

THE NEWSROOM

Debate: roller head versus centrifugal pumps



Daytona McDonald



Joshua Singh

Pro Centrifugal: Daytona McDonald

Cardiopulmonary bypass is conducted via the heart lung machine with an open reservoir circuit. In the world of perfusion, there are two options for the arterial boot: one being a roller head and the other being centrifugal pump. There has been a continuous debate as to why one is better than the other. Roller heads are argued to be more beneficial in pediatric practice and centrifugal pumps are more beneficial in adult practice. Contrary to what some believe, centrifugal pumps are more advantageous than roller head pumps in terms of pressure dependency and less hemolysis of the blood components. Centrifugal pumps are preload dependent and afterload sensitive. This concept of centrifugal pumps is extremely important because this prevents the perfusionist from over-pressuring the circuit while priming and conducting cardiopulmonary bypass. This non-occlusive pump allows for flow to be dependent upon pressure, hence the afterload sensitive mechanism of the pump.

The second advantage the centrifugal pump has is less trauma to the blood. The non-occlusive impeller within the pump creates a negative pressure at the inlet of the pump and a positive pressure at the outlet of the blood pump. The negative pressure at the inlet of the centrifugal head allows for blood to enter and be pushed out via the positive pressure at the outlet of the pump. With that being said, there is no spallation of the tubing used as the arterial boot and less hemolysis of the blood cells that pass through. Another advantage to the centrifugal pump is a decreased risk for massive air embolism. Due to the pump being preload dependent, the flow ideally will be reduced if it senses a lack of preload and minimize massive air embolism events, but this is not to say it will not de-prime with gross air.

Overall, centrifugal pumps are more advantageous to roller pumps because they protect the fundamental practice of a perfusionist to not pump air to the patient. Also, centrifugal pumps protect the second most important task of perfusion practice and that is conservation of red blood cells and reducing trauma to the blood. Preload dependent and afterload sensitive pumps will always be superior to preload and afterload independent pumps.

Pro Roller: Joshua Singh

The discussion about roller versus centrifugal pumps is a popular and ongoing topic among perfusion students and professionals. While many may agree that centrifugal pumps are considered safer, roller pumps offer slight pulsatile flow which is better on vasculature and the endothelial lining of the blood vessels. This notion is backed up by an article written by Mohammadzadeh and others in 2013. "Pulsatile CPB is considered to be more natural and beneficial than continuous perfusion, because pulsatile flow provides motion of the tissue fluid around [the] cell membrane, improves microcirculation and increases diffusion. It also facilitates decreased systemic vascular resistance and enhanced oxygen consumption." Additionally, the authors found that pulsatile roller pump flow results in smaller decreases in cerebral oxygen saturation levels compared with centrifugal pump flow at all time points as seen by NIRS. This promotes improved cerebrovascular hemodynamics and recovery times for patients. Further benefits of roller pump or pulsatile flow include reduced SIRS associated with bypass, less need for inotropic support, and superior organ preservation. It has also been found that "the use of pulsatile flow during and after pediatric open heart surgery resulted in improved patient outcomes in terms of preserving better cardiac, renal, and pulmonary functions in the early post-CPB period."

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The more commonly known benefits of roller pumps include lower prime volume and lower cost, and they are considered by many to be easier to connect and test the latency of the arterial line. In addition to these, roller pumps are not prone to have retrograde flow therefore the use of an E-clamp to prevent retrograde flow is typically not needed. Flow is also much easier to control with roller as they are afterload independent and will hold their RPMs and calculated flow regardless of patient pressures.

This afterload independence and better controlled flow dynamics allow perfusionists to match their root vent after weaning off bypass for procedures that require the surgeon to deair the heart. With all of these potential benefits, it is easy to see why there is ongoing debate. Hopefully this article may offer students and those interested in the topic to see some of the pros and cons of each and will help make a more informed decision on their pump of choice.

Response: **Daytona McDonald**

While those who present pro- roller head may argue that pulsatile flow is better than continuous flow for the vasculature and microcirculation, they fail to mention that a roller pump can cause hemolysis of the red blood cells. Hemolysis can lead hematuria and postoperatively lead to coagulopathies, platelet dysfunction, and renal injury. (Tan & etal). Yes, it has been stated that roller heads mimic the physiological processes of the human body, but it comes at a cost. The constant pounding of tubing in the raceway can lead to spallation of the tubing potentially leading to a SIRS response, but most importantly it can lead to cavitation of air resulting in air embolism. (Tan & etal). Flow may be easier to control with roller heads due to the fact that they are afterload independent, but that also comes with the risk of potentially drawing air out of solution and over-pressurizing the circuit. Also, a perfusionist can keep up with the root vent after termination of bypass with a centrifugal pump as well.

Roller pumps and centrifugal pumps both have advantages and disadvantages when it comes down to perfusion practice. Deciding which type of pump is most advantageous for patient care depends on patient population as well as perfusionist preference. Ultimately, as perfusionists, it is our responsibility to make an educated decision as to which one pump system works for our practice and for our patients.

“ROLLER PUMPS AND CENTRIFUGAL PUMPS BOTH HAVE ADVANTAGES AND DISADVANTAGES WHEN IT COMES DOWN TO PERFUSION PRACTICE. DECIDING WHICH TYPE OF PUMP IS MOST ADVANTAGEOUS FOR PATIENT CARE DEPENDS ON PATIENT POPULATION AS WELL AS PERFUSIONIST PREFERENCE.”

For Further Reading:

Mohammadzadeh, A., Jafari, N., Hasanpour, M., Sahandifar, S., Ghafari, M., & Alaei, V. (2013). Effects of pulsatile perfusion during cardiopulmonary bypass on biochemical markers and kidney function in patients undergoing cardiac surgeries. *American journal of cardiovascular disease*, 3(3), 158–162.

Tan Z., Besser M., Anderson S., Newey C., Iles R., Dunning J., & Falter F. Pulsatile Versus Nonpulsatile Flow During Cardiopulmonary Bypass: Extent of Hemolysis and Clinical Significance. *ASAIO Journal*: September/October 2020 - Volume 66 - Issue 9 - p 1025-1030 doi: 10.1097/MAT.0000000000001154



The MUSC CVP Class of 2024 completed the #AmSECT heart walk today! A week late due to Hurricane Ian but we still got our 3.5 mile walk in! Great day in Charleston SC for it. #Perfusion #MUSC #HeartWalk



Students and professors from The Medical University of South Carolina gathered to complete the walk the week following hurricane Ian.

PUMP UP THE VOLUME



Madeline Alfieris

On October 1, 2022 at 11am EST, perfusion students from all around the country participated in the first annual AmSECT Student Heart Walk! The purpose of this event was to create an additional fundraising opportunity for the AmSECT Student Council, with all proceeds supporting student attendance at the 61st Internal Conference in March 2023.

Current Student Council Members that were able to attend the 2022 AmSECT Conference in Phoenix, AZ felt that the experience was invaluable. Not only did the educational sessions open our eyes to the endless learning opportunities ahead, but the energy of the meeting itself elevated our excitement for our future profession. We were able to network with seasoned professionals, connect with students from other programs, and get a sneak peak of the countless new technologies that are infiltrating the field. As such, the 2022/2023 Student Council is focused on making attendance more attainable to students. Thus, the Heart Walk was born!

Madeline Alfieris • 1st
MS Candidate, Cardiovascular Perfusion
1mo • Edited •

Thank you to everyone who participated in the AmSECT (American Society of ExtraCorporeal Technology) Perfusion Student Heart Walk Fundraiser! I'm so excited to announce that we reached our fundraising goal! All proceeds will go towards supporting student attendance at this year's AmSECT Conference in Orlando, FL.

An extra thank you to my fellow AmSECT Student Council Members who helped make this event possible!

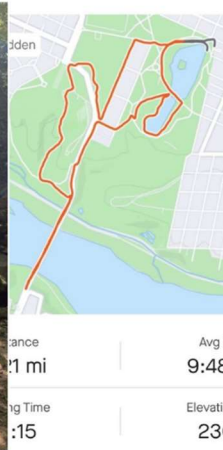
I had a blast completing my three miles with two of my clinical preceptors at Wrightsville Beach in Wilmington, NCI #amsect #heartwalk



Emily Behr • 1st
Clinical Perfusion Student at UNMC
1mo •

It's always a great day when I can combine two of my favorite things: running and perfusion! I was thrilled to put in my 3 miles from Richmond, Virginia for the AmSECT (American Society of ExtraCorporeal Technology) Student Council #HeartWalk fundraiser for perfusion students. Thank you to everyone who walked/donated and for helping perfusion students everywhere have the chance to participate in AmSECT conferences!

<https://lnkd.in/eReau5rj>

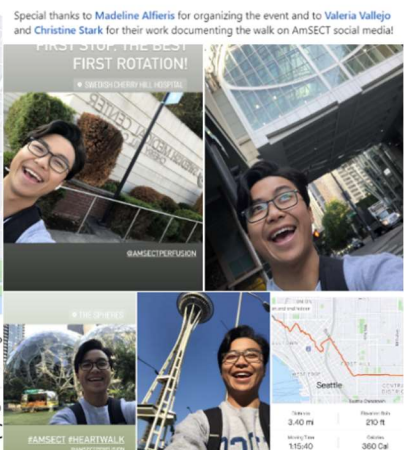


Daniel Nguyen (He/Him) • You
MS, Cardiovascular Perfusion Student at MUSC | AmSECT Student Council Pr...
1mo • Edited •

Completed my 3 miles for the AmSECT (American Society of ExtraCorporeal Technology) Student Council #HeartWalk today! Thank you to those who helped support us students, we appreciate you all! If you would like to donate, it's not too late, the link to our gofundme is below. All proceeds go towards off-setting conference costs for ALL perfusion students!

Thank you so much!

<https://gofund.me/43959cbb>



Students participated by sharing their Heart Walk on social media, showcasing sights from across the country.

For several weeks leading up the event, perfusion students advertised the Heart Walk to friends, family, and future colleagues. Additionally, AmSECT sent out communications regarding the fundraiser to student AmSECT members and to each Perfusion School Program Director to ensure all students had a chance to participate. We used several forms of social media to spread the word and to share the GoFundMe page that was set up for donations. By asking others for contributions to the fundraising effort, we each committed to participating in a 3-mile walk (either with fellow classmates for those students on campus or with clinical preceptors for those out on rotations). Regardless of location, we all walked “together” on October 1st at 11am EST.

Not only did we surpass our fundraising goal for this event, raising over \$1,500, but we did so with an incredible amount of participation from the nationwide perfusion student body. We had representation from several perfusion schools and had students walking in cities all over the country! An AmSECT Instagram Student Takeover featured photos of participants out on our walks, which added to the sense of community and accomplishment. We are very excited by the success of the event, and we are so grateful to all who contributed!

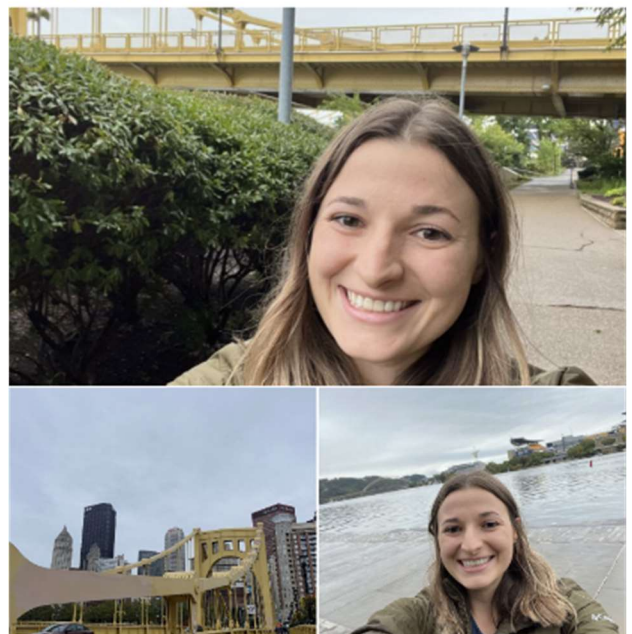
The Student Council has a groovy 2023 AmSECT International Conference t-shirt design in store for our next fundraiser, which will be launched this winter! Be on the lookout, as we're eager to share these shirts with the perfusion community to help further our 2023 fundraising efforts!

“NOT ONLY DID WE SURPASS OUR FUNDRAISING GOAL FOR THIS EVENT, RAISING OVER \$1,500, BUT WE DID SO WITH AN INCREDIBLE AMOUNT OF PARTICIPATION FROM THE NATIONWIDE PERFUSION STUDENT BODY”

Laurel Egerter • 1st
Master's Cardiovascular Perfusion Student || UPMC Shadyside
1mo •

Today I had the opportunity to participate in the AmSECT (American Society of ExtraCorporeal Technology) Student Council 3 mile #HeartWalk. If you are feeling called, please consider donating to our go fund me to help offset the costs associated with attending the annual AmSECT conference for students.

<https://lnkd.in/eqXykWVe>



BACK TO THE STACKS

Grayce Owens

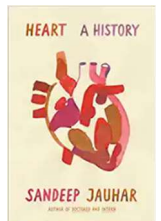
Have you ever heard an interesting tidbit about the history of cardiac surgery and wished you had something other than a textbook or a Wikipedia page to find out more? Have you ever wondered how handwashing became the foundation of infection prevention? Or did you ever struggle to think of a good resource to recommend to someone who was interested in pursuing a career in the medical field? If so, keep reading!

Whether you're a current perfusion student, a prospective student, or an experienced CCP, the following books are great resources to learn more about our field and the greater world of medicine. Go ahead and add one or two (or all three) to your Christmas list.

Heart: a History

By Sandeep Jauhar

Written by a cardiologist, this book is a fascinating look at the history and progression of cardiac medicine. It recounts the stories of some of the great advances in our field, like how Werner Forssmann performed the first cardiac catheterization (on himself!) and how the first total artificial heart implant started a feud between two great surgeons. The author also gives a thoughtful account of what today's cardiac patients experience with long-term support such as pacemakers and VADs. Reading these patients' perspectives helped me appreciate the path our patients walk before they come to the operating room.

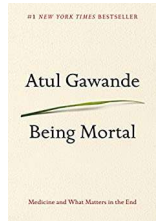


Being Mortal: Medicine and What Matters in the End

By Atul Gawande

Being Mortal will introduce you to some difficult questions about supportive and end-of-life care. As perfusionists, these are questions that become especially relevant as we think about therapies such as ECMO and ventricular assist devices. Each patient's priorities and values are different, and the goal is not to create an ultimate standard for end-of-life care but to find the best approach for each patient and their family. As care providers, we need to be prepared to have these conversations with our care teams.

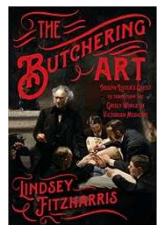
This book also struck a chord with me in how it addresses the shortcomings of modern elder care. Before attending perfusion school, I worked as a nurse aid in both nursing home and home health settings. I witnessed a lot of frustration with the status quo for elder care: frustration from patients, their families, and my coworkers. How could such a huge money-making industry be failing its patients? Why do five-star, cushy nursing homes fail to meet the psychological needs of their residents? *Being Mortal* introduced me to alternative approaches to elder care and gave me hope for a better way forward. I'd recommend this book to anyone who works in medicine, anyone who has aging family members, and anyone with questions about life-supporting care.



The Butchering Art: Joseph Lister's Quest to Transform the Grisly World of Victorian Medicine

By Lindsey Fitzharris

If you want to learn more about the history of surgery, but worry it might be boring, then *The Butchering Art* is the book for you. *The Butchering Art* is a quick, engaging read about the birth of surgery and the work of Joseph Lister. I was gripped from the introduction. Joseph Lister (who is, interestingly, the namesake of Listerine mouthwash) was a doctor who promoted the use of antiseptic technique to prevent post-surgical infection. Before germ theory was widely accepted, his practices seemed radical-- almost superstitious-- despite his thorough laboratory research. You may recognize some familiar names in this book, such as that of Louis Pasteur, who was investigating the microbial activity of winemaking in France while corresponding with Lister about the microbial origins of disease. A fair warning: this book is not for the squeamish. However, reading about the days of reused blood-crusting bone saws and early anesthetics will give you a greater appreciation for our anesthesia and infection control colleagues.



“WHETHER YOU’RE A CURRENT PERFUSION STUDENT, A PROSPECTIVE STUDENT, OR AN EXPERIENCED CCP, THE FOLLOWING BOOKS ARE GREAT RESOURCES TO LEARN MORE ABOUT OUR FIELD AND THE GREATER WORLD OF MEDICINE.”

The Vitals



Charlotte Clonts

"THIS CASE WAS A TRUE DEPICTION OF HOW IMPORTANT TEAMWORK AND COMMUNICATION ARE IN THE CARDIAC OR AND HOW IMPORTANT IT IS TO RELY ON OUR DIDACTIC KNOWLEDGE FOR PROBLEM-SOLVING IN OUR CLINICAL SETTINGS."

Exploratory cases are often complex and unpredictable. This particular case included a thrombectomy with mitral valve repair and CABGx1. It was difficult given the history of recent MVR, CABG, stroke, and evidence of no right heart function and total left heart occlusion with total ECMO support. The outcome of this case was positive, successfully placing the patient back on ECMO as planned.

A few of the issues we had to work through during the case were managing the original mechanical circulatory support (MCS) circuit, the patient's pressures, and oxygen supply, given little to no heart function. We chose to preserve the original MCS circuit by creating a loop as we transitioned to CPB and found that air had been introduced to the circuit's oxygenator. Since there was no patient or reservoir attached to the ECMO circuit, there was nowhere to purge the air out. We resolved this issue by practicing fluid displacement, introducing normal saline pre-oxygenator, thus forcing air across the oxygenator's membrane while simultaneously pulling that air out post-oxygenator.

The second issue regarding the management of the patient's pressures was a shared concern between perfusion and anesthesia. Since the patient arrived on MCS, sedation was anesthesia's initial concern. Given that MCS was being used, anesthesia could not give anesthetic gas, so sedation was controlled via propofol, which was also responsible for decreasing the MAP overall. This issue was resolved by getting on CPB quickly, with perfusion managing anesthetic gas and high flows and anesthesia pushing pressors to counteract the effects of the propofol and the transfer from MCS to CPB. The last issue regarding oxygen supply was persistent, despite high blood flows, hemoconcentration which pulled off 1.5L of volume, and administering 6 units of RBCs. We managed this deficit by keeping FIO2 levels at 100% from the initiation of CPB, which proved to be greatly beneficial. This case was a true depiction of how important teamwork and communication are in the cardiac OR and how important it is to rely on our didactic knowledge for problem-solving in our clinical settings.

PERFUSION GOOFS & BLUNDERS

I was so nervous about spraying the surgeon in the face while bumping up the arterial line, so my bump up during my first case was about as slow as physically possible. After the case, the team joked that it was like watching grass grow hahaha. Luckily the surgeon has a great sense of humor and was so patient with me! – MA

The surgeon instructed us to start our RAP and I placed my clamps in the "RAP position". A few seconds later, I was given the instruction to run up pleg. Without thinking, I cranked up the pleg. Unfortunately, my "RAP" clamp was stopping blood from being pulled into the cardioplegia circuit so I deprimed the whole thing. My preceptor was in stitches, and we all had a good laugh about my newfound invention: Whole Air Cardioplegia™. - DN (Dr. Del Air-O)

I was priming the pump one morning when my level detector went off. I couldn't figure out where all the volume had gone until I walked around the back of the pump and saw a puddle. Turns out I forgot to clamp the cardioplegia spike lines! Just another reminder that our safety devices are there for a reason– turn 'em on early and keep 'em on! -BRB, grabbing a towel

While trying to hand up lines for the first time, I accidentally contaminated a clamp on the sterile field with the plastic housing of the AV loop. Luckily, the surgical team was able to quickly fix the problem, but I felt so guilty! I am so grateful to be working with a patient and kind surgeon, especially in moments like this! - MA

I was trying to practice closed loop-communication in the OR when the surgeon said, "Down on flow." I repeated back, "down on flow." A second later he said "back up"-- so I said "back up" and started increasing flow. He immediately looked over at me like I was crazy-- "Not yet! I wasn't talking to you!" Actually, he had been telling anesthesia to move the bed back up. Context is important! -GO

I was doing my check of the circuit for at least the 100th time cause a connector may have come loose in the 5 mins I was sitting there staring at it running through my physical checklist and mental checklist in my head. I went to check the recirculation cardioplegia pressure valve line was tight on the top of the reservoir, and it snapped off in my hand. Of course, these only come in the large pump in a box packs and we did not have any extra. My preceptor helped me rig it with a high-pressure stopcock and some tubing. I felt terrible but it worked really well! I am thankful as well for kind and patient preceptors! - AEM

Today I went to disconnect the water lines from the oxygenator, but I accidentally forgot to turn the Heater-Cooler off before doing so. Safe to safe I made a big mess in the OR! One of the surgical PAs had to turn around and ask us why he was standing in a puddle! – MA

One of our roles at this center is to help transport the patient up to the ICU after cases and give a small report including checking the chest tube and foley output. After one of my cases, we went through the routine. I did our ancillary tasks, checked the chest tubes but when I went to check the urinometer, it was nowhere to be found. I was patting around and lifting blankets, increasingly frantically, as I felt my turn to speak draw nearer. While searching, I hear my name and look up to a room full of nurses, PA's and Physicians waiting for me to speak. I give our times and chest tube output while still searching and end with "but I think I'm going crazy because I can't find the urinometer". Perplexed and seemingly full of disbelief, everyone starts searching with me and sure enough, we find no urinometer...or foley. A murder mystery style discussion ensues finally ending with a call down to the OR. "Hey, uh, do you guys know where the foley is?" "Oh yea, it fell out down here, we just threw it away." Cue lots of ahhs and a relieved perfusion student. -DN (Urine trouble)

THE RESERVOIR



AmSECT Student Membership

Student membership is now FREE! Register now and become an official part of the perfusion community.

<https://www.amsect.org/Members/Student-Corner>

Have a perfusion blunder you want to share?

Please email owensgr@musc.edu to have your blunder included in the next issue.





61st AmSECT International

March 24-26, 2023 | Orlando, FL

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ORLANDO

Save the date!