Exponent®
Engineering & Scientific Consulting

Kyle Baylous, Ph.D.

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Professional Profile

Dr. Baylous specializes in cardiovascular biomechanics, product design and optimization, including performance testing and fatigue/failure analysis. His formal training in biomedical engineering includes optimizing transcatheter heart valves through in silico and in vitro modeling techniques for novel device evaluation, design optimization, and mitigation of clinical complications. He is an expert in patient-specific modeling and developing novel in silico frameworks to analyze durability of stents and transcatheter heart valves, studying thromboembolic complications and material property characterization of tissues. With expertise in digital twin modeling, data processing, and visualization, he is well-equipped to support clients in the development of next-generation medical technologies, enhancing healthcare solutions and improving patient outcomes.

Structural Analysis and Material Characterization

Dr. Baylous has extensive experience in finite element analysis (FEA) to model nitinol stent crimping and deployment and patient-specific transcatheter valve replacements. Dr. Baylous has utilized advanced beating heart models to track stent deployment, eccentricity and strains throughout multiple cardiac cycles for device durability assessments. He has utilized in silico durability approaches to assess medical devices using standards such as ISO 5840. In addition, Dr. Baylous also helped perform accelerated benchtop durability testing of prosthetic valve leaflets. He has also utilized inverse FEA methods for material property characterization of calcified aortic valve tissue, performing a first-of-its-kind study to demonstrate how calcium deposits can be modeled as crushable foams, more accurately capturing their structure and behavior while being validated with in vitro data.

Flow Analysis and Hemodynamics

Dr. Baylous has extensive experience in computational fluid dynamics (CFD) and fluid-structure interaction (FSI) to assess complex products such as heart valves. Dr. Baylous has performed design optimization of transcatheter valves to maximize orifice areas and reduce peak stresses during the cardiac cycles. He has developed in silico workflows to assess thrombosis risk due to platelet activation in patient-specific models. Dr. Baylous has simulated clinical performance and hemodynamics of deployed transcatheter valves, also performing validation studies with pulse duplicator systems.

Novel Device Design and Testing

Dr. Baylous has extensive experience developing and performing feasibility analysis of novel transcatheter valve devices – especially those with polymer valve leaflets. He has developed one of the first known polymeric transcatheter devices dedicated for patients with bicuspid aortic valves (BAV) using computational modeling and optimization to improve fatigue resistance and hemodynamic performance in these patients.

Experience Prior to Joining Exponent

Prior to joining Exponent, Dr. Baylous worked as a research and development engineer for a startup company where he contributed to product design and development of a second generation polymeric transcatheter aortic valve. He manufactured prototype valves via transfer molding while also designing and prototyping a delivery system for acute ovine trials. Dr. Baylous also worked as a sponsored intern through the Strategic Partnership for Industrial Resurgence (SPIR) at Stony Brook University, where he performed consulting for polymeric valve projects and researched the clinical complications associated with transcatheter aortic valve replacement (TAVR) in patients with BAV disease. In this role, he also supervised projects related to AI-driven patient model reconstruction and meshing for in silico modeling to streamline patient-specific mesh model generation - overcoming the major time bottleneck between segmentation from cardiac CT scans and generating a usable patient mesh. Dr. Baylous worked as a research assistant in the Department of Biomedical Engineering at Stony Brook University and was granted the Applied Research & Development Project (ARaD) Award from the Center for Biotechnology. Dr. Baylous also served as a teaching assistant during his graduate studies, supervising and mentoring biomedical engineering students.

Academic Credentials & Professional Honors

Ph.D., Biomedical Engineering, Stony Brook University, 2025

M.S., Biomedical Engineering, Stony Brook University, 2023

B.E., Biomedical Engineering, Stony Brook University, 2021

Stony Brook University Provost’s Award for Academic Excellence

Prior Experience

Research and Development Engineer, PolyNova Cardiovascular Inc., 2024-2025

Intern - Strategic Partnership for Industrial Resurgence (SPIR), Stony Brook University, 2024-2025

Research Assistant, Stony Brook University, 2021-2024

Teaching Assistant, Stony Brook University, 2021-2022

Army Educational Outreach Program (AEOP) Mentor, Stony Brook University, 2020

Professional Affiliations

2024 – Biomedical Engineering Society (BMES)

Patents

U.S. Patent No. US20240226458A9: Device for addressing needlestick related injuries in injection practices, July 2024 (Baylous K, Meltzer D, Tam R, Helenek C, Lobenhofer J).

Publications

Baylous K, Anam S, Kovarovic B, Parikh P, Price J, Yammine M, McLarty A, Slepian M, Bluestein D. In Vitro biomechanical examination of excised calcified aortic leaflet tissue for material property assessment and improved In Silico modeling. Biomedical Materials & Devices 2025; 1-19.

Baylous K, Kovarovic B, Paz RR, Anam S, Helbock R, Horner M, Slepian M, Bluestein D. Thrombogenic

risk assessment of transcatheter prosthetic heart valves using a fluid-structure interaction approach. Computer Methods and Programs in Biomedicine 2024; 257:108469.

Baylous K, Helbock R, Kovarovic B, Anam S, Slepian M, Bluestein D. In silico fatigue optimization of TAVR stent designs with physiological motion in a beating heart model. Computer Methods and Programs in Biomedicine 2024; 243:107886.

Kovarovic B, Helbock R, Baylous K, Rotman OM, Slepian MJ, Bluestein D. Visions of TAVR future: development and optimization of a second generation novel polymeric TAVR. Journal of Biomechanical Engineering 2022; 144(6):061008.

Presentations

Baylous K, Anam S, Kovarovic B, Slepian M, Bluestein D. In vitro biomechanical examination of excised calcified aortic leaflet tissue for material property assessment and improved in silico TAVR modeling. Podium, ASME Summer Biomechanics, Bioengineering and Biotransport Conference (SB3C), Santa Ana Pueblo, New Mexico, June 22-26, 2025.

Baylous K, Thaker S, Pak D, Duncan J, Bluestein D. AI-driven patient segmentation, reconstruction and meshing for in silico TAVR modeling. Podium, Institute for Engineering Driven Medicine (IEDM) Workshop, Stony Brook University, New York, March 6th, 2025.

Baylous K, Kovarovic B, Anam S, Helbock R, Slepian M, Bluestein D. Thrombogenic risk assessment of transcatheter prosthetic heart valves using a fluid-structure interaction approach. Online Symposium, ANSYS Cardiovascular Symposium Series - Medical Devices and Cardiovascular Surgery Innovations With Engineering Simulation, September 12th, 2024.

Baylous K, Helbock R, Kovarovic B, Anam S, Slepian M, Bluestein D. In silico fatigue optimization of TAVR stent designs with physiological motion in a beating heart model. Online Symposium, Webinar – 10th International Symposium on the Living Heart and Virtual Twin for Humans, September 11th, 2024.

Baylous K, Kovarovic B, Anam S, Helbock R, Slepian M, Bluestein D. Thrombogenic risk assessment of transcatheter prosthetic heart valves using a fluid-structure interaction approach. Podium, Biomedical Engineering Society (BMES), Baltimore, Maryland, October 23-26, 2024.

Baylous K, Kovarovic B, Anam S, Helbock R, Slepian M, Bluestein D. Post-TAVR thrombogenic risk comparisons for bicuspid aortic valve patients using novel fluid-structure interaction approach. Podium, Summer Biomechanics, Bioengineering and Biotransport Conference (SB3C), Lake Geneva, Wisconsin, June 11-14, 2024

Baylous K, Kovarovic B, Anam S, Helbock R, Slepian M, Bluestein D. Mitigating post-TAVR thrombogenic risk: design and optimization of novel Trileaflet and bicuspid aortic valve devices. Podium, Biomedical Engineering Society (BMES), Seattle, Washington, October 11-14, 2023.

Baylous K, Kovarovic B, Anam S, Helbock R, Slepian M, Bluestein D. Mitigating post-TAVR thrombogenic risk: design and optimization of novel Trileaflet and bicuspid aortic valve devices. Podium, Summer Biomechanics, Bioengineering and Biotransport Conference (SB3C), Vail, Colorado, June 4-8, 2023.

Baylous K, Helbock R, Kovarovic B, Anam S., Slepian M, Bluestein D. In silico fatigue optimization of TAVR stent designs with physiological motion in a beating heart model. Poster, Summer Biomechanics, Bioengineering and Biotransport Conference (SB3C), Chesapeake Bay, Maryland, June 20-23, 2022.

Project Experience

- Developed novel in silico frameworks to analyze durability of stents and transcatheter heart valves, in addition to studying thromboembolic complications.
- Material testing of excised calcified aortic valve tissue for more accurate material parameter classification, thereby enhancing accuracy of computational models.
- Designed and optimized a novel, self-expandable TAVR device for patients with bicuspid aortic valve (BAV) disease for better durability, hemodynamic performance.
- Product development and design of an optimized second generation transcatheter polymeric aortic valve device and delivery system.
- In silico stent design optimization for deployment, reduced device stresses. Valve prototype manufacturing. Consulting for R&D of polymeric valve technologies.
- AI-driven patient reconstruction and meshing for in silico TAVR modeling. Collaboration with cardiovascular interventionalists, radiologists
- Independent research of transcatheter valve device design and testing methods. In vitro (pulse duplicator, high-cycle fatigue) and in silico (FEA, CFD, FSI) models. Hemodynamic analysis of TAVR leaflets.
- Developed novel attachment to a syringe barrel to mitigate needlestick injuries during intramuscular injections.