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: March 7th, 2025 to March 14th, 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:
    - Consulted client on updated design and prototypes
    - Resubmitted IRB for approval
- Hunter Belting:
    - Finished fabrication of the pump/electric box including the 3-d printed base for the pump and soldering.
    - Began printing the heart chambers out of elastic 50A and the reoriented heart base
- Anna Balstad:
    - Edited the heart STL to prepare for printing
    - Created the new box to hold the heart in the correct position
- Rebecca Poor:
    - Finished fabricating the pump and the electrical components
    - Finished writing the draft of the user manual
    - Researched glue for tank fabrication
- Daisy Lang:
    - Assisted with pump fabrication
    - Placed orders for glue and monitor cord
    - Created sign up schedule for student testing and survey codes

Weekly / Ongoing Difficulties

N/A

Upcoming Team and Individual Goals

- Team:
    - Begin testing the week of April 1st
    - Continue writing report

- Hunter Belting:
    - Work on finalizing the jugular vein base
    - retest the annulus fatigue testing while seated in the heart model
    - Help with user testing
- Anna Balstad:
    - Help with preparing for user testing
    - Start writing the draft of the executive summary
- Rebecca Poor:
    - Add pictures to user manual
    - Assist in user testing
- Daisy Lang:
    - Submit IRB as soon as client has completed training
    - Final assembly of all parts
    - Begin scheduling student testing

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	100%	X
Executive Summary	4/18	All		
Final Poster Presentation	4/25	All		
Final Deliverables	4/30	All		

Expenses

Running Total: $596.30

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
Full Model Tank	Tank to hold the entire model submerged in water: Superio Clear Storage Box with Lid, 44 Quart Plastic Container	Superio	B0D8518W1F	Amazon	3/3/2025	1	$34.01	$34.01	https://www.amazon.com/Superio-Container-Organizing-Stackab
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-Tubin
Small 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-Ratcheting-Adjustable/dp/B08P3S7NHT/ref=asc_df_B08P3S7NHT?mcid=82869f5d75ac3ec79ac60d8c10a56129&hvocijid=14693359646575673253-B08P3S7NHT-&hvexpln=73&tag=hyprod-20&linkCode=df0&hvadid=7303128205988&hvpos=&hvnetw=g&hvrand=14693359646575673253&hvp=undefined&th=1)
Circuit Switch	6A 250V/ 10A 125V Circuit Switch	ELMA	39122226	Makerspace	2/18/2025	1	$0.20	$0.20	https://www.yorklighting.com/brand-satco-products-inc/hi-low-metal-round-rocker-switch-w-diode-2-circuit-rated%3A-6a-250v-10a-125v/sku-V27-80-2101
Project Box	Zulkit Junction Box ABS Plastic Dustproof Waterproof IP67 Junction Boxes Universal Electrical Project Enclosure DIY Electronic Project Box Grey 7.87 x 5.91 x 5.12 inch (200 x 150 x 130 mm)	Zulkit	B08MYWFT6D	Amazon	3/3/2025	1	$18.98	$18.98	https://www.amazon.com/Zulkit-Dustproof-Waterproof-Electrical-Electronic/d
Large Hose Clamps	12.3-14.2mm - 0.48-0.55in - Plastic Hose Clamp - Herbie Clip - Black - PP	HCL	HCL HC-D-PP-BK	HCL	3/3/2025	10	$0.57	$5.70	https://hcl-clamping.com/products/plastic-hose-clamp-herbie-clip-12-3-14-2
Power Adaptor	12V DC 1.5A-2A Converter Adapter Power Supply Power Cord Power Cable Charger DC Power Supply Plug 5.5mm x 2.5mm	ShenZhen Moveforest Electric Appliance Industry Co.,LTD	9553171318326	Amazon	2/18/2025	1	$7.89	$7.98	https://www.amazon.com/1-5A-2A-Converter-Adapter-Supply-Charger/dp/B0CNV6BHL7/ref=asc_df_B0CNV6BHL7?mcid=c2c6f93d820b3e4584d2d0f5ce88bdd4&hvocijid=4882312312521876959-B0CNV6BHL7-&hvexpln=73&tag=hyprod-20&linkCode=df0&hvadid=730312820598&hvpos=&hvnetw=g&hvrand=4882312312521876959&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018944&hvtargid=pla-2281435178298&psc=1
							TOTAL:	$596.30	