Multidimensional imaging-based models for cardiovascular procedural skills training (BVP model)

Client: Dr. Sonja Tjostheim
Advisor: Dr. Tracy Puccinelli
Team: Hunter Belting, belting@wisc.edu (BSAC)
Anna Balstad, abalstad@wisc.edu (Communicator)
Rebecca Poor, poor2@wisc.edu (Team Leader)
Daisy Lang, dllang@wisc.edu (BWIG & BPAG)
Date: February 21st, 2025 to February 28th, 2025

Problem Statement
Interventional cardiology is a rapidly expanding field in veterinary medicine. Pulmonary valve stenosis occurs when a dog is born with a malformed pulmonary valve, which restricts blood flow from the right heart to the lungs. Balloon valvuloplasty is a palliative procedure in which a balloon-tipped catheter is inserted into the jugular vein to the valve and is then inflated to help reduce the severity of the stenosis. Recently, the UW-Madison School of Veterinary Medicine has experienced a decrease in caseloads of canines with pulmonary valve stenosis, preventing the cardiology residents from being able to practice repairing this disorder. There is a need for a heart model to mimic pulmonary valve stenosis for residents to learn and practice repairing these valves.

This device, a model-based simulation program will be implemented to maintain the cardiologists' surgical skill set and to aid in cardiology resident training. Simulator training using multidimensional imaging-based models will augment the training already provided in the interventional lab and help protect against the ebb and flow of procedural caseload eroding skills. It also provides a more consistent experience for our residents and provides an objective method of assessing individual progress amongst our trainees.

The goal is to develop a silicone 3D model of canine pulmonary valve stenosis which can be used to learn/practice essential skills like handling of guidewires/catheters, balloon positioning and inflation, and communication between veterinary interventionists. Computed tomography angiography (CTA) of dogs with pulmonary valve stenosis will be used to create the 3D models, which will be secured in place. Lastly, a document camera will project an image of what the user is doing with their hands onto a screen. This provides a more realistic recreation of the interventional surgery, where the surgeon watches a fluoroscopy screen to monitor the movement of the interventional equipment inside the patient.

Summary of Weekly Team Member Design Accomplishments

- Team:
    - Submit IRB request
    - Create full model usage test questionnaire
    - Print jugular vein
    - Submit preliminary report
- Hunter Belting:
    - Edited and finished the preliminary report
    - Made design considerations to the jugular vein for a next print
    - Work on finding the water basin the model will sit in
- Anna Balstad:
    - Created a list of questions to include in the surveys for the study
    - Edited the heart STLs
    - Edited preliminary report
- Rebecca Poor:
    - Fabricate the electronic circuit for the pump
    - Decide on a box size for the pump
    - Test the pump connections with the 3D printed heart
- Daisy Lang:
    - Completed IRB submission, wrote study protocol, recruitment email, and consent form
    - Fabricated electronic circuit for the pump
    - Made final changes to jugular vein

Weekly / Ongoing Difficulties

N/A

Upcoming Team and Individual Goals

- Team:
    - Submit preliminary report
    - Begin reaching out to trial volunteers

- Hunter Belting:
    - Finalize the preliminary report
    - Aid in working through model edits such as the jugular vein and model base
    - Look to order a basin and get dimensions finalized for the base of the model

- Anna Balstad:
    - Finalize edits to the heart STL and print out of Flexible 80A
    - Create the heart box STL

- Rebecca Poor:
    - Solder the electrical components for the pump

    - Create a connection piece for the pulmonary valve to the tubing

- Daisy Lang:
    - Begin reaching out to trial volunteers with Dr. Tjostheim
    - Assist with fabrication of model
    - Order new hose clamps

Project Timeline

Project Goal	Deadline	Team Assigned	Progress	Completed
Preliminary Presentation	2/7	All	100%	X
IRB	02/26	All	90%	X
Preliminary Report	2/26	All	75%	
Executive Summary	4/18	All		
Final Poster Presentation	4/25	All		
Final Deliverables	4/30	All		

Expenses

Link to spreadsheet: https://docs.google.com/spreadsheets/d/1zrmdodVMy9Tak7XrOqHdQ6oMQDw5lYqqROYaAgWNKoQ/edit?usp=sharing

Item	Description	Manufacturer	Manufacture Part Number	Vendor	Date	QTY	Cost Each	Total	Link
3D Printed Materials									
Elastic 50A	Heart and Jugular Material	Formlabs	RS-CFG-ELCL-02	Formlabs	10/14/2024	1	$208.57	$208.57	https://formlabs.com/store/materials/elastic-50a-resin-v2/
Flexible 80A	Orignial Material for Heart	Formlabs	RS-CFG-FL80-01	Formlabs	10/14/2024	1	$208.57	$208.57	https://formlabs.com/store/materials/flexible-80a-resin
Model Stand Materials									
Super Glue	Secure Jugular to Heart and Stand to Base Plate: 0.07 oz Tube	The Original Super Glue Corporation	SGH2J	Makerspace	11/19/2024	2	$2.42	$4.84	https://supergluecorp.com/product/super-glue-tube/
3D Printed Stand	PLA Prints of stand to hold the Jugular and Heart	N/A	N/A	Makerspace	11/19/2024	2	$8.00	$8.00	N/A
Acrylic Base Plate	Secure the Model	N.A	N/A	Makerspace	11/19/2024	1	$0.00	$0.00	N/A
Phone Stand	Phone Tripod Stand, 85" Tall Cellphone Tripod with Gooseneck Remote, Flexible Tripod Stand for iphone, Portable Phone Stan Tripod for Recording, Compatible with iPhone 14 13 12 pro Android Cell phone	Vivtiv	p18-353	Amazon	2/13/2025	1	$21.99	$21.99	https://www.amazon.com/Cellphone-Gooseneck-Flexible-Record
Pump Materials									
Perisaltic Pump	900ml/min high Flow peristaltic Pump 12V dc Brush Motor Liquid dosing Pump with BPT Tube	Kamoer	KPHM900-HB-B24	Amazon	2/7/2025	1	$58.88	$58.88	https://www.amazon.com/dp/B0BB75XPRX/ref=sspa_dk_detail
Tubing	10 Feet - 1/4" ID x 3/8" OD Clear Vinyl Tubing, Translucent Plastic PVC Tubing Hose Pipe for Water Air Pump	Kesoto	601279606865	Amazon	2/13/2025	1	$6.99	$6.99	https://www.amazon.com/Kesoto-Clear-Translucent-Plastic-Tubi
Hose Clamps	3/8" Heavy Duty Double Snap Grip Nylon Hose Clamps Several Ratcheting Adjustable Clamp	Quickun	767065462036	Amazon	2/13/2025	1	$11.59	$11.59	https://www.amazon.com/Quickun-Double-Several-Rat
							TOTAL:	**$529.43**	