The
Academy
NEWSLETTER

THE AMERICAN ACADEMY
OF
CARDIOVASCULAR PERFUSION
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Inside This Issue

This really is <u>not</u> an anatomy lesson! It's Making Use of Your Gifts

'The salt of the earth' was first published in English in Geoffrey Chaucer's Canterbury Tales in the "Summoner's Tale," circa 1386, although Chaucer undoubtedly took his lead from Latin versions of the Bible from the book of Job around 2,250 BC, (there are 31 other references to salt in the Bible):

"Ye been the salt of the erthe and the savour."

To say the history of salt is essentially the history of the world is not an overstatement. Some call salt a "primordial condiment." It has been on earth for as long as there has been water and rock to create it. Its history dates billions of years in the making and it grows richer with each generation of human existence. American history although brief compared to salt's history, reveals the important role of salt in our development as a nation. During the Revolutionary War, the British enlisted American Loyalists to intercept the Patriots' salt supplies in order to prevent their ability to preserve food. In the War of 1812, our economic-strapped government paid soldiers with salt brine. Salt received the nickname of *White Gold* during the Middle Ages. Our English word *salary* is derived from the Latin word salarium (salt money), which was the name given to the mineral when it was used as currency. To say you are the salt of the earth implies purity and a message of hope to maximize your potential. The membership of the AACP certainly ranks at the forefront when it comes to applying this term to the history of cardiovascular perfusion.

Perhaps the single greatest event in man's creation or evolution was the act of *walking* upright or erect.

It is estimated that the femur became elongated 2.5 million years ago to accommodate this change, one million years before the forearm shortened resembling our human structure today. During this evolutionary stage of Homo habilis, another very important development occurred – the fine motor skilled application of a newly acquired anatomical extension – the opposing *thumb*. Some argue that the gripping hand preceded walking and was a necessary development prior to becoming bipedal. In other words, walking was perhaps a by-product of increasingly busy hands. Without it, can you imagine a world with no artistic paintings – sculpture – music? All of which would have been unthinkable; people require thumbs to hold paintbrushes, chisels, and musical instruments and yes, to finely adjust the speed of a roller or centrifugal pump – let alone setup a perfusion cir-

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cuit. This digital aid is arguably the most influential component in the advancement of mankind. Its functional use modernly could be considered regressing with computer keyboards and other devices as it tags along with the other digits.

When we became knowledgeable will of course forever elude us. One thing is for certain; intellect was simply delayed and was not hopelessly repulsed. The *brain* is the center of the nervous system in all vertebrate and most invertebrate animals — only a few primitive species such as sponges, jellyfish, sea squirts and starfishes do not have one. In evolutionary biology, it is speculated that the human brain attained its current size roughly 200,000 years ago. It is now conceded the status of master organ of the body, the regulator of life and the source of human progress.

At first glance – this does indeed look a little like an anatomy or chemistry lesson, "trust me," it is not. It is a diversion to the truth and purpose we all serve and hopefully motivational as well.

Make strong your use of these anatomical and biochemical gifts of advantage. The American Academy of Cardiovascular Perfusion evolved going on 36 years ago and was built upon the strongest of foundations and spirit, formal perfusion education!

It was Thomas Wharton's vision and legacy which facilitated this and today we enjoy the rich rewards of this distinguished and highly motivated organization as a result. It is made up of people like you and it is only as strong as its weakest link. You are the binding elements that make us the force that we are. Every member is very critical to its vibrancy. Learn the history and purpose of this organization and those who sacrificed to mold it into the distinction and purpose it serves in our society.

The oral tradition of fairy tales existed long before the written page. The epic of Gilgamesh is the oldest known written story on Earth. It is of immense interest that world literature has captured many of these epic sagas and documented them in immortal Greek classics. You must study and learn the history of the AACP, its founders, its principles, and purpose in continuing to building it, expanding its reach. We have preserved this very well in memorial lectures. Why you may ask? The founding guide of the AACP was to establish a global network of perfusion science and disseminate study beyond regional borders. Again, we have done this quite well in assisting foreign professionals to establish themselves organizationally. We are now like a spider's web, interwoven in a bond that welcomes academic dialogue and exchange of clinical experiences and techniques for the sole purpose of making cardiovascular perfusion a safe and beneficial methodology for the human subjects who undergo surgical treatment for their ailments. Grow this and be fulfilled professionally.

It is the walk we embark upon together at present and the use of our enormous brain power which will define our future course.

Just as the thumb was required for tool making and cultural advancements, the AACP requires your energetic support and contributions. This comes in many forms, (1) volunteerism, (2) financial, (3) active participation, (4) attendance, (5) sharing your ideas, and (6) leadership. Most importantly, the exchange of clinical experience and scientific study greatly contributes to the cause. We need your presentations and manuscripts; it is the heart and soul of this professional organization. Yes, this is a call, bring them forth and submit whether it is a case report or investigative work – this is the essence of the AACP. Program Directors, students, and fellow professionals are all welcome here!

Those who attended our most recent meeting in Orlando experienced an exceptional program, Scott Lawson especially and others who worked with him are to be commended – we all departed with enthusiasm and learning. Mark Kurusz exemplified the legacy of this passion and strength in the Reed Memorial Lecture illustrating in his presentation the commitment of focus and keeping our eye on the target – THE AACP as a recipe for success. The present leadership involving Council and Officers accept the challenge of maintaining this continuity and share the vision.

The 2015 Annual Academy Meeting
San Antonio, Texas
February 5 - 8, 2015
Omni La Mansion del Rio Hotel

Our meeting takes place near the site of a famous battle which symbolizes independence. The Alamo is maintained as a shrine and museum by the Daughters of the Republic of Texas. Visitors gain a glimpse into early Spanish colonial life in the Southwest. As the first civilian settlement in Texas, San Antonio de Béxar was founded in 1718. After thousands of years of succeeding indigenous cultures, the historic Payaya Indians coalesced as a distinct ethnic group living near the San Antonio River Valley, in the San Pedro Springs area, which they called Yanaguana, meaning "refreshing waters". We convene our meeting on the Paseo del Rio (the River Walk) to refresh your direction and education at the luxurious Omni ***La Mansión del Rio Hotel***.

The 2015 annual meeting is fast approaching, energize yourself and fellow practitioners and take the lead in making this a very successful event. Your officers, national office and executive director, and leaders are working diligently and tirelessly to advance the cause of the AACP now and into the future. Perfusion education in the clinical sciences is deeply rooted in our membership. This is what defines me and my willingness to go the distance; I hope you will join me in this endeavor.

"If your actions inspire others to dream more, learn more, do more and become more, you are a leader."

John Quincy Adams

We are thinking out-of-the-box and attempting to innovate by making use of modern technology and media to enhance the experience of everyone who participates. Have you ever reflected on the power of participation? It is could be described as a contagion, the act of touching others in a motivational or inspirational manner as a vector of goodwill – go ahead, I dare you – give it to others. Watch it grow! It demands salesmanship, leadership, and determination as defining principles along the way; discover your role in making this happen. The time is now!

Steven W. Sutton, President
American Academy of Cardiovascular Perfusion

THE ACADEMY TO OFFER LIVE WEBCAST

For the first time, the American Academy of Cardiovascular Perfusion will be offering a live webcast of our 2015 Annual Meeting in San Antonio. The General Sessions of the meeting will be broadcast in high quality streaming video. There will also be an opportunity for attendees to ask questions, thus qualifying for Category I CEUs from the American Board of Cardiovascular Perfusion.

More information along with registration details will be available on our website (*www.TheAACP.com*) by early Fall.

2015 Annual Academy Meeting

Omni La Mansion del Rio Hotel
San Antonio, Texas
February 5-8, 2014

Thursday, February 5, 2015

9:00 AM – 1:00 PM	Council Meeting
10:00 AM – 3:00 PM	REGISTRATION
2:30 PM – 4:30 PM	Fireside Chats (Session #1)
4:30 PM – 5:30 PM	REGISTRATION
5:00 PM	Opening Business Meeting *Fellow, Member, Senior and Honorary Members*
6:00 PM – 8:30 PM	Sponsor's Hands-On Workshop & Reception

Friday, February 6, 2015

7:00 AM	REGISTRATION
8:00 AM – 9:30 AM	Scientific Session
9:30 AM – 10:00 AM	Break
10:00 AM – 11:30 PM	Special Scientific Session

Perfusion Techniques and the Expanding Role of the Perfusionist: A How To Series (Part I)

11:30 PM – 1:00 PM	Lunch

1:00 PM – 3:30 PM Special Scientific Session

Perfusion Techniques and the Expanding Role of the Perfusionist: A How To Series (Part II)

3:30 PM – 5:30 PM Fireside Chats (Session #2)

6:30 PM Induction Dinner
Fellow, Senior, Honorary Members & Guests

Saturday, February 7, 2015

7:00 AM REGISTRATION
8:00 AM – 9:30 AM Scientific Session
9:30 AM – 10:00 AM Break
10:00 AM – 11:30 AM Memorial Session
Charles C. Reed Memorial Lecture
Thomas G. Wharton Memorial Lecture
Steven W. Sutton, CCP - President, AACP

11:30 AM – 1:00 PM Lunch
1:00 PM – 3:30 PM Special Scientific Session (Panel)

Perfusion Safety / Simulation / Education

Perfusion Education and Direction In The 21st Century
Safety
Evidence-Based Practice
Simulation & Intraoperative Behavior

3:30 PM – 5:30 PM Fireside Chats (Session #3)
5:30PM Closing Business Meeting
Fellow, Senior and Honorary Members Only

Sunday, February 8, 2015

8:00 AM – 10:00 AM Scientific Session
10:30 AM – 12:30 PM Fireside Chats (Session #4)

Our Host Hotel

The Omni La Mansión del Rio Hotel

112 College Street
San Antonio, Texas 78205

$184.00 Single/Double Occupancy
Reservations: 800-THE-OMNI

Please mention that you will be attending the Annual Conference of The American Academy of Cardiovascular Perfusion when making your reservations.

The Omni La Mansión del Rio is ideally nestled along the historic River Walk among the banks of the Paseo del Rio in downtown San Antonio, where it is perfectly situated for any visitor seeking to explore all of San Antonio's extensive range of tourist attractions. It is within easy walking distance of the fabled Alamo, El Mercado, La Villita District, Spanish Governors Palace, San Antonio Convention Center and other well-known landmarks.

Blending Spanish colonial architecture and European style, the four-diamond Omni La Mansión del Rio surrounds guests with the romance, grace and charm of a grand hacienda. Our San Antonio River Walk accommodations provide a haven for guests with graceful service and tranquil surroundings. Built on three levels that descend to San Antonio's festive River Walk, the Las Canarias Restaurant offers a romantic atmosphere of graceful palms, flowing waters and scenic views. This luxury San Antonio hotel located on the San Antonio River Walk, was recognized in the Celebrated Living's Magazine as one of the top hotels in the Nation.

ON BYPASS

A novel approach to "del Nido" type single-dose techniques in adults

Candice A. Kalin, CCP, Catherine E. Berry, CCP, William A. Cooper, MD, MBA and Richard J. Myung, MD

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With single-dose cardioplegia solutions making a surge into the adult arena of cardiac surgery, there remains a real need and potential benefit from combining the high oxygen carrying capacity, low hemodilution, reduced myocardial edema qualities of an all blood microplegia with that of the lower maintenance, single-dosing type solutions.

Having tried del Nido cardioplegia for our adult patients in its traditional form, we believed it would be a disservice to our patients to abandon our standard of all blood microplegia for a single-dose crystalloid carrier approach. With the advancements made over the last 20 years, and the development of the Quest Myocardial Protection System, we were driven to develop a method that would provide all of the qualities of an all blood cardioplegia, combined with a modified single-dosing strategy appropriate for the diseased adult heart.

We have developed a modified solution to be given in an all blood fashion with no crystalloid carrier, yet are still able to achieve the sustained arrest times of well over 60 minutes as seen with other single-dose cardioplegia solutions. With a directed protocol, we make modifications to accommodate the aged adult heart, rather than a "one size fits all" single-dose approach.

To date, we have used this method on over 230 cardiac surgery patients, most of which were complex combined valve procedures. Encouraged by observed results, retrospective and prospective studies are pending IRB approval. We hope to have retrospective data available in the near future.

FOR INFORMATION ABOUT ATTRACTIONS IN THE SAN ANTONIO AREA GO TO : HTTP://VISITSANANTONIO.COM/

Research and Reading the Literature

Richard Chan, Mark Kurusz and **Jeff Riley**

Introduction

These topics were presented at the 2013 and 2014 seminars of the American Academy of Cardiovascular Perfusion as Fireside Chats. For those who were unable to attend the meeting, the handout material in three parts is being published in the next three issues of the *AACP Newsletter*. This issue contains Part 1, and it also includes a list of resources for additional information pertaining to all three topics. Part 2 is entitled, "Preparing a Presentation" and Part 3 is entitled, "Publishing a Paper." They will appear in the Fall and Winter issues of the *AACP Newsletter* later this year.

What to Read? Continuing education is a high priority for perfusionists to keep abreast of latest developments in the field. There are now several good sources besides thoracic surgery journals (*The Annals of Thoracic Surgery*, *The Journal of Thoracic and Cardiovascular Surgery*, and *The European Journal of Cardio-Thoracic Surgery*). Today the two major perfusion journals are *Perfusion* (6 issues/year) and AmSECT's *The Journal of ExtraCorporeal Technology* (4 issues/year). Manuscripts from presentations at the AACP meeting are submitted to *Perfusion* for peer review. Another journal that has relevant perfusion -related articles is the *ASAIO Journal*. Occasionally, articles of interest to perfusionists appear in *The Journal of Cardiothoracic and Vascular Anesthesia*, *Artificial Organs*, and *The International Journal of Artificial Organs*. Thompson Reuters assigns an Impact Factor to journals to help consumers understand the potential influence of their future publication and the chance for their paper to be referenced in the future. There are also often citation statistics published for individual papers in PubMed, OVID, and the Web of Knowledge.

Keywords. The assignment to your manuscript and use of keywords for a search are skills to hone. PubMed provides a MeSH Database of keywords and phrases that are commonly employed. Potential authors should use the MeSH Database for searches and writing. MeSH is a good starting place for new researchers and authors.

Reference File. These may consist of photocopies or reprints or more commonly electronic files with pdfs of full-text journal articles. The files should be categorized so that when a question comes up, you can easily retrieve pertinent articles on any given topic. It is advised to use reference management databases such as RefMan or EndNotes to collect selected evidence articles to use to support your practice, your clinical procedure guidelines, or to research and write your manuscripts. You can set up your own personal PubMed search engine to notify you when articles are published according to your list of key words from the MeSH Database. You can do the same activity at many journal sites so you are notified when a publication in your area of interest is published.

Reading the Literature. It may seem obvious, but the first thing to read is the title followed by the abstract. If both appear to meet your needs, then a careful reading of the entire article follows. You should approach every article as a skeptic—that is, you should constantly be asking yourself, "Is the author being objective yet persuasive?" or "Does the paper appear authoritative?" or "Is the language simple and does the narrative flow logically from one section to another?" One of the ways to confirm first impressions is to flip between the text and the reference list to see not only what papers are being cited but whether the au-

thor has cited references correctly when making statements or reiterating conclusions from other works. The references should also be up-to-date on the subject matter thus demonstrating the author has done a credible review of the literature.

Statistics. Virtually all studies rely on statistics to evaluate data because statistics bring a study's results into focus. The type of statistics used is important as well as how they are applied. Data sets should report the mean (average) and the standard deviation (SD) and rarely the standard error of the mean (SEM). Student's t-test is used to compare the difference between two test groups. If there are more than two groups being compared, analysis of variance (ANOVA) statistics should be used. The p-value quantifies the probability a difference exists between groups of data being compared that it is not due to chance or random sampling. Reporting a p-value of <0.05 means there is less than a 5% chance that there is an error when you report a significant difference between groups. There are additional subtleties regarding sample size, Type I or Type II errors, the Null Hypothesis, randomization, survey methodology, and measures of validity and bias explained in the Berryessa *et al*. and Toomasian papers cited below. It is worthwhile to consult a statistician unless you are familiar with basic statistics.

Types of Papers

Clinical Practice-Device These probably are the most common perfusion papers. The gold standard is a prospective randomized study comparing devices, which is not always possible for perfusionists to undertake. A more simple paper of this type is to describe common clinical measurements when using a new device. Retrospective reports also can be easily done to compare closely matched groups of patients. It is important to get physician or institutional approval before undertaking a study, particularly if patient outcomes are reported. As noted above, there is a need for conflict of interest disclosure so readers can make a judgment if bias in favor of a product is apparent.

Clinical Practice-Technique This is most often a description of a new way to do something. As above, it is important to get the necessary approvals before submitting the paper for publication. If the technique involved physicians in its execution, they should be offered co-authorship with its attendant responsibilities. Technique papers typically involve a series of patients. There is a distinct ranking of published articles, and readers should appreciate the hierarchy from highest to lowest: meta-analysis (systemic reviews), randomized control trials, cohort studies, case-controlled studies, case-series/reports and editorials/expert opinion.

Case Report This is another common and relatively easy type of paper for perfusionists to write. It should include all relevant details of an unusual case (patient pathology, unexpected event, or previously unreported case). As above, one must abide by hospital rules regarding patient confidentiality (HIPAA). The good case report summarizes other similar cases reported in the literature so readers can put in context the one being reported.

Review Article Anyone with access to a library (or a computer these days) can do a literature review. This often entails the exhaustive collection, reading, and summarizing of the findings of other authors on a given topic. This type of paper is sometimes called a meta-analysis that entails use of statistics applied to previous reports to detect trends, patterns, or areas of disagreement. A benefit of a meta-analysis is that study results involving large numbers of patients from multiple centers can be pooled for analysis. One of the major problems with a meta-analysis is to identify common data points from various articles. For example, sampling time lines, exclusion and inclusion criteria, or differences in perfusion techniques are variables difficult to deal with since the studies are not collaborative efforts. Analyses are seldom conclusive with any confidence level (p-value).

Meta-analysis The main purpose of a review article or a meta-analysis is to draw conclusions from large bodies of work so that new perspectives might be elucidated. While ii may be difficult for perfusionists to perform blinded, prospective randomized human clinical research independently, students and practicing perfusionists can perform reviews and meta-analyses. There is meta-analysis software to help guide these projects.

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Basic Research This type of paper seeks to answer a question (or prove or disprove a hypothesis) in the laboratory setting that is not amenable to clinical study alone. This type of research also may include descriptions of unique prototypes. Most perfusionists have limited ability to conduct basic research depending on their setting and available funding for laboratory supplies. Search engines are very useful. Clinicians and authors will find PubMed, OVID, CINAHL, ISI Web of Knowledge, SCOPUS, clinical trials finders, and Cochrane Reviews helpful tools to perform searches.

Abstract Despite being brief, writing an abstract is often a challenge because authors are forced to distill down the key points of a paper. It is typically written after the paper has been completed and it allows readers to gain a quick understanding of the subject matter. If the abstract appears interesting or important, the reader will then be inclined to read the full text and perhaps add it to a reference file. Some journals require the abstract have sections corresponding to sections in the full paper to further aid the reader in making a quick assessment (see IMRAD below). Abstracts are also submitted to program committees for consideration for presentation at a meeting. When submitting an abstract to a program committee, you should avoid the "kiss and a promise" type of submission in which little information is conveyed other than "we did so-and-so study and the results will be presented" because this gives the program committee little to determine if the presenter deserves a slot on the program.

Textbook These most often have a single or a few editors who solicit book chapters from noted experts on given topics. The editors are responsible for making the chapters consistent in style without significant overlap in content. Alternatively, a book may be written by one or more authors, which represents their accumulated experience, perspective, and judgment on a given topic.

Invited Commentary This type of publication is sometimes solicited by journal editors and is often the result of a manuscript review by the person being solicited. It is intended to offer a different perspective on a paper published by others. The commentary most often appears immediately following the paper being commented upon and is limited in size. It may or may not have references.

Letter to the Editor Like the invited commentary above, these are limited in size, but unlike a commentary, they are sent unsolicited to the journal editor regarding a previously published paper. They may be critical of some aspects of the paper or may offer additional details or an uncited reference that was not included in the original paper. Usually the original author of the paper being critiqued is offered the chance to reply, so the advantage goes to the first author since she or he has the last word. The language is generally polite and complimentary in tone, and letters are typically very short with only a few references, if any.

Editorial These typically are written by journal editors or section editors. The subject matter is often broad, they can be more philosophical in tone, and they almost always draw attention to the content of a given issue of the journal.

Book Review These appear infrequently, but can alert readers of new books. By their nature they are judgmental. Somewhat surprisingly, favorable book reviews rarely increase sales, while unfavorable reviews can hurt book sales.

Historical Review These are reviews of noteworthy cases or events and contain details that may not be generally well-known. They often appear decades after the original report(s) of the case or event.

Panel Discussion These appear infrequently nowadays because they are lengthy and can be somewhat unfocused depending on the skill of the moderator. They are based on edited transcripts of discussions that transpired at a meeting.

Newsletter Article These often are the first publications of students and therefore are a good way to gain experience in writing a paper. A disadvantage is that they are not cited by the major indexing services such as PubMed, OVID, or Web of Science. They often do not contain an extensive reference list and may, in fact, not have any references at all.

It is important to note that modern ranking of published papers by experts for the level of evidence

and clinical practice recommendations is now the standard. The American College of Cardiology and the American Heart Association have designed a systemic process to evaluate publications (evidence) to categorize the level of effectiveness and the expert recommendations that come from the published evidence. Researchers today need to be familiar with the evidence-recommendation rating systems.

Additional Resources

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Abstract Deadline for the 2015 Meeting October 31, 2014

The Student Section

Concepts, Clinical Applications and Significance of Autotransfusion Devices

Jennifer Mottern and **Richard Chan, CCP**

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Intraoperative blood salvage devices, better known as cell savers, are often used to conserve the patient's own blood and avoid allogenic blood transfusions. This has become an important part of surgeries that cause massive blood loss (such as liver transplants) or blood activation [such as cardiac surgeries involving cardiopulmonary bypass (CPB)]. Specifically, cardiopulmonary bypass and extracorporeal circulation impact the blood in various ways. The interaction between the bypass circuit and blood can lead to a number of issues, including platelet dysfunction, inflammatory response, and hemodilution. In addition to these responses, the use of suction in the surgical field may activate coagulation factors, fibrinolysis, white blood cells, and platelets because of "pericardial contact". The suctioned blood may contain microparticles, fat, and cellular aggregates – all byproducts from the surgical field. Blood in the cardiopulmonary bypass circuit, as well as suctioned blood, typically show increased levels of hemolysis and inflammatory mediators. Cell saver devices are often used to process these fluids, as well as any blood remaining in the circuit. Once processed, the packed red blood cells have a higher hematocrit and can be re-administered to the circuit or to the patient by the anesthesia team.

Cell savers have been shown to reduce the need to transfuse donor blood to patients. Allogenic blood transfusions have the capacity to save a patient's life if there has been severe blood loss or complications involving massive bleeding. Blood transfusions help to increase the patient's hematocrit, which theoretically will increase oxygen delivery to organs and tissues. Although blood transfusions have life-saving capabilities, it has been demonstrated that the use of donor blood can have many negative effects on patients, including increased morbidity and mortality. Some disadvantages of donor blood transfusions include hemolytic transfusion reactions, transfusion-related lung injury, coagulopathic complications, mistransfusion, etc. The fact that cell saving has dramatically reduced the usage of donor blood makes it of great clinical importance.

The principles of cell recovery and washing are universal among most blood salvage devices. The patient's blood is vacuum-aspirated and simultaneously heparinized and deposited from the surgical field into a cardiotomy reservoir. Red blood cells are separated via centrifugation during the saline wash process**.** The processing of these red blood cells removes a number of items from the blood, including of fibrin, debris from the surgical field, plasma, platelets, free hemoglobin, and procoagulants. The final product of packed red blood cells is then pumped into a transfusion transfer bag and returned to the patient.

Although almost all cell saver devices follow this general principle there are two major types of technology currently in use today, the discontinuous autotransfusion systems and the continuous autotransfusion systems. The Latham Bowl is the original concept of cell washing that follows the discontinuous wash technology. It is comprised of two bowls (inner and outer), works by discontinuous washing of the blood. The inner bowl remains stationary and contains the inlet and outlet ports for the blood, while the outer bowl rotates. The blood is pumped into the bowl and spun down so that the lighter superna-

tant is removed, and the heavier red blood cells collect at the walls. When the bowl is full, the cells are then washed and the red cells are pumped out of the centrifuge. There are different designs of bowls including the Baylor Bowl, which work using the same concept of centrifugation, but have different angles of slope in the bowl design. These distinct shapes can affect the RPM speeds that are required to achieve separation of the formed elements in the blood. For example, the centrifuge speed in Baylor Bowl is approximately 4,400rpm, while the Latham Bowl is approximately 5,600rpm. The need for higher RPM speeds could likely cause higher stress to the formed elements and therefore has the potential to damage to the blood being washed. However, activation, perhaps, may be the greater of two evils. The Fresenius Continuous Autotransfusion System (CATS) does not require a "full bowl" to start the wash cycle; rather it continuously processes the blood until a certain hematocrit is reached. This cell saver uses continuous washing of blood so that there is a reduced wait for the completion of an entire bowl before processing. The CATS device contains a centrifuge chamber that modeled after a double spiral. The blood is pumped into the inner spiral where centrifugal forces (approximately 2,400rpm) drive red blood cells into the outer spiral. Once in the outer spiral, the blood is washed by separately adding washing solution to the chamber. As blood moves through the spiral, the lighter components (fat, contaminants, plasma components, etc.) move to the middle and are pumped out while red blood cells get denser and cleaner. The quality of the washed blood may be affected by these differences in bowl design (Latham vs. Baylor), centrifugation speed, and operating procedures (fill and wash speeds, wash volumes, and other parameters).

Use of cell salvage devices provides a number of clinical applications and advantages. Indications for cell saving include any invasive procedure where there is expected to be significant blood loss. Such surgeries include liver transplants, major spinal surgeries, thoracic and abdominal aortic aneurysm repairs, and almost all cardiac surgeries that require cardiopulmonary bypass. During cardiac surgery with cardiopulmonary bypass, not only is there significant blood loss, but the blood is also diluted and activated by the circuit and pericardial contact. Cell saving allows the reuse of blood left over in the circuit after bypass. Once processed by the cell saver, this salvaged blood will have an increased hematocrit. The processed blood can then be used to increase the hematocrit of the patient, or to counteract volume issues while on cardiopulmonary bypass. By processing salvaged blood it allows the removal of undesirable products from the blood such as, microaggregates, fat, tissue debris, potassium, hormones, bioactivators, etc.

Despite the advantages, there are a number of contraindications of cell saving that may discourage its use. There may be additional activation of white blood cells and release of cytokines during the processing of blood. Different methods of washing can impact the effectiveness of the "wash". Blood salvaged in the cell saver is not immediately available for use because time is needed to wash the red blood cells, and this often requires the aide of an additional person to operate the machine. Processing the blood can result in loss of important blood factors such as plasma proteins (especially albumin), coagulation factors, and platelets. If materials that result in red blood cell lysis are present in the salvaged blood, this could be detrimental to the patient upon re-administration of washed blood. Such materials include sterile water, hydrogen peroxide, and alcohol. Cell saver should also not be used if amniotic fluid. The added expense of the cell saver device and disposables is also an added objective.

An important topic related to intraoperative cell salvage devices is the quality of the blood products after processing. One study focused on comparing the effect of different devices on the levels of inflammatory mediators before and after processing with five different devices. The BRAT2 (Cobe, standard Baylor bowl), Sequestra (Medtronic, Latham bowl), Compact Advanced (Sorin, Latham bowl), Cell Saver 5 (CS5) (Haemonetics, Latham bowl), and Continuous Autologous Transfusion System (CATS) (Fresenius) devices were compared. Concentrations and elimination rates of the inflammatory markers IL-1β, IL-2, IL-8, TNFα, myeloperoxidase (MPO), and elastase were noted in the blood in the cardiotomy reservoir before and after the processing of the blood. Parameters for each device were kept as similar as possible, within the limitations of the manufacturer's protocols, to allow for comparison. These parameters included priming speeds, washing volume, bowl emptying speed, and ratio of washing volume to bowl size. The centrifuge speeds were different, ranging from 2,400rpm (CATS) to 5,600rpm (Latham) and the wash volume used in the BRAT2

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was 850mL while 1L was used in the other devices. All systems showed significant increases in hematocrit, with the mean hematocrit ranging from 53.7% (Compact) to 68.9% (CATS). The Sequestra, Compact, and BRAT2 had low elimination rates of white blood cells (approximately 30%), while CATS and CS5 had moderate elimination of 52.5% and 54.5% respectively. Most of the inflammatory markers were decreased in the processed blood of the various devices. However there was a non-significant increase in IL-1β in each of the cell salvage systems. The concentration of IL-8 was only significantly reduced when using the CATS system, while an increase was seen when Sequestra system was utilized. The quality of packed red blood cells after processing may be affected by the design of the centrifugal bowl, the centrifugation speed, and operating procedure applied to each system.

This study is one of the few that compares the levels of inflammatory markers in the salvaged blood before and after processing. Overall, it showed that the use of various cell washing devices results in significant decrease of inflammatory markers present in cell saver blood. Variations were observed between the devices, especially in the removal of IL-1β and IL-8. These discrepancies could be attributed to differences in basal concentrations of the factors or differences in the washing processes between varying system designs. This paper failed to adequately compare the efficacy of each device from one another. Therefore, it is implied that the type of protocol based on inlet hematocrit, fill and wash speeds, and wash volume is important in getting the best efficacy in eliminating inflammatory markers.

Cell saving has become standard, not only during cardiopulmonary bypass, but also in many invasive procedures that commonly cause massive blood loss or trauma. The future of intraoperative cell salvage perhaps could not only wash red blood cells, but also conserve other important components like blood proteins. Eventually, future advancements should work to save all components of blood, including platelets and other clotting factors, to further attenuate the use of donor products. Another technique that could possibly influence the future of cell salvaging and autotransfusion is apheresis. Apheresis can allow multiple components of blood to be collected from the same donor. This permits blood products to be standardized based on what the patient needs, and could further reduce the use of donor products. In the future, technologies such as apheresis will greatly influence the practice of perfusionists, especially once this technique becomes advanced enough to separate all blood elements instantaneously. This will allow for the distribution of the various components to separate compartments for storage required during certain procedures. Until such advancements are made, the use of intraoperative cell salvaging and cell washing techniques will continue to be clinically relevant and advantageous.

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1 Francesco Onorati, et al. "Polarizing" microplegia improves cardiac cycle efficiency after CABG for unstable angina. Int J Cardiol; July 2012

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