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Autumn CME
An Update on Pediatric HIV
By Mobeen Rathore, MD, CPE, FAAP, FPIDS, FIDSA, FACPE, FSHEA

The management of HIV infection has improved significantly over the last three decades of the epidemic. The treatment of pediatric HIV infection has benefited significantly from the progress. Of the advances, the most significant is the success of prevention of mother to child transmission of HIV infection.

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One City, One Jacksonville

“One City, One Jacksonville.” This is the rallying cry of our newly inaugurated mayor, Lenny Curry. He emphasized this after a very contentious and partisan campaign. Whether he received your vote or not, it is a simple yet powerful message of cooperation in order to better our community as a whole. His hope is that multiple civic organizations will work to bring sections of our city together to accomplish great things. The goal is One City, One Jacksonville.

The DCMS certainly has and will continue to contribute to this message of unity and collaboration within our wonderful city. In fact, it has been doing this for multiple decades. It was Dr. George Trotter, as a member of the DCMS indigent care committee who founded We Care Jacksonville in 1993. This is a volunteer coalition of health care professionals and clerical staff that assist in providing primary and secondary care to the underserved people of Jacksonville. Promoting healthy living without alcohol and tobacco may encourage these individuals to make the right choices which will allow them to be successful in other aspects of their lives. By offering our services to these men and women, we are doing our part in assisting them on the road to independence.

Physicians of the DCMS have been involved with the Jacksonville Sports Medicine Program (JSMP). This unique program provides valuable services to the community in order to improve and/or maintain the health and wellness or our local student athletes. Volunteers from the DCMS and various other medical institutions participate in preschool year sports athletic screenings. This is a terrific way to ensure that these children are healthy enough to participate in football, soccer, basketball and swimming for instance. Each year, a few students are identified who have a heart murmur or an orthopedic condition that requires further evaluation prior to being cleared for sports. Many DCMS physicians also volunteer to provide medical coverage at local Friday night high school football games in the fall. Without our services many of the great things done by the JSMP may not be possible.

Members of the DCMS are active on a variety of other local organizations aimed at keeping Jacksonville healthy. These groups include the Center for Global Health and Medical Diplomacy, the Childhood Obesity Coalition, the Environmental Protection Board, the First Coast Diabetes Coalition, Healthy Start Coalition of Northeast Florida, the Mayor’s Council on Fitness and Wellness and Volunteers in Medicine just to name a few.

Thus, it is crystal clear that the medical community, led by the DCMS, has been all about One City, One Jacksonville for many decades. However, there is room to do even more. For example, unfortunately gun violence has become a more evident concern in Northeast Florida. Certainly many factors, including socioeconomic and cultural issues make this quite a complex problem. Local doctors are in a position and have the opportunity to discuss gun safety in order to protect our community’s children from causing or being the victim of intentional or unintentional injury and/or death. A “physician gag law” limits our ability to discuss these issues with the most vulnerable members of our society…the children. Not only does this violate the doctor’s first amendment rights, it also is preventing us from truly looking out for the best interests of our patients while also doing our part in reducing senseless gun violence. What can we do about this? Through our efforts in organized medicine, we can send resolutions to the FMA and/or AMA so that these organizations can fight on our behalf to reduce such unfair government restrictions on our medical practices.

The DCMS has been and will continue to be an organization that looks out for the well-being of the public. This group of volunteers will continue to help physicians care for the health of our community for many years to come. In the process we will do our part in living out the motto One City, One Jacksonville. ✞
Announcing the DCMS Leadership Academy

As you are probably aware from previous communications, the DCMS Leadership through Mentorship initiative is designed to help our medical community develop leaders and to support our members through challenges they face in their careers in medicine. Dr. Uday Deshmukh and Dr. Steven Cuffe are leading a task force to develop a mentoring program that will also enhance the talent in our local medical community.

The Leadership through Mentorship Task Force includes Drs. Tra’Chella Johnson-Foy, William Palmer, Ana Alvarez and Cynthia Anderson. The task force met numerous times and decided to pursue two aspects. The first aspect is a curriculum-based program in association with the University of North Florida that will provide leadership training to physicians in Northeast Florida. The second aspect provides social events designed to introduce our talented physicians and improve their social and professional communication, sharing of ideas, and trust among our members. As a result, the task force expects such events will launch coaching and mentoring relationships among participating mentors and mentees.

In collaboration with the Brook’s College of Health at the University of North Florida (UNF), the DCMS Leadership through Mentorship task force is proud to announce the DCMS Leadership Academy. Enrollment in the first class is available now until January 31, 2016 by calling 904-355-6561. The sessions will take place on Fridays starting in February and ending in May 2015.

The program will kick off with an orientation luncheon at the University Club on February 12. This day will also include the first of two-part media training sessions. Three other leadership sessions are planned for March 11, April 8 and May 6 at the University of North Florida. The first session will cover the role of a physician leader. Topics include setting priorities, applying time management principles and defining your leadership purpose. This day will also include the second part of media training, giving physicians hands-on practice with media interviewing. The second session is on emotional intelligence and team building. Participants will learn various management styles, how to create high performance teams and how to reduce work-related stress, among other topics. The final session will cover strategic planning and culture change.

DCMS is proud to have Dr. Pamela S. Chally as a presenter. Dr. Chally is the dean and professor of nursing in the Brooks College of Health at the University of North Florida. She oversees the administration of the Dept. of Public Health, the Dept. of Clinical and Applied Movement Sciences, the Dept. of Nutrition and Dietetics and the School of Nursing.

Along with Dr. Chally, UNF Continuing Education Instructor Michael R. Clark will be the second presenter. He has an extensive background in the areas of management, supervisory development, quality improvement efforts and facilitation of strategic planning sessions and executive retreats. He has designed numerous training programs, including online, using the Instructional Systems Design methodology, and has provided over 1000 seminars, workshops, and presentations covering a diverse set of topics with a focus toward developing leadership skills for managers and supervisors.

DCMS Executive Vice President, Bryan Campbell, will be leading the media training session. Before transitioning to organized medicine in 2006, he spent four years as the Executive Producer at First Coast News. During his nearly 14 years in the broadcast television industry, he received three Emmy awards, two Edward R. Murrow awards and multiple Associated Press awards. He worked in several television markets including Omaha, Nebraska and Eugene, Oregon.

The DCMS Leadership Academy naturally supports the mission of DCMS to “Help physicians care for the health of our community” because stronger leaders create a stronger, more impactful medical society.

Tuition for the DCMS Leadership Academy is $799. However, thanks to our generous sponsors we are able to offer this exciting opportunity at a discounted cost. DCMS members will pay just $399 and non-members will pay $599. Space is limited, so reserve your spot today!

If you are interested in participating in the DCMS Leadership Academy or in the Leadership through Mentorship events, please email our Communications Coordinator, Kristy Wolski, at kristy@dcmsonline.org. I encourage you to participate. I truly believe that you receive most when you invest time and effort into strengthening your own community. Please do not hesitate to share your suggestions and thank you for your support! 

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From the Executive Vice President’s Desk

The $6,000 Egg

One of the great joys I have in life is my commute to and from work. I know that seems antithetical, but it’s true. Running enthusiasts always talk about clearing their head on a long run and focusing on problem solving, planning their day, or brainstorming for the future.

You’ve seen my picture; clearly I’m not going on many long runs. However, the 45 minute commute from Orange Park to downtown Jacksonville gives me the opportunity to get myself motivated for the day ahead and align the day’s priorities, while the ride home gives me a chance to unwind and leave the office behind.

My companion on my commute is Podcast Addict, a podcast aggregation service that brings the latest podcasts on everything from leadership to cooking. It’s like I’ve programmed my own personal talk radio station. It was just a few weeks ago, as I was driving to the office, that I heard the story of the $6,000 egg.

The very short version is that a man and his wife were in a diner which they frequented three times a week near their office. The special of the day was a waffle with a fried egg on top. The husband, knowing his wife likes fried egg on her hamburgers, requested a fried egg on her burger.

The server stated that they couldn’t do that, and even checked with the cook in the back who confirmed they couldn’t do it. When the manager came to the table she stated “I understand we have a problem here.” The man offered to pay for the egg, just say the price. The manager explained that there were a certain number of eggs and waffles, and that if they sold an egg for the burger, they wouldn’t be able to sell the special.

Not to be deterred, the man offered to give $5 to the busboy and have him run across the street to the grocery store, get a dozen eggs, and just use one on the burger, leaving eleven for the business.

“No.”

The man decided that they would no longer patronize this establishment. He figured that he spent roughly $6,000 per year at the business. That ended up being a $6,000 egg for the diner.

This story struck home to me. Every day, the Duval County Medical Society staff is hard at work, trying to make your society the best medical society in America.

Kristy Wolski is the DCMS Communications Coordinator and Managing Editor of the journal you are reading right now. She has years of experience as a television news reporter and has used those skills to greatly enhance the overall communications of the organization.

Courtney Hassan is the DCMS Meetings and Membership Manager. If there’s a DCMS event, Courtney is the one who planned it. She’s working on everything from our annual meeting, the visit from AMA President-elect Dr. Steven Stack, or the ever-popular Beers with Peers events for medical residents. She has a degree in meeting management, and has greatly enhanced the quality of our meetings in just a short time.

Patricia “Patti” Ruscito is the DCMS Director of Operations, and if you’ve been a member for any amount of time, you’ve talked to Patti at some point. She works closely with the Board of Directors, the Delegation to the Florida Medical Association, and is the keeper of all knowledge DCMS related. If I have a question about a member that was on the Board 20 years ago, Patti knows the answer.

Every day, we meet to talk about how to make the membership experience better. When you call the office during business hours, you will talk to a person, and not a machine. We work to create membership value and experiences for a myriad of different membership types.

We are currently working on two more major programs that will continue to demonstrate the value of the medical society to the health of the community. As you will read about in Dr. Assar’s column, the DCMS Leadership Academy is launching in 2016. This will be an exciting way for physicians of all walks of life to increase their leadership ability, and will help bring future leaders to the table.

Additionally, the DCMS Foundation is very close to a major announcement about how together we can help to improve the health of our entire community.

But these are our specials. This is what we have on the menu.

I am constantly on the lookout for the $6,000 egg. When you go to our website, when you attend an event, when you come to a meeting… are we overlooking your fundamental needs? Are we telling you "no" without even knowing it? Are you asking for something and not being heard?

At its core, the DCMS is a membership organization and it only runs if the members are satisfied. We hope that you all enjoy this issue of Northeast Florida Medicine. We hope that you join us for our Annual Meeting and Inaugural Ball on December 4th. And we hope that you have ideas and suggestions to help us continue to grow and become an even greater organization in the future.

And as for Kristy, Courtney, Patti and myself, we’ll be anxiously awaiting your feedback; because no egg is worth $6,000. ✴
A Look at Endovascular Neurosurgery

We are very honored by the opportunity to help create this issue of Northeast Florida Medicine about endovascular neurosurgery. The concept of endovascular treatment of cerebrovascular disease became a modern reality with the description of aneurysm coiling in 1991. Since that time, the field has grown dramatically.

Similar to the shift that has occurred in cardiology over recent decades, catheter-based treatment for cerebrovascular disease is now displacing craniotomy and open surgical techniques at a rapid pace.

The endovascular approach with less invasive technology minimizes the associated morbidity with vascular procedures. As an example, the advent of flow diverters is changing the paradigm of aneurysm treatment and allowing safe management of extraordinary lesions which, until recently, would have necessitated lengthy surgery with a high risk profile.

Catheters can now be navigated safely within all the vascular territories of the brain. This allows embolization of arteriovenous malformations and tumors with liquid embolic material, which can facilitate resection while minimizing blood loss.

While carotid endarterectomy remains an excellent surgery, carotid angioplasty and stenting has emerged as a valuable alternative for a high risk candidate.

While the advances in technology now allow for safer treatment of certain cerebrovascular diseases, it expands and revolutionizes the treatment of other conditions. Nowhere is this more evident than in the treatment of acute ischemic stroke from large vessel occlusion. The randomized trials published in the New England Journal of Medicine over the last year have confirmed clot retrieval and mechanical thrombectomy to be the standard of care for this disabling condition.

In this issue of Northeast Florida Medicine, we have included authors from all current Northeast Florida institutions where subspecialized neurointerventionalists are present.

Dr. David Miller from Mayo Clinic Florida highlights the history of our relatively young field and discusses the principal landmarks of our technology driven specialty.

Our group from Lyerly Neurosurgery, an affiliate of Baptist Health, reviews endovascular brain aneurysm treatment and provides an overview of all the current modalities available.

Dr. Benjamin Brown from Mayo Clinic Florida demystifies spinal dural arteriovenous fistulas, a potentially disabling spinal vascular pathology that is frequently missed or misdiagnosed.

Our team also provides an update on carotid disease therapy and the role of angioplasty and stenting in selected patients.

Dr. Philipp Aldana from University of Florida, Jacksonville, along with our team, discusses the exciting and newly confirmed role of endovascular therapy for acute ischemic stroke secondary to large vessel occlusions.

Finally, we review the role of endovascular therapy and the various modern options available in the complex management of brain arteriovenous malformations.

We are fortunate to practice cerebrovascular neurosurgery in this exciting time. We hope this issue reflects our enthusiasm and that you find this update helpful when discussing this complicated condition with your patients.
Residents’ Corner: Mayo Clinic

**Overview of Training Program**

Mayo Clinic School of Graduate Medical Education was one of the first medical specialty teaching programs in the world, with more than 24,000 graduates of residencies and fellowship programs across all medical and surgical specialties. In 1986, Mayo Clinic in Jacksonville, Florida became Mayo’s first campus outside of Rochester, Minnesota. Mayo Clinic hospital now operates at an expanded capacity of 304 beds, 22 operating rooms, 20 medical and 15 surgical specialties and a full service Emergency Department. There are presently more than 200 residents and fellows in training, and over 300 trainees when pharmacy and medical students are included. Residents and fellows are allotted further clinic opportunities at nearby institutions including, Mission House of Jacksonville, Nemours Children’s Clinic, Wolfson Children’s Hospital, University of North Florida, UF Health Jacksonville and the Jacksonville Naval Hospital. The Mayo Clinic Health System now includes the 231-bed Satilla Regional Medical Center in Waycross, Georgia with opportunities for resident and fellow educational experiences.

**Leadership in Resident/Fellow Health and Wellness**

Mayo Fellows Association (MFA) has prioritized the issues of burnout and fatigue among residents and created the Fellows’ Health and Wellness Initiative (FERAWI) to use arts and the humanities to combat these issues. Results showed that Internal Medicine residents who participated in the program reported reduced fatigue and increased motivation. This initiative has received national attention and was highlighted at the annual meeting of the American Medical Association where Dr. Olufunso Odunukan, the program pioneer, was part of a panel convened to discuss solutions to resident wellness. Now, the residency program has earmarked monthly humanities-related activities including artistic projects such as water coloring, print making, reflective writing, facilitated art discussions and guided visual imagery. Dr. Odunukan and his team have been nominated for the 2015 ACGME David Leach Award for advancing humanism among medical caregivers.

**Resident Research**

A cornerstone of Mayo Clinic, resident participation in medical research continues to be highly encouraged and supported by the institution and staff physicians. Our residents have been past winners at the Florida Medical Association (FMA) Research Symposium and the American College of Physicians Florida Chapter Research Symposiums. Below are a few examples of ongoing research:

Internal Medicine Resident Donneshia Clayton, MD recently completed a study on biliary fully covered self-expandable metal stents as an alternative to traditional esophageal stents for proximal esophageal stricture and fistula treatment. The study was presented at the Digestive Disease Week annual meeting. The manuscript is being prepared for publication.
Cardiovascular Diseases fellow Christopher Austin, MD completed a large retrospective study that demonstrated the utility of echocardiography to predict survival in patients with pulmonary arterial hypertension. The study was previously presented as an abstract at the American College of Cardiology scientific session and recently published as a manuscript in CHEST.

Gastroenterology/Transplant Hepatology fellow William Palmer, MD recently completed a large study on endoscopic treatment of Barrett’s esophagus with high grade dysplasia in patients with esophageal varices. This study was presented as an oral plenary at the American College of Gastroenterology annual meeting and published as a manuscript in Digestive and Liver Diseases.


Community Outreach
Through the Mayo Fellows Association, Mayo Clinic residents and fellows remain very active in the local community, providing their time and clinical expertise to those in need. Here are several examples of their activities:

- Yearly holiday clothing drives for Mission House of Jacksonville.
- Annual canned food drive for the Second Harvest Food Bank.
- Annual blood and bone marrow drive for The Blood Alliance

Peer Leadership
Residents and fellows are encouraged to participate in organized medicine and advocacy. Internal Medicine Resident Jordan Ray participated at the Inaugural FMA Resident and Fellow Section (RFS) Legislative Visit Day in Tallahassee in March 2015. Drs. Olufunso Odunukan, Jordan Ray, Tasneem Khalil and Kayeen Jeffers have just been elected to serve on the RFS Governing Council.

Education: Today and Tomorrow
Mayo Clinic education revolves around the three shields: patient care, medical education and research. Training at Mayo provides all these, in addition to opportunities for leadership, management and quality improvement. In the words of Dr. William J. Mayo (the older of the Mayo brothers) - “The glory of medicine is that it is constantly moving forward, that there is always more to learn. The ills of today do not cloud the horizon of tomorrow, but act as a spur to greater effort.”

Olufunso Odunukan, MBBS, MPH is a PGY-6 Fellow in the Department of Cardiovascular Diseases and serves as the President of the Mayo Fellows Association in Florida.
Carotid Angioplasty and Stenting

Carotid angioplasty is a procedure that opens clogged arteries to prevent or treat stroke. The carotid arteries are located on each side of your neck and are the main arteries supplying blood to your brain. The procedure involves temporarily inserting and inflating a tiny balloon where your carotid artery is clogged to widen the artery.

Carotid angioplasty is often combined with the placement of a small metal coil called a stent in the clogged artery. The stent helps prop the artery open and decreases the chance of it narrowing again. Carotid angioplasty and stenting may be used when traditional carotid surgery isn’t feasible or is too risky.

Why it’s done

Carotid angioplasty and stenting may be an appropriate stroke treatment or stroke prevention option if:

- You have a carotid artery with a 70 percent blockage or more, especially if you’ve had a stroke or stroke symptoms, and you aren’t in good enough health to undergo surgery — for example, if you have severe heart or lung disease or had radiation for neck tumors
- You’ve already had a carotid endarterectomy and are experiencing new narrowing after surgery (restenosis)
- The location of the narrowing (stenosis) is difficult to access with endarterectomy

In some cases, traditional carotid surgery (carotid endarterectomy) may be advised to remove the buildup of plaques (fatty material) that is narrowing the artery. In other cases, angioplasty and stenting may be a better option.

Risks

- Stroke or ministroke (transient ischemic attack, or TIA)
- New narrowing of the carotid artery (restenosis)
- Blood clots
- Bleeding

Results

For most people, carotid angioplasty and stenting increase blood flow through the previously blocked artery and reduce the risk or symptoms of stroke. **Seek emergency medical care** if your signs and symptoms return, such as trouble walking or speaking, numbness on one side of your body, or other symptoms similar to those you had before your procedure, contact your doctor immediately.

Lifestyle changes will help you maintain your good results:

- Don’t smoke.
- Lower your cholesterol and triglyceride levels.
- Maintain a healthy weight.
- Control other conditions, such as diabetes, high blood pressure and sleep apnea.
- Exercise regularly. ♦

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Endovascular Neurosurgery

Thinking Small: The Evolution of Neuroendovascular Therapy

By David A. Miller, MD
Assistant Professor of Radiology and Neurosurgery
Director Comprehensive Stroke Center at Mayo Clinic Florida

Abstract: The sub specialty of Neuroendovascular therapy has become a prominent feature of neurosurgical practice. It arose from the origins of cerebral angiography in the early 20th century, and has developed with a wave of advances in biology and technology.

Introduction

Neuroendovascular surgery is a very young subspecialty. It has been only recently that we have overcome the technical challenges to operate effectively within the cerebral vasculature. Still, it is hard to imagine a vascular neurosurgery practice today without an endovascular section, or without a neuroendovascular partnership. While neurovascular disease was not the first application of endovascular therapy, it is perhaps the most intriguing. The complexity of the intracranial vascular and bony anatomy, the very small vessel diameters (less than 1 mm in diameter,) and the unforgiving nature of brain tissue make the endovascular approach to the brain a distinct engineering challenge. However, it is these same features that make such a compelling case for endovascular solutions. The principles which underlie neuroendovascular treatment actually stretch very far back in history. As with every advancement in medicine, progress in this field has benefited from the inspiration of individuals and continued technological innovation.

Early Efforts at Intervention

The idea of treating vascular lesions, particularly aneurysms, with nonsurgical methods is not new. Treatment of aneurysms by the insertion of foreign bodies such as needles and wire, and even the application of electrical current, was reported in the late 18th century. While the emphasis was generally on thoracic aortic aneurysms, other peripheral aneurysms and the occasional carotid or cerebral aneurysm were treated. In the 1800s, Phillips in London and Velpeu in France reported inducing thrombus formation in aneurysms by introducing a foreign body (generally long pins). In 1864, C.H. Moore recovered a bullet from the ascending aorta during an autopsy and discovered it was covered with fibrin. Based on this he introduced 26 yards of metal coil into a thoracic aortic aneurysm in another patient, on the theory that this would promote thrombus and reduce flow into the aneurysm sac. Almost immediately after treatment, he noted a decrease in the pulsation and the size of the aneurysm, as well as a reduction in the patient's pulse from 116 to 92 beats per minute. The patient died several days later from sepsis, but this "packing" technique caught on, with a number of other investigators packing aneurysms with everything from horse hair to watch springs. Electrothrombosis (also referred to as galvanopuncture) was practiced widely in the latter part of the 1800s in Europe, and into the early 20th century in the United States. With this technique, needles are inserted into an aneurysm, and an electric current is applied to promote thrombosis. In 1856, Ciniselli published 50 cases of galvanopuncture of aortic aneurysms, with a cure rate of 50 percent. However, there was a procedure associated mortality of 14 percent. While an improvement over the results of other treatments at the time, it could not be recommended for most patients. In 1879, Corradi described a technique combining the two approaches: a permanent coil was placed and electric current applied. The technique gained a number of proponents, but a lack of consistent success eventually led to this technique also falling out of favor.

These treatments all shared one great flaw. There was no visualization of what the physician was placing. X-rays were not discovered until 1895, and a workable angiogram was not developed until well into the 20th century. Still, these earnest and well documented attempts to treat diseases with no good surgical options laid a foundation for the sophisticated endovascular treatments of today.
Endovascular Neurosurgery

The Development of Cerebral Angiography

Endovascular technique requires that the operator see what he is doing. The basis of almost all current endovascular therapy is the cerebral angiogram. Moniz, a Portuguese neurologist, is credited with the discovery of angiography. Prior to this, the only method for imaging the brain was by pneumoencephalography, which introduced air directly into the cerebrospinal space. This painful and cumbersome method, developed by Dandy, had only limited utility for imaging vessels. Early attempts to inject contrast media into arteries included an injection of the hand of a corpse with a toxic amalgam of petroleum, quicklime and mercuric sulfide, and several reports of injection of lipiodol into limbs had failed to provide images. Moniz believed that if he could introduce a radiopaque material that would concentrate in the brain, the brain could become visible on x-rays. In his first attempts, Moniz gave patients large oral doses of bromides. However, the brain was not opacified on subsequent radiographs. He then performed direct injections of bromide solution into the carotid arteries of dogs and into the vessels of cadaver heads that he arranged to have delivered to his laboratory in taxicabs. He eventually obtained very crude images of the cerebral vessels.

The first reported successful cerebral arteriogram took place in 1927. Moniz performed surgical exposure and temporary ligation of the carotid artery and injected a solution of 25 percent sodium iodide. Interestingly, while hailed as a great advance by the neurology community at the time, the technique was somewhat slow to be adopted. Still, by the 1950s, cerebral angiography had become the dominant imaging modality for the brain, and it remained so until the advent of computed tomography (CT) scanning in the 1970s. For many years, cerebral angiography was the only reasonable imaging method to look at the human brain. It was performed mostly by neurosurgeons, and generally by surgical cutdown or later direct carotid cannulation. Gazi Yasargil, a neurosurgeon recognized as one of the fathers of the microsurgical treatment of cerebral aneurysms, is reported to have performed over 10,000 angiograms between 1953 and 1964.

Moniz received the Nobel Prize in 1949 – but not for his work with angiography. He was honored for the development of the frontal lobotomy procedure. At the time, with no medicines to control severely mentally ill patients, this procedure was widely adopted to control unruly psychiatric patients. Angiography has clearly been a far more significant and lasting contribution to modern medicine.

Cross-sectional imaging techniques such as CT and magnetic resonance imaging (MRI) have supplanted cerebral angiography as a diagnostic tool for most brain imaging. However, angiography remains the gold standard for vascular imaging. In addition, advances in angiography, including digital subtraction techniques, “road map” real-time image overlays, and rotational arteriograms, allowing three-dimensional reconstruction, have become invaluable in both planning interventional procedures and in providing precise intraprocedural images to guide treatment. (Figure 1)

The Birth of Modern Endovascular Technique

Reports of efforts to embolize cerebral vascular lesions appeared soon after Moniz’s description of the cerebral angiography procedure. However, these procedures hardly resemble what we would consider true “endovascular” procedures today. Most were performed in the context of a surgical procedure, or involved surgical exposure of the cervical carotid artery to place a catheter. Embolic agents were often introduced directly into the vascular lesion, or were released into the cervical carotid artery, far from the target lesion. The technology did not exist to advance catheters into the distal cerebral vasculature. In 1930, Brooks described embolization of a carotid cavernous fistula (CCF) by placing thin pieces of muscle in the internal carotid artery. The pieces were then carried to the fistula. However, more

Figure 1: Anterior communicating artery aneurysm
A. Aneurysm sac with measurements
B. Anterior Cerebral Artery (parent vessel for aneurysm)
C. Ventricular drain (for subarachnoid hemorrhage)
recent reviews of the article suggest that the muscle may have been placed by a direct surgical procedure, as opposed to delivered using arterial flow.9 Still, the procedure framed the concept, and it became the standard treatment for CCFs until the development of detachable balloon catheters.

In 1941 Werner et al. inserted silver wire into an aneurysm during a transorbital craniotomy, and heated the wire to 80 degrees centigrade for one minute.10 They reported occlusion of the aneurysm sac. In 1965, Mullen reported a series of 12 aneurysms treated with electrothrombosis using stereotactic placement of the electrode needle through a burr hole. It was clear that many still thought that there was merit in less invasive strategies. In 1958, Luessenhop and Spence described embolization of a large left hemispheric arteriovenous malformation (AVM) with spheres of methyl methacrylate ranging from 2.5 to 4.2 mm in diameter.11 The carotid was surgically exposed and the embolic material was released into the left cervical internal carotid artery. The internal carotid artery (ICA) was then ligated. Luckily, the high flow of the AVM carried the embolic material to the target. This proved that arterial flow could be used to deliver embolic material in the brain. While the achievement was groundbreaking, and actually remains the concept of how we treat many AVMs today, it was clear that there had to be a better way to deliver such material.

By 1950, cerebral angiography had become relatively routine at large medical centers, as a diagnostic tool. Accessing the cervical arteries was not without risk. Generally, access was through the carotid arteries, either by cut down or direct puncture. The studies were performed through a large bore needle puncture which left a large hole in the artery and the risks of arterial wall damage were high. In 1951, Pierce developed a polyethylene catheter for angiography.12 This could replace the much more traumatic and less flexible angiography needles. Two years later, Seldinger developed a technique for placing the flexible catheter into an artery over a guidewire.13 This reduced much of the risk involved with percutaneous arterial punctures. His work also showed that all arteries in the body could be reached from a femoral arterial puncture. This eliminated the more risky carotid artery punctures. Angiography, as a technique for both diagnosis and therapy, suddenly became much safer to perform, and could be much more widely applied.12,13

The Rise of Endovascular Devices

The era of catheter-based endovascular therapy for the intracranial compartment really started to take off in the late 1960s and early 1970s. Advances in materials, such as high-end polymers and plastics, created enormous opportunities for exciting new devices. However, it was not the venture capital “startup company” model that advanced the field. The landscape was dominated by a few established medical device companies. The attitude of many was that the volume of sales that would come from neurovascular procedures would be small, and the legal liability could be very high. Therefore, most innovators found few backers for their new ideas. Progress was therefore slow. In 1970, Kessler and Wholey reported the use of a percutaneously-placed balloon for ICA occlusion.15 The catheter was placed until thrombosis was achieved and then removed.15

Perhaps the seminal advancement in the field came from Serbinenko, a Russian neurosurgeon. The story is Serbinenko was watching a May Day celebration in Moscow’s Red Square in 1959 and noticed children manipulating their helium balloons with simple manipulations of the tether lines.16 He wondered if a balloon on the end of a long catheter could be as easily manipulated and navigated intravascularly. Years of experimentation and development culminated in the silicone and latex balloon-tipped microcatheter.16 The flexible catheters could navigate multiple curves. The < 1 mm diameter balloons could be inflated and deflated to harness the flowing blood in the vessel. This greatly increased the ability of the microcatheter to “track” along vessels, and navigate the tortuous cranial vascular anatomy. The balloons were for the most part flow directed, but could be
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steered to a certain degree. This allowed for a more distal and more precise placement of the catheter in the cerebral circulation. Physicians could accomplish temporary balloon occlusion of selected vessels, or create permanent occlusion of vessels feeding AVMs, or arteriovenous fistulas (AVFs). In some cases the balloons could be placed inside cerebral aneurysms. Serbinenko famously published a series of 304 cases of temporary balloon occlusion and 162 cases of permanent balloon occlusion for diagnosis and treatment of intracranial vascular lesions with excellent results in 1974. This was the first report demonstrating the feasibility of endosaccular balloon occlusion of cerebral aneurysms with preservation of the parent artery. Later refinements included a truly detachable microballoon with a valve mechanism. (Figure 2) This development was soon followed by the calibrated-leak balloon catheter developed by Kerber in 1976. This flow-directed balloon-tipped catheter had a calibrated leak incorporated in the balloon. This allowed for both very distal navigation and precise delivery of liquid embolic agents through the balloon tip. It ushered in the era of precise embolization of AVMs and AVFs with liquid embolic agents such as Isobutyl 2-cyanoacrylate or IBCA (better known as Super Glue).

The Emergence of a Subspecialty

Despite the obvious advantages of balloon-tipped microcatheters, the technology was not yet to the point where endovascular therapy could claim to be a viable alternative to surgery for most conditions. Balloon-tipped microcatheters generally followed the vessel with the most flow. This limited their steerability in distal vessels. On occasion, one would be required to place a second microcatheter to “block” the higher flow vessel and force the catheter into the desired channel. Detachable balloons were not the answer for cerebral aneurysms. The balloons did not conform to the aneurysm shape. They were associated with higher rates of procedural rupture, lower rates of aneurysm occlusion, and higher rates of recanalization. Before endovascular therapy could challenge surgery as preferred therapy two things would be required: A better catheter and a better occlusion device.

The better catheter came about with the development of the Tracker “over the wire” microcatheter in the 1980s. A creation of Engleson, the Tracker catheter had a variable stiffness shaft design, providing more support proximally, and a hydrophilic coating allowing for improved trackability. It had a steam shapable deflecting tip, and it could be maneuvered over a steerable guidewire. The catheter could be much more easily navigated around tight curves and across intracranial arterial bifurcations. This allowed for a much more controlled direct catheterization of distal vessels and cerebral aneurysms.

The better occlusive device came in the form of Guglielmi Detachable Microcoils (GDC) (Figure 3.) The concept for the coils came while searching to refine the long-ago explored concepts of placing a foreign body in an aneurysm, using a magnet to attract iron microspheres in an aneurysm, and applying current to promote coagulation in an aneurysm. While applying current to a magnet placed within an aneurysm model, the researchers eroded the stainless steel wire holding the magnet, detaching the magnet by electrolysis. A precise delivery system was developed where platinum GDC microcoils attached to a stainless steel delivery wire could be placed and replaced until they are in an ideal position. Current could then be applied, electrolytically detaching the coil in position and providing some impetus for electrothrombosis. The process could be easily repeated to fill the aneurysm with detachable coils. The improved catheter and new coil system delivered an effective embolic device to distal locations easily, and provided precise placement in the aneurysm. This alternative to surgical therapy for cerebral aneurysms can provide equal or better morbidity and mortality for aneurysm patients.

The first GDC coil was placed in a patient March 6, 1990. The rise of what is now called “neuroendovascular surgery”
from that time on has been meteoric. The innovations have kept coming, and now endovascular therapy takes its place beside surgery for the treatment of neurovascular diseases. The other articles in this issue outline the current practices for treatment of aneurysms, AVMs, dural fistulas, and new therapies for acute stroke. They are high tech solutions, built upon the shoulders of pioneers who took personal and professional risks to push forward with innovative solutions to tough problems.

Recently, a new type of device has emerged, representing a true paradigm shift in the way cerebral aneurysms are treated. Flow diverters are a class of device placed across the aneurysm neck to occlude aneurysms.23,24 The devices essentially provide for endoluminal reconstruction, as opposed to filling of the aneurysm sac to promote thrombosis within the aneurysm. The devices look similar to traditional intravascular stents. However, they have a much different design. Traditional stents are designed simply to create scaffolding inside the vessel. They have relatively large interstices (or pores), and do not provide a significant barrier to flow. Flow diverters have much smaller interstices (a much tighter weave so to speak) (Figure 4). This allows for several important physiologic actions. The tighter weave dramatically slows flow across the wall. This dramatic decrease in flow results in stasis of blood in the aneurysm and thrombosis, without the need for entering the sac and placing coils. Another effect of the small pore size is that it allows for the growth of endothelial cells across the pores. This results in the reconstitution of the endothelial lining, providing a true “healing” of the vessel wall.24 While still relatively early in our experience, these devices have greatly expanded the aneurysms that can be treated. Early results suggest a high success rate with increased patient safety.25,26

Conclusion

Neurosurgical endovascular therapy can trace its origins to treatments devised centuries ago. It has taken a few hundred years of technical innovation to allow for the practical application of these ideas. However, it is clear that the future of neurosurgical treatment lies in the endovascular realm, with the promise of less invasive, safer, and more targeted therapies. Innovations continue, with new agents and devices emerging to address problems such as cerebral aneurysms, arteriovenous malformations and dural AV fistulas, stenosis of intracranial vessels, and acute stroke. The following articles in this issue outline the current endovascular practices for treatment of these often complex diseases. They also cover some new and exciting therapies for acute stroke. These are high tech solutions, built upon the shoulders of pioneers who took personal and professional risks to push forward with innovative solutions to tough problems. ©
References


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Arteriovenous Malformations: A Review of Epidemiology, Pathology, and Management Options in the Modern Era

By Ramesh Grandhi, MD, Richard Williamson, MD, Leonardo B. C. Brasiliense, MD, Eric Sauvageau, MD, Ricardo A. Hanel, MD, PhD

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Abstract: Intracranial arteriovenous malformations (AVMs) represent an uncommon vascular pathology with a yearly hemorrhage rate of upwards of four percent. Defined as a collection of veins and arteries without an intervening capillary bed, AVMs are congenitally acquired lesions that are often asymptomatic; when symptomatic, patients may experience headaches, seizures or ischemic symptoms.

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Introduction

An arteriovenous malformation (AVM) is a collection of abnormal veins and arteries that lack a normal intervening capillary bed. The lack of the capillary bed creates a low-resistance system and results in high-velocity blood flow (arteriovenous shunting) and venous hypertension. High flow results in vascular recruitment and arterialization of venous structures.2,3 An AVM can be divided structurally into three components: arterial pedicle(s) (feeding vessels), nidus, and draining vein(s). The nidus is a conglomeration of densely packed abnormal vessels with minimal or no intervening tissue. It is believed that AVMs are most often

Figure 1. A 14-year-old male with seizures was referred to our institution. (A) Computed tomography (CT) scan demonstrated a heterogeneous hyperdense lesion on the right parietal lobe (white arrow). (B) Magnetic resonance imaging (MRI) revealed an AVM located in the parietal lobe and (C) extending into the sylvian fissure. (D-F) Digital subtracted angiography (DSA) in multiple views showed the AVM nidus (white arrows) and venous drainage (black arrows). For surgical planning, we obtained (G) tractography and mapping of motor area, which provides more detailed information regarding the location of motor fibers and their relationship to the AVM. A stealth-guided craniotomy was performed and complete resection of the lesion was achieved. (H-I) Follow-up DSA demonstrated no residual contrast filling of the AVM.
The first decision that must be made is whether to treat the AVM. This is a complex decision based on multiple factors including the patient’s age, medical history (in special presence of hemorrhage), patients’ wishes, the AVM grade, and the experience of the treating physician. There are several currently practiced strategies to treat an AVM: (1) microsurgery alone, (2) radiosurgery alone, (3) embolization alone, (4) embolization plus microsurgery, and (5) embolization plus radiosurgery.

**AVM Treatment Modalities**

**Microsurgery**

Surgery has a long track record in the treatment of AVMs. The effectiveness of microvascular AVM resection for preventing hemorrhage and reducing seizures in patients who present with epilepsy has been established (Figure 1). Although advances in microsurgery over the past three decades have resulted in a dramatic increase in the feasibility of AVM resection, it is clear that certain AVMs are associated with unacceptable surgical risks. The Spetzler-Martin grading scale attempts to quantify this differential risk by analyzing three AVM factors: size, venous drainage pattern, and eloquence of congenital, arising during approximately the third week of gestation. At that point an arrest or aberration in vascular development results in the formation of direct arteriolar to venous communications without an intervening capillary bed. Occasionally, an AVM can contain a true fistulous connection between the arterial and venous side (i.e., the arterioles empty directly into the draining veins without an intervening nidus).

Cerebral AVMs occur in approximately 0.15 percent of the American population and ninety percent are supratentorial. AVMs are one of the most common causes of hemorrhage in young adults. Ondra et al. found cerebral AVMs to have a yearly hemorrhage rate of 4 percent and a yearly combined morbidity and mortality rate of 2.7 percent. Certain angiographic features, such as venous stenoses and intranidal aneurysms, have been associated with a more aggressive course. AVMs can cause headaches, seizures, and ischemia related to steal. Steal is defined as a reduction in blood flow to areas adjacent to the AVM, because blood flow follows the path of least resistance through the AVM. Although all AVMs can be formidable to treat, large and deep-seated AVMs pose special problems and often require multimodality treatment.
endovascular neurosurgery

Figure 3. A 40-year-old female was diagnosed with a left AVM. (A) CT scan and (B) and post-contrast MRI showed a small AVM located near the midline in the frontoparietal region. (C-F) DSA in multiple views demonstrated the AVM nidus (white arrows) and superficial draining veins (black arrows). (G) Selective contrast injection depicting in detail the arterial feeders and venous drainage of the AVM as well as (H) post-embolization results. (I-J) DSA after complete occlusion of the AVM with embolization agent (black arrow).

the cortex involved (Table 1).\textsuperscript{9} Large (> 6 cm) lesions, deep venous drainage, and eloquent cortex have been associated with worse surgical outcomes (Table 2).

Radiosurgery

Radiosurgery has emerged as a safe method for the treatment of small AVMs.\textsuperscript{10,11} Radiosurgery involves the use of stereotactic localization to precisely focus a large dose of radiation onto a lesion, and is oftentimes performed in a single treatment. This treatment modality is particularly attractive for small, deep-seated AVMs. AVMs with volumes equal to or less than 10 ml have a 78 to 88 percent obliteration rate at three years.\textsuperscript{12} The disadvantage of this form of treatment is the risk of hemorrhage during the 2- to 3-year lag time until AVM obliteration occurs.

Endovascular Therapy

The endovascular treatment strategy for an AVM is significantly influenced by the overall treatment plan for any given AVM and any given patient. Endovascular AVM embolization strategies can be considered within the following categories of goals and issues: (1) embolization as a presurgical tool, (2) embolization as a pre-radiosurgery tool, (3) embolization alone as a curative modality, (4) embolization for palliation of symptoms, and (5) embolization of associated aneurysms.

Embolization reduces the amount of blood loss that is associated with AVM resection by decreasing the vascularity of the nidus.\textsuperscript{13} Embolized AVM vessels can also serve as a roadmap during surgery by helping the surgeon define the anatomy of the feeding pedicles and the nidus. Despite these advantages, AVM embolization carries considerable risk. In presurgical planning of AVM embolization, a physician must embolize those pedicles felt to be the most technically challenging to access during surgery (Figure 2).

For the radiosurgery patient, embolization strategies have been used to reduce the volume of an AVM and to eliminate the pedicle and proximal aneurysms. The size of an AVM nidus influences the success of radiosurgery.\textsuperscript{10} Hence, reducing the size of an AVM with embolization may increase the success rate of radiosurgery and help avoid using the higher radiation doses needed to treat a larger
AVM. Circumferential embolization of the AVM, rather than fragmentation of the nidus, is the preferred strategy as a fragmented nidus may result in multiple targets for radiation dosing. This could make radiosurgery planning difficult, thereby negating the benefits of embolization. Some limited evidence exists to support the embolization of large AVMs to a size that is amenable to radiosurgery.\textsuperscript{14,15}

Endovascular treatment alone is rarely curative.\textsuperscript{15} In general, this strategy works for some small AVMs with limited arterial feeders and draining veins (Figure 3). Rarely, a medium-size AVM can be embolized over the course of months until a cure is achieved.

Embolic solely for palliation of symptoms is rarely indicated. Some AVMs may be too dangerous to treat because of size and/or location. Conversely, an AVM may be responsible for debilitating symptoms such as severe headaches or ischemia related to steal phenomena. In these situations, partial embolization may help reduce flow through the AVM and ameliorate the patient’s symptoms. Embolizing dural feeders may be particularly helpful in reducing headaches. Steal symptoms can be reduced by embolizing large “incurable” AVMs.\textsuperscript{16}

Emboliciation techniques can be used to treat associated aneurysms. Owing to the risk of rupture of proximal aneurysms during AVM embolization or excision, treatment of these lesions should precede AVM treatment when possible. If the aneurysm is appropriate for coiling, it can potentially be occluded during the first embolization session before the AVM nidus is addressed. If the aneurysm appears to be better suited to surgery, surgical clipping can be performed before AVM embolization. Aneurysms on feeding pedicles of the AVM, known as flow-related aneurysms, can be treated in one of two ways. They can be occluded primarily using detachable coils. Alternatively, an aneurysm that is close to the AVM nidus can often be occluded by embolization of the pedicle that harbors the aneurysm, while injecting glue from the microcatheter (the glue refluxes from the nidus into the pedicle and aneurysm). This occlusion can result from infiltration of glue into the aneurysm sac or secondarily as the feeding pedicle becomes occluded. Attention should be paid to intranidal aneurysms during embolization. If a hemorrhage has occurred, an intranidal aneurysm should be suspected as a rupture site. When possible, the pedicle feeding the nidus harboring the aneurysm should be treated first.

\section*{Controversies in the Management of Unruptured AVMs}

Management of unruptured brain AVMs has been a subject of significant debate in recent medical literature, especially after the publication of two large trials.\textsuperscript{17,18}

Simplistically speaking, if left untreated, AVMs confer a risk for neurologic morbidity and mortality; however, treatment is associated with risks, but offers the potential for lifetime eradication.

The first important trial on unruptured brain AVMs, entitled A Randomized Trial of Unruptured Brain AVMs study (ARUBA)\textsuperscript{17} was a randomized, multi-center trial comparing “best possible AVM eradication” with medical management. The primary endpoint was a composite of symptomatic stroke or death. Treatment modalities included radiosurgery, microsurgical resection, and endovascular embolization, alone or in combination. The secondary outcome measure was disability at five years post-randomization. The initial study design had called for enrollment of 800 patients, but this number was later reduced to 400; however, the study enrolled only 223 patients from 65 certified sites. AVMs in the study cohorts were relatively well-matched for size, location, and venous drainage pattern, and Spetzler-Martin Grade. The majority were comprised of S-M grade 1, 2, or 3 (approximately equal) with 10 percent grade 4 patients and no grade 5 patients. Based on intent-to-treat analysis, ten adverse events (7.9 percent), defined as death or stroke, occurred in the medical management arm while 34 adverse events (35.1 percent) occurred in the interventional therapy arm. There was no significant difference in the number of deaths. When analyzed according to S-M Grade, patients with grade 1 AVMs fared better in the interventional group while adverse events were much higher in patients with grades 2 to 4 lesions. In addition, the trial was not powered to evaluate treatment effect by modality. Additional criticisms of the trial include patient selection and short follow-up times.

An even more recent trial, published in JAMA by Al-Shahi Salman and colleagues, prospectively watched 204 patients with unruptured AVMs over 12 years.\textsuperscript{18} Morbidity and mortality rates amongst patients managed conservatively versus those who underwent interventions were compared. Over a four-year period, the authors reported 36 events leading to sustained handicap or death in the conservative arm versus 39 in the interventional group. The number of AVM-associated symptomatic strokes or deaths in patients managed conservatively versus those who underwent intervention was 14 and 38, respectively. Interestingly, the authors documented an obliteration rate of 66 percent in patients who underwent intervention, an extremely poor outcome given that 90 percent of the treated AVMs were low grade. In comparison, a meta-analysis of 13,698 patients documented a surgical obliteration rate of 96 percent for low-grade AVMs.\textsuperscript{19} Moreover, the complication rate in the treatment arm of the study was 27.1 percent, as compared to the 5.7 percent rate reported in the meta-analysis.

Given the very heterogeneous populations within the interventional groups included in the two trials, the nu-
merous treatment modalities employed and the inherent difficulty with comparison to the conservatively managed cohorts, the evidence suggests that for unruptured AVMs, it is not possible to conclude that conservative management is superior to intervention. Further large-scale, prospective, randomized studies are needed to better understand the risks and benefits of treating this particular pathology.

Conclusions and Future Directions

The treatment of cerebral AVMs must be approached strategically with a clear and logical plan in mind. Future studies comparing the results of the application of modern technological advancements in the treatment of AVMs with patients left to conservative therapy is crucial for developing a further understanding of the best management options for patients. Multidisciplinary discussion amongst cerebrovascular neurosurgeons, neuroendovascular specialists, stroke neurologists, neuroradiologists, and radiosurgery experts is also of absolute importance.

References

The Endovascular Treatment of Intracranial Aneurysms

By Leonardo B. C. Brasiliense, MD, Eric Sauvageau, MD, and Ricardo A. Hanel, MD, PhD

Abstract: The advent of endovascular therapies for intracranial aneurysms has completely changed the landscape for patients and physicians. The safety and clinical results of lesions previously considered challenging and complex for microsurgical clipping has increased significantly. Enthusiasm, increased expertise with endovascular techniques, and collaboration between physicians and engineers has spurred a wave of innovation that has shifted the fundamental treatment strategies. Today, “hybrid” cerebrovascular neurosurgeons are able to tailor the management of ruptured and unruptured aneurysms with a large number of options ranging from microsurgical clipping to endoluminal and intravascular devices.

Introduction

In the past two decades the treatment of intracranial aneurysms has seen a paradigm shift from open neurosurgical techniques to minimally invasive endovascular procedures. Evidence from randomized clinical trials including the ISAT1 (International Subarachnoid Aneurysm Trial) and BRAT2 (Barrow Ruptured Aneurysm Trial) have provided the impetus to support an “endovascular first” with respect to the treatment of certain types of intracranial aneurysms. The available endovascular devices have also quickly evolved. This new era of endovascular treatment has achieved more durable reconstruction of vessels and enabled treating physicians to tailor sophisticated treatment strategies for even the most complex intracranial lesions.

Management of Intracranial Aneurysms

In general, the most important management strategy for an intracranial aneurysm is to differentiate between ruptured and unruptured lesions. This is due to the radically different natural history and outcomes from treatment.

Ruptured Aneurysms

After an aneurysmal subarachnoid hemorrhage (SAH), the primary goal of treatment is to secure the ruptured aneurysm and prevent further bleeding. These lesions are almost always treated provided that the patient is neurologically and medically stable enough to undergo therapy. At some institutions, treatment is typically carried out urgently, rather than emergently (first 72 hours). However, recent evidence points to the benefit of treatment within 12 hours of hemorrhage. For ruptured aneurysms amenable to either open surgical or endovascular treatment, there is evidence to support better long-term clinical outcomes with endovascular techniques. Placement of embolization coils inside the aneurysm sac is the preferred treatment option for ruptured aneurysms, because it obviates the need for dual antiplatelet therapy associated with other endovascular devices and allows the operator to preserve access to the aneurysm in the event of future treatment. In contrast, patients with lesions anatomically not amenable to coiling, or patients with expansive hematomas are operated upon immediately to evacuate the hematoma and secure the aneurysm. This strategy also allows placement of the external ventricular drain (Figure 1).

After securing the aneurysm, all SAH patients are treated at the neurointensive care unit to obtain close monitoring of intracranial pressure, hemodynamic parameters, and medical complications. In addition, these patients are at an increased risk to develop arterial vasospasm and cerebral ischemia from breakdown of blood products into the subarachnoid space. Timely recognition of vasospasm is paramount to prevent severe neurological morbidity.
**Unruptured Aneurysms**

The large majority of asymptomatic unruptured aneurysms are discovered incidentally, on brain CT or MRI studies ordered by referring physicians. Symptomatic unruptured aneurysms may cause symptoms from mass effect and compression of adjacent neurovascular structures, inflammation related to aneurysm thrombosis or rapid aneurysm expansion. Symptomatic aneurysms have worse natural history compared to asymptomatic lesions and thus warrant prompt treatment. Acutely symptomatic aneurysms should prompt the work up for SAH, sudden increase in aneurysm size or less frequently, acute aneurysm thrombosis. The prototypical scenario is a posterior communicating aneurysm that produces the subacute onset of a third cranial nerve palsy, warranting accelerated imaging and treatment.

Asymptomatic aneurysms frequently place the treating physician in a clinical dilemma, because the benefit of treatment must be superior to the natural history. Also, the benefit of intervening upon asymptomatic lesions is not nearly as demonstrable as it is in symptomatic or ruptured aneurysms. Management decisions are rarely straightforward.

There are currently no strict guidelines. The decision making process is based on unbiased assessment of patient history and lesion characteristics, and available data regarding all treatment modalities. Observational cohort studies of unruptured aneurysms have identified several factors that can alter the rate of aneurysm formation and rupture.\(^4\)\(^-\)\(^8\) These include: family history of SAH, cigarette smoking, presence of symptoms attributable to the lesion, irregular shape, narrow aneurysm neck, size relationship between aneurysm/parent vessel, aneurysm location, and most prominently, aneurysm size \(4\)-\(^8\) (Tables 1 and 2). Aneurysm size is the single strongest predictor of aneurysm rupture, yet it should never be used as the sole indicator. Generally, a 7 mm aneurysm diameter is the best cut-off point for an increased risk of hemorrhage (Table 3). ISAT investigators found that the mean size of ruptured lesions was around 5 mm, showing a potential role for treating smaller unruptured lesions.\(^1\) Aneurysm location is also an important factor to consider. For example, lesions located in the posterior circulation (vertebral artery, basilar artery, and posterior inferior cerebellar artery), posterior communicating artery and, more recently, anterior communicating artery have increased risk of rupture.\(^4\)\(^-\)\(^8\) In contrast, aneurysms located in the cavernous segment of the internal carotid artery have much lower risk of rupture unless symptomatic or larger than 13 mm.\(^8\) Exercise caution when dealing with so-called cavernous lesions. Transition aneurysms (lesions past the “distal dural ring” and located in the subarachnoid space) may be mistakenly labeled as cavernous aneurysms. Transition aneurysms behave clinically as non-cavernous lesions and must be dealt with as such.

Cigarette smoking has been associated with a higher likelihood of developing intracranial aneurysms, accelerated aneurysm growth and increased risk of rupture.\(^4\)\(^-\)\(^9\) First-degree relatives of patients with aneurysms also have an increased risk of harboring an incidental lesion. Individuals with one first-degree relative affected have an increased risk of 4 percent to 5.6 percent compared to the general population. That risk doubles to approximately 8 percent if two first-degree relatives are affected.\(^8\) Therefore, screening for incidental lesions is recommended in these circumstances, especially

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**Table 1.** Risk Factors to Develop Intracranial Aneurysms

<table>
<thead>
<tr>
<th>General risk factors</th>
<th>Inherited risk factors</th>
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<tbody>
<tr>
<td>Female gender</td>
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<tr>
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<td>Fibromuscular dysplasia</td>
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<td>Hypertension</td>
<td>Type IV Ehlers-Danlos syndrome</td>
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<td>Age over 50 years</td>
<td>Alpha-1-antitrypsin deficiency</td>
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<td>Cocaine use</td>
<td>Pseudoxanthoma elasticum</td>
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<td>Neurofibromatosis type 1</td>
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<td>Neoplastic emboli</td>
<td>Phaeochromocytoma</td>
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<td>Tuberculosis</td>
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**Table 2.** Risk Factors for Aneurysm Rupture

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<th>Aneurysm-related</th>
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<td>Previous SAH</td>
<td>Aneurysm location</td>
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<td>-</td>
<td>Irregular shape (daughter sac)</td>
</tr>
<tr>
<td>-</td>
<td>Narrow neck</td>
</tr>
<tr>
<td>-</td>
<td>Parent vessel/aneurysm relation</td>
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**Figure 2:** Detachable embolization coils are used to fill the aneurysm sac and create stagnation of blood flow, leading to aneurysm occlusion. Today, these coils are developed to produce 3-dimensional shapes before being detached inside the aneurysm sac to optimize filling of the lesion and improve the rates of aneurysm occlusion.
in individuals with other risk factors such as polycystic kidney disease or fibromuscular dysplasia (Table 1).

Ultimately, treatment recommendations for unruptured aneurysms fall under three categories: (1) conservative management (including imaging surveillance), (2) microsurgical clipping, or (3) endovascular treatment. The patient is guided by the physician to the final decision based on the best available information regarding all treatment options.

Aneurysm Treatment

**Detachable embolization coils**

The modern era of endovascular treatment for intracranial aneurysms occurred with the FDA approval of Guglielmi detachable coils (GDC) in 1995.10 The GDC system consists of soft platinum coil soldered to a stainless steel delivery wire (Figure 2). After the coil is navigated into the aneurysm sac, a 1 mA current is applied to the delivery wire. The current dissolves the stainless steel delivery wire proximal to the platinum coil and deploys the coil at the appropriate location. The process is continued until the aneurysm is densely packed with coils and no longer opacifies during diagnostic contrast injections (Figure 3). This technique remains one of the pillars of aneurysm management and is particularly advantageous following acute rupture where aneurysm occlusion can be obtained faster and less invasively (Figure 4). Complex-shaped, three-dimensional coils were later introduced to facilitate the embolization of more complex lesions.

**Balloon Remodeling**

Unfavorable anatomy, such as wide-necked aneurysms, was a major impediment to GDC coil embolization. Prolapse of the embolization coil into the parent artery could occur, causing potential thromboembolism or complete vessel occlusion.

Balloon-assisted coiling was developed in the late 1990s for the treatment of wide-neck aneurysms.11 Briefly, a temporary occlusion balloon mounted on a microcatheter is navigated and inflated across the neck of the aneurysm while the embolization coil is introduced in the lesion (Figure 5). The balloon prevents prolapse of the coil into the parent artery. This technique is repeated sequentially until occlusion of the aneurysm has been achieved. However, in some instances the introduced coil

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**Figure 4**: Digital subtracted angiogram depicting the anteroposterior view of a carotid terminus aneurysm before (left) and after complete occlusion of the aneurysm with detachable embolization coils (right).

**Figure 3**: Illustration demonstrating embolization coils inside an aneurysm. After a microcatheter is inserted inside the aneurysm sac, the embolization coils are sequentially placed until the aneurysm shows minimal filling at contrast injections. Ideal aneurysms for this technique have a narrow neck to avoid prolapse of the coils into the parent artery.

**Figure 5**: Balloon-remodeling techniques advance a balloon mounted on a microcatheter across the aneurysm neck and inflate to provide support in aneurysms with a wide neck and prevent complications with embolization coils or liquid embolic agents.
may prolapse into the parent artery immediately after balloon deflation or the introduction of a new coil could displace a previously detached coil from the aneurysm into the parent vessel and cause thromboembolic complications.

**Intracranial Stenting**

The introduction of balloon-mounted stents and, later, self-expanding stents in the late 1990s\(^3\) and early 2000s\(^4\) was a major milestone. These devices allowed treatment of fusiform and very wide-necked lesions. Typically, fusiform aneurysms are circumferential dilatations of the vessel wall and lack a neck. Therefore, coil placement, even with a balloon remodeling technique, is practically impossible. Self-expanding stents provide mechanical support to safely introduce embolization coils inside the aneurysm, virtually eliminating the risk of coil prolapse. In addition, stents change flow dynamics allowing aneurysm thrombosis. As experience with stent-assisted embolization grew, operators shifted their focus from endosaccular aneurysm

### Table 3. Summary of Aneurysm Natural History Studies and Risk of Rupture

<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>Number of Patients</th>
<th>Number of Aneurysms</th>
<th>Mean Follow-up (yrs)</th>
<th>Rate of Rupture</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ISUIA retrospective study (1998)(^7)</td>
<td>1449</td>
<td>1937</td>
<td>8.3</td>
<td>Group 1: &lt;10 mm: 0.05%/yr ≥10 mm: 1%/yr Group 2: &lt;10 mm: 0.5%/yr ≥10 mm: 1%/yr</td>
</tr>
<tr>
<td>Rinkel (1998)(^6)</td>
<td>3907</td>
<td>N/A</td>
<td>N/A</td>
<td>Overall: 1.9%/yr &lt;10 mm: 0.7%/yr ≥10 mm: 4%/yr</td>
</tr>
<tr>
<td>Juvela (2001)(^5)</td>
<td>142</td>
<td>181</td>
<td>18.1</td>
<td>10.5% at 10 yrs 23% at 20 yrs 30.3% at 30 yrs</td>
</tr>
<tr>
<td>*ISUIA prospective study (2003)(^8)</td>
<td>1692</td>
<td>2686</td>
<td>4.1</td>
<td>Group 1: &lt;7 mm: 0%/yr 7-12 mm: 2.6%/yr 13-24 mm: 14.5%/yr ≥25 mm: 40%/yr Group 2: &lt;7 mm: 2.5%/yr 7-12 mm: 14.5%/yr 13-24 mm: 18.4%/yr ≥25 mm: 50%/yr</td>
</tr>
<tr>
<td>#UCAS (2012)(^4)</td>
<td>5720</td>
<td>6697</td>
<td>11,660 aneurysms-years</td>
<td>Overall: 0.95%/yr 5-6 mm: 1.13%/yr 7-9 mm: 3.35%/yr 10-24 mm: 9.09%/yr ≥25 mm: 76.26%/yr</td>
</tr>
</tbody>
</table>

*ISUIA – International Study of Unruptured Intracranial Aneurysms  
#UCAS – Unruptured Cerebral Aneurysm Study  
N/A – Not available

Endoluminal devices revolutionized the treatment of intracranial aneurysms. Intracranial stents (left A,B) enabled physicians to treat complex and wide-neck aneurysms by securing the embolization coils and allowing denser filling of the aneurysm (right). Flow diveters were designed with a denser metallic mesh (left C) and provide a higher metal coverage area in the vessel, disrupting the inflow jet inside the aneurysm and redirecting blood flow along the parent artery. This technology has offered a safe and durable solution for some of the most difficult aneurysms which would have previously required parent vessel sacrifice or intracranial bypass.
occlusion alone to techniques that incorporated intravascular stents, not only to support aneurysm occlusion, but also to achieve reconstruction of the diseased vessel (Table 4).

**Flow Diversion**

The principle of flow diversion is a relatively new approach. With this technique, the diseased parent artery giving rise to the aneurysm is reconstructed through the implantation of a flow diverter between two healthy segments of the artery. Flow diverters are stent-like devices that provide higher metal surface area coverage compared to intracranial stents, and were designed to disrupt the inflow jet inside the aneurysm and redirect blood flow along the parent artery (Figure 6). This creates an environment that is conducive to aneurysm thrombosis and shrinkage. In addition, flow diverters provide a scaffold for neo-endothelialization to permanently seal the neck of the aneurysm and provide long-lasting aneurysm occlusion (Figure 7). A wave of innovation resulted in several different types of flow diverters such as the Surpass, SILK and FRED. As of mid-2015, the Pipeline Embolization Device (PED; Covidien Vascular, Mansfield, MA, USA) remains the only flow diverter approved by the Food and Drug Administration (FDA). Still, this technology is not without caveats. After implantation of flow-diverters, dual-antiplatelet therapy is mandatory and continued for at least three months, leaving this technology unattractive for ruptured aneurysms. Bifurcation aneurysms are also not candidates for treatment with flow-diverters due to inherent design limitations. Recent studies have warned against the use of multiple telescoping devices due to the risk of occlusion of perforator arteries and stroke.

**Intrasaccular Devices**

The limitations of endoluminal flow-diverters have stimulated the development of a new type of embolization device. These new devices are self-expanding ovoid or cylindrical braided implants that, when deployed into the aneurysm cavity, produce an attenuated mesh of metal across the neck/parent artery interface.

### Table 4. Morbidity and Mortality of Aneurysm Treatment in Large Studies

<table>
<thead>
<tr>
<th>Treatment modality</th>
<th>Study</th>
<th>Number of patients</th>
<th>Duration of follow-up</th>
<th>Combined rate of morbidity &amp; mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stent-assisted coiling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neuroform</td>
<td>Fiorella et al (2010)(^{16})</td>
<td>284</td>
<td>13 months</td>
<td>8.1%</td>
</tr>
<tr>
<td>Neuroform/Enterprise</td>
<td>Piotin et al (2010)(^{17})</td>
<td>216</td>
<td>14 months</td>
<td>13.4%</td>
</tr>
<tr>
<td>Neuroform/Enterprise/LEO</td>
<td>Shapiro et al (2012)(^{18})</td>
<td>1517</td>
<td>13 months</td>
<td>5.3%</td>
</tr>
<tr>
<td><strong>Flow-diversion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipeline</td>
<td>PUFS Trial (2013)(^{19})</td>
<td>107</td>
<td>12 months</td>
<td>5.6%</td>
</tr>
<tr>
<td>Pipeline/Silk</td>
<td>Brinjikji et al (2013)(^{20})</td>
<td>1651</td>
<td>6 months</td>
<td>9%</td>
</tr>
<tr>
<td>Pipeline</td>
<td>IntrePED Registry (2015)(^{21})</td>
<td>793</td>
<td>19.3 months</td>
<td>8.3%</td>
</tr>
</tbody>
</table>
and induce thrombosis of the aneurysm. Because the metallic mesh of the device is contained inside the lesion, dual-antiplatelet therapy after treatment is unnecessary. The first experimental results using this technology have been recently published in Europe and have shown promising results for wide-neck and bifurcation aneurysms. In the U.S., intrasaccular devices have yet to be approved by the FDA and data regarding their safety profile and indications is warranted in clinical trials and institutional registries.

Conclusions

The treatment of intracranial aneurysms has reached a new era of unique endovascular devices and techniques, which has led to unprecedented levels of safety and aneurysm occlusion rates. In the near future, multiple minimally invasive options will become available and the field is moving towards tailored devices and techniques based on the characteristics of the lesion and needs of the patients. Still, enthusiasm should be tempered and treatment recommendations based on judicious unbiased assessment of the available data. Microsurgical clipping should be regarded as a complimentary therapy and remains a viable option in certain groups of lesions. Lastly, the treatment of intracranial aneurysms should be carried out in centers offering multidisciplinary expertise in microsurgery, endovascular, and neurocritical care in order to optimize management and results.

References


**Spinal Dural Arteriovenous Fistulas**

By Benjamin Brown, MD

**Abstract:** Spinal dural arteriovenous malformations are the most common type of spinal vascular malformation. This rare and diverse group of lesions can pose challenges for clinicians in both diagnosis and treatment. However, recent advances in endovascular techniques have provided an alternative to surgical treatment of spinal dural arteriovenous fistulas (SDAVFs).

**Introduction**

SDAVFs represent the most common subset of a broader group of pathology known as spinal vascular malformations. Spinal vascular malformations are a complex and diverse set of lesions that are a challenge to diagnose and treat. They can affect upper and lower motor neurons and thus manifest with a wide array of signs and symptoms that mimic other, more prevalent spinal pathology. As a result, patients with a spinal vascular malformation often go months or years before the lesion is found. Moreover, many undergo unnecessary spinal procedures for conditions unrelated to their true diagnosis. If left untreated, lesions can cause progressive disability leading to weakness, incontinence, or total paralysis. Patients who are successfully diagnosed and treated often feel immediate improvement in numbness, pain, weakness, or balance.

There is a broad range of spinal vascular malformations, with SDAVFs being the most common type of lesion.

**General Pathophysiology and Classification**

In broad terms, spinal vascular malformations represent an abnormal connection of an artery to a vein without an intervening capillary bed. Thus, high pressure arterial blood is transmitted directly to the venous system resulting in anatomic changes and physical exam findings. Symptoms can arise from mass effect of engorged veins, ischemia due to vascular steal, venous hypertension, or, rarely, hemorrhage. All of these phenomena can affect upper or lower motor neurons depending on the location of the lesion. Historically, the most common classification scheme for spinal vascular malformations has been the Type I-IV classification. More recently, an effort has been made to classify these lesions based on the location of their respective nidus. Table 1 summarizes the classification system proposed by Spetzler, et al in 2002, with the corresponding Type I-IV designations. As seen in the table, SDAVFs are known as Type I or dorsal intradural fistulas.

**Table 1. Summary of the classification scheme proposed by Spetzler, et al in 2002 with corresponding classic Type I-IV nomenclature.**

<table>
<thead>
<tr>
<th>Pathophysiology</th>
<th>Extradural</th>
<th>Dorsal Intradural</th>
<th>Ventral Intradural</th>
<th>Intramedullary</th>
<th>Extradural-Intradural</th>
<th>Conus Medullaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression, venous congestion, vascular steal</td>
<td>Myelopathy</td>
<td>Myelopathy</td>
<td>Myelopathy</td>
<td>Pain, acute myelopathy</td>
<td>Pain, myelopathy</td>
<td>Myelopathy, radiculopathy</td>
</tr>
<tr>
<td>Venous congestion</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Variable</td>
</tr>
<tr>
<td>Radicular artery to medullary vein at root sleeve</td>
<td>Pial surface</td>
<td>Spinal cord parenchyma</td>
<td>Diffuse: Extradural, intradural, parenchymal, muscle, bone</td>
<td>Multiple feeders from anterior and posterior spinal arteries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type IV, angorier intradural AVF, or Perimedullary AVF</td>
<td>Type II, Classic AVM, or Glomus</td>
<td>Type III, Metameric, or Juvenile</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epidural fistula</td>
<td>Type IA, Spinal dural AVF</td>
<td>Type 2, Classic AVM, or Glomus</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Epidemiology

SDAVFs are the most common spinal vascular malformation. They comprise approximately 70 percent of all spinal vascular malformations5 and affect males over females 5:1, as do cerebral dural arteriovenous fistulas. The annual incidence is estimated at 5-10/million.6 These are most frequently diagnosed in the 5th to 6th decades of life.8 They are located in the thoracolumbar area in greater than 80 percent of cases, but can be found in the sacral and cervical regions.3,7,8

Anatomy

SDAVFs occur when a single radiculomeningeal artery connects pathologically with a medullary vein. This connection typically occurs in the dural sleeve surrounding the nerve root within the intervertebral foramen.9 The radiculomeningeal artery supplies the nerve roots and meninges, but not necessarily the spinal cord parenchyma. There are two subtypes: Subtype A involves a single feeding artery, while Subtype B involves multiple feeders that converge into a single fistula.4 The exact etiology of these shunts is not clear, but venous outflow obstruction is thought to play a role. SDAVFs are acquired lesions and most likely result from traumatic injury, infection, or prior surgery; although, often, the causative agent is never identified.

Pathophysiology

Foix and Alajouanine first described the pathology of SDAVFs in 192610 as a progressive subacute necrotizing myelopathy. Their research found evidence of vascular obstruction, spinal cord necrosis and tortuous and dilated vasculature on the surface of the spinal cord. This set of signs and symptoms is now known as Foix-Alajouanine syndrome. The actual etiology of the noted pathology was not defined until Aminoff and Logue proposed that it was venous congestion and venous hypertension that resulted in cord ischemia.8 Venous hypertension results in arterialization of the coronal venous plexus,4 which leads to a decreased pressure gradient between the artery and vein and, therefore, decreased venous drainage of the spinal cord. This results in progressive venous congestion and edema of the spinal cord parenchyma with progressive symptoms.

Clinical Manifestation

Aminoff et al. also characterized the clinical presentation of their patients with SDAVF. They found that the symptoms arose gradually and tended to progress. They also noted that SDAVF led to severe disability in approximately half of the patients.8 Early symptoms of SDAVFs are often non-specific and may lead to delay in diagnosis. These lesions are often mistaken for more prevalent degenerative disorders of the spine or even primary neurologic disorders, such as multiple sclerosis or myelitis. If left untreated, there is a progressive myelopathy. The most common presenting symptom is lower extremity weakness, which is seen in about half of cases11; although, in retrospect, patients will report milder symptoms months to years prior to presentation. The other symptoms that can be seen at presentation vary widely. In order of descending frequency these include gait disturbance, paresthesias, back pain and bladder or sexual dysfunction.11 Fortunately, SDAVF rarely presents with hemorrhage. Patients are graded clinically based on the Aminoff-Logue Scale (ALS) (Table 2), which is a useful tool to follow a patient’s progress over time.8

Imaging

Magnetic Resonance Imaging

The initial imaging modality to evaluate a suspected SDAVF should be magnetic resonance imaging (MRI). Cord edema will manifest itself as increased signal intensity at the center of the cord on T2-weighted MRI images and may span several levels. Dorsal intradural flow voids may be present and are more evident on T2-weighted images or contrast-enhanced T1-weighted images. Magnetic resonance angiography can sometimes locate the actual fistula.

Table 2. Spinal angiogram showing a dorsal intradural SDAVF filling from the right at T5

<table>
<thead>
<tr>
<th>Gait</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg weakness present, but able to walk without assistance</td>
<td>1</td>
</tr>
<tr>
<td>Decreased exercise tolerance</td>
<td>2</td>
</tr>
<tr>
<td>Requires a cane to ambulate</td>
<td>3</td>
</tr>
<tr>
<td>Requires two canes or crutches to ambulate</td>
<td>4</td>
</tr>
<tr>
<td>Requires a wheelchair, unable to stand with assistance</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micturation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td>Hesitancy, urgency, frequency, altered sensation, but remains continent</td>
<td>1</td>
</tr>
<tr>
<td>Occasional urinary incontinence or retention</td>
<td>2</td>
</tr>
<tr>
<td>Total incontinence or retention</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bowel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild constipation</td>
<td>1</td>
</tr>
<tr>
<td>Intermittent incontinence or persistent constipation</td>
<td>2</td>
</tr>
<tr>
<td>Persistent incontinence</td>
<td>3</td>
</tr>
</tbody>
</table>
point though spinal angiography remains the gold standard (Figure 1).12,13

Selective spinal angiography (SSA)

Even with advances in MRI imaging and angiography, catheter angiography remains the gold standard for diagnosis of SDAVFs. It also allows for possible endovascular treatment. SSA reveals tortuous dilated vessels that may span many levels and a characteristic slow-flow pattern produced by the feeding dorsal radiculomeningeal artery (Figure 2).

While diagnostic SSA is still considered superior to other modalities for diagnosis, it is not without potential complications. SSA requires selective catheterization of many spinal feeders to determine the main feeding artery. This results in lengthy procedures with extensive exposure to ionizing radiation and potential nephrotoxic levels of contrast agent.12 Also, due to the length of the procedures and the need for complete patient immobilization, SSA is often done with general anesthesia which presents its own complications. There have also been reports of neurologic injury caused by catheterization of spinal arteries.

Indocyanine Green Angiography

Indocyanine green angiography has been used in ophthalmologic procedures to assess the microcirculation of the retina.14 In the early 2000s, neurosurgeons migrated this technology to the brain for assistance in clipping cerebral aneurysms.15 Since this time its use has expanded to include the resection of cerebral arteriovenous malformations, as well as spinal dural arteriovenous fistulas. Injection of indocyanine green dye illuminates the vasculature when viewed with the correct microscope filter. This allows a surgeon to visualize an early draining vein and verify that it is no longer filling after ligation of a fistula (Figures 3a and 3b). This reduces the need for intraoperative or postoperative selective spinal angiography.

Treatment

Secondary to the progressive nature of this disease, definitive and prompt treatment is required.

Microsurgical Ligation

Historically, SDAVFs were thought to be posterior angiomas. Surgical treatment involved the stripping of dorsal perimedullary veins. This often resulted in worsening of neurologic function. It was discovered that, instead, treating the intradural arterialized vein at the nerve root was the appropriate course of action. Therefore, surgery involves performing a hemilaminectomy, opening the dura, and following the dorsal radiculomeningeal artery as it heads towards the dorsal nerve root and ligating the artery-vein connection by coagulation or clipping. Surgery has been shown to be associated with very low morbidity (2 percent), with complete occlusion achieved in >98 percent of cases.16 Recurrence rate has been estimated at around 17 percent via the surgical approach.17

Endovascular Embolization

The recent advances in endovascular techniques have provided an alternative to surgical treatment of SDAVFs. It is less invasive and may be performed at the same time as the diagnostic an-
Spinal vascular malformations are a rare and diverse group of lesions that can pose challenges for clinicians both in diagnosis and treatment. SDAVFs represent the largest proportion of this heterogeneous group of lesions. Due to their relative rarity when compared to degenerative spinal disorders, a high level of suspicion must be maintained to make a timely diagnosis. Preoperative workup with quality imaging, including MRI and angiogram, is necessary to confirm the diagnosis, delineate the vascular anatomy, and determine the effect on the spinal cord parenchyma. With this knowledge the proper open, endovascular, or combined treatment can be selected with opportunity for increased neurologic function in these challenging patients.

**References**


**Current Endovascular Treatment of Carotid Stenosis**

By Leonardo B. C. Brasiliense, MD, Ramesh Grandhi, MD, Ricardo A. Hanel, MD, PhD, and Eric Sauvageau, MD

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**Abstract:** Stroke remains a major health care problem in the United States and worldwide. According to the World Health Organization and the Centers for Disease Control and Prevention, stroke was the second leading cause of death around the globe, with an estimated 6.7 million fatalities in 2012 and the fourth leading cause of death in the United States. Each year, approximately 800,000 Americans suffer a new or recurrent stroke with an estimated direct and indirect cost of $68.9 billion dollars. Development of atherosclerotic disease of the carotid arteries is responsible for 30 percent of ischemic strokes. In the past two decades, the endovascular treatment of carotid stenosis has quickly evolved from an infant technology to a valuable tool in the surgical management of selected patients with carotid stenosis. Using sophisticated disease and anatomy-specific devices, minimally invasive treatment of even the most complex carotid lesions is now a safe alternative in the majority of cases.

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**Initial Evaluation**

Carotid stenosis, like all atherosclerotic disease, results from a combination of genetic factors and lifestyle choices. The initial evaluation of patients with carotid disease should be carried out bearing in mind the underlying risk factors for atherosclerotic disease and previous attempts at treatment with medical therapy. For the most part, patients are referred to a specialist after the diagnostic workup has been initiated. It is common to receive a patient after the primary care physician has identified a carotid bruit, obtained by a carotid ultrasound or further imaging. Symptomatic patients either present with a hemispheric/retinal transient ischemic attack (TIA), or have developed a stroke. Carotid duplex ultrasonography remains the standard initial, non-invasive test for evaluation of the extracranial carotid circulation (Figure 1). However, carotid ultrasound leaves much to be desired regarding the exact degree of stenosis, the level/location of the stenosis, proximal and distal anatomy, as well as the status of collateral flow. Because of these shortcomings, patients with an ultrasound that suggests carotid stenosis should have additional imaging before treatment considerations can be made. Options include computed tomography angiography (CTA), magnetic resonance angiography (MRA), or digital subtraction angiography (DSA). The combination of carotid...
duplex ultrasonography and CTA has been shown to be the most cost effective and is therefore highly recommended (Figure 2). While still considered the gold standard, DSA is necessary only in selected cases to make a therapeutic decision. DSA still has the advantage over non-invasive technologies to dynamically evaluate with reasonable precision the status of collateral flow in the intracranial circulation.

Management Strategies

The fundamental nature of carotid disease management has not changed significantly since the 1950s when carotid artery endarterectomy (CEA) was first introduced. The goal of surgical treatment is to provide carotid revascularization and restoration of a near-normal vessel lumen without incurring significant morbidity and mortality. For the most part, CEA has been established as the main surgical option for management of carotid disease, which has been corroborated by nearly 99,000 inpatient carotid endarterectomy procedures performed in the United States in 2006 and by evidence from several seminal studies in the 1990s. Nevertheless, an increased risk of CEA in certain patients has lead to development of minimally invasive therapies beginning with the first angioplasty of the carotid bifurcation in 1980.

Balloon angioplasty of carotid stenosis gained increased acceptance among interventionalists, but it was initially associated with a high risk of distal embolic complications and major neurological deficits. In order to overcome this problem, embolic protection devices (EPDs) were developed. An EPD can be classified into three main groups, each with its own working principle: (1) distal occlusion devices, (2) distal filtration systems, and (3) proximal occlusion devices. In brief, distal occlusion devices work by inflating a balloon in the internal carotid artery (ICA) between the lesion and the brain to stop blood flow during manipulation of the stenotic segment and therefore, prevent debris from entering the cerebral circulation. Any embolic material created by the procedure is later aspirated and flushed either into the external carotid artery or out of the circulatory system through a sheath in the common carotid artery. Distal filtration systems function similarly to an umbrella and are placed between the carotid lesion and the brain to capture all debris during the procedure. At the end of intervention, the filter and captured material are removed. The main advantage of distal filtration systems is that cerebral perfusion and angiographic assessment are maintained throughout the procedure. Lastly, proximal occlusion systems are comprised by two compliant balloons, of which one is inflated in the proximal common carotid artery and another in the external carotid artery. This double-balloon arrangement creates either a no-flow or a reversed-flow pattern within the ICA that prevents debris from entering the intracranial circulation. Proximal occlusion systems are increasingly attractive because complete cerebral protection is obtained before crossing the lesion with a catheter.

The major incentive to adopt endovascular treatment of carotid disease occurred after development of stents designed specifically for the carotid system. Current commercially available self-expanding stents are comprised of either nitinol (nickel-titanium alloy) or stainless steel (cobalt alloy). These stents are placed across the stenotic carotid segment and, once deployed, the struts and metallic mesh engage the plaque material, preventing dislodgment of debris, as well as providing support to the vessel wall to restore luminal patency. The purported advantages of stents over simple balloon-angioplasty include prevention of plaque dislodgment, management of intimal dissection, decreased rate of recurrent stenosis, and vessel recoil. Following the results of the Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy (SAPPHIRE) Trial, the neurovascular community recognized that certain patients considered high risk for CEA were less likely to have complications if treated with carotid artery stenting (CAS) with distal embolic protec-
tion. In subsequent years other trials have confirmed the advantages of CAS and refined the indications for both CEA and CAS.15–17

Treatment Recommendations

The distinct separation between symptomatic and asymptomatic carotid disease is paramount because any extrapolation on the benefits from revascularization is dependent on clear-cut definitions of the terms symptomatic and asymptomatic. The confusion exists because some ‘symptomatic’ patients experience symptoms that are not referable to the carotid system. These include syncope, generalized weakness, dizziness, and visual changes (scotoma or floaters). These events do not qualify as symptomatic carotid stenosis. The typical clinical scenario involves a transient or permanent focal neurological deficit involving the ipsilateral retina or cerebral hemisphere in order to label the carotid stenosis as symptomatic.

The degree of stenosis, the presence or absence of symptoms referable to the carotid stenosis, the estimated surgical risk, and patient age (especially over 80 years) are the main factors when deciding to intervene on a patient with ICA stenosis.

Symptomatic and Asymptomatic Patients

The use of CAS in the United States is primarily determined directly and indirectly by the Food and Drug Administration (FDA) and Centers for Medicare and Medicaid Services Policy (CMS). The initial position of the FDA had been to support clinical application of CAS for carotid revascularization only in patients considered high risk for CEA (Table 1). In addition, patients eligible for CAS either had a recent stroke with at least a moderate carotid stenosis (50 percent or greater) or did not have a recent stroke but were found with severe stenosis (80 percent or greater). Following overwhelming evidence from clinical trials, especially data from the CREST Trial (Carotid Revascularization Endarterectomy versus Stenting), the FDA expanded the recommendations for CAS and included patients with average-to-low risk for CEA.16,18 Today, evidence-based guidelines have been proposed to determine the use of CAS and these treatment recommendations were assessed according to criteria published by the American Heart Association/American Stroke Association (AHA/ASA) and the University of Oxford’s Center for Evidence Based Medicine (CEBM).19 The guidelines are as follows:

- CAS should be considered in symptomatic patients with severe stenosis (70 percent) who have a high-risk for CEA. (AHA/ASA Class IIb; Level of Evidence B, CEBM Level 2b, Grade B19)
- CEA is recommended in symptomatic patients with moderate-to-severe stenosis (50–69 percent). CAS is considered an alternative to CEA for patients at average-to-low risk of endovascular treatment and patients who are considered high risk (over 6 percent of morbidity and mortality) for CEA. (AHA/ASA Class I; Level of Evidence B, CEBM Level 1b; Grade B)
- The benefit of CAS in asymptomatic patients is less clear and there is uncertainty regarding CAS over CEA. (AHA/ASA Class IIb; Level of Evidence B, CEBM Level 2b, Grade B20)
- In patients with carotid stenosis less than 50 percent there is no indication for CEA or CAS. (AHA/ASA Class III; Level of Evidence B, CEBM Level 1b; Grade B19)

In addition, data from CEA and CAS trials provided the basis to determine an upper limit for complications following carotid revascularization. These recommendations established an upper limit of 6 percent for perioperative risk of stroke and death in symptomatic patients and 3 percent upper limit in asymptomatic patients, assuming a life expectancy exceeding five years.21,22 Competency regarding the management of carotid stenosis is usually based on the benchmark of a complication rate inferior to the recommended thresholds, or else the morbidity and mortality from treatment outweighs the natural history of carotid stenosis. Overall, patient selection is the most important factor to minimize complications associated with CAS. Commonly recognized risk factors include medical, neurologic, anatomic, and genetic arteriopathy (Table 2). Advanced age is often considered a risk factor. In the SAPPHIRE trial,13 patients 80 years or older were considered high risk for CEA. However, the CREST trial 17 showed that CAS is beneficial in patients younger than 70 years old. We suggest that age alone should not be considered in determining CEA versus CAS and other, patient-specific, factors should be considered.

The major medical risk factor for patients with carotid stenosis is myocardial infarction (MI). A patient with carotid stenosis may also have severe coronary disease.

A sudden decline in blood pressure and onset of severe bradycardia may occur during intervention, after manipulation of the carotid sinus. The result is MI. Neurologic risk factors for CAS include recent large infarction, crescendo TIA’s, and stroke in evolution. A large hemispheric infarction may be complicated by an intracerebral hemorrhage. Treatment of these patients is usually delayed 4–6 weeks to allow the stroke tissue to ‘heal’ before intervention. Patients with acute TIA’s or stroke in evolution require urgent treatment but there is increased risk of stroke or death.
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Procedure Overview - Key Points

The technique for CAS has evolved significantly since it was first introduced in the 1990s and, similar to any procedure, operator-related variability and technical nuances exist.

CAS is performed with biplane angiography with the aid of 3-D rotational angiography (Figure 3). Before the procedure, the patient is typically sedated but arousable for neurological assessment. A percutaneous femoral artery access is most commonly used to navigate the catheters, but in selected patients a brachial or radial artery access may be more beneficial.23,24 Once the degree of stenosis is confirmed on contrast injections, a sheath or guiding catheter is placed in the common carotid artery and the patient is given heparin to obtain an activate clotting time (ACT) of approximately 250 seconds. Before advancing the embolic protection device (EPD), attention is paid to determining the size of the patent lumen in the stenotic segment to facilitate crossing of the lesion with the microwire and EPD. Sizing the filter wire appropriately is also important to minimize dislodgment of plaque material and to obtain circumferential device apposition in the landing vessel. After the filter wire and EPD catheter are in place, smooth inflation and deflation of the entire stenotic segment using a coaxial balloon catheter is accomplished (angioplasty). Angiography is then performed to evaluate the degree of stenosis post-angioplasty and to search for embolic material in the distal filter system. Angioplasty of lesions in the common carotid bifurcation may cause overstimulation of the carotid body. Although rare, severe bradycardia and hypotension may occur and thus atropine and vasopressors must be readily available, as well as continuous hemodynamic monitoring with a femoral sheath transducer or a radial artery line.

There are several commercially available carotid stents, including balloon-expandable stents and nitinol self-expandable stents. Stent selection begins by measuring the diameter of the stenosis, which is determined according to the caliber of the largest segment of the carotid artery to be covered. Sizing the stent correctly is important because oversized self-expanding stents may cover a longer portion of the vessel than initially anticipated and undersized stents may be ‘floating in the vessel’ with increased likelihood of developing thromboembolic complications. After the stent is deployed, post-stent angioplasty may be performed to improve stent apposition to the vessel wall. This maneuver should be employed with caution and only sparingly, because plaque material can be dislodged and produce emboli. Lastly, the EPD is removed using its retrieval catheter, followed by final cervical and intracranial angiograms to assess immediate stenting results and recognize distal embolic events.

Post-Procedure Management

Following CAS, patients require serial imaging surveillance. Baseline carotid duplex ultrasonography is typically performed before discharge and repeated at one month, three months, six months, and yearly thereafter. In addition, dual-antiplatelet therapy of aspirin and clopidogrel is mandatory after CAS for at least six weeks. After that time period clopidogrel is usually discontinued and patients remain on aspirin therapy indefinitely. Appropriate management of atherosclerosis risk factors is also paramount to optimize patient care. Atherosclerosis is largely recognized as...
a chronic systemic vascular disease and after CAS or CEA, patients should be evaluated by neurologists or primary care physicians regularly to identify potentially treatable problems and ensure adequate treatment compliance.

**Long-Term Durability of CAS**

The durability of CAS was a source of controversy in the neurovascular community. The three-year follow-up data of the SAPPHIRE trial revealed only a 4 percent rate of recurrent stenosis,\(^2\) which compares favorably with the restenosis rate after CEA.\(^3\) More recently, a secondary analysis of the largest randomized clinical trial of CAS vs. CEA to date (CREST trial) evaluated long-term results in 1086 patients after CAS and 1105 patients after CEA. At two year follow-up, the investigators identified restenosis (defined as a reduction in diameter of at least 70 percent or peak systolic velocity of at least 3.0 m/s) in 58 patients who underwent CAS (6 percent) and 62 who underwent CEA (6.3 percent). Interestingly, female sex (hazard ratio 1.79), diabetes (hazard ratio 2.31), and dyslipidemia (hazard ratio 2.07) was an independent predictor of vessel restenosis after both procedures, whereas cigarette smoking increased the rate of restenosis only after CEA (hazard ratio 2.26).\(^3\) The rate of restenosis following CAS also appears to be improving with increased experience and expertise but, more importantly, the durability of CAS should not influence the decision between open surgery and endovascular treatment.

**Conclusions**

In the treatment of carotid stenosis, the most important aspect is deciding which patients benefit from CAS, CEA, or observation. It is only when the morbidity and mortality of the procedure are low that the benefits of CAS outweigh the risks of natural history. Therefore the impetus to intervene on any patient with carotid stenosis should always be tempered by the Hippocratic precept of primum non nocere…first, do no harm.

**References**


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Endovascular Therapy for Acute Ischemic Stroke

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Introduction

Despite recent advances in management and prevention of atherosclerotic disease, stroke remains a significant public health problem. It is estimated that stroke kills nearly 130,000 Americans each year - an average of one death every four minutes.¹,² In addition, as many as 800,000 people may suffer a stroke in the United States, with an estimated cost of $34 billion per year in health care services, medications and missed days of work.² According to the American Heart Association, the vast majority of strokes occur following acute large vessel occlusion.² Currently, the only FDA-approved medical therapy for acute ischemic stroke (AIS) is intravenous (IV) tissue plasminogen activator (t-PA) administered within three hours of symptom onset. However, the recanalization rates after IV t-PA for proximal large vessel occlusion (distal internal carotid artery, middle cerebral artery, vertebral artery or basilar artery) are suboptimal, ranging from 10 percent in the internal carotid artery to 30 percent in the middle cerebral artery.³ Additionally, only a small fraction of patients with ischemic strokes are eligible to receive IV t-PA therapy due to the narrow therapeutic window and multiple contraindications.

The Concept of Ischemic Penumbra

In the early 1980s, Astrup and investigators outlined the physiological differences between the infarct core and the surrounding ischemic brain tissue following an acute large vessel occlusion.⁴ The ischemic penumbra represents the tissue surrounding the infarct core and was defined as “ischemic tissue that is functionally impaired and is at risk of infarction but has the potential to be salvaged by reperfusion and/or other strategies. If it is not salvaged, this tissue is progressively recruited into the infarct core, which will expand with time into the maximal volume originally at risk.” Timely assessment of blood flow parameters is of essence in the initial evaluation of acute ischemic stroke to determine the presence, volume and location of ischemic penumbra. Computed tomography perfusion (CTP) is typically used over other imaging modalities because it is readily available, cost-effective and provides information regarding cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) in the acute setting (Figure 1). CBF represents the volume of blood moving through a given volume of brain per unit of time, with units of milliliters of blood per 100g of brain tissue per minute. CBV represents the total volume of blood in a given volume of brain tissue, with units of milliliters of blood per 100g of brain tissue. MTT represents the average time for blood to transit through a given brain region, measured in seconds. Infarct core is typically represented by an area of extremely low CBF and CBV and prolonged MTT. In contrast, the area of ischemic penumbra is determined by decreased CBF, prolonged MTT and preserved CBV. Computed tomography angiography (CTA) is also an essential part of the initial evaluation to determine the location of vessel occlusion, collateral flow status and coexisting pathology in other vascular territories.

2015 - New Clinical Trials

Until recently, the debate on whether patients with acute ischemic stroke benefited from endovascular intervention compared to IV t-PA alone was uncertain. This controversy was particularly heightened in 2013 following the results of three clinical trials that suggested the futility of endovascular therapy in patients that received IV t-PA therapy: the Interventional Management of Stroke (IMS) III, Local...
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versus Systemic Thrombolysis for Acute Ischemic Stroke (SYNTHESIS Expansion) and Mechanical Retrieval and Recanalization of Stroke Clots using Embolectomy (MR RESCUE).

These trials were largely criticized because of flawed study design and the inability to answer whether intra-arterial therapy with recanalization is beneficial for large vessel occlusion. However, 2015 saw a paradigm shift in the treatment of acute ischemic stroke with the publication of five randomized clinical trials showing that endovascular therapy is highly beneficial in patients with occlusion of the intracranial internal carotid artery or middle cerebral artery up to six hours after stroke onset (Figure 2).

**2015 Clinical Trials Highlights:**

**MR CLEAN (Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands)**

- Eligible patients had confirmed large vessel occlusion in the anterior circulation within six hours of stroke onset
- 500 patients enrolled at 16 medical centers (233 endovascular therapy vs. 267 medical therapy alone)
- Absolute difference of 13.5 percentage points (95 percent confidence interval, 5.9 to 21.1) in the rate of functional independence (mRS 0 to 2) in favor of endovascular intervention (32.6 percent vs. 19.1 percent)
- No significant difference in mortality or symptomatic intracranial hemorrhage

**EXTEND-IA (Extending the Time for Thrombolysis in Emergency Deficits – Intra-Arterial)**

- Trial was stopped early because of efficacy of endovascular therapy after 70 patients were enrolled in 12 medical centers in Australia (35 endovascular therapy vs. 35 medical therapy)
Percentage of ischemic territory that underwent reperfusion at 24 hours was greater in the endovascular therapy group (median, 100 percent vs. 37 percent; P<0.001)

Endovascular intervention increased early neurologic improvement at three days (80 percent vs. 37 percent, P=0.002) and improved functional outcome at 90 days (mRS 0 to 2, 71 percent vs. 40 percent; P=0.01)

No significant differences in mortality or symptomatic intracranial hemorrhage

**ESCAPE (Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times)**\(^1\)

- Trial was stopped early because of efficacy of endovascular therapy
- 316 patients were enrolled at 22 centers worldwide
- The rate of functional independence at 90 days (mRS 0 to 2) was increased after endovascular intervention (53 percent vs. 29.3 percent; P<0.001)
- Endovascular therapy was associated with reduced mortality (10.4 percent vs. 19 percent; P=0.04)
- No significant differences in symptomatic intracranial hemorrhage (3.6 percent in the endovascular group vs. 2.7 percent in the medical group; P=0.75)

**SWIFT PRIME (Solitaire with the Intention for Thrombectomy as Primary Endovascular Treatment)**\(^1\)

- Trial was stopped early because of efficacy of endovascular therapy
- 196 patients were enrolled at 38 centers
- The rate of functional independence (mRS 0 to 2) was higher in the endovascular group (60 percent vs. 35 percent; P<0.001)
- No significant differences in 90-day mortality (9 percent in the endovascular group vs. 12 percent in the medical group; P=0.50)
- No significant differences in symptomatic intracranial hemorrhage (0 percent in the endovascular group vs. 3 percent in the medical group; P=0.12)

**REVASCAT (Randomized Trials of Revascularization with Solitaire FR Device versus Best Medical Therapy in the Treatment of Acute Stroke Due to an Anterior Circulation Large Vessel Occlusion Presenting within Eight Hours of Symptom Onset)**\(^2\)

- 206 patients enrolled in four centers in Spain
- The rate of functional independence at 90 days (mRS 0 to 2) was higher in the endovascular group (43.7 percent vs. 28.2 percent; adjusted odds ratio, 2.1; 95 percent confidence interval, 1.1 to 4.0)
- No significant differences in mortality (18.4 percent in the endovascular group vs. 15.5 percent in the medical group; P=0.60) or symptomatic intracranial hemorrhage (1.9 percent in both groups)
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Technique

Although it is beyond the scope of this article to discuss the merits of one endovascular technique over another, mechanical thrombectomy using stentrieveres (self-expanding tube-like devices composed of a metallic mesh) has amassed considerable support and acceptance after the publication of the aforementioned clinical trials.

Patients considered appropriate candidates for acute stroke intervention are placed supine on the angiography table. Conscious sedation is favored over general anesthesia to prevent hypotension and avoid delays in reperfusion. A femoral approach is most frequently used and a guiding catheter is positioned in the cervical vessel at the level of the skull base. Using contrast injections and roadmap guidance, a microcatheter is gently advanced through the occluded vessel over a distance likely to be distal to the thrombus/embolus. At this point, the stentriever or another device is deployed. As the device expands, it pushes the clot against the blood vessel wall causing an immediate restoration of flow and perfusion to the ischemic brain while at same time embedding the clot within the struts of the device (Figure 3). As the catheter and device are carefully pulled out, suction is performed to prevent dislodgment of small pieces of the clot and distal embolization. At the conclusion of the procedure, the patient is transferred for close monitoring in the neurointensive care unit.

Discussion and Conclusion

In resounding fashion these recent clinical trials have shown unprecedented outcomes with endovascular treatment of ischemic stroke, driven by state of the art technology, optimized patient selection and reduced door-to-groin puncture times. The absolute benefit of endovascular treatment compared to IV t-PA alone measured by functional independence at 90 days (mRS score ≤ 2) ranged from 13.5 to 31 percentage points. This can be translated into a number needed to treat as low as 3 patients and no more than 7 patients in order to obtain clinical benefit. These figures are impressive considering that 17 patients with STEMI are needed in order to prevent one myocardial infarction/stroke or death with percutaneous coronary intervention. The future of stroke therapy now requires adapting the infrastructure to include endovascular angiosuites and rapid protocols to identify salvageable brain tissue. There are now protocols that have optimized rapid response strategies in patients with suspected large vessel occlusion. For instance, patients with high index of suspicion for stroke are quickly scanned to

Figure 3. Photographs depicting a clot removed with a stentriever from a patient with complete occlusion of the middle cerebral artery. Panel A shows the material attached to the mesh of the device immediately after removal. Panel B shows in a magnified view the macroscopic characteristics of the clot.
obtain CTA and CT perfusion studies. This enables clinicians to exclude a hemorrhagic event and determine whether there is salvageable brain tissue based on perfusion parameters while concomitantly locating a target vessel for mechanical thrombectomy. It is important to stress that the neurological exam is also a critical component of stroke management and serial scores on the NIHSS (National Institutes of Health Stroke Scale) are routinely obtained before and after stroke therapies are initiated, including medical (tPA) or surgical. In general terms, a decrease in the NIHSS score is an indicator of successful treatment and recanalization.

Moreover, not every hospital can or should perform endovascular stroke therapy, thus creating major implications for triaging decisions by emergency medical services. Futile measures that may delay access to a comprehensive stroke center are not in the patient’s best interest to say the least. The current state of endovascular technology may provide the tools to reopen an occluded middle cerebral artery but real clinical benefit is time-dependent and as the volume of infarct core increases, so does the risk of hemorrhagic conversion after recanalization, a devastating complication of stroke intervention. Based on the current standard of care for stroke patients, triage decisions should take into consideration whether there is large vessel occlusion and administration of IV tPA should no longer dissuade physicians from referring patients to the neurointervention suite. These decisions can be facilitated by creating treatment algorithms and educating health care providers. Simultaneously, technological advancements such as telestroke and mobile stroke units gained momentum recently and have the potential to revolutionize stroke treatment by extending the reach of excellence centers to smaller communities and underserved areas. Ultimately, the decision to undertake endovascular thrombectomy should be made jointly by a multidisciplinary team including, at a minimum, a stroke physician and an experienced specialist in neurointervention. There is now a great deal of enthusiasm regarding the future of stroke treatment and the real winners of this new era are the patients who now have better than ever chances of overcoming the odds.

References

You are cordially invited to attend the 2015 DCMS Presidential Inaugural Ball and 163rd Annual Meeting.

There will be a live band, dancing, dinner, reduced room rates for all attending guests, and the official inauguration of Sunil Joshi, MD. Do not miss this unforgettable event with your peers.

LOCATION
The ball begins at 6:00pm on Friday December 4th at the Hyatt Regency Hotel: 225 East Coastline Drive

TICKETS
100 dollars per person for members and guests; 140 dollars per person for non-members and guests.

HELP
Please don’t hesitate to contact Courtney Hassan at 355-6561 or courtney@dcmsonline.org with any questions.

ACCOMMODATIONS
Call the Hyatt at (904) 588-1234 to book a room for the evening at the exclusive DCMS rate of 89 dollars.

Complimentary childcare will be provided thanks to the DCMS Alliance.
The DCMS Nominating Committee is pleased to present to the membership the following proposed slate of Officers, Board of Directors, FMA Delegates and Alternate Delegates for 2016:

### Officers
- **President-elect:** Tra’Chella Johnson Foy, MD
- **Vice Presidents:** Stephen Mandia, MD; Ruple Galani, MD
- **Treasurer:** Uday Deshmukh, MD
- **Secretary:** James Altomare, MD

### Board of Directors
- **Term to Expire December 31, 2018**
  - Elizabeth DeVos, MD
  - Meridith Farrow, MD
  - Gianrico Farrugia, MD
  - Nitesh Paryani, MD

- **Term to Expire December 31, 2017**
  - Parveen Khanna, MD (filling unexpired term of James Altomare, MD, if elected Secretary)

- **Term to Expire December 31, 2016**
  - Ana Alvarez, MD (filling unexpired term of Uday Deshmukh, MD, if elected Treasurer)

### FMA Delegates
- **Term to Expire December 31, 2018**
  - James Altomare, MD
  - Mara Cvejic-Paryani, MD
  - Parveen Khanna, MD
  - Daniel Lestage, MD
  - Stephen Mandia, MD
  - Michael Nussbaum, MD
  - Nitesh Paryani, MD
  - Stephen Porter, MD
  - Tracy Sinha-Khona, MD

- **Term to Expire December 31, 2016**
  - Ali Kasraeian, MD

### FMA Alternate Delegates
- **Term to Expire December 31, 2016**
  - Saswata Roy, MD

The DCMS membership will vote on this slate of nominees at the DCMS Presidential Inaugural Ball & Annual Meeting on December 4, 2015, 6:00 pm, at the Hyatt Regency Jacksonville Hotel.
Want to be a Peer Reviewer?

We want you! Northeast Florida Medicine is looking for volunteers from all specialties to assist with peer reviewing articles that are published in the journal. If you’re interested in serving as a peer reviewer, please email kristy@dcmsonline.org.
An Update on Pediatric HIV

Background:
The Duval County Medical Society (DCMS) is proud to provide its members with free continuing medical education (CME) opportunities in subject areas mandated and suggested by the State of Florida Board of Medicine to obtain and retain medical licensure. The DCMS would like to thank the St. Vincent's Healthcare Committee on CME for reviewing and accrediting this activity in compliance with the Accreditation Council on Continuing Medical Education (ACCME).

This issue of Northeast Florida Medicine includes an article, “An Update on Pediatric HIV” authored by Mobeen Rathore, MD, CPE, FAAP, FPIDS, FIDSA, FACPE, FSHEA, which has been approved for 1 AMA PRA Category 1 credits. For a full description of CME requirements for Florida physicians, please visit www.dcmsonline.org.

Faculty/Credentials:
Mobeen Rathore, MD, CPE, FAAP, FPIDS, FIDSA, FACPE, FSHEA is the Professor/Director at the University of Florida Center for HIV/AIDS Research, Education and Service (UF CARES) and Chief, Pediatric Infectious Diseases at Wolfson Children's Hospital in Jacksonville, FL.

Objectives:
1. To understand the epidemiology of HIV.
2. To understand prevention of transmission of HIV.
3. To understand principles of infection control in HIV.

Date of release: September 1, 2015  Date Credit Expires: September 1, 2017  Estimated Completion Time: 1 hour

How to Earn this CME Credit:
1. Read the “An Update on Pediatric HIV” article.
2. Complete the posttest and email your test to Patti Ruscito at patti@dcmsonline.org or mail it to 1301 Riverplace Blvd., Suite 1638, Jacksonville, FL 32207.
3. You can also go to www.dcmsonline.org to read the article and take the CME test online.
4. All non-members must submit payment for their CME before their test can be graded.

CME Credit Eligibility:
A minimum passing grade of 70% must be achieved. Only one re-take opportunity will be granted. A certificate of credit/ completion will be emailed within four to six weeks of submission. If you have any questions, please contact Patti Ruscito at 904.355.6561 or patti@dcmsonline.org.

Faculty Disclosure:
Mobeen Rathore, MD, CPE, FAAP, FPIDS, FIDSA, FACPE, FSHEA reports no significant relations to disclose, financial or otherwise with any commercial supporter or product manufacturer associated with this activity.

Disclosure of Conflicts of Interest:
St. Vincent's Healthcare (SVHC) requires speakers, faculty, CME Committee and other individuals who are in a position to control the content of this educations activity to disclose any real or apparent conflict of interest they may have as related to the content of this activity. All identified conflicts of interest are thoroughly evaluated by SVHC for fair balance, scientific objectivity of studies mentioned in the presentation and educational materials used as basis for content, and appropriateness of patient care recommendations.

Joint Sponsorship Accreditation Statement
This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of St. Vincent’s Healthcare and the Duval County Medical Society. St. Vincent’s Healthcare designates this educational activity for a maximum of 1 AMA PRA Category 1 credits. Physicians should only claim credit commensurate with the extent of their participation in the activity.
An Update on Pediatric HIV

By Mobeen Rathore, MD, CPE, FAAP, FPIDS, FIDSA, FACPE, FSHEA

**Abstract:** The management of HIV infection has improved significantly over the last three decades of the epidemic. The treatment of pediatric HIV infection has benefited significantly from the progress. Of the advances, the most significant is the success of prevention of mother to child transmission of HIV infection.

**Introduction**

Pediatric HIV infection remains a global problem. Although there have been tremendous advances in HIV medicine over the last three decades of the epidemic, not all communities throughout the world have benefited from these advances. In the developed world, HIV is now a chronic, manageable and treatable disease that is akin to hypertension or diabetes. Unfortunately that is not the case in the under resourced parts of the world. Through the efforts of the World Health Organization (WHO) and programs such as the US government-sponsored President’s Emergency Plan for AIDS Relief (PEPFAR) many more HIV infected individuals than before are being helped. However, there is still a long way to go.

Locally manufactured antiretroviral medications, which are much less expensive and more affordable for the under resourced nations, have been a great help in making these antiretroviral available to more persons with HIV infection then would have otherwise been possible. However, the presence of other familiar problems, such as lack of safe and clean drinking water, poor nutrition and tuberculosis, makes management of HIV in most countries of the world an even bigger challenge. Abject poverty in many of the countries where HIV prevalence is high makes it a huge challenge to establish a healthcare infrastructure that can handle and control ongoing epidemics such as HIV and newer ones such as Ebola.

Table 1 shows the latest available data from the WHO. Since the onset of the HIV epidemic there have been many successes. However, arguably three sentinel events have defined this epidemic. The first was the discovery by French investigators of the virus responsible for causing AIDS. Second was the development and approval by the Food and Drug Administration of the very first antiretroviral drug Zidovudine (ZDV, originally abbreviated as AZT) developed by the British pharmaceutical company GlaxoSmithKline. Third was the ability to prevent mother to child HIV transmission (MTCT) proven by the Pediatric AIDS Clinical trial (PACTG) study 076, conducted by the National Institutes of Health in the United States.

HIV can be transmitted by several mechanisms including sexual contact, intravenous drug abuse, exposure to blood and body fluids (including needles), transfusion of infected blood and blood products (a route that no longer occurs in the United States of America) and MTCT.

**MTCT**

Since the early 1990s PACTG 076 has been the standard of care in the United States decreasing the MTCT (also referred to as perinatal transmission) to < 1 percent. In Jacksonville, under the auspices of University of Florida...
center for HIV/AIDS Research, Education and Service (UF CARES), which was also a part of the PACTG, the PACTG 076 protocol has been implemented since 1994. By doing so, UF Cares researchers report seeing perinatal transmission of HIV plummet from approximately 25 percent to less than 1 percent. There have also been years when there has been no transmission.

However, even in the United States, substantial racial and ethnic disparities exist in the perinatal transmission of HIV infection (Figure 1). In the under resourced parts of the world, perinatal prevention protocols are less available and difficult to implement. Not surprisingly, most HIV infected children live in under resourced parts of the world and most of them do not have access to appropriate treatment. Although research to find more cost effective and appropriate MTCT prevention protocols for countries with fewer resources has shown promise, implementing these protocols remains a huge challenge.

Preventing and treating MTCT

One of the most effective ways to prevent MTCT is to diagnose HIV before or early in pregnancy and then treat the HIV infected mother. It is also critical to provide intrapartum antiretroviral therapy and provide the newborn with antiretroviral medications after birth. In addition, breast feeding should be avoided. Major challenges exist in each of these effective elements in preventing MTCT. As Figure 2 displays, many pregnant women do not receive antiretroviral therapy. Although avoidance of breast feeding in Africa decreased the transmission of perinatal HIV infection, mortality increased in the breast feed avoidance group.\(^3\) This is most likely due to poor hygiene and lack of clean and safe water. Consequently, WHO does not recommend avoidance of breast feeding in the

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**Figure 1:** Rates (per 100,000 Live Births) of Diagnosed Perinatally Acquired HIV Infections, by Year of Birth and Race/Ethnicity.a 2007-2009 – 46 States/ Source: Centers for Disease Control and Prevention

**Figure 2:** Number of pregnant women living with HIV in low- and middle-income countries and the number and percentage of those women receiving ARV drugs for PMTCT of HIV, 2005-2013
under resourced parts of the world. Conversely, breast feeding by a HIV infected mother is not recommended in the United States and other developed countries.

While the number of HIV infected pregnant females has increased by about 30 percent, from 6000 in 2000 to almost 9000 in 2006, the United States has been successful in decreasing MTCT. This success is mostly due to better systems to diagnose HIV infection in women of childbearing age, especially pregnant women, and subsequent intervention to prevent MTCT. This is probably one of the most significant public health interventions in the US, if not the world, in modern history. Despite great success in the United States, perinatal HIV transmission does still occur. In 2010, 217 children <13 years were diagnosed with HIV and 162 (75 percent) of those children contracted their infection as a result of MTCT.4 By 2009, a cumulative of 10,834 children were diagnosed with HIV and 88 percent were a result of MTCT.4 63 percent of those MTCT children were African American.4 The story of pediatric HIV in 2015 is the story of prevention of MTCT and is inextricably associated with HIV infection in females. Although there have been tremendous leaps in the prevention of MTCT, infections are still being transmitted and challenges remain. Many barriers result in missed opportunities. Some of these challenges, according to the CDC, include:\4

1. Primary HIV prevention strategies for females
2. Unintended pregnancies
3. Lack of appropriate prenatal care, prenatal HIV testing, prenatal antiretroviral medication, Cesarean delivery when appropriate and avoidance of breast feeding
4. HIV testing
5. Substance abuse
6. Socioeconomic issues
7. Pre-chewing food for infants
8. Limited access to safe conception methods and services
9. Mental health issues

**Pediatric HIV in Florida**

Of all the reported cases in Florida of HIV infection in 1987, 11 percent were in women. This number grew to 29 percent in 2005. In 2014 this figure was 20 percent.5 When it comes to states with the highest number of pediatric AIDS cases, the state of Florida, with 1,571 pediatric AIDS cases in 2013, ranks second, after New York, in the number of pediatric AIDS cases.6,7 Through 2013, Florida has reported 2,561 cases of pediatric HIV infection, of which 74 percent were in African Americans and 95 percent were the result of MTCT.6,7 The number of perinatally acquired HIV-infected babies born in Florida (N=1,208 through 2013) has steadily declined (91 percent) from a peak of 110 cases in 1993 to 10 cases in 2013.6,7 Of the 503 babies known to be born to an HIV-infected mother in Florida in 2013, 10 (2 percent) were infected.6,7

The risk factors for these transmissions include:

1. Mothers who do NOT know their HIV status prior to birth
2. Inadequate prenatal care (adequate care is defined as: 5 or more visits, starting by month 4 or earlier),
3. No prenatal antiretroviral therapies (ART)
4. No ART at delivery, and/or
5. Non-caesarean birth
6. No neonatal ART (within the first 6 weeks of the infant’s life)
7. Breast feeding
8. A mother who is a substance abuser during pregnancy
9. A mother who acquired a STD during pregnancy
10. Issues associated with poverty and limited access to health care

In Florida, state law requires that healthcare providers must offer HIV testing to all pregnant patients early and late in pregnancy. HIV testing should be offered at the initial visit and then at 36 weeks gestation or after. The use of an “opt-out” HIV testing strategy in Florida has increased HIV testing in pregnant women by making it easier. In Florida there are many sites where HIV testing can be obtained free of charge. Testing is always confidential and has the same protection under HIPPA laws as any other medical condition.

In Jacksonville there is a system of care for HIV-infected women and children led by the University of Florida Center for HIV/AIDS Research, Education and Service, in collaboration with many community and healthcare partners. As a result, MTCT of HIV remains a rare occurrence and is considered a sentinel event for which UF CARES conducts an intensive route cause analysis.

Developing this infrastructure and a system of care using the Testing, Engaging and Retain (TEAR) in care methodology is key to identifying HIV-infected women and bringing
them into care early, even before they get pregnant. In Jacksonville, this is done by offering HIV testing by several state designated HIV testing sites, including UF CARES. Innovative outreach programs are also conducted by UF CARES, including programs such as Targeted Outreach to Women with HIV/AIDS (TOPWA) and the Expanded Testing Initiative (ETI). Both are funded by the Florida Department of Health using CDC funds. Once identified, HIV-infected women receive intensive case management and referral to obstetric providers. These women are followed by UF CARES case managers along with their obstetric providers. Women have access to mental health services at UF CARES, along with many other essential services. Women are also offered access to the latest innovative research at UF CARES through research projects funded by the National Institutes of Health and the CDC. All women have access to the latest intervention protocols to interrupt MTCT. Once the infants are born they are followed by the pediatric HIV providers from UF CARES and receive the necessary interventions. These infants also have access to cutting edge research.

Treatment of Infants

Infants born to HIV-infected mothers need antiretroviral therapy for at least six weeks. It is imperative the mother leaves the hospital with the necessary prescriptions. Follow-up at appropriate intervals is necessary so that diagnosis of HIV infection can be detected as soon as possible. Early treatment with antiretrovirals and prophylaxis for PCP infection in the infant is critical to decrease the morbidity and mortality associated with MTCT of HIV infection. Other opportunistic infections, such as tuberculosis, are fortunately rare in children in the United States, but are still a huge problem in the under resourced parts of the world. Nevertheless, HIV-infected children are at increased risk for tuberculosis and require appropriate screening for tuberculosis on a regular basis. Early diagnosis of HIV infection in the newborn period and the first 18-24 months of age requires molecular tests, such as HIV DNA or RNA PCR and, in some cases, a NAAT test. The routinely-used antibody-based HIV testing for adults is not accurate in infants, because of the presence of transplacentally acquired maternal HIV antibody.

Treatment of Children

Although many antiretroviral treatment options are available for children, the management of HIV-infected children is highly specialized. Such children should be managed by pediatric infectious diseases specialists who are experienced and knowledgeable about the latest treatment guidelines for pediatric HIV infection. Management of HIV is quite fluid and dynamic as the field burgeons and evolves. The latest information can be obtained from living documents at AIDSinfo.org.

All healthcare providers have a critical role in the prevention of MTCT of HIV. First and foremost, all healthcare providers and institutions should offer HIV testing to their patients annually, as recommended by the CDC in 2006. This will identify HIV-infected individuals so that they can receive appropriate treatment. Such treatment would decrease the chance of MTCT if a woman gets pregnant. Testing of HIV-infected men would identify potentially infected women. When appropriately treated and educated, HIV-infected men would be less likely to transmit the infection to their uninfected partners. As a result, a female partner would be less likely to transmit to their infants.

Treatment of Adolescents and Emerging Adults

Adolescent HIV cases, although not strictly defined by the CDC as pediatric HIV, are usually cared for by pediatric HIV specialists. This is a hard to reach group and even harder to retain in care. This is also the group of individuals in the pediatric HIV domain who are increasing in number. While the traditionally defined pediatric HIV infection cases are usually the result of MTCT, adolescents are usually behaviorally infected. At UF CARES special programs for adolescents (13-18 years old) and emerging adults (19-24 years old), focus on their specific needs phased on their maturity and psychosocial development. Perhaps the most challenging group in this age group are those with alternate life styles, including the lesbian, gay, bisexual, transgender and questioning (LGBTQ) communities who are at heightened risk for many life problems, including HIV. Young men who have sex with men are particularly at risk for HIV and especially vulnerable and difficult to reach.

Florida statistics show that in 2014, 16 percent of all new HIV infections occurred in individuals less 25 years of age. Between 2012 and 2014, 548 new cases of HIV infection were reported among those between 13 to 19 years of age and 2,117 cases among those between 20 and 24 years of age. As of June 30, 2014 a total of 3,768 adolescents between the ages of 13 and 24 years old were infected.

While there has been tremendous success in preventing MTCT of HIV infection, there is a long way to go to identify and provide services to young people infected with HIV or at risk for HIV.
Preventing Transmission to Health Care Personnel

Prevention, of MTCT or other types of transmission, is the best approach. In the same spirit, prevention of transmission to health care personnel (HCP) is important. Following the recommended infection control policies is key. HCP should follow standard universal precautions for all patients. All blood and body fluids should be considered infectious and handled accordingly. All exposures must be reported and documented. This is important for protection of the HCP who may benefit from preventive antiretroviral protocols.

Conclusion

The solution to the HIV epidemic worldwide is a safe and effective vaccine. Unfortunately the field of HIV vaccinology has been fraught with more failures than successes. Although, each of these failures has guided the path to developing a safe and effective vaccine, progress has been slow and a vaccine remains elusive. Other prevention modalities such as condoms, diaphragms and microbicides have been available for years and offer significant protection for preventing HIV transmission, but they have not been very easy to implement. More recently, there has been success with the use of post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP) in the prevention of HIV transmission. None of the discussed modalities are perfect and require the at-risk person to proactively seek these modalities of prevention before or after an at-risk encounter making them less than optimum. A vaccine remains the best hope.

References

**Pediatric HIV CME Test – Autumn 2015**

**CME Questions & Answers (circle one answer)/Free to DCMS Members/$55.00 charge non-members***

(Return by September 1, 2017 BY MAIL: 1301 Riverplace Blvd. Suite 1638, Jacksonville, FL 32207 or ONLINE: www.dcmsonline.org.)

1. With regards to breast feeding in the United States, it is recommended that an HIV infected mother:
   a. Should breast feed her newborn
   b. Should not breast feed her newborn
   c. It is the mother’s choice whether she wants to breast feed her newborn
   d. There are no specific recommendations about breast feeding

2. With regards to HIV testing in pregnancy, healthcare workers caring for a pregnant mother should:
   a. Offer testing as soon as possible after a woman is identified as pregnant
   b. Should delay testing as late as possible to test closer to delivery
   c. Test as soon as possible after a woman is identified as pregnant and also at or about 36 weeks of pregnancy
   d. It is not necessary to test in pregnancy

3. Regarding HIV testing in the newborn, the test(s) that is helpful in definitive diagnosis is (are):
   a. HIV DNA PCR
   b. HIV RNA PCR
   c. HIV antibody
   d. a or b

4. Infection control procedures for the prevention of HIV infection include:
   a. Universal Precautions
   b. Standard Precautions
   c. Red Precaution
   d. No precautions are needed

5. Opportunistic infections in patients with HIV include:
   a. PCP
   b. Tuberculosis
   c. Both a and b
   d. Neither a or b

6. In the state of Florida, HIV testing of pregnant women is:
   a. Opt out
   b. Opt in
   c. Never offered during pregnancy
   d. Must be done before a women becomes pregnant

7. Challenges resulting in missed opportunities for the prevention of MTCT include all of the following EXCEPT:
   a. Lack of HIV testing
   b. Unintended pregnancies
   c. There are no real challenges
   d. Substance abuse
   e. Mental health issues

8. Risk for transmission include all of the following EXCEPT:
   a. The mother not knowing her HIV status
   b. No antiretroviral therapy at delivery
   c. The father’s inability to attend delivery
   d. Inadequate prenatal care

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Moments

Recently, our son, Max, was at a restaurant with his friends. His cellphone vibrated and he looked at it. He looked up and exclaimed, “I just got into the University of Florida College of Medicine!” His friend Grayson, jumped up, turned to the bartender, pointed at Max, and shouted, “Give this man a shot!” It was a great moment. Anytime you get into medical school is a great moment. However, Max’s moment sounds perfect.

A long time ago, I was pre-med at New York University. I took all the typical classes. I suffered through chemistry and biology and physiology and physics and organic chemistry. I took all the classes that have absolutely no relation to what makes a good doctor. I took all the classes that I have never, ever used in clinical practice. It’s a marathon.

As a lark, I decided to test the right side of my brain and signed up for an acting class. It is the only class I remember and the only class I use every day. There are many different types of acting theories. One is the Lee Strasberg method. Some call it Method Acting. This form of acting has been alive for centuries. It has many guises: Romantic Acting, Emotional Acting, Divine Inspiration, The Muses, Feeling the Role. All of these techniques share a common organic process of creativity to provide an audience with a moving experience. The foundation of this technique is to apply one’s experiences within the fiction of the story as if they were current. The Method Acting technique is an homage to Aristotle who noted that evoking emotions in others is only accomplished by invoking your own emotions. This is only possible by bringing to the surface remote experiences from life. In essence, Aristotle is merely the root of the “System” by Konstantin Stanislavsky, which evolved into The Strasberg Method at The Actor’s Studio. They all teach the following: acting is founded upon the actor’s ability to remember his life’s moments at a moment’s notice and apply them to every moment in the play.

Our class was taught by a woman who learned from Uta Hagen, who practiced an offshoot of this technique. She asked the class, “What is the smallest unit of time?” We all thought, yet none of us could come up with an answer. A millisecond is shorter than a second. I was sure there is something smaller than a millisecond. However, our teacher pointed out that the shortest period of time is a moment. I thought that was brilliant. She said that life is made up of an endless string of moments. In order to be a good actor you need to remember certain moments in your life and draw upon them. She instructed us to use those moments in order to play a scene. She offered that when certain things happen in your life we should not just live that moment, but remember it. Store it. Catalogue it. Moments are our greatest resources.

I remember when I was accepted to the Sackler School of Medicine. I came home and checked the mailbox. Waiting for me was a thin letter. I had been behaviorally modified to realize that thin envelopes are never good. A thick envelope has lots of instructions and papers and forms. Thick envelopes are good. Thin envelopes are always bad. Thin envelopes mean you have been fired. Thick envelopes mean you have been rejected. I opened my thin envelope and I was shocked. “Congratulations! Welcome to the Class of 1990.”

No one was home. I got into my 1979 Formula Firebird, turned on the engine and the radio and lowered all the windows. Soon I was on the Belt Parkway in Brooklyn. I got into the left hand lane and I was flying. It was neither legal nor mature, but I was flying, emotionally and physically. I flew in that left hand lane as Lionel Richie was singing “Dancing on the Ceiling.” There was a cop sitting in his car underneath the Verrazano Bridge. He sat there every day. I knew he was there. Even now, when I visit my parents, he is still sitting there. On that day, I didn’t care. I didn’t slow down. I didn’t look back. I kept flying. In a moment, the police car was behind me with his lights celebrating my acceptance to medical school, or so I thought. I pulled over. My windows were down and my tunes were blaring. He asked me to lower the radio.

“Oh, but it’s such a good song!” I replied earnestly. He was not amused and I shut off the radio.

“License and registration, please,” he intoned.

I gave him my license and registration, and I gave him my gloriously thin envelope.

“What’s this?” he barked.

“It’s my acceptance to medical school!”

I told Max there are going to be times as a physician when you’re tired and feel exhausted and, sometimes, even defeated. You will be dragging yourself through the dimmed hallways of a hospital at two in the morning. It will be just you, the nursing staff, the transporters and a bunch of sick neighbors. They will be counting on you. You may think to yourself that perhaps you should have gone to business school or law school. If you had chosen those paths you would be home in bed asleep. You would actually be making a living. I told him, when you feel that way, remember that moment when you were accepted. I told him that when things at work become overwhelming, I have always been able to hear Lionel Ritchie singing “Dancing on the Ceiling” in my head, and I’m ready to go.

Cherish this moment, my son. ♡
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