

Vito Starc

Long Term CVS Control

Introduction

This course is divided into two parts. The purpose of the first one is to introduce basic elements of the cardiovascular system and their properties, necessary for the mathematical description of the short-term and long-term regulation of blood pressure. The second part will be focused on the current understanding of the essential hypertension, describing possible pathophysiologic mechanisms using the basic elements from the first part, though with more phenomenological than mathematical description.

The topics covered are as follows:

1. Basic elements of the cardiovascular system and their properties;
 - (a) The heart as a pump, cardiac output and its determinants (preload, afterload, heart rate and contractility), description in the pressure volume diagram and in the flow pressure diagram.
 - (b) Vessels, vessel resistance, and compliance and its control: local (autoregulation, endothelium dependent vasodilatation) and central (nervous and endocrine).
 - (c) Valves
2. Modelling of the CVS elements (heart models, vessel models);
 - (a) how to relate geometric properties to the function (lumped parameter models, distributed models; cavity pressure-wall stress and cavity volume -wall strain relationships).
3. Closed CVS and its properties, distribution of fluid in the CVS (stressed volume, unstressed volume), contribution of the vascular system (venous return curves), and the heart (cardiac function curves) to the circulation.
4. Extracellular volume homeostasis,

- (a) Distribution of fluid between the extracellular (EC) and intracellular space (basic concepts of the transcellular fluid and electrolyte exchange), and between the EC and vascular space (transcapillary fluid exchange).
 - (b) The kidney and the role of renal sodium handling in the retention of body water, pressure natriuresis
5. Short term CVS control;
- (a) Cardiovascular reflexes (baroreflex and its influences).
 - (b) The role of the 'central command' as a baroreflex modulator in regulation of blood pressure, the concept set-point and its necessity in the blood pressure regulation.
 - (c) The 'central command' model based on the demand-supply mechanism.
6. Long term control
- (a) Endocrine control of the CVS: renin-angiotensin-aldosterone system, NO, endothelin.
 - (b) Mechanisms of sodium retention in the essential hypertension.
 - (c) Cardiovascular system remodeling as an adaptation to increased blood pressure and increased flow.
7. Essential hypertension: what do epidemiologic data and the related risk factors (diet factors: high sodium, low potassium and calcium intake), and genetic data suggest on possible mechanisms of the long term CVS regulation.