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Introduction Lecture

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Abstract. Functions of cardiovascular system include transportation and immune system, but also acid and base balance. The components performing function are pump (heart), vessels, and blood. Finally, the system has two divisions; pulmonary and systemic divisions.

Anatomical Aspects. To understand cardiovascular hemodynamics including modelling and its clinical applications we need to know anatomical overview, amounts of blood, cross sectional areas, rate of flow and pressure differences. The heart has two major components: contractile – cardiac muscle and conductile – SA node, AV node, bundle of His, Purkinje system and bundle branches. Vessels have different structures and inside the vessel there is endothelium under that basement membrane and under that internal elastic lamina. Tunica media includes smooth muscles and externa elastic lamina, tunica externa is mostly composed of collagen. The structure of arterioles, capillaries, venules and veins is a little bit different. Special attention should be focused on the pressure, which is highest in the arteries and lowest in the veins. Between these there are arterioles, capillaries and venules. The function of arteries is elastic recoil and pressure curve formation. Atherosclerosis and aneurysms are the major of pathologies, which may change the function and pressure.

Regulation of Hemodynamics. Arterioles regulate flow especially during the exercise. The functional control of this arteriolar regulation is via autonomic nervous system and also via local regulators like CO2, H+, O2, prostaglandins, kinins and histamines. Capillaries are needed in regulation of flow, especially microcirculation, and are important in exchange between fluid compartments via diffusion and filtration-bulk flow. Venules and veins have a special anatomy. The healthy valves improve the venous return to the heart and on the other way varicose veins cause abnormal return of venous flow especially in the lower extremities.

Both pressure and flow are important parts of hemodynamics. There are two circulations, the other one via lungs and the other one via the whole rest of the body. The systemic veins return blood via vena cava to the right atrium and then via tricuspid valve to the right ventricle, and finally via pulmonary semilunar valve to pulmonary arteries. Oxygenated blood returns back via pulmonary veins to the left atrium and via bicusbid valve to the left ventricle and then through the aortic semilunar valve to the systemic aorta. Considering hemodynamics, both pressure and flow are different in the small circulation and the systemic circulation. The vascular resistance is also totally different in this small circulation compared to the systemic circulation.

The blood pressure is regulated by neural mechanisms: Baroreceptors, chemoreceptors, CNS, as well as ischemic and chemical mechanisms: Renin-angiotensin system and vasopressin. The profile of cardiovascular hemodynamics may be altered by several ethiological dysfunctions. Cardiac dysfunction can be due to ischemic heart disease, hypertension, cardiomyopathy, valvular pathology and other pathological factors. The right heart dysfunction normally is due to pulmonary pathologies, which may be caused by idiopathic mechanisms or thromboembolic events. Also left heart failure may cause right heart failure on the long run.

Imaging of Hemodynamics. Imaging of the hemodynamics is extremely important in order to understand cardiovascular pathologies, to study pathological conditions and also to repair structures distroyed by diseases. Basic measuring of hemodynamic profiles has included central venous pressure, pulmonary pressures, capillary wedge pressures, systemic blood pressures, arterial blood pressures. To

measure cardiac output adequately has been problematic until these days. Invasive measurements are commonly used in ICUs and operating theatres and are helpful evaluating the pathological conditions. Most of these measurements are routinely used and give the information we need in daily duties.

During cardiac catheterizations and standard studies the information quite often is adequate but in some rare cases we should have more precise and more exact methods for measuring hemodynamic profiles and cardiac function.

Future. In future the most interesting area is non-invasive measurement of hemodynamic profiles. It is needed for ambulatory patients at home and on outpatient clinics. There are not only patients with mechanical assist devices or pacemakers or vascular prothesis, who need these measurements. When developing new technology or studying effects of new medication, there is a high need for more exact and reliable methods to model and to follow small changes in hemodynamics.

I feel that the present Joint 8th Ragnar Granit Symposium and 1st CSC Scientific Meeting on the topic Cardiovascular Hemodynamics from modeling to clinical applications is extremely interesting and needed for co-operation with scientists in medicine and technology and I hope this forum is fruitful to create discussions between the participants from all the areas of research.