

**Project title:**

The Cardiovascular Morbidity in Children with Chronic Kidney Disease (4C) Study

**Length of the project:**

From June 1<sup>st</sup> 2010 to May 31 2017 (end of funding, the Study continued till December 2018)

**Principal Investigator:**

Franz Schaefer

**Proposed research:**

While most patients with childhood-onset chronic kidney disease (CKD) nowadays survive into adulthood, their cardiovascular (CV) morbidity and mortality at young adult age is excessive due to extensive cumulative exposure to non-traditional CV risk factors associated with uremia. Therefore, the prevention, diagnosis and treatment of early CV disease is becoming a primary objective of pediatric CKD management. While early CV disease has been observed in children with even moderate CKD, the causative factors and natural evolution of CV morbidity and their relationship to CKD progression are incompletely understood due to a lack of prospective studies.

Due to the absence of vascular pathology secondary to ageing, diabetes and smoking, the pediatric CKD population should permit a uniquely sensitive assessment of associations between early CV lesions and biochemical and genetic risk factors.

The ESCAPE Network, a consortium of pediatric nephrology centers in 13 European countries, has previously generated fundamental information about CV abnormalities in pediatric CKD. Building on this expertise, the Network is launching the Cardiovascular Comorbidity in Children with CKD (4C) Study, a long-term observational study exploring the prevalence, extent and progression of CV pathology and its association with CKD progression.

The morphology and function of the heart and large arteries will be monitored by sensitive non-invasive methods in 700 children aged 6-17 years with eGFR 10-45 ml/min/1.73m<sup>2</sup>. Age-specific reference cohorts will be studied in parallel. Arterial biopsies obtained on occasion of access or transplant surgery will be characterized pathoanatomically and pathochemically. Multiple potential clinical, anthropometric, biochemical and pharmacological risk factors will be monitored and related to the evolution of CV status. A genome-wide association study will be performed to identify common genetic variants associated with CV disease and/or CKD progression.

Monitoring will be continued when ESRD is reached to study effects of different renal replacement therapy modalities.

**Aim of the research:**

The 4C Study is an observational longitudinal study in children and adolescents with advanced chronic kidney disease designed to address the following research topics:

- Distribution of indices of large artery morphology (carotid intima media thickness, cIMT) and function (aortic pulse wave velocity, PWV) in healthy children
- Prevalence of left ventricular hypertrophy (LV mass index) and myocardial dysfunction (cardiac strain) in children with CKD
- Prevalence of abnormal large artery morphology (cIMT) and function (PWV) in children with CKD
- Change of cardiac and arterial morphological and functional abnormalities during CKD progression
- Impact of dialysis and transplantation on cardiac and arterial pathology in children with end-stage renal disease
- Impact of conventional, uremia- and dialysis-associated risk factors on cardiac and arterial abnormalities in children and adolescents
- Predictive value of established and novel serum and urine biomarkers for cardiac and vascular abnormalities in children with CKD
- Association of common genetic variants with progression of CKD and cardiovascular disease in children and adolescents with CKD (genome wide association study)
- Impact of uremia and dialysis on arterial tissue morphology, gene and protein expression in children with end-stage renal disease

- Identification of novel risk factors and biomarkers of kidney disease progression in children with CKD
- Identification of common of genetic variants associated with kidney disease progression in children with CKD

#### **List of the papers published in peer reviewed journals:**

- Schmidt BMW\*, Sugianto RI\*, Thurn D, Azukaitis K, Bayazit AK, Canpolat N, Guler Eroglu A, Caliskan S, Doyon A, Duzova A, Karagoz T, Anarat A, Deveci M, Mir S, Ranchin B, Shroff R, Baskin E, Litwin M, Özcağkar ZB, Büscher R, Soylemezoglu O, Dusek J, Kemper M, Matteucci MCi, Habbig S, Laube G, Wühl E, Querfeld U, Sander A, Schaefer F, Melk A, for the 4C Study Consortium. Early effects of renal replacement therapy on cardiovascular comorbidity in children with end-stage kidney disease: Findings from the 4C-T Study. *Transplantation* 2018; 102:484-492. · Schaefer F, Trachtman H, Wühl E, Kirchner M, Hayek SS, Anarat A, Duzova A, Mir S, Paripovic D, Yilmaz A, Lugani F, Arbeiter K, Litwin M, Oh J, Matteucci MC, Gellermann J, Wygoda S, Jankauskiene A, Klaus G, Dusek J, Testa S, Zurowska A, Caldas Afonso A, Tracy M, Wei C, Sever S, Smoyer W, Reiser J, for the ESCAPE Trial Consortium and the 4C Study Group. Elevated suPAR serum levels are associated with progression of kidney disease in children. *JAMA Pediatr* 2017; 171:e172914. · Harambat J, Kunzmann K, Azukaitis K, Bayazi AK, Canpolat N, Duzova A, Niemirska A, Sözeri B, Thurn D, Anarat A, Bessenay L, Candan C, Paripovic D, Yilmaz A, Bucher B, Testa S, Jankauskiene A, Hakan E, Rosales A, Alpay H, Lugani F, Arbeiter K, Mencarelli F, Kiyak A, Dönmez O, Drozd D, Melk A, Querfeld U, Schaefer F. Metabolic acidosis is common and associates with disease progression in children with chronic kidney disease. *Kidney Int* 2017; 92:1507-1514.
- Morato M, Correia-Costa L, Sousa T, Cosme D, Schaefer F, Areias JC, Guerra A, Afonso AC, Barros H, Azevedo A, Albino-Teixeira A. Longer duration of obesity is associated with a reduction in urinary angiotensinogen in prepubertal children. *Pediatr Nephrol* 2017; 32:1411-1422.
- Schaefer F, Doyon A, Azukaitis K, Bayazit A, Canpolat N, Duzova A, Niemirska A, Sözeri B, Thurn D, Anarat A, Ranchin B, Litwin M, Caliskan S, Candan C, Baskin E, Yilmaz E, Mir S, Kirchner M, Sander A, Haffner D, Melk A, Wühl E, Shroff R, Querfeld U; 4C Study Consortium. Cardiovascular Phenotypes in Children with CKD: The 4C Study. *Clin J Am Soc Nephrol* 2017; 12:19-28.
- Correia-Costa A, Correia-Costa L, Caldas Afonso A, Schaefer F, Guerra A, Moura C, Mota C, Barros H, Areias JC, Azevedo A. Determinants of carotid-femoral pulse wave velocity in prepubertal children. *Int J Cardiol* 2016; 218:37-42.
- Burkhardt D, Bartosova M, Schaefer B, Grabe N, Lahrmann B, Nasser H, Freise C, Schneider A, Lingnau A, Degenhardt P, Ranchin B, Sallay P, Cerkauskiene R, Malina M, Ariceta G, Schmitt CP, Querfeld U. Reduced Microvascular Density in Omental Biopsies of Children with Chronic Kidney Disease. *PLoS One* 2016; 11:e0166050.
- Correia-Costa L, Cosme D, Nogueira-Silva L, Morato M, Sousa T, Moura C, Mota C, Guerra A, Albino-Teixeira A, Areias JC, Schaefer F, Lopes C, Afonso AC, Azevedo A. Gender and obesity modify the impact of salt intake on blood pressure in children. *Pediatr Nephrol* 2016; 31:279-88.
- Schaefer B, Bartosova M, Macher-Goepfing S, Ujszaszi A, Wallwiener M, Nyarangi-Dix J, Sallay P, Burkhardt D, Querfeld U, Pfeifle V, Lahrmann B, Schwenger V, Wühl E, Holland-Cunz S, Schaefer F, Schmitt CP. Quantitative Histomorphometry of the Healthy Peritoneum. *Sci Rep.* 2016; 6:21344.
- Correia-Costa L, Schaefer F, Afonso AC, Bustorff M, Guimarães JT, Guerra A, Barros H, Azevedo A. Normalization of glomerular filtration rate in obese children. *Pediatr Nephrol* 2016; 31:1321-8.
- Chinali M, Emma F, Esposito C, Rinelli G, Franceschini A, Doyon A, Raimondi F, Pongiglione G, Schaefer F, Matteucci ME. Left ventricular mass indexing in infants, children, and adolescents: A simplified approach for the identification of left ventricular hypertrophy in clinical practice. *J Pediatr* 2016; 170:193-8
- Correia-Costa L, Sousa T, Morato M, Cosme D, Afonso J, Areias JC, Schaefer F, Guerra A, Afonso AC, Azevedo A, Albino-Teixeira A. Oxidative stress and nitric oxide are increased in obese children and correlate with cardiometabolic risk and renal function. *Br J Nutr* 2016;116:805-15.
- Doyon A, Schmiedchen B, Sander A, Bayazit A, Duzova A, Canpolat N, Thurn D, Azukaitis K, Anarat A, Bacchetta J, Mir S, Shroff R, Yilmaz E, Candan C, Kemper M, Fischbach M, Cortina G, Klaus G, Wuttke M, Köttgen A, Melk A, Querfeld U, Schaefer F; 4C Study Consortium. Genetic, Environmental, and Disease-Associated Correlates of Vitamin D Status in Children with CKD. *Clin J Am Soc Nephrol* 2016; 11:1145-53.

- Correia-Costa L, Sousa T, Morato M, Cosme D, Afonso J, Moura C, Mota C, Areias JC, Guerra A, Schaefer F, Afonso AC, Barros H, Albino-Teixeira A, Azevedo A. Association of myeloperoxidase levels with cardiometabolic factors and renal function in prepubertal children. *Eur J Clin Invest* 2016; 46:50-9
- Gupta J, Kanetsky PA, Wuttke M, Köttgen A, Schaefer F, Wong CS. Genome-wide association studies in pediatric chronic kidney disease. *Pediatr Nephrol* 2016; 31:1241-52.
- Pais C, Correia-Costa L, Moura C, Mota C, Severo M, Guerra A, Areias JC, Schaefer F, Caldas Afonso A, Barros H, Santos AC, Azevedo A. Accelerated growth during childhood is associated with increased arterial stiffness in prepubertal children. *Int J Cardiol* 2016; 204:83-5.
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- Correia-Costa L, Morato M, Sousa T, Cosme D, Guimarães JT, Guerra A, Schaefer F, Afonso AC, Azevedo A, Albino-Teixeira A. Urinary fibrogenic cytokines ET-1 and TGF- $\beta$ 1 are associated with urinary angiotensinogen levels in obese children. *Pediatr Nephrol* 2016; 31:455-64
- Chinali M, Matteucci MC, Franceschini A, Doyon A, Pongiglione G, Rinelli G, Schaefer F. Advanced Parameters of Cardiac Mechanics in Children with CKD: The 4C Study. *Clin J Am Soc Nephrol* 2015; 10:1357-63.
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- Correia-Costa L, Santos AC, Severo M, Guerra A, Schaefer F, Caldas Afonso A, Barros H, Azevedo A. Sex-Specific Mediating Role of Insulin Resistance and Inflammation in the Effect of Adiposity on Blood Pressure of Prepubertal Children. *PLoS One*. 2015;10:e0132097.
- Pais C, Correia-Costa L, Moura C, Mota C, Severo M, Guerra A, Areias JC, Schaefer F, Caldas Afonso A, Barros H, Santos AC, Azevedo A. Accelerated growth during childhood is associated with increased arterial stiffness in prepubertal children. *Int J Cardiol* 2015; 204:83-85.
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- Doyon A, Kracht D, Bayazit AK, Deveci M, Duzova A, Krmar RT, Litwin M, Niemirska A, Oguz B, Schmidt BM, Sözeri B, Querfeld U, Melk A, Schaefer F, Wühl E, 4C Study Consortium. Carotid artery intima-media thickness and distensibility in children and adolescents: reference values and role of body dimensions. *Hypertension* 2013;62:550-6.

- Doyon A, Schaefer F. The prodromal phase of obesity-related chronic kidney disease: early alterations in cardiovascular and renal function in obese children and adolescents. *Nephrol Dial Transplant* 2013 Nov;28 Suppl 4:iv50-7.
- Hoher B, Oberthür D, Slowinski T, Querfeld U, Schaefer F, Doyon A, Tepel M, Roth HJ, Grön HJ, Reichetzeder C, Betzel C, Armbruster FP. Modeling of oxidized PTH and non-oxidized PTH receptor binding and relationship of oxidized to non-Oxidized PTH in children with chronic renal failure, adult patients on hemodialysis and kidney transplant recipients. *Kidney Blood Press Res* 2013; 37:240-51.
- Kracht D, Shroff R, Baig S, Doyon A, Jacobi C, Zeller R, Querfeld U, Schaefer F, Wühl E, Schmidt BM, Melk A; 4C Study Consortium. Validating a new oscillometric device for aortic pulse wave velocity measurements in children and adolescents. *Am J Hypertens* 2011; 24:1294-9.
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#### **List of presentations at major congresses/meetings:**

##### **German Society for Pediatric Nephrology 2010**

- Kracht D et al. Arterielle Gefäßsteifigkeit von gesunden Kindern und Jugendlichen - eine Normwerterhebung. *Der Nephrologe* 2010; 5 (Suppl.1): 68.
- Kracht D. Validierung der Pulswellengeschwindigkeitsmessung mittels Vicorder bei Kindern und Jugendlichen. *Nephrologe* 2010; 5 (Suppl.1): 68.
- Doyon A et al. Oszillometrische Messung der zentralen Pulswellengeschwindigkeit: Methodische Validierung bei Kindern. *Der Nephrologe* 2010; 5 (Suppl.1): 52.

##### **European Academy for Pediatric Societies (EAPS) 2010**

- Kracht D et al. Normal Values for Arterial Stiffness in A Large Cohort of Healthy Children and Adolescents. *Pediatr Res* 2010; 68 (Supplement 1):11.
- Kracht D et al. Measurement of Aortic Pulse Wave Velocity in Children and Adolescents - Validation of the Vicorder Device in Healthy Individuals. *Pediatr Res* 2010; 68 (Supplement 1): 492-493.

##### **Turkish Society of Pediatric Nephrology, Annual Meeting 2010**

- Doyon A et al. Oscillometric measurement of aortal pulse wave velocity in children.

##### **International Pediatric Nephrology Association (IPNA) 2010**

- Kracht D et al. Arterial Stiffness in Healthy Children and Young Adults - Normal Values in a Large Cohort. *Pediatr Nephrol* 2010; 25: 1950
- Kracht D et al. Aortic Pulse Wave Velocity in Children and Young Adults - Validation of the Vicorder Device in Healthy Individuals. *Pediatr Nephrol* 2010; 25: 1958
- Doyon A et al. Oscillometric Measurement of Aortal Pulse Wave Velocity in Children. *Pediatr Nephrol* 2010; 25: 1955

##### **ASN 2010**

- Kracht D et al. Normal Values for Arterial Stiffness in a Large Cohort of Healthy Children And Adolescents. *J Am Soc Nephrol* 2010; 21: 515A – 516A

##### **German Society for Pediatric Nephrology 2011**

- Doyon A et al. Kardiovaskuläre Komorbidität bei Kindern mit chronischer Niereninsuffizienz: Erste Ergebnisse der 4C-Studie. *Der Nephrologe* 2011; 6 (Suppl.)

##### **ESPN 2011**

- Doyon A et al. Carotid Intima Media Thickness in Children with Chronic Kidney Disease: Baseline Results of the 4C Study. *Pediatr Nephrol* 2011 Suppl.

##### **European Society of Hypertension, 21st Meeting on Hypertension and Cardiovascular Prevention 2011**

- Kracht D, Doyon A, Jacobi C, Schaefer F, Sorrentino S, Schmidt B, Wuehl E, Melk A. Normal Values for Aortic Pulse Wave Velocity in a Pediatric Population. *J Hypertens* 2011; 29 (e-Supplement A): e126.

##### **ESPN 2012**

- The 4C Reference Study Consortium. Pulse Wave Velocity in Healthy European Children: Reference Values and Role of Body Dimensions. *Pediatr Nephrol* 2012

- Doyon A et al. Distribution and Determinants of Serum Vitamin D Concentrations in European Children with Chronic Kidney Disease. *Pediatr Nephrol* 2012
- Doyon A et al. Altered Arterial Morphology and Function in Children with CKD: Role of Mineral-Bone Disorder. *Pediatr Nephrol* 2012

### **Annual Meeting of the German Society of Pediatric Nephrology 2012**

- Doyon, A et al. Progression kardiovaskulärer Risikofaktoren bei Kindern und Jugendlichen mit chronischer Niereninsuffizienz – Ergebnisse der 4C-Studie (Cardiovascular Comorbidity in Children with Chronic Kidney Disease Study) *Nephrologe*, 2012 Suppl.

### **American Transplant Congress 2013**

- Melk A et al. Cardiovascular Risk Profile in Children after Renal Transplantation - Introducing the 4C-T Sub-Study.

### **EDTA 2013**

- Schaefer B, Macher-Goeppinger S, Bayazit AK, Sallay P, Holland-Cunz S, Querfeld U, Warady BA, Schaefer F, Schmitt CP. First results from the International Pediatric Peritoneal Biopsy Study

### **IPNA 2013**

- Doyon A et al. Prediction of chronic kidney disease (CKD) progression in children by urinary neutrophil-associated lipocalin.
- Doyon A et al. Impact of recombinant growth hormone (rGH) therapy on bone metabolism in children with chronic kidney disease (CKD): Findings from the 4C Study
- Matteucci CM et al. Advanced Parameters of Cardiac Mechanics in Children with Chronic Kidney Disease: A Preliminary Report From the 4C Study
- Melk A et al. Cardiovascular Comorbidity in Children after Renal Transplantation – First Results from the 4C-T Study

### **ASN 2013**

- Doyon A et al. Serum hepcidin is a superior indicator of functional iron status in children with chronic kidney disease.
- Doyon A, Scharnagl H, Kracht D, Zeller R, Anarat A, Mir S, Sander A, Melk A, Querfeld U, Schaefer F. Prediction of Chronic Kidney Disease (CKD) Progression in Children by Urinary Neutrophil-Associated Lipocalin (NGAL)
- Melk A, Kracht D, Doyon A, Duzova A, Caliskan S, Litwin M, Zeller R, Querfeld U, Wuehl E, Schaefer F. Cardiovascular comorbidity in children after renal transplantation – first results from the 4C-T study
- Hocher B, Reichetzedler C, Slowinski T, Querfeld U, Schaefer AS, Doyon A, Tepel M, Roth HJ, Armbruster FP. Relationship of Oxidized to Non-Oxidized PTH in Children with Chronic Renal Failure, Adult Patients on Hemodialysis and Kidney Transplant Recipients

### **ESPN 2014**

- Duzova A et al. Prevalence and evolution of ambulatory hypertension in children with CKD: Results from the 4C Study
- Duzova A et al. Arterial ambulatory stiffness index and blood pressure variability in healthy children and adolescents
- Wühl E et al. and the ESCAPE/4C Study Consortium: UMOD genotype, renal diagnosis, GFR, and gender determine uromodulin excretion in children with chronic kidney disease (CKD)

### **ASN 2014**

- Wühl E et al. Uromodulin excretion predicts renal disease progression in children with chronic kidney disease (CKD)
- Doyon et al. Genetic, Environmental and Disease-Associated Determinants of Vitamin D Status in Children with Chronic Kidney Disease: Findings from the 4C Study.
- Wuttke et al. Baseline GWAS Results in the PediGFR Cohort: Six Novel Loci Associate with Estimated GFR and proteinuria.

### **American Transplant Congress 2015**

- Melk, D. Thurn-Valsassina, B. Schmidt, A. Duzova, B. Soezeri, A. Bayazit, S. Caliskan, U. Querfeld, K. Ažukaitis, E. Wuehl, F. Schaefer. Longitudinal Follow-Up of Cardiovascular Comorbidity in Pediatric Renal Transplant Recipients – Results from the 4C-T Study

### **25th European Meeting on Hypertension and Cardiovascular Protection, 2015**

- B. Schmidt, D. Thurn-Valsassina, A. Duzowa, B. Soezeri, A. Bayazit, S. Caliskan, U. Querfeld, K. Azukaitis, U. Wuehl, F. Schäfer, A. Melk. Longitudinal evaluation of cardiovascular risk after pediatric kidney transplantation.

#### **ESPN 2015**

- Ali Duzova, Anke Doyon, Marietta Kirchner, Daniela Kracht, Rene Zeller, Aysun Karabay Bayazit, Betül Sozeri, Nur Canpolat, Tevfik Karagoz, Murat Deveci, Ana Niemirska, Sevcan Erdem, Behrouz Kassai, Cengiz Candan, Giacomo Simonetti, Anette Melk, Uwe Querfeld, Franz Schaefer, Elke Wühl for the 4C Consortium. Isolated nocturnal hypertension is associated with increased pulse wave velocity and carotid intima-media thickness in children with chronic kidney disease (ckd): results from the 4c study.

- Karolis Azukaitis, Daniela Thurn, Mieczyslaw Litwin, Aysun K. Bayazit, Ali Duzova, Nur Canpolat, Sevgi Mir, Anette Melk, Uwe Querefld, Franz Schaefer. Serum biomarkers of cardiovascular stress in children with chronic kidney disease: Findings from the Cardiovascular Comorbidity in Children with Chronic Kidney Disease (4C) Study.

- Karolis Azukaitis, Anna Niemirska, Salim Çaliskan, Betül Sözeri, Aysun K. Bayazit, Daniela Thurn, Ali Duzova, Anette Melk, Uwe Querfeld, Franz Schaefer. Trends of antihypertensive medication use in children with chronic kidney disease: Findings from the Cardiovascular Comorbidity in Children with Chronic Kidney Disease (4C) Study.

- Anette Melk, Daniela Thurn, Bernhard Schmidt, Ali Duzova, Betül Soezeri, Aysun K. Bayazit, Salim Caliskan, Uwe Querfeld, Karolis Azukaitis, Elke Wuehl, Franz Schaefer. Longitudinal follow-up of cardiovascular comorbidity in pediatric renal transplant recipients - results from the 4C-T study

#### **Jahrestagung der Deutschen Gesellschaft für Nephrologie 2015**

- U. Querfeld, A. Doyon, E. Wühl, D. Thurn-Valsassina, M. Litwin A. Bayazit, A. Duzova, M. Civilibal, B. Sözeri, F. Schaefer. Kardiovaskuläre Komorbidität bei Kindern mit chronischer Nierenerkrankung: Baseline Daten der 4C-Studie.

- Doyon A, Arbeiter K, Büscher R, Cortina G., Galiano M. Gellermann J, Gimpel Ch, Habbig S, Jungraithmayr T, Kemper M, Klaus G, Kracht D, Kranz B, Laube G, Liebau M., Pohl M., Simonetti G, Wigger M., Wygoda S, Melk A., Querfeld U, Schaefer F Familiäre Risikofaktoren sind mit dem vaskulären Phänotyp von Kinder mit chronischer Niereninsuffizienz assoziiert

#### **ASN 2015**

- Uwe Querfeld, MD, Anke Doyon, MD, Elke Wuehl, MD, Daniela Thurn-Valsassina, Mieczyslaw P. Litwin, PhD, Aysun Bayazit, MD, Ali Duzova, MD, Mahmut Civilibal, MD, Betül Bs Sozeri, Franz S. Schaefer, MD, PhD. The Cardiovascular Comorbidity in Children with Chronic Kidney Disease (4C) Study: Baseline Data of a Multicentre Prospective Observational Study.

- Uwe Querfeld, MD, Betti Schaefer, Aysun Bayazit, MD, Ursula Schulz, Kerstin Sommer, Markus J. Kemper, MD, Guido Laube, MD, Francesca Mencarelli, MD, Sandra Habbig, MD, Franz S. Schaefer, MD, PhD, Rainer Büscher, MD, Claus Peter Schmitt, MD, PhD, Christian Freise. Arterial Biopsies of Children with CKD Show Altered Morphology, Calcium Content and Gene Expression.

- Anke Doyon, MD, Pascal Haas, Maria chiara Matteucci, MD, Francesca Mencarelli, MD, Uwe Querfeld, MD, Franz S. Schaefer, MD, PhD. Impaired Systolic and Diastolic Left Ventricular Function in Children with Chronic Kidney Disease: Results from the Cardiovascular Comorbidity in Children with Chronic Kidney Disease (4C) Study.

- Christine Pietrement, Anja Christine Sander, Stephane Jaisson, Laetitia Gorisse, Philippe Gillery, MD, PhD, Uwe Querfeld, MD, Franz S. Schaefer, MD, PhD. Carbamylation of Plasma Proteins in Children with Chronic Kidney Disease.

- Bartosova M, Schaefer B, Goepfinger-Macher S, Sinn P, Querfeld U, Zaloszc A, Ariceta G, Yok-Chin Y, Romero P, Schaefer F, Warady BA, Schmitt CP for the members of the International Pediatric PD Biobank The PD Membrane Microvasculature in Uremia and PD - Findings from the International Pediatric PD Biobank

- Bartosova M, Schaefer B, Lorenzo Bermejo J, Lasitschka F, Tarantino S, Aufricht C, Kratochwill K, Warady BA, Vondrak K, Schmitt CP for the members of the International Pediatric PD Biobank Complement activation in PD induced arteriopathy

- D. Burkhardt, B. Schaefer, M. Bartosova, H. Nasser, B. Lahrmann, J. Nyarangi-Dix, A. Schneider, A. Lingnau, C. P. Schmitt, U. Querfeld. Capillary rarefaction in omental biopsies of children with CKD.

#### **EuroPD 2015**

- M. Lopez-Anton, M. Lambie, M. Lopez-Cabrera, C. P. Schmitt, M. Bartosova, B. Schaefer, S. Davies, T. Stone, R. Jenkins, P. R. Taylor, N. Topley, T. Bowen, D. Fraser. MicroRNA -21 and -31 indicate peritoneal membrane characteristics during peritoneal dialysis therapy.

- M. Bartosova, B. Schaefer, P. Sallay, B. Ranchin, G. Ariceta, R. Cerkauskiene, A. K. Bayazit, S. Testa, A. Zaloszc, M. Dzierzega, K. Kratochwill, S. Tarantino, F. Schaefer, C.P. Schmitt for Members of the Pediatric PD Biopsy Study Group.

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