

Department of Pediatrics and Adolescent Medicine

Division of Pediatric Cardiology

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Research focus

- Cardiopulmonary exercise testing in patients with congenital heart disease
- Perioperative risk stratification after surgery for congenital heart disease
- Comparison of peak serum level, serum-clearance, and urinary lactate excretion as a prognostic marker for outcome and major adverse events in children after cardiac surgery
- Pathophysiology of the Fontan circulation
- Quality of life in patients and families with congenital heart disease (L.I.S.A.-Studie)
- Patient Blood Management (PBM)
- Digital health at the interface of ambulatory and inpatient treatment of congenital heart disease
- Clinical application of echocardiographic deformation imaging in the field of pediatric cardiology
- Pathophysiology of congenital heart disease in a rat model
- Multimodality imaging in pediatric cardiology

Structure of the Division

- Professorship: 1
- Personnel: 79
- Doctors (of Medicine): 22
- Scientists: 2 (thereof funded externally: 2)
- Graduate students: 20

Clinical focus areas

- Interventional therapy of congenital heart defects in the catheter laboratory
- Surgical therapy of congenital heart defects in close cooperation with the Division of Pediatric Cardiac Surgery
- Intensive care after cardiac surgery

Research

In the Division of Pediatric Cardiology, patient research on treatment techniques and care structures is performed. A particular focus is on

different modalities of cardiovascular imaging and pathophysiology in univentricular hearts after Fontan operations. In basic research there are two working groups on the pathophysiology of congenital heart defects in the small animal model and a material biobank on the molecular genetic causes of congenital heart defects.

Cardiopulmonary exercise testing in patients with congenital heart disease

PI: Dr. Dr. I. Schöffl

Our goal is to establish cardiopulmonary exercise testing (CPET) for children at a younger age and to reach a better understanding of the use of CPET in children with congenital heart disease. We want to establish an exercise regimen for children with congenital heart disease in order to improve their fitness, their quality of life and their heart function.

Perioperative risk stratification after surgery of congenital heart disease

PI: Dr. M. Alkassar, Dr. R. Zant

The first 45 minutes after cardiac surgery in pediatric patients is crucial for the later outcome. Due to the intraoperative blood contact with artificial surfaces during cardiopulmonary bypass support, the operation itself, and intraoperative organ ischemia, there is a consecutive systemic inflammatory response commencing in the early phase post-surgery. Therefore, aim of this study is to identify patients with a high risk of profound shock by defined clinical parameters. Once identified, a structured approach is initiated to provide optimal organ-oxygenation.

Comparison of peak serum level, serum-clearance, and urinary lactate excretion as a prognostic marker for outcome and major adverse events in children after cardiac surgery

PI: Dr. R. Zant, Dr. M. Schöber

Urinary lactate measured as ratio of urinary lactate to urinary creatinine has to the best of our knowledge not been evaluated as prognostic parameter in critically ill patients so far. However, this method may provide advantages and therefore may be superior to serum lactate measurements in this patient collective: Urinary lactate summarizes a greater time period and therefore may be superior by equalizing short, but clinically irrelevant peak values.

Pathophysiology of the Fontan circulation

PI: Dr. J. Moosmann

Fontan patients are infants who were born with only one functional ventricle (single ventricle malformation) and were palliated by the Fontan

procedure during the first years of life. Fontan circulation results in a passive pulmonary blood flow and the single ventricle supporting the systemic perfusion. 3-15% of all Fontan patients develop a protein losing enteropathy (PLE). In this project immunologic, hemodynamic, and laboratory alterations of the Fontan circulation leading to PLE are investigated.

Our collaborators are the Institute of Human Genetics, the Department of Medicine 5, and the laboratory of the Department of Pediatrics and Adolescent Medicine.

Current projects are:

- miRNA analysis for identifying inflammatory pathways in Fontan patients with and without PLE
- Identification of immunologic alterations of lymphocytes in Fontan patients
- Microbiome analyses of stool in Fontan patients
- Metabolomics study of Fontan patients

Quality of life in patients and families with congenital heart disease (L.I.S.A.-Studie)

PI: Dr. W. Wällisch

More than 6,000 children undergo inpatient cardiac surgery or intervention in the cardiac catheterization laboratory in Germany each year, however, little is known about the impact of cardiac surgery/intervention on children's health-related quality of life during the months after the procedure. The aim of our L.I.S.A. – study (Life in Children and Families with Congenital Heart Disease – Interventions and effect of an Integration of Stationary und Ambulant Sectors) is to determine this impact on children and families and furthermore offer and examine the potential benefits of interventional strategies, such as physiotherapy, psychotherapy, or family orientated rehabilitation, with regard to the recovery process. This randomized, placebo-controlled trial includes children from 3- 18 years of age. We were able to enroll 125 patients over a 30-month study period. The results will be published in the near future.

Patient Blood Management (PBM)

PI: Dr. J. Schirrmeister, K. Rubarth

The center of attention of PBM lays upon preserving and strengthening a patient's own resources. This regards prophylaxis and therapy of preoperative anemia, operative loss of blood as well as postoperative bleeding and anemia triggered by numerous iatrogenic blood withdrawals from children undergoing heart surgery. Our aim is to show that implementing a PBM does not cause an extension of postoper-

ative (pediatric intensive care unit) treatment by PICU. Observation will end as soon as the patient is able to leave the PICU.

The PBM-concept is partially based on the assumption that there is an acceptance of lower hemoglobin levels as well as avoiding a preoperative anemia. This can be provided by an in time identification and treatment of upcoming problems like an iron deficiency.

Digital health at the interface of ambulatory and inpatient treatment of congenital heart disease

PI: Dr. U. Doll

Since 2007, the Division of Pediatric Cardiology is connected with surrounding clinics and pediatric cardiologists' offices in a "University competence network for congenital heart disease in Northern Bavaria". Sponsored by "Bayern Innovativ GmbH", a telemedicine platform has been established via cloud for bidirectional data transfer. Thus, it is possible to transfer relevant findings and image files to our colleagues within the network. Besides, we receive echocardiographic data for discussion and as a second opinion and to arrange for in-patient treatment, if necessary. In addition, pediatric cardiologists from our network can prospectively participate in interactive chats.

Clinical application of echocardiographic deformation imaging in the field of pediatric cardiology

PI: Dr. M. Schöber

Deformation imaging by strain represents an echocardiographic technology for measuring myocardial deformation of the myocardium. It can give insights into cardiac pathophysiology and expands the ability to evaluate ventricular function in children with congenital or acquired heart disease. Currently, we routinely utilize strain imaging in our Echolab when assessing ventricular function in congenital heart lesions and impaired ventricular function. Another field of research is the acute effect of anthracycline therapy on myocardial function in pediatric oncology diseases. Deformation imaging is an exciting area of investigation in the field of echocardiography that is likely to significantly improve the diagnostic capabilities of cardiac ultrasound in the future.

Pathophysiology of congenital heart disease in a rat model

PI: Dr. M. Alkassar

Due to the small amount of children with congenital heart disease, cellular and animal models play an important role. We examine changes in

the development of power inside single cardiac muscle cells and tissue in diseased animals. These results are used to optimize a simulation software specifically designed to depict impending cardiac insufficiency at an early stage. The simulation illustrates the power inside the cardiac muscle in four dimensions and shows critical areas.

Funding: Klaus Tschira Foundation

Multimodal imaging in pediatric cardiology

PI: Dr. M. Alkassar

Aim of our multimodal research is to further optimize the therapy by three-dimensional display of anatomical structures. We established new three-dimensional display options with echocardiography, CT, and MRI which help to develop a realistic idea of heart and vessels. The use of such a display in the field of pediatric cardiology is investigated in various studies. We were able to prove an enormous advantage of 3D-heart models in the context of catheterizations. A following study currently investigates the benefit of 3D-imaging regarding the compensation of respiration and heartbeat. Another study investigates the advantages of 3D-models in the pre-procedural planning of surgical operations. Therefore we project very real-looking three-dimensional images of the heart with the help of a virtual reality glasses (VR) into the room. For a tactile perception, we also create three-dimensional life-sized pressure of the heart of silicone. The Division of Pediatric Cardiology is one of the leading international centers for the establishment and further development of multimodal methods for the treatment of children with heart disease in Germany.

Teaching

The Division of Pediatric Cardiology takes part in the general teaching program of the Department of Pediatrics and Adolescent Medicine. Additionally, medical students are taught pediatric cardiology within an elective course on pediatrics. Furthermore, we offer the possibility to perform clinical electives in our Division. MD doctorates are supervised.

Selected publications

Hammon M, Rompel O, Seuss H, Dittrich S, Uder M, Ruffer A, Cesnjevar R, Ehret N, Glöckler M. Accuracy and Specific Value of Cardiovascular 3D-Models in Pediatric CT-Angiography. *Pediatr Cardiol.* 2017 Dec;38(8):1540-1547

Maass PG, Glažar P, Memczak S, Dittmar G, Hollfänger I, Schreyer L, Sauer AV, Toka O, Aiuti A, Luft FC, Rajewsky N. A map of human circular RNAs in clinically relevant tissues. *J Mol Med (Berl).* 2017 Nov;95(11):1179-1189

Messroghli DR et al. Toward evidence-based diagnosis of myocarditis in children and adolescents: Rationale, design, and first baseline data of MYKKE, a multicenter registry and study platform. *Am Heart J* 2017;187:133-144

Stegmann H, Bauerle T, Kienle K, Dittrich S, Alkassar M. 4D cardiac magnetic resonance imaging, 4D and 2D transthoracic echocardiography: a comparison of in-vivo assessment of ventricular function in rats. *Lab Anim* 2018; 23677218789971

Ehret N, Alkassar M, Dittrich S, Cesnjevar R, Ruffer A, Uder M, Rompel O, Hammon M, Glöckler M. A new approach of three-dimensional guidance in paediatric cath lab: segmented and tessellated heart models for cardiovascular interventions in CHD. *Cardiol Young* 2018;28(5):661-667