Department of Cardiac Surgery
Chair of Cardiac Surgery

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Research focus
- Chronic rejection of allografts
- Therapy of end-stage heart failure: Heart transplantation or support with a left or right ventricular assist device
- Electromechanical coupling in heart failure
- Development of a non-blood contacting heart actor
- High speed camera investigations on heart valves in a pulse duplicator

Structure of the Chair
Professorship: 1
Personnel: 100
- Doctors (of Medicine): 15
- Scientists: 3 (thereof funded externally: 0)

Clinical focus areas
- Adult cardiac surgery
- Heart transplantation in adults and children
- Minimally invasive valve surgery
- Mechanical circulatory support
- Wound management
- Heart insufficiency therapy
- Rhythm surgery
- Surgery in grown-up with congenital heart disease
- Interventional heart valve surgery
- Interventional aortic surgery

Research
Main research topics are on the one hand basic research in transplantation and on the other hand clinical research in mechanical circulatory support and the development of new heart assist devices. and translate them into clinical success, a detailed understanding of the mechanisms responsible for the development of transplant vasculopathy is essential. We have recently established and characterized the abdominal aortic allograft model as a suitable tool to study the development of transplant vasculopathy. Ongoing projects involve the role and importance of platelets and their inhibition in the development of transplant vasculopathy. Immunomodulatory effects of Clopidogrel could be shown in small animal models. The results of these preclinical studies could be translated into a multi-center study (CEDRIC). Additionally, microvascular integrity of pulmonary grafts was shown to be essential for the long-term success of animal transplant models. In cooperation with the Department of Medicine 4, another major aim of this working group is the use of antiproliferative substances to explore potential strategies to avoid the development of transplant vasculopathy in experimental transplant models.

In some cases heart disease has already progressed to such an extent that the patients need to be stabilized with a left ventricular assist device or – in case of additional right heart failure – with a biventricular assist device.

Electromechanical coupling in heart failure
PI: PD Dr. C. Heim
Remodelling of cardiomyocytes in heart failure patients is well described in the literature, but not completely understood. The calcium delivery in cardiomyocytes may be altered in heart failure patients. In previous studies the remodelling of the T-system of the cardiomyocytes was discussed as responsible for cardiac recovery in ventricular assist device patients. Therefore the aim of the ongoing projects in cooperation with the Institute of Physiology and Pathophysiology is to further analyze underlying mechanisms of the T-system remodeling using human heart tissue from VAD or transplant patients.

Development of a non-blood contacting heart actor
PI: Prof. Dr. M. Weyand
The support of the insufficient heart muscle function by artificial support systems is world-wide an intensive field of research and an aim sought for for about 60 years. Rising life expectancy and the growing number of heart-insufficient patients on the one hand as well as restricted availability of donor organs and damping of the increase of the health costs will further raise the need in innovative support systems in the future. On account of the risks of the existing, invasive, clinical methods, a carefully implantable technology is necessary. It must be functioning reliably as well as permanently and intervene not invasive in the heart-circulatory system. Within a clinical-medical setting, the investigation of a research project pursues from the interpretation over the production up to the clinical validity of the system function more new, acting, and patient-individual heart muscle support systems for the purposes of an external compression of the heart. Therefore the main focuses are the investigation of a biomechanically efficient, mechanical system as well as the development of di- or piezoelectric based actor material patterns.

High speed camera investigations on heart valves in a pulse duplicator
PI: Dr. M. Kondruweit
High-speed camera investigations on heart valves in an animal model are an already established model. In this project these proceedings

Mechanisms in CAV
After I/R injury, endothelial damage is likely to occur. Adhesion molecules are upregulated and after platelet-leukocyte interaction, leukocytes transmigrate through the endothelial layer. There they produce several cytokines and growth factors. As a result, SMC produce collagen, proliferate, and migrate into the neointima. This finally leads to a progressive narrowing of the transplanted vessels and to subsequent graft failure. CAV, cardiac allograft vasculopathy; IFN-γ, interferon-γ; I/R, ischemia/reperfusion; MCP-1, monocyte chemotactant protein-1; PDGF, platelet-derived growth factor; SMC, smooth muscle cell; TGF-β, transforming growth factor-β; TNF-α, tumor necrosis factor α. (Reproduced from Heim et al., Thorac Cardiovasc Surg 2018, with permission from Thieme)
are applied into a pulse duplicator to be able to compare several heart valve types in a standardized procedure. Special situations, as for example the Ventricile Assist Devices support and the effect on the hemodynamic on the heart valves, are examined. The results should show possible reasons for heart valve attrition by measuring power vectors. If possible, these reasons shall be corrected by changing the valve design.

**Teaching**

The Department of Cardiac Surgery takes part in compulsory and elective subjects for the curricular teaching of the Medicine and Dentistry. Bachelor’s and Master’s theses are supervised as well as MD and PhD theses.

**Selected publications**


**International cooperation**

Dr. M. Nicolls, Professor in Pulmonary and Critical Care Medicine, Stanford University, CA: USA