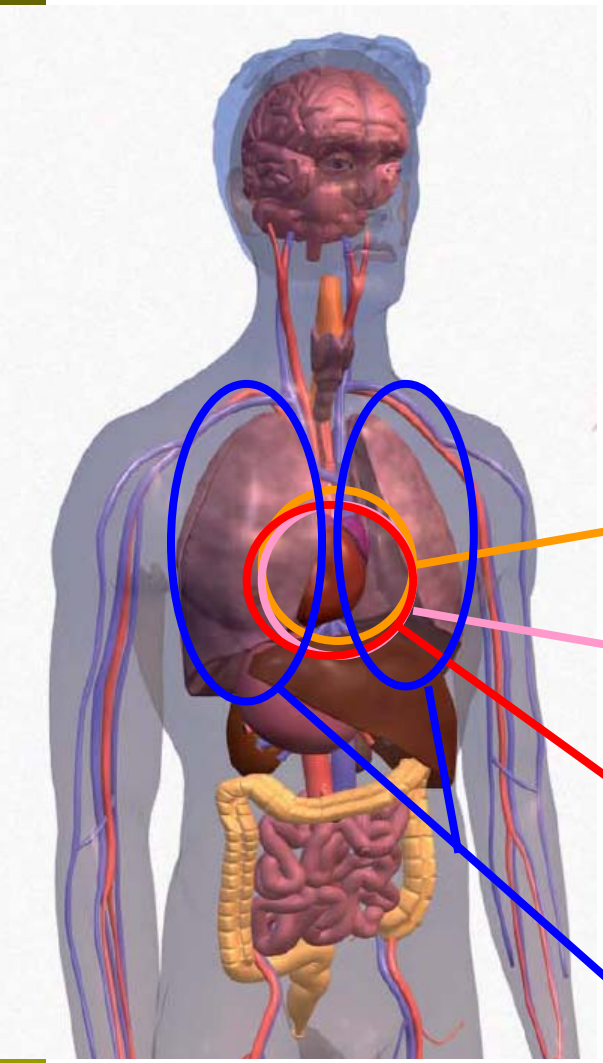
溫差變化(求得CO,ITBV,EVLW,PVPI…)

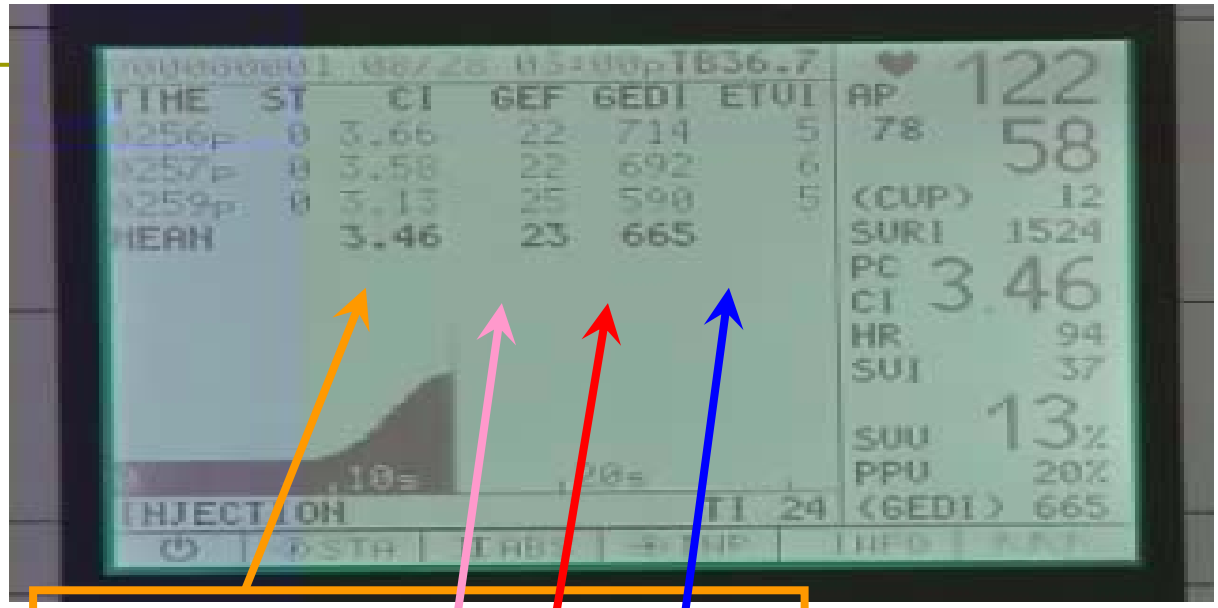
脈搏曲線分析法 Pulse Contour analysis

- ❑PiCCO動脈導管監測動脈波形

脈搏波形(求得CCO,SVR,SVV…)

經肺式溫度稀釋測量獲得心胸容積參數





心輸出量CI
Cardiac Index

心臟功能指示CFI
Cardiac Function Index

收縮能力參數

心臟舒張末期容積量GEDI
Global end-diastolic Volume Index

胸內血容積量ITBI
Intrathoracic Blood Volume Index

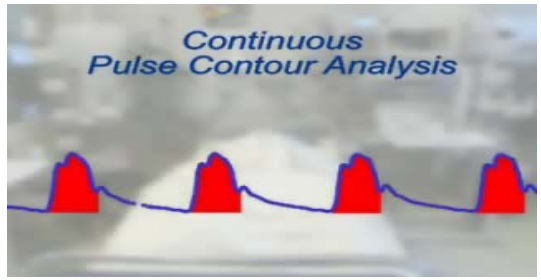
容積量參數

肺血管外水容積量EVLWI
Extravascular lung water Index

肺部狀況參數

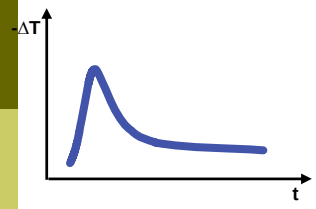
脈搏曲線分析連續獲得血流動力參數

連續心輸出量PCCI
Pulse Continuous Cardiac Index
動脈血壓AP
Arterial Blood Pressure
心跳HR
Heart Rate
心動排出量SV
Stroke Volume
全身血管阻力SVR
Systemic Vascular Resistance
左心室收縮力dPmx
Index of Left Ventricular Contract
心動排出變化率SVV
Stroke Volume Variation

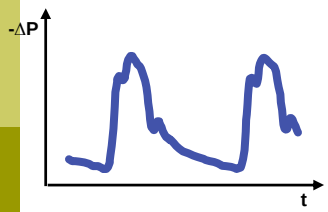


※每12秒更新乙次血流動力參數

Normal ranges



		Index	Range	Unit
Thermodilution Parameters				
Cardiac Output	CO	CI	3.0-5.5	l/min/m²
Global End-Diastolic Volume	GEDV	GEDI	680-800	ml/m²
Intrathoracic Blood Volume	ITBV	ITBI	850-1000	ml/m²
Extravascular Lung Water*	EVLW*	ELWI	3.0-7.0	ml/kg
Pulmonary Vascular Permeability Index	PVPI		1.0-3.0	-
Cardiac Function Index	CFI		4.5-6.5	1/min
Global Ejection Fraction	GEF		25-35	%



Pulse Contour Parameters				
Pulse Continuous Cardiac Output	PCCO	PCCI	3.0-5.5	l/min/m²
Arterial Blood Pressure	AP			
Heart Rate	HR			
Stroke Volume	SV	SVI	40-60	ml/m²
Stroke Volume Variation	SVV		<10	%
Pulse Pressure Variation	PPV		<10	%
Systemic Vascular Resistance	SVR	SVRI	1700-2400	dyn*s*cm^{-5}*m²
Index of Left Ventricular Contractility	dPmx			mmHg/sec