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The American Society of Echocardiography (ASE) is a professional organization of over 17,000 physicians, cardiac sonographers, nurses, and scientists involved in echocardiography, the use of ultrasound to image the heart and cardiovascular system. The Society was founded in 1975 and is the largest international organization for cardiovascular ultrasound imaging.

ASE'S MISSION
ASE is committed to excellence in cardiovascular ultrasound and its application to patient care through education, advocacy, research, innovation, and service to our members and the public.

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"Burnout" is all over the news and the focus of many articles and lectures. Why has this risen to the top of our current consciousness? Perhaps the culminating effects of our fast-paced lifestyle, especially the increasing prevalence of electronics immersed in our activities. Today you can be reached around the clock and across the globe with the expansion of Wi-Fi on planes, buses, etc. You can never really get away from work. The ways we develop to cope with this new "normal" are varied; in this issue our executive committee discusses their methods (article found on page 5).

During the Foundation's humanitarian outreach to Yan'an, China in September, our team used the "WeChat" app to communicate with one another and with our colleagues from the Xi'an hospital. The result was that my phone would be "binging" news and pictures at all hours as people were on different time zones and sleep patterns. This sparked a discussion of what members of the team did to take a break from work. I related that as a family, we follow the same rules as we instituted for my daughter, i.e. all electronics must be plugged in at night in our kitchen, far away from our bedrooms where they could disturb our sleep. This, plus a regular dose of walking each day, helps build my resilience to this overly busy world, and keeps me energized about work, even after 18 years at ASE. I hope you too are mindful of your need to recharge. Got your own tips to share? Spark the conversation on ASE's Twitter page @ASE360 #resilience and inspire others to do the same!

Robin Wiegerink, CEO

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EDITORS' NOTE

ASE is very grateful to our members who contribute to Echo magazine and values their willingness to share personal insights and experiences with the ASE community, even if they may not be in total alignment with ASE's viewpoint.

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Focus on LEADERSHIP

As a successful medical professional, how do you take care of yourself and stay resilient?

MADHAV SWAMINATHAN, MD, FAHA, MMCi, FASE

PRESIDENT, ASE
DUKE UNIVERSITY HEALTH SYSTEM

"The pressure of productivity and the expectation of efficiency in an imperfect system have placed a heavy burden on all of us. Having firmly established itself as a healthcare crisis in the United States, burnout seems to be agnostic of specialty, level of training, gender, or ethnicity. While we can await organizational strategies that are directed towards improving the culture of professional relationships, shift management, and inclusion in the hierarchy decision making, implementing personal strategies for staying resilient and keeping burnout at bay is an imperative.

For me, personal resilience is a function of managing time efficiently and promoting positive psychology. I have been extremely fortunate to have a strong support structure around me that helps me counterbalance negative forces with positive energy.

First, managing time seems to be a universally challenging phenomenon for most of us. My personal strategy is to choose my battles wisely and, in the process, learn to say "No" gracefully. When opportunities present themselves to write, speak, or participate in any project, I carefully assess the time commitment and determine where it falls in my hierarchy of priorities and whether it aligns with my personal and professional goals. If it does, I'll find time and space. If it doesn't, or if I cannot commit appropriate time, I'll respectfully decline, but suggest a suitable alternative for the work. Without a plan, this strategy usually fails, and the pressure to deliver resumes, increasing the risk of fatigue. I've learned over the years that saying "No" gracefully makes my "Yes" more valuable and reliable. Mentorship and coaching is crucial for this strategy to be successful. Having someone to guide me has been invaluable in this effort.

> I've learned over the years that saying "No" gracefully makes my "Yes" more valuable and reliable.

Second, positive psychology is a valuable ally for enhancing my personal resilience. I ensure I commit time with my family, especially my wife, who coaches me when I struggle with exhaustion. Spending time exploring local restaurants, and carving time out for creating art with colors on canvas help me be a more effective professional. I try and express gratitude to my colleagues for doing what they do (including custodial staff and leadership alike), which helps my own positivity a great deal.

Being successful isn't my goal, resilience is. Success usually follows.

This is an incredibly relevant question as healthcare professionals are struggling increasingly with physical and mental exhaustion or 'burnout.' The reasons for this are multifactorial and will need a multi-faceted solution. This is why the ASE Cares campaign is so important. The ASE Cares Campaign provides wellness initiatives for ASE members and promotes the well-being of all cardiovascular ultrasound professionals in their communities. I have learned through personal experience that taking care of yourself, both mentally and physically, should be a priority. You need to make time for yourself whether it be early, during, or after work. I take 15-30 minute breaks during the day to meditate and or take power naps. Recently, I have been biking to work which I really enjoy and look forward to. After an hour ride along the river, my mind and body are refreshed. I have so much more energy at work when I bike in. Getting enough sleep is another priority for me and helps keep me resilient.

JUDY W. HUNG, MD, FACC, FASE

PRESIDENT-ELECT, ASE
MASSACHUSETTS GENERAL HOSPITAL

Taking care of yourself is important to ensure that you are always functioning at your highest level and able to provide the best care for your patients. As a healthcare provider, it is easy to always put others first and neglect ourselves. Thus, it is important to schedule time for yourself doing an activity you enjoy to keep yourself fresh. For myself, I have started actually scheduling time on my calendar to be able to work out. I find if I actually add working out to my calendar, I am more likely to do it – and I do feel refreshed and more energetic after a good workout. For me, I enjoy doing a mix of yoga and cardio. Yoga to clear my mind, and a good cardio workout to get my heart rate up. I also like to set workout goals to always have something to work towards.

CAROL MITCHELL, PHD, RDMS, RDCS, RVT, RT(R), ACS, FASE

TREASURER, ASE
UNIVERSITY OF WISCONSIN SCHOOL OF MEDICINE AND PUBLIC HEALTH

I believe one of the keys to resilience is the ability to overcome adversity. In my own life, I have felt that my overall well-being should not be tied to circumstances, but to attitudes and practices. At times when I have been overwhelmed, I have often taken a step back, enjoyed a moment of silence, and re-adjusted my thinking. I personally enjoy traveling to our cottage in the Northwoods of Wisconsin, a place I have enjoyed since childhood with my family. In this day and age, it is refreshing to have no cellular service. The lack of service forces me to disconnect from my emails, texts, current events, etc. I find that taking time away from being connected allows me to reflect, get focused, and find that place for a positive outlook on tasks ahead. I try to take action so as not to become paralyzed by the negativity of mistakes or inability to complete a specific task; instead to learn from the challenges in life, find an opportunity for growth, and maintain a positive outlook.

MATT UMLAND, ACS, RDCS, FASE

SECRETARY, ASE
AURORA HEALTH CARE

Raymond F. Stainback, MD, FACC, FASE

Vice President, ASE
Texas Heart Institute

Self-care and resilience strategies were not part of the success manual when I was growing up in the 1960s and 1970s. Like many, I was drawn into cardiology with the following positive and seemingly innocent personal traits:

- Strong desire to serve and nurture others
- Interest in all biological processes
- High capacity for work and delayed gratification
- Stamina (physical and mental)
- Upbeat "I can do it" nature
- Performs well in high intensity, stressful situations

On reflection, this list does not sound very restful or self-nurturing to most bystanders, including significant others and clinical psychologists. I am fortunate to have learned from an early career bout of moderate burnout. Where is the joy? Am I just meant to be tasking? Where did this temper come from? Why am I so tired? Thankfully I grew through this to become more resilient for myself and those who need me, and that feels really good! At first, attention to one's self-care can feel unnatural for care providers, but care is what we can do best. My personal care and resilience strategies are a balancing act that could seem tortuous for some. For me, they seem to work! What are yours?

SLEEP

I need seven hours of sleep; and I am a morning person, waking up and able to do my best work around 5:00 AM. I place creative work such as writing and strategy early in the day, and then I actually enjoy it more. I try to work very hard all day, until around 6:00-7:00 PM when my efficiency declines. Then, I reward myself with any kind of relaxing activity including sports, cleaning, TV, a jog, or collapsing on the couch with no remorse. I am sound asleep by 10:00 PM.

NUTRITION

I eat a healthy substantial breakfast, lunch, and dinner 80% of the time. I don't snack much or eat party food which seems to abound. Reward: good meals with friends and family without too many limits 20% of the time.

EXERCISE

Exercise relaxes me and improves my mood. During the week: I run three miles at least 2 days, including every Tuesday at 5:00 AM with a medical school buddy who is also an affable psychiatrist (perfect for venting and laughing). Two other weekdays: one hour with a fitness trainer at 5:30 AM – scheduled, costs money (no misses). Weekends: Play, team sports, the farm, and extra work time if I need it.

NATURE

In another life, I must have been a farmer. I own a small farm west of Houston, Texas where I manage pasture land, trees, and wildlife. I can tractor for hours, observing the amazing skies, and this peace does follows me to work.

MINDFULNESS PRACTICE

Experiencing emotions and thoughts (e.g., why am I here, what am I doing, why did this happen?) occurs naturally for me during my exercise routines, when performing farm labor, or observing nature. I believe these regular intervals of conscious mindfulness enable me to be more fully present and engaged with work, patients, and colleagues.

SOCIAL LIFE

Where would we be without our friends and family time on a regular basis?

Do I sometimes have long stretches of grueling work and lost sleep? You bet! This too can provide satisfaction of a hard job completed. But, after that, some down time!

> “...a healthy dose of humor goes a long way in easing frustrations

To me, resiliency is a balanced combination of strength and flexibility. This definition should be familiar to those of us who are concerned primarily with the heart, which conceptually is a resilient organ under normal circumstances. As individuals, personal and professional resiliency is tested at every stage of our training, and continues to be tested periodically during our careers as healthcare professionals. In what now seems like the distant past, resiliency used to simply be a measure of how one responded to grueling hours and the stress associated with taking care of the ill and their worried families. Things have changed. Increasingly, we are faced with mandates to learn completely new tasks, such as becoming proficient with the EMR, and to become familiar and compliant with new federal, hospital, insurance, or accreditation policies.

We must also handle the seemingly endless growth in administrative tasks. How we face these stressors is as varied as our own individual personalities. Though I don’t qualify as the biggest fan of college basketball, the great coach Jim Valvano provided a quote that best reflects my philosophy: “If you laugh, you think, and you cry...that’s a full day.” In other words, to me, stoicism is not the same as resiliency. I find it easier to make it through stressful times when I think through stressful situations, and speak up (or even complain) when infractions and stressors are unnecessary or excessive. Perhaps more importantly, a healthy dose of humor goes a long way in easing frustrations and ensuring there is still joy in our daily jobs despite times of stress or burden. I am always amazed at how a witty or funny comment at the right time can be something that helps others find their resiliency as well.

JONATHAN R. LINDNER, MD, FACC, FASE

IMMEDIATE PAST PRESIDENT, ASE
OREGON HEALTH & SCIENCE UNIVERSITY

To recharge and take my mind off of work, I do what I counsel my patients to do...I exercise regularly. This helps me physically as well as mentally. I especially enjoy running, as it allows me to socialize while exercising. Since I also like desserts, the exercise allows me to consume the extra calories with less guilt.

WYMAN W. LAI, MD, MPH, MBA, FASE

COUNCIL REPRESENTATIVE, ASE
CHOC CHILDREN’S HOSPITAL

Burnout & Moral Injury in the Echo Lab

Contributed by: James N. Kirkpatrick, MD, FACC, FASE, Professor of Medicine, Division of Cardiology, University of Washington Medical Center, Seattle, WA

According to Google, "Burnout" is, among other things, "physical or mental collapse caused by overwork or stress." More comprehensively and for the purpose of research studies, burnout is defined in the Maslach Burnout Inventory[1] as a constellation of symptoms that fit under three distinct domains: emotional exhaustion, depersonalization, and decreased personal accomplishment (Figure 1). Much has been made of physician burnout. A recent Medscape survey of 15,069 US physicians across 29 specialties found that 44% of respondents were burned out and 11% met criteria for clinical depression. Female physicians reported higher levels of burnout than males (50% vs. 39%). The most burned out specialists in this survey were urologists (54%) and the least were public health and preventive medicine physicians (28%). Cardiologists and Anesthesiologists were solidly in the middle (43% and 42%, respectively), though internal medicine, emergency medicine, and family medicine ranked higher (48-49% for each). The survey also asked respondents to rate burnout on a seven-point scale. Half of respondents rated their burnout as either four or five.[2] Ten percent of burned-out physicians reported that burnout was leading them to consider leaving medicine. In a separate study reporting on the change over time from 2011 to 2014 to 2017, physician burnout rates were higher at all time points than those of the general population.[3]

The impact of burnout is considerable. Han, et al. estimated the cost breakdown of physician burnout in the United States, finding that turnover and, to a lesser extent, reduced work hours cost the healthcare system $2.6 to $6.3 billion annually. Costs were higher for primary care and other specialties vs. surgeons, and for surgeons <55 years old vs. older surgeons. A greater cost is reflected in the tragedy that the suicide rate for physicians is higher than that of the general population by 40% for men and 130% for women.[4] But burnout impacts patients as well; a recent study suggests that burnout is related to major medical errors and workplace safety.[5]

Although less well studied, sonographer burnout is a significant concern. A study of sonographers in Tennessee found overall burnout scores in the moderate range.[6] Sonographers in Australia and New Zealand were reported to have high burnout scores, with severe emotional exhaustion present in 98.3%, severe depersonalization in 98.2%, and severely decreased personal accomplishment in 34.7%.[7]

What causes burnout? Sonographer burnout has been linked to overtime hours and lack of time spent in training students. Physician burnout has been linked to a wide variety of factors (Figure 2), but paperwork and other bureaucratic tasks seem to be prime contributors, along with long hours at work, the electronic health record, lack of respect at

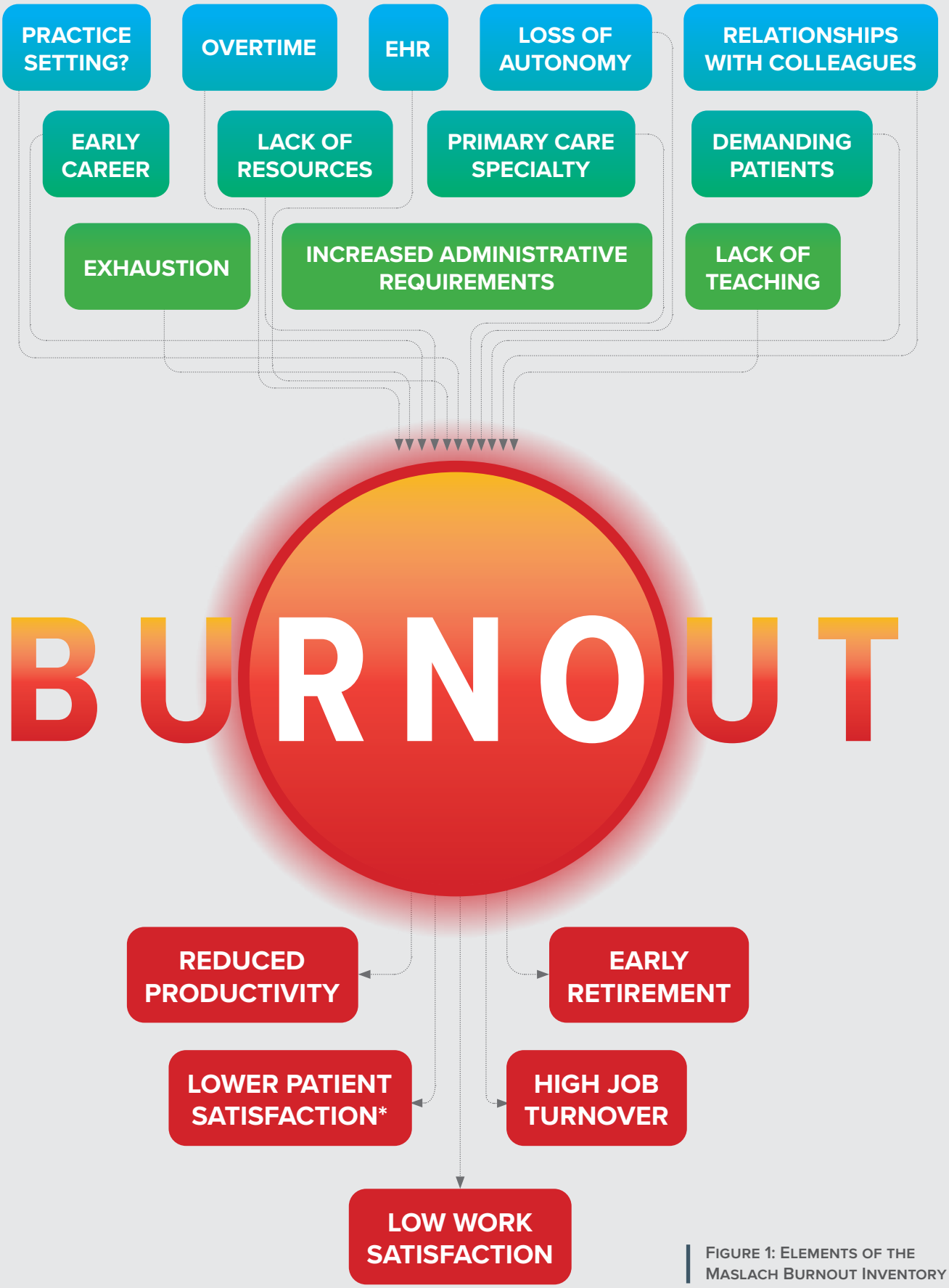

FIGURE 1: ELEMENTS OF THE MASLACH BURNOUT INVENTORY

*Conflicting data: some studies suggest patients are more satisfied with burned out physicians.

work, and perceived insufficient compensation. Interestingly, seven of the top 10 contributors to burnout in the Medscape survey had to do with structural issues in the workplace, rather than personal problems.[2]

This finding is interesting in light of the many solutions that have been proposed to address burnout. Traditionally, institutions and researchers have focused on behavioral health of individuals. Yoga, meditation, counseling, massages, art therapy, personal days, healthy dietary practices, facilitated exercise, and community-building and social events all address, to some extent, emotional exhaustion. Mindfulness training can also equip its practitioners to meet the challenges of work with a healthy cognitive orientation and directly address depersonalization. These practices can be very helpful but they tend not to address structural problems in the workplace that lie at the heart of so much burnout in modern medicine. Attributed to multiple different sources on the Internet, the following quote encapsulates the limits of personal, rather than institutional, methods to address burnout: "Burnout has been called the 'canary in the coal mine' predicting problems in the medical workplace. Well, you can teach a canary to meditate, but it is still going to die."

Furthermore, some have suggested that the term "burnout" pejoratively and inaccurately localizes the problem with medical professionals and their inability to handle "overwork and stress." Dean, et al. suggest a better term is "moral injury," because medical professionals are pulled in multiple different directions by systems that pit quality patient care against things like institutional financial considerations and insurance company rules.[8]

A weighted meta-analysis by Panagioti, et al. provides data to highlight this point. The authors separated studies on burnout intervention into those that addressed the burned-out individual and those that attempted to change the structure of the workplace. While both showed improvements in burnout scores compared to control groups, there was a larger positive effect for structural interventions.[9] In line with these findings, the American Medical Association has developed a "systems approach: beyond encouraging resilience" to burnout. Elements of this process include 1. Implementing a team-based model of care, 2. Enhancing communication based on team huddles/co-location, 3. Developing "float pools" to cover for life events, 4. Ensuring that metrics for organizational success include staff satisfaction and well-being, 5. Developing schedules that promote flexibility and staff control.[10]

CONTRIBUTOR	Emotional Exhaustion	Depersonalization	↓ Personal Accomplishment
RESULT	Overextended	Unfeeling Impersonal response to patients	↓ Feelings of Competence ↓ Achievement in work with people

FIGURE 2: CONTRIBUTORS AND RESULTS OF BURNOUT

In addition to implementing these structural "fixes," are there other ways to address burnout in the echo lab? Proper staffing can help address some of the "moral injury" caused by the perceived inability to provide high quality healthcare. Hurried sonographers, nurses, and physicians with heavy workloads can prevent high quality scanning and interpretation. They are at risk for exhaustion and decreased personal accomplishment. Conversely, sufficient staffing may be a good investment to prevent burnout. Ironically, even though artificial intelligence (AI) creates some consternation over valid concerns about machines replacing people, it may help with moral injury.

Automated measurements may decrease workloads, freeing up time to spend with patients and in thoughtful, high level interpretation. In general, AI and other novel, time saving interventions hold promise in addressing a key aspect of workplace causes of burnout by freeing up time for more satisfying, human interaction.

The American Society of Echocardiography (ASE) recently launched the ASE Cares campaign (https://www.asecho.org/ase-cares-campaign/). This campaign provides wellness initiatives for ASE members, but it also focuses on structural solutions, including nursing stations and childcare at the ASE Scientific Sessions. Although the campaign is new, ASE has been in the business of promoting quality patient care and aligned institutional practices through its guidelines and standards, in particular, the 2011 Recommendations for Quality Echocardiographic Laboratory Operations.[11]

Burnout and moral injury are real phenomena in the echo lab. Methods to increase medical professional resilience can have positive effects, but they should not take the place of organizational interventions to reduce stress in the workplace and enable, rather than impede, high quality patient care. The best interventions will address the key issue that Schwenk captured so well in a recent paper:

> "What all of these features of the current health care system [contributing to burnout] have in common...is their detraction from and disruption of nurturing, satisfying, supportive, and caring relationships with patients."[12]

1 Maslach C, Leiter MP: Burnout: a social psychological analysis, in Sanders G, Suls J (eds): The Burnout Syndrome. Park Ridge, IL, London House, 1982.

2 https://www.medscape.com/slideshow/2019-lifestyle-burnout-depression-6011056?faf=1#28

3 Shanafelt TD, et al. Mayo Clinic Proceedings, 2019

4 Ellison, E. Annal Int Med 2019;170(11):807-808.

5 Han S, Shanafelt TD, Sinsky CA, Awad KM Dyrbye LN, Fiscus LC, Trockel M, Goh J. Estimating the attributable cost of physician burnout in the United States. Ann Inten Med 2019;170(11):784-790.

6 Daugherty, J. JDMS 2002;18:305-12

7 Singh N, et al. Journal of Medical Imaging and Radiation Oncology 61 (2017) 304–310

8 Dean, W, Dean CQ, Talbot SG. "Why 'burnout' is the wrong term for physician suffering." Medscape Jul 23, 2019. https://www.medscape.com/viewarticle/915097?src=wnl_tp10f_190823_mscpedit&uac=90222AK&impID=2054364

9 Panagioti M, JAMA Intern Med. 2017;177(2):195-205. doi:10.1001/jamainternmed.2016.7674.

10 https://www.ama-assn.org/practice-management/physician-health/these-tools-resources-address-physician-burnout-systems-level

11 Picard MH, Adams D, Bierig SM, Dent JM, Douglas PS, Gillam LD, Keller AM, Malenka DJ, Masoudi FA, McCulloch M, Pellikka PA, Peters PJ, Stainback RF, Strachan GM, Zoghbi WA; American Society of Echocardiography. American Society of Echocardiography recommendations for quality echocardiography laboratory operations. J Am Soc Echocardiogr. 2011 Jan;24(1):1-10. doi: 10.1016/j.echo.2010.11.006.

12 Schwenk TL. Physician Well-being and the Regenerative Power of Caring. JAMA. 2018;319(15):1543–1544. doi:10.1001/jama.2018.1539

Figure 1: Awake scan on Jomo

How Do the GREAT APES' HEARTS Compare to Each Other and Humans?

Contributed by: Jennifer Schaaf, BS, ACS, RDCS, FASE, Assistant Manager, Cardiovascular Imaging Services, Technical Director of Echocardiography, The Christ Hospital Health Network, Cincinnati, OH

It was in the early spring of 2010 when the Cincinnati Zoo & Botanical Garden veterinary team contacted The Christ Hospital's Cardiac Imaging Medical Director, Dr. Wojciech Mazur, about supporting their quest for participating in a national cardiac health project. The Great Ape Heart Project (GAHP), which is an organization run by Zoo Atlanta with the Institute of Museum and Library grant funding, is the home of a national database that collects great ape cardiac data from countless zoos and sanctuaries in the United States. The collaborative efforts allow the coordination of experiences and findings through the organization and research activities based at Zoo Atlanta. The echocardiograms most often require an imaging professional to assist with capturing all data necessary for a complete exam. That's where I came in. At the time, I was the Lead Sonographer & Technical Director of our echo lab and jumped on the opportunity to help with this project. Even though my title at the hospital has changed over the years, I have continued to volunteer my time ever since day one and have never looked back.

Some may question the importance of collecting cardiac data of animals in human care. The GAHP clearly states their mission as, "the ultimate goal of reducing cardiovascular-related mortalities and improving the health and welfare of captive great apes." The Cincinnati Zoo has three different great ape species comprised of gorillas, bonobos, and orangutans. Interestingly, the majority of the echoes that I perform at the zoo are "awake," which allows us to collect the echo data without the use of sedation or anesthesia. The zoo staff spends quite a bit of time during training sessions getting the apes to the station to voluntarily expose their chests to the front of their enclosures to allow for us to gain access to the parasternal and apical windows. During this process, the apes receive positive reinforcement, often in the form of grapes. For these awake echoes, the zoo staff, usually the primary keeper who has a good connection with the ape, manipulates the probe on the ape's chest while I work the machine and coach the keeper how to operate the probe. As you can imagine, this can sometimes get a little challenging guiding the keeper on the minute angling required to obtain on-axis images, but with clear communication and experience working as a team over the years, it has gotten much easier. Completion of each scan is heavily dependent upon the cooperation of the ape. When we first started scanning, it would

FIGURE 2: ECHO IMAGE COMPARISON OF A 425LB GORILLA (TOP) VS A HUMAN HEART

take several visits to the zoo to acquire a complete echo partly due to the fact that it was all very new to the apes, as well as the keepers and me. But, with the ape's familiarity of the expectations along with the collaborative efforts between the keepers and myself, we now work like a well-oiled machine and have become quite efficient. We can usually complete several echoes in one visit and perform serial annual awake echoes for our apes.

In addition to the awake scans, I am also present when the apes are anesthetized, which is typically for a physical. During these visits, I perform the echo studies myself. With the zoo staff's help, we are able to maneuver the ape in the optimal left decubitus position, similar to positioning humans for their studies. Echocardiograms have become an adopted staple of the ape physicals. This allows us to collect more data for the national database, and we are also able to compare these studies to the awake findings on the same ape. After each echo is completed at the zoo, I download the images and bring them with me to the hospital to upload to our PACs system. I make additional measurements offline and build the report, and then Dr. Mazur provides the interpretation. From there I send copies of the images and the report to the zoo where the staff keep them on file and send the other copy into the national GAHP database.

How do the great apes' hearts compare to each other and humans? To be completely honest, in my experience of performing hundreds of great ape echoes, I can say that you wouldn't be able to tell the difference between a human and ape echo (see Figure 2). Amongst the great apes, I have found that it is most challenging to acquire images on the orangutans. It's thought that the air pockets on their chests attribute to the challenge of gaining access to adequate windows.

I am sure many people are curious about the findings that we have encountered throughout the years. Interestingly enough, we have come across many similarities to what we find in the human population; diastolic dysfunction across the spectrum of grades, as well as depressed ejection fractions. These important findings have allowed the veterinary staff to treat these apes much like humans with similar findings would be treated, through medical management. Currently, we have an elder gorilla, an elder bonobo, and a middle-aged bonobo being treated with agents such as Lisinopril, Carvedilol, and Enalapril. These particular apes get awake echoes every six months and medications are adjusted if needed.

My involvement in helping our zoo with their apes' cardiac health has been one of the most rewarding experiences of my lifetime. It has allowed me to mesh my love of animals with my passion for echocardiography and for that, I am grateful.

VETERINARY IMAGING CASES NOW INCLUDED IN ASE'S CASE JOURNAL

REBECCA L. STEPIEN, DVM, MS, DACVIM (CARDIOLOGY), UNIVERSITY OF WISCONSIN SCHOOL OF VETERINARY MEDICINE, MADISON, WI, AND ASSOCIATE EDITOR – CASE

In the accompanying article by Jennifer Schaaf, she describes her experiences performing echocardiography on awake and anesthetized great apes. Her recollections provide a perfect opportunity for ASE's online case reports journal, CASE, to introduce the newest section: Veterinary Imaging. This new feature, developed in partnership with the American College of Veterinary Internal Medicine (ACVIM) Specialty of Cardiology, will showcase images and case material submitted by veterinary cardiologists and other human-based or animal-based practitioners performing imaging on non-human animals. Veterinary cardiology covers a wide variety of animals, including not only pet dogs, cats, and horses, but also farm animals, great apes, bears and other zoo animals, aquatic species (e.g. dolphins), and laboratory species. The value of comparative cardiology is apparent when shared pathology is discovered. For example, hypertrophic cardiomyopathy is the most common acquired cardiac disease of domestic cats, interventional catheterization-based procedures for certain congenital heart diseases in dogs are common, and the list of laboratory animal models for cardiovascular disease is long. We invite our veterinary- and human-focused colleagues to share our enthusiasm for cardiovascular imaging in whichever species we specialize, and hope that this new joint venture of the ASE and ACVIM-Cardiology will be a fruitful one. To learn more about how to submit your veterinary case to CASE, visit CVCASEJournal.com.

THE UNINTENDED CONSEQUENCES OF MANDATORY ECHO SCREENING

Contributed by Susan A. Mayer, MD, FACC, FASE,
St. Luke's Mid America Heart Institute, Kansas City, MO

After a tragedy such as the death of a young athlete, there is a rush to "do something" and make sure that it never happens again. Unfortunately, these rapidly created solutions often, while well intended, have unintended consequences. This common reaction is seen when state legislatures introduce legislation or patient groups advocate for mandatory echo screening.

This happened in Texas when Cody Stephens, a Texas student-athlete, died from an undiagnosed heart condition. The response was to introduce House Bill 76, an Act relating to cardiac assessments of high school participants in extracurricular athletic activities sponsored or sanctioned by the University Interscholastic League (UIL). Originally, House Bill 76 mandated that high school students participating in extracurricular athletic activities sanctioned or sponsored by the UIL, who are already required to have physical exams, must also have an electrocardiogram or echocardiogram. In the end, the Texas legislature amended the language and removed the echocardiogram requirement.

We have also seen patient groups advocating that Medicare require coverage of a cardiac ultrasound as a part of the wellness exam. It is easy to understand why these types of proposed legislation and policy changes would garner a great deal of support and be well received. However, mandating echocardiograms could cause some very serious unintended consequences.

While echocardiograms are non-invasive and safe, testing an asymptomatic population can lead to outcomes that are unforeseen and even detrimental. Mandating echocardiogram screening is too broad and runs counter to the American College of Cardiology's AUC guidelines, the American Society of Echocardiography's guidelines, and the American Board of Internal Medicine Foundation's Choosing Wisely campaign. In addition, mandating more testing across the country is premature based on the current state of care in the United States. Echocardiograms need to be conducted by specially trained cardiovascular sonographers and interpreted by trained physicians.

An echocardiogram is the most common imaging test, but it is also the only imaging test that does not require any form of accreditation or credentialing for those giving it. At this point in the U.S., echocardiography labs are not federally mandated to be accredited, unlike those that conduct Computed Tomography, Magnetic Resonance Imaging, and Nuclear studies (i.e. advanced imaging). This means the echo labs that patients visit may not meet minimal quality standards. Mandating additional echocardiograms without the proper safeguards could compromise care and lead to unnecessary testing that could potentially harm patients.

Ensuring appropriate testing not only contains costs but also reduces the possibility of false positive results, which lead to unwarranted further testing that carries additional inherent risks. A false positive result can also lead to possible negative psychosocial consequences or a mistrust of the medical community that impedes cases in the future.

There is also the potential for an increase in the number of false negative results. Such results often lead to false reassurance and the potential for delayed diagnosis. Delays in care may lead to more serious complications and impact a patient's chance of recovery and survival.

The patients bear much of the risk, but the provider is also exposed. Both false positive and negative results may lead to legal action being taken by those affected and may reduce public confidence in screening.

Currently, there is no way to safeguard appropriate use, quality of image acquisition, and interpretation of studies generated through cardiovascular ultrasound. Until there are standards in place to prevent poor quality images by untrained providers, mandatory screening will hamper patient care by adding financial burdens, unnecessary delays, and the potential for further evaluation and testing.

While we all want to ensure the best care is provided, we need to work to see that the right person gets the right test at the right time. In today's current healthcare environment, mandating echocardiography screening poses risks that cannot be ignored and a potential strain on the healthcare system.

ASE Foundation Outreach Event in China Reaches Almost 12,000 People

Contributed by: Mary Carmody, ASE Foundation Manager, Durham, NC

During the first week of September, seven ASE Foundation volunteers participated in free patient scanning and physician training events spanning multiple sites in central China. The week concluded with the 3rd Xijing International Summit Forum on Cardiovascular Ultrasound where the team presented lectures on various heart ultrasound topics alongside Chinese physicians from across the country.

Drs. Janardhanan and Taub scanning

The free patient scanning events took place at three different locations: a children's welfare home in Yan'an, the Ganquan People's Hospital, and the Zhidan People's Hospital. We spent half a day at the children's home and full days at the hospitals. Each day we travelled to a new location but our reception was the same no matter where we were arriving. Staff members lined up outside, clapped their hands, and waved to us as we arrived. It was a truly humbling experience every morning.

Each day of scanning began with a warm welcome and introduction from our hosts. Our volunteers then paired off and were assigned the room where they would be stationed for the day. Chinese clinicians were also assigned to each room and assisted with scanning, scribing the medical reports, and communicating with the patients. Patients' scans were analyzed in real time and dictated to a scribe for inclusion in the patients' medical reports. The arrangement of working side-by-side with local clinicians provided a great environment for sharing knowledge and the perfect opportunity to collaborate and ask questions.

Walking through the hallways at each site, our volunteers were able to appreciate the sheer volume of patients waiting to be seen. It took 40 hospital staff to handle the triage alone at the Ganquan People's Hospital! By the end of the third and final day of scanning, a total of **625** patients had been scanned, and each was provided a copy of their medical report within just hours of their examination.

Our week in China concluded with the 3rd Xijing International Summit Forum on Cardiovascular Ultrasound. Sponsored by the Shaanxi Association of Ultrasound in

Attendees enjoyed receiving the translated ASE guideline poster

Medicine and Engineering and organized by the Ultrasound Department of Cardiovascular and Cerebrovascular Ward of the First Affiliated Hospital of Yan'an University and ASEF. This day of lectures provided the latest international ideas of medicine and innovative results of

medical research. Our team had the great fortune to participate alongside our colleagues in China. The aim of the forum was to improve the abilities of ultrasound practitioners and to promote development in the field of echocardiography. There were over 300 attendees on-site and the lectures were live-streamed to over 11,000 viewers! During the afternoon break, translated copies of the Evaluation of Mitral Regurgitation poster from the Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation guideline document (Zoghbi, et al.) were given away to attendees. This very popular giveaway was in high demand!

The expected long-term, residual impact of this event is a deepening relationship with a potential long-term partner in China, advanced training for clinicians in China, improved patient care in rural areas, cultural and educational exchange, and a unique volunteer opportunity for ASE members.

DR. QIAN YANG FROM XIJING HOSPITAL, ASEF VOLUNTEERS ROBIN BILLMAN, BS, RDCS, CHFN AND DR. FENG XIE WITH HOSPITAL STAFF

BY THE NUMBERS:

PATIENT OUTREACH – **2 ½** DAYS, **3** SITES, **625** PATIENTS SCANNED

TRAINING – **1** DAY, OVER **300** ON-SITE ATTENDEES AND OVER **11,000** LIVE STREAMED ONLINE

This event was supported by the ASE Foundation, its donors, and by a grant from the Edwards Lifesciences Foundation's Every Heartbeat Matters program.

ASEFoundation.org/China-2019

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Dongguan Cardiovascular and Cerebrovascular Disease Specialist Ward of the First Affiliated Hospital of Yan'an University

Industry Supporters:

Siemens Healthineers

Philips China

Hitachi

Scanning Little Hearts in Africa

ASE FOUNDATION RETURNS TO KENYA

CONTRIBUTED BY ANDREA M. VAN HOEVER, MSGH
ASE DEPUTY DIRECTOR, DURHAM, NC

On Sunday, September 15, a team of 10 ASE members touched down at Eldoret International Airport, having traveled from across the globe to participate in an ASE Foundation (ASEF) global health event. In collaboration with the Moi Teaching and Referral Hospital (MTRH), the Foundation was returning to Western Kenya – an area it first visited in 2016 – to assess primary and secondary school children for undiagnosed rheumatic and congenital heart disease.

Why Kenya

Kenya's population is disproportionally young as compared to developed countries; more than half are estimated to be under 18 years old. Children outside the capital of Nairobi often do not have access to cardiac care, due in part to limited providers, prohibitive travel distances to clinics, and significant wait times. Only about a quarter of the public health centers in Kenya have the supplies necessary to effectively diagnose and treat cardiovascular disease. This leads to under-diagnosis of congenital and rheumatic heart disease, and contributes to an increasing burden of morbidity and premature death, much of which could be preventable with proper detection and treatment.

Although access to healthcare remains a barrier, the Education Act of Kenya has made primary school free and compulsory for all children between six and 13 years old, and school-based surveying has been shown to be an effective means to detect heart disease. These two factors combined create ideal opportunities to bring cardiac care to large populations of at-risk children, collect data to better define local disease burden, and then link those children with probable or definite heart disease to the local healthcare system for further follow-up and treatment.

What We Did

After months of planning and countless phone calls and emails, the team gathered for the first time on Saturday morning, September 14, in Nairobi. In collaboration with the Kenya Cardiac Society (KCS), we developed a Joint Symposium on Congenital Heart Disease. KCS leadership Drs. Bernard Gitura, Bernard Samia, and Christine Jowi recruited over 70 local clinicians from across Nairobi to engage with the ASEF team in a full day of didactic lectures and hands-on applications training. The symposium was an important opportunity to further foster a cultural and professional exchange with the Kenyan medical community, and to develop new friendships with another membership-based society.

The team then spent the following six days in Eldoret. Working closely with a large group of nurses, clinical officers, and sonographers from MTRH, the team visited three primary schools (for children ages 6-13) and one secondary school (for children ages 14-18). At the end of the week, they had scanned 1,229 students, plus many of the adult teachers at each school. Of the students, 6.8% were diagnosed with pathology and will be further assessed by the clinicians at MTRH.

SONOGRAPHER GREG FRARY, BS, RDCS, FASE, DEMONSTRATES ACQUISITION TECHNIQUES DURING THE NAIROBI SYMPOSIUM.

Defining Impact

The immediate impact of this effort is in improving the health of the region's pediatric population. Identifying existing disease and facilitating access to appropriate treatment is an important step towards improving quality of life and preventing further morbidity and mortality, not just for today's youth but Kenya's future adult population as well. Just as importantly, in an area of the world where a diagnosis of heart disease can be a death sentence, being able to tell so many parents that their children have a baseline of a normal heart is truly powerful medicine. In the long-term, ASEF's support for the education of Kenyan healthcare workers – beginning in 2016 and continuing through today – will help MTRH implement future assessments in additional schools, ultimately leading to a sustainable Kenyan-led program for early identification and prevention of more advanced cardiac disease.

Lessons Relearned

I wrote the following about the Foundation's global outreach efforts back in 2015, and in re-reading them, I'm struck by how relevant they still are today.

> *Why do we do this? Because the Foundation's humanitarian events are about more than just providing training to developing countries, or patient care to those in need. We are building a global community, full of connected, inspired, and dedicated cardiovascular ultrasound professionals. It is a sense of common purpose, unexpected acts of kindness, and bonded friendships cemented by hard work. You can see it growing through the meals that are shared, through the smiles and laughter that spontaneously erupt across barriers of language or culture, barriers that ultimately end up just being a perception and not a reality.*

> *A global community woven together by knowledge exchange and mutual respect is not what the Foundation set out to create when we first conceived these events, but in the end it's exactly what we are building. These programs will continue to make a world of difference long after our teams come back home.*

Improving healthcare delivery through data collection and research, ensuring healthcare workers have access to tools and strategies for improvement of cardiovascular health standards worldwide, collaborating with partners to foster early and accurate diagnosis – these are the pillars that the ASEF's strategic plan is built upon. Where all of those values meet is within the ever-growing global community we continue to build. To everyone who has played a role in the Foundation's global outreach program over the years, and to everyone who has ever donated to the Annual Appeal, you are part of this common purpose and a vital component of its continued success. Asante sana, thank you!

TEAM KENYA 2019

TEAM KENYA 2019

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Partners in Care:

Kenya Cardiac Society

Moi Teaching and Referral Hospital

GE Healthcare

Hitachi Healthcare Americas

ASEFoundation.org/Kenya-2019

This event was supported by donor contributions to the ASE Foundation and in-kind contributions from our Partners in Care.

Highlights from the 2019 Trends Survey

Contributed by: Andie Piddington, MBA, ASE Corporate Relations Manager, Durham, NC

In June 2019, ASE performed a membership survey to ask our members' opinions on a series of trends shaping the healthcare landscape, in particular the field of echocardiography. ASE has conducted similar surveys for the past several years, as a way to find out how new technologies and practices are affecting echo practitioners in both the U.S. and around the world.

The survey has a wealth of information and insights, and ASE plans to release a summary survey report later this year. In the meantime, there are several interesting trends we want to highlight.

OVERALL RESPONDENT DEMOGRAPHICS

- **674** total respondents
- Overall, **93%** of respondents were ASE members
- **46%** of respondents were sonographers, **44%** were physicians
- Largest portion of respondents are at academic medical centers **(44.2%)**
- **74%** of respondents were located in the United States

ARTIFICIAL INTELLIGENCE

Over the past few years, Artificial Intelligence (AI) has become the buzzword for healthcare in general, and its application to medical imaging in particular has been a hot topic at various annual conferences. But how much is AI really being used in echo labs, and how do ASE members feel about it? According to the survey, about 23% of respondents worldwide are using some form of AI in their echo lab, primarily as software embedded within their ultrasound machine(s). When asked about barriers to wider adoption of AI, the top two answers were cost/reimbursement concerns (36%) and concerns about verification of algorithms (25%). ASE's efforts with our echo registry, ImageGuideEcho, and with the WASE Normal Values study, may help address the validation issue.

TRENDS IN UTILIZATION OF ULTRASOUND ENHANCING AGENTS (UEA)

In an effort to continue gaining insights into the use of UEA (contrast), several questions focused on this topic were included. Since practices and regulations differ dramatically overseas, ASE chose to analyze the data only for those respondents who indicated that they were located in the United States. We also compared the answers to results from 2017:

UEA Usage by Study	2017 Result	2019 Result
0%	25%	24%
1-15%	45%	40%
16-30%	19%	23%
>31%	11%	16%

The above data would seem to indicate that facilities are using UEA agents more often than in the past. In 2017, 70% of respondents were using UEAs between 0-15% of the time, with 30% using them in greater than 15% of studies. For 2019, the percentage of those using UEAs 0-15% dropped to 64% and the percentage of those using them in greater than 15% of studies increased to 39%. ASE will continue our efforts to educate members about the value of UEAs and work to overcome the various barriers to their usage.

TECHNOLOGICAL ADVANCES

The final section of the survey posed several questions designed to provide insights into trends and behaviors surrounding the adoption of new technologies in echo.

When comparing results with the 2017 survey, it is clear that the use of Global Longitudinal Strain (GLS) has made great strides. In both years, respondents were asked for what percentage of patients GLS was acquired, quantified, and reported, with the following results:

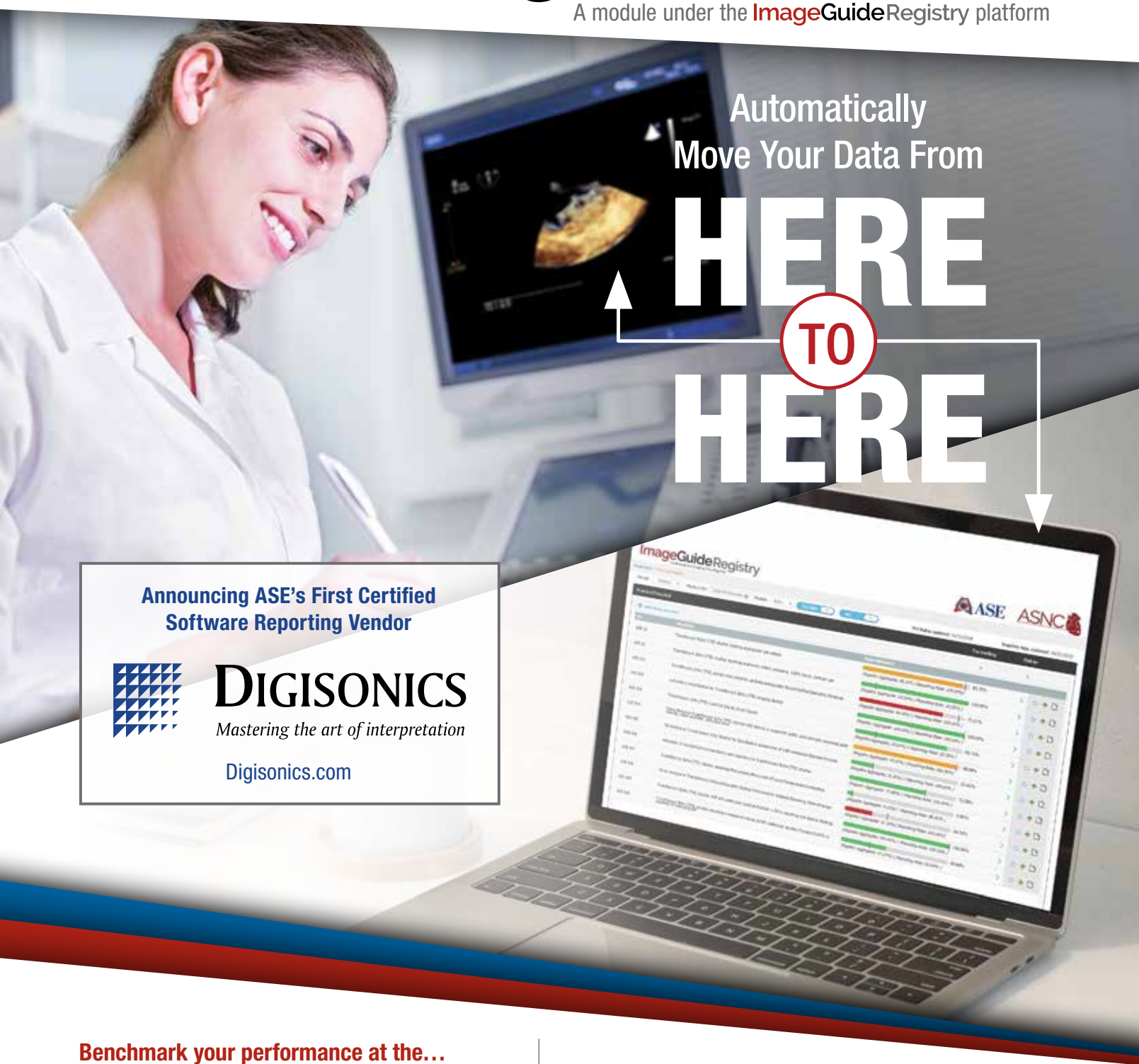
GLS Usage Percentage	2017 Result	2019 Result
0%	30%	15%
1-25%	49%	51%
26-50%	12%	12%
51-75%	4%	6%
>75%	5%	7%
Not Applicable	--	9%

With regards to the use of 3D/4D echocardiography, the 2019 survey asked respondents if their institution uses this technology, with nearly 73% responding that they do. While we did not ask a similar question in previous surveys, based on anecotal evidence, it appears that 3D/4D echocardiography is being more widely used than perhaps five years ago. However, when comparing U.S. responses based on location, there are clearly disparities; 82% of Urban and 63% of Suburban respondents are using 3D/4D echo, while only 55% of Rural responents are.

ASE will continue to analyze these survey results and share them with our members to provide insight into practice trends and highlight gaps in education and training that we can continue working to overcome.

ImageGuideEcho

A module under the ImageGuideRegistry platform



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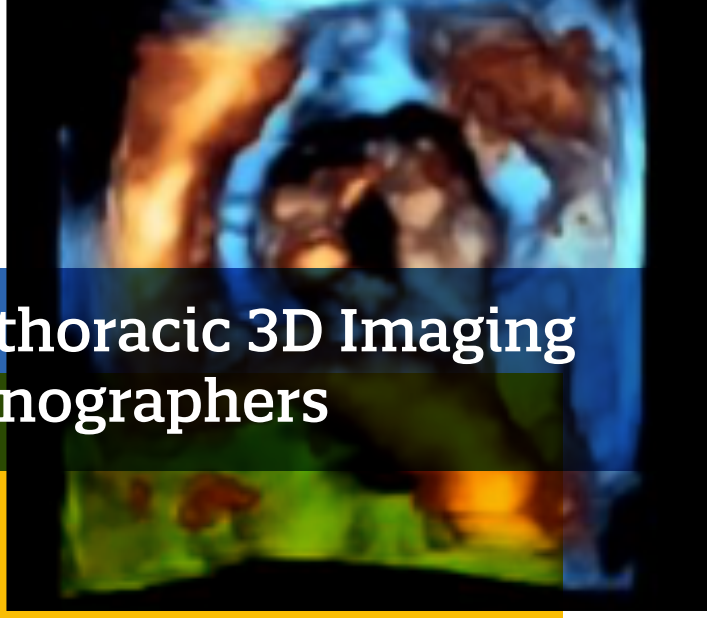
Beyond Volumes to Valves

Transthoracic 3D Imaging for Sonographers



Contributed by: Madeline Jankowski, BS, RDCS, FASE, Lead Cardiac Sonographer, Northwestern Medicine, Chicago, IL

It is a normal day in the echo lab, and the sonographer sees an echo ordered for evaluation of severe valvular disease. The patient opts for testing to see if they meet the requirements for a research study, a new trial valve that can be put in percutaneously, therefore avoiding open heart surgery. The echo protocol for this requires some daunting three-dimensional imaging (3D). The sonographer takes a deep breath, the patient takes one too, and the echo image appears.

The field of cardiology is expanding in new directions, for example, in the interventional realm, and echocardiography is coming right along with it. 3D imaging was introduced in the 1990s, making its way to the market in the early 2000s, with at least five major vendors currently offering 3D imaging capabilities (Canon, GE Healthcare, Hitachi Healthcare, Philips, and Siemens Healthineers). Now, it is being routinely used in labs for biplane imaging, 3D volumes, and 3D transesophageal echocardiography (TEE). 3D imaging is here to stay. The introduction of interventional cardiology and echocardiography has increased the use of 3D transthoracic echocardiography (TTE) to include valve visualization. Along with the advances in technology, the patient base has broadened to include more technically challenging and acutely ill patients. This imaging and the accompanying literature on imaging parameters can be intimidating, especially to sonographers. This article explains how to optimally use 3D imaging as an integral part of TTE exams, offers advice on acquisition and optimization, and encourages sonographers to persevere and keep practicing and perfecting 3D imaging.

3D in a Nutshell (or a Jellybean)

There are three related factors in acquiring 3D imaging to answer the question: what do you want to show in your 3D volume? Balancing these three factors is crucial for any optimal 3D imaging:

- **Spatial Resolution** — Definition: the resolution needed to differentiate structures next to each other along the sound beam. Most of the time, machine settings are optimized for adequate spatial resolution, including the line density. Spatial resolution determines the quality of the voxel, or the building blocks of the 3D images' appearance and definition.
- **Temporal Resolution** — Definition: the resolution needed to define structures moving over time. In regards to frame rate, the two terms are used interchangeably because of their direct relationship. Optimal temporal resolution will allow you to have more frames within the cardiac cycle, helping visualize quickly moving structures, such as valves, and determining end-systole and end-diastole.
- **Pyramidal Size** — This factor determines what structures are included or excluded from the volume.

WAYS TO ACQUIRE A 3D IMAGE

There are two main types of acquisition: live 3D imaging/one beat and gated acquisition. Both will produce a 3D volume which may be cropped to the desired structure or view and have their own sets of advantages and limitations. Live 3D, also called one beat acquisition, is easy to acquire and allows the user to visualize structures on the desired plane with adequate spatial resolution. It is really helpful for patients who are in arrhythmia or have trouble holding their breath. The tradeoff is lower temporal resolution. The limitations of live 3D have been addressed by vendors. On some machines, there is an adjustable frame rate setting, allowing the frame rate to be increased manually, although image quality may be poorer due to lessened spatial resolution. Philips offers high volume rate (HVR) imaging which averages the beat before and after the acquisition to increase frame rates while allowing just a one-beat capture.

Gated acquisition, or multi-beat, builds a 3D image over two to six heart cycles. This building increases the frame rate so the temporal resolution is improved, giving better definition to smaller and more mobile structures. However, this type of acquisition is not good for patients who are in arrhythmias or cannot hold their breath.

TYPES OF ACQUISITIONS

	What is it?	Advantages	Limitations
Full Volume	Encompass the whole heart or whatever is within the sector	• Increased spatial resolution • Can visualize surrounding structures	Decreased temporal resolution
Narrow Sector	Full volume with a decreased sector size	• Helpful in guiding interventional procedures • Adequate spatial resolution	Decreased temporal resolution
Zoom	Focused on specific structures	• Improved temporal resolution • Improved spatial resolution	May "cut out" structures

Optimization of a 3D Volume

CONQUERING A 3D VOLUME – START WITH THE BASICS

Left ventricular 3D imaging is routinely used in labs and is the easiest to obtain, validate, and reproduce data from 3D. It's crucial to understand and build the skill of obtaining these data sets before jumping into more complex imaging. The more you practice this on normal patients in routine TTEs, the better you will be at obtaining this information on the sicker, more technically challenging patients that require this data to guide therapy. Here are some tips that experts routinely think about during acquisition.

- **Inclusion Of The Anterior And Lateral Walls** — Frequently excluded, using biplane imaging *(IMAGE A)*
- **Avoiding Stitch Artifact** — Stitch is a disruption in the acquisition that leads the volume's slices to be "mismatched." This can be evaluated by turning the volume towards you or doing a multi-slice view. Stitch artifact can be minimized by having the patient hold their breath and holding the probe still *(IMAGE B, STITCH SEEN BY BLUE ARROWS)*
- **Check 3D Volumes Against 2D Contrast Imaging** — Providing correlation and also helping to distinguish accurate tracking of a wall motion abnormality

Post-Processing Techniques

After acquiring your data set, adjustments can be made in post-processing to optimize the appearance and orientation of what you want to visualize.

APPEARANCE

Gain: After slightly over gaining your original image, adjusting the gain will define the structures more clearly. Over-gained images will appear blurry and definition of structures is unclear. If an image is under gained, drop-out will occur and possibly look like pathology when there isn't any! The image on the left *(IMAGE C)* is over gained; the image on the right *(IMAGE D)* is under gained.

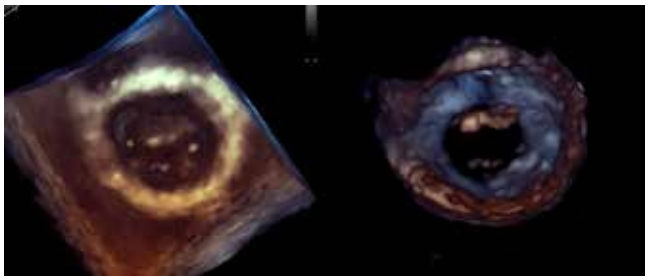


IMAGE C IMAGE D

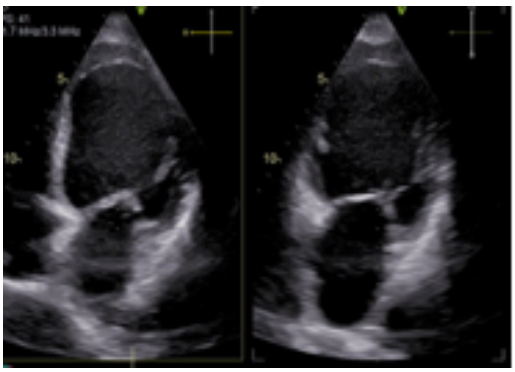


IMAGE A

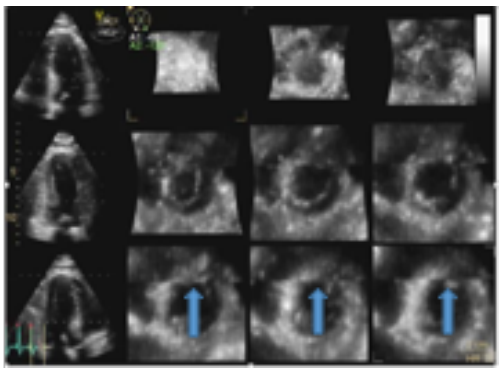


IMAGE B

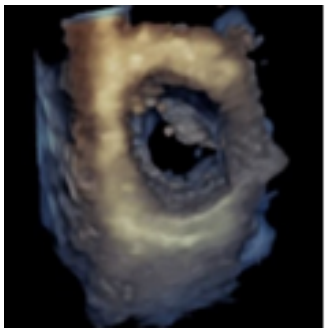


IMAGE E

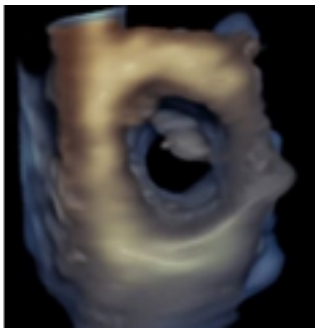


IMAGE F

Smoothing/Compression: These controls give contrast to the lights and darks of the image, making it crisper. If the image is too smooth, definition of small structures will be lost. The image on the left *(IMAGE E)* has decreased smoothing (crisper image) that better defines the leaflets; on the right *(IMAGE F)* has too much smoothing, blurring out some of the definition of the leaflets' myxomatous changes.

Transillumination: It controls where the light source is hitting the structures. This gives attention to structures or lesions that may be otherwise missed and gives depth to the 3D image. Vendors have different names for this, including 'gamma' or 'TrueVue.'

ORIENTATION

Manual Cropping: With any volume, cropping can be done to better visualize a certain area of the structure. For valves, using a crop tool like GE "2 Click Crop" or Philips "QuickVue" is most helpful where you can define the size of the area and direction you are viewing *(IMAGE G)*.

Auto Cropping: After checking the alignment of your reference images, many ultrasound machines can provide an auto crop of different structures. Sometimes small adjustments need to be made, like the thickness of the cropping slice to see more or less of a structure (i.e. excluding redundant chordae and making the slice closer to the valve), or the position of the cropping (i.e. move slice up to include a vegetation ventricular to the leaflet tips).

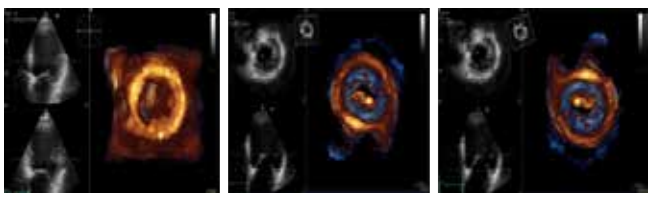


IMAGE G

1. Acquire LV volume. 2. Select cropping tool (i.e. 2-click crop) and define region of interest (dotted blue line). The first click is where you want to look from. 3. Rotate the volume to correct orientation.

Standard Displays: The European Association of Echocardiography (EACVI) and ASE have standardized the ways structures should be displayed to ensure location of lesions can be accurately described.[1] With these standard displays, it is also crucial to report which side you are viewing from, i.e. ventricular or atrial.

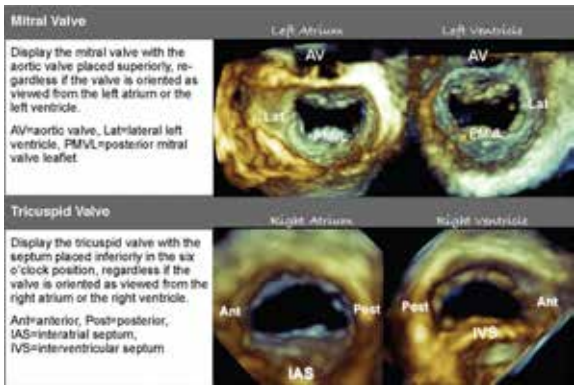


IMAGE H

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Imaging the Mitral and Tricuspid Valves

There are several nuances to each valve that incorporate expert imaging technique and knowledge of valvular pathology.

MITRAL VALVE (MV)

A 3D image can be acquired from anywhere you can see the valve best, but some views are easier than others. For the MV, images can be easily be acquired in an apical four chamber. The ultrasound beam is aligned well and it is easy to include surrounding structures. 3D can help you visualize the valve from the atrial or ventricular side. This is particularly helpful in cases of eccentric jets or fibroelastic deficiencies in cases of mitral valve prolapse or flail. When acquiring a zoomed image or cropping into a volume from the apical window, make sure to include the interventricular septum and the entire mitral annulus in the image. This way you can visualize each leaflet scallop and localize a lesion. Including part of the tricuspid valve may help to ensure the volume includes the whole MV plane, but does however, require doing a longer gated acquisition.

From the parasternal image, the MV can be seen with better visualization of the relationship to the left ventricular outflow tract and aortic valve. Additionally, in cases of mitral stenosis, there is less ring down artifact in this plane so better assessment of the restriction to the valve can be seen. Planimetry of the valve has been shown to better correlate with effective orifice area due to better en face alignment with 3D. Outside the United States, many countries struggle with rheumatic disease, and this tool can better define the valve area and guide

intervention. When imaging or cropping to the MV from the parasternal window, you want to include the aortic valve in the image. This way the orientation of the valve is clear.

Imaging of prosthetic valves can be enhanced by using 3D tools. Utilizing 3D can help visualize components of the prosthesis and using 3D color flow can help localize paravalvular leaks or areas of dehiscence.

TRICUSPID VALVE (TV)

3D TTE imaging has been shown to be equally as successful or better at imaging the TV than 3D TEE. Imaging and visualizing of the TV can be a little more challenging because the right ventricle is innately harder to see.

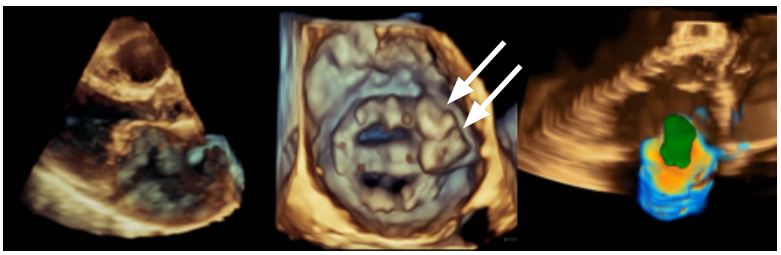


IMAGE I

The left image shows rheumatic mitral stenosis pre mitral annuloplasty. Using the biplane tool, the leaflet tips can be easily visualized to trace an accurate mitral valve area. The middle image shows a mechanical mitral prosthesis with paravalvular plugs (white arrow). The right image shows EROA calculation using Siemens automated eSie PISA with color 3D and looking from the ventricular side of the valve.

The majority of the time, imaging the TV can be done from some version of an apical four chamber.

TV Impingement from a Pacemaker/ICD Lead: An RV focused view is needed to correctly identify how the lead is interacting with the TV leaflets. As a result, when the image is cropped, the valve can be viewed en face to identify where the lead sits. Studies have shown the best placement for a pacemaker lead is in the posteroseptal commissure or in the middle of the valve.[2] Lead placement and possible impingement can be visualized by 3D TTE.

Mechanism of Tricuspid Regurgitation (TR): When trying to identify the mechanism of significant TR, visualization of the leaflets is crucial. Sliding to more of a medial four chamber or a low parasternal short axis, in which you might be able to obtain a better TR signal, may help better visualize the leaflets.

Image J is a pacemaker lead *(white arrow)* impinging the tricuspid septal leaflet. Image K is of a dilated annulus with tricuspid malcoaptation.

Sonographers can help image the TV for better definition of new interventions and can lead the field for diagnosing tricuspid disease. These imaging techniques are difficult and sometimes daunting but can help guide the patient to therapeutic intervention. In many cases, the images can help avoid unnecessary further testing (TEE, MRI) and the patients receive more immediate care for their clinical issue. I encourage you to try practicing these techniques with patients with good imaging windows.

3D TTE imaging will continue to grow as sonographers master the skill of 3D acquisition and analyzation. Introducing 3D imaging into your lab may be intimidating, but routinely using it is crucial for learning. Feedback from a reviewer trained in 3D echo is also imperative to become competent in this specialized imaging. If echo readers are not used to having these images included in the study, try to incorporate them in the middle of the study so they cannot be overlooked. Readers will start to compare the volumes to the 3D data and can provide a better interpretation. Continuity will lead your lab to its routine use.

Acquiring and providing 3D TTE data within routine echocardiograms is essential to mastering your 3D skill and incorporating it into everyday use. Although sometimes daunting, this imaging can help patients receive better care and advance your lab into the newer technology in the field of echo. Mastering 3D imaging of volumes, and especially valves, takes repetition and patience, but will ultimately make sonographers an even more invaluable part of the diagnostic imaging team.

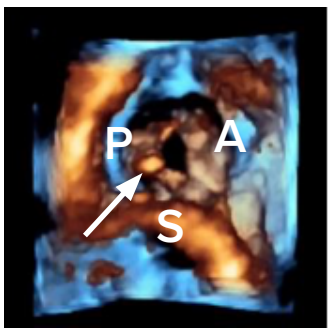


IMAGE J

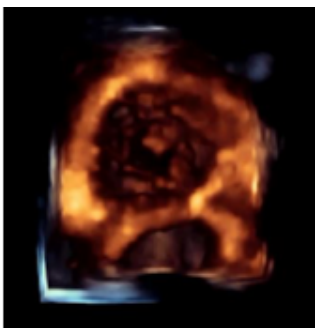


IMAGE K

1 Lang R, Badano L, et al. EAE/ASE Recommendations for Image Acquisition and Display Using Three-Dimensional Echocardiography. Journal of the American Society of Echocardiography, Vol. 25, Issue 1, p3-46. 2012.

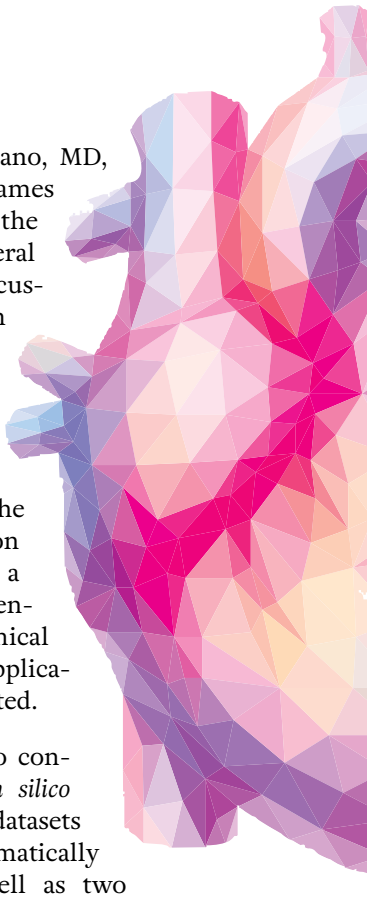
2 Addetia K, Maffessanti F, et al. Impact of Implantable Transvenous Device Lead Location on Severity of Tricuspid Regurgitation. Journal of the American Society of Echocardiography, Vol. 27, Issue 11, p1164-1175. 2014.

3 Lang R, Goldstein S, et al. ASE's Comprehensive Echocardiography. Second Edition. 2016.

Innovative Collaborations

Advance Cardiovascular Ultrasound and Patient Care

Contributed by: Meredith Morovati, MBA
ASE Vice President of Business Development, Durham, NC



Cardiovascular ultrasound is an imaging modality with roots in scientific inquiry and innovation. ASE excels at bringing stakeholders together and employs a vision of the future and a desire for improvements to practice in order to accelerate clinically-based solutions. Efforts to cultivate innovation are undertaken with the goal to support the field, current and future members, and to improve patient care.

Specifically, the Society has spearheaded various efforts around projects to reduce intervendor variability of measurements and reporting; linking clinical gaps with commercial engineering; improving interoperability and workflows; and keeping an eye on safety and evolving issues. All these efforts require a guiding organization to bring the brightest minds and best ideas together. In the past year, ASE has embarked on significant efforts to incubate and accelerate technology that will help the field and patients continue to thrive. Below are a few of these efforts.

STRAIN STANDARDIZATION

In 2010, the leaders of ASE and the European Association of Cardiovascular Imaging (EACVI) invited technical representatives from all interested vendors to participate in a joint effort to reduce intervendor variability in strain measurement. The *Initiative to Standardize Deformation Imaging* was a unique collaboration in that it addressed standardization of deformation imaging from both a technical engineering perspective as well as from a clinical utility viewpoint.

Led by co-chairs Luigi Badano, MD, PhD, FASE, (EACVI) and James Thomas, MD, FASE, (ASE), the group first undertook several months of technical discussion to create a common standard of definitions, formulas, and procedures for the assessment of myocardial deformation by Doppler or speckle-tracking echocardiography. The establishment of a common nomenclature baseline was a vital first step towards identifying differences in clinical parameters and technical applications that could then be tested.

The group then went on to conduct several rounds of *in silico* model testing (synthetic datasets simulated from mathematically modeled ventricles), as well as two clinical scanning trials to test the variability of speckle-tracking global longitudinal strain and analysis algorithms against conventional echocardiographic parameters. These efforts not only resulted in over a dozen publications on variability and reproducibility in both global and longitudinal strain measurements to assess left atrial, right ventricular, and right atrial function, but also developed universal technical specifications for both initial acquisition and the software packages designed to post-process echocardiographic datasets.

This multi-year cooperative effort among vendors and between imaging societies has helped move deformation imaging from a primarily research application to a technique that is now being utilized in routine clinical practice. It was this demonstrated potential for collaboration that led ASE and EACVI to initiate a second standardization initiative focused on 3D/4D imaging.

OPEN 3D/4D ECHOCARDIOGRAPHY

The first ever public demonstration of an interoperable reader for 3D/4D echocardiography data took place at the ASE 2019 Scientific Sessions in Portland, Oregon. This innovative demo was the result of years of planning and collaboration led by ASE and EACVI. Unlike standardizing the data format, this innovative demo was the result of vendors opening the access methods to the data through a standardized Applications Programming Interface (API). The goal is to enable data to eventually be read across platforms, enhance the lab experience, and to improve workflows.

The vision of a collaboration among the five vendors that create 3D/4D echo to move toward interoperability of that data was put forward during the 3D Echo 360° meeting held in Padova (Italy) in 2017. From this meeting, the ASE/EACVI 3D Industry Task Force was set up in Lisbon during EuroEcho 2017. From this initial meeting, ASE convened a more inclusive industry group. Ultimately the formed group included Canon Medical Systems, Hitachi, GE Healthcare, Philips, and Siemens Healthineers. All stakeholders met and worked at the 2018 ASE Scientific Sessions in Nashville and other European cardiology and imaging meetings throughout 2018.

Clinician-leaders from each society worked together to provide essential feedback about real-world issues. ASE gathered the expertise of clinicians and engineers together – the group was dedicated to the vision of working toward interoperability of 3D data in iterative steps and to make sure that industry partner engineers understand the applications and current challenges.

The result was the first ever demonstration of 3D data being read across vendor platforms in Portland, Oregon at ASE's 2019 Scientific Sessions. The group hopes to continue to improve interoperability and allow for wider use of this important technology.

"ASE collaborated with industry and EACVI to test the feasibility of reading 3D datasets across vendors in a neutral way. Now we know this innovative idea is possible."

Roberto Lang, MD, FASE, University of Chicago Medical Center, Chicago, IL

E21 RESEARCH GRANTS FOR CLINICIAN-SCIENTIST AND ENGINEERING PARTNERSHIPS

"A major focus for ASE leadership this year has been to examine the future of sponsored research. The re-invigoration of collaborations between clinician-scientists and engineers is of the utmost importance." (quote by Jonathan Lindner, MD, FASE, in JASE blue page vol. 32 no 4)

On April 10, 2019, ASE announced a formal request for proposals for up to three grants of $200,000 each with the purpose of engaging clinician-scientists and engineers in a major clinical problem in cardiovascular ultrasound. Research partnerships like these have been responsible for most of the major breakthroughs in echocardiography that occurred over the past five decades. The advent of 2D imaging, color Doppler, spectral Doppler, 3D imaging, TEE, and contrast ultrasound all resulted from interactions between engineering scientists and investigators with unique knowledge in medical imaging and physiology/pathophysiology.

For this reason, ASE and the ASE Foundation developed a partnership with the American Institute of Ultrasound in Medicine (AIUM), National Board of Echocardiography, Inc. (NBE), Bracco Diagnostics Inc., and Lantheus Medical Imaging, Inc. to develop the E21 research initiative and fund highly innovative approaches to clinical problems in cardiovascular ultrasound that can be solved through engineering solutions.

An overwhelmingly positive response to the request for application resulted in three outstanding proposals being selected for funding. (See page 34 for more on the grant recipients.) These projects range in topic from bedside monitoring of neonates with PDAs, to optimization of septal reduction for hypertrophic cardiomyopathy, to deep learning for detection and prognostication of heart failure. By encouraging investigators to approach clinical problems in partnership with engineering, we are helping lay the foundation for bold new work that will further innovate how we practice tomorrow.

THE OPERATING ROOM OF THE FUTURE

On April 7, 2019, ASE gathered a variety of stakeholders involved in structural heart disease imaging to discuss important topics. Expertise in areas such as education, clinical work, medical research, advocacy and government affairs, and device and imaging were present. This meetings was part of a regular convening, held by ASE, to engage industry partners, keep an eye on innovations in the field, and to strategize collaborative opportunities around fostering ways to care for patients and support the clinician.

The structural heart conversation was wide and varied, however, a portion of the day included a talk by G. Burkhard Mackensen, MD, PhD, FASE, called "The Hybrid OR of the Future." Dr. Mackensen highlighted urgent needs as well as current innovations in the operating room. The OR during a structural heart procedure is a busy, high-stress, loud, and dangerous environment. Radiation exposure is dangerous for patients and physicians who are exposed to it repeatedly. Fortunately, ergonomic, communication, and safety issues are being addressed in novel and innovative ways. For instance, new shielding techniques are being approved to protect operators and patients. Some of these efforts even enlist the power of machine learning.

In addition to improvements in radiation safety, integration of various technical equipment including that which manages data, workflows, and hygiene can improve operations and overall safety. These ideas and examples were presented to the group of stakeholders, and in this small-group setting, clinical leaders and industry participated in deep discussion, debate, and brainstorming exercises aimed at clinical guidance of innovations. It is clear that the cardiovascular imager will continue to guide much of the structural heart procedures and communicate with surgeon and others, and that there are many opportunities to improve the patient and operator experience and safety.

Novel cardiovascular ultrasound techniques are the result of efforts in research and engineering, combined with a desire to solve problems. ASE's role leading these efforts is more important than ever in today's environment with competing priorities, busy schedules, and the tendency to work in silos. The coming years will see more leadership by ASE to support a modern and visionary technological road map with our members at the heart of it.

THE POWER OF SOUND: THERAPEUTIC ULTRASOUND IN CARDIOLOGY

Contributed by: Jonathan R. Lindner, MD, FACC, FASE, Knight Cardiovascular Institute, Oregon Health & Science University, Portland, OR

Ultrasound is able to produce bioeffects through different mechanisms of action involving thermal effects and non-thermal effects such as cavitation, microstreaming, and shock wave formation (**Figure 1**). These bioeffects have been leveraged for a variety of therapeutic applications outside of cardiology. Unfocused ultrasound at modest acoustic pressures has been used to accelerate healing of soft tissue and bone injuries. High-intensity focused ultrasound (HIFU) techniques have also been developed (**Figure 2A**).[1] Depending on the pressure and pulse generation, HIFU produces either thermal necrosis (searing) or boiling histotripsy (thermal plus mechanical disruption of tissue). Established and investigational uses of HIFU include the ablation of uterine fibroids, malignancies (e.g. prostate cancer), and focal regions of the brain responsible for motion disorders; and for denervation of pain foci.[1,2] Acoustic energy in the form of shock-wave therapy where an extremely high-pressure ultrasound cycle is given with much higher positive than negative pressure phase is powerful enough to fragment kidney stones by selectively disrupting rigid structures. And, of course, those of you who have been glued to cable news channels have undoubtedly been witness to miracles of cosmetic lipolysis, the ability of ultrasound to dissolve away love handles or cellulite. A broad palette of cardiovascular applications for thermal and non-thermal effects of ultrasound are also now under investigation, some of which have made the transition to clinical studies.

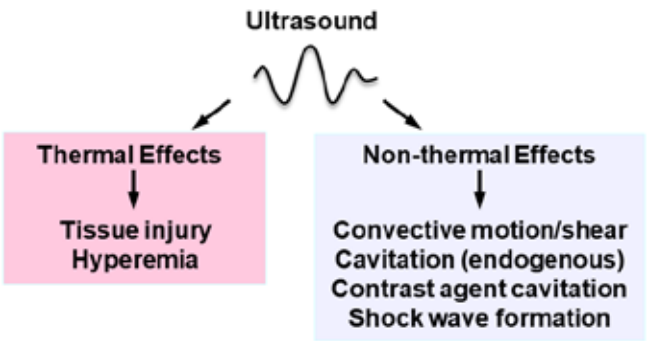


Figure 1

TISSUE ABLATION

The use of HIFU for myocardial ablation procedures has been a research focus (no pun intended). HIFU applications can be categorized by either: (a) the location of the ultrasound source (external versus catheter-based), or (b) the cellular response (thermal necrosis versus boiling histotripsy) which determines the ultimate tissue fate which spans from fibrosis to the complete "emulsification" of tissue. Externally-located HIFU devices that produce extremely high pressures where ultrasound beams intersect can produce high enough energy to produce channels through cardiac tissues.[3] Accordingly, these devices are being investigated for their potential to non-invasively produce palliative intracardiac shunts or pericardial windows, or to reduce cardiac tumor burden. By altering the duty factor or the acoustic pressure, HIFU is also being examined as a non-invasive method for producing tissue fibrosis in order to reduce outflow gradients by ablating the portions of the septum

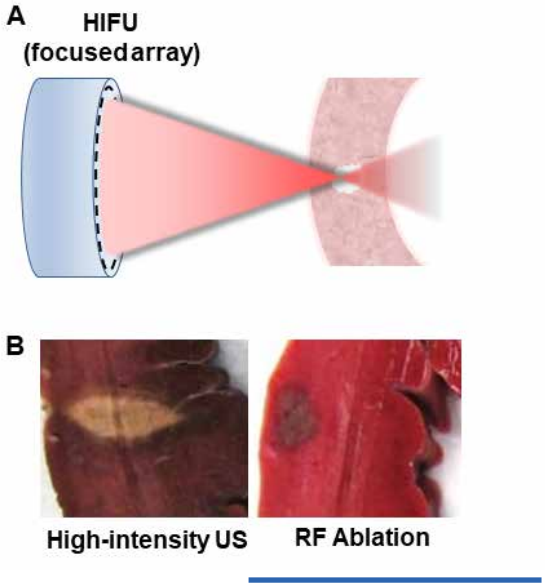


FIGURE 2

in hypertrophic cardiomyopathy (HCM), or to eliminate cardiac electrical conduction in predicable locations (e.g. AV node ablation). HIFU devices placed externally to the atria at the time of cardiac surgery or on a balloon platform have been developed as a treatment for atrial fibrillation, but trials have been suspended based on a variety of safety concerns and failure rates.[4]

Intracardiac therapeutic ultrasound catheters have also been developed for potential use in cardiac arrhythmia ablation and possibly for HCM.[5] The production of true HIFU devices on intracardiac catheters is technically challenging based on scale. However, these ultrasound catheters have a natural focus so that there is an "offset" between the catheter and the ablation zone (**Figure 2B**). This offset provides a potential advantage to radiofrequency ablation of arrhythmias by allowing deeper or mid-myocardial regions for ventricular arrhythmia ablation, and avoidance of coronary arteries when performing epicardial approach to ablation. It also may allow for ventricular septal endocardial ablation possible in HCM from catheters placed in the right ventricle, which is the topic of one of the ASE Foundation's E21 Research Grants awarded this year.

SONOTHROMBOLYSIS

The pressure fluctuations of ultrasound produce convective motion and focal microstreaming. Accordingly, ultrasound has been used as a way of coaxing therapeutic agents to penetrate into areas that are otherwise difficult to access. One application that is already approved for use by the U.S. Food and Drug Administration is an intravascular delivery system that simultaneously infuses thrombolytic drugs and emits ultrasound from a multi-element ultrasound catheter to promote the penetration of thrombolytics into clots in patients with pulmonary embolus or deep venous thrombosis. In pulmonary embolus, these catheters accelerate clot lysis and resolution of increased right-heart pressures.[6] The mechanisms of action may extend beyond penetration of drug since ultrasound can also render fibrin more amenable to fibrinolysis.[7]

Recently, there have been major advances in the cavitation of microbubble contrast agents for thrombolysis. At sufficiently high ultrasound power, but still within the conventional diagnostic frequency and pressure range, encapsulated microbubble contrast agents undergo non-linear oscillation and collapse, known as inertial cavitation.[8] This type of cavitation can produce direct physical effects from exaggerated bubble motion and generate high velocity microstreaming. When microbubbles cavitate in the proximity of a clot, they can produce clot fragmentation.[9] A pioneering clinical trial in patients presenting with acute myocardial infarction demonstrated that cavitation of microbubbles by transthoracic echocardiography with a conventional diagnostic imaging system can increase the likelihood for establishing patency of the infarct-related artery and reduce infarct size.[10] Since cavitation was performed both before and after catheter-based revascularization, it is still unclear how much of the benefit was from opening of the infarct-related artery, and how much was from resolution of downstream microvascular thrombus.

DRUG AND GENE DELIVERY

Many of the effects of ultrasound such as convective motion, microstreaming, and thermal effects have the potential to: (a) make vessels more permeable to the extravascular emigration of therapeutic drugs/genes, or (b) to encourage cells to take up drugs/genes through calcium-dependent processes. These effects are the basis for new therapeutic strategies such as ultrasound-facilitated transdermal delivery of drugs such as insulin. For cardiovascular applications which rely on delivery to deeper tissues, the application of microbubble cavitation has gained considerable attention for several reasons. First, investigation of payload-bearing microbubbles can be used as a method for site-targeted gene/drug delivery within the acoustic field.[11] Second, the cavitation effects of microbubbles focally amplify the bioeffects of ultrasound for increasing tissue uptake.

While gene delivery to a tissue exposed to ultrasound can be enhanced simply by simultaneous injection of microbubbles with the viral or plasmid cDNA, the direct conjugation of DNA to the surface of the microbubble has been shown to be much more effective. Early studies used the non-specific interaction of viral particles or plasmid DNA to denatured albumin in the shell of microbubbles.[12] The dominant approach recently has been use charge conjugation of different forms of DNA (or RNA), which has a net negative charge, to the surface of cationic lipid-shelled microbubbles.[11] Surface

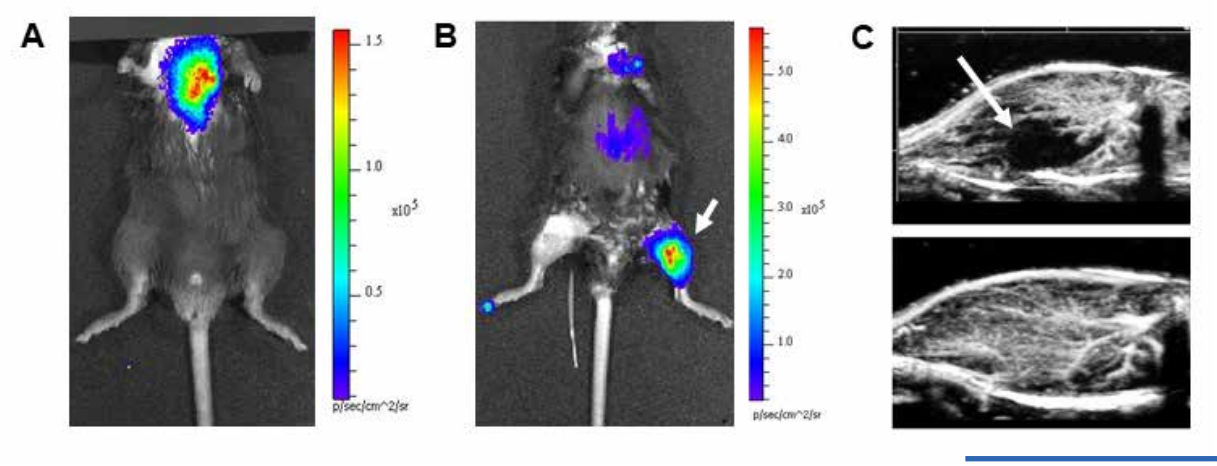


FIGURE 3

conjugation protects genetic material from enzymatic degradation, focally increases the concentration of DNA at the site of cavitation, and promotes ballistic penetration of DNA into cells. Contrast-ultrasound mediated gene transfection is currently being evaluated for many applications including delivery of pro-angiogenic genes to treat ischemic diseases, protection of myocytes from ischemia-reperfusion injury or cardiotoxic drugs, and delivery of key enzymes in certain metabolic disease.[11,13]

Drug delivery through cavitation of microbubble carriers is also a promising approach for the extravascular delivery of therapeutic agents that either need "help" penetrating into tissue, or that require ultrasound-targeted delivery only into a specific tissue based on the need to avoid high systemic levels. Many investigative agents have been developed which are reviewed elsewhere.[11] These agents include emulsion-based contrast agents with cores composed of gas and drug; and microbubbles with either an inner lining of oil-dissolved drug or drug-filled packages (e.g. liposomes, nanoparticles) on their surface.

ULTRASOUND AUGMENTATION OF TISSUE PERFUSION

High shear forces within blood vessels are a strong stimulus for vasodilation. Ultrasound over a wide range of frequencies and powers has been shown to produce vasodilation and to augment tissue blood flow, probably as a result of the convective motion and oscillatory shear produced by sound. High pressure ultrasound in the form of extracorporeal shock wave therapy has been shown to not only improve ischemic symptoms and left ventricular dysfunction, but also to stimulate coronary angiogenesis (growth of new blood vessels) probably through shear-dependent mechanisms.[14,15]

The presence of microbubbles within the microcirculation that undergo acoustic cavitation can produce very high focal shear and markedly augment the effects of ultrasound on blood flow. Recent studies have provided a comprehensive understanding of the biologic reasons for flow augmentation during contrast cavitation, which includes the shear-mediated release of vasodilators such as ATP not only by endothelial cells that line blood vessels and control tone, but also by red blood cells that happen to be in the cavitation zone (**Figure 3A and 3B**).[16]

In pre-clinical models and in the clinical trial of patients with MI mentioned earlier, microbubble cavitation has been shown to increase myocardial blood flow and reduce infarct size even when the occluded artery isn't open.[10] It is quite likely that direct effects to increase microvascular perfusion, perhaps through collateral flow, were responsible for some of the benefit of this trial. Microbubble cavitation has also been shown in animal models to completely reverse limb ischemia due to severe peripheral artery disease (PAD) (**Figure 3C**).[16] This has led to clinical studies whereby limb perfusion was augmented by microbubble cavitation using conventional ultrasound enhancing agents and imaging systems in patients with PAD and with sickle cell disease.[16,17] These studies all provide hope that ultrasound-mediated modulation of tissue perfusion can eventually be used to treat either acute ischemic diseases or chronic ischemic conditions.

SUMMARY

There are a wide variety of potential therapeutic applications for ultrasound in cardiovascular disease, only some of which have been discussed in this article. It is highly encouraged that physicians and sonographers alike begin to familiarize themselves with some of these lines of investigation since the time may come when clinical echocardiographers begin to use their prowess in ultrasound not only for diagnosis, but also for treatment as well.

FIGURE LEGENDS

FIGURE 1. SCHEMATIC DEPICTING THE VARIOUS BIOEFFECTS PRODUCED BY ULTRASOUND ENERGY.

Figure 2. High-energy ultrasound for tissue ablation. (A) Schematic depicting the principle behind high-intensity focused ultrasound (HIFU) where ultrasound beams are focused on a small region of intersection which produces extremely high pressures and temperatures. (B) Images of ventricular tissue ablated by high-intensity ultrasound catheters placed on the epicardium demonstrating deeper penetration and greater fibrotic response (appearance) than the radiofrequency (RF) catheter ablation. Images courtesy of Dr. Babak Nazer.

Figure 3. Microbubble cavitation for increasing tissue ATP and for flow augmentation. (A and B) Optical imaging of focal ATP release at the site of ultrasound application to the heart and to the hindlimb (arrow) of anesthetized mouse receiving intravenous ultrasound enhancing agents and ultrasound (1.3 MHz, mechanical index 1.3). (C) Contrast ultrasound perfusion imaging of a mouse leg with a region of ischemia (arrow) produced by arterial occlusion (top), and complete recovery of blood flow after 10 minutes of applying ultrasound cavitation of the ischemia.

REFERENCES

1. Brown MR, Farquhar-Smith P, Williams JE, ter Haar G and deSouza NM. The use of high-intensity focused ultrasound as a novel treatment for painful conditions-a description and narrative review of the literature. *Br J Anaesth*. 2015;115:520-30.
2. Elias WJ, Lipsman N, Ondo WG, Ghanouni P, Kim YG, Lee W, Schwartz M, Hynynen K, Lozano AM, Shah BB, et al. A Randomized Trial of Focused Ultrasound Thalamotomy for Essential Tremor. *N Engl J Med*. 2016;375:730-9.
3. Owens GE, Miller RM, Ensing G, Ives K, Gordon D, Ludomirsky A and Xu Z. Therapeutic ultrasound to noninvasively create intracardiac communications in an intact animal model. *Catheter Cardiovasc Interv*. 2011;77:580-8.
4. Laughner JI, Sulkin MS, Wu Z, Deng CX and Efimov IR. Three potential mechanisms for failure of high intensity focused ultrasound ablation in cardiac tissue. *Circ Arrhythm Electrophysiol*. 2012;5:409-16.
5. Nazer B, Salgaonkar V, Diederich CJ, Jones PD, Duggirala S, Tanaka Y, Ng B, Sievers R and Gerstenfeld EP. Epicardial Catheter Ablation Using High-Intensity Ultrasound: Validation in a Swine Model. *Circ Arrhythm Electrophysiol*. 2015;8:1491-7.
6. Piazza G, Hohlfelder B, Jaff MR, Ouriel K, Engelhardt TC, Sterling KM, Jones NJ, Gurley JC, Bhatheja R, Kennedy RJ, et al. A Prospective, Single-Arm, Multicenter Trial of Ultrasound-Facilitated, Catheter-Directed, Low-Dose Fibrinolysis for Acute Massive and Submassive Pulmonary Embolism: The SEATTLE II Study. *JACC Cardiovasc Interv*. 2015;8:1382-92.
7. Chernysh IN, Everbach CE, Purohit PK and Weisel JW. Molecular mechanisms of the effect of ultrasound on the fibrinolysis of clots. *J Thromb Haemost*. 2015;13:601-9.
8. Dayton PA, Morgan KE, Klibanov AL, Brandenburger GH and Ferrara KW. Optical and acoustical observations of the effects of ultrasound on contrast agents. *IEEE Trans Ultrason Ferroelectr Freq Control*. 1999;46:220-32.
9. Xie F, Slikkerveer J, Gao S, Lof J, Kamp O, Unger E, Radio S, Matsunaga T and Porter TR. Coronary and microvascular thrombolysis with guided diagnostic ultrasound and microbubbles in acute ST segment elevation myocardial infarction. *J Am Soc Echocardiogr*. 2011;24:1400-8.
10. Mathias W, Jr., Tsutsui JM, Tavares BG, Fava AM, Aguiar MOD, Borges BC, Oliveira MT, Jr., Soeiro A, Nicolau JC, Ribeiro HB, et al. Sonothrombolysis in ST-Segment Elevation Myocardial Infarction Treated With Primary Percutaneous Coronary Intervention. *J Am Coll Cardiol*. 2019;73:2832-2842.
11. Unger E, Porter T, Lindner J and Grayburn P. Cardiovascular drug delivery with ultrasound and microbubbles. *Adv Drug Deliv Rev*. 2014;72:110-26.
12. Shohet RV, Chen S, Zhou YT, Wang Z, Meidell RS, Unger RH and Grayburn PA. Echocardiographic destruction of albumin microbubbles directs gene delivery to the myocardium. *Circulation*. 2000;101:2554-6.
13. Chen HH, Matkar PN, Afrasiabi K, Kuliszewski MA and Leong-Poi H. Prospect of ultrasound-mediated gene delivery in cardiovascular applications. *Expert Opin Biol Ther*. 2016;16:815-26.
14. Prasad M, Wan Ahmad WA, Sukmawan R, Magsombol EB, Cassar A, Vinshtok Y, Ismail MD, Mahmood Zuhdi AS, Locnen SA, Jimenez R, et al. Extracorporeal shockwave myocardial therapy is efficacious in improving symptoms in patients with refractory angina pectoris--a multicenter study. *Coron Artery Dis.* 2015;26:194-200.
15. Nishida T, Shimokawa H, Oi K, Tatewaki H, Uwatoku T, Abe K, Matsumoto Y, Kajihara N, Eto M, Matsuda T, et al. Extracorporeal cardiac shock wave therapy markedly ameliorates ischemia-induced myocardial dysfunction in pigs in vivo. *Circulation*. 2004;110:3055-61.
16. Belcik JT, Davidson BP, Xie A, Wu MD, Yadava M, Qi Y, Liang S, Chon CR, Ammi AY, Field J, et al. Augmentation of Muscle Blood Flow by Ultrasound Cavitation Is Mediated by ATP and Purinergic Signaling. *Circulation*. 2017;135:1240-1252.
17. 17.Mason OR, Davidson BP, Sheeran P, Muller M, Hodovan JM, Sutton J, Powers J and Lindner JR. Augmentation of Tissue Perfusion in Patients With Peripheral Artery Disease Using Microbubble Cavitation. *JACC Cardiovasc Imaging*. 2019.

ASE Testing the Waters of Virtual Education in 2020

Contributed by: Christina LaFuria
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Durham, NC

Imagine being able to get the best ECHO education without having to leave your living room. No time away from work, no bags to pack, no airport hassles. Just a day of pajamas and a laptop.

That notion will no longer be a fantasy because ASE is proud to be offering two virtual events in 2020. Participate in top-notch educational programs from the comfort of your own home, office, or even your favorite coffee shop.

Virtual delivery of educational content is becoming one of the hottest trends in professional development and has a widespread appeal. Attendees can interact with speakers, network, listen to lectures, and participate almost as if they were in the room. Using the features of the platform, participants can be a part of the peer-to-peer conversations as well as ask specific questions of the faculty.

Once the event is over, the attendees have access to all the content for 30 days. This gives learners the opportunity to review the content or view content that was missed. So, if you had to miss a couple hours because of your child's soccer game, you can always catch up later.

ASE will be offering two types of virtual events in 2020. The first is virtual attendance of a live course after the event has occurred. The live course will be recorded and streamed at a later date. There will be an opportunity to chat with all other virtual attendees as well as interact with the faculty.

Virtual attendance will be available for the 33rd Annual State-of-the-Art Echocardiography live course. The live course will take place in Scottsdale, Arizona, on February 21 – 24, 2020. Although the live course includes a comprehensive hands-on learning lab that shouldn't be missed, all the content from the main conference will be part of the virtual event. The virtual event will take place later in the spring. Upon approval, this event will offer a maximum of 18 *AMA PRA Category 1 Credits™*.

The second type of event ASE will be offering is a virtual conference. This event is completely virtual with no live component. The same options are available for chatting, asking questions, and interacting with the faculty. All content will be available for 30 days post-event for easy review. ASE's first completely virtual conference, Advanced Imaging, will take place in the Fall of 2020.

We know nothing will ever take the place of attending a course in person and enjoying the personal connections and networking opportunities, but if you find yourself looking for alternative educational offerings, try one of our new virtual events. We look forward to seeing you online.

ASE Foundation Funds Three E21 Research Grants for Almost $600,000

Contributed by: Andrea Van Hoever, MSGH
ASE Deputy Director, Durham, NC

A monumental moment occurred for the ASE Foundation in October 2019 when it announced funding for three highly innovative research projects totaling almost $600,000 in support. This marks the largest multi-tiered funding outlay in the organization's history. This is historic, not only for the Foundation, but also for ASE and the field of cardiovascular ultrasound.

The aim of the E21 Research Grant program is to promote research partnerships between clinician-scientists and engineering-scientists. The advent of 2-D mechanical and phased-array imaging, color Doppler, spectral Doppler, 3-D imaging, TEE, harmonic imaging, and contrast ultrasound all resulted from interactions between engineering scientists and investigators with unique knowledge in medical imaging and physiology/pathophysiology. Over time these types of collaborations have become much less common. Instead, the introduction of new ultrasound technology of late has been driven by industry and as such may not always be targeted to the most important clinical gaps. The E21 grants are conceptually designed to solve this issue by offering grant funding for innovative research projects that are similar to the concept and aims of NIH R-21 awards.

These awards represent a mechanism to monetarily support daring research collaborations that aim to use engineering solutions to solve a relevant clinical problem in cardiovascular ultrasound. The E21 grants are not intended to entirely solve a clinical problem, but to lay the foundation that will lead to major advances in future patient care or clinical practice. The funding will allow investigators to make substantial progress over the next two years towards aims that can then be used for secondary high-level funding from extramural sources (NIH, DOD, etc.), or industry/investor funding.

ASE Immediate Past President and Chair of the E21 Grant Review Committee Jonathan R. Lindner, MD, FACC, FASE, said, "Research partnerships between clinicians and engineers have been responsible for most of the major breakthroughs that have made echocardiography an indispensable part of cardiovascular medicine. Together with multiple stakeholders, ASE has led efforts to create and provide these E21 Research Awards to three pioneering clinician-engineer teams who will engage in a two year 'high-risk, high-reward' research program to address the clinical gaps that face us today."

Congratulations to the 2019 E21 Research Grant recipients.

- **Oliver Kripfgans, PhD, FAIUM**, University of Michigan, Ann Arbor, MI, for *Bedside Cardiovascular Monitoring of Neonates with Patent Ductus Arteriosus*
- **Babak Nazer, MD**, Knight Cardiovascular Institute, Oregon Health and Science University, Portland, OR, for *Echocardiographic Optimization of Ultrasound Septal Reduction for Hypertrophic Cardiomyopathy*
- **Patricia Pellikka, MD, FASE**, Division of Cardiovascular Ultrasound, Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN, for *DeepEcho: Echocardiogram Image Normalization Using Deep Learning for Detection and Prognostication of Heart Failure*

The investigators have all committed to present the results of their projects during an upcoming ASE Scientific Sessions and we look forward to their involvement.

In addition to the ASE Foundation and ASE, funding support for these grants was provided by the American Institute of Ultrasound in Medicine's Endowment for Education and Research, the National Board of Echocardiography, Inc., Bracco Diagnostics Inc., and Lantheus Medical Imaging, Inc.

E21 Grant Review Committee

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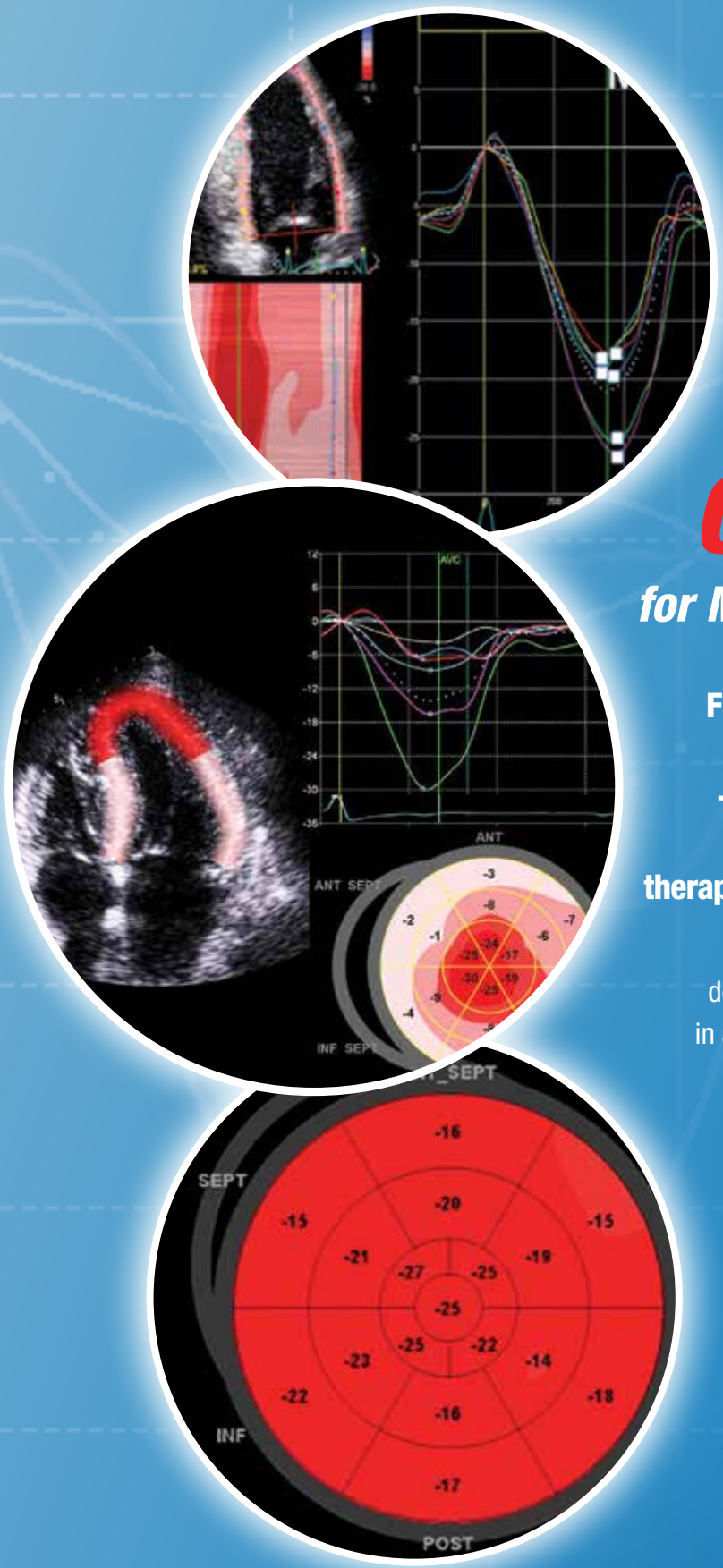

New Echo Code
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This new code recognizes that Strain Imaging has a great diagnostic and therapeutic value for improving patient care.

Thank you to all the ASE members who helped document their use of myocardial strain imaging in an effort to gain this new CPT Code that can be used beginning January 1, 2020.

For more 2020 payment information please visit **ASEcho.org/2020-CMS**

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ASE'S MISSION

ASE is committed to excellence in cardiovascular ultrasound and its application to patient care through education, advocacy, research, innovation, and service to our members and the public.

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