为什么需要中心动脉压?

北京协和医院重症医学科

何怀武

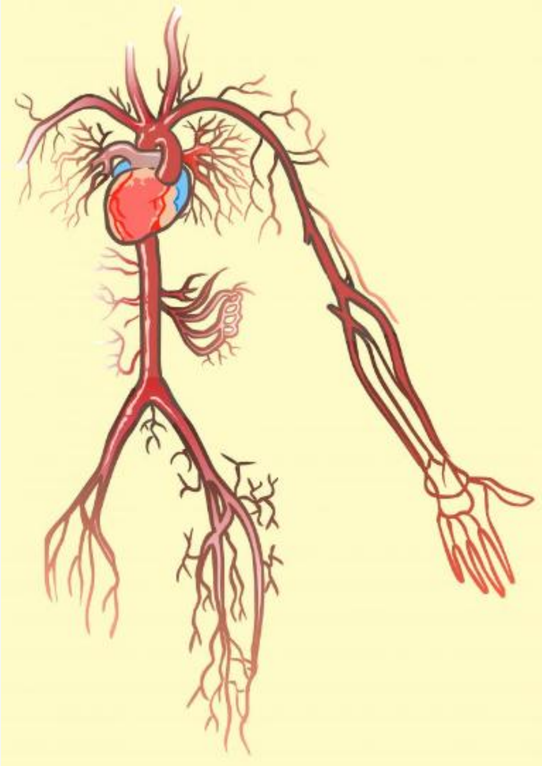
动脉血管功能分类

- 弹性贮器血管（大动脉）

  Windkessel vessel

- 分配血管（中动脉）

- 毛细血管前阻力血管（小动脉、微动脉）



Windkessel 效应

- 德国学者“Air chamber”译为Windkessel
- 弹性腔模型，可扩张性，弹性
- 搏动血流转变外周血管的平流
- 保证器官和组织连续灌注

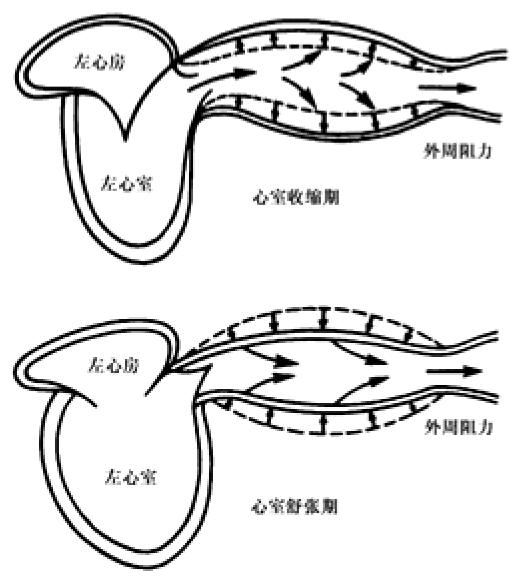
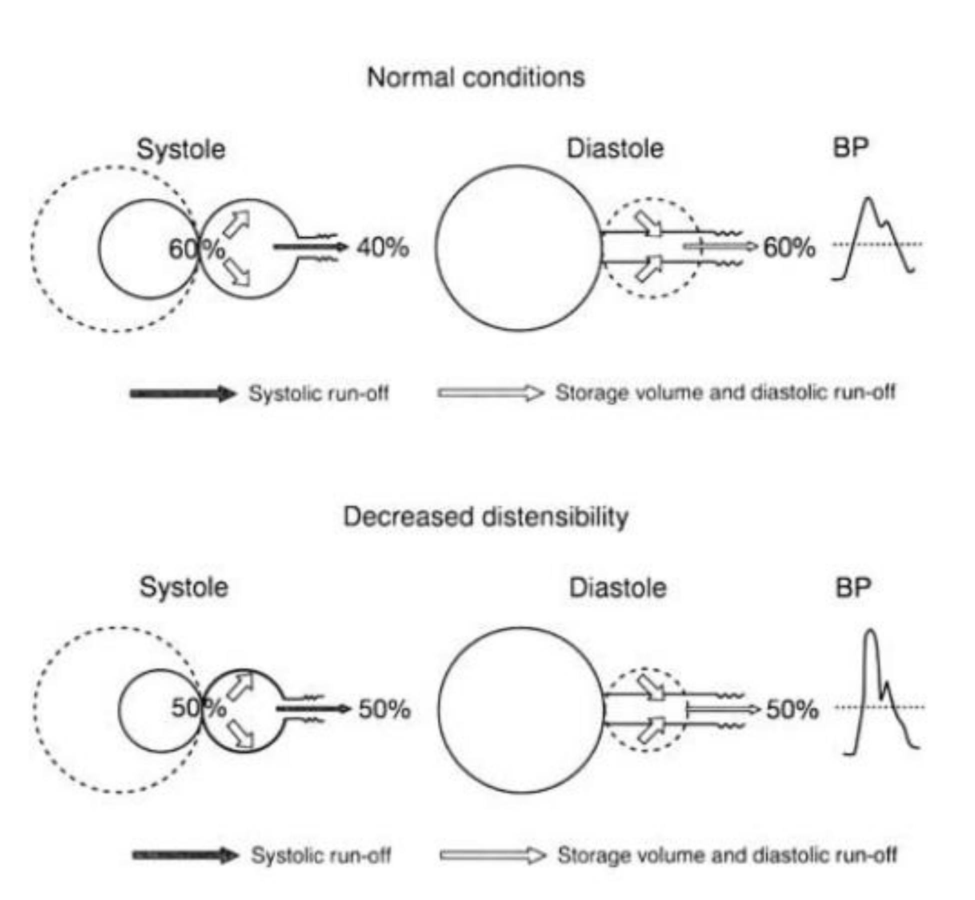


图3-16 主动脉管壁弹性作用示意图

Windkessel 效应



London GM, Am Heat J, 1999

脉搏波形的形成

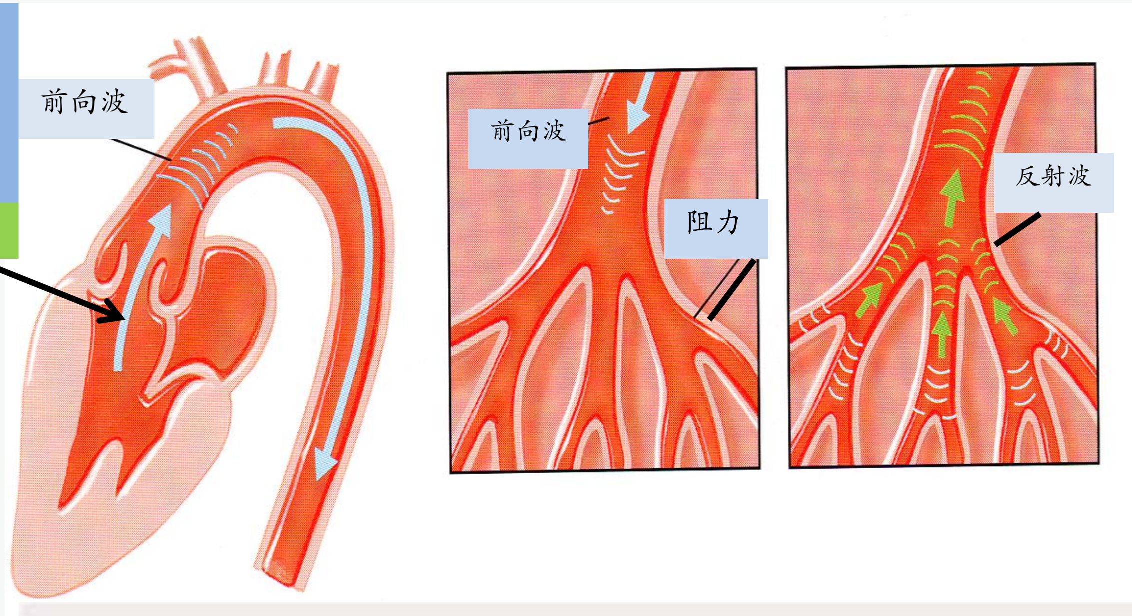
搏动传导速度

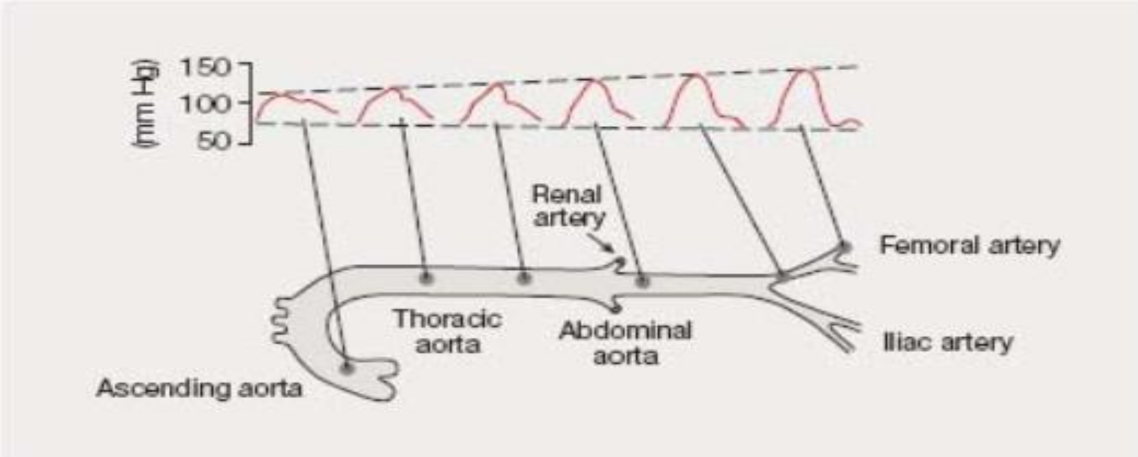
主动脉 3~5m/s

大动脉 7~10m/s

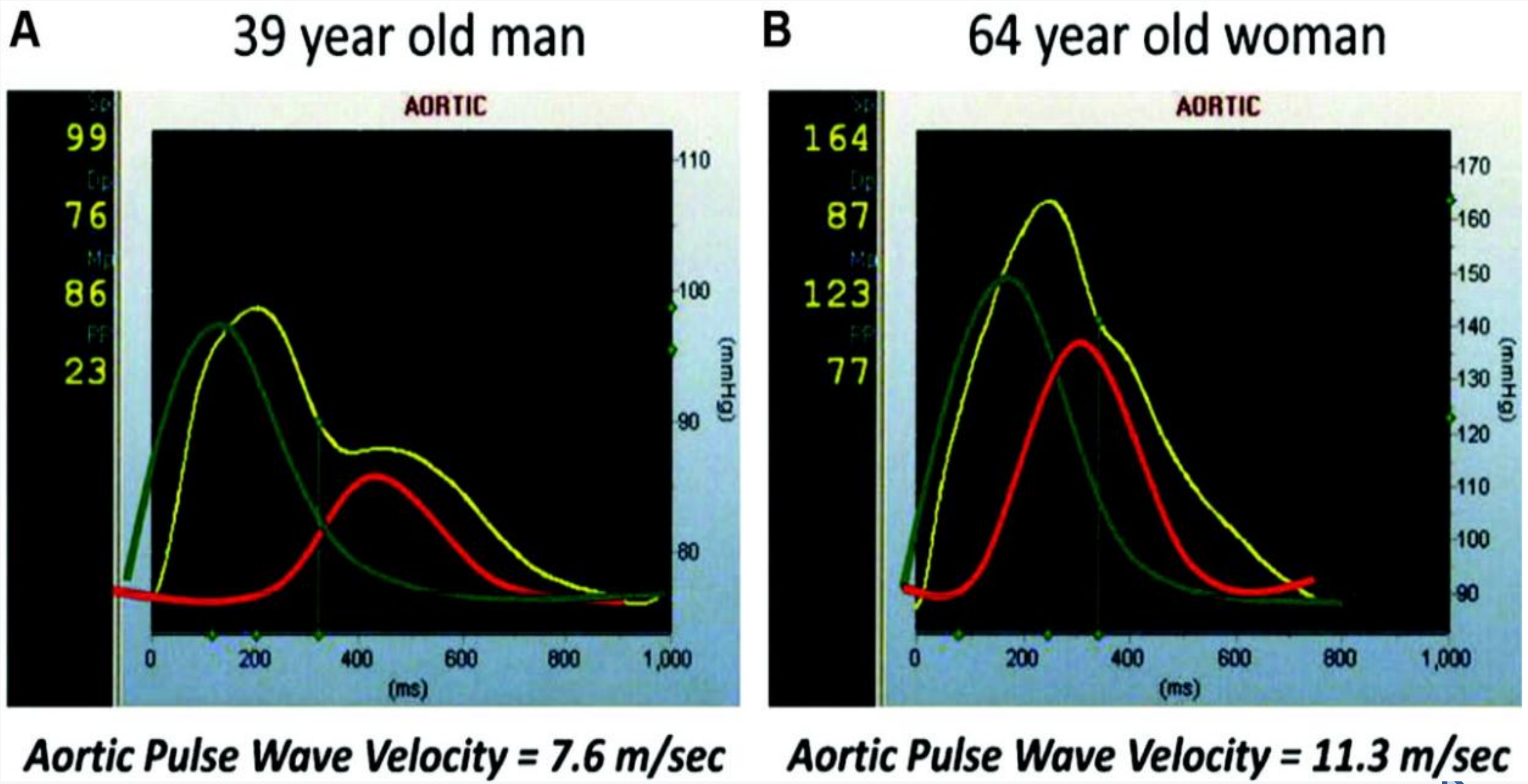
小动脉 15~35m/s

血流速度1m/s



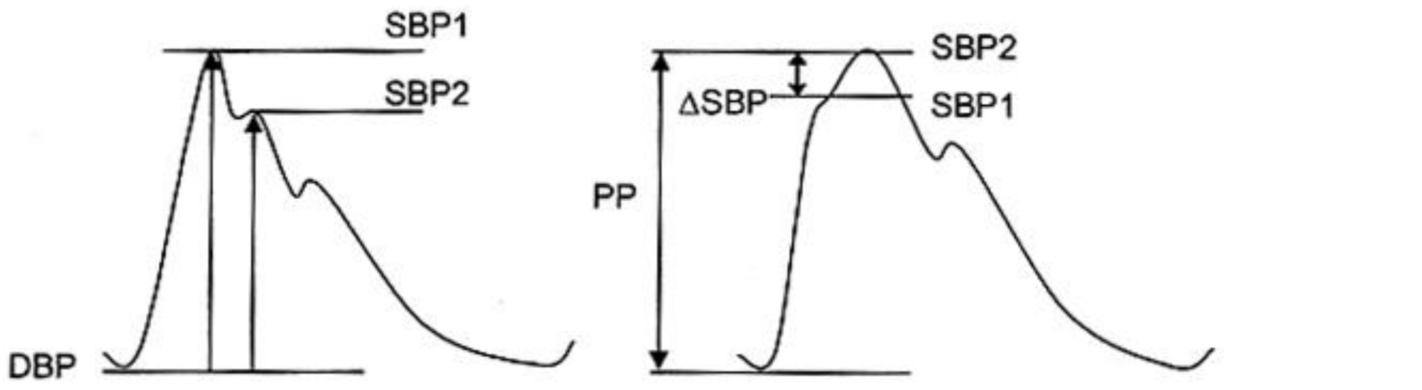


脉搏波与血压



随年龄逐渐增加，反射波升高，AI增加

中心动脉和外周动脉压力波形



Radial pressure pulse

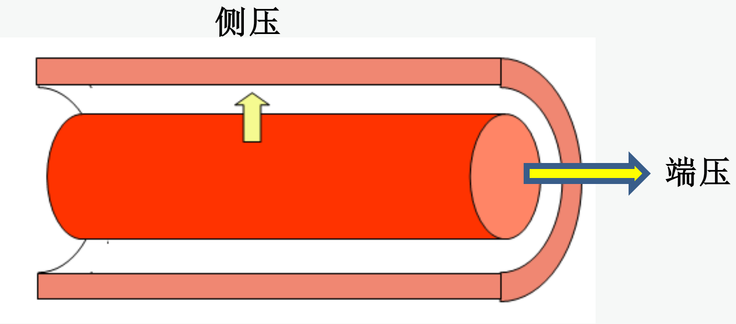
Aortic pressure pulse

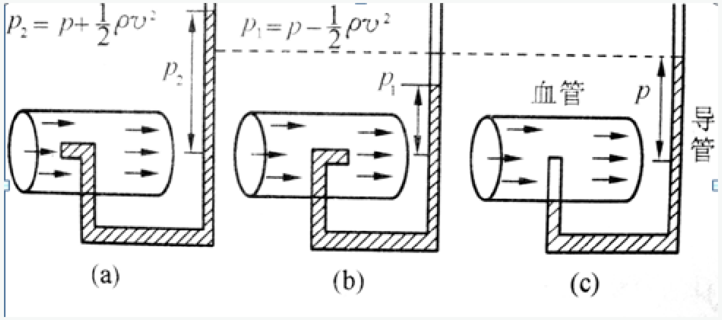
$$\text{Radial AI} = \frac{\text{SBP2} - \text{DBP}}{\text{SBP1} - \text{DBP}}$$

$$\text{Aortic AI} = \frac{\text{SBP2} - \text{SBP1}}{\text{PP}} = \frac{\Delta\text{SBP}}{\text{PP}}$$

Kohara K. Am J Hypertens 2005;18:11s-14s

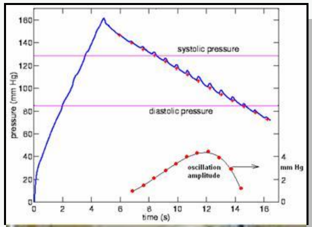
中心动脉压

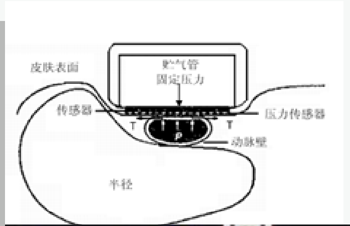




- 血压指血液对单位面积动脉管壁的侧压力
- 通常说的血压是指主动脉压
- 中心动脉压一般指主动脉根部的收缩压
- 中心动脉压是左心室的直接后负荷

血压测量的方法


systolic pressure
diastolic pressure
oscillation amplitude
time (s)
pressure (mm Hg)
mm Hg


皮肤表面
传感器
压力传感器
动脉壁


NBP
133
90
65
77
36.3


208
94/50 (77)
94/2 (52)
130/39 (72)

△ △

中心动脉压的测量

- 直接测量
- 间接测量 1.替代法 颈动脉压力波形

  2.合成法 转换函数 PWA的原理

桡骨动脉脉波测量（脉压测量法）	
AI	Augmentation Index
AI P75	脉搏数75/分时换算成AI值
P	脉搏数
SBP	发射波的最高血压
SBP2	反射波的最高血压

中心动脉压在高血压中的应用

- 硝酸酯类，减慢PWV，在未降低肱动脉血压，也可见中心动脉压下降
- 噻嗪类利尿剂和二氢吡啶类钙拮抗剂降低肱动脉和中心动脉的幅度相近
- β—受体阻滞剂降低中心动脉收缩压的幅度小于肱动脉
- ACEI降低中心动脉压的幅度大于肱动脉

中心动脉压在高血压中的应用

- 中心动脉压与高血压靶器官损害、心血管疾病发病率独立相关
- 预测、决定终点事件方面中心动脉压的意义优于外周动脉压
- 不同降压药在降低外周脉压上相近，而降低中心动脉压却有显著差异
- “血压外”效应或“袖带外”效应

中心动脉压的影响因素

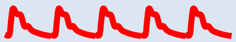
- 心输出量
- 外周阻力血管僵硬程度（PWV）
- 反射点的位置
- 反射波幅度
- 心率

中心动脉压在ICU中的提示

- 中心动脉压比外周动脉压更直接反映心室血管偶联
- 中心动脉压更直接地决定器官灌注
- 外周低灌注/大剂量血管活性药物，外周动脉和中心动脉压差异较大?
- 外周动脉波形对CCO监测的影响?

评价心脏后负荷的指标

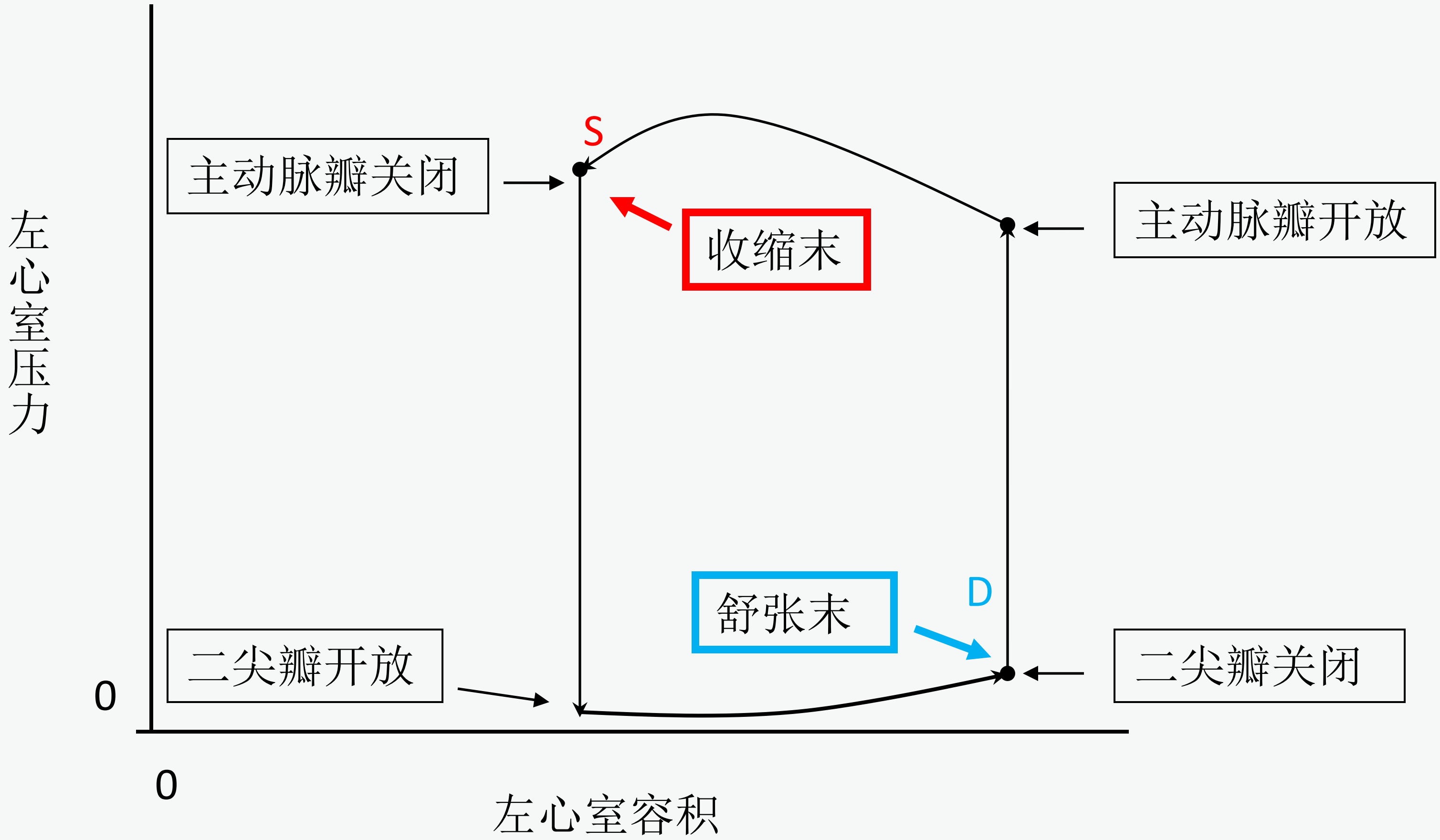
- 血管张力（arterial tone）＝ $K \cdot \dfrac{PP}{SV}$

搏动血流
阻 抗 

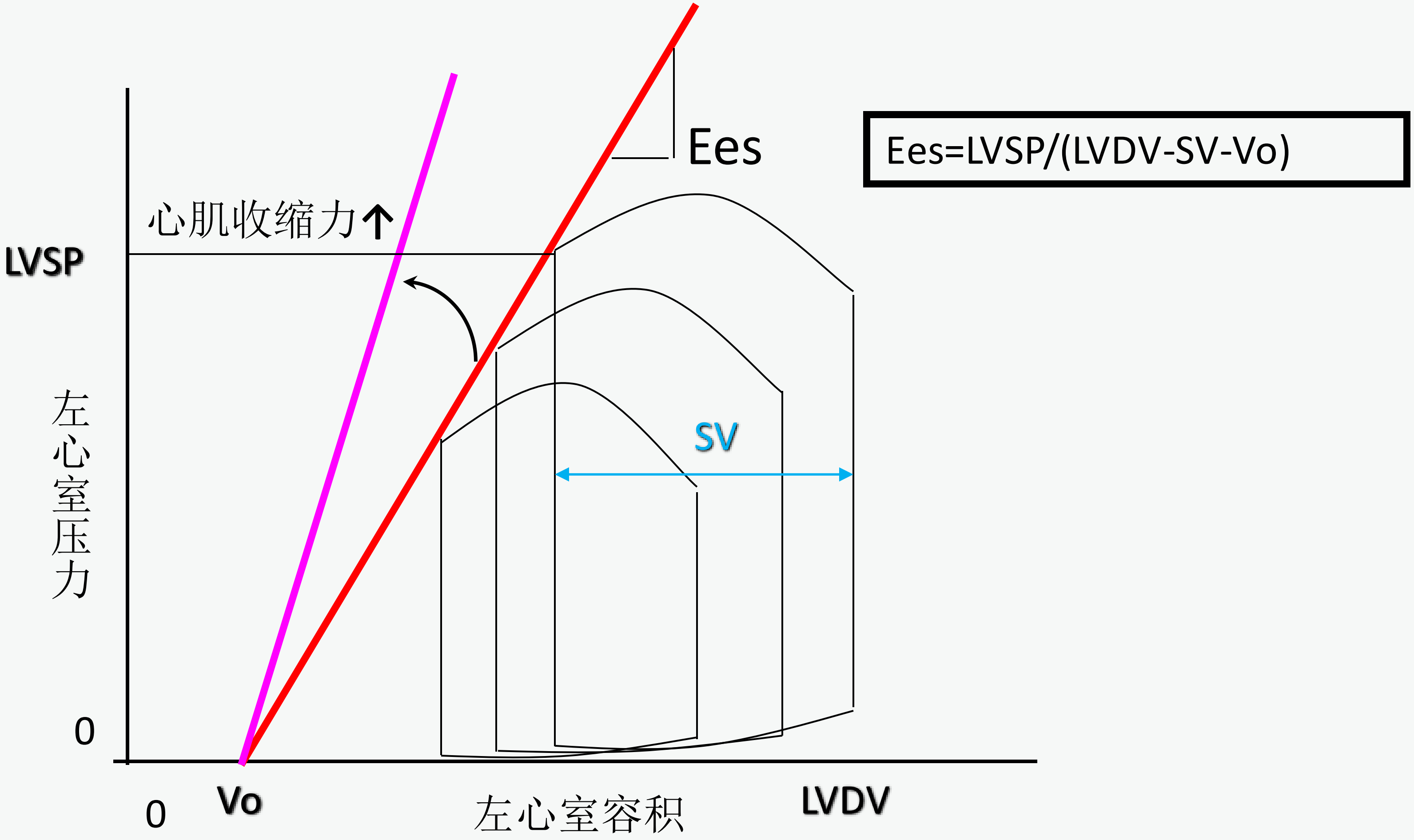
- 外周血管阻力（SVR）＝ $80 \cdot \dfrac{MAP-CVP}{CO}$

平 流
电 阻 

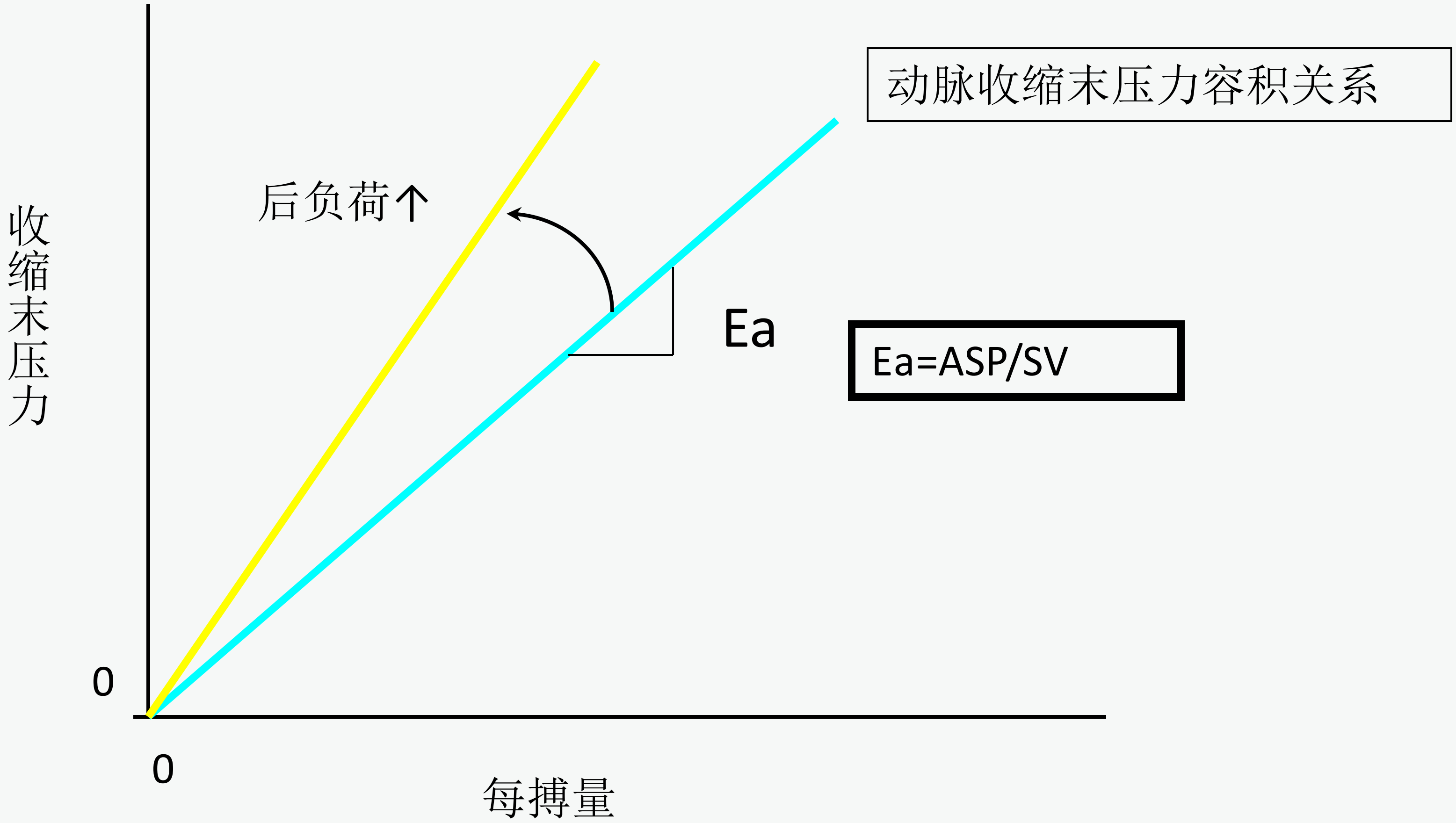
P-V 模型（心室压力容积环）



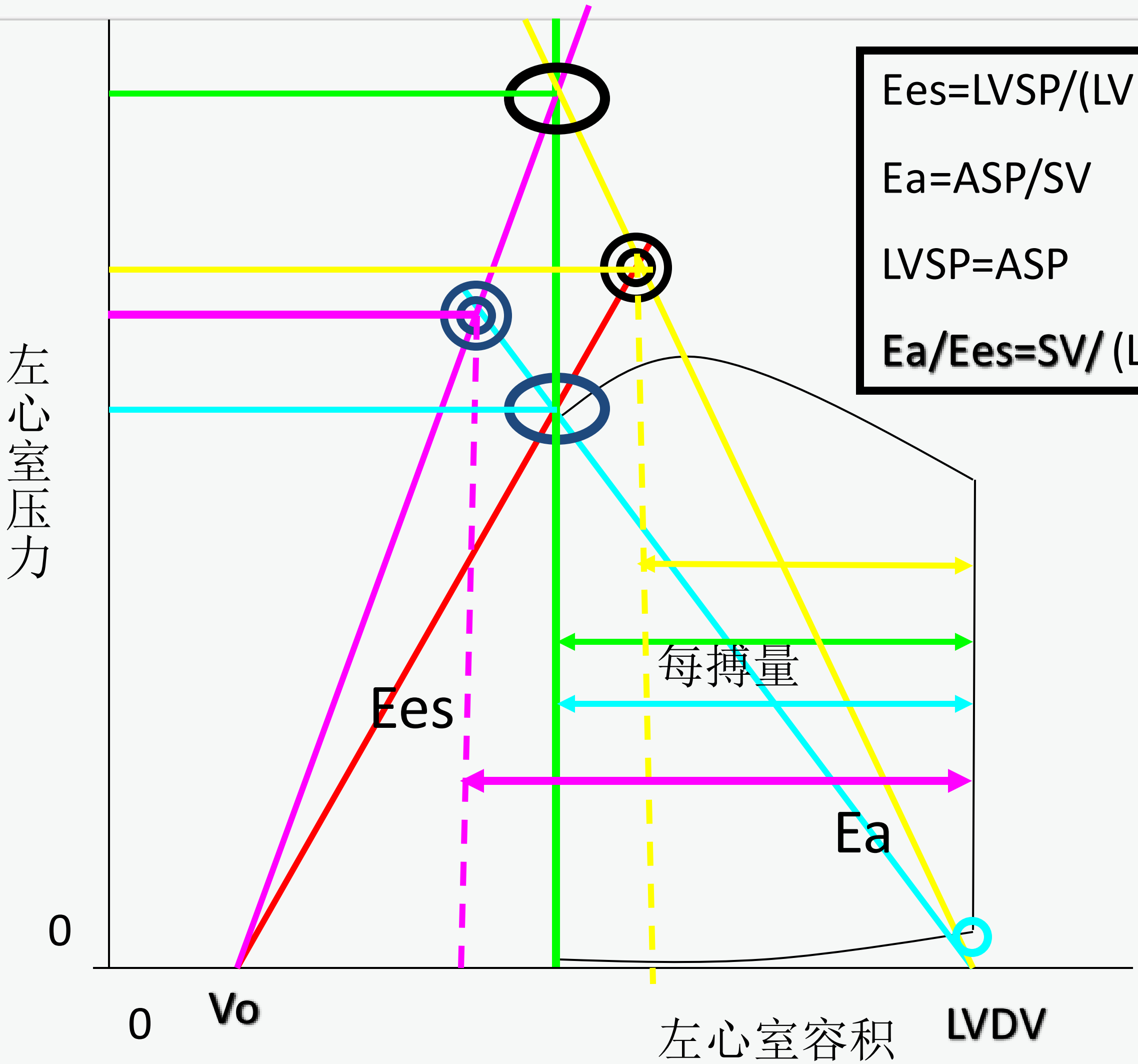
P-V模型 （Ees心室收缩末弹性=心肌收缩力）



P-V模型（Ea有效动脉弹性=后负荷）



P-V模型（Ea/Ees=偶联）



Ees=LVSP/(LVDV-SV-Vo)

Ea=ASP/SV

LVSP=ASP

Ea/Ees=SV/ (LVDV-SV-Vo)

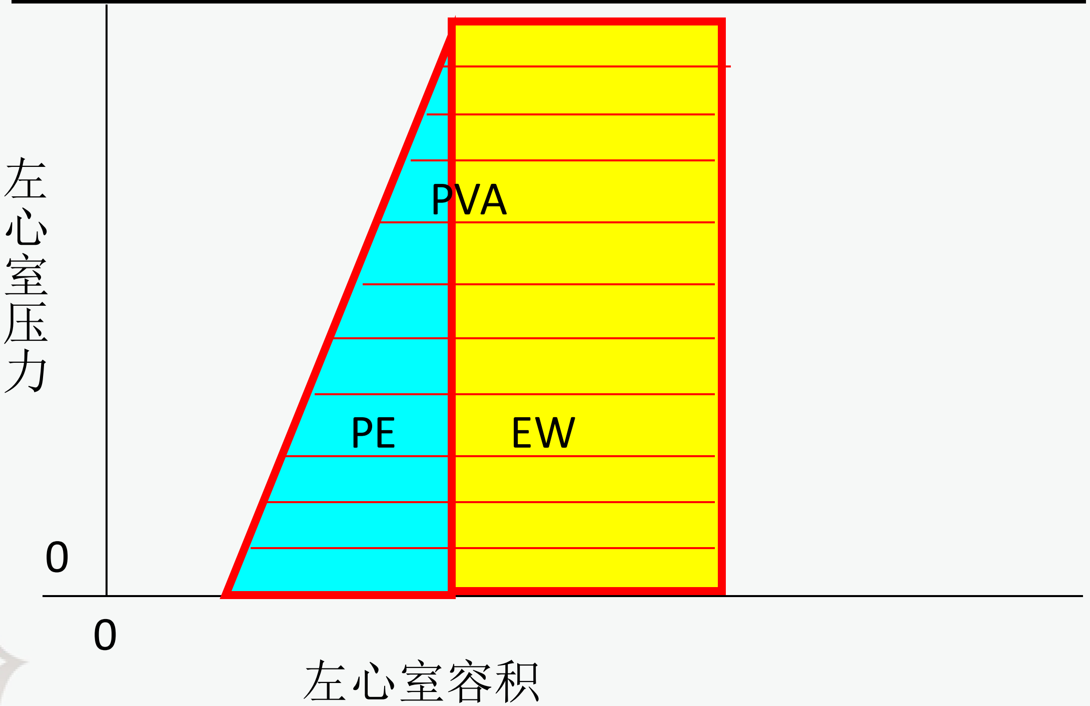
P-V模型（Ea/Ees=偶联）

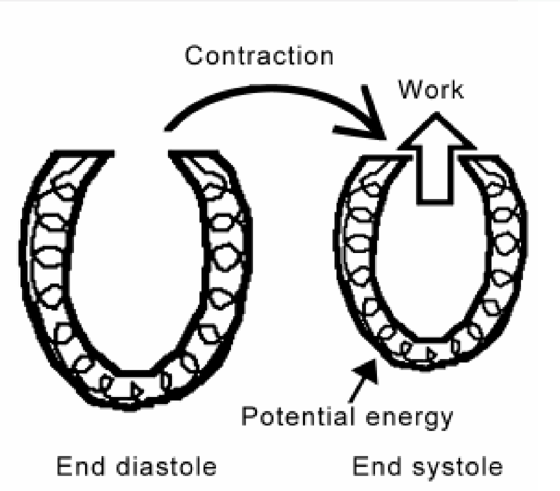
外功（EW, external work)= SW=SV×ASP

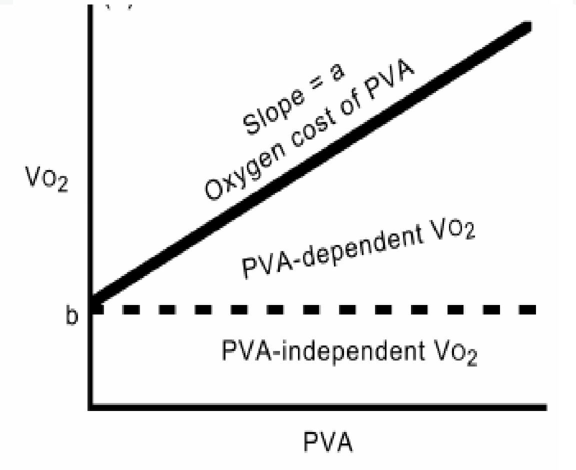
势能(PE ,potential energy) = (LVDV-SV-Vo) ×ASP/2

总机械功（PVA, pressure volume area ）=SW+PE

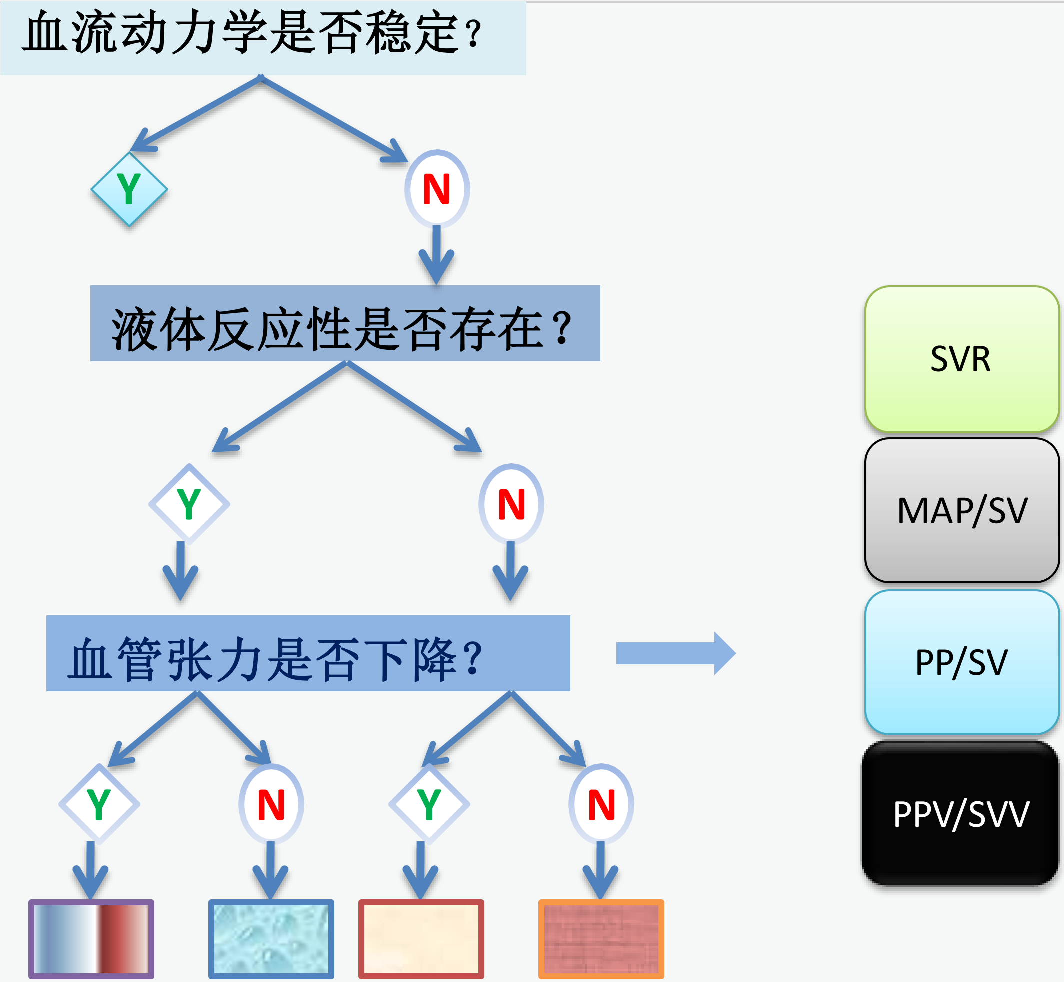
功效（Ef, work efficiency)=SW/PVA







心室-动脉偶联导向的血流动力学策略



Protocolized Cardiovascular Management Based on Ventricular-arterial Coupling

M. R. Pinsky

血流动力学

- 液体反应性，预测CO/SV的增加，血压呢?
- 去甲肾上腺素能替代液体吗?
- 液体能替代去甲肾上腺素吗，撤药试验?
- 心脏弹性-大动脉弹性
- 器官与器官

Factors influencing the accuracy of oscillometric blood pressure measurement in critically ill patients

Andreas Bur, MD; Harald Herkner, MD; Marianne Vlcek, MD; Christian Woisetschläger, MD; Ulla Derhaschnig, MD; Georg Delle Karth, MD; Anton N. Laggner, MD; Michael M. Hirschl, MD

Objective: Comparison of oscillometric blood pressure measurement with two different devices (M3000A using a new algorithm and M1008A using an established algorithm, both Hewlett Packard) and evaluation of current recommendations concerning the relation between cuff size and upper arm circumference in critically ill patients.

Design: Prospective data collection.

Setting: Emergency department in a 2000-bed inner-city hospital.

Patients: A total of 30 patients categorized into three groups according to their upper arm circumference (I, 18–25 cm; II, 25.1–33 cm; III, 33.1–47.5 cm) were enrolled in the study protocol.

Interventions: In each patient, two noninvasive blood pressure devices with three different cuff sizes were used to perform oscillometric blood pressure measurement. Invasive mean arterial blood pressure measurement was done by cannulation of the radial artery.

Measurement and Main Results: Overall, 1,011 pairs of simultaneous oscillometric and invasive blood pressure measurements were collected in 30 patients (group I, n = 10; group II, n = 10; group III, n = 10). The overall discrepancy between both methods with the M3000A was −2.4 ± 11.8 mm Hg ($p < .0001$) and, with the M1008A, −5.3 ± 11.6 mm Hg ($p < .0001$) if the recommended cuff size according to the upper arm circumference was used (352 measurements). If smaller cuff sizes than recommended were used (308 measurements performed in group II and III), the overall discrepancy between both methods with the M3000A was 1.3 ± 13.4 mm Hg ($p < .024$) and, with the M1008A, −2.3 ± 11.5 mm Hg ($p < .0001$).

Conclusion: The new algorithm reduced the overall bias of the oscillometric method but still showed a significant discrepancy between both methods of blood pressure measurement, primarily due to the mismatch between upper arm circumference and cuff size. The improvement of the algorithm alone could not result in a sufficient improvement of oscillometric blood pressure measurement. A reevaluation of the recommendations concerning the relation between upper arm circumference and cuff size are urgently required if oscillometric blood pressure measurement should become a reasonable alternative to intra-arterial blood pressure measurement in critically ill patients. (Crit Care Med 2003; 31:793–799)

KEY WORDS: oscillometric blood pressure measurement; cuff size; critically ill patients; emergency medicine; intensive care medicine; noninvasive; monitoring; upper arm circumference; mean arterial blood pressure; catecholamine treatment; mechanical ventilation

Noninvasive monitoring of blood pressure in the critically ill: Reliability according to the cuff site (arm, thigh, or ankle)*

Karim Lakhal, MD; Christine Macq, MD; Stephan Ehrmann, MD; Thierry Boulain, MD; Xavier Capdevila, MD, PhD

Objective: In the critically ill, blood pressure measurements mostly rely on automated oscillometric devices pending the intra-arterial catheter insertion or after its removal. If the arms are inaccessible, the cuff is placed at the ankle or the thigh, but this common practice has never been assessed. We evaluated the reliability of noninvasive blood pressure readings at these anatomic sites.

Design: Prospective observational study.

Setting: Medical–surgical intensive care unit.

Patients: Patients carrying an arterial line with no severe occlusive arterial disease.

Intervention: Each patient underwent a set of three pairs of noninvasive and intra-arterial measurements at each site (arm, ankle, thigh [if Ramsay sedation scale >4]) and, in case of circulatory failure, a second set of measurements after a cardiovascular intervention (volume expansion, change in catecholamine dosage).

Measurements and Main Results: In 150 patients, whatever the cuff site, the agreement between invasive and noninvasive readings was markedly higher for mean arterial pressure than for systolic or diastolic pressure. For mean arterial pressure measurement, arm noninvasive blood pressure was reliable (mean bias of 3.4 ± 5.0 mm Hg, lower/upper limit of agreement of −6.3/13.1 mm Hg) contrary to ankle or thigh noninvasive blood pressure (mean bias of 3.1 ± 7.7 mm Hg and 5.7 ± 6.8 mm Hg and lower/upper limits of agreement of −12.1/18.3 mm Hg and −7.7/19.2 mm Hg, respectively). During acute circulatory failure (n = 83), arm noninvasive blood pressure but also ankle and thigh noninvasive blood pressure allowed a reliable detection of 1) invasive mean arterial pressure <65 mm Hg (area under the receiver operating characteristic curve of 0.98 [0.92–1], 0.93 [0.85–0.97], and 0.93 [0.85–0.98] for arm, ankle, and thigh noninvasive blood pressure, respectively); and 2) a significant (>10%) increase in invasive mean arterial pressure after a cardiovascular intervention (area under the receiver operating characteristic curve of 0.99 [0.92–1], 0.90 [0.80–0.97], and 0.96 [0.87–0.99], respectively).

Conclusion: In our population, arm noninvasive mean arterial pressure readings were accurate. Either the ankle or the thigh may be reliable alternatives, only to detect hypotensive and therapy-responding patients. (Crit Care Med 2012; 40:1207–1213)

Key Words: ankle; arm; arterial pressure; calf; intensive care unit; monitoring; noninvasive blood pressure determination; oscillometry; physiologic; thigh

Results of a survey of blood pressure monitoring by intensivists in critically ill patients: A preliminary study

Arjun Chatterjee, MD, MS; Kirk DePriest, DO; Russell Blair, MD; David Bowton, MD; Robert Chin, MD

Objectives: Maintenance of mean arterial pressure >65 mm Hg has been associated with improved clinical outcomes in many studies of critically ill patients. Current guidelines for the management of septic shock and guidelines for managing other critical illnesses suggest intra-arterial blood pressure measurement is preferred over automated oscillometric noninvasive blood pressure measurement. Despite these recommendations, anecdotal experience suggested that the use of noninvasive blood pressure measurement in our institution and others in preference to intra-arterial blood pressure measurement remained prevalent.

Design: We designed an online survey and sent it by e-mail.

Setting: Intensive care units.

Patients and Subjects: A randomly selected group from the membership of the Society for Critical Care Medicine.

Interventions: None.

Measurements and Main Results: Use of non-invasive and invasive blood pressure devices. Eight hundred eighty individuals received an invitation to complete the survey and 149 responded. We found that 71% (105 of 149) of intensivists estimated the correct cuff size rather than measuring arm circumference directly. In hypotensive patients, 73% of respondents (108 of 149) reported using noninvasive blood pressure measurement measurements for patient management. In patients on a vasopressor medication, 47% (70 of 149) of respondents reported using noninvasive blood pressure measurement for management.

Conclusions: The use of noninvasive blood pressure measurement measurements in critically ill patients is common despite the paucity of evidence validating its accuracy in critically ill patients. Given this widespread use, accuracy and precision validation studies comparing noninvasive blood pressure measurement with intra-arterial blood pressure measurement in critically ill patients should be performed. (Crit Care Med 2010; 38:2335–2338)

Key Words: arterial blood pressure monitoring; hemodynamic monitoring; blood pressure; monitoring; medical devices

Research

Open Access

Peripheral arterial blood pressure monitoring adequately tracks central arterial blood pressure in critically ill patients: an observational study

Mariano Alejandro Mignini[1], Enrique Piacentini[1,2] and Arnaldo Dubin[3]

Abstract

Introduction Invasive arterial blood pressure monitoring is a common practice in intensive care units (ICUs). Accuracy of invasive blood pressure monitoring is crucial in evaluating the cardiocirculatory system and adjusting drug therapy for hemodynamic support. However, the best site for catheter insertion is controversial. Lack of definitive information in critically ill patients makes it difficult to establish guidelines for daily practice in intensive care. We hypothesize that peripheral and central mean arterial blood pressures are interchangeable in critically ill patients.

Methods This is a prospective, observational study carried out in a surgical-medical ICU in a teaching hospital. Fifty-five critically ill patients with clinical indication of invasive arterial pressure monitoring were included in the study. No interventions were made. Simultaneous measurements were registered in central (femoral) and peripheral (radial) arteries. Bias and precision between both measurements were calculated with Bland-Altman analysis for the whole group. Bias and precision were compared between patients receiving high doses of vasoactive drugs (norepinephrine or epinephrine >0.1 µg/kg/minute or dopamine >10 µg/kg/minute) and those receiving low doses (norepinephrine or epinephrine <0.1 µg/kg/minute or dopamine <10 µg/kg/minute).

Results Central mean arterial pressure was 3 ± 4 mmHg higher than peripheral mean arterial pressure for the whole population and there were no differences between groups (3 ± 4 mmHg for both groups).

Conclusion Measurement of mean arterial blood pressure in radial or femoral arteries is clinically interchangeable. It is not mandatory to cannulate the femoral artery, even in critically ill patients receiving high doses of vasoactive drugs.

CRITICAL CARE

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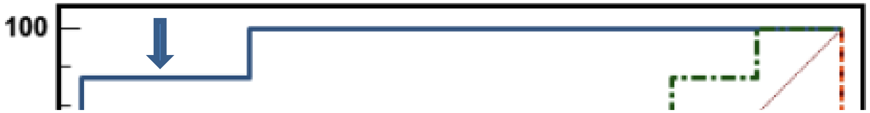
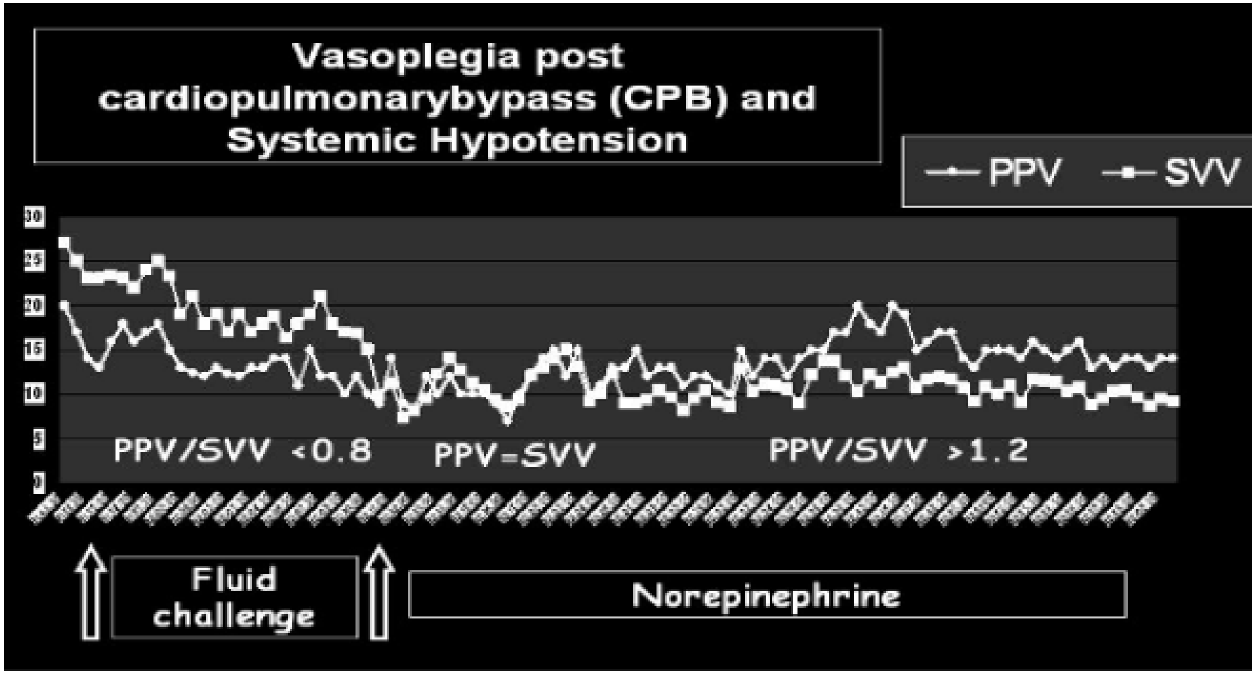
Dynamic arterial elastance to predict arterial pressu… preloa…





sensitivity of 9… 0 20 40 60 80 100

Conclusions: F… 100-Specificity …licted arterial pressure response after volume loading in hypotensive, preload-dependent patients under controlled mechanical ventilation.

Eadyn(PPV/SVV) 导向的低血压循环衰竭复苏策略

Eadyn < 0.89 → 液体+血管活性药 → BP↑

Eadyn > 0.89 → 液体 → BP↑

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Thanks

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