Cleveland Clinic

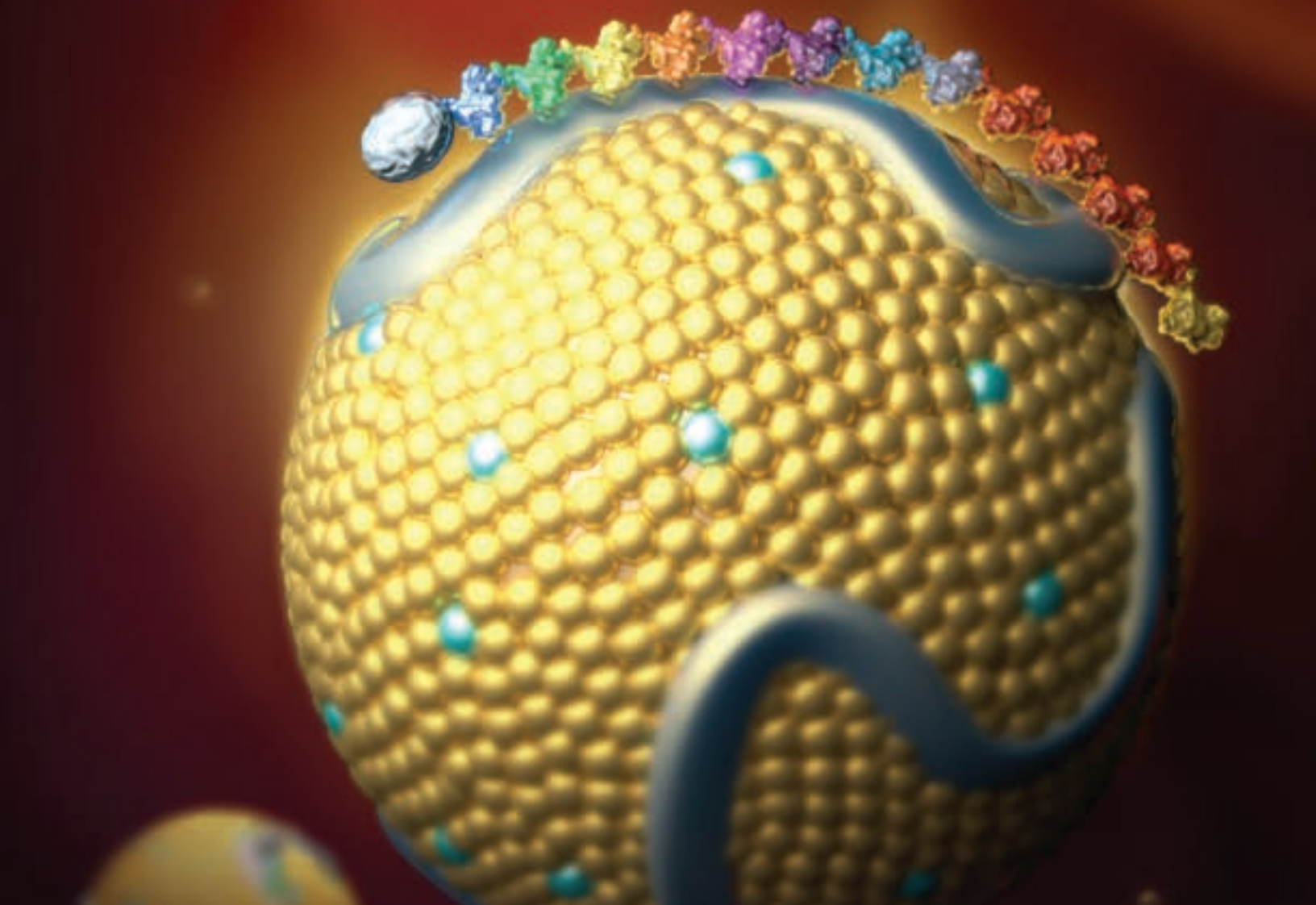
CardiacConsult

Heart, Vascular and Thoracic News from Cleveland Clinic | 2020 | Issue 1

› CARDIAC CONSULT FEATURE

The Latest in Lipids – p. 4

New developments in LDL-C therapy and long-sought progress on Lp(a)



Dear Colleagues,

Every issue of this *Cardiac Consult* newsletter features a "Vitals" insert in the centerfold that shares a sampling of outcome and volume statistics from across Cleveland Clinic's Miller Family Heart, Vascular & Thoracic Institute. We have been publicly reporting statistics like these for years because we believe these data are useful to colleagues around the world when they consider where to refer their most complex cases. Public reporting of outcomes also keeps our teams at the top of their game and always striving to do better.

The lead graph in this issue's center insert presents some data we find especially gratifying. It details annual in-hospital mortality rates and volumes for Cleveland Clinic adult cardiac surgery cases over the past 13 years. As the graph shows, mortality has declined fairly steadily from a high of 3.3% in 2007 to a low of 1.1% in 2019. This two-thirds reduction in mortality was achieved even as annual volumes rose and case complexity increased over this period. In fact, 60% of our adult cardiac surgery patients in 2019 required operations more complex than those rated by the Society of Thoracic Surgeons.

We calculate that this improvement in mortality rates translates to approximately 1,500 lives saved over just the past 10 years thanks to continuing refinements of the care delivered to our adult patients requiring cardiac surgery. Numbers like these give us confidence to invite your trust if you wish to reach out for consultation or referral for an especially complex case.

Respectfully,

Lars G. Svensson, MD, PhD

CHAIRMAN | Sydell and Arnold Miller Family Heart, Vascular & Thoracic Institute

Cover image: Based, in part, on a model created using Molecular Maya (clarafi.com/tools/mmaya/) and PDB ID 1JFN (Maderegger B, Bermel W, Hrzenjak A, Kostner GM, Sterk H. Solution structure of human apolipoprotein(a) kringle IV type 6. *Biochemistry*. 2002;41:660-668).

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BEST HOSPITALS U.S.News & WORLD REPORT NATIONAL CARDIOLOGY & HEART SURGERY 2019-20

Cleveland Clinic was named a top U.S. hospital in *U.S. News & World Report*'s "Best Hospitals" rankings for 2019-20, as well as the No. 1 hospital in cardiology and heart surgery for the 25th consecutive year.

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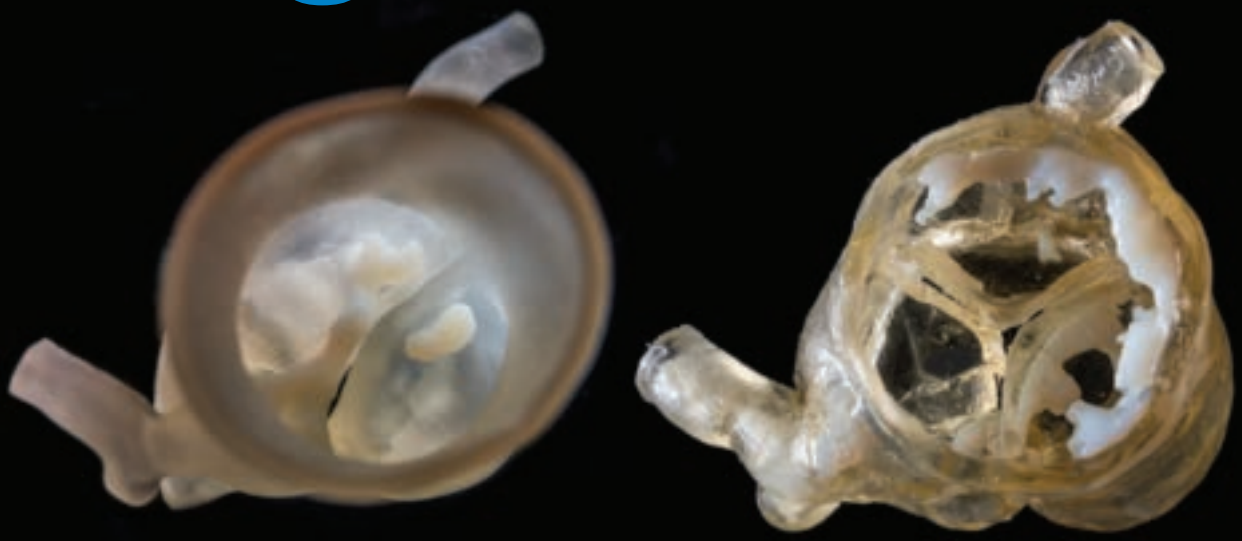


3D-printed replicas of a bicuspid aortic valve (left) and a tricuspid aortic valve (right) showing calcification. The extensive leaflet calcification in the model on the right caused severe aortic stenosis in the affected patient.

3D PRINTING IN PERCUTANEOUS STRUCTURAL HEART DISEASE

Several years into the era of 3D printing applications for percutaneous treatment of structural heart disease, the benefits of the technology are clear, including utility for device sizing, procedural simulation, anticipation of procedural complications and hemodynamic assessment.

But just as clear are the technology's current limitations, which include (among others) a lack of data from randomized trials and a lack of accepted methods for evaluating the accuracy of 3D-printed anatomic replicas.

These and other issues in the evolution of 3D printing in structural heart disease are explored in a practical, image-rich review by a team of Cleveland Clinic experts in *Circulation: Cardiovascular Imaging* (2019;12:e009014).

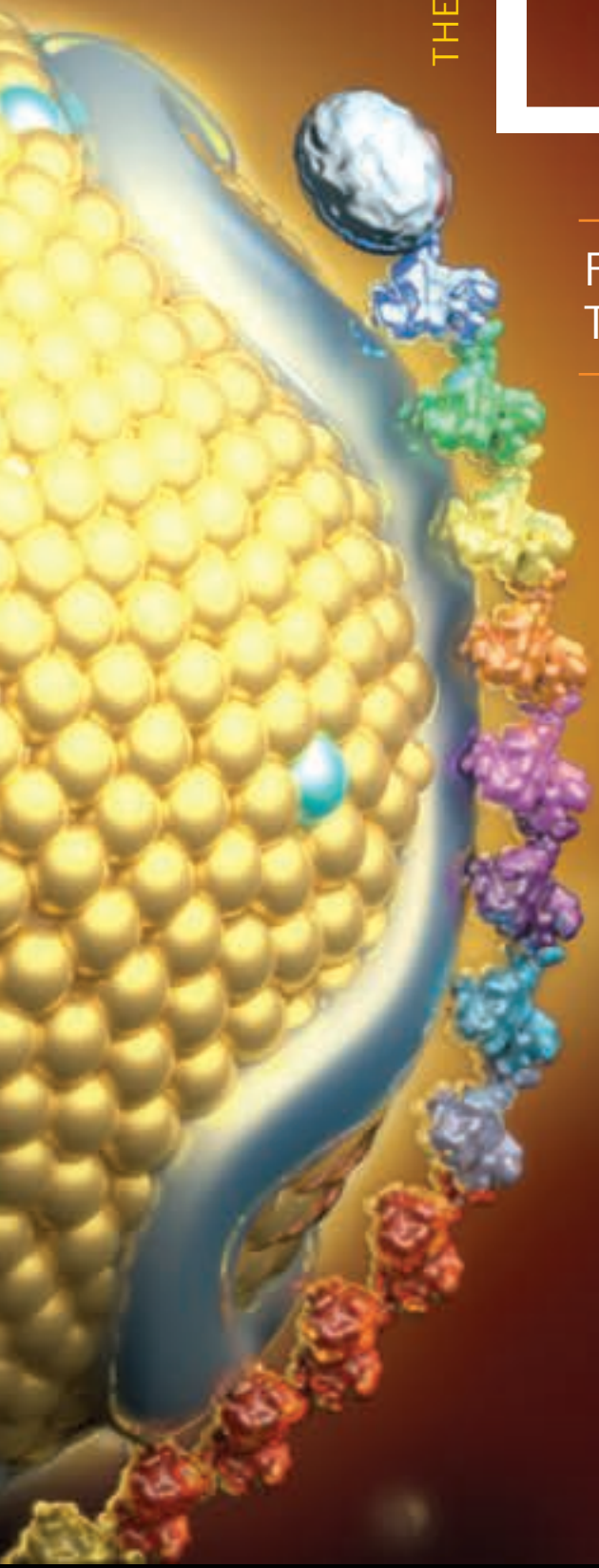
After reviewing essentials of the process of producing 3D-printed cardiac models, the team surveys applications to date for interventions involving all four heart valves, paravalvular leaks and left atrial appendage occlusion.

They also offer guidance for building a 3D printing program for structural heart disease. "Our experience shows it's important to have a cardiac imaging specialist with expertise in multimodality imaging working closely with an engineer or technologist who intimately understands 3D printing," says lead author Serge Harb, MD, of the Section of Cardiovascular Imaging. "On the technology side, it's crucial to have post-processing software that meets regulatory standards for segmentation as well as access to an advanced 3D printer."

In discussing challenges to be overcome, the authors note that current materials used in 3D printing fall short of true replication of the physical and mechanical properties of heart tissue. "This can limit the accuracy of simulated assessments of how tissue will behave in an actual procedure," says co-author Samir Kapadia, MD, Chair of Cardiovascular Medicine. "But the materials are continually improving, so we expect this limitation to diminish over time."

The review concludes by calling for guidelines to standardize image acquisition and post-processing techniques to ensure best practices for accuracy and reproducibility. "This is an important next step for realizing the full potential of 3D printing to reshape the diagnosis and percutaneous treatment of complex structural heart disease," says Dr. Kapadia. ■

Contact Dr. Harb at 216.444.3316 and Dr. Kapadia at 216.444.6735.



THE LATEST IN

Lipids:

FROM INTERMITTENT STATIN DOSING TO A LONG-SOUGHT Lp(a) THERAPY

Just when it seems like everything is settled about management of lipids, new developments crop up. That's been the case lately, prompting *Cardiac Consult* to tap experts from Cleveland Clinic's Department of Cardiovascular Medicine to survey some of the latest in dyslipidemia management, including real-world strategies for statin intolerance, a newly approved therapy for LDL cholesterol reduction that doesn't cause muscle symptoms and promising late-stage development of the first pharmacotherapy for reducing elevated lipoprotein(a) levels.

A Coordinated Strategy for Statin Intolerance

Intermittent statin dosing for statin-intolerant patients isn't new — Cleveland Clinic researchers published a study supporting this approach several years ago (*Am Heart J.* 2013;166:597-603) — but the practice has since gained traction and has become the cornerstone of an expanding suite of strategies to effectively care for statin-intolerant patients.

Important to that progress was the Cleveland Clinic-authored GAUSS-3 trial (*JAMA*. 2016;315:1580-1590), which used a randomized, blinded, placebo-controlled crossover design to provide the first robust evidence that muscle-related statin intolerance is a real and reproducible phenomenon. "This multicenter study showed that about 40% of patients with a history of muscle-related intolerance to at least two statins reported muscle symptoms while taking atorvastatin 20 mg/day but not while taking placebo," says GAUSS-3 lead investigator Steven Nissen, MD, Chief Academic Officer of Cleveland Clinic's Heart, Vascular & Thoracic Institute.

"GAUSS-3 was important because it demonstrated that muscle-related statin intolerance really does exist," says Leslie Cho, MD.

As Co-Section Head of Preventive Cardiology, Dr. Cho has for years spearheaded Cleveland Clinic's efforts to identify and care for patients with statin intolerance. Doing so, she notes, begins with a good history and physical exam. "To identify true statin intolerance, you need to really listen to your patients," she says.

This involves asking them to describe their muscle symptoms — statin-induced aches can be severe and often affect large muscle groups. It is important to rule out substances that could be interfering with statin metabolism or elimination. These include alcohol, certain herbal supplements and medications such as diltiazem, amiodarone and some antibiotics and antifungals.

Once other causative substances are excluded, patients who report muscle aches after trying two different statins are started on intermittent dosing of one of the hydrophilic statins — usually rosuvastatin, because of its long half-life, although pravastatin can be tried as well. "We use hydrophilic statins because they are less likely to get into muscle than the lipophilic statins," Dr. Cho explains.

Intermittent dosing starts with a very low dose — typically 2.5 mg of rosuvastatin — once a week. Dosing is slowly escalated to 2.5 mg twice a week and then to 5 mg twice a week, with further increases in frequency as tolerated.

Cleveland Clinic has now used this approach in more than 3,000 patients, which Dr. Cho says is the world's largest experience with intermittent statin dosing. This experience shows that about 70% of these patients end up being able to tolerate intermittent and/or low-dose statin therapy. "About 60% of patients can take a statin every day, after we start them on this slow process, and another 10% can take a statin three times a week," Dr. Cho explains. "Only about 30% of patients who try intermittent dosing truly cannot take any statin therapy at all."

What kinds of LDL cholesterol (LDL-C) reductions can be achieved with this intermittent dosing approach? The 2013 *American Heart Journal* study mentioned above, which Dr. Cho led, achieved a mean LDL-C reduction of 21.3% with intermittent dosing, and she says results since then have been at least as good, with some patients achieving reductions of 25% to 30% with additive ezetimibe therapy.

Some are amazed that as little as 5 mg of rosuvastatin a week can achieve any meaningful LDL-C reduction, but Dr. Cho points to the agent's long half-life. And Dr. Nissen notes that early clinical trials of rosuvastatin showed LDL-C reductions of 30% with a dosage of just 1 mg/day. "There are real randomized controlled trial data that are supportive of this approach," he observes.

"Of course, diet and exercise play a role too," Dr. Cho adds. "In our prevention clinic, we always emphasize lifestyle factors in addition to medication, and for the 15% of the population who are high absorbers of dietary cholesterol from the small intestine, diet can make a tremendous difference."

Patients who continue with intermittent/low-dose statin therapy can be treated with any of several additive lipid-lowering medications, as needed, to help them achieve their goal LDL-C, such as ezetimibe, niacin and colesevelam.

Continued next page ›

For those who still don't reach their goal, as well as for the 30% of participants who can't tolerate any statin therapy whatsoever, PCSK9 inhibitor therapy is a good next option that achieves dramatic LDL-C reductions with a low risk of muscle-related adverse effects.

In these cases, the extensive initial trials of other therapies as part of the intermittent-dosing approach often help overcome any insurance barriers to reimbursement for PCSK9 inhibitors. "At Cleveland Clinic we have a wonderful specialty pharmacy that helps with PCSK9 inhibitor requests, and the approval rate for our patients is upward of 90%," says Dr. Cho.

A New Non-Statin Oral Option

She adds, however, that even if cost and insurance coverage are not a barrier to PCSK9 inhibitor therapy, there are occasional patients for whom anxiety over injections rules out PCSK9 inhibitors. That's one reason Dr. Cho welcomes the February 2020 FDA approval of a novel once-daily oral therapy for LDL-C reduction — bempedoic acid.

Approval of this agent, the first of the ATP citrate lyase inhibitor drug class to gain marketing clearance, was based largely on data from the 2,230-patient CLEAR Harmony trial published last year (*N Engl J Med.* 2019;380:1022-1032). That study showed that bempedoic acid significantly reduced LDL-C levels over 52 weeks relative to placebo when added to maximally tolerated statin therapy in people with atherosclerosis and/or heterozygous familial hypercholesterolemia. Adverse effects were similar to those with placebo.

While approval was sought solely on the basis of LDL-C reduction, bempedoic acid's effect on clinical outcomes is being assessed as the focus of the ongoing CLEAR Outcomes trial of 14,000 patients with statin intolerance who have, or are at high risk for, cardiovascular disease . Results from that multicenter study, which is being led by Cleveland Clinic with Dr. Nissen as the study chairman, are expected in 2022.

"Bempedoic acid is interesting because it acts on ATP citrate lyase, an enzyme that sits upstream of HMG-CoA reductase, which is the enzyme that statins act upon," Dr. Nissen says. "But bempedoic acid has to be transformed in the liver to be active, and it is not active in muscle, so it can't cause myalgias."

CLEAR Outcomes at a glance

Phase 3 trial | NCT02993406

- 14,000 patients with statin intolerance who have, or are at high risk for, cardiovascular disease
- Randomized, double-blind comparison of bempedoic acid 180 mg orally once daily vs. matching placebo (target mean treatment of 3.75 years)
- Primary outcome: time to first occurrence of a major adverse cardiovascular event
- Results expected in 2022

LDL-C reductions are more modest with bempedoic acid than with statins; for instance, levels were lowered by a mean of 18% relative to placebo in CLEAR Harmony among patients already on maximal statin therapy. However, LDL-C reductions are somewhat greater in patients who do not tolerate statins — typically about 25%, Dr. Nissen says. A recent phase 3 trial showed a 38% mean reduction versus placebo when bempedoic acid was combined with ezetimibe in patients on background statin therapy.

In its recent actions, the FDA also approved bempedoic acid as part of a fixed-dose combination tablet with ezetimibe. Dr. Nissen notes that because bempedoic acid can be given with low doses of statin therapy as well, he believes a triple-therapy regimen consisting of bempedoic acid, ezetimibe and a very low statin dose — perhaps 5 mg/week of rosuvastatin — may play an important role in the future treatment of statin-intolerant patients.

"Such a combination could produce LDL-C reductions of 50%, which is in the range of PCSK9 inhibitors," he says. "It will be interesting to see how bempedoic acid ultimately fits best into practice."

Finally a Treatment for Elevated Lipoprotein(a)?

An additional development in lipid management involves lipoprotein(a), or Lp(a), a distinctive particle with two components: a lipoprotein core that resembles LDL, along with a shell that contains apolipoprotein(a), or Apo(a). Elevated blood Lp(a) levels are primarily due to genetic variations in the *LPA* gene that encodes for Apo(a) and cannot be lowered by diet, exercise or current lipid-lowering therapies.

"By combining the atherosclerotic effects of LDL with the prothrombotic effects of Apo(a), elevated Lp(a) essentially delivers a double whammy of noxious atherothrombotic effects to affected individuals," explains Dr. Nissen.

Those effects manifest as a heightened risk — and often an accelerated course — of cardiovascular diseases, most notably premature myocardial infarction (MI), venous thromboembolism and calcific aortic stenosis.

Interestingly, despite the progress in reducing LDL-C over the past three decades, there remains a subset of patients whose LDL-C levels do not fall as expected after optimal therapy with statins or other lipid-lowering medications. In some of these cases of so-called statin resistance, the culprit is a very high level of Lp(a), which contributes to the laboratory-measured levels of LDL-C.

Normal Lp(a) levels are considered to be less than 25 mg/dL, with significant risk of atherothrombotic events beginning at levels between 50 and 70 mg/dL and rising thereafter. And that risk is not at all rare: 64 million U.S. residents have an Lp(a) level of 60 mg/dL or higher. Over 3 million have levels of 180 mg/dL or more, which confer extremely high risks.

Despite such widespread and significant clinical stakes, Lp(a) levels are infrequently measured in clinical practice, chiefly because there have been no effective Lp(a)-lowering pharmacotherapies to date. That includes statins, which actually can slightly raise Lp(a) levels.

This absence of therapies is likely to soon end, however, thanks to one or more gene silencing approaches to Lp(a) reduction now under investigation. The approach that's furthest along involves antisense oligonucleotide (ASO) therapy and is the focus of a newly launched international phase 3 trial with Cleveland Clinic as the coordinating center, Dr. Nissen as study chairman and Dr. Cho as a principal investigator.

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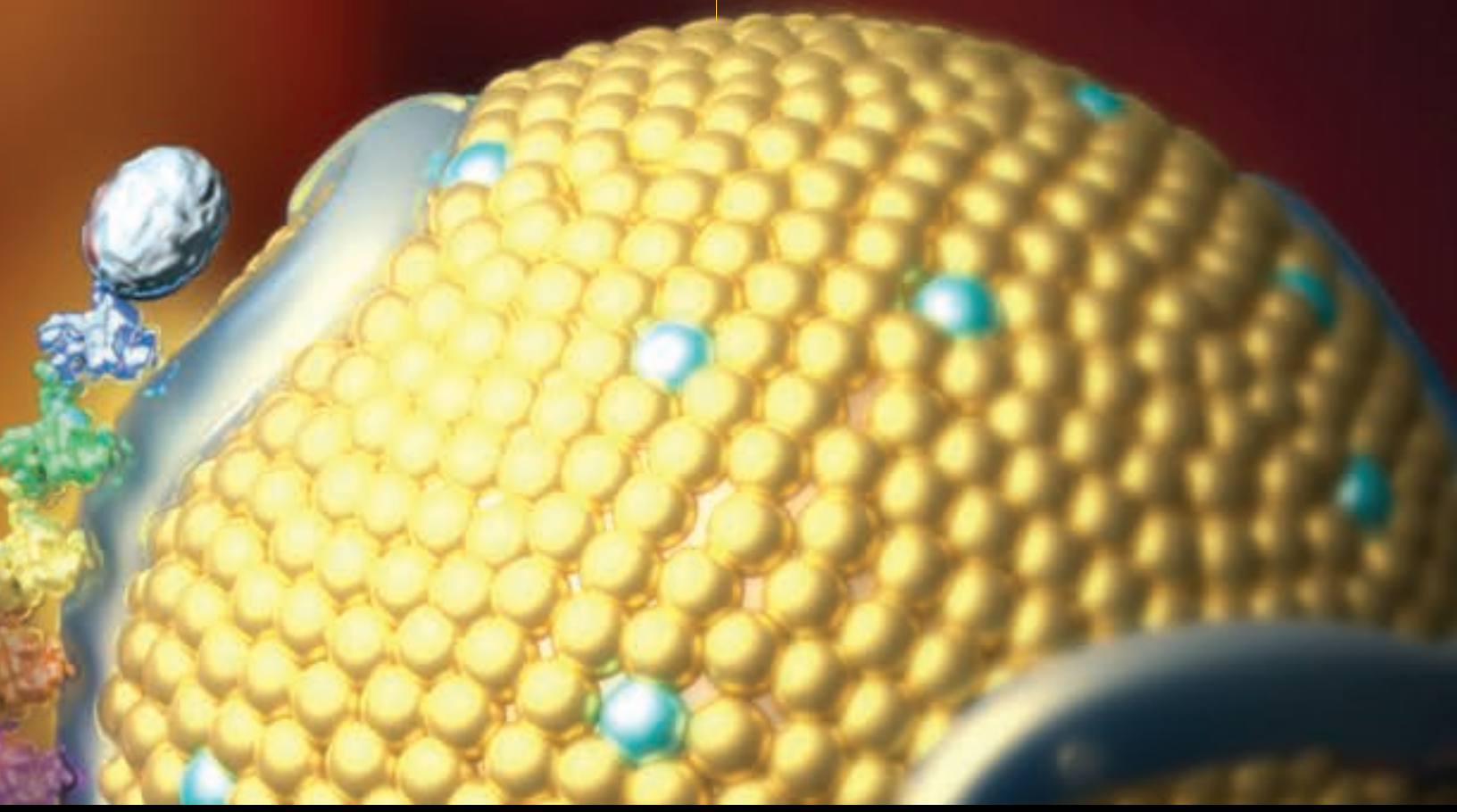


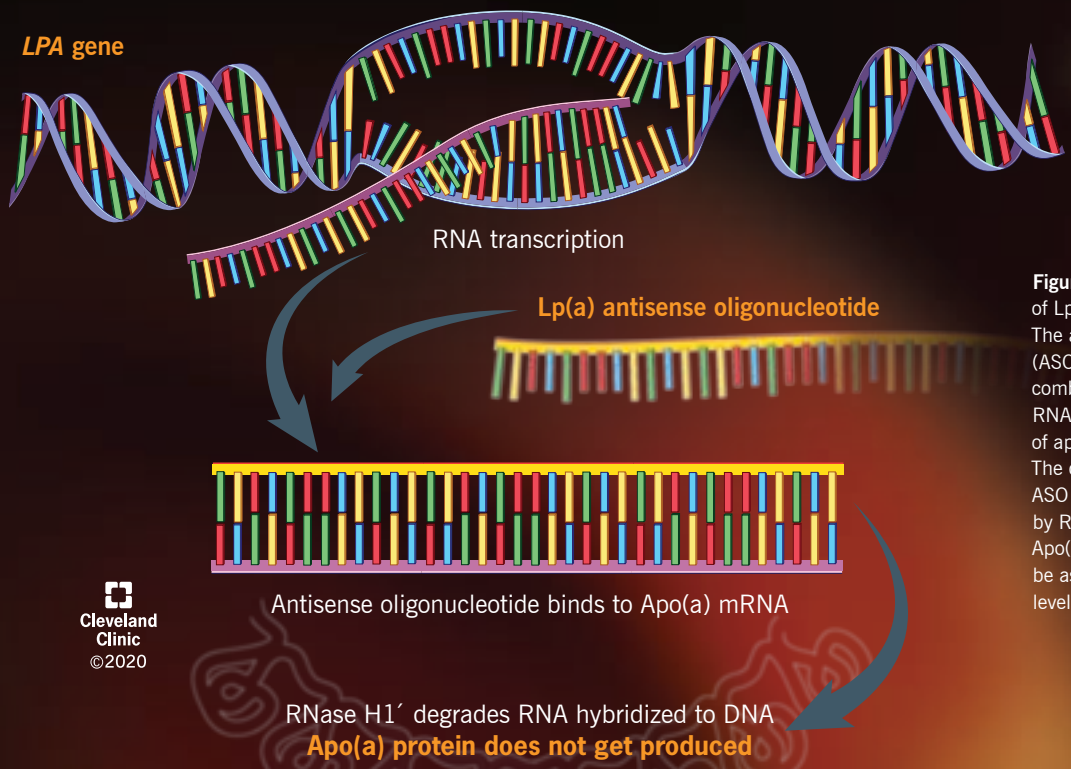


Figure. Mechanism of action of Lp(a) antisense therapy. The antisense oligonucleotide (ASO) is a DNA-like strand that combines with the messenger RNA responsible for production of apolipoprotein(a), or Apo(a). The complex of Apo(a) and the ASO is subsequently degraded by RNases. In the absence of Apo(a), the Lp(a) particle cannot be assembled, and circulating levels fall by up to 80%.

"The ASO approach to gene silencing involves single-stranded DNA that binds to messenger RNA, which is subsequently degraded so that the message to produce Apo(a) never gets transmitted," explains Dr. Nissen (see figure). "It's as if you're turning off the *LPA* gene responsible for elevated Lp(a) levels."

He notes that the specialized ASO therapy, known as APO(a)-L_{Rx}, is conjugated with *N*-acetyl-galactosamine (GalNAc3), an efficient ligand for the asialoglycoprotein receptor on the surface of hepatocytes. "This approach helps the therapy accumulate in the liver so that it doesn't reside much in the circulation, which minimizes potential adverse effects," Dr. Nissen says.

Conjugation with GalNAc3 increased the therapy's potency up to 30-fold over that of the parent ASO, allowing much lower dosing and improved tolerability. In newly published phase 2 trial data in 286 patients (*N Engl J Med.* 2020;382:244-255), 20 mg of APO(a)-L_{Rx} once weekly reduced plasma Lp(a) levels by a mean of 80% with no notable safety issues.

The new phase 3 trial that Dr. Nissen is chairing, which is known as Lp(a) HORIZON, aims to definitively assess the efficacy and safety of APO(a)-L_{Rx} among 7,680 patients worldwide. Participants will have established coronary artery disease and fall into one of two Lp(a) strata: ≥ 70 mg/dL and ≥ 90 mg/dL. They will receive optimal background therapy, including statins, and be randomized to four years of therapy with either placebo or APO(a)-L_{Rx} 80 mg given by subcutaneous injection once monthly.

Lp(a) HORIZON at a glance

Phase 3 trial with Cleveland Clinic as coordinating center | NCT04023552

- 7,680 patients with cardiovascular disease and elevated Lp(a)
- Randomized, double-blind comparison of antisense oligonucleotide therapy (APO[a]-L_{Rx}) 80 mg subcutaneously once monthly vs. matching placebo for four years
- Primary outcome: time to first occurrence of a major adverse cardiovascular event; analysis stratified by patients with Lp(a) ≥ 70 mg/dL and ≥ 90 mg/dL
- Results expected by 2024

Lp(a) HORIZON is an outcomes trial, with the primary measure being time to first occurrence of the composite endpoint of cardiovascular death, nonfatal MI, nonfatal stroke or urgent coronary revascularization requiring hospitalization. Outcomes will be evaluated for both strata of baseline Lp(a) levels (≥ 70 and ≥ 90 mg/dL). Study completion is expected in 2024.

"This is a trial with enormous public health implications," notes Dr. Nissen. "Lp(a) reduction represents one of the last frontiers in lipid management. We are optimistic as this investigation gets underway." ■

Contact Dr. Cho at 216.445.6320 and Dr. Nissen at 216.445.6852.

$12 Million NIH Grant Aims to Drive Deeper Discovery of Heart Health/Gut Microbe Links

Hazen group to pursue research programs in atherosclerosis, thrombosis and obesity.

The National Institutes of Health (NIH) has awarded more than $12 million to Cleveland Clinic researchers to study the critical link between gut microbial pathways and the development of cardiometabolic diseases.

The researchers are led by Stanley Hazen, MD, PhD (shown at right), Co-Section Head of Preventive Cardiology and Director of Cleveland Clinic's Center for Microbiome and Human Health.

He and his collaborators — J. Mark Brown, PhD; Zeneng Wang, PhD; Adeline (Lynn) Hajjar, DVM, PhD; and Joseph DiDonato, PhD, all of Cleveland Clinic's Lerner Research Institute, plus Michael Fischbach, PhD, of Stanford University — will explore the concept that gut microbes act as a key endocrine "organ" that converts digested nutrients into chemical signals that function like hormones, creating physiological changes in humans. They will focus on specific novel pathways linked to atherosclerosis, thrombosis and obesity, as well as the participation of specific gut microbe-driven pathways in increased susceptibility to cardiovascular and metabolic diseases.

Three related projects

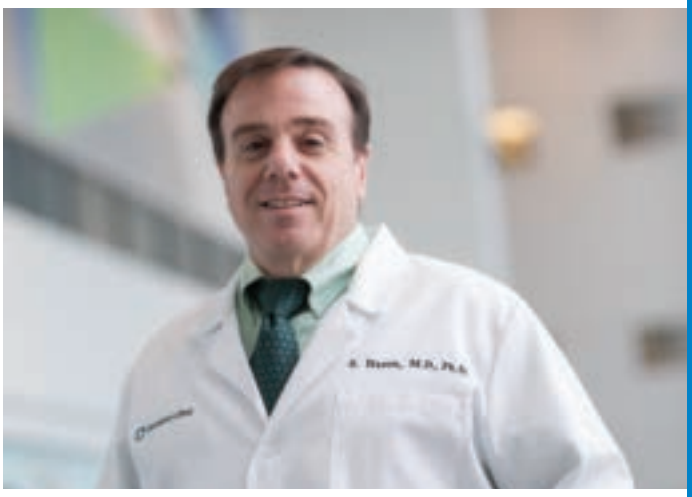
The new research program is the first "Program Project" grant funded by NIH focused on the gut microbiome and its links to human health and disease. The program consists of three specialized projects that will:

- Explore in vivo how newly identified gut microbial pathways affect thrombosis and atherosclerosis
- Investigate how microbial metabolites act like hormones to drive disease in a high-fat environment
- Identify specific microbial genes and metabolites responsible for enhancing cardiovascular disease

"We are only beginning to understand the critical links between the gut microbiome and heart disease," says Dr. Hazen. "We are grateful to the NIH for this funding and excited about the potential of this research to open up new avenues for improving health and combating cardiovascular disease."

Extending a track record of discovery

Dr. Hazen and his team have made pioneering discoveries in atherosclerosis and inflammatory disease research, including the seminal discovery linking gut microbial pathways



to cardiovascular disease and metabolic diseases, such as atherosclerosis, thrombosis, heart failure and chronic kidney disease. He and Cleveland Clinic cardiologist W.H. Wilson Tang, MD, joined with two European colleagues to summarize these and related discoveries in a recent major "state-of-the-art review" in the *Journal of the American College of Cardiology* (2019;73:2089-2105).

Central to those discoveries was the Hazen group's demonstration that TMAO (trimethylamine *N*-oxide) — a byproduct of gut bacteria formed during digestion — contributes to the development of cardiovascular disease. High blood levels of TMAO are a powerful tool for predicting future risk of heart attack, stroke and death, according to research spearheaded by the Hazen group and subsequently replicated around the world. TMAO testing is now widely available for clinical use as a result.

The team also recently reported the development of a new class of drugs that target the TMAO pathway and reduce atherosclerosis and thrombosis potential in preclinical models (*Nat Med.* 2018;24:1407-1417). "As part of the Program Project, we seek to further develop therapeutics that leverage insights into mechanistic links between the gut microbiome and cardiometabolic diseases," Dr. Hazen concludes. ■

Regionalizing Congenital Heart Surgery Would Reduce Mortality with Modest Effects on Patient Travel

Data-based simulations imagine funneling U.S. pediatric operations to bigger centers.

If children in the U.S. who need congenital heart surgery (CHS) were sent to the nearest large, regional center instead of the closest low-volume facility, they would have a better chance of a good outcome with just modest added travel distance. So concludes a recent study published in *Seminars in Thoracic and Cardiovascular Surgery* that used computer simulations to imagine regionalization of CHS in the U.S.

"Concentrating complex services saves lives," says Tara Karamlou, MD, MSc, a Cleveland Clinic pediatric and congenital heart surgeon who served as senior author of the study, which was conducted by a research team from institutions across the nation. "Regionalizing care makes sense in pediatric congenital heart surgery, just as it does in organ transplantation, another service that entails low national volume and intensive resources."

The challenge of quantifying potential effects

Although regionalizing specialized surgeries is generally regarded as an important way to improve outcomes, quantifying potential gains — and drawbacks — can be difficult.

Previous research by this investigative group found that larger CHS volumes are associated with better patient survival. In addition, simulation studies of CHS regionalization in California by other researchers found that it led to low added travel burden, and actual regionalization in Sweden has been shown to slash mortality rates.

The current study is the first, however, to model CHS regionalization and its impacts across the entire U.S. using both volume and complexity thresholds.

Modeling methods

The study identified patients ≤ 18 years old who underwent CHS in 2012 from all available state inpatient databases for that year (plus two states with data from 2011), for data from a total of 39 states representing 90% of the U.S. population. Operations were stratified using the RACHS-1 system (Risk Adjustment for Congenital Heart Surgery, version 1), which ranks mortality risk from 1 (low) to 6 (high). Patients with an unknown RACHS-1 category were assigned to category 0. Regionalization was modeled by progressive termination of CHS services by hospitals, starting with the lowest-volume hospital in a region.

After sorting hospitals by number of CHS operations performed, two simulations were conducted, as follows:

- **General regionalization.** CHS offerings at the lowest-volume hospital were terminated, and affected patients were relocated to the closest remaining hospital. This process was reiterated with remaining hospitals. Travel distance and mortality were calculated for each iteration, with distances estimated using patients' ZIP codes.
- **Regionalization for high-risk operations.** Only patients with RACHS-1 scores of 4 to 6 were moved to the nearest larger hospital (qualifying hospitals had conducted > 20 operations, of which at least one was for a RACHS-1 category 4-6 case).

Mortality rate analyses were conducted in two ways: either hospitals maintained their original mortality rate throughout the simulation, or stratified mortality rates were used to simulate reduced mortality expected from increased volumes.

Study cohorts

The study identified 19,880 CHS discharges from 330 hospitals. After exclusion of hospitals that performed only patent ductus arteriosus ligations, the cohort was reduced to 19,064 operations at 153 hospitals in 36 states — a greater than 50% decrease in the number of hospitals. This cohort was used for the mortality analyses. The high-risk cohort consisted of 2,183 operations at 111 hospitals.

Patients with unknown ZIP codes were excluded, resulting in a cohort of 15,887 patient discharges used for distance calculations.

Results: General simulation

The baseline overall mortality rate before simulation was 3.5% (666 deaths). As more patients were moved to higher-volume hospitals in each simulation round, mortality progressively decreased.

By the time the lowest-volume remaining hospitals performed at least 311 CHS operations per year, the mortality rate (based on each hospital's original mortality rate) would have fallen to 3.1% (583 deaths), a 12.5% relative reduction from baseline ($P < 0.01$). In the stratified mortality rate analysis, mortality dropped to 2.9% (550 deaths), a 17.4% relative reduction from baseline ($P < 0.01$).

To achieve the above results, 7,019 patients would have been moved and 37 hospitals would still have been performing CHS. Median distance traveled by patients would have risen from 38.5 miles at baseline to 69.6 miles ($P < 0.01$).

Results: High-risk operations

When patients were redistributed so that all 2,183 high-risk patients had surgery at hospitals that performed at least 311 CHS operations per year, the number of hospitals performing high-risk operations fell from 111 to 21. Under this scenario, the mortality rate for high-risk patients decreased from 7.5% at baseline to 6.3% ($P = 0.04$), resulting in 26 potential lives saved. However, after factoring in the lower-risk patients staying at their original hospitals, the mortality rate in the overall cohort did not change significantly. Results of the stratified mortality rate analysis were consistent with these findings.

Takeaways

Dr. Karamlou notes that several important findings emerged from the regionalization simulations:

- The number of hospitals performing a high volume of CHS operations increased, with concomitant reductions in mortality.
- Patients undergoing lower-risk operations realized the greatest benefit, as most high-risk patients were already being treated at larger centers and low-risk patients constitute the vast majority of CHS cases.
- Because geographic clustering is already common for hospitals performing CHS, ending CHS services at low-volume facilities leads to efficiencies without much added travel burden for patients, with an increase of just 31 miles in median distance traveled across the cohort.

"Regionalization for congenital heart surgery makes sense, but it faces real obstacles," Dr. Karamlou says. "The current remuneration system does not favor this approach, and few hospitals are willing to cut back on services that are highly lucrative. This analysis may spark needed discussion about how we might collectively serve our patients more effectively and efficiently."

"The outcome of congenital heart surgery for a child may be a normal and very fruitful life, or it may be repeated surgeries and a life with less than optimal functionality — it's directly related to the experience of the treating team," adds her colleague Hani Najm, MD, Chair of Pediatric and Congenital Heart Surgery at Cleveland Clinic. "The increased experience that comes with regionalization can have a tremendous impact on children's lives. The call for regionalization is all about improved outcomes." ■

Contact Dr. Karamlou at 216.442.8278 and Dr. Najm at 216.444.5819.

Survival After **TAVR** Is Better in Patients with Mixed Aortic Valve Disease vs. Pure Aortic Stenosis

A large cohort study provides insights on TAVR in an understudied patient group.

Survival following transcatheter aortic valve replacement (TAVR) appears to be better in patients with mixed aortic valve disease — i.e., both aortic stenosis and aortic regurgitation — than in those with pure aortic stenosis, according to the largest study of the question reported to date.

The survival advantage was greatest among patients who developed residual aortic regurgitation following TAVR, found the retrospective investigation, which was conducted at Cleveland Clinic and published in *JACC: Cardiovascular Interventions* (2019;12:2299-2306).

"The trials that supported approval of TAVR for patients with severe aortic stenosis at high or intermediate surgical risk largely excluded patients with significant mixed aortic valve disease," says the study's senior and corresponding author, Samir Kapadia, MD, Chair of Cardiovascular Medicine at Cleveland Clinic. "Guidelines from major societies address TAVR for mixed aortic valve disease only by recommending that decisions be based on whichever lesion is predominant. We conducted this analysis to get a better understanding of TAVR outcomes in the setting of mixed aortic valve disease, especially since it is believed to have a more aggressive natural history than pure aortic stenosis."

Study design and results

The study compared outcomes among all patients who underwent TAVR at Cleveland Clinic from 2014 through 2017 according to whether they had isolated aortic stenosis (AS) (i.e., no or trivial aortic regurgitation) or mixed aortic valve disease (MAVD) (AS with associated aortic regurgitation that was mild, moderate or severe). The primary endpoint was all-cause mortality.

After exclusion of patients with prior AVR or whose TAVR was done via a nontransfemoral route, 1,133 patients were included in the study — 445 with pure AS and 688 with MAVD. The patient groups were comparable except for a significantly higher median body mass index and higher rates of diabetes mellitus and atrial fibrillation in the pure AS arm and a significantly higher rate of prior stroke or transient ischemic attack in the MAVD arm.

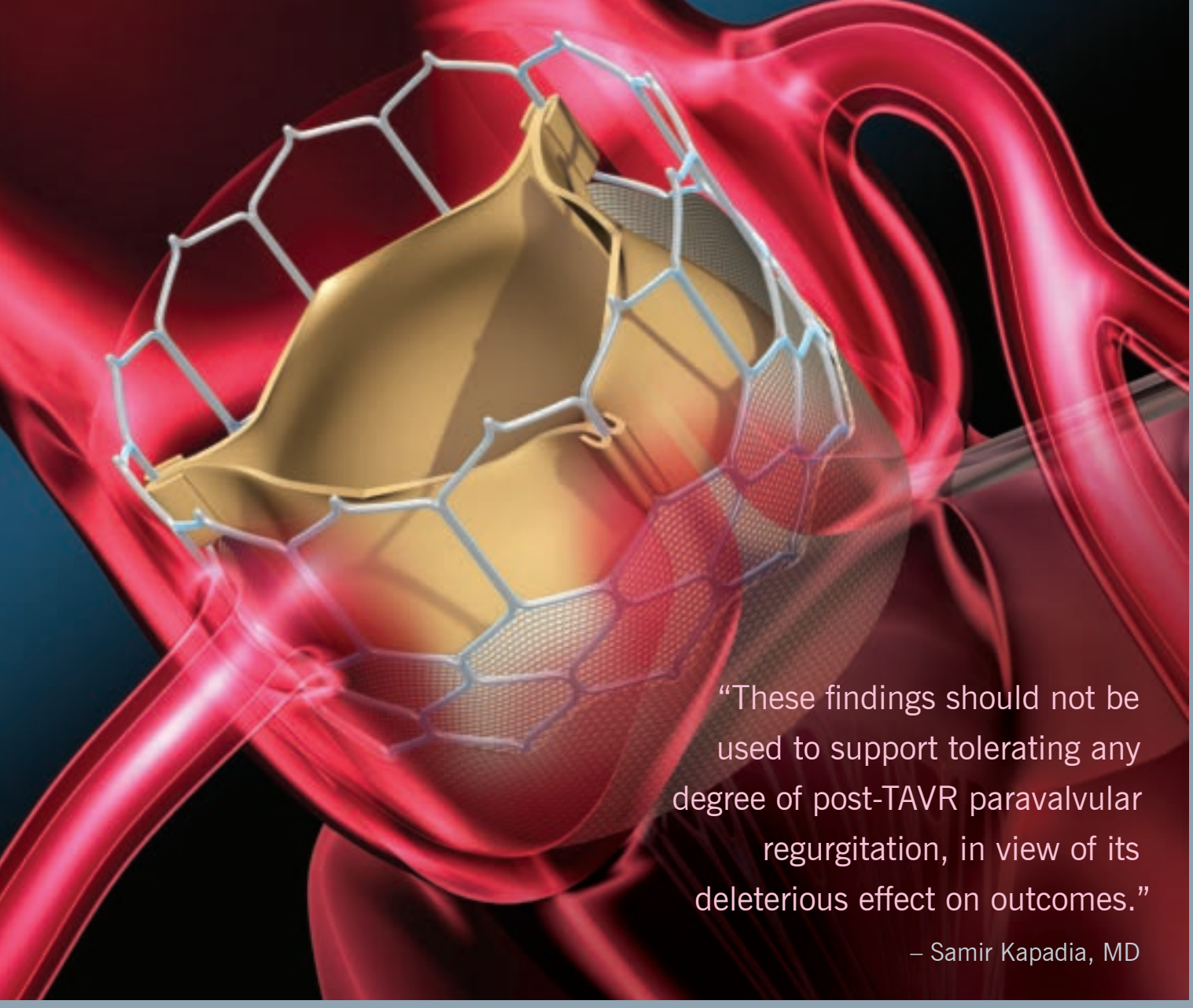
Over median follow-up of 27 months, the following key outcome findings emerged:

- Cumulative long-term survival was greater in the MAVD group than in the pure AS group ($P = 0.03$), including after propensity score matching and multivariate logistic regression. Three-year survival was also significantly higher in the MAVD group.
- Post-TAVR aortic regurgitation developed at a higher rate in the MAVD group (22.1%) than in the pure AS group (14.4%) ($P = 0.001$). In both groups, the large majority of post-TAVR aortic regurgitation was mild.
- Among patients who developed post-TAVR aortic regurgitation, survival was greater in the MAVD group ($P = 0.04$), but among those who did not develop post-TAVR aortic regurgitation, survival was comparable between the two patient groups ($P = 0.11$).
- Secondary outcomes — which consisted of various safety and clinical efficacy measures within 30 days after TAVR — were comparable between the two patient groups.

Making sense of the findings

"These findings suggest that hearts that were previously exposed to aortic regurgitation — in the form of mixed aortic valve disease — before TAVR may be better able to tolerate mild aortic regurgitation after TAVR," says Dr. Kapadia. "This could explain our observation of better survival in the patients with mixed disease, which notably extended specifically to those who had post-procedural regurgitation."

He hypothesizes that this could be due to remodeling of the left ventricle resulting from volume overload related to the prior aortic regurgitation. In contrast, the ventricle is apt to be hypertrophied and have minimal compliance in patients with pure AS, reducing its tolerance of aortic regurgitation following TAVR.



"These findings should not be used to support tolerating any degree of post-TAVR paravalvular regurgitation, in view of its deleterious effect on outcomes."

– Samir Kapadia, MD

"In any case," Dr. Kapadia notes, "these findings should not be used to support tolerating any degree of post-TAVR paravalvular regurgitation, in view of the demonstrated deleterious effect of regurgitation on patient outcomes."

What about surgical AVR?

"It's worth noting that similarly mixed results have been observed in studies of survival among patients with mixed aortic valve disease following surgical AVR," says James Yun, MD, a Cleveland Clinic cardiothoracic surgeon not involved in the current analysis.

He adds, however, that whether the current findings extend to surgical AVR remains to be determined. "Large, prospective, randomized trials are needed to ultimately validate these interesting findings with regard to TAVR for mixed aortic valve disease, and certainly with regard to surgical AVR or aortic valve repair in the setting of mixed disease," Dr. Yun observes.

"The incidence of mixed aortic valve disease is projected to rise due to continued aging of the population and a parallel increase in degenerative valve disease," concludes Dr. Kapadia. "So this will be a growing research priority." ■

Contact Dr. Kapadia at 216.444.6735 and Dr. Yun at 216.445.7845.

Bringing New Efficiency Standards to Cath Lab Ops

How Cleveland Clinic helped an alliance partner improve on-time starts and more

Cleveland Clinic's Miller Family Heart, Vascular & Thoracic Institute has maintained a long-standing alliance relationship with the MedStar Heart & Vascular Institute at MedStar Washington Hospital Center, MedStar Union Memorial Hospital and MedStar Southern Maryland Hospital Center in the Baltimore-Washington metro region. This formal relationship offers value through a variety of in-depth services provided by Cleveland Clinic, including the sharing of clinical and quality best practices.

Cleveland Clinic also supports its alliance and affiliate colleagues by promoting strategies to assess operational efficiency, resource utilization and standardization to enhance patient throughput and caregiver workflow. An ongoing collaboration between Cleveland Clinic and MedStar Southern Maryland Hospital Center (MSMHC) around one set of these strategies — aimed at reducing late starts and between-procedure turnover times in the cardiac catheterization lab — initiated an efficiency project at MSMHC in the spring of 2018. That project is the focus of this case study in collaboration.

Analyzing the data

After identifying cath lab efficiency improvement as a priority, MSMHC leadership recognized that two elements would be crucial to success: the engagement of physician operators, and the leadership of a physician champion to facilitate changes.

Such leadership was obtained early in the cath lab initiative when interventional cardiologist William Suddath, MD, joined MSMHC as Chairman of Cardiology and medical director of the cardiac catheterization lab. Dr. Suddath came from MedStar Washington Hospital Center and was a well-known leader in cardiac care in the region.

To determine opportunities for improvement in cath lab efficiency, Dr. Suddath worked with Director of Cardiology Services Ora Reaves, MBA, RN, and the MSMHC cath lab team to collect data requested by the Cleveland Clinic clinical and continuous improvement teams that were advising MSMHC. Specifically, the requested data were time stamps that provided information on the following:

- Scheduled procedure start time
- Patient arrival time
- Time when patient is prepped and ready
- Time of patient arrival in cath lab (wheels in)
- Physician arrival time
- Actual procedure start time as defined by lidocaine administration
- Procedure end time
- Time of patient departure from lab (wheels out)

When the MSMHC team and Cleveland Clinic clinical and continuous improvement teams analyzed the data, they realized that invasive procedures — specifically the first procedures on the daily schedule — were not starting on time. The data further showed that when the first case starts late, all subsequent cases start late as a result, leading to scheduling difficulties and lab utilization inefficiencies that increase the cost of care and result in decreased patient and employee satisfaction.

Additionally, Ora Reaves and her team conducted a manual audit of patient documentation to identify reasons for the case delays so they could be addressed by Dr. Suddath.

Engagement and accountability

The Cleveland Clinic clinical and continuous improvement teams recommended that MSMHC address these findings by enforcing a mandatory start time that would hold physicians and cath lab staff accountable for procedures starting on time.

Dr. Suddath was tasked with enforcing the rule — which he calls "bringing the MedStar culture" — among the physician staff, which includes both MedStar physicians and many independent practitioners. The expectation is that all operators are to be present and ready to begin their procedures on time, as is consistent with the MedStar culture of efficiency and accountability, or lose the opportunity to have first-round cases.

The nursing and technical staff are also held accountable for having patients ready on time for their procedures, with this oversight ensured by Ora Reaves.

Results to date

In July 2018, only 20% of the first cases of the day started on time. Since then, as detailed in the graph below (left), this percentage has grown to levels approximately three times that rate, reaching 61% in the most recent month reported.

Another key metric has been room turnover time, or the interval between the wheels-out time of one case to the wheels-in time of the next case. The MSMHC team believed their room turnover times, which averaged 68 minutes in July 2018, could be shortened considerably to a target of 25 minutes. Their Cleveland Clinic clinical and continuous improvement partners provided recommendations on team members' roles and responsibilities to help "turn" the cath lab more efficiently between cases. These included process improvements made in pre-procedure documentation, scheduling and room utilization. Ora Reaves was able to come to Cleveland Clinic to observe these processes firsthand in September 2018.

The improvement in cath lab efficiency also resulted in greater work-life balance and employee satisfaction for lab nurses and technicians, which will promote staff retention.

As detailed in the graph below (right), implementation of these recommendations in mid-2018 was associated with a swift and generally steady decline in room turnover times, with MSMHC achieving times well below its target of 25 minutes in the two most recent months reported.

"There are so many people who deserve credit and recognition for these improvements because of their hard work," says Dr. Suddath.

"This is no small feat," notes Christopher Bajzer, MD, who is part of the Cleveland Clinic clinical team that works with MSMHC under the alliance partnership. "What the MSMHC team has accomplished in such a short time under Dr. Suddath and Ora's leadership is amazing."

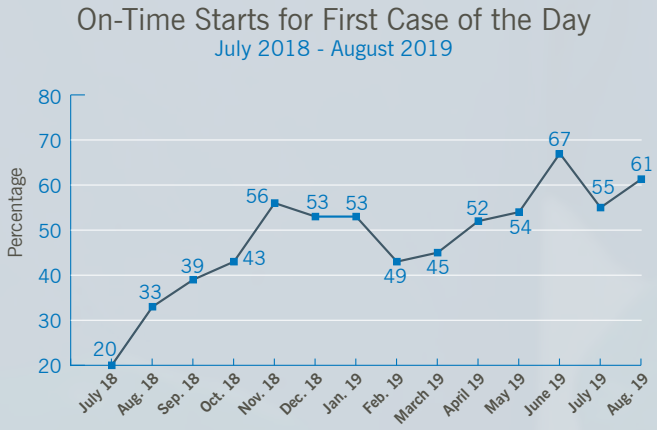
More initiatives underway

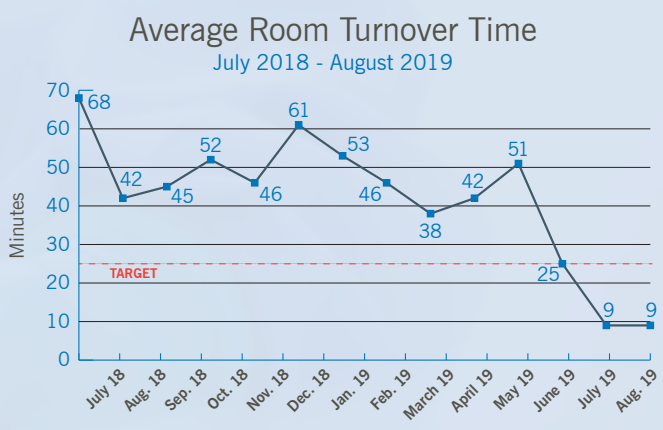
On the heels of these successes, MSMHC has undertaken other quality improvement efforts, including an initiative to decrease hospital transport time from areas of rural southern Maryland to MSMHC using state of Maryland air transport for patients with suspected ST-elevation myocardial infarction (STEMI).

Reduction of STEMI mortality has been a focus of collaboration between Cleveland Clinic and MSMHC. STEMI identification in the field and time to treatment have been identified as opportunities by Dr. Suddath. The aim is to eliminate the use of ground transport to take STEMI patients to the closest hospital, which then often requires transporting them again to MSMHC for cardiac intervention. "Transporting suspected STEMI cases directly to MSMHC by air, with the help of the state, is estimated to cut transport time by 66%," notes Dr. Suddath.

In support, Cleveland Clinic has supplied its protocols to help effectively triage and transfer patients. "We commend Dr. Suddath and the MSMHC team for undertaking this initiative," says Dr. Bajzer. "The quicker you get a STEMI patient to treatment, the better the chances of survival and recovery. We look forward to seeing this initiative in action and the effect it will have on MSMHC's door-to-door-to-balloon time and first medical contact to reperfusion." ■

For information on affiliation and alliance opportunities with Cleveland Clinic's Heart, Vascular & Thoracic Institute, visit clevelandclinic.org/heartaffiliates.

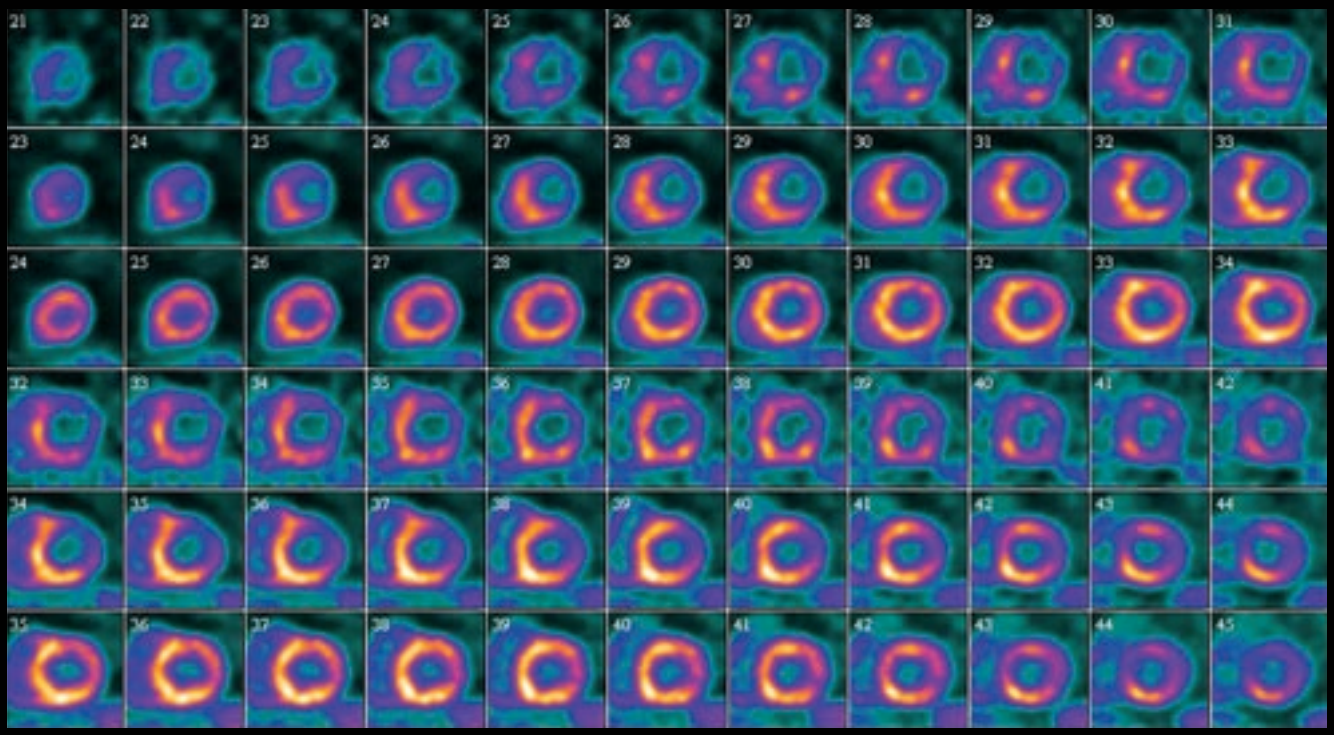




A Novel Risk Classification Scheme for SPECT-MPI

A Cleveland Clinic-developed tool guides referrals and predicts mortality.

A novel risk classification scheme for single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI) studies can predict mortality and successfully guide referral for revascularization and angiography, according to a recent prospective study of the Cleveland Clinic-developed tool. Researchers presented the appropriate use criteria (AUC)-derived scheme and study results at the American Heart Association's 2019 Scientific Sessions in November.



The new risk tool incorporates the amount of myocardium at risk, the presence of scar, ventricular function and response of the ventricle to stress. The score is incremental rather than binary (ischemia/no ischemia) and uses various thresholds to confer risk.

"We developed this holistic tool specifically to avoid overusing these tests," says senior investigator Wael Jaber, MD, a cardiologist in Cleveland Clinic's Section of Cardiovascular Imaging, "and to ensure that the stress test is reported in a way that's useful for making decisions about referral to either revascularization or medical therapy."

An effort to 'choose wisely'

The classification scheme arises amid a multiyear effort from the American Board of Internal Medicine called Choosing Wisely®, a national campaign to avoid unnecessary tests across all areas of internal medicine. The American Society of Nuclear Cardiology published AUC in 2009 for SPECT-MPI, as well as a simplified list of five do's and don'ts (see choosingwisely.org) as part of the Choosing Wisely campaign launch. Generally, the criteria exclude routine testing, general screening and testing in low-risk patients.

"We are seeing an overall downward trend in the use of these tests as a result, but we need to ensure that we select patients according to a risk paradigm that makes sense," says Dr. Jaber. "Until our study, the AUC for SPECT-MPI had not been tested in this clinical practice setting."

Testing the risk classification scheme

The research team conducted a prospective study of patients who underwent SPECT-MPI at Cleveland Clinic from 2015 to 2017. They used a proprietary schema to stratify patients for scan risk — low, intermediate, high or indeterminate — and then assessed whether patients were referred for revascularization and angiography within 90 days of the study. They also tracked mortality.

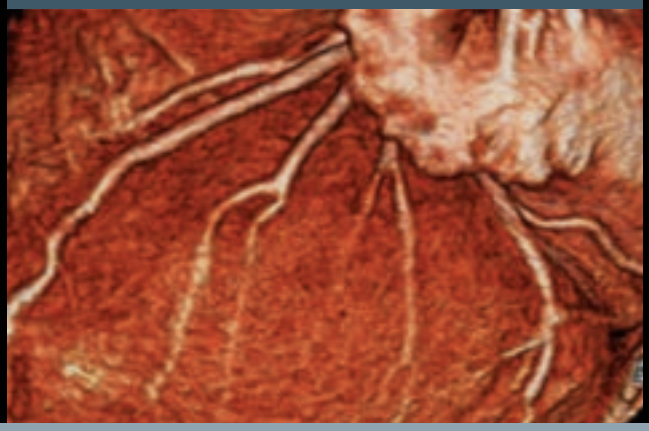
The study captured 12,799 patients with a median age of 67 years. Exercise studies were performed in 37.2% of patients.

Using the novel classification scheme, patients were stratified into risk groups as follows:

- High risk, 5.2%
- Intermediate risk, 9.9%
- Low risk, 83.6%
- Indeterminate risk, 1.3%.

Compared with patients at low/indeterminate risk, patients with intermediate/high risk were referred more frequently for revascularization ($P < 0.001$) and angiography ($P < 0.001$), even after adjusting for the presence of ischemia or scar (hazard ratio = 1.74 [95% CI, 1.52-1.97]; $P < 0.001$).

At mean follow-up of 2.3 years, mortality tracked with risk classification, increasing incrementally from 4.1% in low-risk patients to 10.4% in high-risk patients ($P < 0.001$). Differences in findings for pharmacologic versus exercise SPECT-MPI were not significant.



"[This tool] has allowed us to standardize how we manage patients with stable ischemic heart disease undergoing stress testing."

– Wael Jaber, MD

"Interestingly," says Dr. Jaber, "doctors referring these patients for stress tests, without knowing the intent of this project, respected the results of the test and risk classification and rarely referred patients for invasive testing if they were deemed low risk."

The risk classification scheme in practice

Current strategies base referral decisions on clinical data and noninvasive testing coupled with clinical judgment. This new classification scheme incorporates all known risk factors into a proprietary score to provide an evidence-based tool for making referral decisions.

"Currently, we use this tool across all Cleveland Clinic campuses," says Dr. Jaber, who notes that commercialization of the tool is being explored. "It has allowed us to standardize how we manage patients with stable ischemic heart disease undergoing stress testing."

He points out that the scheme serves as an effective decision-making tool that aligns with the Choosing Wisely campaign's goal to reserve invasive procedures for patients with test results indicating high risk. "Our prospective data show that this tool works and can be used widely in practice," he observes.

"This tool represents an important effort to identify high-risk patients with stable coronary artery disease using noninvasive testing," adds Cleveland Clinic Cardiovascular Medicine Chair Samir Kapadia, MD, who served as a study co-investigator. "It promises to be particularly relevant when clinicians want to implement results of the ISCHEMIA trial in practice." ■

Contact Dr. Jaber at 216.444.8305 and Dr. Kapadia at 216.444.6735.

Are You Making the Best Use of Echo in Your Practice?

State-of-the-Art Echocardiography

Fri.-Sun., Oct. 2-4, 2020
Hilton Downtown Cleveland | Cleveland
ccfcme.org/echocardio20

Echocardiography is one of the most ubiquitous tools in heart care, but advances are changing how and when it's used. Are you making the most of it in your practice?

Learn the latest from a lineup of Cleveland Clinic experts at "State-of-the-Art Echocardiography," a 2.5-day CME event in Cleveland early this autumn.

"This will be a comprehensive update on a technology that pervades cardiac clinical practice," says activity director Richard Grimm, DO, Director of Echocardiography at Cleveland Clinic. "We'll discuss the most current and relevant research studies, new guidelines and noteworthy technical innovations to keep attendees on the leading edge of this field."

Practical issues, real-world cases

The course devotes multi-presentation sessions to exploring various aspects of diagnosing and/or managing aortic stenosis, mitral regurgitation, endocarditis, adult congenital heart disease, cardiomyopathy, structural heart disease and heart failure — the latter with an emphasis on device therapies.

To ensure every key facet of echocardiography is covered, Saturday afternoon of the course features an array of 15-minute presentations on special topics, such as incorporating strain imaging in practice and using echo in cardio-oncology.

Ample time is allotted for attendees' questions throughout.

"We'll showcase practical issues using real-world cases," says activity director Brian Griffin, MD, Section Head of Cardiovascular Imaging. "Expert panels of cardiologists, interventional cardiologists, cardiac surgeons and cardiothoracic anesthesiologists will debate some of the most challenging cases and invite audience participation."

Topics will be explored from multiple angles. For instance, the course's final morning is devoted to a dozen different aspects of structural heart disease. "Attendees will come away with a detailed understanding of the imaging and procedural techniques for structural disease and how they fit together," says Section Head of Interventional Cardiology Amar Krishnaswamy, MD, one of over two dozen Cleveland Clinic faculty for the course.

Hands-on workshops

Attendees also are encouraged to practice echocardiography skills during optional hands-on workshops on the following:

- 3D image and multiplanar reconstruction/display, with an emphasis on structural heart interventions
- Echocardiography simulation lab focusing on transthoracic echo, transesophageal echo and point-of-care ultrasound
- Incorporating strain, 3D volume/ejection fraction quantification and 3D multiplanar image reconstruction into your practice

Who should attend?

"If you're preparing for initial certification or maintenance of certification assessment in general cardiology or echocardiography boards, this course is for you," says activity co-director L. Leonardo Rodriguez, MD, of the Section of Cardiovascular Imaging. "Consider it a 2.5-day review session of echo insights that all practicing heart specialists should know."

"Cardiac sonographers will also benefit," adds Dr. Grimm, "both from the sharing of technical tips and pearls and from enhanced understanding of the clinical relevance of imaging findings resulting from the case-based format."

The course is offered in cooperation with the American Society of Echocardiography (ASE), with discounted registration offered to ASE members. ■

For more details and registration, visit ccfcme.org/echocardio20. Early-bird registration rates apply through July 1, 2020.

This activity has been approved for *AMA PRA Category 1 Credit™*.

Research Roundup Quick Takes on Recent Cardiovascular Studies of Note

WRAP-IT Substudy Documents Huge Impact of CIED Infections

Infections after changes or revisions to cardiac implantable electronic devices (CIEDs) have enormous clinical and financial impacts, according to the first large prespecified study of the clinical and economic effects of CIED infection. The analysis was planned as part of the 7,000-patient WRAP-IT trial led by Cleveland Clinic researchers. That study showed a 40% reduction in major CIED infections within 12 months of a CIED procedure among those receiving an antibiotic-eluting envelope for their CIED (*N Engl J Med*. 2019;380:1895-1905).

The new analysis, presented at the American Heart Association 2019 Scientific Sessions, explored the impact of the 75 major CIED infections that occurred during WRAP-IT. It revealed a host of negative effects of CIED infection, including a threefold rise in 12-month mortality, therapy interruption lasting from days to over a year, multiple extra clinic visits and hospitalizations, and thousands of dollars in losses for hospitals for each infection. "CIED infection is a major event," says lead author Bruce Wilkoff, MD. "These real-world data underscore the need for systemwide efforts for infection prevention." More at **consultqd.clevelandclinic.org/wrapitsubstudy**.

Use Both MR Severity and Infarct Size to Assess Risk in Ischemic Cardiomyopathy

Cardiac MRI offers significant prognostic value in assessing patients with ischemic cardiomyopathy (ICM), thanks to its ability to quantify the interaction of ischemic mitral regurgitation (IMR) severity and infarct size. So finds a retrospective Cleveland Clinic study in *JACC: Cardiovascular Imaging*. Researchers evaluated 578 patients with a diagnosis of ICM with left ventricular (LV) systolic dysfunction referred to Cleveland Clinic for cardiac MRI assessment from 2002 to 2013. Cardiac MRI was used to quantify infarct size as the proportion of LV mass and to quantify IMR using the mitral regurgitant fraction (MRFraction), an index of MR severity that accounts for LV stroke volume. Over mean follow-up of 4.9 years, both large infarct size (≥ 30% of LV mass) and significant IMR (MRFraction ≥ 35%) were strongly associated with all-cause mortality or transplant ($P = 0.008$) regardless of surgical intervention. Patients with small or moderate infarct size and significant IMR had no significant increase in mortality or transplant. "Ischemic MR severity is not sufficient for accurate prognosis," says co-author Deborah Kwon, MD. "It must be evaluated in the context of infarct size." More at **consultqd.clevelandclinic.org/cardiacmr**.

Bare Metal Stents Hold Their Own in Chronic Mesenteric Ischemia

Use of ostial flaring techniques during endovascular stent placement in the superior mesenteric artery (SMA) for chronic mesenteric ischemia (CMI) has put patency outcomes for bare metal stents on par with those for covered stents. So finds a review of Cleveland Clinic's experience with bare metal stents in 150 CMI patients from 2003 to 2014 (*J Vasc Surg*. 2020;71:111-120). For interventions on the celiac axis, primary patency was 86% at one year and 66% at three years; secondary patency at three years was 100%. For interventions on the SMA, primary patency was 81% at one year and 69% at three years; secondary patency at three years was 96%. Outcomes steadily improved over the 12-year study.

"We leveraged our experience with fenestrated stent grafting to flaring visceral stents to allow for better ostial expansion and easier retreatment of restenosis during this period," says Cleveland Clinic Vascular Surgery Chair Sean Lyden, MD. "In the current era, bare metal stents deliver patency comparable to the costlier option of covered stents for CMI. Our experience indicates that the costlier option is not defensible without evidence from a randomized comparative study." More at **consultqd.clevelandclinic.org/baremetal**.

CRT Nonresponse: Detection and Care Are Coming Up Short

Centers that implant cardiac resynchronization therapy (CRT) devices tend to overestimate the success of CRT due to inadequate criteria for assessing response, concludes a prospective analysis of the ADVANCE CRT heart failure registry. Participating sites (N = 69) enrolled patients up to 30 days after implantation of a CRT pacemaker or defibrillator with quadripolar LV leads. CRT response was assessed at six months using site-specific criteria and also with the patient's clinical composite score, an established standard for heart failure assessment.

Of 1,327 patients, 20% were classified as nonresponders based on site-specific criteria versus 31% based on clinical composite score ($P < 0.001$). "This reveals a lack of consensus on how CRT nonresponse should be assessed and treated," says Cleveland Clinic's Niraj Varma, MD, PhD, lead author of the study (*J Am Coll Cardiol*. 2019;74:2588-2603). Even when CRT nonresponders were accurately identified, 44% received no effective additional treatment. "Some physicians may not know what to do with CRT nonresponders," Dr. Varma says. More at **consultqd.clevelandclinic.org/advancecrt**.

Cleveland Clinic

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Cardiac Consult

Live CME Events from Cleveland Clinic

Emerging Concepts in Cardiac Electrophysiology: The Present and the Future

Tues., May 5, 2020, 6:30-9:15 p.m.
(complimentary dinner program)
Marriott Marquis San Diego Marina | San Diego

An official educational satellite session at Heart Rhythm 2020

Information/registration:
ccfcme.org/epconcepts2020

Lead Management 2020: Predicting Risks, Strengths and Limitations

Wed., May 6, 2020, 6:30-9:15 p.m.
(complimentary dinner program)
Marriott Marquis San Diego Marina | San Diego

An official educational satellite session at Heart Rhythm 2020

Information/registration:
ccfcme.org/leadmgmt2020

2nd Multidisciplinary Master Class in Endocarditis and Other Cardiovascular Infections

CANCELLED

Thu.-Fri., May 14-15, 2020
InterContinental Hotel & Conference Center | Cleveland

Information/registration:
ccfcme.org/endocarditis20

Heart Failure 2020

Fri., July 31, 2020
InterContinental Hotel & Conference Center | Cleveland

Information/registration:
ccfcme.org/heartfailure2020

21st Annual Intensive Review of Cardiology

Sat.-Wed., Aug.15-19, 2020
InterContinental Hotel & Conference Center | Cleveland

Information/registration:
ccfcme.org/cardioreview20

Global EP 2020

Fri-Sat., Sept. 11-12, 2020
Hilton Cleveland | Cleveland

Information/registration:
ccfcme.org/globalep2020

State-of-the-Art Echocardiography

Fri-Sun., Oct. 2-4, 2020
Hilton Cleveland | Cleveland

Information/registration:
ccfcme.org/echocardio20
(see page 18 for more detail)

These activities have been approved for *AMA PRA Category 1 Credit™*.

19-HRT-5597

Aorta Surgery*

2.9% operative mortality in latest 12-month period** (N = 1,111)
(no predicted rate available)

2.0% operative mortality **for elective cases** in latest 12-month period** (N = 890)
(no predicted rate available)

*Aorta surgery data are from the Society of Thoracic Surgeons Adult Cardiac Surgery Database and thus do not include vascular surgery cases.
**10/1/2018 - 9/30/2019

For more data like this, visit clevelandclinic.org/hvtioutcomes and clevelandclinic.org/e15

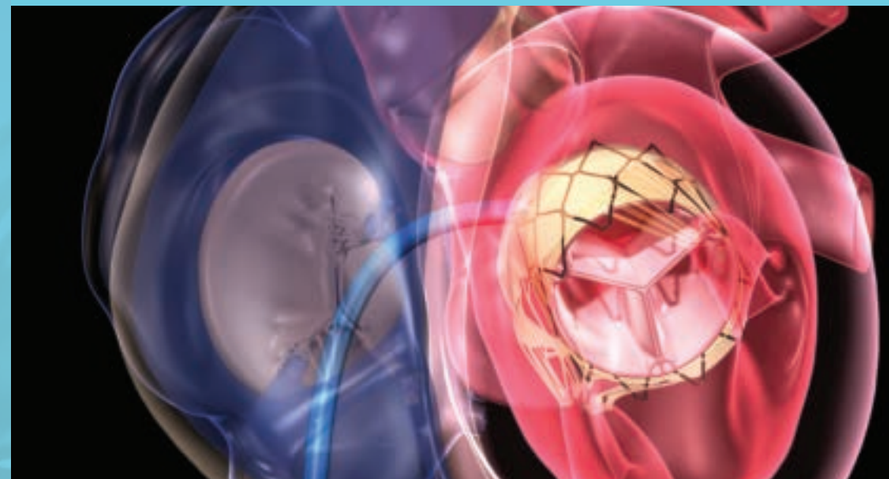
Cleveland Clinic

19-HRT-5999

HEART, VASCULAR & THORACIC

Vitals

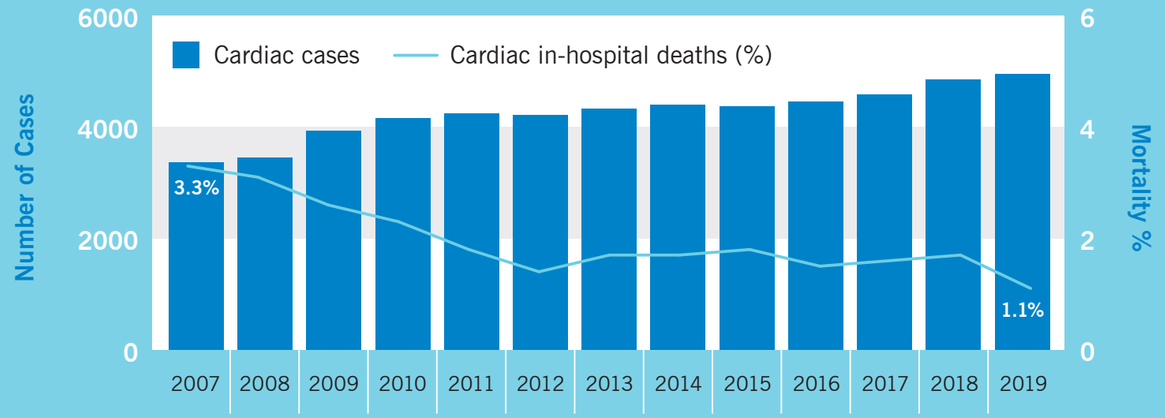
Volumes and outcomes from a sampling of centers in Cleveland Clinic's Miller Family Heart, Vascular & Thoracic Institute



- Adult Cardiac Surgery
- Valve Surgery
- Aorta Surgery

Adult Cardiac Surgery

Adult Cardiac Surgery Mortality Declines Even as Volume and Case Complexity Increase



Case complexity increased over this period, with 60% of patients in 2019 requiring operations more complex than those classified by the Society of Thoracic Surgeons.

Aortic Valve Replacement (AVR)

SURGICAL AVR OPERATIVE MORTALITY

0% for isolated AVR in latest 2-year period* (N = 737)
(vs. 1.3% STS predicted mortality)

1.2% for AVR + CAB in latest 12-month period** (N = 171)
(vs. 3.2% STS predicted mortality)

TRANSCATHETER AVR PROCEDURAL MORTALITY

0% in calendar year 2019 (N = 696)
(no predicted rate available)

Mitral Valve Repair and Replacement

ISOLATED MITRAL VALVE REPAIR

0% operative mortality among 2,333 cases from 2014 through 9/30/2019
(vs. 0.6% STS predicted mortality)

ISOLATED MITRAL VALVE REPLACEMENT

1.3% operative mortality in latest 12-month period** (N = 153)
(vs. 3.9% STS predicted mortality)

*10/1/2017 - 9/30/2019 | **10/1/2018 - 9/30/2019 | STS = Society of Thoracic Surgeons; CAB = coronary artery bypass