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

Client: Dr. Sonja Tjostheim Advisor: Dr. Tracy Puccinelli Team: Hunter Belting, <u>belting@wisc.edu</u> (BSAC) Anna Balstad, <u>abalstad@wisc.edu</u> (Communicator) Rebecca Poor, <u>poor2@wisc.edu</u> (Team Leader) Daisy Lang, <u>dllang@wisc.edu</u> (BWIG & BPAG) Date: April 4th, 2025 to April 11th, 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:
 - Finalized design/fabrication of model
 - Recruit subjects for testing
 - Human subjects testing began!
- Hunter Belting:
 - Helped with model testing
 - Helped at Expo
- Anna Balstad:
 - Helped with model testing
 - Started the final poster draft
 - Volunteered at Engineering Expo
- Rebecca Poor:
 - Glued final assembly of heart box to tank
 - Assisted in model testing
 - Outreach event!!
- Daisy Lang:
 - Assisted with model testing
 - Began outlining how we will analyze the results of the study

Weekly / Ongoing Difficulties

N/A

Upcoming Team and Individual Goals

- Team:
 - Complete human subjects testing
 - Begin analyzing human subjects testing results
 - Begin creating final poster
- Hunter Belting:
 - Continue user testing
 - Write results and discussion section and start poster
- Anna Balstad:
 - Finish testing and analyze results
 - Start writing results and discussion section of report
 - Work on final poster
- Rebecca Poor:
 - Continue human factors testing
 - Finalize user manual with images
 - Outreach write up
- Daisy Lang:
 - Finish human testing
 - Upload all results from paper to spreadsheet
 - Complete analysis of results

Project Timeline

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

Expenses

Running Total: \$616.07

Link to spreadsheet:

https://docs.google.com/spreadsheets/d/1zrmdodVMy9Tak7XrOqHdQ6oMQDw5IYqqROYaAgW NKoQ/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 Materials | | | | | | | | | |
| | | The Original | | | | | | | |
| | | Super Glue | | | | | | | |
| | Secure Jugular to Heart and | Corporation | | | | | | | |
| Super Glue | Stand to Base Plate: 0.07 oz Tube | | 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 | N/A | N/A | Makersnace | 11/19/2024 | 2 | \$8.00 | \$8.00 | N/A |
| Acrylic Base Plate | Secure the Model | NA | N/A | Makerspace | 11/19/2024 | 1 | \$0.00 | \$0.00 | N/A |
| Pictylic base flate | Tank to hold the entire model submerged | 10.0 | B0D8518W1E | makerspace | 11/15/2024 | - | 20.00 | 20.00 | 11/0 |
| | in water: Superio Clear Storage Box with Lid, | | | | | | | | |
| Full Model Tank | 44 Quart Plastic Container | Superio | | Amazon | 3/3/2025 | 1 | \$34.01 | \$34.01 | https://www.amazon.com/Superio-Container-Organizing-Stackable |
| | Coat the inside of the model to help the | Super Lube | | | | | | | |
| Industrial Lubricant | catheter slide easly through | Kano Laboratories LLC | 56204 | Amazon | 4/3/2025 | 1 | \$8.94 | \$8/94 | https://www.amazon.com/Super-Lube-56204-Silicone-Lubricant/dg |
| | Adaptor Cord to connect phone to | | | | | | | | |
| | for testing | | | | | | | | |
| | JSAUX USB C to HDMI Cable 10ft | | | | | | | | |
| | 4K@60Hz USB 3.1 Type C to | | | | | | | | |
| | HDMI 2.0 Cord for Home Office, | | | | | | | | |
| | (Thunderbolt 3/4 Compatible) with iPhone | | | | | | | | |
| | 16 Pro Max, MacBook Pro/Air, Galaxy S8 to | 15 4 1 14 | | | 4/2/2025 | | 443.00 | 640.00 | |
| HDMI Adaptor Cord | S24, IPad Pro, IMac-Black | JSAUX | USB-C to 4K@60Hz HDMI Cable | Amazon | 4/3/2025 | 1 | \$13.99 | \$13.99 | https://www.amazon.com/dp/BUBQBM4V5V?ref=cm_sw_r_cso_sr |
| | Elex Glue Mini White Super Strong | | | | | | | | |
| | Rubberized Waterproof Adhesive, Works | | | | | | | | |
| | Underwater, Use On Pools, Showers, | | B07PNQPFG6 | | | | | | |
| Water Proof Super | Outdoors, Concrete, Brick, Pavers, Masonry, | | Flex Glue Mini Strong | | | | | | |
| Glue | and UV Resistant, 0.75 fl oz | Swift Response, LLC | Rubberized Waterpr | Amazon | 4/3/2025 | 1 | \$5.78 | \$5.78 | https://www.amazon.com/Flex-Strong-Rubberized-Waterproof-Adl |
| | Phone Tripod Stand, 85" Tall Cellphone | | | | | | | | |
| | Tripod with Gooseneck Remote, Flexible | | | | | | | | |
| | Tripod for Recording | | | | | | | | |
| | Compatible with iPhone 14 13 12 | | | | | | | | |
| Phone Stand | pro Android Cell phone | Vivtiv | p18-353 | Amazon | 2/13/2025 | 1 | \$21.99 | \$21.99 | https://www.amazon.com/Cellphone-Gooseneck-Flexible-Recordin |
| Pump Materials | | | | | | | | | |
| | 900ml/min high Flow peristaltic Pump | | | | | | | | |
| | 12V dc Brush Motor Liquid dosing | | | | | | | 400.00 | In the second |
| Perisaitic Pump | 10 Foot 1/4" ID x 2/9" OD Close View | Kamoer | KPHW900-HB-B24 | Amazon | 2/7/2025 | 1 | \$58.88 | \$58.88 | https://www.amazon.com/dp/BUBB/5XPRX/ref=sspa_dk_detail_1 |
| | Tubing, Translucent Plastic PVC Tubing | | | | | | | | |
| 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-Tubing |
| | | | | | | | | | https://www.amazon.com/Quickun-Double-Several- Patchating. Advatabacid/000001S72bit/Treference_df_000001S72bit/T2mcid=820005475ac3ac |
| | 3/8" Heavy Duty Double Snap Grip Nylon | | | | | | | | The EGOR MARK AND THE |
| Small Hose Clamps | Adjustable Clamp | Quickup | 767065462036 | Amazon | 2/13/2025 | 1 | \$11 59 | | inkCode=df08hvadid=73031 |
| Sindi Hose eldrips | hajastable elamp | quickun | 707003402030 | 741102011 | 2,15,2025 | - | Q11.55 | 311.59 | 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 |
| Circuit Switch | 6A 250V/ 10A 125V Circuit Switch | ELMA | 39122226 | Makerspace | 2/18/2025 | 1 | \$0.20 | \$0.20 | |
| | Zulkit Junction Box ABS Plastic Dustproof | | | | | | | | |
| | Electrical Project Enclosure DIV Electronic | | | | | | | | |
| | Project Box Grey 7.87 x 5.91 x 5.12 inch | | | | | | | | |
| Project Box | (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/dpi |
| | 12.3-14.2mm - 0.48-0.55in - Plastic Hose | | | | | | | | |
| Large Hose Clamps | 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-12-3-14-2mm |
| | | | | | | | | | https://www.amazon.com/1-5A-2A-Converter-Adapter-Supply-Charger /dp/BDCNV6BHL7/ref=asc_df_BDCNV6BHL7?mcid=c2c6f93d820b3e |
| | | ShenZhen | | | | | | | 4584d2d0f5ce88bdd4&hvocijid= |
| | | Moveforest | | | | | | | 4882312312521876959-B0CNV6BHL7-&hvexpln=73&tag=hyprod-2 0&linkCode=df0&hyadid=730312820598&hypos=&hypetw= |
| | 12V DC 1.5A-2A Converter Adapter Power | Appliance | | | | | | | g&hvrand=4882312312521876959&hvpone=&hvptwo=&hvqm |
| Power Adaptor | DC Power Supply Plug 5.5mm x 2.5mm | Industry CoLTD | 9553171318326 | Amazon | 2/18/2025 | 1 | \$7,89 | \$7,98 | t=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018944&hvtargid =ola-2281435178298&psc=1 |
| | a subbiliting and an and and and | contraction of the second | 55552, 1510520 | | 2, 20, 2023 | - 1 | TOTAL: | \$616.07 | |