Colorado Science and Engineering Fair

2025 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Simulating Cardiovascular Flow in a Fontan Heart

Finalist's Name: Divyanshi Pandey

School and City: Peak to Peak Charter School, Lafayette

Sponsor's Name: Bayley Zubler

Category: Biomedical & Health Sciences

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Single ventricle disease (SVD) affects 5–7 out of every 1,000 live births, often requiring the Fontan procedure between 18 months and 2 years of age. This surgical intervention redirects the ventricle to bypass the heart by bridging a connection directly to the pulmonary arteries for oxygenation. While the Fontan circulation allows for oxygenation with reduced cardiac strain, it introduces significant physiological challenges, particularly in hepatic flow regulation. Over time, these complications can contribute to the development of Fontan-associated liver disease (FALD) and other systemic complications. Understanding the hemodynamics of hepatic circulation in Fontan patients is crucial for optimizing surgical approaches, improving patient management, and developing targeted interventions. This project aimed to simulate hepatic flow dynamics in a Fontan patient using data from an open repository. The patient's vascular system was segmented and modeled to create a three-dimensional computational representation of hepatic and systemic circulation. Image processing techniques and computational fluid dynamics (CFD) simulations enabled an in-depth analysis of flow distribution, pressure gradients, and perfusion patterns. The simulation identified potential flow abnormalities, highlighting areas of uneven hepatic perfusion that could contribute to long-term complications. These findings help bridge the knowledge gap regarding Fontan circulation challenges. By demonstrating the feasibility of CFD modeling for predicting hepatic flow patterns, this study supports the development of patient-specific interventions to improve hepatic circulation. Additionally, it offers a non-invasive approach to assessing risk factors for FALD, aiding in long-term clinical management strategies, and enhancing post-Fontan patient care.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature: Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**