

Karoline-Marie Bornemann, PhD

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Department of Pediatrics (Cardiology), Stanford University

I am a **computational biomedical engineer** specialized in **cardiovascular fluid dynamics** with a **background in aerospace engineering**. My research focuses on the computational modeling of **heart valves** using **fluid-structure interaction simulations**. My **long-term research goal** is to **use numerical modeling to understand complex cardiovascular pathophysiology and answer relevant clinical questions**. In my previous research, I investigated the onset of turbulence past bioprosthetic valve prostheses in adults. Given the significant lack of cardiovascular research in pediatrics compared to adults, I decided to apply my acquired knowledge in the modeling of valve prostheses to tackle highly complex and patient-specific problems of congenital heart diseases. At Stanford University, a world-class leader in pediatric cardiovascular disease and surgery, I apply my obtained skill set to the computational modeling of congenital valve diseases and valve repair within an interdisciplinary team combining the individual strengths of both engineers and clinicians. My research **differs from the mainstream** as I use my **strong fundamental background in aerospace engineering to bridge the two worlds of highly sophisticated computational simulations and daily clinical practice** guided by the **mission to improve children's health**.

EDUCATION

PhD in Biomedical Engineering – summa cum laude ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland	10/2024
Diplom-Ingenieurin (Dipl.-Ing., equivalent to MSc.) Mechanical Engineering with specialization Aerospace Engineering Technical University Dresden, Germany	09/2020

HONORS AND AWARDS

Graduate School for Biomedical and Cellular Sciences Best PhD Thesis of the Year 2024 Best thesis award across Graduate School for Biomedical and Cellular Sciences, University of Bern	06/2025
Winner of the Gallery of Fluid Motion Award American Physical Society (APS), Division of Fluid Mechanics	11/2024
UniBE Short Travel Grant for (Post)Docs University of Bern	04/2024
Best poster award in the category 'Pathology, Mechanisms and Outcomes' Heart Valve Society (HVS)	02/2024
PROMOS International Scholarship German Academic Exchange Service (DAAD)	04/2019

RESEARCH EXPERIENCE

Postdoctoral Scholar Stanford University, USA Department of Pediatrics, Division of Pediatric Cardiology PIs: Alexander D. Kaiser, PhD Alison L. Marsden, PhD Clinical collaborator: Michael R. Ma, MD, Division Chief Pediatric Cardiac Surgery (Department of Cardiothoracic Surgery, Stanford University, USA) <i>Patient-specific computational modeling of a quadricuspid truncal valve in a neonate before and after truncus arteriosus repair</i>	05/2025 - now
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Postdoctoral Scholar	11/2024 - 03/2025
PhD Candidate	10/2020 - 10/2024
University of Bern, Switzerland	
ARTORG Center for Biomedical Engineering Research	
PIs: Dominik Obrist, PhD Peter Schmid, PhD	
Clinical collaborators: Caglayan Demirel, MD Stefan Stortecky, MD (Department of Cardiology, University Hospital Bern, Switzerland)	
<i>Instability mechanisms leading to laminar-turbulent transition past bioprosthetic aortic valves</i>	
Visiting PhD Candidate	04/2024 - 06/2024
KTH Royal Institute of Technology, Sweden	
FLOW Group, Department of Mechanics	
PIs: Ardeshir Hanifi, PhD Dan Henningson, PhD	
<i>Global stability analysis of three-dimensional flow fields past bioprosthetic aortic valves</i>	
Master Student	01/2020 – 09/2020
Technical University Dresden, Germany	
Institute of Fluid Mechanics	
PI: Jochen Fröhlich, PhD	
<i>Numerical investigation of turbulent flow over and through inhomogeneous vegetation canopies</i>	
Visiting Student	04/2019 – 10/2019
University of Melbourne, Australia	
Department of Mechanical Engineering	
PI: Richard Sandberg, PhD	
<i>Application of novel, machine-learning closure models for Reynolds averaged Navier Stokes calculations to an S-shaped diffuser</i>	
Intern and Working Student	10/2017 - 03/2018
IABG mbH, Germany	
<i>Investigation of vortex lift of two generic jet fighter aircrafts at high angles of attack</i>	

TEACHING, MENTORING AND SCIENCE OUTREACH TO SOCIETY

Science mentor for Stanford Science Penpals	10/2025 – now
Mentoring underserved middle school and high school students in the US and abroad	
<i>Stanford University</i>	
Interviewee for multiple newspaper articles showcasing my PhD research	2025
“20 Jahre GCB - Nachwuchsförderung in der Biomedizin (20 years of GCB – Fostering the new generation in biomedical sciences)”, Interview for the GCB Best Thesis of the Year Award, 2025 LINK	
“Scientists identify key risk factor for thrombosis after heart valve surgery”, Swiss National Supercomputing Centre, 2025 LINK	
Winner of the Gallery of Fluid Motion LINK	11/2024
Submitted a winning entry for the Gallery of Fluid Motion which aims to establish visual record of the aesthetic and science of contemporary fluid mechanics, shared with cross-disciplinary researchers and the general public	
<i>American Physical Society, Division of Fluid Dynamics</i>	
Instructor at Children’s University Bern	03/2021 – 03/2025
Planned and held workshops for children of age 8 to 12 to gain inspiring insights into biomedical fields of science	
<i>University of Bern</i>	
Bachelor thesis supervisor for Guillaume Van Rossem	11/2023 – 02/2024
Thesis: The impact of neon-sinus on flow characteristics and sinus washout in transcatheter aortic heart valve thrombosis patients	
<i>University of Bern / ETH Zurich</i>	

Instructor at Night of Research, University of Bern

08/2021 – 08/2024

Co-organized the participation of the Cardiovascular Engineering lab at the annual Night of Research in Bern which aims to make current science topics and research questions accessible for the general public and children specifically

*University of Bern***Teaching assistant and substitute lecturer for course ‘Fluid Mechanics’**

02/2021 – 01/2024

Taught weekly seminars, acted as substitute lecturer, corrected and graded weekly assignments, held office hours for graduate level students, graded final exams

*University of Bern***Teaching assistant for course ‘Fluid Mechanics’**

04/2018 – 03/2019

Taught weekly seminars, created new course material, held office hours for graduate level students

*Technical University Dresden***Teaching assistant for course ‘Engineering Design and CAD’**

10/2016 – 09/2017

Taught seminars twice per week, created an interactive student forum to foster discussion and collaboration, held office hours for undergraduate level students, graded assignments

*Technical University Dresden***Volunteering tutor for “Studenten bilden Schüler e.V.”**

02/2016 – 03/2017

Offered free tutoring for children and young adults from low-income backgrounds within a voluntary organization aiming to fight and overcome educational inequality

Technical University Dresden

JOURNAL PAPERS – PUBLISHED

1. **Bornemann K-M**, Moniripiri M, Henningson D, Obrist D, Schmid P, Hanifi A. Optimal three-dimensional perturbations in a fluttering and non-fluttering bioprosthetic aortic valve. *Journal of Fluid Mechanics*. 2026 [DOI](#)
2. **Bornemann K-M**, Obrist D. Transition to turbulence past bioprosthetic aortic valves. *Physical Review Fluids*. 2025 [DOI](#)
3. **Bornemann K-M**, Obrist D. Leaflet fluttering changes laminar-turbulent transition mechanisms past bioprosthetic aortic valves. *Physics of Fluids*. 2025. [DOI](#)
4. **Bornemann K-M**, Jahren SE, Obrist D. The relation between aortic morphology and transcatheter aortic heart valve thrombosis: Particle tracing and platelet activation in larger aortic roots with and without neo-sinus. *Computers in Biology and Medicine*. 2024. [DOI](#) | [PMID](#)
5. **Bornemann K-M**, Obrist D. Instability mechanisms initiating laminar-turbulent transition past bioprosthetic aortic valves. *Journal of Fluid Mechanics*. 2024. [DOI](#)
6. Jahren SE, Vennemann B, **Bornemann K-M**, Rösger T, Obrist D. Modes of leaflet fluttering: quantitative characterization of a bovine bioprosthetic heart valve. *Annals of Biomedical Engineering*. 2025. [DOI](#)
7. Jahren SE, Demirel C, **Bornemann K-M**, Corso P, Stortecky S, Obrist D. Altered blood flow due to larger aortic diameters in patients with transcatheter heart valve thrombosis. *APL Bioengineering*. 2023. [DOI](#) | [PMID](#)

PREPRINTS

1. **Bornemann K-M**, Choi PS, Huber J, Reed AK, Sharir A, Maskatia SA, Marsden AL, Ma MR, Kaiser AD. Simulations predict improved valve performance without direct leaflet intervention after neonatal truncus arteriosus repair. *arXiv:2601.08932*, 2026. [DOI](#)

INVITED SEMINARS

1. “Fluid-structure interaction simulations of heart valves: From aortic valve prostheses for adults to congenital valve diseases in newborn children”, Technical University Dresden, Dresden, Germany, 2026
2. “Heart valve mechanics: From transcatheter aortic valve thrombosis to congenital valve disease”, Introduction to Bioengineering Research, Stanford University, Stanford, USA, 2025
3. “Experimental and numerical insights into laminar-turbulent transition mechanisms in bioprosthetic aortic valves”, MEchanics GATHERing – MEGA – Seminar, EPFL, Lausanne, Switzerland, 2024
4. “Computational Modelling of the Cardiovascular System: Fluid-Structure-Interaction Simulations of Heart Valves”, Cardiovascular Technology, University of Bern, Switzerland, 2023
5. “Computational Modelling of the Cardiovascular System: Fluid-Structure-Interaction Simulations of Heart Valves”, Cardiovascular Technology, University of Bern, Switzerland, 2022
6. “Mechanisms of laminar-turbulent transition past bioprosthetic aortic valves”, Cardiovascular Technology, University of Bern, Switzerland, 2021

CONFERENCE ABSTRACTS

1. **Bornemann K-M**, Moniripiri M, Henningson D, Obrist D, Schmid PJ, Hanifi A. Optimal three-dimensional perturbations in fluttering and non-fluttering bioprosthetic aortic valves. 17th ERCOFTAC SIG 33 Workshop, Progress in Flow Instability, Transition and Control, 2026
2. **Bornemann K-M**, Choi PS, Huber J, Sharir A, Maskatia SA, Ma MR, Marsden AL, Kaiser AD. Computational modeling of a quadricuspid truncal valve in neonatal hemodynamic conditions. *APS DFD*, 2025
3. **Bornemann K-M**, Choi PS, Huber J, Sharir A, Maskatia SA, Marsden AL, Kaiser AD, Ma MR: Computational modeling of a quadricuspid truncal valve in a neonate after truncal repair. *MCHRI Symposium*, 2025.
4. **Bornemann K-M**, Kaiser AD, Choi PS, Huber J, Sharir A, Maskatia SA, Marsden AL, Ma MR: Computational modeling of a quadricuspid truncal valve in a neonate before and after truncal repair. *Bay Area Symp.*, 2025
5. Choi PS, Tarun S, Sharir A, Huber J, Shibata M, **Bornemann K-M**, Kaiser AD, Marsden AL, Ma MR: Ex-vivo Assessment of Pulmonary Valve Leaflet Replacement Using Autologous Pulmonary Arterial Wall. *Korean Heart Valve Conference*, 2025.
6. **Bornemann K-M**, Jahren SE, Obrist D: Effect of bioprosthetic heart valve design on leaflet fluttering and laminar-turbulent transition. *EFDC2*, 2025
7. **Bornemann K-M**, Jahren SE, Obrist D: The relation between bioprosthetic valve design, leaflet fluttering and laminar-turbulent transition. *CMBBE 2025*, 2025
8. **Bornemann K-M**, Obrist D: Transition to turbulence past bioprosthetic aortic valves. *APS DFD*, 2024
9. **Bornemann K-M**, Obrist D: The influence of aortic wall geometry and leaflet fluttering on three-dimensional laminar-turbulent transition mechanisms past bioprosthetic aortic valves. *EFDC1*, 2024
10. **Bornemann K-M**, Jahren SE, Corso P, Demirel C, Stortecky S, Obrist D: Investigation of sinus washout and platelet activation in transcatheter valve thrombosis patients. *HVS*, 2024
11. **Bornemann K-M**, Obrist D: Three-dimensional laminar-turbulent transition mechanisms downstream of a bioprosthetic aortic valve. *ETC18*, 2023
12. **Bornemann K-M**, Jahren SE, Corso P, Demirel C, Stortecky S, Obrist D: Particle tracing in aortic root models investigating sinus washout in transcatheter valve thrombosis patients. *ESBiomech23*, 2023
13. **Bornemann K-M**, Jahren SE, Corso P, Demirel C, Stortecky S, Obrist D: Blood flow patterns in larger aortic roots promote thrombus formation: The missing link between aortic root morphology and transcatheter aortic heart valve thrombosis? *CFC2023*, 2023
14. **Bornemann K-M**, Jahren SE, Corso P, Demirel C, Stortecky S, Obrist D: Connection between larger aortic diameters and transcatheter aortic heart valve thrombosis: A computational study. *HVS*, 2023

15. **Bornemann K-M**, Corso P, Obrist D: Geometrical parameterization of the aortic wall to investigate the evolution of hydrodynamic instabilities initiating laminar-turbulent transition past bioprosthetic aortic valves. *EFMC14*, 2022