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Cardiac Surgery Expertise in Greater Kansas City

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• Bicuspid Aortic Valve: Treatment and Replacement
• Adult Extracorporeal Membrane Oxygenation
• Increased Coronary Artery Plaque Volume Among Male Marathon Runners

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Kansas City Medicine

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Conference Explores Impact of Value-Based Care

KCMS members are invited to a special late afternoon and evening conference on Tuesday, Sept. 22, “Getting to Value: The Future of Physician Compensation,” exploring the impact of the movement toward value-based care. The program will be held from 4 to 9 p.m. at the Intercontinental Hotel, 401 Ward Parkway.

Featured speakers are Paul Grundy, MD, MPH, FACOEM, FACPM, and Marci Nielsen, PhD, MPH, both with the Patient-Centered Primary Care Collaborative (PCPCC), a Washington, DC-based not-for-profit membership organization dedicated to advancing an effective and efficient health system built on a strong foundation of primary care and the patient-centered medical home.

Dr. Grundy will keynote the dinner program which will open at 6:30 p.m. with cocktails and networking. He is the founding president of the PCPCC and director of global health-care transformation for IBM, where he develops and executes strategies that support IBM’s health-care industry transformation initiatives. Dr. Grundy is also an adjunct professor at the University of Utah Department of Family and Preventive Medicine. He was elected to the Institute of Medicine in 2012.

Dr. Nielsen will kick off the afternoon program from 4:00 to 6:30 p.m. discussing “The Medical Neighborhood: Delivering the Value.” She previously served as vice chancellor for public affairs and associate professor at the University of Kansas School of Medicine, and as executive director of the Kansas Health Policy Authority. She is on the board of directors of the American Board of Family Medicine and the National Academy for State Health Policy.

Other speakers for the afternoon session include Gregg Laiben, MD, Karen Johnson and David Olson of Blue Cross and Blue Shield of Kansas City; Betsy Green of Commerce Bank; and KCMS Past President Bridget McCandless, MD, of the Healthcare Foundation of Greater Kansas City.

Conference objectives include increasing understanding of value-based health care including quality measurement and cost reduction, learning how value-based health care will be disruptive to the current systems of health care, and exploring what transitional measures are needed for the health-care system to move into full implementation of value-based care.

Watch your KCMS email and www.metromedkc.org for announcement of the opening of registration. There is no charge to attend, thanks to support from event sponsors Merck and Blue KC.

KCMS Annual Meeting Oct. 21

Oct. 21 from 5:30 to 8:00 p.m.

At the 5:30 p.m. opening reception heavy hors d’oeuvres and cocktails will be served in lieu of dinner. At 6:30 p.m., the program will begin featuring presentation of the Lifetime Achievement and Friend of Medicine awards, along with a main speaker to be announced. The incoming and outgoing KCMS presidents also will give remarks.

Physician members may bring a guest or spouse. Dress is business casual. As a benefit of attendance, portrait artists will offer realistic sketches of those in attendance.

Thanks to Tesla Motors for again serving as a sponsor. Watch your KCMS email for further announcements of event details and registration.
Medical School Graduates Will Be Eligible for License as Assistant Physicians Under New Missouri Law

KCMS BOARD ENDORSES PROPOSED REGULATIONS

In a move designed to extend medical care to underserved areas, medical school graduates who have not completed residency training will be eligible for license as Assistant Physicians under a 2014 Missouri law being prepared for implementation.

The law provides that—after 30 days of supervision by a collaborative physician and with the physician’s authorization—Assistant Physicians could treat patients in settings up to 50 miles away and would be able to prescribe Schedule III, IV and V drugs. They would provide only primary care services and only in medically underserved rural or urban areas of the state or in any pilot project areas. An assistant physician is defined as any medical school graduate who has passed the prescribed medical examinations and who has not entered into post-graduate residency training.

Currently, regulations have been proposed that will govern how assistant physicians will be licensed and monitored. In May, the KCMS Board of Directors sent a letter (facing page) to the Missouri Board of Professional Registration for the Healing Arts endorsing draft regulations covering supervision, continuing education and mentoring that would be required of assistant physicians. Academic physicians from Kansas City and across Missouri worked with the Board in drafting the proposed regulations.

The draft regulations were available for public comment from April 30 to July 10. The next step in the process is for the Board for the Healing Arts to submit proposed regulations to the Secretary of State and the Joint Commission on Administrative Rules, after which several more steps in the approval process will take place.

AIMED AT PHYSICIAN SHORTAGE IN UNDERSERVED AREAS

The law was first proposed by the Missouri State Medical Association’s Legislative Committee and Council, and MSMA was the main advocate for the legislation at the Capitol. Jeff Howell, MSMA general counsel and government relations director, noted that Missouri recently was listed by the federal government as one of the 10 most medically underserved states in the nation. “Patients in these areas aren’t getting any care now. Our attitude is that some care is better than no care. We hope this law will be a trailblazer for other states,” Howell said.

The other argument for the law is that it helps provide work for medical school graduates who are unable to secure residency positions because the number of graduates exceeds the number of available positions.

The assistant physician law received extensive national criticism after its passage. Most outspoken was the Accreditation Council for Graduate Medical Education. Its CEO Thomas Nasca, MD, told Medscape Medical News, “Physicians in the United States are not trained to enter practice upon graduation from medical school. … It’s a flawed assumption to suggest that novices are prepared to provide clinical care on their own in a rural area where any medical condition could present itself.”

The ACGME suggested that efforts should be intensified to increase the number of residency positions. Also speaking out against the law were associations representing physician assistants and nurse practitioners, saying they should be called upon to help ease the shortage.

At the AMA House of Delegates, opposition was strong in 2014 but lessened considerably in 2015 as the focus shifted to increasing the number of GME resident positions, according to AMA delegate Charles W. Van Way, III, MD, of Kansas City. (See his article on the GME residency shortage on page 9 of this issue of Kansas City Medicine.)

The concept is spreading to other states. Arkansas and Kansas passed assistant physician laws in their 2015 legislative sessions. Legislation was also introduced this year in Oklahoma.

REFERENCES
May 14, 2015

Missouri State Board of Registration for the Healing Arts
3605 Missouri Blvd.
P.O. Box 4
Jefferson City, MO 65102

This is a letter from the Kansas City Medical Society Board of Directors in support of recommendations suggested by Academic Physician members of the Society regarding implementation of the Assistant Physician Licensure legislation. This recommendation specifically relates to work of Academic Physicians in the State of Missouri with the Board of Healing Arts to develop and implement educational methods and programs relating to the collaborative practice service with an Assistant Physician.

The recommendations for consideration by the Board of Healing Arts are:

1. Require a defined period of time when the Assistant Physician (AP) must be mentored directly by the Collaborative Physician (CP) to determine a level of competence before allowing the AP to practice independently—with every patient seen by the AP also seen by the CP during that mentoring period.

2. Continue an ongoing, once a week direct mentoring of the AP by the CP for continued education and evaluation of competence.

3. Require the AP to take specific educational courses prior to independent practice such as BLS, Medical Record Documentation, REMS Training (for controlled substance prescription privileges), and Basic Medical Bioethics.

4. Require the AP to obtain 30 additional hours of CME each year related to primary care medicine.

5. Encourage CP to become educated regarding the six ACGME Core Competencies and how to evaluate mentored physicians regarding their level of competence.

We appreciate the opportunity to work with the Board of Healing Arts to suggest opportunities for further education of Assistant Physicians in order to better prepare them for the safe collaborative practice of medicine in underserved rural and urban areas of the State of Missouri.

Please contact Angela Bedell, Executive Director, at abedell@metromedkc.org or 816-531-8432 if you have any questions.

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Truman Lakewood

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John O. Stanley, MD, Serving as MSMA President

Congratulations to Kansas City’s John O. Stanley, MD, who is serving as Missouri State Medical Association president for the 2015-16 year. He is a board-certified family physician with Meritas Health based at North Kansas City Hospital.

A KCMS past president, Dr. Stanley also is a member and past president of Kansas City Academy of Family Physicians. A native of Omaha, Neb., Dr. Stanley obtained his undergraduate education at Missouri Western State University and his medical degree from University Autonoma of Guadalajara in Guadalajara, Mexico. He completed his fifth pathway and internship, then his residency, at Prince George's General Hospital in Cheverly, Md. Dr. Stanley worked in the Washington, D.C., area for three years before moving back to Kansas City in 1987.

Medicine runs in the Stanley family. His brother Gerard Stanley, Sr., MD, is a family physician in Iowa, and their father was a family physician in Kansas City.

Dr. Stanley and his wife, Kath, have five children, John, Suzanne, Ken, Tom and Luke.

Charles Van Way, III, MD, Receives Arthur Gale Freedom of Expression Award

Editor Charles Van Way, III, MD, received the 2015 Arthur Gale Freedom of Expression Award for a commentary he wrote for Missouri Medicine, the journal of the Missouri State Medical Association.

The award is presented annually to the author of what is judged as the journal’s best commentary article. Dr. Van Way’s contribution, “Secondary Gain, Gone With the Wind and the SGR,” appeared in the May/June 2014 issue.

St. Louis internist Arthur Gale, MD, a frequent contributor to Missouri Medicine and St. Louis Metropolitan Medicine, created the award to encourage physicians to write for the journal.

Signature Medical Group Adds Independence Surgical Clinic

Independence Surgical Clinic has joined Signature Medical Group effective May 1, 2015. The practice comprises general surgeons Pascal E. Spehar, MD, FACS; Jared B. Smith, MD, and Mindi S.T. Beahm, MD.

All three are certified by the American Board of Surgery and are members of the Kansas City Medical Society. Dr. Spehar and Dr. Smith and are Fellows of the American College of Surgeons; Dr. Beahm is a member of the America Society of Breast Surgeons.

Signature Medical Group includes more than 130 multi-specialty private-practice physicians in 28 medical practices in the Kansas City and St. Louis areas and in Bolivar, Mo.
From May through July of 2014, we lived through a media frenzy over the Veterans Health Administration (VHA). You may want to consult Wikipedia for details, or perhaps CNN. Briefly, the VHA was found to be poorly run, with long waiting times and inadequately staffed facilities. Not only that, but VHA officials were gaming a system that was put in place specifically to correct some of the same problems. Bureaucrats were systematically lying to their superiors and being given bonuses. Their superiors then turned around and took credit and received their own bonuses. Patients languished on waiting lists. Politicians were shocked, shocked! There was soul-searching and hand-wringing. The President made statements. Congress held hearings. The FBI investigated. Then Congress passed a $16 billion extra appropriation and went home for the rest of the summer. Who says Congress can't get anything done, eh? And the President took executive action. A grand total of five bureaucrats lost their jobs, and the Secretary of Veterans’ Affairs resigned. So … has there been great improvement? Has anything changed? The answer depends on your frame of reference. Overall, across the country, a lot of veterans receive pretty good care in the VHA. But in terms of the specific problems turned up last year? There hasn’t been much done. At this year’s 2015 American Medical Association meeting, there was much testimony which documented continuing problems. The sad truth is, we’ve been here before, and more than once.

One of the most distinctive elements of Japanese culture is Kabuki, a performance art of great antiquity. It has elements of dance, music, drama, pageantry and ritual. It is highly stylized, rigidly plotted and elaborately costumed. All of the plays are well-known, with the artistry being in the presentation and the spectacle. Perhaps the closest Western art form is grand opera, but by comparison with Kabuki, opera is free-form and unstructured.

The response of the media and the political system to the VHA scandal was very like a Kabuki play. There was the stylized astonishment. The ritual outrage. Actors hiding behind masks. The dance. The ritual executions. The denouement, with Congress throwing money from the stage. It was a drama acted out on a large stage. The costuming wasn't up to Japanese standards, but we can't have everything.

The VHA is, of course, a large part of the Department of Veterans Affairs (VA). And one thing the VA does well is to outlive scandal. The Kabuki-like performance has been repeated many times. There have been about one major scandal and several minor scandals per decade. President Truman fired the head of the (then) Veterans Administration in 1945. Multiple commissions and investigations followed. President Nixon's presidential investigation in 1974. Congressional investigations in 1983 and 1994. President Bush's presidential commission in 2003. The firing of the head of the Miami VA in 2009. It’s not even a funding problem. The overall VA budget has grown dramatically over the past few years. From 2009 to 2012, the total VA budget went from $87 to $132 billion. And that’s just recently. From 2001 to 2013, funding for the VHA by itself alone rose 250%. Funding per patient nearly doubled, as did funding per enrollee in the system.

So what’s wrong? Well, that depends on whom you ask. To some, there isn’t enough money. To others, this scandal is an indictment of all government-run health care. Still others, looking for causes, blame a sclerotic bureaucracy. Too many managers. Inappropriate management incentives. Perhaps there continued on next page
VA CRISIS (continued)
were simply too few caregivers, i.e.,
doctors and nurses. Of course, that
last one is pretty easy to get people to
agree on. Hey, we’ll just throw a few
more docs and RNs into the mix! The
question of whether the doctors and
nurses are organized and supported
well enough to take care of patients
is more subtle, and gets lost in the
details. The truth is, we don’t know.
The VHA throws off these scandals
about like trees drop their leaves in the
fall, and nearly as often. Given the size
of the system and the intensive media
and political attention, perhaps that’s
not as surprising as it seems.
The VHA is huge. There are 150
VHA medical centers, plus about
1,400 individual outpatient clinics
and clinical facilities throughout the
U.S. It cares for 8.3 million veterans
each year.5 Putting it another way,
every state has on average 10 VHA
facilities, and every Congressional
district has two. In effect, the VHA
has a board of directors consisting of
535 senators and representatives. Each
and every one likes to take credit for
anything the VHA does, and all tend to
micromange. Veterans’ organizations
watch over the system with hawk-
like attention. Moreover, the VHA
is a large bureaucracy, embedded
in the giant VA bureaucracy. The
Department of Veterans Affairs has
280,000 employees, with multiple
layers of oversight and management.
Within that, VHA facilities, because
they’re federal, are subject to all of the
multiple rules of civil service. There
are thousands of little inefficiencies,
ranging from personnel policies
to procurement and even to the
centralized design of VHA facilities.
Whether all of these things are good
or bad by themselves, the net overall
effect is to slow things down.
There is, indeed, a strong case to
be made for beginning to dismantle
the whole system. The population
of veterans is slowly decreasing,
despite the wars in the Middle East.
Today, veterans comprise 7% of the
population, and less than half are
enrolled in the VHA. And yet, the
VHA is still growing, at 8.6% per year.
Weeks and Auerbach have suggested
that we begin to replace the bricks and
mortar with subsidies for premiums,
deductibles and co-payments for
veterans who need to use the system.4
We could reserve the VHA facilities
for those areas in which it has
real expertise, like post-traumatic
psychiatric care, chronic sequelae of
neurologic injuries, amputee care and
rehabilitation. The process would take
many years. But perhaps, it’s time to
start. To be sure, the forces opposing
any such changes are … formidable.
I have to admit to nostalgia. I
spent about a third of my training
at the Nashville VA Medical Center,
and then was on faculty part-time at
the Denver VAMC. They were great
good places to work. True, the bureaucracy
drove us nuts, and the inefficiencies
were annoying, but … we took care
of a lot of patients, nearly all of whom
did well. All appreciated the care they
received. The career professionals at
the VHA were dedicated, experienced
and hard-working. Honestly, I have
trouble believing it’s all that different
today. Now, most of my experience
is 30 to 40 years past. While I’ve had
privileges at the Kansas City VAMC
more recently, I’ve done very little
patient care there. Personally, I think
the VHA is still filled with dedicated
professionals. But that doesn’t mean
that the system works well. It’s
entirely possible that the system has
deteriorated seriously, and is no longer
serving our needs.
But we won’t really know. That’s the
point of the Kabuki dance. Everyone
wears a mask and puts on an elaborate
costume for the occasion. The main
players are all actors in a scenario,
everyone knows the story, and the
resolution is the same every time. Is
this time different? Not so far. And so
far, it’s ending the same way as all of
the others. Investigate, show outrage,
retire a few bureaucrats, throw money,
and take your bow. It’s just political
show business.

Charles W. Van Way, III, MD,
is editor of
Kansas City Medicine and is emeritus professor
of surgery at the University of Missouri-Kansas
City. He can be reached at cvanway@kc.rr.com.

REFERENCES
1. Veterans Health Administration Scandal of 2014, Wikipedia.
Match Day 2015
MEDICAL SCHOOL GRADUATES BEING DENIED RESIDENCY POSITIONS IS A TRAGEDY THAT SHOULD HAUNT US
By Charles W. Van Way, III, MD, Editor, Kansas City Medicine

Every March, I find myself especially grateful to be a senior physician. That’s because I’ll never have to go through the Match again. Yes, the National Resident Matching Program announces its results in March. Match Day this year was March 20. Actually, it’s a whole Match Week. If you’re a senior student, you found out on March 16 if you’ve matched (but not where).

Every March, I find myself especially grateful to be a senior physician. That’s because I’ll never have to go through the Match again. Yes, the National Resident Matching Program announces its results in March. Match Day this year was March 20. Actually, it’s a whole Match Week. If you’re a senior student, you found out on March 16 if you’ve matched (but not where).

Figure 1

<table>
<thead>
<tr>
<th>Number of</th>
<th>Number matched</th>
<th>Percentage matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total applicants</td>
<td>41,334</td>
<td></td>
</tr>
<tr>
<td>Total active applicants*</td>
<td>34,905</td>
<td></td>
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<tr>
<td>Positions matched</td>
<td>26,252</td>
<td></td>
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<td>US seniors, allopathic schools</td>
<td>18,025</td>
<td>16,932</td>
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<tr>
<td>US seniors, osteopathic schools</td>
<td>2,949</td>
<td>2,339</td>
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<tr>
<td>US citizens, international schools</td>
<td>5,014</td>
<td>2,660</td>
</tr>
<tr>
<td>Non-US citizens, international schools</td>
<td>7,366</td>
<td>3,641</td>
</tr>
<tr>
<td>Previous graduates, allopathic schools</td>
<td>1,520</td>
<td>662</td>
</tr>
</tbody>
</table>

* Those who submitted a rank order list.

If you didn’t match, then you went through a secondary match (called SOAP, for some reason). Then on March 20, everyone found out where they matched. Although some found out they’re not going to have a job.

So, what are the results of the match? They’re available from the NRMP.1 There is a lot of data. And the data are subject to some qualifiers—a lot of qualifiers, in fact. It was the biggest match ever, with 41,334 applicants and 30,212 positions available. Of those, 27,253 positions were for first-year residents, and only 398 were unfilled at the end of the match. These figures, it should be noted, are nearly the same as last year and are typical of the last several years.

There are some other categories, so these numbers don’t add up. There are several caveats, as well. The biggest one is that a sizeable number of applicants don’t complete the process. Overall, of 41,334 applicants, only 34,975 finished. Who drops out? Why? Maybe they didn’t get interviews and became discouraged. We don’t know. But it’s reasonable to assume that if someone applied in the first place, they’d like to have a residency slot.

Osteopathic graduates are a special case. There are over 5,000 osteopathic graduates per year. Of these, nearly 3,000 applied through the NRMP. There is also an American Osteopathic Association match, which places 2,179 graduates this last year. There were 939 positions left open after the match, and the post-match is still going on.2 For this year, osteopathic students could apply to both matches. Combined figures are not available. The osteopathic “no match” rate is probably about the same as it is for allopathic graduates. Probably.

Currently, all osteopathic programs are joining allopathic programs under the Accreditation Council for Graduate Medical Education (ACGME). After the merger the separate match will presumably go away. (For further discussion on the joining of osteopathic and allopathic programs, see article in the April Kansas City Medicine by John J. Dougherty, DO, of the Kansas City University of Medicine and Biosciences.)

If you are a U.S. senior in an allopathic school, you have a 94% chance of matching. Even if you complete the application process, and do everything you should, you have a 6% chance of not having a job at the end of the match. Maybe you’ll find something to do between the end of March and the end of June. Maybe you’ll find a residency job after the match is over. And maybe not. To be as optimistic as possible, most graduates of American (continued on next page)
MATCH DAY (continued)
MD and DO schools appear to find training jobs by June. But it may not be a job they really want, and it may be for only one year.

It is very much worth noting that the match rate for international graduates is much lower, around 50%. U.S. citizens who are graduates of international schools do very little better than non-U.S. citizens (53% to 49%). These figures are not broken down by country of schooling. There are currently about 37 proprietary medical schools in the Caribbean, in which English is the language of instruction.3,4 They graduate several thousand new physicians each year, many of whom are from the U.S.3 Their chances of obtaining residency training are, as they say in Las Vegas, even odds at best.

From the standpoint of training programs, this situation is pretty good. Virtually all major specialties fill over 95% of their offered positions, usually 98 or 99%. From the standpoint of the medical student, this is not so good. To be sure, we’ve had more applicants than positions for many years. Ten or fifteen years ago, complacency was perhaps understandable. U.S. graduates were all getting jobs. Some international graduates were being turned away, but at least they could continue to practice in their home countries. Today, some of our own students are being turned away. American graduates of international schools are simply in a lottery. And if a new graduate doesn’t get a residency, his or her career comes to an abrupt halt. It’s a personal tragedy.

Moreover, it’s a failure of our medical education system. We talk about personal responsibility. We may point out that students attending schools in other countries assume some risk. But really, now. We’ve depended for many years on international graduates, of both U.S. and foreign birth. Some 25% of physicians practicing in the U.S. are international graduates. They are our colleagues. “They” are us. Besides, it’s not just international graduates. This year, a thousand MD graduates of U.S. schools didn’t get training positions. Plus as many as a few hundred DO graduates. Plus over 2,000 IMGs of U.S. origin. Plus nearly 4,000 IMGs of international origin. Bottom line: We need to train more residents; it’s as simple—and as difficult—as that. Neither an MD nor a DO degree should be a $200,000 lottery ticket.

There aren’t enough teaching hospitals; of 5,000 acute-care hospitals, only 600 have residents, and only 300 are major teaching hospitals. More hospitals must step up and train residents. We need more practicing physicians to train residents. If increased federal funding isn’t going to be available—and it won’t be—then we have to find other ways to finance training. As John Inglehart put it, “The absence of health-workforce planning ... may come back to haunt policymakers ...”5

Yes, it will. And it should haunt all of us, today. Just as it haunts every medical student in every medical school. We cannot afford to keep ignoring. And that’s how it was … a normal Match Day, in March.

REFERENCES
The Kansas City area is fortunate to have many outstanding medical institutions and expert physicians. In this issue of *Kansas City Medicine*, physicians from the cardiac surgery programs at Saint Luke’s Hospital and The University of Kansas Hospital discuss several key elements in cardiac care. Articles highlight the approaches of both groups to extracorporeal membrane oxygenation, aortic valve replacement and other topics. Let us know your comments on these articles. Send comments to editor@metromedkc.org. *continued on next page*

Your Articles Wanted
*Kansas City Medicine* will regularly publish in-depth articles from our local physicians on the latest advancements in medicine and treatment procedures in our region. If you have a topic about which you would like to write, please contact us. We are always looking for review articles about problems of medical interest. To get started, just write up an abstract of a paragraph or two, and then work with one of our associate editors to prepare the final article. We use standard AMA formatting for references. Do you have a medical topic you would like to write about for *Kansas City Medicine*? Send your concept to editor@metromedkc.org.
BACKGROUND
Since the first transcatheter valve was implanted in the pulmonary valve of a 12-year-old boy by Dr. Phillip Bonhoffer in France in 2000, physicians have imagined what could be accomplished with less invasive therapy for their aortic stenosis patients. Aortic stenosis is primarily a disease of the elderly, with frailty and comorbid conditions making interventional therapy more complex. Surgical aortic valve replacement (SAVR) has remained the cornerstone of therapy for patients with severe symptomatic aortic stenosis, but the introduction of transcatheter aortic valve replacement (TAVR) in the U.S. has transformed the options for our patients. TAVR has gone from being a novel technique to a procedure with well-defined risks and benefits. The next generation of technology holds promise to further reduce procedural risk. Clinicians are increasingly faced with expanding this technology into lower-risk patients, as well as determining who is too sick to benefit from any intervention.

SURGICAL AORTIC VALVE REPLACEMENT (SAVR)
Surgical technique has evolved much since the first SAVR in 1960 using a mechanical valve. Not only have mechanical valves improved, but tissue valve options have relieved the burden of lifelong anticoagulation for many patients. In our practice, almost all patients over age 60 receive tissue prosthesis. Even younger patients often receive tissue valves with the knowledge a second procedure will ultimately be necessary. The influence of TAVR is strongly felt in these discussions with younger patients. The initial placement of a tissue valve, with the fall back of a TAVR if the valve fails in the long term, is an increasingly common pathway. It is important to note that there is very little data on outcomes from placing a transcatheter valve into a surgically placed tissue valve (often referred to as valve in valve).

Despite the enthusiasm for less invasive therapy, surgery remains the gold standard for aortic valve replacement therapy. Modern surgical results show 30-day mortality rates as low as 0% and actuarial survival at one and three years of 97% and 94%. Yet in those patients over age 80, the length of stay was seven days and only 50% were discharged to home. In appropriately selected patients, SAVR is extremely safe and effective. TAVR has a very high bar to match clinical outcomes. Yet, it is our elderly patients who survive the operation but are left with lengthy recoveries that they are not well equipped to handle.

TRANSCATHETER AORTIC VALVE REPLACEMENT (TAVR)
Any discussion of TAVR has to include mention of the PARTNER trial conducted in the U.S. to evaluate Edwards’ Sapien valve in the treatment of severe symptomatic aortic stenosis. The Sapien valve is a balloon expandable valve that can be delivered either transfemorally or through the apex of the left ventricle. We can now also place it directly through the aorta, but this was not available at the time of the trial. Sapien had been used extensively in Europe at the time of the trial, but there were no rigorous randomized trials conducted. PARTNER filled a huge knowledge void on many fronts. PARTNER was actually two simultaneous trials. PARTNER A focused on patients eligible for surgery but at increased risk. It randomized patients in a 1:1 fashion to either surgery or TAVR. PARTNER B addressed patients considered inoperable for conventional AVR. Chronologically, PARTNER B completed enrollment first and thus I will discuss it first.

PARTNER B provided many landmark observations. I will present the recently updated three-year results. Patients were screened by a heart team consisting of both cardiologists and surgeons and were felt to have a surgical risk of death or irreversible morbidity of greater than 50% with SAVR, truly a very sick population of patients. Patients once admitted to the trial were randomized to either transfemoral TAVR or optimum medical therapy (OMT) which could include balloon aortic valvuloplasty (BAV).

As you can see in Figure 1, all-cause
mortality and cardiovascular mortality were significantly improved for TAVR compared to medical therapy. One of the most striking numbers from this study was the mortality in the medical arm, 50.8% at one year and 80.9% at three years. Medical therapy truly is palliative care for patients with severe symptomatic aortic stenosis. TAVR significantly decreased these numbers to 30.7% and 54.1% at one and three years respectively. The take-home messages from PARTNER B trial are the lethality of severe aortic stenosis and the benefit of TAVR therapy for this very sick cohort of patients.

PARTNER B involved the 1:1 randomization of high-risk patients eligible for surgery to either TAVR or SAVR. Two-year results showed that death from any cause was similar in both groups. The frequency of strokes did not differ between the groups. Improvement in valve area was similar and maintained at two years. Paravalvular leak (PVL) was more common in the TAVR group.

The conclusion from this trial is that SAVR and TAVR both have excellent outcomes in patients with severe AS that are at high risk for SAVR. It is important to note that the trial also highlighted that complications with TAVR therapy can be devastating, and that appropriate anatomical evaluation is essential to good patient outcomes.

Since the publication of these landmark trials, the next generation Sapien XT balloon expandable valve was approved in June 2014, based on the randomized data available from PARTNER II trial. Sapien XT allows for a larger range of sizes to be treated as well as a lower delivery profile allowing for smaller sheath sizes. This should allow more patients to receive TAVR therapy with potentially fewer vascular complications.

The next catheter-based valve to enter trial in the U.S. was the CoreValve. It is a self-expanding valve based on a nitinol frame. The delivery sheath required is 18F, allowing for delivery transfemorally, via the axillary artery or by directly aortic cannulation. It is a porcine pericardial tissue valve that when deployed actually sits above the native aortic annulus.

The CoreValve pivotal trial started after the initial reports on PARTNER B. It was thus felt unethical to randomize to medical therapy. Therefore the results of the TAVR cohort were compared to an objective performance goal (OPG). This OPG was derived by taking contemporary results from PARTNER B medical therapy patients and seven other BAV studies.

The 12-month results showed for those patients considered extreme risk for SAVR (inoperable), the rate of all-cause mortality or major stroke was 26% with TAVR versus 43% in the OPG group. The frequency of moderate or severe PVL was 4.2% at 12 months. Based on these results, CoreValve has received FDA approval and was the second commercial valve in the U.S. market.

Figure 1: 36-Month Results of PARTNER B.
AORTIC STENOSIS (continued)

The CoreValve® trial also included an arm randomizing patients considered high risk for SAVR to either SAVR or TAVR in a 1:1 fashion. This trial was notable for several important findings. First, it showed that current surgical results are excellent. The predicted risk of 30-day mortality for these patients with SAVR was 7%; the observed rate was 4.5%.

This provided a rigorous comparison group for TAVR. Yet, even with these excellent open surgical results, the rate of death from any cause at one year, which was the primary end point, was lower in the TAVR group than in the surgical group (14.2% vs. 19.1%). There was no difference in the rate of strokes between the two groups. Permanent pacemakers were more common in the TAVR group compared with SAVR (22% vs 11% at one year). Bleeding, acute kidney injury, and new-onset or worsening atrial fibrillation were significantly more common in the surgical group than in the TAVR group. This was the first randomized trial to demonstrate superiority of TAVR over SAVR in a high-risk cohort of patients.

These landmark trials (PARTNER and CoreValve) have greatly increased our understanding of the natural history of severe aortic stenosis and its treatment options. Severe symptomatic aortic stenosis is a lethal disease with a one-year mortality rate of 50%.

These patients should be referred to a multidisciplinary valve clinic including surgeons and cardiologists. This “heart team” concept is very important to providing patients with a balanced look at treatment options. Both quality and length of life are improved with TAVR for those patients who cannot tolerate open surgery. For those patients at high risk for open surgery, TAVR has demonstrated equal if not superior results compared with SAVR. These patients also benefit from referral to a center with the full spectrum of therapeutic options.

FUTURE CHALLENGES

CASE SELECTION

As with any intervention, patient
selection is critical. The very nature of the disease leads to a number of elderly, frail patients. The concept of frailty versus futility has been discussed since the inception of the technology. In essence, it is trying to determine which patients are dying with aortic stenosis, not from it. Current risk assessment tools do not include several important factors including frailty, pulmonary hypertension and cirrhosis. The term “Cohort C” refers to the subset of patients who have both poor survival and quality of life even after a technically successful TAVR. Common clinical parameters in these patients include extreme comorbidities (STS >15), severe pulmonary or liver disease, severe dementia, and living in a nursing home. The increasing technical success rates of TAVR, and the dismal outcome with medical therapy, lead to some very difficult clinical decisions on offering TAVR therapy.

INTERMEDIATE RISK

On the other side of the risk equation are the intermediate-risk patients. Currently in the U.S. both Sapien XT and CoreValve are approved for patients at high and extreme risk for SAVR. There are trials underway evaluating intermediate-risk patients in a randomized fashion in the U.S. and Europe. However, the line between high risk and intermediate risk is very blurry, perhaps even invisible. Patients are increasingly well informed of TAVR and often refuse SAVR even when low risk. CMS and insurance companies are refusing reimbursement for patients without severe risk. It is very important to complete these trials to better understand the role of TAVR in these patients. Medical history is littered with instances of gold standard therapy abandoned for less invasive procedures that ultimately led to patient injuries. As we drop down to lower-risk patients, the bar is set very high with modern surgical results. We must be careful to not abandon well-established therapy for the “next best thing.”

ACCESS ALTERNATIVES

Transfemoral delivery remains the most common route for TAVR, but technologic and procedural advances have opened up opportunities for patients with inadequate femoral arterial anatomy. Access is available now via the axillary artery or by directly cannulating the aorta. Transapical access, cannulation of the apex of the heart via limited thoracotomy, remains a lower-volume option due to higher procedural risk. It is very appealing as an avenue for future therapies aimed at the mitral valve.

As the delivery profile of the next generation of devices gets smaller, many centers are performing TAVR without general anesthesia. In combination with healthier, lower-risk patients this procedure may truly approach outpatient therapy.

STROKE

Many patients are more concerned with stroke than death. Strokes in the perioperative setting contribute to decreased quality of life and increased mortality. Recent reviews have found acute and subacute CVAs in 3-6% of patients after TAVR. Approximately 45% of these events occur within two days of the procedure, and an additional 28% between three and 10 days. Important predictors of early CVAs include small aortic valve area, new onset atrial fibrillation, and balloon post dilation. Late CVAs are most commonly associated with chronic atrial fibrillation, prior cerebrovascular disease and transapical approach.

There is little doubt that technologic and procedural advances have reduced the rate of CVA compared with earlier experience. Rates of CVA with TVAR are comparable with SAVR.
AORTIC STENOSIS (continued)
Much of the focus of future technology centers on reducing CVA. This technology involves better TAVR devices as well as adjunctive measures to deflect or capture cerebral emboli.

PARAVALVULAR REGURGITATION
Paravalvular regurgitation (PVL) is more common after TAVR than conventional surgery. There is little doubt that mortality is increased in patients with moderate to severe PVL after TVAR. There is also little doubt that rates of PVL are decreasing with better technology and better understanding of preoperative sizing measurements. The impact of mild PVL on quality of life and mortality after TAVR is less understood. Heterogeneity of methods to evaluate and quantify PVL has confused the issue.

The next generation of TAVR devices includes technology specifically designed to combat this issue, and the early results have been very promising. The speed of progress in this area may mean the problem is resolved before we are fully able to describe its clinical importance. Once described as the “Achilles heel of TAVR,” it is clear that better preoperative planning and better devices will significantly decrease the importance of PVL for our future patients.

SUMMARY
TAVR has emerged as the procedure of choice for those patients without surgical options. Better preoperative and procedural techniques have improved procedural success to the point that TAVR is now an acceptable alternative for SAVR in high-risk patients with severe AS. Ongoing studies will help us understand the role of TAVR in intermediate- and lower-risk candidates for surgery. It is important that clinical decisions are made in the setting of a heart team comprised of both surgeons and cardiologists to achieve the best outcomes. It is an exciting time for clinicians treating patients with aortic stenosis.

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REFERENCES

Take an Art Fair Break at the KCMS Office

The 84th annual Plaza Art Fair returns to Country Club Plaza Sept. 25-27. On the first night of the fair, Friday, Sept. 25, KCMS will open its office to members as a place to take a break from the crowds. Cool beverages will be available. The office, 315 Nichols Rd., Suite 250, above one of the fair’s main avenues, will be open from 6 to 8 p.m. Cool off and enjoy a few minutes of relaxation with your fellow Medical Society members.

The fair today features over 240 artists covering nine city blocks and welcomes a crowd of over 250,000. For more information on the Plaza Art Fair, http://countryclubplaza.com/event/plaza-art-fair/.
ABSTRACT

Surgical aortic valve replacement (SAVR) remains the standard of care for patients with severe aortic stenosis who are at low to intermediate risk for surgery. However, transcatheter aortic valve replacement (TAVR) is now generally accepted as the new standard of care for patients with symptomatic aortic stenosis who are either not candidates for open surgery or who are considered high risk because of comorbidities or specific anatomic and technical issues. In 2008, Saint Luke’s Mid America Heart Institute was the first center in the region to implant a transcatheter aortic valve and continues to expand the indications for TAVR for its patients using both FDA-approved and investigational valves. Our multidisciplinary structural heart program has expanded its use of transcatheter technology beyond the aortic valve to treat mitral and pulmonary valve disease, intra cardiac shunts, paravalvular leaks and the left atrial appendage. This article summarizes the current status of transcatheter aortic valve replacement and provides insight into ongoing research.

INTRODUCTION

Aortic stenosis is a progressive disease that results in functional limitation leading to symptoms such as syncope, angina, heart failure and ultimately premature death. Surgical aortic valve replacement (SAVR), regardless of age, remains the gold standard in patients with severe aortic stenosis who are at low or intermediate risk for surgery and carries a Level I recommendation with grade A evidence from multiple medical societies. There remain patients, however, because of extreme comorbidities or frailty, who are considered inoperable or at extremely high risk (surgical mortality estimated to be >10%) for SAVR. Historically these patients were rarely offered surgery and, in many cases, were not even referred for evaluation. The evolution of TAVR now affords these patients a reasonable therapy where once their options were limited.

TAVR was first performed 13 years ago and has evolved rapidly in all facets from device design, indication, and implantation technique. Delivery platforms provide for both balloon expandable and self-expanding valves mounted within either cobalt chromium or nitinol frames. Unlike SAVR, where the diseased valve is excised and a new valve sewn in place, the transcatheter valve displaces the diseased native leaflets; outward radial force from the metal frame secures and seals the valve at the annular or sub-annular level (Figure 1). TAVR is typically performed through a low profile delivery sheath (16-19 French) introduced into the femoral artery. Our preferred technique is percutaneous placement of the sheath into the common femoral artery using conscious sedation, however, surgical cut down under general anesthesia is sometimes required. Alternatively the delivery sheath can be placed surgically in the left ventricular apex or ascending aorta.

The intuitive appeal of TAVR is tied to its less-invasive nature compared with surgical aortic valve replacement. The true success of TAVR, however, owes more to its strong evidence-based support derived from well-designed, multicenter, randomized trials. The Saint Luke’s Mid America Heart Institute has provided cutting-edge technology to its patients supported...
TAVR (continued)

by a strong tradition of research and innovation (Figure 2). In 2008 the landmark PARTNER trial was initiated at 22 U.S. centers including the Saint Luke's Mid America Heart Institute to evaluate the safety and efficacy of TAVR in patients with severe aortic stenosis considered inoperable or at high surgical risk for conventional aortic valve replacement. In the PARTNER trial, transfemoral TAVR using a balloon expandable transcatheter valve demonstrated improved survival in inoperable patients compared with medical therapy (Figure 3), and both transfemoral and transapical TAVR were found to be equivalent to surgical aortic valve replacement in patients at high operative risk.3,4 These benefits for both inoperable and high-risk but operable patients have now been shown to be durable through five-year follow-up.5

More recently, studies using a self-expanding transcatheter valve demonstrated that in patients with severe aortic stenosis who are at high surgical risk, TAVR was associated with a significantly higher rate of survival at one and two years compared with surgical aortic-valve replacement, making TAVR the preferred approach for that patient population (Figure 4).6,7

Although mortality is undoubtedly a critical endpoint for patients undergoing aortic valve replacement, many other factors must be considered in this treatment decision. Appropriate patient selection for this rapidly evolving procedure relies on a clearer understanding of the risks and benefits in particular patient subgroups. We have recently demonstrated that TAVR not
only improves mortality for inoperable and high-risk patients but also leads to important and sustained quality of life benefits as well.8-10 In addition, the Saint Luke’s health economic and technology assessment research group has examined the cost-effectiveness of TAVR—the positive result of which has helped to support appropriate insurance coverage for this costly new technology.11,12 Finally our research has focused on refining our understanding of which patients do (and do not) derive meaningful survival and quality of life benefits after TAVR.13,14 This information is critical for both patients and physicians who are trying to decide whether to undergo what is still a major procedure.

Based on the results of the PARTNER trial, the U.S. Food and Drug Administration (FDA) approved TAVR for the treatment of severe, symptomatic aortic stenosis in patients considered inoperable in November 2011. The indication for TAVR was expanded in September 2012 to include patients considered operable but at high surgical risk (mortality estimated >10%). Further label expansion has subsequently allowed TAVR to be performed via a variety of alternative approaches for patients who are not suitable for transfemoral delivery and, most recently, has allowed TAVR to be used “valve-in-valve” to treat failing stenotic or regurgitant surgical aortic bioprostheses. Saint Luke’s Mid America Heart Institute continues to evaluate the safety and efficacy of TAVR in intermediate surgical risk patients (mortality estimated at 3-8%) through participation in the Medtronic SuriTavi Trial and the Edwards Sapien S3 Trial.

In the U.S., two transcatheter aortic valves are currently FDA-approved and commercially reimbursed by most payers including Medicare (Figure 5). To meet coverage requirements as outlined by the Centers for Medicare & Medicaid Services (CMS) National Coverage Determination, centers performing TAVR must meet quality and volume benchmarks and participate in the Transcatheter Valve Therapy (TVT) Registry.

Access to next-generation investigational transcatheter valves is crucial for the structural heart team. With refinements in both device size and development of sophisticated methods for imaging the three-dimensional structure of the native aortic valve, adverse events associated with TAVR such as permanent pacemaker, perivalvular regurgitation and vascular access complications have continued to decline. Reducing the delivery profile to 14 French and adding a “skirt” to the bottom of the valve to prevent perivalvular insufficiency are two such innovations currently under investigation at Saint Luke’s Mid America Heart Institute (Figure 6).

ACCESS SITE STRATEGY SELECTION

Patient selection for TAVR requires a multidisciplinary heart team approach involving cardiac surgeons, interventional cardiologists, cardiac imaging specialists and anesthesiologists.15,16 Transfemoral access is (continued on next page)
TAVR (continued)

our preferred approach for TAVR but despite a continuing reduction in delivery sheath profile up to 30% of patients still require alternate non femoral access for device delivery (Figure 7). Alternative access strategies have allowed the heart team to expand the TAVR technology to even more patients.\(^{17-22}\) Until recently, if TAVR could not be performed using transfemoral, transapical, direct ascending aortic or subclavian access patients could not be treated. Our growing experience with trans carotid,\(^{23}\) direct descending thoracic aorta,\(^{19}\) iliac,\(^{18,22}\) trans septal and even trans caval access means no patient should be denied TAVR due to inadequate vascular access (Figure 8).

CONCLUSION

Currently, SAVR remains the standard of care for the majority of patients with symptomatic severe aortic stenosis who are at low to intermediate risk for surgery. However, TAVR has emerged as the preferred choice in patients for whom surgical risk is deemed high or prohibitive. The collaboration between the cardiac surgeons, cardiologists, anesthesia and critical care on the heart team allow for optimal care of a wide spectrum of patients, from the most complex to the routine. Ultimately, long-term durability and economics will dictate the future expansion of TAVR as a primary strategy for aortic valve replacement for most patients.

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REFERENCES


Bicuspid aortic valve is the most common congenital heart abnormality, occurring in 0.5 – 2.0% of the population. There is a known male predominance. It is also one of the most frequently encountered valvular abnormalities seen in daily practice. The clinical presentation of patients with bicuspid aortic valves is quite varied both in time and type of presentation. Pediatric patients can present at birth with severe regurgitation. Yet, an octogenarian can also present with regurgitation. Patients in their late teens and early 20s can be seen with either aortic regurgitation or aortic stenosis but also can be affected by endocarditis. There are some who are diagnosed but never require intervention. These variations, both in presentation and course of the disease, make it important to understand this valvular abnormality.

Adding to the complexity of this disease is the association with aortic aneurysms. There is uncertainty whether the cause is post-stenotic dilatation or an inherent abnormality in the aortic wall, whether the entire aorta is affected, and whether the risk of rupture is the same as that of a Marfan’s aorta. These are all important considerations, but the most important aspect of the aortic dilatation is that it must be recognized so that appropriate measures can be taken to treat it.

**BICUSPID VALVE ANATOMY**

A true bicuspid valve is one in which there is fusion of two cusps with a raphe between them, a separate more normal appearing cusp, often a more elliptical opening vs. a more oval opening (as seen in a tricuspid valve).

Before calcification occurs there are smooth cusp margins distinguishing each leaflet as opposed to rheumatic or other inflammatory valvular disease. The most common finding is fusion of the left and right coronary cusps with a separate noncoronary cusp. All three configurations of fused left and noncoronary cusps, fused right and noncoronary, and fused left and right have been reported. There are also bicuspid valves with truly just two leaflets, but these do not pertain to this discussion. Many of these other abnormalities have the same consequences (endocarditis, AS, AR and aneurysms).

Bicuspid valves can be identified by the auscultation of a murmur but diagnosis depends on the echocardiogram. Trans-thoracic echocardiogram can accurately identify over 95%, but it is less accurate when there is heavy calcification of the valve with difficulty distinguishing a tricuspid from a bicuspid valve. Transesophageal echocardiogram can help, but it also may have difficulty distinguishing the two. Intraoperatively this is more obvious, but often the presentation of the patient (younger age 40-60) and other aortic abnormalities can help to confirm the diagnosis.

The importance of distinguishing
bicupid valve vs. other pathology has clinical implications for treatment. If identified in a child, one should also rule out a coarctation of the aorta because it is commonly associated. Other aortic abnormalities should be considered. Often an echocardiogram can identify proximal aortic enlargement but does not evaluate the remaining ascending aorta well. Transfemoral aortic devices initially were felt unsuited to treat bicuspid valves because of their elliptical orifice. This prohibition has changed for some but not all transfemoral devices.

**AORTIC ANEURYSMAL DISEASE**

Patients with bicuspid pathology have an inherent risk of associated aortic disease. Marfan’s disease patients have cystic medial degeneration and a decrease in their fibrillin-1 in their aortic wall, which cause an increased risk of aneurysm formation, rupture and dissection. Patients with bicuspid aortic valves have also been documented to have cystic medial degeneration. This may be the cause of their aortic disease, as opposed to the post stenotic dilatation theory proposed earlier. Given this information, many have begun to more aggressively treat the aneurysmal disease associated with a bicuspid valve.

Some observations about the aneurysmal disease process are unique to bicuspid valves. Often the coronary sinuses are spared, especially early in the process. The sinotubular junction is preserved, and the dilatation occurs beyond this point. Some will have a more diffuse process but can be isolated to the noncoronary sinus sparing the left and right coronary sinus. And finally, the dilatation tends to extend to the innominate artery but does not extend into the distal aortic arch or the descending aorta.

**TREATMENT OF THE AORTIC VALVE**

Treatment of the bicuspid aortic valve is well documented and there are well defined guidelines to timing of treatment. Whether it is regurgitation or stenosis, the guidelines should be followed as they are for all aortic valve pathology. The guidelines per the 2014 AHA/ACC Executive Summary are as follows:

1. **Class I**
   - AVR is recommended in symptomatic patients with severe AS with:
     a. Decreased systolic opening of a calcified or congenitally stenotic aortic valve; and
     b. An aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher; and
     c. Symptoms of HF, syncope, exertional dyspnea, angina, or pre-syncope by history or on exercise testing.

2. **Class Ia**
   - AVR is recommended for asymptomatic patients with severe AS with:
     a. A calcified aortic valve with reduced systolic opening;
     b. An aortic velocity of 4.0 m per second to 4.9 m per second or mean pressure gradient of 40 mm Hg to 59 mm Hg; and
     c. An exercise test demonstrating decreased exercise tolerance or a fall in systolic blood pressure (BP).

3. **Class IIa**
   - AVR is reasonable in asymptomatic patients with low-flow/low-gradient severe AS with reduced LVEF with:
     a. Calcified aortic valve with reduced systolic opening;
     b. Resting valve area 1.0 cm² or less;
     c. Aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg; and
     d. LVEF less than 50%; and
     e. A low-dose dobutamine stress study that shows an aortic velocity 4.0 m per second or greater or mean pressure gradient less than 40 mm Hg with a valve area 1.0 cm² or less at any dobutamine dose.

4. **Class IIa**
   - AVR is reasonable in asymptomatic patients with low-flow/low-gradient severe AS with an LVEF 50% or greater, a calcified aortic valve with significantly reduced leaflet motion, and a valve area 1.0 cm² or less, only if clinical, hemodynamic and anatomic data support valve obstruction as the most likely cause of symptoms and data recorded when the patient is normotensive (systolic BP <140 mm Hg) indicate:
     a. An aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg; and
     (continued on next page)
BICUSPID AORTIC VALVE (cont’d)

b. A stroke volume index less than 35 mL/m²; and
c. An indexed valve area 0.6 cm²/m² or less.

5. AVR is reasonable for patients with moderate AS with an aortic velocity between 3.0 m per second and 3.9 m per second or mean pressure gradient between 20 mm Hg and 39 mm Hg who are undergoing cardiac surgery for other indications.

Class IIb

1. AVR may be considered for asymptomatic patients with severe AS with an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher if the patient is at low surgical risk and serial testing shows an increase in aortic velocity 0.3 m/s or greater per year.

REPLACEMENT

Replacement is the gold standard in all situations. Some surgeons employ repair techniques. This is primarily for regurgitant valves and should be reserved for those that are not calcified and require minimal manipulation to obtain a competent valve. The long-term results are mixed, and many do not see such repair as permanent. Repair is not indicated for a stenotic valve except in the pediatric population. If the valve is calcified, repair will almost universally fail, usually early. The AHA/ACC Executive Summary for the guidelines for the treatment of aortic regurgitation and the timing of replacement are as follows:

Class I

1. AVR is indicated for symptomatic patients with severe AR regardless of LV systolic function
2. AVR is indicated for asymptomatic patients with chronic severe AR and LV systolic dysfunction (LVEF <50%) at rest if no other cause for systolic dysfunction is identified
3. AVR is indicated for patients with severe AR while undergoing cardiac surgery for other indications.

Class IIa

1. AVR is reasonable for asymptomatic patients with severe AR and normal LV systolic function at rest (LVEF ≥50%) but with progressive severe LV dilatation (LV end-diastolic dimension >65 mm) if surgical risk is low.

CHOICE FOR VALVE REPLACEMENT

Choice for valve replacement is an ongoing discussion which covers a wide range of topics and many varying opinions. In the simplest of terms, the choice comes down to mechanical vs. tissue valves. With this comes the long debated discussion of anticoagulation vs. repeat operation.

Mechanical valves all require anticoagulation. Today, this means warfarin. There are ongoing studies comparing antiplatelet therapy vs. warfarin, but antiplatelet therapy has not yet received FDA approval. The patient should understand that this will be a lifelong commitment to anticoagulation at some level. Although mechanical valves have not been shown to wear out, this does not exclude these patients from reoperation. Other complications including endocarditis, pannus formation and intolerance to anticoagulation can lead...
Tissue valves do not require anticoagulation except for aspirin therapy. There is some retrospective data which would suggest that a statin will extend the life of a tissue valve, but yet there has been no prospective study to prove this. All tissue valves have structural valve deterioration. There are many charts and studies to compare and contrast various valves but in the end they all have a failure rate. There are many factors, including age, infection, hypertension and need for hemodialysis. Despite these known risks there is no way to accurately predict who will fail, or when. There has been a clear change in practice patterns over the past 10 years, shifting away from mechanical valves to tissue valves. However, there are no strong studies or clinical data to support that any one particular valve is better than the other. Each case has unique circumstances.

A new consideration in the use of tissue valves is replacement with a transfemoral route using a valve-in-valve technique. This is routinely in use in Europe today, but less so in the U.S. Other factors are important to consider, including valve size and potential for high pressure gradient because of a small (<23 size) prosthesis needing to be replaced. The long-term outcome of transfemoral replacement is still undetermined.

**REPLACEMENT OF THE ASCENDING AORTA**

More often than not, aortic valve disease is the driving force for surgery in these patients. However, there are those that have reasonable valve function but yet have an aneurysm which requires intervention. Knowing that bicuspid valves have aortas with cystic medial degeneration is an important point to understand when treating these aortas. Some, although not all, believe that the risk of rupture or dissection is higher for these patients compared to the tricuspid aortic population. The pulmonary artery in these patients may also have cystic medial degeneration. This becomes an important point to consider in patients who may undergo a Ross procedure (replacement of the aortic valve/root with the pulmonary autograft) and the potential that the autograft will become aneurysmal.

Any discussion about aneurysms assumes that one understands the physics behind aneurysm growth and potential for rupture. The Law of Laplace is usually cited when discussing these issues. However aneurysms are not true spheres, they have noncylindrical shapes, their wall thickness can vary, and composition of the aorta (calcified) is non-homogeneous—all of which can all have effects on growth of aneurysms. Other factors are also important to consider. Regurgitant valves have a much higher stroke volume and can create higher wall tension. This is apparent in a wide pulse pressure but even more obvious in vivo observation with large changes in aortic size with beat-to-beat variation.

Recommendations for aortic replacement based on size have come under scrutiny because of lack of data to support prior recommendations. Aortic aneurysms measuring 5.5 cm have been frequently cited, as a criterion to suggest elective repair. However, this recommendation is based on outdated material and on limited series. When considering surgical repair, one should always weigh the surgical risks of repair vs. the risk of rupture or dissection with medical therapy. Autopsy studies on ruptured ascending aortas have shown that almost 15% are less than 5 cm. Interestingly, more than 60% of aneurysms greater than 5 cm did not rupture, and 50% of those greater than 7 cm did not rupture. This continues to add to the confusion. One must continue to understand that the bicuspid aorta is different from normal aortas. (continued on next page)
BICUSPID AORTIC VALVE (cont’d)

The more difficult question becomes what to do with a moderately enlarged aorta (4cm) in the face of severe aortic stenosis (AS) and bicuspid aortic valve. There are many series of patients with functional prosthetic valves who have later developed aortic aneurysms. Many have come to recommend replacement of the moderately enlarged aorta when addressing severe AS. This is based on lower surgical complication rates, differing cannulation techniques which allow for safer circulatory arrest, and the fact that many of these patients are young (40-60) and have a long life expectancy and potential for continued aneurysmal growth. A more recent retrospective review suggests that these aortas do not behave in a malignant fashion and that they do not require aggressive management or intervention. Although interesting, many believe this is difficult to defend in the face of known rupture and the potential for severe complications and death with acute aortic rupture or dissection.

Replacement of the aorta is performed with a Dacron graft. These do not wear out and do not require anticoagulation. The aortic tissue is usually reasonable and does not require reinforcement with felt strips, unless the aorta has been thinned. Replacement can include total aortic root replacement with reimplantation of the coronary arteries, circulatory arrest with extension of the graft into the aortic arch, or simply replacement of the ascending aorta at the sinotubular junction done distally below a cross clamp.

As noted previously, it is common to see that the noncoronary sinus enlarges sparing the left and right coronary sinus. In this circumstance, it is safe to replace just the noncoronary sinus with the ascending aorta. Follow up studies have demonstrated stability of this repair. This also allows for maintaining the annular size so that one does not have to downsize the aortic prosthesis.

Circulatory arrest is also an important procedure to understand when treating these aneurysms. It is common to see 4-4.5 cm aneurysms left behind at the distal ascending aorta to avoid circulatory arrest. These have been shown to continue to increase in size, again remembering the age of this patient population. Use of circulatory arrest has significantly improved over the years. Newer cannulation techniques with axillary artery cannulation have allowed for continuous antegrade perfusion during distal aortic work. This has also eliminated retrograde perfusion with its risk of embolization. It has allowed for less aggressive cooling of the patient and subsequently decreased the risks associated with cooling, including coagulopathy and RV dysfunction. We have also instituted the use of fresh frozen plasma during the cooling and rewarming phase of the operation to help minimize the coagulopathy which is commonly encountered. These measures, in addition to advances in cardiopulmonary bypass and anesthesia, have led to lower operative risks and shorter ICU and hospital stays.

FINAL RECOMMENDATIONS

The bicuspid aortic valve is the most common congenital cardiac lesion encountered. Its expected progression to aortic stenosis or regurgitation is often the driving force in making a decision about intervention. During the evaluation of these patients, it should be kept in mind that aortic pathology is commonly associated with these valves. Proper evaluation including transthoracic echocardiogram and CT scanning of the chest are excellent screening tools prior to making decisions about surgical procedures. Valve choice is a personal and lifestyle decision, but the realistic outcomes with all valves should be understood and discussed with the patient well in advance of surgery. Aortic resection should be considered even in marginally enlarged aortas, especially in younger patients. Patients should be reassured that surgical outcomes are excellent and should be pursued when guidelines for replacement have been met.

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INTRODUCTION
Extracorporeal Membrane Oxygenation (ECMO) is an advanced short-term mechanical support modality used for patients with severe acute life-threatening cardiac and/or pulmonary dysfunction refractory to conventional management. ECMO rapidly restores vital oxygen delivery to cells and manages all components of gas exchange. ECMO can fully support the heart and/or lungs until the underlying problem is resolved or if indicated, device implantation or organ transplantation can occur. There are two primary types of ECMO cannulation: veno-venous (VV ECMO), which is used solely and preferentially for isolated pulmonary support, and veno-arterial (VA ECMO), used primarily for cardiac failure but can also support the pulmonary system. An advantage of ECMO support is that the harmful effects of extremes of conventional management are avoided, allowing organ rest and recovery. ECMO utilization has grown in popularity over the last decade due to major advances in circuit technology and safety combined with sophisticated critical care expertise in managing these very sick patients.

CASE
A 21-year-old otherwise healthy male presented with an onset of acute febrile illness that began approximately 72 to 96 hours prior to admission while on a hunting trip in Texas. Initially, he was slightly short of breath and had a mild cough. In the ensuing 24-72 hours, the patient developed fevers up to 104°F along with chills, myalgia and headache. Initial workup for viral and bacterial causes of this acute febrile illness were negative, and he was empirically started on Azithromycin. The next day the patient was admitted to the hospital with a working diagnosis of acute febrile illness with dehydration and started on IV fluids. The following day, he became hypotensive and hypoxemic. An ECG revealed sinus tachycardia with a right bundle branch block (RBBB). An echocardiogram was performed and revealed a severe decrease in left and right ventricular contractility with an estimated ejection fraction of 25% with mild mitral regurgitation. Throughout the day the patient’s oxygen requirements continued to increase and eventually required endotracheal intubation and mechanical ventilation. Following intubation, a wide complex tachycardia developed with hemodynamic decompensation. This was successfully cardioverted after two 300 J DC shocks. He was started on norepinephrine, dobutamine and amiodarone drips and airlifted to Saint Luke’s Mid America Heart Institute.

Upon arrival the patient was hypotensive, tachycardic and febrile at 103.1°F. He was transported to the cardiac catheterization lab for placement of an intra-aortic balloon pump. After arrival in the cardiac catheterization lab, his hemodynamics further deteriorated with the development of ventricular tachycardia (VT). Cardioversion was unsuccessful, and cardiopulmonary resuscitation (CPR) was performed for 36 minutes while (continued on next page)
ADULT ECMO (continued)

Emergent VA ECMO was initiated for cardiopulmonary rescue.

In an effort to protect neurologic integrity post cardiac arrest, hypothermia to 34°C was initiated for 24 hours followed by gradual rewarming at 0.5°C per hour. After 24 hours sedation was weaned and he was able to follow all commands. The patient developed acute kidney failure requiring hemodialysis. He was placed on a lung protective strategy of low tidal volume ventilation.

After extensive discussion among cardiovascular surgery, heart failure cardiology, critical care and the transplant team, a para-corporeal bi-ventricular assist device (Bi-VAD) was placed five days after admission as a bridge to either recovery or heart transplant. Upon weaning from cardiopulmonary bypass after BiVAD placement, the patient was unable to be adequately oxygenated using conventional mechanical ventilation due to severe acute pulmonary edema. Therefore, VV ECMO was initiated for pulmonary support. After one week, he was removed from VV ECMO and maintained on low mechanical ventilation support until lung recovery. Myocardial biopsy showed severe myocardial necrosis with extensive lymphocytic infiltration consistent with fulminant myocarditis. Over the next several weeks, the patient’s kidney, liver, lung and neurologic function markedly improved. However, with no improvement in heart function the patient was listed for heart transplantation and received a successful orthotopic heart transplant on hospital day 104. The patient was subsequently discharged 112 days after admission with only a mild neurologic deficit, returned and graduated from college and is a fully functioning and productive member of society.

ECMO FOR RESPIRATORY SUPPORT

ECMO was first successfully utilized in 1971 to support an adult patient with respiratory failure due to acute respiratory distress syndrome (ARDS) after a traumatic aortic injury.1 In 1979, a landmark randomized controlled trial performed by Zapol et al, compared ECMO to conventional ventilatory therapy in patients with ARDS.2 This trial showed a poor survival in both arms with no benefit for ECMO. Of note, all patients were managed on VA ECMO, high levels of anticoagulation were used, lung protective ventilation was unknown, and all patients were managed on very high levels of ventilatory support in excess of seven days before they were randomized. Modern-day ECMO utilizes veno-venous as the cannulation method of choice for respiratory failure which has been shown to have fewer associated complications. Lower levels of anticoagulation are needed due to circuit design improvements, and importantly, patients are placed on lung rest ventilatory settings to reduce ongoing injury and promote healing. These important advances in knowledge and technology make early experiences in ECMO incomparable to the present day. The most recent and largest multi-centered randomized controlled trial (RCT) to date, Conventional Ventilation or ECMO for Severe Adult Respiratory Failure (CESAR) trial, was conducted in the United Kingdom between 2001 and 2006. CESAR compared patients with severe reversible respiratory failure who were randomized to an ECMO referral center to patients managed with conventional ventilation at tertiary care centers, which encouraged the use of lung protective ventilation. This study showed survival without severe disability at six months was 63% for those patients referred to the ECMO center and 47% for those treated at tertiary care centers.3 This was an intention to treat analysis, and not all patients randomized to the ECMO referral arm actually received ECMO as some patients improved and some died before ECMO could be initiated. This was an important study because it represents modern-day practice realities and will encourage further study into the potential benefit of early VV ECMO for severe refractory respiratory failure.

Figure 2. CXR of a typical ARDS patient receiving VV ECMO support. Arrow -31 F right internal jugular dual stage cannula used for veno-venous ECMO.
The use of VV ECMO for respiratory salvage dramatically increased in 2009, mainly due to the effects of Influenza A H1N1 and the predilection for severe respiratory failure in a young population. Retrospective analysis in this cohort showed better than expected survival when VV ECMO was implemented early in both the Australian and North American experiences.\textsuperscript{4, 5} The influenza season of 2013-2014 also showed a predominance of the 2009 H1N1 subtype with preferential severe respiratory failure in young otherwise healthy patients. At Saint Luke’s we placed a total of 10 patients on VV ECMO support due to severe hypoxemia from influenza A with a greater than 80% survival to discharge. The longest duration of support was 48 days with survival in this patient. It is important to recognize that these patients were refractory to the extremes of conventional management such as proning maneuvers, inhaled pulmonary vasodilators, increased positive end expiratory pressure (PEEP) and mean airway pressure, and had a very high likelihood of death without rescue on VV ECMO.

VV ECMO can be a life-saving therapy for patients with acute severe respiratory failure unresponsive to the limits of lung protective ventilation and other advanced therapies to improve oxygenation. The causes of respiratory failure may vary, but the forces used to provide for adequate oxygen delivery can lead to further lung injury and eventual multi-organ dysfunction. VV ECMO restores oxygen delivery to cells and prevents ongoing iatrogenic injury, providing time for lung repair and recovery. Extremes of patient management such as excessive ventilator settings, inotropes, vasopressors and fluids can create ongoing organ injury and promote iatrogenic harm. Recent advances in VV cannulation technology enable patients to ambulate and even liberate from mechanical ventilation while on ECMO support, thus decreasing all the known complications associated with an intubated, sedated and supine patient. VV ECMO also allows for rapid weaning of cardiovascular support due to an immediate reduction of intra-thoracic pressure. Although ECMO is still considered an experimental therapy and should only be used in patients with a high likelihood of death, it will be interesting to see if future studies like the Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome (EOLIA) trial (NCT01470703) show benefit for early use in patients with severe respiratory failure refractory to escalating treatment.

Implementation of modern VV ECMO most commonly involves percutaneous insertion of a dual lumen cannula into the right internal jugular vein directed into the inferior vena cava (Figures 1 and 2). This cannula removes venous blood by a centrifugal pump with flows up to 7 L/min. The blood is then directed through a polymethylpentene membrane oxygenator where gas exchange occurs and then through a heat exchanger where the blood temperature is controlled. Oxygenated blood is then returned to the right atrium through the inner cannula (Figure 3). Insertion can also be achieved through a femoral vein–femoral vein approach. With VV ECMO the membrane oxygenator and the patient’s lungs function in series and the resulting saturation of arterial blood in the patient is determined by a combination of the saturation of venous blood returning to the heart, the saturation of blood returning from the ECMO circuit (always 100%), ECMO flow rate, the patients cardiac output and any residual lung function. Recent innovations in cannula, tubing, pump and oxygenator technology have improved durability, simplicity, efficiency and safety. The main complications (continued on next page)
ADULT ECMO (continued)
with VV ECMO include hemorrhage and cannula perforation during insertion.

Arterial-venous ECMO (AV ECMO) is a form of ECMO support utilized for carbon dioxide (CO₂) removal. Typical indications may include acute severe asthma or COPD exacerbations. Current membrane oxygenators are extremely efficient at CO₂ removal, allowing significantly lower flow rates than what is required for oxygenation. This allows for smaller cannula use. This form of ECMO support has not gained wide popularity in the United States.

ECMO FOR CARDIOPULMONARY SUPPORT
VA ECMO can provide immediate return of oxygen delivery to cells in patients suffering from acute cardiogenic shock due to multiple etiologies. It is intuitive that the longer patients remain in shock and cells are starved of critical oxygen, the result is that cellular functions cease, acidosis worsens, multi-organ system failure develops and death ensues. VA ECMO can be instituted expeditiously and when initiated early and managed by a critical care team with ECMO experience, it has been shown to be extremely useful for hemodynamic rescue in patients with refractory cardiogenic shock.

VA ECMO is much less expensive than other ventricular assist devices options and can provide biventricular temporary support while serving as a bridge to decision, mechanical support, recovery or heart transplant. The International Society for Heart and Lung Transplantation Guidelines endorse a high recommendation (Class 1A) for utilizing temporary short-term support as opposed to more long-term VAD support in patients “in extremis” with multi-organ failure to allow successful optimization of clinical status. Unfortunately, there have been no randomized controlled trials evaluating the efficacy of VA ECMO in adult patients. Also important to note is that survival with VA ECMO is poorer than with VV ECMO, and the associated complications can be more severe and require aggressive management. The Extracorporeal Life Support Organization (ELSO) has collected outcome data since 1989 on over 4,000 adult cardiac ECMO patients by diagnosis. ECMO to support acute myocarditis shows the highest survivability. These patients are typically young without comorbid disease. Overall survival to discharge is 40% for all adult cardiac ECMO support (Table 1). The major complications associated with VA ECMO include hemorrhage, thromboembolic events, left ventricular distension, pulmonary edema and limb ischemia. Systemic anticoagulation is required with VA ECMO especially with lower flow rates. Anticoagulation is recommended but not mandatory for VV support and has been used successfully on patients with poly-trauma and intracerebral hemorrhage where anticoagulation was contraindicated.

VA ECMO cannulation is commonly performed peripherally utilizing the femoral vein and femoral artery (Figure 4). Central cannulation is most often employed after cardiac surgery.
with failure to wean from cardiopulmonary bypass. There are advantages and disadvantages of both cannulation techniques that are beyond the scope of this article. With VA ECMO, venous blood is removed from the patient and flows through the same apparatus and at the same rate of flow as VV ECMO. The difference is that oxygenated blood is then returned to the arterial side of the circulation. The heart and lungs are in parallel to the circuit, which reduces pulmonary blood flow, significantly augments perfusion, and provides bi-ventricular support. The management of these patients is therefore more complex than with VV ECMO. The main contraindication for ECMO support is irreversible organ failure and non-candidacy for device or transplantation.

VA ECMO during CPR is termed extracorporeal cardiopulmonary resuscitation (E-CPR) and has shown improved survival compared to conventional CPR especially when implemented in under 60 minutes.9 The ability to perform successful ECPR requires a highly coordinated effort with early identification and notification of the ECMO team and effective CPR while awaiting full ECMO support.

ECMO AT SAINT LUKE’S MID AMERICA HEART INSTITUTE

The case used in this publication was our first patient placed on ECMO support using modern-day technology. Since then we have placed over 80 patients on ECMO for respiratory and/or cardiac support. Our program is a member of and actively participates in the Extracorporeal Life Support Organization (ELSO) data registry for national and international ECMO Centers. ELSO monitors quality standards for member ECMO Centers around the world.

We believe that when ECMO is initiated early, before organ systems fail, the best outcomes can be achieved. We have an exceptionally engaged, collaborative and highly functional team involved in the care of these patients, which include cardiovascular surgery, cardiac anesthesiology, 24/7 intensivist lead critical care, heart failure cardiology, 24/7 perfusionist support, and ECMO specialty trained nurses. The team has extensive training in ECMO management and troubleshooting. Our clinical experts work together to create a comprehensive care plan for each individual, ensuring the best possible treatment outcomes.

One of the most difficult tasks for a referring physician and a consulting ECMO physician is to determine when a patient should be transferred to an ECMO center. Transporting such a sick patient is not without risk but may be the only option for a favorable outcome. The decision to transfer is an enormous responsibility that can be eased by early consultation with the ECMO center. This allows early planning for transport before a patient becomes so unstable that transport cannot occur.

CONCLUSION

Over the last decade ECMO support has increased for both cardiac and respiratory failure, and outcomes continue to improve. This is likely the result of improved technology, reduced complications and improvements in and recognition of the importance of a highly skilled critical care team managing these patients. ECMO can be a life-saving therapy for patients with acute severe cardiac and/or respiratory failure failing conventional medical management but is a time-critical intervention and should be considered early for the best outcome.

CONSENT

Written informed consent was obtained from the patient for publication of this report and any accompanying images.

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The advent of Extracorporeal Life Support (ECLS) in the latter half of the 20th century was a watershed moment in the history of modern medicine. Following John Gibbon, MD (Figure 1), in development and first successful implementation of cardiopulmonary bypass technology in 1953, surgeons have vigorously explored the limits of this modality in the hope of treating patients with grave cardiac and pulmonary conditions. Initial use was “short-term” and confined to procedures taking place in the operating room (OR). But some intrepid physicians, first and foremost Robert Bartlett, MD, from the University of Michigan, extrapolated their operative experience to successfully treat infants suffering from cardiorespiratory failure in the Intensive Care Unit setting. In these cases, critically ill pediatric patients were placed on ECMO (Extracorporeal Membrane Oxygenation) circuits, essentially cardiopulmonary bypass, for hours or days at a time, often with profound success. However, the initial experience utilizing ECMO to treat adult patients with respiratory failure was dismal, with mortality rates exceeding 90% in a multicenter NIH study published in 1979.¹

Since that time, new and better surgical techniques, as well as advances in circuit technology, have led to dramatically improved outcomes.² Undoubtedly, lives have been saved as a result of early and aggressive implementation of ECMO. The role of this modality is under active investigation at numerous major medical centers around the world. This review aims to provide a brief overview of ECMO technology, the types of patients that may benefit from ECMO, and the challenges and questions that remain on the horizon for this promising modality.

**WHAT IS ECMO?**

ECMO refers to the method of temporary replacement of the lung and/or heart functions by connecting patients to extracorporeal perfusion circuits. The term “ECMO” itself is a bit incomplete, since the circuit that provides support in these patients with severe cardiorespiratory embarrassment serves not only to oxygenate blood, but also to exchange CO₂. Thus, the “oxygenator” component of the ECMO circuit is in reality a highly efficient “gas exchanger” which introduces oxygen into the perfused blood while removing CO₂. This task is facilitated by placing large-bore wire-wrapped cannulas into central blood vessels and positioning them in such a way as to establish optimal support. Cannulation is routinely performed in the OR at our institution, but in certain circumstances, it can be accomplished in an intensive care or cardiac catheterization laboratory setting. Accurate positioning of the cannulas is critical and this can be challenging at times. Thus, access to fluoroscopy, trans-esophageal echocardiography (TEE), and optimal anesthetic support in a specially equipped “hybrid OR suite” greatly facilitates this task.

Practically speaking, there are two basic configurations of ECMO circuits: Veno-arterial (VA) and veno-venous (VV), each having a specific role. VA ECMO is by and large utilized in situations in which both gas exchange and cardiac function are failing, and mechanical support is necessary to maintain hemodynamic stability. In this scenario, blood is drained from the venous system into the ECMO circuit where gas exchange occurs, and then directed by a centrifugal pump into the arterial system in order to support a patient’s hemodynamics.
can be accomplished either peripherally (femoral or internal jugular vein [IJ] and femoral artery) or centrally via a sternotomy (right atrium [RA] and ascending aorta). Peripheral arterial cannulation does have the advantage of not requiring re-entry into the chest for decannulation, however this is balanced by technical problems that can result from this approach, such as distal limb ischemia and retrograde dissection of the iliofemoral arterial system. Another potential concern with peripheral cannulation for VA ECMO is the phenomenon of upper body hypoxemia, the so-called “Harlequin Syndrome,” in which oxygenated blood returning from the oxygenator serves to perfuse mainly the lower body (via the femoral cannula) while deoxygenated blood ejected from the heart perfuses the upper. Nonetheless, there are institutions throughout the country in which surgical teams are routinely dispatched throughout the hospital to establish ECMO peripherally in patients suffering sudden cardiac deterioration from potentially reversible processes (such as acute myocardial infarctions in the catheterization laboratory).

In cases in which cardiac function is good, but the lungs are failing from an acute disease process (such as ARDS or overwhelming infection), VV ECMO is the modality most frequently employed. This avoids arterial cannulation and perfusion, thereby significantly ameliorating the risks associated with ECMO (discussed below). VV ECMO is accomplished by placing both the drainage and perfusion limbs of the circuit within the venous system. This allows oxygenated blood from the pump to enter the right side of the heart before traversing the pulmonary circuit and entering the left atrium. This technique almost always can be performed peripherally, utilizing a variety of cannula configurations. A sternotomy is not required, a major advantage of the technique. Cannulation may be either multiple or single. The former requires percutaneous cannulation of the femoral and IJ veins. In this procedure, the drainage cannula is directed into the iliac vein or IVC while the ECMO outflow cannula is positioned in the RA. An additional drainage cannula is sometimes necessary in larger patients to provide adequate ECMO circuit flow, thus requiring bilateral femoral venous cannulation. Optimal positioning of the cannulas is assured by TEE and/or fluoroscopic guidance.

Recently, a dual lumen ECMO cannula (Avalon Laboratories, Rancho Domingo, CA) inserted percutaneously into the right IJ vein has been utilized effectively for VV ECMO (Figure 2). The distal tip of the cannula lies in the intrahepatic IVC while the proximal (inflow) channel directs blood through the TV and into the RV. Optimal positioning of this device can be somewhat challenging, even requiring periodic adjustment in the ICU. But this cannula confers some distinct advantages. First, by avoiding femoral perfusion lines, patients can be more easily and safely repositioned in the ICU bed. At some centers, patients who have been on ECMO for multiple days, for instance patients being bridged for lung transplantation, have even been weaned off sedation and ambulated with these devices in place, while on ECMO. Another advantage is that decannulation can be accomplished very simply in the majority of cases with minimal risk of hemorrhage afterwards.

The ECMO circuit itself is comprised of several major components that are assembled and controlled by cardiac perfusionists who have extensive experience using and trouble-shooting cardiopulmonary bypass circuits in the OR. In most hospitals employing this modality, a portable setup (Figure 3) is assembled to accomplish the task. The key components in these systems include: a hollow-fiber membrane oxygenator (Figure 4), the magnetically-driven roller pump, heating and cooling elements, a gas blender unit and various inline monitors to detect $\text{O}_2$ saturation and other parameters. Miniaturization is on the horizon. Macquet Cardiopulmonary has recently developed the “Cardiohelp” system, a small, portable, fully functional device that can be used to retrieve and transport patients to regional ECMO centers sometimes hundreds of miles away from the patient’s primary facility.
ECMO IN ADULTS (continued)
WHO WILL BENEFIT FROM ECMO?

The precise role of ECMO is still somewhat ill-defined. A recent meta-analysis of 10 separate studies comparing ECMO and conventional mechanical ventilation for acute respiratory insufficiency failed to demonstrate an overall mortality benefit for ECMO. Still, there is some promising favorable data utilizing VV ECMO in select patients. The most compelling evidence that ECMO could likely play a salutary role is derived from the CESAR trial, a British study published 2009. In this study, 180 patients with severe respiratory failure were randomized to receive either "conventional" medical treatment or ECMO. Of these, 63% of patients allocated to consideration for treatment by ECMO survived 6 months, compared to 47% who received conventional management. This trial has been criticized for several reasons. There was lack of standardization of "conventional" therapy. Only 75% of patients randomized to the ECMO group actually ended up receiving this therapy. There have been several observational series showing successful ECMO treatment of patients during the deadly 2009-2010 H1N1 Influenza Pandemic. The CESAR study, together with the more anecdotal H1N1 reports, have led to a continued enthusiasm for and belief in this modality to treat refractory respiratory insufficiency. It appears that lives have been saved by prudent utilization of ECMO in cases of respiratory failure. However, with excellent outcomes resulting from modern “lung protective” ventilation modalities, the advantage of ECMO in this setting remains debatable.

In patients with refractory respiratory failure, unresponsive to ventilator treatment and in precipitous clinical decline, when should ECMO be a consideration? There is some indication, if controversial, that the earlier a patient is placed on ECMO, the better the chance of survival. On the other hand, if ECMO is initiated too early before a good effort at ventilation has run its course, one could argue that the patient has been placed at unnecessary risk by instituting ECMO prematurely. This is the dilemma that faces intensivists who routinely care for these very ill patients. The literature is replete with recommendations and criteria to facilitate arriving at this decision. Most of them involve examining metrics of progressive respiratory insufficiency, such as a PaO2/FiO2 ratio < 80 despite high PEEP or uncompensated hypercapnia with acidosis. Ultimately, clinical judgment tempered with experience must determine that the patient is on an unfavorable trajectory, keeping in mind the extremely toxic effects of barotrauma and high oxygen concentrations on the diseased lungs. The aim is to intervene early enough for salvage, but not without giving conventional less-invasive strategies some time to succeed.

While the role of VV ECMO in the clinical armamentarium has yet to be determined, the current status of VA ECMO is still more uncertain. The most common scenario in which VA ECMO comes under consideration, is in cases involving postcardiotomy patients in the OR who have developed refractory cardiogenic shock. Typically in these cases, conventional inotropic support including intra-aortic balloon counterpulsation is insufficient to allow for successful weaning from cardiopulmonary bypass. The surgeon can be faced with the difficult decision of instituting ECMO or facing intraoperative demise of the patient. The evidence for the efficacy of ECMO in this setting is from anecdotal reports and small observational studies. Despite utilization of the latest in oxygenator and pump technology, in-hospital mortality rates in this setting are reported consistently to be upwards of 75%. This makes casual implementation of ECMO technology in this scenario imprudent unless there is a reasonable expectation of success.

CONDUCT OF ECMO AND COMPLICATIONS

Once ECMO has been initiated, patients are normally cared for in an ICU specifically designated for this purpose and by nursing staff who have been trained and certified in their management. At our institution, patients are transferred to our cardiothoracic
intensive care unit where intensivists, surgeons and perfusionists are readily available. Each patient is assigned two ICU nurses, at least one of whom is ECMO-certified, around the clock. Patients are sedated, and ventilation is reduced to “rest” levels, minimizing the effects of high settings while allowing for airway expansion. Management is by protocol, with careful monitoring of hemoglobin (Hb) levels, platelet counts, arterial blood gasses, chest radiographs and coagulation studies on a regular basis. Since there is admixing of deoxygenated blood from the lungs and blood from the oxygenator, the usual target SaO₂ is in the 85-92% range. This can be modified by changes in such factors as pump flow, FiO₂ provided to the oxygenator, cannula position and patient position. One common problem leading to systemic hypoxemia is the phenomenon of “recirculation,” in which close proximity between the delivery and return lines causes recently oxygenated blood from the pump to be immediately captured by the drainage port or cannula. Once this is detected (by comparing pre- and post-oxygenator saturations), cannula repositioning will usually correct this problem.

Since the oxygenator and circuits tend to collect thrombus, patients are fully anticoagulated during the ECMO period. Because of this, every additional invasive procedure contemplated for these patients (such as central line placement, drainage of pleural effusions, and tracheostomy for example) must be carefully considered, weighing the risk vs. the benefit of the intervention.

ECMO is continued as long as the respiratory and/or hemodynamic difficulties persist. Most often, improvement of the arterial blood gasses and chest radiographs herald clinical recovery. ECMO support can be gradually weaned to the point where it is no longer necessary. Normally, perfusion at low levels of supplemental FiO₂ will be continued for several hours prior to removing the patient from ECLS and decannulating. ECMO perfusion can last a matter of days or even weeks as long as there is some indication of reversibility. Oftentimes, the palliative care team will be asked to assist when the time on ECMO becomes prolonged, particularly if there is very little improvement or even worsening of the clinical situation.

The risks associated with ECLS are certainly not trivial, which makes the initial decision to institute ECMO difficult. In addition to cannulation problems already mentioned, major concerns in these patients relate to bleeding and thrombosis. This is particularly true when peripheral arterial access is necessary because the presence of such lines can inhibit blood flow downstream and result in distal limb-threatening ischemia. Even venous cannulation can lead to problems however; perforation of the heart and great vessels has occurred. Once the cannulas are safely in place, thrombotic problems often arise, interfering with the oxygenator function – even despite systemic anticoagulation with heparin and careful monitoring. This problem is usually detected by careful visual inspection of the circuit and measurement of the oxygenator “reserve,” taking into account the oxygen delivery relative to the circuit’s post-oxygenator PaO₂ measurement. Once discovered, prompt replacement of the oxygenator is required to address this problem.

Since these patients are fully anticoagulated and may be so for some time, bleeding problems are particularly worrisome and dangerous. Not only can bleeding be related to cannulation sites, but it can occur at surgical or procedure areas, the GI tract, pulmonary system, or, most catastrophically, intracranial. Patients on VA ECMO require greater degrees of anticoagulation, therefore their risk of complications is greater. ECMO requires assiduous monitoring of ACT, INR and platelet levels. More sophisticated studies might be indicated to make sure that anticoagulation is therapeutic but not supra-therapeutic. In a crisis situation, the patient on VV ECMO can even be run without heparin for up to 48 hours without adverse effects, though this is far from ideal.

**THE FUTURE OF ECMO**

Over 40 years following the first successful ECMO procedure reported by Dr. Bartlett in 1972, determining the precise role of this modality still (continued on next page)
ECMO IN ADULTS (continued) presents a challenge, at least in the case of adult patients. Despite technological advances in ECLS circuitry which have already taken place and are bound to accelerate with time, this modality will probably not enjoy wide applicability. ECMO is a labor intensive and expensive modality. However, in certain specialized centers, some patients with no other option will survive due to the fact that ECMO is available—we have seen that. The key to successful use of this modality probably lies in a multidisciplinary, protocol-based approach to these very ill patients by teams of caregivers experienced in the nuances of ECLS in the intensive care unit setting. They will be able to determine who the appropriate candidates for ECMO are, and how it can be implemented in an effective and favorable manner.

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REFERENCES

UMKC Graduate Earns National Award

Megan Litzau, a May 2015 graduate of the UMKC School of Medicine, has been selected as a winner of the 2015 American College of Emergency Physicians National Outstanding Medical Student Award. The honor will be presented in October at the organization’s annual scientific assembly in Boston. The award recognizes a medical student who intends to pursue an emergency medicine career and has displayed outstanding patient care and involvement in medical organizations and the community. Litzau will continue her training in emergency medicine with a residency at the Indiana University School of Medicine.

Study Demonstrates Potential of Rapid Whole-Genome Sequencing in Critically Ill Infants

A study published in April in The Lancet Respiratory Medicine and presented at the annual Pediatric Academic Societies Meeting reveals the early results of the clinical usefulness of rapid whole-genome sequencing in neonatal and pediatric intensive care units (NICUs and PICUs). Children’s Mercy Kansas City’s STAT-Seq test helped diagnose a genetic disease in more than one half of 35 critically ill infants tested, compared to just nine percent with standard genetic tests.

As a result of receiving a specific disease diagnosis, clinical care was refined in 62 percent of infants, including 19 percent who had a markedly favorable change in treatment, and palliative care was initiated in 33 percent. Lead authors of the study were Laurel Willig, MD; Josh Petrikin, MD (KCMS member); and Stephen Kingsmore, MB, ChB, BAO, DSc, FRCPath, of Children’s Mercy Kansas City.

“Genomic diseases are the leading cause of death in NICUs and PICUs, but a timely and accurate diagnosis can significantly improve the precision of the care we provide. We’ve shown that rapid diagnosis using whole-genome sequencing is feasible and changed management for a majority of infants that were diagnosed,” said Dr. Willig, a pediatric nephrologist. “We hope STAT-Seq will be instrumental in introducing precision medicine into the NICU and PICU.”
Increased Coronary Artery Plaque Volume Among Male Marathon Runners

By Robert S. Schwartz, MD; Stacia Merkel Kraus, MPH; Jonathan G. Schwartz, MD; Kelly K. Wickstrom, BS; Gretchen Peichel, RN; Ross F. Garberich, MS; John R. Lesser, MD; Stephen N. Oesterle, MD; Thomas Knickelbine, MD; Kevin M. Harris, MD; Sue Duval, PhD; William O. Roberts, MD; & James H. O’Keefe, MD

INTRODUCTION

Regular physical activity is a key component of a healthy lifestyle. Vigorous aerobic exercise is considered protective against coronary artery plaque development based on its favorable effects on many cardiovascular (CV) risk factors including lower resting blood pressure and heart rate, improved lipid profile and glucose metabolism, reduced body mass index (BMI), and association with healthier lifestyles such as eating a nutritious diet and avoiding tobacco.1-3 Daily physical activity and high levels of cardiorespiratory fitness are also associated with lower inflammatory markers and better life expectancy.4-8

Four decades ago, Thomas Bassler, MD, an American physician, notably hypothesized that marathon running confers immunity against coronary atherosclerosis.9 Exercise might be best understood as a drug with powerful benefits, especially for CV health. As with any potent drug, establishing the safe and effective dose range is critically important—an inadequately low dose may not confer full benefits, whereas an excessive dose may produce adverse effects that outweigh its benefits.

Four decades ago, Thomas Bassler, MD, an American physician, notably hypothesized that marathon running confers immunity against coronary atherosclerosis.9 Exercise might be best understood as a drug with powerful benefits, especially for CV health. As with any potent drug, establishing the safe and effective dose range is critically important—an inadequately low dose may not confer full benefits, whereas an excessive dose may produce adverse effects that outweigh its benefits.

Two recently published long-term large observational studies independently showed that runners, as compared to non-runners, have increased life expectancy. However, these longevity benefits were most significant for those obtaining moderate doses of running; individuals chronically performing high-intensity long-distance running appeared to lose the mortality benefit.10,11 Indeed, an emerging body of scientific data suggests that chronic, excessive, high-intensity exercise may induce oxidative stress and myocardial fibrosis, accelerate atherosclerosis, increase vascular wall thickness, and increase cardiac chamber stiffness.12,13 Demand ischemia related to significant coronary narrowing may also occur in endurance running, and rarely this may even result in myocardial infarction and cardiac arrest.14,15 Male marathon runners have also been shown to have paradoxically increased coronary artery calcified plaque as measured by computed tomography (CT) coronary calcium scoring.16 However, a study using high-resolution coronary computed tomographic angiography (CCTA) for quantifying coronary artery plaque volume in marathoners has not been previously performed.

Recent advances in CCTA provide quantitative, noninvasive assessment of coronary artery plaque, and permit accurate measurement of plaque volume and location. In this study we used CCTA to examine whether long-term marathon running in men is associated with quantitative coronary artery plaque differences compared to a sedentary control group.

(continued on next page)
MARATHON RUNNERS (continued)

METHODS

The study was approved by the Institutional Review Board of Abbott Northwestern Hospital (Minneapolis, Minn.). It was a single-center observational study of male long-term, very long-distance runners who participated in the Twin Cities’ Marathon (Minneapolis-St. Paul, Minn.). Eligible individuals were identified and invited to participate by reviewing marathon race records. After reviewing eligible subjects, participation thresholds were chosen as a minimum of 25 consecutive races for men.

A sedentary group of men was obtained from a coronary screening study of individuals who underwent CCTA scanning for clinical indications.17, 18 All subjects in this group were self-reported to lead sedentary lifestyles. Attempts were made to match the marathon runners to the sedentary controls for coronary disease risk factors.

INCLUSION CRITERIA

All subjects signed informed consent. Exclusion criteria were those who declined to participate, were allergic to x-ray contrast, and had serum creatinine ≥ 2.0. Scans were not scheduled if a subject had run a marathon within the previous two weeks or intended to run a marathon within the following two weeks (to avoid potential nephrotoxic effects from intravenous contrast, since marathon running is associated with a transient creatinine rise).19

PROCEDURES

CCTA was performed per standard clinical practice using Siemens Dual Source or FLASH CT in a minimum x-ray dose protocol. At or near the time of the CCTA, the following procedures were performed: 12-lead electrocardiogram, height, weight, blood pressure, resting heart rate, serum lipid panel, historical lifestyle and risk factor questionnaire, and serum creatinine.

DATA ANALYSIS

CCTA scans were evaluated for all measurable plaque, both calcified and non-calcified. Plaque was manually identified and characterized for volume and stenosis severity using validated, commercial software on a commercial CCTA 3-D workstation (Vitrea, Vital Images, Minnetonka, Minn.).

Descriptive statistics were calculated and included means and standard deviations or numerical counts and percentages. Chi-squared or Fisher’s exact tests were used to assess the statistical significance of categorical variables and t-tests or Wilcoxon tests were used for continuous variables where appropriate. The Shapiro-Wilk test was used to test for normality of continuous data. If normality assumptions failed, conclu-

### Table 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sedentary (n=23)</th>
<th>Marathon (n=50)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>65.43 ± 10.39</td>
<td>59.44 ± 6.66</td>
<td>NS, 0.061</td>
</tr>
<tr>
<td>Systolic BP, mmHg*</td>
<td>134.00 ± 18.35</td>
<td>127.02 ± 13.74</td>
<td>NS</td>
</tr>
<tr>
<td>Diastolic BP, mmHg</td>
<td>79.30 ± 10.39</td>
<td>79.04 ± 9.49</td>
<td>NS</td>
</tr>
<tr>
<td>Heart Rate, bpm</td>
<td>70.33 ± 10.57</td>
<td>52.36 ± 9.31</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Height, inches*</td>
<td>70.39 ± 2.10</td>
<td>70.19 ± 2.44</td>
<td>NS</td>
</tr>
<tr>
<td>Weight, kg*</td>
<td>96.8 ± 17.0</td>
<td>76.9 ± 11.5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>BMI, kg/m²*</td>
<td>30.29 ± 5.16</td>
<td>24.15 ± 2.88</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1525 ± 652</td>
<td>12 / 47 (25.5)</td>
<td>0.001</td>
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<tr>
<td>Hyperlipidemia</td>
<td>19/23 (62.6)</td>
<td>22 / 47 (46.8)</td>
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<tr>
<td>Diabetes</td>
<td>4 / 23 (17.39)</td>
<td>0 / 50 (0)</td>
<td>0.008</td>
</tr>
<tr>
<td>History of Smoking, %</td>
<td>9 / 23 (39.1)</td>
<td>29 / 50 (52.0)</td>
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</tr>
<tr>
<td>Creatinine, mg/dl*</td>
<td>1.03 ± 0.30</td>
<td>1.15 ± 1.00</td>
<td>NS</td>
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<tr>
<td>Total Cholesterol, mg/dl*</td>
<td>183.56 ± 48.56</td>
<td>186.44 ± 28.83</td>
<td>NS</td>
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<tr>
<td>HDL, mg/dl</td>
<td>40.67 ± 9.86</td>
<td>59.02 ± 11.50</td>
<td>&lt; 0.001</td>
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<tr>
<td>LDL, mg/dl*</td>
<td>108.13 ± 45.22</td>
<td>111.9 ± 26.69</td>
<td>NS</td>
</tr>
<tr>
<td>Triglycerides, mg/dl*</td>
<td>130.60 ± 63.00</td>
<td>83.36 ± 38.58</td>
<td>NS</td>
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</table>

### Table 2

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sedentary (n=47 lesions)</th>
<th>Marathon (n=95 lesions)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lesions</td>
<td>47</td>
<td>95</td>
<td>—</td>
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<tr>
<td>Lesion prevalence</td>
<td>12 (52.2)</td>
<td>30 (60.0)</td>
<td>NS</td>
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</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sedentary (n=47 lesions)</th>
<th>Marathon (n=95 lesions)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion area*</td>
<td>43.4 ± 26.0 (44)</td>
<td>46.9 ± 24.2 (94)</td>
<td>NS</td>
</tr>
<tr>
<td>Lesion diameter*</td>
<td>42 ± 22.4 (43)</td>
<td>41.7 ± 19.9 (94)</td>
<td>NS</td>
</tr>
<tr>
<td>Lesion length*</td>
<td>15.1 ± 8.0 (43)</td>
<td>20.0 ± 17.3 (94)</td>
<td>NS</td>
</tr>
<tr>
<td>Plaque volume*</td>
<td>125.5 ± 80.5 (46)</td>
<td>200 ± 144.2 (95)</td>
<td>0.002</td>
</tr>
<tr>
<td>Calcified plaque volume mm³*</td>
<td>46.0 ± 36.8 (46)</td>
<td>83.8 ± 67.7 (95)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Non-calcified plaque volume mm³*</td>
<td>81.5 ± 58.1 (46)</td>
<td>116.1 ± 95.7 (95)</td>
<td>0.039</td>
</tr>
</tbody>
</table>

* p values from T-test/Wilcox test for non-normal data. * Indicates failure of the normality assumptions based on Shapiro-Wilk test.
sions were based on non-parametric comparisons. A p value of ≤ 0.050 was considered statistically significant, and all reported p values were two-sided. Statistical calculations were done with SAS software version 9.2 (SAS Institute Inc., Cary, N.C.).

RESULTS

Fifty male marathon runners and 23 sedentary male control subjects were enrolled. All male runners reported no CV symptoms and had no CV or coronary history. The marathoners and controls were similar in age, resting blood pressure, height, smoking history, serum creatinine, total cholesterol and low density lipoprotein (LDL) cholesterol (p = NS for all) (See Table 1). Marathoners had significantly lower resting heart rate, weight, BMI and triglyceride levels, but had higher high density lipoprotein (HDL) levels, and were less likely to have a history of diabetes and hypertension (See Table 1).

Tables 2 and 3 summarize coronary CT lesion analysis. There were 46 lesions in 12 of the 23 sedentary subjects and 95 lesions in 30 of the 50 marathon participants. There was no difference in lesion prevalence between groups. Male marathon runners however had paradoxically increased total plaque volume (200 vs. 126 mm³, p = 0.002), calcified plaque volume (84 vs. 44 mm³, p < 0.0001), and non-calcified plaque volume (116 vs. 82 mm³, p = 0.04) (See Figure 1). Lesion area, diameter stenosis, and length differences did not reach statistical significance between the two groups.

DISCUSSION

The association of decades-long marathon training/racing with coronary artery plaque was examined in this study. Few prior studies have focused on this association, and none using plaque quantitation by CCTA. We found that long-term marathon running in men may not engender protection against coronary artery plaque development, despite conferring advantages in many traditional coronary risk factors including favorable changes in lipid levels, glucose metabolism and blood pressure. To the contrary, this study found that long-term participation in marathon training/racing is paradoxically associated with increased coronary plaque volume (despite comparable plaque prevalence).

A recent study found the incidence of sudden death in marathon running is approximately 1 in 100,000 participants, 15 with coronary artery disease (CAD) accounting for the majority of fatalities.14 Fortunately, these deaths, though tragic and disturbing, are rare. However, the bigger concern may be the fact that excessive exercise ultimately deprives the individual from reaping the significant longevity benefits conferred by moderate exercise.

The Copenhagen City Heart Study followed 1,878 runners and 10,158 non-runners for up to 35 years.10 The runners had an impressive 44% lower risk of mortality during follow-up, with an increase in life expectancy of about six years for both genders. Importantly though, U-shaped curves were apparent for mortality with respect to dose of running, whereby the benefits of running were most significant for those who jogged between 1 to 2.5 hours per week, at a slow to moderate pace, with a frequency of about three times per week.10 In those runners who were performing higher volume, higher-intensity running, the long-term mortality rates were not significantly different from non-runners. In other words, excessive running may have abolished the remarkable improvements in longevity conferred by lower doses of running.

Strikingly concordant data were seen in a large decades-long observational study of 54,000 Americans.11 Highly significant mortality reductions were seen in the runners compared to (continued on next page)
MARATHON RUNNERS (continued)

the non-runners, but U-shaped curves again showed that the lowest mortality rates were seen in those running 5 to 20 miles/week, and that the longevity benefits of running completely disappeared with distances greater than 25 to 30 miles/week. Still, the mortality rates in the high-mileage runners were similar to but did not exceed those for sedentary individuals.11

Cardiac over-use injury is a term that we have proposed for problems that arise with chronic excessive high intensity exercise. Reports have documented myocardial fibrosis and scarring, potentially dangerous rhythms, and accelerated coronary atherosclerosis (a constellation of pathology which has been labeled Pheidippides’ Cardiomyopathy by Peter McCullough, MD).12, 13, 19 The number of individuals running in marathons and other extreme endurance events has been rising dramatically during the past 40 years (See Figure 2).12, 13 We suspect some runners might choose shorter, less exhausting challenges if they were aware of the potential adverse cardiac effects of chronic extreme endurance efforts.

The metabolic and mechanical stresses produced by excessive running could constitute a causal role in accelerated atherosclerosis. Runners who train and race over very long distances experience protracted elevations in heart rate, blood pressure, cardiac output, and atrial and ventricular volumes for up to several hours per day. Intense exercise generates large quantities of free-radicals that outstrip the buffering capacity of the system after approximately one hour of vigorous continuous exercise, leaving these individuals susceptible to oxidative stress, atherogenic modification of cholesterol particles, and endothelial dysfunction.20 Ultra-endurance efforts also cause multiple other disturbances within the system including sustained elevations of catecholamines and resultant coronary vasoconstriction, protracted sinus tachycardia which reduces the diastolic filling time of the coronary arteries, changes in free fatty acid metabolism, lactic acidosis, and other metabolic derangements.12, 13, 19

LIMITATIONS

The control group, although matched for age, gender and several CV risk factors, was unable to be matched to the marathoners for resting heart rate, weight and HDL levels, likely the result of chronic high-intensity aerobic exercise. Still, these differences would be expected to protect against atherosclerosis, thereby favoring the marathoners. However, the sedentary controls had significantly less coronary plaque despite the marathoners’ more favorable CV risk factors.

This was a single-center observational study, based on recruitment from known runners who chose to participate. However, a study that randomly assigned individuals to either run marathons for 25 years or be sedentary for 25 years is practically impossible, and will never be done. Thus, a cause-and-effect relationship between marathon running and accelerated coronary plaque development cannot be established. Nonetheless, multicenter studies comparing coronary plaque volume in larger numbers of marathoners and matched sedentary control subjects would be of great interest.

CONCLUSION

Long-term training for and competing in marathons may in men be paradoxically associated with accelerated coronary artery plaque formation.

ACKNOWLEDGMENTS

Presented in abstract at the American Heart Association Scientific Sessions, November 2011. This work was supported in part by the Ken Rome Foundation, Minneapolis, Minn.
James H. O’Keefe, MD, is with Saint Luke’s Mid America Heart Institute and is a Missouri Medicine Preventive Medicine Editorial Board Member.

REFERENCES
FINDING TIME MEANING SATISFACTION

By Jim Braibish, Kansas City Medicine
Today’s younger physicians expect more than 12-hour days that leave them with too little time to spend with their families or get involved in activities outside of work. Many also recognize the importance of getting involved in organized medicine to help shape the future working environment of health care.

Achieving balance is not easy, and takes effort. A study of 4,000 business executives published in the March 2014 Harvard Business Review concluded, “By making deliberate choices … leaders can and do engage meaningfully with work, family and community. They’ve discovered through hard experience that prospering is a matter of carefully combining work and home so as to not lose themselves, their loved ones, or their foothold on success.”

The definition of work-life balance varies widely according to one’s individual goals and outlook. “Work-life balance basically comes down to being fulfilled and successful in personal life and at work,” said Iris Grimm, an Atlanta-based physician coach.

“Balance is personal—everyone has a different perspective of what life is supposed to look like,” she said. “Some physicians want to make their profession their life and that is what makes them happy. And others like to have more variety, have a big family, make time for hobbies and practice medicine that supports this lifestyle.” She also noted that the definition of balance can change over time. “When you are 30 and have a young family, the priorities and how you spend your time are different than when you are 50 or when you are single.”

The level of balance fluctuates day-to-day, with some days requiring long work hours and others where family issues or events draw priority, Grimm said. “But when you look at life with a wider lens, there is balance, optimal performance, and fulfillment.”

Younger physicians are part of a generational shift in which younger workers place greater importance on travel, hobbies and personal downtime and not waiting until they are retired to enjoy these, according to Grimm. “Many young doctors come from physician families where they saw and experienced (mostly) their fathers missing their major life events, leaving the dinner table to respond to an emergency situation or being on call frequently. But back then physicians also received greater financial reimbursements and it was a highly recognized profession.”

In the face of day-to-day demands and on-call schedules, what are some tactical ways physicians can help maintain balance?

The website Physicians Practice offers 18 work-life balance tips for physicians. Among them:

- Carve out time to accomplish your most critical tasks of the day
- Know your limits
- Consider delegating lower-priority tasks
- Outsource such tasks as housekeeping and lawn maintenance
- Make time for self-care outside of work
- Let go of something before you take on more
- Be present and focus on the moment, whether it be at home or at work

“Balance is the foundation to being a good and productive physician,” Grimm concluded. “Physicians need downtime from work to recharge; they need a solid and harmonious family life in order to be a good and empathetic physician.”

Iris Grimm offers a confidential and individualized coaching program for physicians, The Balanced Physician. For further information, visit www.balanced-physician.com.

Young physicians strive to achieve balance of time to include family, fitness and organized medicine.

REFERENCES

1. Interview with Iris Grimm, July 6, 2015.
The idealized vision of work-life balance is one of smooth sailing, but the real-life version for him is more complicated, says Lancer Gates, DO. “From day to day, moment to moment, it often feels like there are many balls in the air,” he said. “It would be nice to keep everything even, but generally it’s not. You just want to try and come back to level as much as possible.”

With six kids, Dr. Gates and his wife, Stacey, spend a lot of time shuttling the children between extracurricular activities that include tennis, piano, and ballet. Stacey also serves as the manager of his medical practice. And then, of course, come the parenting responsibilities of providing a homework-friendly environment and keeping an eye on the kids as they mature.

So why, then, does Dr. Gates take on the added responsibility of being heavily involved with the Kansas City Medical Society? It all comes down to taking better care of patients, he said.

Participating in organized medicine, Dr. Gates said, allows him to help address systemic problems that can hinder the delivery of care.

He offers several insights into his ability to manage work, family, and outside activities. First, is a solid support network that includes an understanding wife, kids and colleagues. Multi-tasking is also important, Dr. Gates said.

A former high school distance runner, he still tries to run a few times a week. He incorporates family time into his running by bringing the kids along to the track so they can run along at their own pace. He also plays tennis with the kids occasionally.

“In that way, we can all get in shape together,” Dr. Gates said. “I have to incorporate the two things. There is not time enough to watch them exercise and me exercise at a different time.”

And finally, he said, he acknowledges the boundaries of his own time. His rule is that he does not take on a new responsibility without freeing himself up from another one. Certainly one can learn and grow by becoming involved in outside activities, but you have to be realistic about your capabilities, he said.

“You have to keep a close eye on how much you have committed to do and how much you can deliver,” he said, “and if you are having a hard time, and there will be times, you have to step back, you have to know in your own mind what is your priority.”

The fine line is this, he said: “You don’t just want to be busy. You want to be effective.”
Sarah Lovinger Florio, MD, reminds herself every day of what is most important to her: family and church.

Working four days a week, 7:30 a.m. to 5:30 p.m., she arrives home from the office by 6 p.m. for family dinner and time with her husband and son. After play, bath and stories, she will often spend another two or more hours finishing notes, verifying labs and returning emails.

Completing work late in the evening is preferable to staying longer at the office. She said, “I choose to bring work home because missing time with my son in the morning and dinner with my family in the evening are sacrifices I am not willing to make.”

Nevertheless, working mother’s guilt is a challenge. “I’ve missed things with my son that I will never get back in order to care for my patients. There always is more to do for work, and it is hard for me to say ‘no’ when asked to be on a committee or take on additional responsibility.”

Fortunately, she credits her husband “who makes regular sacrifices to support our common goals.”

Getting involved in organized medicine has been modeled for her by other family members including her father, Warren Lovinger, MD, who is currently chair of the Missouri State Medical Association Council. Her brother Thomas Lovinger, MD, is a member of the KCMS Board of Directors.

“Young physicians (and society in general) seem to be pulled in a million directions personally, and thus our generation of physicians does not seem to understand the importance of involvement,” Dr. Florio said. “We practice in ‘the age of the employed physician;’ this reality has made young physicians significantly less likely to participate in leadership positions. It can be difficult to establish one’s voice within the complexities of a hospital system. However, for a young physician who has an interest in leadership, there are opportunities available if one is willing to put in the extra time and energy.”

Does maintaining balance make her a better doctor? Absolutely.

She concluded, “I am happiest when I feel like I am maintaining good balance. Happy doctors are good doctors. My patients appreciate that church and family are important to me. It makes them feel better about me as a physician to know that there is more to me than just my job.”
SCOTT ROETHLE, MD

Age: 37

Practice: Anesthesiologist with Anesthesia Associates of Kansas City (AAKC); Director of OB Anesthesia, Fetal Health Center at Children’s Mercy Hospital

Years in practice: 5

Family
Wife, Alana; Children, Taggart (8), Thatcher (6), Scarlett (4) and Eliza (2)

Professional activities
Member, Kansas City Medical Society Board of Directors; AAKC Executive Board; AAKC Center Chief 2012-2015; Secretary, Kansas Society of Anesthesiologists; Kansas Delegate, American Society of Anesthesiologists

Personal activities
Spending time with family, exercising, weightlifting, church, playing poker; children’s activities include bible school, piano, swimming, Spanish; wife Alana is involved in local politics

Advice for aspiring leaders
“Find a mentor, if you can, and also, don’t dawdle. Just jump in and start doing something—that is the key. It might take a while to catch on or really find a role that you enjoy or can make work.”

Scott Roethle, MD, strives to make time for family alongside medical practice while also being active in leadership in the medical profession. In 2015, he has added membership on the Kansas City Medical Society Board of Directors to his activities.

“My family is most important, but they also understand that other responsibilities might take short-term priority and I might be gone for work and meetings several nights a week,” he said. “Luckily I am able to spend a lot of time with the family, and we make intentional efforts to be involved with the kids.”

With so many changes ahead in medicine, it is critical for physicians to make their voices heard. “I just want to be involved in helping to maintain and shape our specialty. If you are not involved, then you are going to have things done to you, instead of being proactive and help shape it for the future,” he noted.

Dr. Roethle credits his wife, Alana, for allowing him to juggle his personal and professional priorities. He said, “She is very understanding and giving, which allows me to get involved in leadership and advocacy activities. She knows that some sacrifices now should gain huge benefits in the future for us and our family.”

He also is bullish on the benefits of regular exercise and was a triathlete in medical school. Today he focuses on weightlifting.

“Exercise makes me feel better. It helps me mentally,” he said, adding, “We also use exercise as a family activity to encourage a healthy lifestyle.”

How does he keep everything in balance? “My biggest keys are communication, understanding and selflessness. In our family we have a great team mindset which works well for us. We expect to be busy but welcome relaxation as well.”

He concluded, “It is hard to keep the scale perfectly balanced at all times, as certain things come up or fill the schedule, but I always remember our priorities and maintain balance overall in my life.”
The support of her family and co-workers is key for Kortnee Lanning Sorbin, MD.

“Ideally, I would like to be everywhere I need to be … attending all the kids’ activities, doing Pilates three nights a week, having family dinners every night, doing all my nonclinical work, having date time with my husband and more,” she said. “But there often are times when clinical work or on-call take away from these. That is why my husband and family are so important to my success as an anesthesiologist. Their support and understanding is THE KEY to making it all work.”

Her husband Mike gave up his job teaching and coaching baseball in the Olathe School District to stay home with the kids. Not every husband could accept the role of having a wife as the family breadwinner, but Dr. Sorbin said Mike has embraced the arrangement. Theirs is a blended family with the two having brought three children into the marriage. They added daughter Aubree while Dr. Sorbin was in residency.

She also praises her colleagues at Anesthesia Associates. “I work with great, supportive people. My partners are a lifeline at times and our nurse anesthetists are very good at what they do, which makes work much easier and less stressful. I truly am blessed.”

Dr. Sorbin said she has missed her share of her boys’ sporting events, and she recalled a time she had to leave a school production when she was on call and could not get phone service at the venue.

But, Dr. Sorbin said, “I like to think of it as a lesson to (the children) to a certain extent, that you can’t get everything handed to you. I really want my kids to grow up and be successful and know that no job is a perfect job. It is called ‘work’ for a reason.”

Indeed, she has overcome several challenges in her life. One was an unplanned pregnancy that left her raising her oldest son through college and medical school. She also has battled microscopic colitis, which has led her to commit to exercising regularly and maintaining a fresh, clean diet.

“Healthy living helps me personally and improves how I handle things at work, even if it is a stressful day,” she said. “This in turn helps me function better as a leader.”
When I meet someone new and tell them that I’m an insurance broker, they often change the subject as soon as possible; that’s because people don’t want to be sold to. Physicians are no different when it comes to medical professional liability insurance. Health-care providers want and deserve a trained professional advisor who is on their side; someone who will guide them to the right buying decision without pressuring them into a decision against their will. The amount of information at our fingertips has changed the way physicians select insurance coverage, and they want to work with someone who understands their needs.

The Internet has changed the way we all make buying decisions. Before buying a car, new kitchen cabinets, or tickets to the theater, most people do some research online. We used to live in a seller’s market where the salesman had all the information, and the consumer had to depend solely on what information that salesman would share. In the last couple of decades, however, with access to unlimited information, the situation has changed and we now live in a buyer’s market where both buyer and seller are on an even playing field. What this change means for physicians is that they now need a consultant, an advisor, a resource rather than a salesman.

**ACCESS TO ALL INSURANCE CARRIERS**

By working with an Independent Insurance Agency that has access to all available insurance companies, physicians will find a consultative approach rather than a salesperson who only wants to sell insurance. This is because Independent Agencies employ brokers who represent the client and have access to all the insurance carriers in the market. Insurance buyers need a fair view of all the options in the market, and not just a “one size fits all” approach. An Independent Agency will guide the client through the process of comparing coverage, policy features, company financial strength and claims handling.

Working with physicians on their medical professional liability needs is much more than just finding the lowest price, though saving money is always an important factor. To be effective, your insurance advisor needs to think outside the traditional box, and look for alternatives which maintain the integrity of coverage, while addressing the needs of the ever-changing medical environment. For example, participation in an accountable care organization or adding unique services or provision of services in an unconventional setting may open your practice up to new and unforeseen liability risks. A part of the consultative approach is to ask discovery questions to find these unique coverage challenges, and to make sure that these challenges are covered under your policy.

An independent insurance professional acting as a consultant will:
- Work for the client not the insurance carrier
- Review the risks and exposures of the practice and identify the carriers and policies that cover these risks
- Solicit competitive quotes and gather information on the insurance carriers
- Educate the client about the differences between carriers and policies
- Let the client make the buying decision
- Provide proof of insurance and copies of the policies
- Provide service throughout the policy period and keep the client informed and updated

**COMMITMENT TO INTEGRITY AND RESPECT**

As one of the largest independent medical professional insurance agencies in the nation, the Keane Insurance Group works with both single physician practices and large groups as a health-care practice consultant. Our commitment to our clients is to provide service with the highest integrity and respect in the timeliest manner possible. We offer creative, innovative and cost-effective solutions for every physician and practice.

The following are a few recent success stories of how we were able to help clients:
1. A multi-physician specialty group wanted to save money on their coverage. Not having a carrier that would offer a lower premium under their renewal quote from their existing carrier, we had to look for another option. So we went to the underwriters at their existing carrier and worked with them to get the group “experience rated” instead of book rated, which resulted in 28% savings over their renewal quote. Not every group will qualify for experience rating or will be helped by experience rating, but some will. You will not receive this option automatically; your producer must be working for you.

2. A Kansas City-area physician client recently moved his office to Kansas during the year and changed the scope of his practice; over 80% of his patient visits are now in nursing homes. These changes were identified at renewal time, but his current carrier was not admitted to Kansas and did not want to provide coverage for a practice largely dominated by nursing home care. On less than two weeks’ notice, we found a new carrier that would cover Kansas and the nursing home care and in addition, we were able to get the physician a lower premium.

3. A physician decided to open a new clinic that offers a variety of medical services including some non-traditional. The intent was to use a number of physicians to provide the services, knowing that some of the physicians involved would be short-term. We worked with the practice to design a package that provides the desired coverage in a cost-effective manner that will eliminate the need for expensive tail policies every time a physician leaves. The Keane Insurance Group believes that focusing on one line of coverage (in our case, medical professional liability) and doing it extremely well is more important than trying to be an expert in all lines. That is what we have done for over 20 years. As a national agency we write business in states across the nation and have the opportunity to see liability risks and trends often before they appear in Missouri and Kansas. This exposure helps us better serve physicians in the Midwest marketplace.

Tom McNeill is a health-care specialist with the Keane Insurance Group. He has over 30 years’ experience in the health-care industry including serving in hospital and physician practice management, and most recently as COO of the Missouri State Medical Association Insurance Agency. Physicians look to Tom for resources such as medical professional liability insurance through NORCAL Mutual Insurance Company, physician disability insurance, cyber and regulatory liability coverage, and HR guidance. He can be contacted at 314-966-7733, email tom.mcneill@keanegroup.com.

Stress Triggers Key Molecule to Halt Transcription of Cell’s Genetic Code

Researchers at the Stowers Institute for Medical Research and elsewhere have uncovered new information about the role of the molecule elongin A in transmitting genetic code. When cells are normal and unstressed, the molecule keeps transcription moving so that genes are “expressed” and RNA is jotted down more quickly. When cells are stressed and transcription runs into a glitch caused by damage to the DNA, it marks the machinery to be disassembled. Now, Stowers scientists and their collaborators have discovered how the molecule morphs between these two alternate identities, one as facilitator and the other as destroyer.

“For any cell, transcriptional regulation and gene expression is a very delicate balancing act. If the machinery gets stalled on a gene it becomes a physical block to transcription. That can have a devastating effect if the gene is a tumor suppressor gene or an essential survivor gene, and it can’t be transcribed until the machinery is removed,” says Juston Weems, Ph.D., a postdoctoral research associate and lead author of the study. “Understanding how elongin A helps to disassemble the transcription machinery gives us insight into diseases like cancer that can result when genes are inappropriately turned on or off.”

To turn a gene on, parts of the transcription machinery proceed in a stepwise fashion along specific sections of DNA in order to convert the genetic information in the DNA into a working copy of RNA. Transcription doesn’t always go smoothly, and the machinery stutters occasionally when it gets a bit askew or off track. It can also stall or stop altogether when it hits a glitch—a section of DNA that is damaged from exposure to ultraviolet radiation or just simple wear and tear.

The findings were reported in April in the Journal of Biological Chemistry. Weems’ research mentors on the project were Joan Conaway, Ph.D. and Ronald Conaway, Ph.D., who have spent almost three decades studying the fundamental mechanisms that drive transcription.
MARK YOUR CALENDAR

GETTING 2 VALUE
THE FUTURE OF PHYSICIAN COMPENSATION

TUESDAY, SEPTEMBER 22, 2015
4:00 – 9:00 PM
INTERCONTINENTAL HOTEL

Health care financing is quickly moving toward value-based care which rewards those that deliver health and wellness, and prevent illness among the population served. How can physicians prepare for these changes?

FEATURED SPEAKERS

PAUL GRUNDY, MD, MPH, FACOEM, FACPM
Founding President, Patient-Centered Primary Care Collaborative
Director of Global Healthcare Transformation, IBM

MARCI NIELSEN, PHD, MPH
Chief Executive Officer, Patient-Centered Primary Care Collaborative

No registration fee for physician members of KCMS. Watch your KCMS email for registration information.

KCMS Annual Meeting

WEDNESDAY, OCT. 21, 2015
5:30 TO 8:00 P.M.
KAUFFMAN CENTER FOR THE PERFORMING ARTS

Watch your KCMS email for registration information