Department of Cardiac Surgery
Division of Pediatric Cardiac Surgery

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Research focus area
- Organ protection: Cerebral perfusion/beating-heart-surgery
- Heart valve surgery
- Extracorporeal circulatory support
- Transmural endocardial pacing
- Thymus immunology
- Migration of plasticizers into patient’s blood

Structure of the Division
- Professorships: 1
- Personnel: 10
- Doctors (of Medicine): 5
- Graduate students: 15

Clinical focus areas
- Surgery for children and adult patients with congenital heart disease
- Extracorporeal support for children with severe heart and/or lung failure
- Arrhythmia surgery

Research
The aim of our research efforts is to achieve the highest possible level of safety for our patients especially in the context complex operations. The same goal applies for routine operations in order to optimize outcomes of congenital cardiac procedures with special focus on organ protective methods during CPB (cardiopulmonary bypass).

Organ protection: Cerebral perfusion/beating-heart-surgery
Organ protective management during aortic arch surgery has become a major focus of the Division of Pediatric Cardiac Surgery. After experimental validation of selective brain perfusion as an intraoperative measure for cerebral protection, the cerebral perfusion could now be determined and compared in both hemispheres with the use of intraoperative transfontanellar ultrasound.

An additional focus of previous animal experiments was about the overall cardioprotective management. After validation of the ‘beating heart’ method, in which the heart is constantly perfused and beating during the entire aortic arch operation, a modified form of blood cardioplegia has been adapted to pediatric physiology and was shown to preserve cardiac contractility better than conventional cardioprotective solutions. It was then successfully implemented into everyday clinical practice.

Heart valve surgery
A large number of patients with congenital heart defects require surgical reconstruction of the right ventricular outflow tract which can be achieved with or without surgical placement of a pulmonary valve (pulmonary valve replacement). Pulmonary homografts are still considered the “gold standard”, but are only limited available. Existing xenogenous pulmonary valve prostheses offer an alternative, but are only available in limited sizes due to their diameter. Particularly for patients after Fallot correction, markedly dilated pulmonary arteries and an aneurysmatically enlarged right ventricular outflow tract due to long-term pulmonary valve regurgitation are present. In this case, existing large-sized manufactured xenogenic prostheses are proposed which are actually intended for aortic valve replacement, but can also be used as a pulmonary conduit after sewing into a Dacron prosthesis. The advantage of this method is the low transvalvular gradients and an ideal “landing zone” for later transfemoral pulmonary valve interventions or replacement.

Extracorporeal circulatory support
Extracorporeal circulatory support systems are used for patients with acute or chronic terminal cardiac and/or pulmonary failure. Novel diaphragmatic pumping systems have been introduced into clinical practice since 2013. These systems provided an improved management and regulation of the applied device for patients on support by a more intensive monitoring of pump-specific characteristics. It was demonstrated that overall improvement in the management results in more safety and improved outcomes for patients on support.

Transmural endocardial pacing
Pacemaker surgery seems to be of rather marginal relevance in pediatric heart surgery because of the low incidence of patients with rare congenital heart defects or with acquired heart block. Transvenous pacemaker leads, usually used in adults, cannot be applied in small children because of small vessel sizes and later somatic patient growth. Epicardial pacemaker systems offer a temporary alternative, but are frequently difficult to apply because of epicardial scarring on the hearts surface after numerous reoperations.

Endocardial “screwing-in-leads” commonly used for adults can be implanted transmural into the intraventricular septum or the atrial appendage “from the outside”. This method provided excellent long term results in our hands for small often reoperated patients.

Thymus immunology
In cooperation with the Department of Dermatology (Prof. Dr. D. Dudziak), a project related to the differentiation of immunocompetent cells of children with congenital heart defects has been established. Routinely removed thymus tissue is processed systematically in order to examine its immune-competent cells. The same characterizations are carried out in the peripheral blood of patients. Research is focused on thymus subpopulations in order to gain information related to the natural maturation of the immune system.

Migration of plasticizers into patient’s blood
A recent research focus is the investigation of phthalate plasticizers (DEHP) migration from the tubes of the heart-lung machine into blood. These plasticizers have toxic potential in the blood of patients, especially in children. In a joint project with the Institute and Outpatient Clinic of Occupational, Social, and Environmental Medicine (Prof. Dr. T. Goen), the Division of Pediatric Cardiac Surgery investigates alternative emollients with regard to their washout and alternative materials which do not use these toxic plasticizers. The topic has a health-political relevance. In recent years, for example, toxic plastic particles contamination has been found in children’s plastic toys, baby bottles and pacifiers. It has been shown that plasticizers as “endocrine disruptors”, especially in children, cause a change in the development of reproductive organs and fertility.

Teaching
Main lectures, internships, electives and final year clinical rotations are being held throughout
the year. Special surgical techniques, anatomic considerations and pathogenesis of congenital heart disease are being taught in small group student tutorials. Teaching is supported by modern technical equipment. All surgical steps can be followed on additional screens in the operating room.

The Division supervises Bachelor’s and Master’s theses as well as MD and PhD theses.

**Selected Publications**


Eckert E, Munch F, Goen T, Purbojo A, Muller J, Cesnjevar R. Comparative study on the migration of di-2-ethylhexyl phthalate (DEHP) and tri-2-ethylhexyl trimellitate (TOTM) into blood from PVC tubing material of a heart-lung machine. Chemosphere. 2016 Feb;145:10-6


**International Cooperations**

Prof. M. Rodefeld, Indiana University, Indianapolis: USA