Spring 2022

The Academy Newsletter

Academy City Limits

Inside this issue
AACP Meeting Photos ............. 2
Student Article (1) ................. 4
Student Article (2) ............... 9
Important Dates .................. 11
Sponsoring Partners .......... 12
Awards Committee Selections .... 13
New Members .................... 14
Student Article (3) ............. 15
Student Article (4) .......... 17
More Pictures .................... 20
2023 Annual Meeting .......... 22

Editor
David Palanzo
Annville, PA

Contributing Editors
Tom Frazier
Nashville, TN

Kelly Hedlund
Hays, KS

Student Section
Deborah L. Adams
Houston, TX
The American Academy of Cardiovascular Perfusion

Hands-On Workshop

Sponsors
- ABBOTT
- AIRLIFE HEART
- CARDIO GROUP
- EDWARDS LIFESCIENCES
- FRIGENUS MEDICAL CARE
- LIKAVOYA
- MEDTRONIC
- QUEST MEDICAL INC.
- SPECTRUM MEDICAL GROUP
- TELEFLEX
- TERUMO CARDIOVASCULAR SYSTEMS

Exhibitors
- ABOIMED
- CYTOSORBENTS
- ESSENTIAL PHARMACEUTICALS, LLC
- HEMORENDIC CORPORATION
- HEARTBEAT PERFUSION SOLUTIONS, INC.
- INOVUS
- PERFUSION LIFE LLC
**Review of the ECMO “Mixing Cloud” Phenomenon and Comparison of Harvi and Califia Simulators to Diagnose Differential Hypoxia in Adult Peripheral V-A ECMO Models**

**Introduction:**
There is a paucity of published literature on the effectiveness of commercially available high-fidelity simulation software in duplicating the “mixing cloud” phenomenon during peripheral ECMO support. The objective of this study is to evaluate the strengths and limitations of virtual, simulation models in diagnosing differential hypoxia in adult peripheral veno-arterial ECMO models. Specifically, the Harvi-ECMO and Califia 2.0 online simulators were used to simulate “mixing cloud” effects that result in differential hypoxia.

**Methods:**
The Harvi-ECMO web-based model and Califia 2.0 online simulator were used to simulate a “mixing cloud” phenomenon. Parameters for cardiac output, ventilator FiO2, and ECMO flow were altered the same way on each simulator to achieve comparable results. To determine differential hypoxia, simulated blood gases were taken, and oxygen saturations from different collection sites were observed.

**Results:**
The Harvi and Califia simulators were both able to adequately reproduce the “mixing cloud” phenomenon. Due to differences and limitations within both simulators, the results were not exactly the same between the two simulators, but they shared similar trends that showed when native cardiac output increased and ECMO flows decreased, the arterial saturations decreased. This confirmed that by altering the cardiac output, ECMO flow, and ventilator FiO2 it is possible to reproduce the “mixing cloud” for training and educational purposes.

**Conclusions:**
The assessment of both high-fidelity simulators shows promising data on simulating differential hypoxia, although both simulators are not very similar themselves. Educational opportunities are available to simulate differential hypoxia using either simulator, which will aid in the diagnosis of this phenomenon in a real-life setting.

---

*The full manuscript of this article has been submitted to the journal Perfusion for possible publication.*
<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Califia and Harvi Baseline Parameters and Baseline Arterial Blood Gases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ECMO Variables</th>
<th>Califia 2.0</th>
<th>Harvi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep</td>
<td>1L/min</td>
<td>1L/min</td>
</tr>
<tr>
<td>FiO2</td>
<td>100%</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventilator Variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shunt Fraction</td>
<td>60%</td>
</tr>
<tr>
<td>FiO2</td>
<td>21%</td>
</tr>
<tr>
<td>RR</td>
<td>16</td>
</tr>
<tr>
<td>I time</td>
<td>1.6 seconds</td>
</tr>
<tr>
<td>PIP</td>
<td>35mmHg</td>
</tr>
<tr>
<td>PEEP</td>
<td>10mmHg</td>
</tr>
<tr>
<td>DLCO</td>
<td>-</td>
</tr>
<tr>
<td>TV</td>
<td>350ml</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>5LPM (without ECMO support)</td>
</tr>
<tr>
<td>LV Contractility</td>
<td>87.7 dynes/sec/cm⁻⁵</td>
</tr>
<tr>
<td>RV Contractility</td>
<td>84 dynes/sec/cm⁻⁵</td>
</tr>
<tr>
<td>Oxygenator Variables</td>
<td></td>
</tr>
<tr>
<td>Oxygenator</td>
<td>-</td>
</tr>
<tr>
<td>Diffusion</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oxygenator Variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygenator</td>
<td>8mmHg*min/L</td>
</tr>
<tr>
<td>Diffusion</td>
<td>1 dl/min/mmHg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Radial Baseline Arterial Blood Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
</tr>
<tr>
<td>pCO2</td>
</tr>
<tr>
<td>pO2</td>
</tr>
<tr>
<td>SaO2</td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>pCO2</td>
</tr>
<tr>
<td>pO2</td>
</tr>
<tr>
<td>SaO2</td>
</tr>
</tbody>
</table>
Table 2
Califia Collected Data

<table>
<thead>
<tr>
<th>Flow: 4.0 CO: 1.0</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Radial</td>
<td>7.47</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
</tr>
<tr>
<td>Left Radial</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
<td>7.3</td>
</tr>
<tr>
<td>Femoral</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
<td>7.41</td>
<td>7.3</td>
<td>7.48</td>
</tr>
<tr>
<td>paCO2</td>
<td>31</td>
<td>38</td>
<td>56</td>
<td>30</td>
<td>38</td>
<td>56</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>paO2</td>
<td>50</td>
<td>75</td>
<td>528</td>
<td>54</td>
<td>86</td>
<td>535</td>
<td>60</td>
<td>105</td>
</tr>
<tr>
<td>Sao2</td>
<td>89%</td>
<td>96%</td>
<td>100</td>
<td>91%</td>
<td>97%</td>
<td>100%</td>
<td>94%</td>
<td>98%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow: 3.0 CO: 2.0</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Radial</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
</tr>
<tr>
<td>Left Radial</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
</tr>
<tr>
<td>Femoral</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
<td>7.48</td>
<td>7.38</td>
<td>7.48</td>
</tr>
<tr>
<td>paCO2</td>
<td>30</td>
<td>30</td>
<td>44</td>
<td>30</td>
<td>30</td>
<td>44</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>paO2</td>
<td>45</td>
<td>45</td>
<td>500</td>
<td>48</td>
<td>48</td>
<td>506</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>Sao2</td>
<td>86%</td>
<td>86%</td>
<td>100%</td>
<td>88%</td>
<td>88%</td>
<td>100%</td>
<td>90%</td>
<td>91%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow: 2.0 CO: 3.0</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Radial</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
</tr>
<tr>
<td>Left Radial</td>
<td>7.47</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
</tr>
<tr>
<td>Femoral</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
<td>7.47</td>
<td>7.47</td>
<td>7.41</td>
<td>7.41</td>
</tr>
<tr>
<td>paCO2</td>
<td>31</td>
<td>31</td>
<td>39</td>
<td>31</td>
<td>31</td>
<td>39</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>paO2</td>
<td>43</td>
<td>41</td>
<td>458</td>
<td>43</td>
<td>44</td>
<td>468</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td>Sao2</td>
<td>84%</td>
<td>81%</td>
<td>100%</td>
<td>84%</td>
<td>84%</td>
<td>100%</td>
<td>87%</td>
<td>87%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow: 1.0 CO: 4.0</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Radial</td>
<td>7.47</td>
<td>7.47</td>
<td>7.44</td>
<td>7.47</td>
<td>7.47</td>
<td>7.44</td>
<td>7.46</td>
<td>7.46</td>
</tr>
<tr>
<td>Left Radial</td>
<td>7.47</td>
<td>7.44</td>
<td>7.47</td>
<td>7.47</td>
<td>7.44</td>
<td>7.46</td>
<td>7.46</td>
<td>7.43</td>
</tr>
<tr>
<td>Femoral</td>
<td>7.44</td>
<td>7.47</td>
<td>7.47</td>
<td>7.44</td>
<td>7.46</td>
<td>7.46</td>
<td>7.43</td>
<td>7.43</td>
</tr>
<tr>
<td>paCO2</td>
<td>32</td>
<td>32</td>
<td>36</td>
<td>32</td>
<td>32</td>
<td>36</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>paO2</td>
<td>37</td>
<td>37</td>
<td>400</td>
<td>38</td>
<td>38</td>
<td>417</td>
<td>41</td>
<td>43</td>
</tr>
<tr>
<td>Sao2</td>
<td>75%</td>
<td>75%</td>
<td>100</td>
<td>78</td>
<td>79</td>
<td>100</td>
<td>82</td>
<td>82</td>
</tr>
</tbody>
</table>
### Table 3
Harvi Collected Data

<table>
<thead>
<tr>
<th>Ventilator FiO2</th>
<th>Sampling Site</th>
<th>21% Radial/CA</th>
<th>60% Radial/CA</th>
<th>100%</th>
<th>21% Femoral</th>
<th>60% Femoral</th>
<th>100% Femoral</th>
<th>21% ECMO</th>
<th>60% ECMO</th>
<th>100% ECMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow: 4.0</td>
<td>pH</td>
<td>7.39</td>
<td>7.36</td>
<td>7.37</td>
<td>7.37</td>
<td>7.41</td>
<td>7.37</td>
<td>7.41</td>
<td>7.37</td>
<td>7.41</td>
</tr>
<tr>
<td></td>
<td>paCO2</td>
<td>40</td>
<td>44</td>
<td>43</td>
<td>37</td>
<td>43</td>
<td>43</td>
<td>37</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Flow: 3.0</td>
<td>pH</td>
<td>7.46</td>
<td>7.44</td>
<td>7.37</td>
<td>7.46</td>
<td>7.44</td>
<td>7.37</td>
<td>7.46</td>
<td>7.44</td>
<td>7.37</td>
</tr>
<tr>
<td></td>
<td>paCO2</td>
<td>32</td>
<td>34</td>
<td>43</td>
<td>33</td>
<td>34</td>
<td>43</td>
<td>33</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td>Flow 2.0</td>
<td>pH</td>
<td>7.46</td>
<td>7.47</td>
<td>7.37</td>
<td>7.46</td>
<td>7.47</td>
<td>7.37</td>
<td>7.46</td>
<td>7.47</td>
<td>7.37</td>
</tr>
<tr>
<td></td>
<td>paCO2</td>
<td>32</td>
<td>32</td>
<td>43</td>
<td>32</td>
<td>32</td>
<td>43</td>
<td>32</td>
<td>32</td>
<td>43</td>
</tr>
<tr>
<td>CO 3.0</td>
<td>pH</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
</tr>
<tr>
<td></td>
<td>paCO2</td>
<td>33</td>
<td>32</td>
<td>43</td>
<td>33</td>
<td>32</td>
<td>43</td>
<td>33</td>
<td>32</td>
<td>43</td>
</tr>
<tr>
<td>CO 4.0</td>
<td>pH</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
<td>7.45</td>
<td>7.47</td>
<td>7.37</td>
</tr>
<tr>
<td></td>
<td>paCO2</td>
<td>46</td>
<td>54</td>
<td>627</td>
<td>51</td>
<td>59</td>
<td>627</td>
<td>57</td>
<td>69</td>
<td>627</td>
</tr>
<tr>
<td></td>
<td>SaO2</td>
<td>82%</td>
<td>88%</td>
<td>100%</td>
<td>85%</td>
<td>89%</td>
<td>100%</td>
<td>89%</td>
<td>93%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Figure 1
Califia Portrait

Figure 2
Harvi Portrait
COMPARING RECOMMENDED LIMITS OF NADIR DO2I BETWEEN ADULT AND PEDIATRIC PATIENTS DURING CARDIOPULMONARY BYPASS: A META-ANALYSIS

During cardiac surgery the oxygenation of tissues to avoid ischemic injury is an important role of the perfusionist. No measurement better quantifies this directive than the delivery of oxygen indexed (DO2i). The variables perfusionist’s use to control DO2i are hemoglobin and flow. Maintaining a DO2i above a certain threshold is an important aspect of CPB related injury prevention. A broad meta-analysis was performed compiling DO2i data which has followed the landmark 2005 Ranucci et al., study. Two separate data-sets were extracted, one consisting of adult patients (>18yrs) and one of pediatric patients (<18yrs).

This meta-analysis was designed to answer the following research questions: What is the current average safe nadir DO2i of both the adult and pediatric populations during CPB? And is there a difference in the current average safe nadir DO2i between the adult and pediatric populations? Traditionally literature to date has often referenced the 2005 DO2i target of 272 ml/min/m2 as a standard of practice for adults. This meta-analysis attempts to provide an updated target for both adult and pediatric patients.

Eleven studies were included in the adult data set totaling 4179 individual patients. Five studies were included in the pediatric data set totaling 690 patients. Results of the meta analysis are found in Table 1. The weighted average sans Ranucci 2005 was compared to the updated weighted mean DO2i. This produced a p-value of .0857 which is not significant at a 95% confidence interval yet suggests a difference. The weighted mean safe nadir DO2is of the total adult and the total pediatric populations were then compared. This produced a significant p-value of <.0001.

To date no meta-analysis has been performed on the studies reporting safe nadir DO2i in the adult and pediatric populations. This study provides updated DO2i targets for perfusionists to follow based on modern literature.

Table 1

Results from the collected data-sets compiled to create updated weighted mean safe nadir DO2i targets for both adult and pediatric perfusionists.

<table>
<thead>
<tr>
<th>Data-set</th>
<th># of Studies</th>
<th>Range (ml/min/m2)</th>
<th>Weighted Mean Safe Nadir DO2i (ml/min/m2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults (2005-2020)</td>
<td>11</td>
<td>225-310</td>
<td>271</td>
</tr>
<tr>
<td>Adults (2011-2020)</td>
<td>10</td>
<td>&quot;</td>
<td>277</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>5</td>
<td>310-377</td>
<td>350</td>
</tr>
</tbody>
</table>
References


---

**Important Academy Dates**

The ACADEMY ANNUAL MEETING DEADLINES

**ABSTRACT DEADLINE** October 15, 2022

**MEMBERSHIP DEADLINE** December 1, 2022

**PRE-REGISTRATION** January 6, 2023

**HOTEL REGISTRATION** January 6, 2023

**2023 ANNUAL MEETING** February 1-4, 2023
Contact Information for Our Sponsoring Partners

**ABBOTT**
Mechanical Circulatory Support
Phone: 800-456-1477

**BERLIN HEART**
Phone: 281-863-9700
Fax: 281-863-9701
Email: info@berlinheartinc.com
Website: https://www.berlinheart.com/

**CARDIOQUIP**
Phone: 979-691-0202
Fax: 979-691-0206
Email: info@cardioquip.com
Website: https://www.cardioquip.com/us-home

**EDWARDS LIFESCIENCES**
Phone: 800-424-3278
website: https://www.edwards.com/devices/hemodynamic-monitoring/ForeSight

**FRESENIUS MEDICAL CARE**
Phone: 781-699-9000 or 800-662-1237
Website: https://fmcna.com/products/critical-care/novalung/

**LIVANOVA**
Phone: 800-221-7943 or 303-467-6517
Fax: 303-467-6375
Website: http://www.sorin.com

**MEDTRONIC**
Phone: 763-391-9000

**QUEST MEDICAL, INC.**
Phone: 800-627-0226 or 972-390-9800
Fax: 972-390-2881
Website: http://www.questmedical.com/

**SPECTRUM MEDICAL, INC.**
Phone: 800-265-2331
Fax: 803-802-1455
Website: http://www.spectrummedical.com

**TELEFLEX**
Phone: 866-246-6990 (8am-7pm EST / Mon-Fri)
Email: cs@teleflex.com
Website: https://www.teleflex.com

**TERUMO CARDIOVASCULAR SYSTEMS**
Phone: 734-663-4145 or 800-521-2818
Fax: 734-663-7981
Website: https://www.terumocv.com/
Three students received Lawrence Awards for their paper presentations at the Annual Seminar in Lost Pines.

Michelle McArdle - Hemostatic Complications On ECMO In COVID-19 (Sars-CoV-2) Negative Versus COVID-19 (Sars-CoV-2) Positive Patients

Megan Thorbahn - Using Circulating ACE2 Products To Predict Prognosis And Determine Efficacy Of Treatment For ARDS Patients Receiving VV ECMO Therapy

Trevor Millikan - Comparison of Alternative Anticoagulation Strategies for Extracorporeal Membrane Oxygenation

The Lawrence Award is a $500 cash award for the best student paper presentations.
Welcome to New Members

The American Academy of Cardiovascular Perfusion would like to welcome the following individuals whom were voted into membership at the Closing Business Meeting of our annual meeting in Lost Pines, Texas.

**Fellow Members**
Allyson Aquino
Keith Bryant
Chloe Choi

**Members**
Allen, Mikaela
Bertrand, Katie
Carey, Lauren
Carmody, Willow
Carroll, David
Cheek, Christopher T.
Church, Howard
Dance, Garland
Duarte, Melissa
Duong, Olivia
Fristoe, Lance
Frohn, Chasity
Gamez, Jacob
Gayeski, Stephanie
Gubits, Meghan
Holt, Dorothy
Jahadi, Ozzie
Keller, Dan
Kress, Nicholas
Marflak, John
Myles, Richard
Pagel, Anthony
Paugh, Theron
Reitsma, Matthew
Reyes, Christopher
Rusk, Thomas
Vespe, Michael
Ward, Gabrielle

**Beers, Stephanie**
**Bernn, Matt**
**Bolick, Jeremy**
**Burns, Brianna**
**Centronie, Nicholas**
**Chamberlain, Cameron**
**Chaney, Charles**
**Childers, Alexander**
**Chow, Christine**
**Christensen, Lauren**
**Clark, Jarad**
**Collins, Kayla**
**Coombs, Taylor**
**Cronin, Michael**
**Curcio, Sabino**
**Curtis, Shelby**
**Detweiler, Annie**
**DiCapna, Mary**
**Dotson, Zachary**
**Dressler, Hillary**
**Driscoll, John**
**Eby, Allison**
**Fang, Hannah**
**Finch, Joshua**
**Fine, Joshua**
**Finley, Adam**
**Fischer, Kris**
**French, J. Maxwell**
**Fugitt, Hunter**
**Godfrey, Benjamin**
**Goodrich, Sarah**
**Guzman, Keila**
**Hackett, Matthew**
**Harris, Erin**
**Hays, Kasey**
**Hedtke, Hannah**
**Hughes, Grayson**
**Hulbert, Ian**
**Jaramillo, Sydney**
**Johnides, Brian**
**Koroghlian, Daleth**
**Layeghy, Alborz**
**Lee, Jennifer**
**Leone, Jamie**
**Lewis, Frances**
**Matthews, Danielle**
**Mauntel, Emily**
**McAlpin, Christopher**
**McArdle, Michelle**
**McArthy, Cory**
**McDonald, Daytona**
**McIntyre, Angela**
**Milestone, Kalli**
**Montesano, Matthew**
**Nguyen, Daniel**
**Nix, Sarah**
**Olm-Trujillo, Noelle**
**Olvey, Tyler**
**Owens, Grayce**
**Pagano, Nathan**
**Phillips, Jacob**
**Powell, Tyler**
**Rechin, Saskia**
**Redford, Christine**
**Robinson, Tyler**
**Rogers, Emily**
**Saraf, Tullika**
**Schmeck, Carson**
**Schroder, Garrett**
**Shastrri, Karmali**
**Shields, Desiree**
**Silverio, John**
**Simpson, Heather**
**Singh, Joshua**
**Stuart, Caleb**
**Sun, Helen**
**Syquia, Jose Antonio**
**Thorbahn, Megan**
**Thornton, Sable**
**Webb, Johnetz**
**Wilder, Joseph**
**Williams, Carly**
**Wong, Ethan**
**Wong, Ka-Kit**
Heart failure is one of the leading causes of death throughout the world that affects over six million adults in the United States,\(^1\) with an estimated 8 million Americans by 2030.\(^2\) When traditional pharmacological therapy fails, a form of advanced hemodynamic support may be required. Since at most only 2,300 donor hearts become available for transplantation each year, temporary mechanical devices have become vital to support those with advanced heart failure.\(^2\) AbioMed’s Impella heart pump is one of the leading invasive mechanical circulatory support devices since 2008.\(^2\) The Impella is used as a temporary assist device that is most often placed in the left ventricle and aorta to allow for forward flow, while also providing hemodynamic support after acute injury. The Impella has also been shown to improve native heart function after cardiac compromise. The Impella has many indications and can be utilized during refractory cardiogenic shock, a high risk PCI, post MI, post cardiotomy, OPCABG support, or as a bridge to transplant. This device has also been shown to decrease hospital stay, as well as morbidity and mortality in patients undergoing non-emergent PCI.\(^4\)

The design of the Impella maximizes cardiac output while also reducing the workload of the myocardium. The Impella continuously draws blood from the left ventricle via the inlet port and then expels it into the ascending aorta via the outlet port (see Figure 1). The unloading of the left ventricle decreases the myocardial oxygen demand while also increasing cardiac output and coronary perfusion. Various performance levels (P1-P9) allow for a broad range of support. With AbioMed’s new Smart Assist technology on the device, it is now easier than ever to assess placement and cardiac function, which decreases complications and allows for better management. The overall intent is to reduce ventricular work and provide circulatory support to allow for heart recovery.

The Impella: A Mechanical Circulatory Support Device

Figure 1.
When assessing the capabilities of a mechanical circulatory device, the Impella provides a higher level of hemodynamic support when compared to the Intra-Aortic balloon pump. A 2019 study evaluating patients who underwent PCI requiring mechanical circulatory support either the IABP or Impella, those who received the Impella had lower in-hospital mortality, vascular complications, cardiac complications, and respiratory complications compared to those with the IABP, despite having more complications including COPD, renal failure, diabetes and hypertension. Overall for patients suffering with cardiogenic shock, the Impella decreases preload, increases cardiac output, and improves coronary circulation.

References


Transesophageal Echocardiography is a semi-invasive diagnostic and intraoperative ultrasound that was developed in the late 1970s, commonly used today in both inpatient and outpatient settings. The echocardiogram evaluation known as TEE has become a standard of practice monitoring tool for cardiac anesthesiology. The American Society of Anesthesiologists and Society of Cardiovascular Anesthesiologist Practice Guidelines of Perioperative TEE state that TEE should be used in all open heart and thoracic aortic surgical procedures and should be highly considered for coronary artery bypass graft surgeries. Transesophageal Echocardiography (TEE) is performed by inserting a transducer probe into the esophagus to view the posterior structures of the heart and is utilized before cardiopulmonary bypass (CPB) to establish the patient’s structural and functional baseline. After CPB, TEE will assess the interventions, any new abnormalities, and will have the patient’s baseline for reference. Sometimes additional or often neglected findings, such as a patent foramen ovale, can even change the course of a planned procedure. TEE has intraoperative monitoring applications that help determine preload and volume status, intracardiac pressure measurement, cardiac output, and patient hemodynamics, especially when weaning from CPB. This article will apply the basics of TEE examination through assessing valve integrity.

An intraoperative TEE is comprised of a core twenty views for a comprehensive examination. With the TEE probe positioned posterior to the left atrium, the mid-esophageal view captures the majority of these. This view alone covers the cardiac chambers and valves in most patients. Additionally, the upper esophageal view, achieved with the probe at the aortic arch level, is used to visualize the aortic arch, pulmonary artery, and pulmonic valve. The transgastric view captures a superior image plane through the diaphragm by TEE placement inside the stomach below the heart to view the left ventricle, right ventricle, mitral valve, and tricuspid valve. The deep transgastric view can capture the left ventricular outflow tract, the aortic valve, the ascending aorta, and arch. The utility of the TEE probe and respective angles are displayed in the graphic below:
For valve repair or replacement, TEE will help provide a better understanding of the feasibility of the repair by a baseline assessment. The baseline valve assessment will provide a surgeon with information on the feasibility of a repair based on the mechanism and etiology of lesions, the type of repair that is needed, and the assessment of the intervention after CPB. Valves repairs are primarily assessed for residual regurgitation and stenosis. Evaluated by TEE color flow doppler, residual regurgitation that is determined moderate or more should have a repair revision or a valve replacement. TEE color flow doppler is used to assess the valve annulus for paravalvular leaks after valve replacement. It is important to note that some prosthetic valves may show non-pathologic regurgitation patterns, such as bileaflet mechanical valves with one immobile leaflet. In some applications of the aortic valve, TEE color flow doppler will detect regurgitation of homograft and stentless bioprostheses if they are inserted incorrectly.

The aortic valve is assessed using the mid-esophageal AV short and long axis TEE views and may be done so with or without the use of color flow doppler. TEE assesses the severity of aortic regurgitation based on the size of the jet and depth into the left ventricle. Using 2D echocardiography in the mid-esophageal AV short axis view, the valve cusps are evaluated for how they come together as a unit and any perforations should be noted. This technique is also used for evaluating the aortic valve area by planimetry and continuity, with the understanding that the same flow passing through the left ventricular outflow tract should be equal to that passing through the aortic valve per stroke. Doppler flow velocity is used in the transgastric long axis view to assess transaortic gradients by using an ultrasound beam parallel to aortic valve flow. This application is essential for evaluating the aortic valve for stenosis.

TEE is an invaluable tool both preoperatively and intraoperatively given its ability to assess valve integrity. Second to ultrasound imaging, TEE should be considered as a tool used for hemodynamic monitoring applications.

TEE provides the most accurate assessment of cardiac preload and volume status. Pulmonary artery catheter filling pressures may or may not reflect the true ventricular volume status, while the TEE can accurately assess preload. As for volume status, the TEE is most reliable in comparison to central venous and pulmonary capillary wedge pressures as true volume status is overestimated by these values. The transgastric mid short axis view is used to assess the preload and volume status that is essential to CPB weaning, in addition to estimating end-diastolic volume and left ventricular distention. Using fluid dynamics, intracardiac pressure can be measured using TEE doppler technology by applying a modified Bernoulli’s principle. This will show the relationship between the flow velocity through a stenosis and the pressure gradient across a stenosis. Cardiac output can be calculated by TEE doppler using stroke volume to create a velocity-time integral, or by estimation using 2D area of flow by dividing the left ventricle into discs by the Simpson rule. Optimization of the TEE views for monitoring applications is most valuable pre
and post CPB, as TEE utility is lost during CPB with cardioplegia delivery. Additionally, ultrasound definition is lost with empty cardiac chambers due to loss of ultrasonographic contrast and doppler functionality is unavailable in this state. As the heart is filled during the process of weaning from CPB, TEE will guide effective air evacuation before termination.7

The use of TEE during cardiac surgery is a staple to anesthesia practice guidelines for its well-known use to identify pathology and to assess surgical interventions. The monitoring capabilities of TEE should not be overlooked, but rather optimized by the core comprehensive views. With the help of TEE, we can better understand preload and volume status that can supplement pulmonary artery catheter measurements and assist in the process of weaning from CPB. While recommended for coronary artery bypass procedures, the capability of TEE technology is best showcased by viewing an open heart. The most current and foreseeable future of TEE technology, the utilization of 3D imaging, will only provide greater perspective into both minimally invasive and open-heart cardiac surgery.

References


2023 Annual Meeting

Savannah, Georgia
February 1-4, 2023

Our Host Hotel
The Desoto Savannah
15 East Liberty Street, Savannah, GA, 31401

Reservations: 800-239-5118
Single/Double Occupancy: $199.00

Remember to mention that you will be attending the Annual Conference of The American Academy of Cardiovascular Perfusion (AACP).

AACP 2022 Officers and Council

President
Justin Resley
Evans, GA

Vice-President
David Fitzgerald
Mt. Pleasant, SC

Secretary
Tami Rosenthal
Aston, PA

Treasurer
Kenmund Fung
New York, NY

Council Members
William Riley
N. Weymouth, MA
Past President
Molly Bryant
Oronoco, MN
Edward Delaney
Nutley, NJ
Richard Melchior
Woodbury, NJ
Allison Weinberg
Northbrook, IL