CONGENITAL CARDIOLOGY TODAY
Timely News & Information for Congenital/Structural Cardiologists & Cardiothoracic Surgeons Worldwide

January 2019 - Volume 17 - Issue 01
*North American Edition*

**Inside This Issue**



**Upcoming Medical Meeting**

**American College of Cardiology (ACC) 68th Annual Scientific Session and Expo**
*Mar. 16-18, 2019; New Orleans, LA, USA*
www.acc.org/education-and-meetings/meetings/meeting-items/2018/03/12/13/48/acc19-68th-annual-scientific-session-and-expo

**International Workshop on Interventional Pediatric & Adult Congenital Cardiology (IPC)**
*Mar. 28-30, 2019; Milan, Italy*
www.workshopipc.com/main.php

**View a Complete List on our Website Events Page**

Corporate Office
11502 Elk Horn Drive
Clarksburg, MD 20871 USA

www.CongenitalCardiologyToday.com

www.Twitter.com/ccardiology

Official publication of the CHiP Network

# Distilling the Data into Useful Information: The Rise of Artificial Intelligence in the Practice of Pediatric Cardiology

*By Addison S. Gearhart, MD and Anthony C. Chang, MD, MBA, MPH, MS*

## Introduction

What does the future of artificial intelligence (AI) in Pediatric Cardiology hold?

Instantaneous access to relevant, precise, and predicative insights about each patient before the clinic visit. Data from that patient--healthcare records, personal fitness trackers, vital signs, social history, Electronic Medical Records (EMR) etc.-- autonomously added into a collaborative database that syncs, interprets, and translates each patient's health profile against a large aggregate of shared peer health data and outcomes, the current medical body of literature, and ongoing trials (Figure 1) to enhance patient care and elevate the quality of discussion during the face-to-face patient encounter. Useful information from this data could include: morbidity and mortality prediction, drug therapy suggestions targeted to each patient's genetic profile, tailored surgical plans, recommendations for timing of sequential imaging, and autonomously-read advanced imaging studies. The other arm of emerging AI systems, virtual assistants and robotic process automation (RPA), could ease the after-clinic responsibility workload by offering 24/7 assistance to look up patient records, search specific medical questions, schedule appointments, write notes, complete orders dictated in the exam room, check on a patient's progress and even answer some of the patient's basic medical questions.

In our current model, all too often wasted data sits on the wrists of many of our patients, in popularized genetic testing databases, and in EMR. Data is piling up urging the clever physician to find ways to gain access while protecting privacy and for the even cleverer data scientist to develop smarter algorithms capable of distilling the heterogenous, often incomplete forms of medical data, into clinically meaningful and actionable information (Figure 2). Those committed to advancing the field are fueled by this limitless potential to revolutionize the cardiologist's tool set by replacing the current labor-intensive task of finding meaningful connections in an ever-expanding sea of data with interpreting and acting on data-driven insights. Proponents argue this prototypical AI system will usher in an era of unparalleled medical intelligence, redefining the patient's path toward better health.

*Figure 1. A dramatization of a future AI healthcare interactive platform.* [41]

It is increasingly apparent that with the sustained rate in the rise of publications and advances in

AI in and outside of the medical field that we face an inescapable and exciting future in which AI will influence how we as physicians practice medicine and how our patients receive healthcare. The question of if there will be a future partnership between AI and pediatric cardiology is quickly being replaced with the more pressing questions of **why now, how, who and when**. In Part I of this review article we will address the questions of why now and how and in Part II we will discuss the questions of who and when.

**Part I: Why Now and How?**

*Why Now: The Current Healthcare Model*

The first step to agreeing that AI warrants its spotlight in healthcare generally and cardiology specifically is to answer the following question: "Why now?" Historically, any pediatric cardiologist bold enough to initiate such a discussion about the future of AI systems to transform the practice of Pediatric Cardiology was quickly humbled by a reflexive list of all the possible perils and pitfalls. While there remains substantial resistance and fear of incorporating an unfamiliar and byzantine technology into the already complex and highly personal practice of caring for the hearts of pediatric patients, one cannot ignore the exponential rise in scientific publications, magazine articles, podcasts, and news pieces focused on AI in and outside of medicine. AI is quite frankly everywhere. Advances in algorithmic development over the past ten years and the rapid accumulation of data have enabled AI to flourish. The speed at which AI has become a key component of every new technology has added an unprecedented new flavor of excitement to the practice of medicine. Pediatric Cardiology, in particular, became a hub for innovation because AI thrives in specialties rich in imaging and data, two strengths inherent to the field.[1]

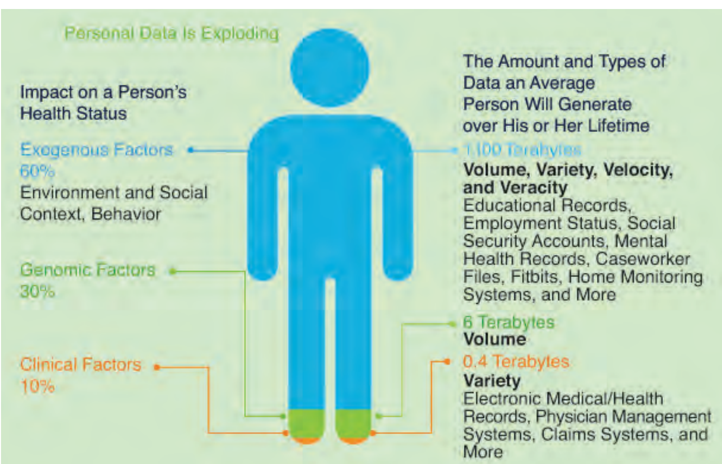



*Figure 2. The patient model has evolved today due to an explosion in the volume and variety of patient data collected (electronic health records, genomic data, wearables, etc.).[42, 43]*

The other reason for the embrace of AI is workload. Today cardiologists tackle innumerable, often impossible, challenges: time demands of data entry in the EMR, increases in patient volume, complexity of tests, and staying current on guidelines and publications. The climate has redefined and expanded the job description of a physician. Not surprisingly, the repercussion is an epidemic of physician burnout, depression, job dissatisfaction, and drop-out rates leading to a projected shortage of 100,000 physicians by 2030.[2,3] Worse yet, exhausted physicians who remain in practice show a higher likelihood for making medical errors.[4] The AI model combats issues that lead to burnout by promoting efficiency. The time saved in the chart-review process and after clinical encounter responsibilities can be better used at the patient's bedside strengthening the patient-physician human relationship known to prevent physician burn out and increase patient satisfaction.[1]

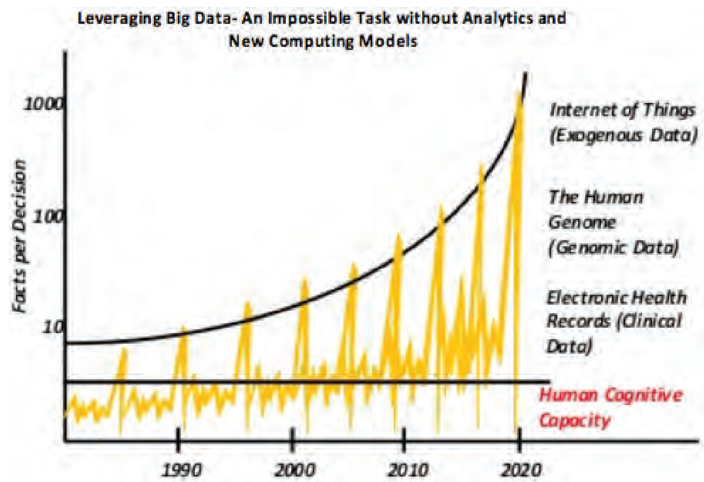


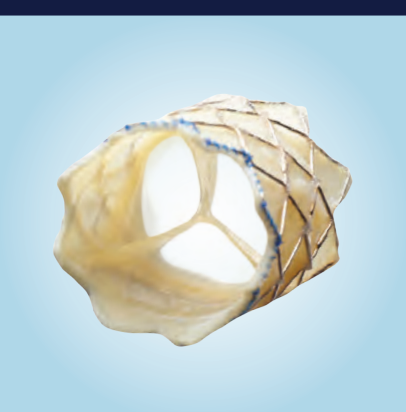

*Figure 3. A depiction of how patient-related information is exceeding human cognative capacity necessitating the implementation of new computational methods to augment human intelligence.[44]*

Lastly, AI empowers the patient to own their personal data. Patients no longer arrive at cardiology clinic with a simple chief complaint; instead they come with a laundry list of concerns, genetic results, outside documents, and results from consumer wearable technology. Under the Obama Campaign, the concept of and desire for Precision Medicine spread with a subsequent shift in the patient's expectation of their physician to interpret this data to adhere to the trend in popularity toward a data-driven, evidence-based personalized healthcare model. Patients now produce 750 quadrillion bytes of data daily.[5] The exponential rate at which data is being produced far exceeds human cognitive capacity (Figure 3). Even if cardiologists want to interpret the data, they simply cannot. The current healthcare model necessitates change.

*How: Examples in Big Data, The Cloud, Wearable Technology, Clinical Decision Support Systems, Precision Medicine*

The next question that arises: How can AI change the current healthcare landscape? The rise in popularity of AI systems is a response to convincing evidence that AI may solve some of the major issues in our current healthcare model. AI thrives in systems with data- healthcare has just that. The famous AI system, Watson during the Jeopardy! Challenge showed off its ability to sift through and analyze 200 million pages of data in under three seconds to provide

# RIGHT
# DATA.



## Melody™

Transcatheter Pulmonary Valve (TPV) System

Proven to Delay Conduit Replacement

**88.8%**

freedom from reoperation*

*US IDE Study

Proven Valve Competence

**98.1%**

of subjects with ≤ mild PR*

## Designed Specifically for Pulmonary Valve Replacement

The Melody valve is the longest studied transcatheter pulmonary valve at seven years post-implant.

The Melody TPV System first received CE mark in September 2006.

The Melody TPV System received Health Canada approval in December 2006 and US approval under an HDE on January 25, 2010 (H080002).

PMA approval received January 27, 2015 (P140017).



UC201900307 EN 05/2018

Medtronic

Further, Together

## Melody™ Transcatheter Pulmonary Valve, Ensemble™ II Transcatheter Valve Delivery System

**Important Labeling Information for the United States**

**Indications:** The Melody TPV is indicated for use in the management of pediatric and adult patients who have a clinical indication for intervention on a dysfunctional right ventricular outflow tract (RVOT) conduit or surgical bioprosthetic pulmonary valve that has ≥ moderate regurgitation, and/or a mean RVOT gradient ≥35 mm Hg.

**Contraindications:** None known.

**Warnings/Precautions/Side Effects:**

- **DO NOT implant in the aortic or mitral position. Pre-clinical bench testing of the Melody valve suggests that valve function and durability will be extremely limited when used in these locations.**
- DO NOT use if patient's anatomy precludes introduction of the valve, if the venous anatomy cannot accommodate a 22 Fr size introducer, or if there is significant obstruction of the central veins.
- DO NOT use if there are clinical or biological signs of infection including active endocarditis. Standard medical and surgical care should be strongly considered in these circumstances.
- Assessment of the coronary artery anatomy for the risk of coronary artery compression should be performed in all patients prior to deployment of the TPV.
- To minimize the risk of conduit rupture, do not use a balloon with a diameter greater than 110% of the nominal diameter (original implant size) of the conduit for pre-dilation of the intended site of deployment, or for deployment of the TPV.
- The potential for stent fracture should be considered in all patients who undergo TPV placement. Radiographic assessment of the stent with chest radiography or fluoroscopy should be included in the routine postoperative evaluation of patients who receive a TPV.
- If a stent fracture is detected, continued monitoring of the stent should be performed in conjunction with clinically appropriate hemodynamic assessment. In patients with stent fracture and significant associated RVOT obstruction or regurgitation, reintervention should be considered in accordance with usual clinical practice.

Potential procedural complications that may result from implantation of the Melody device include the following: rupture of the RVOT conduit, compression of a coronary artery, perforation of a major blood vessel, embolization or migration of the device, perforation of a heart chamber, arrhythmias, allergic reaction to contrast media, cerebrovascular events (TIA, CVA), infection/sepsis, fever, hematoma, radiation-induced erythema, blistering, or peeling of skin, pain, swelling, or bruising at the catheterization site.

Potential device-related adverse events that may occur following device implantation include the following: stent fracture*, stent fracture resulting in recurrent obstruction, endocarditis, embolization or migration of the device, valvular dysfunction (stenosis or regurgitation), paravalvular leak, valvular thrombosis, pulmonary thromboembolism, hemolysis.

*The term "stent fracture" refers to the fracturing of the Melody TPV. However, in subjects with multiple stents in the RVOT it is difficult to definitively attribute stent fractures to the Melody frame versus another stent.

For additional information, please refer to the Instructions for Use provided with the product or available on http://manuals.medtronic.com.

**CAUTION:** Federal law (USA) restricts this device to sale by or on the order of a physician.

**Important Labeling Information for Geographies Outside of the United States**

**Indications:** The Melody™ TPV is indicated for use in patients with the following clinical conditions:

- Patients with regurgitant prosthetic right ventricular outflow tract (RVOT) conduits or bioprostheses with a clinical indication for invasive or surgical intervention, OR
- Patients with stenotic prosthetic RVOT conduits or bioprostheses where the risk of worsening regurgitation is a relative contraindication to balloon dilatation or stenting

**Contraindications:**

- Venous anatomy unable to accommodate a 22 Fr size introducer sheath
- Implantation of the TPV in the left heart
- RVOT unfavorable for good stent anchorage
- Severe RVOT obstruction, which cannot be dilated by balloon
- Obstruction of the central veins
- Clinical or biological signs of infection
- Active endocarditis
- Known allergy to aspirin or heparin
- Pregnancy

Potential Complications/Adverse Events: Potential procedural complications that may result from implantation of the Melody device include the following: rupture of the RVOT conduit, compression of a coronary artery, perforation of a major blood vessel, embolization or migration of the device, perforation of a heart chamber, arrhythmias, allergic reaction to contrast media, cerebrovascular events (TIA, CVA), infection/sepsis, fever, hematoma, radiation-induced erythema, pain, swelling or bruising at the catheterization site.

Potential device-related adverse events that may occur following device implantation include the following: stent fracture*, stent fracture resulting in recurrent obstruction, endocarditis, embolization or migration of the device, valvular dysfunction (stenosis or regurgitation), paravalvular leak, valvular thrombosis, pulmonary thromboembolism, hemolysis.

*The term "stent fracture" refers to the fracturing of the Melody TPV. However, in subjects with multiple stents in the RVOT it is difficult to definitively attribute stent fractures to the Melody frame versus another stent.

For additional information, please refer to the Instructions for Use provided with the product or available on http://manuals.medtronic.com.

The Melody Transcatheter Pulmonary Valve and Ensemble II Transcatheter Delivery System has received CE Mark approval and is available for distribution in Europe.

**medtronic.com**

710 Medtronic Parkway
Minneapolis, MN 55432-5604
USA
Tel: (763) 514-4000
Fax: (763) 514-4879
Toll-free: (800) 328-2518

**LifeLine**
**CardioVascular Technical Support**
Tel: (877) 526-7890
Tel: (763) 526-7890
Fax: (763) 526-7888
rs.cstechsupport@medtronic.com



UC201809495 EN 02/2018

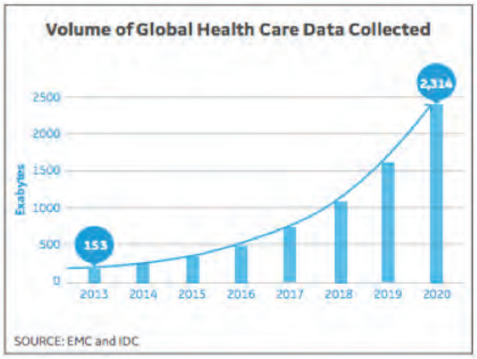



*Figure 4. Graph depicting the steep rise in global healthcare data collected since 2013 with a projected exponential rate of growth reaching 2,314 exabytes by 2020.[45]*

accurate responses. Naturally, the healthcare industry saw the AI-powered Watson as an opportunity to extrapolate its demonstrated superhuman power to the healthcare data dilemma. The end goal of such a system: practice smarter medicine by extending the physician's intelligence and efficiency to improve patient outcomes.

Proponents argue that the implementation of AI into healthcare systems could improve patient health, move towards personalized medicine, give patients more ownership of their data, and reduce medical costs.[6] In Part I of this review article we will discuss examples of current and potential future directions for AI and Pediatric Cardiology under the big themes of *Big Data, The Cloud, Wearable Technology, Clinical Decision Support Systems* and *Precision Medicine* to demonstrate the **how** AI will lead a movement to achieve such goals.

**Big Data**

Big data refers to infinitely large datasets whose scale, diversity, and complexity require more advanced technology than standard processing methods for analysis, interpretation, and storage. Information collected from mobile phones, wearable technology, social media, environmental, and lifestyle-related factors, socio-demographics, "omic" data (e.g., genomics, metabolomics, proteomics), and EMRs all contribute to big data (Figure 4). While the volume of data in its current state contributes to physician workload, it is this very rise in data that enabled the advances in computational algorithmic development capable of interpreting and translating large bodies of health information into meaningful and actionable information.

Experts agree the real challenge in medicine is not to gather the data, but to "clean it up."[5] AI algorithms are only as good as the data that is used to make them. The volume of data is no longer the issue; instead it is the inherent variety and veracity of healthcare data. The variety (pathology reports, echocardiograms, notes, lab results and much more) and veracity (biases, noise and uncertainty in data) abundant in medical data sets pose messiness, heterogeneity, and robustness problems that impede standard algorithmic interpretation. This is complicated by the fact that pediatric cardiology patients often see multiple specialists at different institutions, each with their own idiosyncratic EMR systems and processes for capturing, encoding, storing, and sharing data. While extensions of AI offer unparalleled advantages over former rigid systems to process and transform pools of otherwise uninterruptable "messy" data into meaningful clinical connections, these methods prove less useful in EMR settings where lack of standardization in data collection and billing poses challenges. These systems are not equipped to determine the relevant data missing and account for the variations in physician coding behavior.[7]

Thus, a major barrier remains finding ways to standardize data collection and storage to encourage the development of more precise algorithms. The trend towards developing big data centers is seen in countries such as Italy and Denmark. There local government agencies compile and store all citizens' healthcare information to create large pools of aggregate health information, providing a comprehensive outlook on the health of a country.[8] As an example of the value of such a dataset, researchers utilized the medical records of over 110 million EMRs from the U.S. and Denmark to create a comorbidity AI based algorithm that led to the identification of genetic abnormalities merely from analysis of documented medical conditions.[9] Similarly, The Veteran's Hospital has leveraged its wealth of patient data in a common storage system to drive clinical decisions through a scoring system that calculates a patient's risk for hospitalization based on demographics, diagnoses, vital signs, medications, lab results, and prior use of health services. The system directly links to a web-based application for the corresponding care team to review and respond to accordingly.[10] More hospitals across the country are exploring similar ways to better capture and collect data to improve this process.

In Pediatric Cardiology, there has been a large effort over recent years to form a common collective catalog of patient information resulting in more than 30 recognized databases and registries globally.[11] The online publication *US News and World Report (USNWR)* annually announces the ''ranking'' of US Children's Hospitals for pediatric cardiology and cardiac surgery.[12] Their algorithm contains a variety of components including the participation in various cardiac-related databases and benchmarking activities and routinely tracking and reporting every occurrence of a list of surgical admission outcome parameters to the Society of Thoracic Surgeons (STS) database.[13] Over the past three decades, the recognized benefit of cross-institutional collaborative research efforts for rare pediatric diseases has led to notable increases in large-scale data management proficiencies and participation in multicenter Congenital Heart Disease databases.[11] Finally, mandated reporting for hospital payment and other purposes, regular auditing by fiduciaries, and oversight by state health data organizations has made statewide administrative databases a rich source of information about healthcare delivery.

Proponents of big data contend that it has the potential to reduce the increasing gap between healthcare costs and outcomes by improving healthcare quality and patient outcomes, increasing data availability, and increasing analytic capabilities.[14] However, to fully realize the great potential of big data to improve PediatricCardiology, attention and resources will be required to shift practices toward standardized data collection across i nstitutions to favor algorithmic design.[15]

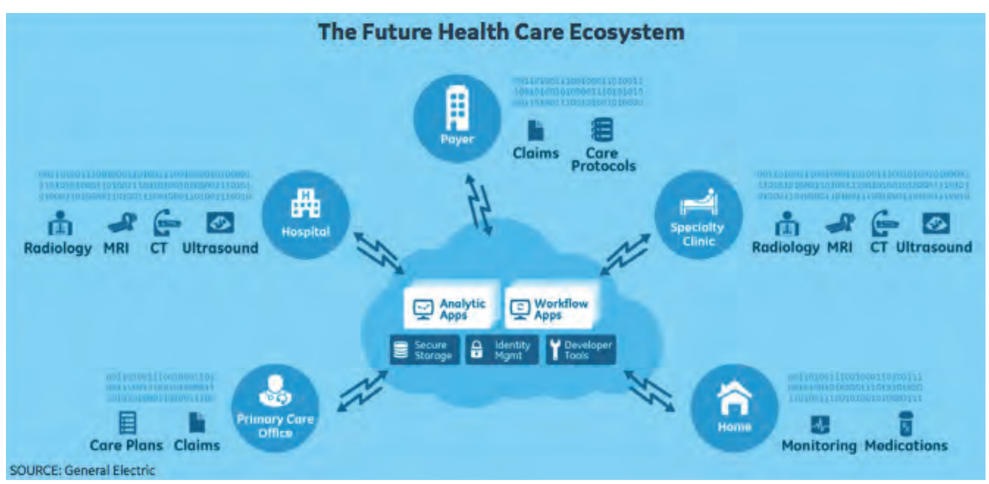



*Figure 5. A prototype for a futuristic healthcare system with a common repository for the common avenues of data connection.[46]*

## The Cloud

In the current atmosphere, healthcare data remains in a myriad of locations and structures without a common repository or format due to the variety of hospitals EMR infrastructures. The adoption of a cloud-based healthcare system could serve as a common storage house for sharing and amassing data. Unlike the majority of models for current cross-institutional patient registries, which require manually uploading patient information and filling out consent paperwork for accessibility to that information, the cloud could facilitate seamless, automatic integration of data into a shared reservoir (Figure 5 on previous page). Cloud services enable the delivery of medical information from multiple computers, anytime, anywhere, and on any mobile device. Once the ethical details of development are sorted, the creation of a globally shared medical cloud could facilitate increased collaborative pediatric research endeavors to circumvent the common limitation in pediatrics of poor enrollment of patient numbers for rare disease processes.

Cloud computing also offers promise for accessing and sharing patient information between institutions to improve continuity of patient care and decrease unnecessary

*Figure 6. An exaggerated depiction of the future of wearable devices.[47]*

redundant studies. Utilization of advances in cloud computing, such as Horizon Cardiology from McKesson, now provides cardiologists with a single-platform cardiovascular imaging and information system (CVIS) to remotely access all inpatient and outpatient echocardiograms, reports, EKGs, and cardiac catheterizations from one workstation. Newer modifications include congenital disease templates, graphical measurement trending, and z-score calculations to adapt to the pediatric cardiology population. This technology has led to marked improvements in workflow efficiency and turnaround time of completed echo reports to the referring pediatricians. The success speaks to the feasibility of cloud computing.[16] In the future, the cloud could promote cross-institutional and global sharing of data to reach new insights previously unattainable in the healthcare research infrastructure.

## Wearable Technology

Widely available wearable technology now monitors for heart rate, heart rhythm, physical activity, sleep, sweat output, blood pressure, and medication adherence. The wearable market is projected to jump from an estimate of 325 million in 2016 to over 830 million in 2020.[17] The global wearable medical devices market is expected to reach $14.6 billion by 2023, up from $5.5 billion in 2017 -- a compound annual growth rate (CAGR) of 18.5%. Experts attribute the steep projected growth estimations to increases in technological advancements, appealing product features, smart phone penetration, and growth in the healthcare smart phone apps.[18] The increased popularity of wearable devices offers unparalleled access to a wealth of patient health information (Figure 6). Such technology may offer an opportunity to improve the management of CHD by matching the optimal type, duration, and assessment method for physical activity to specific lesions and age groups.[19] Intelligent interventions to increase self-efficacy for physical activity together with rehabilitation programs may serve to decrease the high obesity rates, improve functional status, and decrease rates of acquired heart disease in our aging CHD population.

Due to limitations in research, physical activity instruction for CHD patients is restricted to suggestions extrapolated from healthy adult and adolescent patient studies rather than formal recommendations or guidelines based on pediatric CHD patients. The lesion-specific CHD instructions that exist are often limited to recommendations cited from the *36th Bethesda Conference*[20] which apply only to adolescents or adults interested in a competitive organized team sport or individual sport with high degree of training. Wearable data from consenting participants could fill this gap in care by providing the missing objective data on the combined health of the CHD population. Epidemiologic data on the type, tolerance, frequency, and duration of physical activity participation for specific lesions segregated by ages, gender, and other demographics could establish formerly unattainable "normals" for safe level of physical activity.

Wearables may also benefit patients suffering palpitations through improved detection and diagnosis of arrhythmias in real-time. Palpitations are commonly short-lived and evade detection. Some wearables now catch arrhythmias at rates comparable or better than the traditional Holter monitor.[21] For example, wearables now detect Supraventricular Tachycardia (SVT).[22] This is particularly useful for the management of nonverbal infants and immaturely verbal toddler-aged patients with symptomatic SVT. The technology syncs with smartphones in the cloud to connect the physician and patient removing the laborious and time-heavy task of the parent making multiple trips to the cardiologist to drop off the Holter, have it read, and attend a follow-up appointment to discuss the interpretation. Instead the physician can remotely review the output from smart technology, agree or disagree with the technology's read, and give immediate feedback to the parent (Figure 7). In addition, efforts to extend wearable technology into telemedicine could expand the pediatric cardiologists' geographical outreach to parts of the world previously devoid of care.

Smart pill technology is another innovation that hopes to improve healthcare delivery for children on daily medications. Recently FDA approved, the technology includes a

*Figure 7. A depiction of the interplay between health information collected on a wearable transmitted through the cloud for physician review and interpretation.[48]*

tiny ingestible sensor that transmits a signal to a receiver patch that patients wear on their torso.[23] The information from the sensor is transmitted wirelessly to parents and the physician to verify medication compliance. The technology is exciting for the parents of noncompliant adolescents and for the parents of pediatric heart transplant recipients managing a complex dosing schedule.

## Clinical Decision Support Systems

Clinical decision support systems (CDSS) utilizing AI technology provide clinicians with a variety of tools to improve decision-making, clinical workflow, and healthcare outcomes for specific tasks. The majority of CDSS designs are in academic centers. Those for pediatric cardiology aim to improve existing scoring systems by integrating AI applications to increase accuracy. Other work on CDSS comes from the start-up and healthcare business industry realm and focuses on a variety of emerging fields such as virtual assistants, documentation efficiency software, and chatbots.

Virtual Assistants are a form of CDSS that aim to remedy clinical inefficiencies by decreasing charting time, increasing time spent on direct care, reducing medical errors, and improving clinical outcomes.[29]

## *FACULTY POSITION IN PEDIATRIC CARDIOLOGY*
## *UNIVERSITY OF SOUTH ALABAMA COLLEGE OF MEDICINE*

As part of efforts to expand its scholarly and clinical activities, the Department of Pediatrics at the University of South Alabama College of Medicine is currently seeking a BC/BE candidate for a faculty position in Pediatric Cardiology.

USA Pediatric Cardiology currently has more than 3000 outpatient encounters per year, including almost 300 fetal echoes performed in the only ICAEL-accredited fetal echo lab in Alabama. Other services include a rural outreach clinic and a telemedicine clinic for patients with adult congenital heart disease conducted jointly with a regional ACHD specialist. Inpatient care is provided at the USA Health Children's and Women's Hospital, the primary referral center for the region and home to the area's only Level III neonatal intensive care unit, with approximately 900 admissions yearly. Patients requiring cardiac surgery are referred to regional surgical centers primarily in Alabama and Mississippi. Other duties include teaching medical students and pediatric residents.

Candidates should have completed fellowship training in Pediatric Cardiology and be board certified or board eligible. Level of appointment is open and will be commensurate with training, experience, and academic productivity. We offer competitive compensation and benefits. This is an outstanding opportunity to join a collegial, diverse, expanding department committed to providing its faculty with the opportunity to achieve academic and professional growth while enjoying the climate, affordability, and high quality of life of the central Gulf Coast. For information or to apply, please contact:

**David A. Gremse, MD**
**Professor and Chair**
**USA Department of Pediatrics**
**1601 Center Street, Suite 1271**
**Mobile, AL 36604**
**Phone: (251) 434-3919**
**Email: dgremse@health.southalabama.edu**

***USA is an EO/AA Employer - minorities/females/veterans/disabilities/sexual orientation/gender identity***

In the USA, medication errors are estimated to affect at least 1.5 million patients per year and account for 400,000 preventable adverse events.[24] The Landmark Hospital system announced the successful use of an AI-powered cloud-based virtual assistant, Nuance's Florence, reduced medical errors by 30% in 18 months. The interactive virtual assistant's cloud-based interface utilizes natural language processing (NLP), an extension of AI, to provide an innovative way for physicians to engage in a verbal conversation with Florence to have her place orders for labs, images, and medications. Florence responds appropriately and timely to confirm dosing, input the orders, and give reminders to offer a second checkpoint.[25] Other emerging virtual assistants act as a CDSS to aid providers in completing standardized tasks; the Olive Crosschx virtual assistant uses robotic process automation to streamline tasks such as reviewing insurance eligibility, submitting prior authorizations, organizing orders, scheduling payments, reducing no show rates, and making follow-up appointments at two times the productivity and half the cost.[26]

Another emerging technology, the next-generation CDSS computer-assisted physician documentation (CAPD), aims to remove the time burdens of the EMR and increase compliance with regulatory requirements and documentation of the severity of illness to maximize reimbursements. The technology developed by Nuance, the same company that designed the speech recognition software Dragon Medical for verbal note dictation, intends to build off of this former design by incorporating with algorithms that learn distinctive data patterns and leverage data from the cloud to capture patient information to input into the EMR documentation process.

AI chatbots are a new system that uses an extension of AI, NLP, to understand the user's questions followed by knowledge management to offer an answer. The technology enables the system to improve its response with each subsequent interaction. For medical purposes, chatbots can fulfill various objectives such as a diagnostic tool aid for physicians interacting with a patient with a list of seemingly disjointed symptoms and complaints or for a parent to replace the standard Google search, which may spark unnecessary worry, with a medically-approved search engine. Google created a Chabot named Melody that was built-in to Baidu, China's Google, to connect patients with approved sources of medical content, answer medical questions, find local doctors, and book appointments with these doctors to perform medical triage in densely-populated China. While patient interactions with the system are encrypted, the system does maintain a log leading to some privacy concerns.[27]

**Precision Medicine**

Big data, the cloud, wearable technology, and CDSS are the building blocks of the overarching goal of AI: the successful construction of an AI-supported healthcare model that approximates the popular precision medicine model advocated and marketed under the Obama Campaign. Currently diagnostic decision and treatment plans often are based on what usually works for the average pediatric patient with and his or her predominant pathophysiology, the so-called "one-size-fits-all approach". The nuances and exceptions in pediatric cardiology can make it challenging to determine the "best" medical and surgical treatment for each specific patient, especially given the limited data on comparable cases to support it. Precision medicine harnesses healthcare big data and provides physicians with patient-specific risk prediction for future morbidity and mortality as well as patient-tailored treatment modalities to avert these discovered risks.

The precision model promises a paradigm shift in care delivery from evidence-based medicine to intelligence-based medicine. As such machine intelligence plus human intelligence will redefine medical intelligence.[28] In this new care delivery format, medical decisions will be made off of large databases of direct and indirect information sources (wearables, PubMed, medical records, social history changes, genetic tests, etc.) and aggregate patient population data to provide a complete picture of the current and predictive future health for each patient. The sophisticated technology supports physicians to develop a proactive approach to offer highly personalized care at a level that far exceeds with which even the most informed and well-read doctor could provide. In doing so, the system discards the unpredictability of estimations, uncertainty of diagnoses, and guesswork of forming treatment strategies largely based on generalized demographics. Instead, precision medicine gives raw numbers leveraged from big data to provide predictive, precise, and real-time information to support the clinician and patient in making well-informed medical decisions. The inherent benefit of precision medicine: reducing medical decision inaccuracies in spending, diagnoses, medication selection, dosing, and treatment planning.

Supportive technology for precision medicine includes advances in virtual reality (VR). VR involved with 3D printing and virtual device implantation offers innovative approaches for surgical planning and device placement with recent successes in the repair of Tetralogy of Fallot, pulmonary atresia, and pulmonary collaterals.[29,30] Through 3D modeling, the cardiology team can simulate procedures for decisions and approach planning, personalize the type and sizing of materials for each patient's anatomy, create models for procedure and map simulation, and perform procedures remotely using haptic feedback.

Utilization of such tools has led to the successfully guided surgical placement of the SynCardia Total Artificial Heart in at least 32 patients in six countries thus far.[31] The use of 3D printing for the surgical preparation for a cohort of over 200 patients with CHD provided a favorable decrease in mean surgical case time, operating room time, and 30-day readmission rates.[32]

The pharmaceutical industry recently emerged as a big investor in precision medicine. In Pediatric Cardiology, a common limitation of research in drug development remains patient numbers linked to the rarity of disease in the population. Currently, 28 pharmaceutical companies[33] and 93 startups[34] are centered on applying AI to healthcare drug discovery. Pharmaceutical precision medicine utilizes AI applications in the drug discovery pipeline to "test" compounds and investigational treatments for anticipated side effects and adverse reactions through leveraging patient healthcare data. Interest in improving this process has spurred the drug development industry to invest billions of dollars in applying AI algorithms to the drug design pipeline to make the process faster and cheaper. The process of bringing an experimental drug to the market on average commonly takes over ten years and $2.6 billion with less than 12% of phase one drugs succeeding to clinical trials due to concerns for safety and effectiveness.[35] AI can teach machines how to unravel raw complex data through the detection of patterns making it a natural fit for mining and relating the immense genotypic and phenotypic data being collected worldwide in public and private databases,

> ***"The AI model combats issues that lead to burnout by promoting efficiency. The time saved in the chart-review process and after clinical encounter responsibilities can be better used at the patient's bedside strengthening the patient-physician human relationship known to prevent physician burn out and increase patient satisfaction.[1]"***

hospitals and doctors' offices, academic research journals, and individual's wearable health monitoring devices. In pediatrics, this becomes even more important as many chronic diseases are the result of presumed genetic aberrances rather than environmental factors.

**Part II: Who and When**

In the first part of this review, we discussed some current and future applications of AI in big data, the cloud, wearable technology, clinical decision support systems and precision medicine. The next questions often raised are: Who will be involved in launching, maintaining and overseeing the incorporation of AI technology into medical practice? and When will we start to see such changes reflected into everyday practice? Part II of this review will discuss both of these questions.

*Who: Physicians, Data Scientists, Lawmakers, Patients and Families, Pharmaceutical Industry, Startup Companies, Healthcare Administration and Medical Educators*

The recruitment and collaboration between the necessary stakeholders, the humans, will ultimately determine course for implementation of AI technology into cardiology practice. Such stakeholders should include an appointed team of interdisciplinary and visionary representatives equipped to invent a curriculum for the successful and ethical integration of AI into our healthcare system. Furthermore, members must be accountable for designing processes for governance (i.e. checkpoints, maintenance, and regulations) indispensable to preserving the reputation of AI as a groundbreaking technology that preserves the best interest of the patient and medical team. As such, the team should be open to frequent revisions and refinements along the way as unforeseen issues arise.

1. **Physicians:** While the roots of AI are over 100 years old, the idea of integrating AI into healthcare is a relatively new concept. It does not take a physician well versed in AI to appreciate that implementing such a complex technology will require planning, time, effort, collaboration and dialogue. In 2017, the American College of Cardiology Task Force on Health Policy Statements and Systems of Care released a report titled "The Roadmap for Innovation—*American College of Cardiology (ACC)* Health Policy Statement on Healthcare Transformation in the Era of Digital Health, Big Data, and Precision Health" to address concerns on how to approach advances in AI to improve the health of patients.36 More recently, The American Medical Association (AMA) released a Policy Statement on Augmented Intelligence acknowledging that the AMA "has a unique opportunity to ensure that the evolution of augmented intelligence in medicine benefits patients, physicians, and the healthcare community". [37] The baseline policy per board members is to guide the AMA's interaction with the stakeholders and policymakers to represent the perspective of physicians in various practice settings in dialogue surrounding AI. A core component of the implementation process will rely on the engagement and leadership of physician governing bodies to create a reasonable, common strategy for implementation.
2. **Data Scientists:** Currently much of the work in AI is performed by data scientists who have never touched a patient nor worked in the healthcare industry, but who offer the knowledge, skillset, and experience in AI that most physicians lack. Physicians from the position at the frontlines of practice may have inventive ideas about how to fix or improve an issue or a clinical question with AI. The data-scientist, in turn, will have insight into how to develop the appropriate algorithm to answer that question. As such, collaborative projects will likely have more success in providing relevant, meaningful, and effective solutions that could integrate well into the clinical workflow.
3. **Lawmakers:** Prior to full integration into the clinical setting, a team of carefully selected panelists will need to explore the legal implications of AI in healthcare. Raised issues include liability, intellectual property, and the range of validity allowable for acceptable AI in practice. The establishment of laws and regulations will be the segue into the development of safety measurements and oversight committees to ensure laws are upheld and revised as new technologies and issues arise.
4. **Patients and Families:** Most importantly, patients and their families will need to have a voice in what the technology means to receiving healthcare. The popularity of genetic testing, wearable technology, participation in collaborative databases for research, and clinical trials suggests a growing potential for a shared cloud database to reach better precision healthcare options for children with chronic diseases where patient numbers are limited. The crux will be determining how to protect private healthcare information while allowing patients to contribute to the future healthcare of others. Furthermore, how to ensure the human-to-human interaction between the patient and the provider is preserved with the implementation of the technology.
5. **Pharmaceutical Industry:** Between 2016-2017, a string of AI-based startup companies strategically partnered with large pharmaceutical firms. There are now over 28 pharmaceutical companies focused on advancing drug discovery through AI.[33] The growing number of partnerships between major pharmaceutical firms and AI-based startups highlights the expanding pharmaceutical company involvement, voice, and interest in the future AI drug discovery pipeline.
6. **AI-Based Healthcare Start-up Companies:** According to a new report published by Allied Market Research, the global AI in healthcare market was estimated at $1,441 million in 2016 and will increase to $22,790 million by 2023 (an expected compound annual growth rate of 48.7%).[38] With a large financial incentive at stake, over 93 startups are focused on advancing AI in healthcare. It is only a matter of time until the academic world of research-based AI explorations and the business world of AI startups in healthcare will converge and expand into the healthcare industry.
7. **Healthcare Administrators:** Healthcare administrators will be tasked with deciding whether and when a hospital decides to incorporate technology into an already complex system. In a survey administered to 150 health care decision makers, 82% of those employing data analytics reported improved patient care, 63% reported reduced readmission rates, and 62% reported improved overall health outcomes. They also cited improved hospital operational performance, financial reporting capabilities, and management decision making.[39] With the increased awareness of the capabilities of AI to make systematic improvements in the healthcare business model, administrators may feel more eager to extend the scope of AI to other departments.
8. **Medical Educators:** The rise in AI applications invites the question does our current medical student education curriculum need to address AI healthcare applications to prepare the future generation of doctors? The AMA policy recognizes the need for education on AI and advocates for "promoting a greater understanding for the promise and limitations of AI."[37] However, their statement is vague, missing the necessary concrete details on the vision and strategy for promoting this understanding. The future will entail determining who will be responsible for the curriculum design and when it will fit into an already densely packed training course.

*When: Not Necessarily in the Future*

The energy directed towards AI in healthcare is palpable. Healthcare companies now account for one-fifth of the U.S. economy.[5] It is no surprise that there are now over 100 data-driven healthcare startups on a quest to get a bite of the funding promised by anticipated large expenditures and generated revenue from such investments. Governing bodies of physicians are releasing statements on digital health and AI paralleling increased recognition for a future with AI.[36,37] The new and growing attention directed at this technology is creating a significant momentum hinting that it is only a matter of time until the academic world of research-based AI explorations and the business world of AI startups in healthcare will merge and spread to the clinical setting.

## PEDIATRIC CARDIOLOGY
## YALE UNIVERSITY SCHOOL OF MEDICINE

**The Section of Pediatric Cardiology at the Yale University School of Medicine and Yale New Haven Children's Hospital is recruiting a BE/BC pediatric cardiologist with major interest, expertise and experience in non-invasive cardiac imaging and outpatient cardiology at the Assistant Professor level. The ideal candidate has received advanced training in advanced cardiac imaging. Outstanding communication, collaboration and clinical skills are required.**

**This individual will join a division of dedicated faculty and advanced nursing practitioners to provide congenital heart care and cardiovascular imaging to patients throughout the state and region. The Section has an active research program, an extensive and growing clinical program, an outstanding fellowship program and a nationally recognized Pediatric Residency Program at the Yale New Haven Children's Hospital.**

**The successful candidates will receive a faculty appointment in the Yale Department of Pediatrics at the academic level commensurate with experience and qualifications. Yale University and the Department of Pediatrics offer an excellent benefits package. The greater New Haven and Connecticut Shoreline area offers an excellent quality of life with immense cultural and recreational opportunities.**

**Review of applications will begin immediately and will continue until the position is filled.**

**Interested applicants should submit Curriculum Vitae, Cover Letter and 3 references electronically to:**

http://apply.interfolio.com/48974

**Yale University is an equal opportunity, affirmative action employer.
Women, minorities, persons with disabilities and protected veterans are encouraged to apply.**

Despite the upswing in headlines on new individual developments in AI and accruing financial investments, the full of acceptance, and ultimate extension of this technology into the clinical practice of cardiology is not likely on the near horizon (5-10 years) but rather down the line (15-25 years). The first step to understanding and appreciating when AI will become ubiquitous is to recognize the realistic capabilities of the technology today. Marketing ploys often flaunt exaggerated representations of AI contributing to the current state of confusion with polarized feelings of distrust or over-exuberance in the medical community. The vast majority of AI endeavors today are siloed in academic centers or business startups. Most products designed today serve to improve a specific task or address a specific clinical question (autonomously read an echocardiogram, calculate risk for future morbidity, connect the patient with a virtual assistant). Even when products receive FDA approval, their true integration into the clinical setting is rare. Many challenges lay ahead in preparation for the full incorporation of AI into the healthcare system. Likely when a strategy is finalized the actual execution will require frequent checkpoints amongst the stakeholders to refine the process befor true utilization.

## Conclusion

AI is at the heart of a revolution in healthcare. Andrew Ng, the founder of the Google Deep Brain Learning Project, describes AI as "the new electricity" of this era.[40] The accelerated rate of funding, research, and development devoted to AI in healthcare points to a future healthcare delivery model driven by this AI electricity. Excitement for AI stems from the promise for a future complete picture of health in which diagnoses, treatment, and prevention of diseases, unique to each patient, will be accessible for the clinical care team. Human intelligence when coupled with AI methods will elevate the physician's cognitive capacity to redefine the limits of medical intelligence. As such, AI will not supplant the physician, but rather offer a new tool to approach modern healthcare problems. Before that day arrives, the next phase of AI will rely heavily on the various stakeholders to address the ethical and legal questions ranging from patient privacy and data security to the reliability of algorithms and appropriateness of guidance before the full transition of this technology into the clinic setting and overall healthcare model. The resources are here, but the future ahead will rely on the resourcefulness, energy, and leadership of all stakeholders in medicine. More so than ever, this includes the physicians entrusted to care for all aspects of the patient, which in this new era includes AI.

## References


1. Diance Shannon. Physician Well_being: A Powerful Way to Improve the Patient Experience. Am Assoc Physician Leadersh.2013:6-12.file://Users/jamesburns/Desktope2c9a96a82cle390970e840897
2. Shanafelt TD, Hasan O, Dyrbye LN, et al. Changes in Burnout and Satisfaction with Work-Life Balance in Physicians and the General US Working Population between 2011 and 2014. Mayo Clin Proc. 2015;90(12):1600-1613. doi:10.1016/j.mayocp.2015.08.023.
3. Mann S. Research Shows Shortage of More than 100,000 Doctors by 2030. AAMC NEWS. 2018:1-4.
4. Oaklander M. Life\SUPPORT. Time. 2015;186(9/10):42-51. http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=109159580&site=ehost-live.
5. Tech's Next Big Wave: Big Data Meets Biology. Fortune. 2018.
6. Company GE. Big Data, Analytics & Artificial Intelligence The Future of Health Care Is Here. http://newsroom.gehealthcare.com/wp-content/uploads/2016/12/GE-Healthcare-White-Paper_FINAL.pdf.
7. Nilay D. Shah, Ewout W. Steyerberg MMK. Big Data and Predictive Analytics Recalibrating Expectations. JAMA J Am Med Assoc. 2018:1-2. doi:doi:10.1001/jama.2018.5602.
8. Moore P. Congenital interventions enter the era of big data: Risks and rewards. J Am Coll Cardiol. 2016;67(11):1336-1337. doi:10.1016/j.jacc.2016.01.040.
9. Blair DR, Lyttle CS, Mortensen JM, et al. A nondegenerate code of deleterious variants in mendelian loci contributes to complex disease risk. Cell. 2013;155(1):70-80. doi:10.1016/j.cell.2013.08.030.
10. Fihn SD, Francis J, Clancy C, et al. Insights from advanced analytics at the veterans health administration. Health Aff. 2014;33(7):1203-1211. doi:10.1377/hlthaff.2014.0054.
11. Vener DF, Gaies M, Jacobs JP, Pasquali SK. Clinical Databases and Registries in Congenital and Pediatric Cardiac Surgery, Cardiology, Critical Care, and Anesthesiology Worldwide. World J Pediatr Congenit Heart Surg. 2017;8(1):77-87. doi:10.1177/2150135116681730.
12. US News. Best Hospitals in the U.S. | Hospital Rankings | US News Health. U.S News and World Report.
13. Olmsted MG, Geisen E, Powell R, Murphy J, Bell D, Stanley M. Methodology: U.S. News & World Report Best Children's Hospitals 2017-18.; 2018.
14. Raghupathi W, Raghupathi V. Big data analytics in healthcare: promise and potential. Heal Inf Sci Syst. 2014;2(1):3. doi:10.1186/2047-2501-2-3.
15. Rumsfeld JS, Joynt KE, Maddox TM. Big data analytics to improve cardiovascular care: Promise and challenges. Nat Rev Cardiol. 2016;13(6):350-359. doi:10.1038/nrcardio.2016.42.
16. Mercy Children's Hospital Transforms Pediatric Cardiology Workflow With CVIS. Diagnostics Interv Cardiol. 2011.
17. Statistics & Facts on Wearable Technology. Statista. https://www.statista.com/topics/1556/wearable-technology/. Published 2018. Accessed April 9, 2018.
18. Wearable Medical Devices Market Expected to Grow at a CAGR of 18.5 % from 2018-2023. International Supply Demand Market Research. https://www.reuters.com/brandfeatures/venture-capital/article?id=32533. Published 2018.
19. Longmuir PE, Brothers JA, De Ferranti SD, et al. Promotion of physical activity for children and adults with congenital heart disease: A scientific statement from the American Heart Association. Circulation. 2013;127(21):2147-2159. doi:10.1161/CIR.0b013e318293688f.
20. Pelliccia A, Zipes DP, Maron BJ. Bethesda Conference #36 and the European Society of Cardiology Consensus Recommendations Revisited. A Comparison of U.S. and European Criteria for Eligibility and Disqualification of Competitive Athletes With Cardiovascular Abnormalities. J Am Coll Cardiol. 2008;52(24):1990-1996. doi:10.1016/j.jacc.2008.08.055.
21. Garabelli P, Stavrakis S, Po S. Smartphone-based arrhythmia monitoring. Curr Opin Cardiol. 2017;32(1):53-57. doi:10.1097/HCO.0000000000000350.
22. Ferdman DJ, Liberman L, Silver ES. A Smartphone Application to Diagnose the Mechanism of Pediatric Supraventricular Tachycardia. Pediatr Cardiol. 2015;36(7):1452-1457. doi:10.1007/s00246-015-1185-6.
23. Wamsley L. FDA Approves First Digital Pill That Can Track Whether You've Taken It : The Two-Way : NPR. NPR. https://www.npr.org/sections/thetwo-way/2017/11/14/564112345/fda-approves-first-digital-pill-that-can-track-if-youve-taken-it. Published 2017.
24. Stefanacci RG, Riddle A. Preventing medication errors. Geriatr Nurs (Minneap). 2016;37(4):307-310. doi:10.1016/j.gerinurse.2016.06.005.
25. Lee K. Hospital uses intelligent virtual assistant for more accurate order entry. HealthIT. 2017. https://searchhealthit.techtarget.com/feature/Hospital-uses-intelligent-virtual-assistant-for-more-accurate-order-entry.
26. Meet Olive Optimizing Operations. https://crosschx.com/press/. Accessed March 22, 2018.
27. Portz G von. Baidu builds a chatbot app to perform basic medical triage. iMedical Apps. 2016.
28. Miliard M. AI could help make physician work "more interesting," cardiologist says. Healthc IT News. 2018. https://www.healthcareitnews.com/news/ai-could-help-make-physician-work-more-interesting-cardiologist-says.
29. Ryan JR, Moe TG, Richardson R, Frakes DH, Nigro JJ, Pophal S. A novel approach to neonatal management of tetralogy of fallot, with pulmonary atresia, and multiple aortopulmonary collaterals. JACC Cardiovasc Imaging. 2015;8(1):103-104. doi:10.1016/j.jcmg.2014.04.030.

30. Ngan EM, Rebeyka IM, Ross DB, et al. The rapid prototyping of anatomic models in pulmonary atresia. J Thorac Cardiovasc Surg. 2006;132(2):264-269. doi:10.1016/j.jtcvs.2006.02.047.
31. Marsden AL, Feinstein J a. Computational modeling and engineering in pediatric and congenital heart disease. Curr Opin Pediatr. 2015;27(5):587-596. doi:10.1097/MOP.0000000000000269.
32. Ryan JR. Three Dimensional Printing and Computational Visualization for Surgical Planning and Medical Education. 2015.
33. Smith S. 28 Pharma Companies Using Artificial Intelligence in Drug Discovery.2018.
34. Smith S. 93 Startups Using Artificial Intelligence in Drug Discovery. BenchSci. https://blog.benchsci.com/startups-using-artificial-intelligence-in-drug-discovery. Published July 12, 2018.
35. RESEARCH & DEVELOPMENT Clinical Trials. PHRMA. https://www.phrma.org/advocacy/research-development/clinical-trials. Published 2018.
36. Dugas CM, Schussler JM. Advanced technology in interventional cardiology: A roadmap for the future of precision coronary interventions. Trends Cardiovasc Med. 2016;26(5):466-473. doi:10.1016/j.tcm.2016.02.003.
37. REPORT 41 OF THE BOARD OF TRUSTEES (A-18): Augmented Intelligence (AI) in Health Care.; 2018.
38. Tenzin Kunsel and Onkar Sumant. AI in Healthcare Market by Offering, Technology, Application, and End User: Global Opportunity Analysis and Industry Forecast, 2017-2023.; 2018. https://www.alliedmarketresearch.com/artificial-intelligence-in-healthcare-market.
39. Analytics in Healthcare.; 2015.
40. Lynch S. Andrew Ng: Why AI is the new electricity. Stanford News. https://news.stanford.edu/thedish/2017/03/14/andrew-ng-why-ai-is-the-new-electricity/. Published 2017.
41. Rajiv Leventhal. Artificial Intelligence: The Next Frontier in Health IT? (Part 2). Healthcare Informatics. https://www.healthcare-informatics.com/article/analytics/artificial-intelligence-next-frontier-health-it-part-2. Published 2017. Accessed August 13, 2018.
42. Mohamed Nooman Ahmed, Andeep S. Toor KO and DF. Cognitive Computing and the Future of Health Care. IEEE Pulse. 2017. https://pulse.embs.org/may-2017/cognitive-computing-and-the-future-of-health-care/.
43. RUNKEVICIUS D. AI is the next phase of human evolution. The Next Web. https://thenextweb.com/contributors/2017/11/24/ai-next-phase-human-evolution/. Published 2018. Accessed August 13, 2018.
44. Mohamed Nooman Ahmed, Andeep S. Toor KO and DF. THE COGNITIVE POWER OF IBM WATSON HAS THE POTENTIAL TO TRANSFORM GLOBAL PERSONALIZED MEDICINE. IEEE Pulse. https://pulse.embs.org/may-2017/cognitive-computing-and-the-future-of-health-care/. Published 2017. Accessed August 13, 2018.
45. DISCOVER THE DIGITAL UNIVERSE OF OPPORTUNITIES: RICH DATA AND THE INCREASING VALUE OF THE INTERNET OF THINGS. https://www.emc.com/leadership/digital-universe/index.htm. Accessed April 9, 2018.
46. Company GE. Big Data, Analytics & Artificial Intelligence The Future of Health Care Is Here. http://newsroom.gehealthcare.com/wp-content/uploads/2016/12/GE-Healthcare-White-Paper_FINAL.pdf.
47. Abstracts. AIMED. http://ai-med.io/abstracts/. Accessed April 9, 2018.
48. USING TECHNOLOGY TO REIMAGINE THE PATIENT JOURNEY. MEDTECH BOSTON. https://medtechboston.medstro.com/blog/2016/09/06/using-technology-to-reimagine-the-patient-journey/. Published 2016. Accessed August 13, 2018.

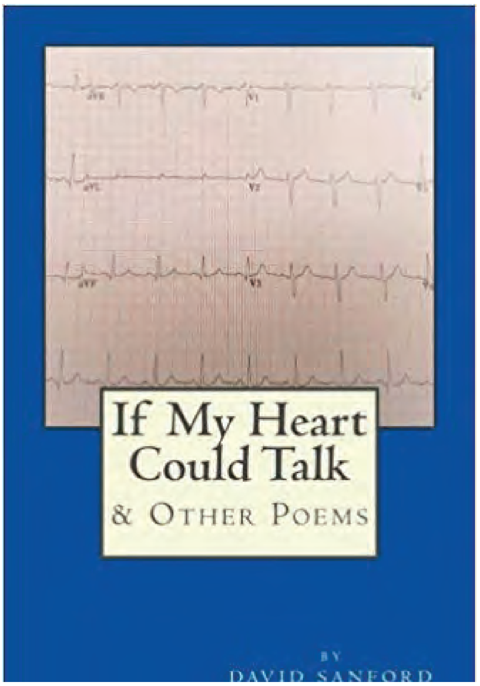
**Addison S. Gearhart, MD**
*Pediatric Resident Physician*
*University of California Irvine/Children's Hospital of Orange County Residency Program*
*505 South Main St, Ste 200*
*Orange, CA 92868 USA*
*T. 714.509.3939*
*E. gearhara@uci.edu*

*Corresponding Author*

**Anthony C. Chang, MD, MBA, MPH, MS**
*Chief Intelligence and Innovation Officer*
*Sharon Lund Medical Intelligence and Innovation Institute (MI3) at Children's Hospital of Orange County*
*505 South Main St, Ste 200*
*Orange, CA 92868 USA*
*T. 714.509.3939*
*E. achang@choc.org*

# A Congenital Heart Disease Patient "Dreams Big" and Writes "If My Heart Could Talk & Other Poems"

*By Virginia Dematatis*



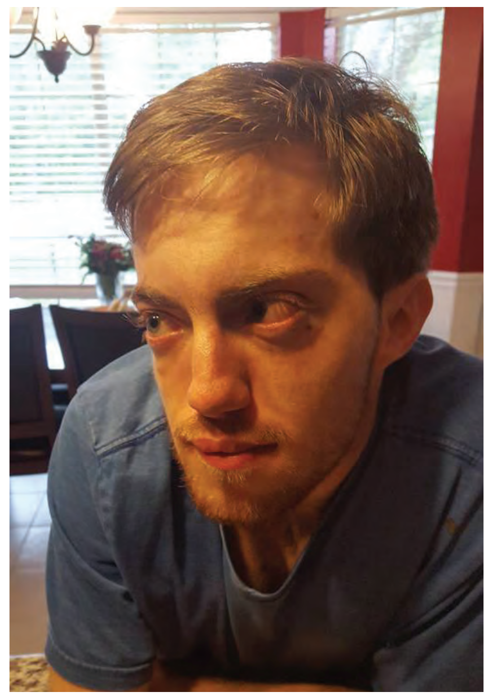

David Michael Sanford was born in 1991 with Double Outlet Right Ventricle and Hemifacial Microsomia, with an ear defect. Before the age of 10, he had multiple surgeries and procedures including: both Central and a Blalock-Taussig Shunts, a Bi-Directional Glenn Anastamosis and a Fenestrated Fontan Procedure followed by fenestration closure with an Amplatzer Device. As described by his mother, Monica Sanford, "He looks a little different, acts a little different, ...and doesn't go out much; except to go to a play, a movie or bookstore". What David does do, with great passion and subtle observation, is write poetry to express his thoughts and feelings about his unique journey in life.

His first published collection of poems "If My Heart Could Talk & Other Poems" will strike a chord with all readers, as the subject of many poems are about basic human needs and emotions. It is the poems about the grief, fear, courage and triumph David and his family have experienced throughout his life as a cardiac patient that will particularly resonate with other cardiac patients, their families, cardiologists and cardiac surgeons, not to mention anyone who has been challenged with a significant health problem. Indeed, the story of David's 27 years is as fascinating as his poetry. It is interesting to look at both the family saga and the poetry itself.

David's journey is part of an amazing family saga that includes a stalwart and loving father, a dynamic and caring mother and a devoted sister. The family saga also provides important lessons all families that include a child with Congenital Heart Disease, or any other special needs, can use to help their child flourish. The Sanford family "rock", David's father, David Lavone Sanford, is a retired Marine Lieutenant Colonel who served twenty years in the Signal Corps, including two tours in Iraq. He and the family lived in numerous places during his military career, including: Japan, D.C., Hawaii, Florida, Maryland, and North Carolina. He retired in 2009 and the family moved to Pensacola, FL. soon thereafter. With a Master's Degree in Leadership, David modeled hard work, discipline, determination and courage to both his fellow Marines and to all members of his family. He led his family on a "mission" to give David Michael as normal a life as possible. He had high expectations for his son and believed, with the right support from the family and proper medical treatment, David Michael was capable of leading a happy, productive life. Consequently, David was mainstreamed in public schools and expected to graduate from high school on time. Ultimately, not only did he graduate from high school, he also went on the graduate from college as well.

Prior to David's birth, his mother, Monica Sanford, a college graduate with a degree in Business, worked in sales and marketing. Her son's Congenital Heart Disease changed the course of her life: she decided to learn as much as she could about his condition and how to treat it by returning to school. Monica first obtained a Bachelor's Degree in Nursing from Johns Hopkins, then went on to complete a Master's Degree in Acute Care Nurse Practitioner(NP) at Georgetown University. She is currently employed as both a part-time Cardiac NP and as a part-time Admitting Hospitalist NP. Monica attended to many of the daily details of the family's life. She made sure David had an Individual Educational Plan (IEP) at every school he attended. She took him for his checkups, and monitored his heart. When he faced challenges, like bullying due to his small stature and Hemifacial Microsomia, she encouraged him to explore his feelings by writing short stories and poetry. As a result, according to David: "It gave me a way to express myself and to make sense of something I couldn't make sense of." Similar to her husband, she encouraged both David and his sister to have confidence in themselves and their future, by often repeating her favorite slogan: "Dream Big!".

Last, but not least, is the role played by David's sister, Marciella. Marciella has helped care for her brother over the years, makes him laugh each day, and often cooks for him as well. She is about to graduate with a degree in Elementary Education. David calls her his "inspiration", as she models the same caring and confident behavior they have both learned from their parents. Clearly, the family was and continues to be a strong source of love and support.



*David Sanford, author of "If My Heart Could Talk & Other Poems"*

David's childhood was not an easy one. In addition to his numerous medical treatments, he was forced to deal with bullying in middle school year. But, something wonderful happened during high school. The school was on the Marine Base at Camp Lejeune, where many of the students had parents serving in war zones. They were a more sensitive, accepting set of peers, perhaps because of their own sense of vulnerability and worry about their absent parent. As David describes it: "One day a teacher made us perform a 60 second skit in front of the class. When I was done, the class applauded and laughed with me, not at me." David was hooked! His confidence grew, he

*David with his sister and dad in New York.*

went on to perform in a number of lead roles in high school plays and he continued to pursue his passion in college. Explaining his love of theatre, he states: “All writers want to study English. In theatre arts, you perform and embody what you are reading. It is a more visceral opportunity to express yourself and tell a story.” In addition to Theatre Arts courses, such as Acting, Set and Costume Design, etc, he also took a number of elective courses in Psychology. He graduated from the University of West Florida with a Bachelor’s Degree in Fine Arts in 2015. Both as an actor, a writer, and a cardiac patient, David has continued to explore his own feelings of fear, vulnerability, acceptance, hope and celebration. Upon his graduation, he returned to his first love, writing, and has recently published his first book, “If My Heart Could Talk & Other Poems”.

The poems in David’s book are written in free verse, i.e., the poems do not rhyme or have a regular pattern or meter. Whether long or short, the poems in this collection, invariably cause the reader to stop and think. In the poem “My Voice”, he simply writes: “...The minute I put a pen in my hand, I found my voice.” This simple poem informs us about the poet’s motivation to write. It also causes the reader to think about, and possibly remember, when and how we have found our own “voice”. Whether it be talking, dancing, painting a picture or writing a poem, many of us will recognize that feeling of free expression his poem captures.

Overall, David Sanford’s book of poetry includes an engaging collection of poems. Some of his poems explore universal themes such as: the wonder of childhood, love, heartbreak, forgiveness, death etc. He also writes about real events, such as 9/11 or the fear and anticipation of a hurricane about to arrive and the sense of community that follows its devastating impact. in the poem “Reality”, he captures the fear Mother Nature can evoke among us all: “We hear the vortex like a plane engine. Chaos erupts before hiding ...”. He ends the poem with the lines: “...Message for other victims...You are not alone”. Clearly, the optimism and confidence nurtured by his family are always with him. Finally, some poems are simply whimsical, but invariably, thought-provoking. Whether it be observing a blade of grass, describing a dog eager to go outside, then eager to return home or a wedding dress worried about growing old, grey and dingy hoping to be selected, etc. , David has mastered the ability to elicit a sense of wonder about the simple things in life that represent universal themes like resilience, curiosity, a need for belonging and validation by others. His poems are a pleasure to read! However, as thought-provoking, amusing and/or emotionally intense as many of these poems are, it is the poetry focused on David Sanford’s experience as a cardiac patient that makes his poetry collection special.

David’s poems reflect the sense of vulnerability and self-awareness he and other cardiac patients experience throughout their lives, feelings many of us can only imagine. For example, in his poem “My Heart is Always On My Mind”, he describes the extra “weight” he carries on his shoulders as a cardiac patient:

“I put my hand on my chest everyday
My scar is right down the middle
It’s a constant reminder of my situation
...In school,
Whether I’m walking or sitting in class,
I worry about the next cardiac episode..
...Constantly thinking about my health is exhausting”

This poem captures the fear, vulnerability, and emotional exhaustion so many cardiac patients experience. “Near Death”, one of the most vivid poems in the book, captures the terror a cardiac patient feels as he/she senses a cardiac episode is about to begin:

“Driving down the road, I reach the top of a hill
I grab the steering wheel
It’s like the front bars of a roller coaster
Panic sets in
When I come to the bottom, I still can’t breathe
This is different. I know it is.
One hand’s on my chest and the other’s on the wheel

Cars are close, but I don’t think of crashing
I strain m eyes, focusing on my breath
As I pull over, I nearly hit a sign
I lay in agony as my vision goes white
I have memories of my life
I get ready to say goodbye and hello
Goodbye to my mom and hello to my grandfather

Then my heart slows down
I regain my focus before returning home
The next six months left me traumatized”

This poem gives the reader some insight into the challenges a cardiac patient may face: the vulnerability, fear and exhaustion heart patients know all too well.

Finally, in his poem “If My Heart Could Talk”, David imagines what his heart might say. He expresses a wide range of emotions, such as yearning (“... I was blue wishing to be pink”), appreciation (...”Having magic hands touch me was a gift.”) and despair (“...From the size of a walnut to a fist, I’ve been through hell”). He ends the poem on a positive note:

“Even with my limitations
If my heart could talk
...It would say it’s happy
It would say it loves this world”

Like much of the poetry in the collection “If My Heart Could Talk & Other Poems”, the poet David Sanford is living proof of how much a cardiac patient, with strong family support, can rise above his/her condition and make an important contribution to society in the form of vivid, thoughtful, emotional poetry. When asked what advice David has for other cardiac patients, he replied with the confidence and inspiration his parents taught him, saying: “You can achieve your goals. Find your own voice. “ Hopefully, David Sanford will continue to “Dream Big”, to write about his life and teach us about the lessons he learns as a Congenital Heart Disease patient.

A final note: David dedicates his book to family members. He ended his dedication, "...To my Doctor Frank Midgley, for saving my life". Dr. Frank Midgley is clearly David's and the Sanford Family's "hero". Dr. Midgley operated on David five times, with excellent results.

*David with his ICU nurse after his first surgery.*

*David with his sister living life while swimming with dolphins in Hawai'i.*


**Virginia Dematatis**
*Staff Editor*

*Congenital Cardiology Today*
*11502 Elk Horn Drive*
*Clarksburg, MD 20871 USA*

# Preview of NeoHeart – Cardiovascular Management of the Neonate, March 27th to 29th, 2019, at Hyatt Regency Hotel, Huntington Beach, California

*By John P. Cleary, MD and Amir H. Ashrafi, MD*

*Joining prior honorees Jaqueline Nelson, MD and William Norwood, MD, Dr. Rudolph was honored for his contributions to our understanding of transitional physiology and inspired the audience with both his stories of the past and his ongoing zest for life and knowledge. NeoHeart 2019 will honor Richard Van Praagh, MD – The father of Segmental Anatomy.*

We report on a growing network of physicians and affiliated practitioners who are improving neonatal cardiac care and supporting each other through the Neonatal Heart Society as we describe our fourth edition of the meeting *NeoHeart – Cardiovascular Management of the Neonate*.

A short five years ago, in large part through the mentorship of Anthony Chang MD, we recognized the need to share knowledge and build bridges between the practitioners caring for neonates with congenital heart disease and/or cardiovascular instability across the continuum of care. We were aware of a growing group of neonatologists with interest and training in CVICU, cardiology and imaging, and similarly cardiologists, intensivists and surgeons with primary focus in the fetus and neonate. We recognized that collaboration would improve care, advance research and provide support for an emerging group of leaders in the field. In this spirit we created *NeoHeart* and the *Neonatal Heart Society (NHS)* and the results have exceeded expectations! Members of the *NHS* have opened CVNICUs, consult services in neonatal cardiovascular care, advanced the practice of targeted neonatal echocardiography, established care guidelines and published important research. Collaboration has been created between the *NHS* and the *American Academy of Pediatrics*, the *PCICS* and the *World Congress of Cardiology*. *NeoHeart 2019* hopes to showcase and build on this progress while improving the knowledge of all practitioners in fetal and neonatal care.

The opening to the meeting is part of what differentiates *NeoHeart* – we honor a collaborative pioneer in neonatal care during an evening keynote dinner where attendees are exposed to both medical history and the personal aspects of a professional career. In 2015, our first honoree, Jacqueline Noonan, MD, who trained as many neonatologists as cardiologists, told the story of recognizing and caring for infants with Noonan's Syndrome along with her experience as a woman in medicine. In 2017, Bill Norwood, MD, who changed the care of HLHS from palliative to curative, shared for instance that his progress in this area came not by choice, but out of necessity, as other surgeons did not want 'these cases.' In 2018, Abraham Rudolph, MD, enthralled the audience with his early work on transitional circulation while sharing personal reflections on the random events that can impact a career. Our 2019 Keynote speaker and 4th honoree is Richard Van Praagh, MD, the father of segmental anatomy in Congenital Heart Disease. Attendees will learn the clinical and personal progression of his important career through a relaxed interview with Dr. Ashrafi.

The body of the meeting (Thursday and Friday) will be characterized by focused, "TED-style" presentations from our amazing faculty, paired with extended conversations between the faculty and audience facilitated by expert moderators. Faculty roundtables intentionally represent NICU, CVICU, Cardiology and Nursing in all sessions and breakout sessions have been added to give the attendee choices of areas to dive more deeply into a topic.

Plenary Session 1 will focus on What Makes the Neonate Different? It features Dan Penny MD, PhD, who will speak about maximizing the performance of the neonatal myocardium. Mjaye Mazwi, MBChB, MD, will describe unique aspects of the neonatal vascular endothelium, followed by Istvan Seri, MD, helping us better understand cerebral autoregulation. These and other faculty members such as Martin Kluckow, MBBS, and Carl Backes, MD, will have extended conversations on such topics as the optimal BP for neonates, the effect of preload and afterload on cardiac output, and the management of acute capillary leak surrounding cardiopulmonary bypass. The session will continue with case-based learning as we review and react to some of "the most difficult case(s) I've had this year." Breakout sessions will then focus on hemodynamic issues in the preterm and the hemodynamics of septic shock. Moderated by Patrick McNamara, the prematurity breakout with Martin Kluckow, MBBS, will focus on the transition from intra- to extra-uterine life. Souvik Mitra, MD, will present a unique analysis of therapies for the PDA; Keith Barrington, MBBS, presents the evidence for 'permissive hypotension" and Krisa Van Meurs, MD, presents the potential value of cerebral NIRS in the preterm. The septic shock breakout is moderated by Anthony Chang, MD, MBA, MPH, and will feature Saul Flores, MD, presenting a perspective on how to determine optimal volume resuscitation; Gabriel Altit, MD, suggesting that we can do better than vital signs in evaluating such patients; Kristi Waterberg, MD, reviewing the role of steroids in shock, and David Cooper, MD, discussing the value of ECMO. Each breakout allows time for attendees to contribute to the conversation and to have their questions addressed.

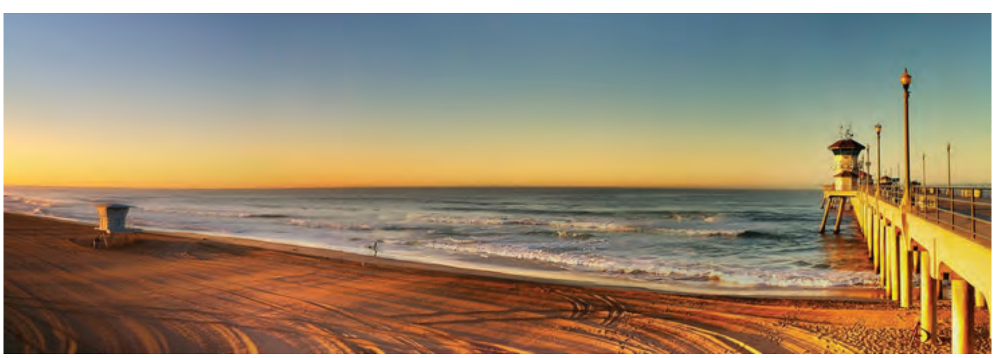
In Plenary 2, we turn our attention to The Right Ventricle in Congenital Heart Disease. Andrew Reddington, MD, will be asked whether we can make the RV function like the RV in HLHS; and Alan Nugent, MD, will suggest an evidence-based approach to increasing the likelihood of bi-ventricular circulation in PA-IVS. Glen Van Ardsell, MD, will describe his surgical decision structure on when/whether to undertake complete repair of Tetralogy of Fallot vs. BT shunt or RVOT stenting followed by Vaughn Starnes, MD, presenting his decision tree in managing severe Ebstein's Anomaly. The discussion surrounding these presentations should be a highlight of the meeting as the amazing presenters will be joined by Ganga Krishnamurthy, MD; Mary Mc Bride, MD; Alan Nugent, MD; and Dawn Tucker, DNP, CPNP, to expand the conversation to include the role of the hybrid procedure in HLHS; the impact of ventriculotomy on long-term RV function; and how management decisions are affected by prematurity. Faculty review of "The most difficult cases I had this year" will continue our shared learning. Breakouts will allow attendees to focus on comparative physiology and controversies in feeding and nutrition. In the comparative physiology session, faculty members Gil Wernovsky, MD, FAAP, FACC; Istvan Seri, MD, PhD, HonD; Carl Backes, MD; and Krisa Van Meurs, MD, compare and contrast the management of CDH vs. Interrupted Aortic Arch, IVH/PVL associated with prematurity vs. cardiopulmonary bypass, pulmonary hypertension in the setting of BPD vs. TAPVR, and deep hypothermic circulatory arrest vs. cooling for HIE. The Feeding and Nutrition breakout features Christine Bixby, MD; Diana Vargas, MD; Rune Toms, MD; and Molly Ball, MD, addressing topics such as breast milk vs formula in CHD, perioperative feeding strategies and probiotics to avoid ischemic bowel in ductal dependent lesions, how to manage malrotation in heterotaxy, and when and whether to place a gastrostomy tube.

Thursday evening features our Abstract Session and Reception that has grown in quality with each meeting. The session is well attended, and the faculty interacts with all authors. Top abstracts will be featured in the Friday morning plenary as well.

NeoHeart rejects the notion of 'all meeting and no play' – venue matters, and this year we are back in Surf City USA, Huntington Beach. Thursday night we host a California Beach Party and will try to raise the bar for fun set by NeoHeart 2018 in Fort Worth.

Friday morning's Plenary Session 3 will once again focus on the Pulmonary Vascular Bed. Robin Steinhorn, MD, will help us in: 'Differentiating preventable vs inevitable pulmonary vascular disease in the newborn," followed by Steve Abman, MD, examining the role of precision medicine in our decision-making in acute pulmonary hypertension. Roberta Keller, MD, will present recent key publications which she believes should alter practice. This group of thought leaders will be joined by Jeff Fineman, MD, and Anthony Chang, MD, to discuss second-line agents in acute pulmonary hypertension, the role of left- to- right shunts in the newborn with PH, and pulmonary hypertension associated with lung injury. Complex cases will then be reviewed to help define our practice with challenges such as the role of catheterization, the use of unproven therapies, and the recognition of pulmonary vein stenosis. The breakouts that follow will include Innovations in Neonatal Cardiac Intensive Care and The Blood and Brain. In the Innovation Session Yoav Dori, MD, PhD, will give an update on lymphatic imaging and interventions; George Mychalika, MD, suggests that the artificial placenta is a coming reality; Vamsi Yargalada, MD, asks whether ventricular assist devices have progressed to be useful in the neonate; and Mjaye Mazwi, MD, suggests that AI and predictive analytics are keys to optimal care of complex patients. The CNS breakout examines whether we can make accurate predictions of outcome in infants with parenchymal hemorrhage – Chris Smyser, MD, the timing of cardio-pulmonary bypass relative to acute hemorrhage – a hematologist's perspective, and anticoagulation on ECMO – surgeon Joanne Star, MD. In addition, David Vener, MD, will answer this simple question –" If benzodiazepines, opioids, ketamine and precedex are so bad for the brain, what the *#@! am I supposed to do?"

For the first time, Plenary Session 4 is both the final session of *NeoHeart* and the opening to another important meeting - Pacific Coast



## NeoHeart
*Guest Faculty*

**Keynote**
Richard Van Praagh, MD

**Cardiology**
Carl Backes, MD
Anthony Chang, MD, MBA, MPH
Mitchell I. Cohen, MD, FACC, FHRS
Yoav Dori, MD, PhD
Wyman Lai, MD
Anita J. Moon-Grady, MD FACC, FASE
Alan Nugent, MBBS, FRACP
Daniel Penny, MD, PhD
Andrew Redington, MD

**Cardiac Intensive Care**
David Cooper, MD, MPH
Jeff Fineman, MD
Saul Flores, MD, FAAP, FACC
Mjaye Mazwi, MBChB, MD
Mary McBride, MD, FAAP, MEd
Gil Wernovsky, MD, FAAP, FACC
Vamsi Yarlagadda, MD

**Neonatology**
Gabriel Altit, MD, FRCPC
Molly K. Ball, MD
Keith Barrington, MBBS
Shazia Bhombal, MD
Annie Janvier, MD, PhD
Roberta Keller, MD
Martin Kluckow, MBBS, FRACP, PhD, CCPU
Ganga Krishnamurthy, MD
Philip T. Levy, MD
Victor Y, Levy, MD, MSPH, FAAP, FACC
Patrick McNamara, MB, BCh
Souvik Mitra, MD, RCPC Affiliate, MSc
Istvan Seri, MD, PhD, HonD
Robin Steinhorn, MD
Rune Toms, MD
Krisa VanMeurs, MD
Diana Vargas, MD
Kristi Watterberg, MD

**Neurology**
Chris Smyser, MD, MSCI

**Nursing**
Annie Denslow, PA-C
Lindsey Justice, DNP, APRN, CPNP-AC
Dawn Tucker, DNP, RN, CPNP-AC

**Pulmonology**
Steven Abman, MD

**Surgery**
Richard Gates, MD
Vaughn A. Starnes, MD
Joanne Starr, MD
Glen Van Arsdell, MD

Fetal Cardiology 2019. In the *NeoHeart* spirit we are collaborating with our colleagues who diagnose and guide families prenatally. Mary Donofrio, MD, will share her approach to multi-disciplinary perinatal planning and delivery management; Anita Moon-Grady, MD, will discuss why we continue to miss CHD before and after delivery, and David Dimmock, MD, will describe how prenatal genetic testing can reach new heights. We know that our most important partners are parents, and NeoHeart will again feature families as key faculty members; an amazing young professional who lived, first with complex heart disease, and now with a new heart, will share life lessons. Her mother who now helps countless other families will give additional perspective. The attendee interaction following such personal stories has been a highlight of prior meetings. The session will continue with a focus upon Fetal Intervention. Philip Levy, MD, will review the role of laser intervention for twin-twin transfusion; Wayne Touretzky, MD, has been asked to suggest who should be referred for intervention when HLHS is diagnosed; and Mitch Cohen, MD, will review options for treatment of fetal arrhythmia. Roundtable discussion will review whether we can inform families of their options without bias, when surgery or palliative care might be offered for patients with Trisomy 13 or 18, whether we can improve screening, and whether we can better prepare families to thrive.

*NeoHeart* will offer additional learning opportunities on the Wednesday before the core of the meeting – the meeting is aimed at experts and novices in the field, and these sessions allow individuals to add to their base knowledge and skills. These sessions have been highly rated in past meetings, as they give a chance for close faculty interaction and complement the faster-paced meeting that follows. Shazia Bhombal, MD, will lead 4-hour basic and advanced hands-on echocardiography sessions for intensivists. Dawn Tucker DNP, CPNP, will again lead a session which is designed so that bedside nurses and APNs can 'excel at the bedside.' Anthony Chang, MD, is a superior educator and will offer a session titled 'Essentials of Neonatal Cardiology,' and John Cleary, MD, will use our amazing neonatology faculty (Barrington, Kluckow, Seri, Janvier and McNamara) to review areas of progress and controversy in neonatal care (for example, what are we supposed to do with the PDA?)

We welcome readers of *Congenital Cardiology Today* to join us in advancing the care of infants with congenital heart disease and/or cardiovascular compromise. We are proud that *NeoHeart* and the *Neonatal Heart Society* are accelerating a movement towards improving outcomes through research, education and, most importantly, collaboration across disciplines.

CHOC Children's is proud to host *NeoHeart* in 2019! For questions, call 800.329.2900 or email choccme@choc.org.

To register - visit www.choc.org/events/neoheart-cardiovascular-management-of-the-neonate-2019

See you at the beach!

**John P. Cleary, MD**
*Associate Director ECMO*

*CHOC Children's*
*1201 W. La Veta Ave.*
*Orange, CA 92868*

*jcleary@choc.org*

**Amir H. Ashrafi, MD**
*Associate Director of Neonatal-Cardiac Intensive Care*

*CHOC Children's*
*1201 W. La Veta Ave.*
*Orange, CA 92868*

*aashrafi@choc.org*

# New Texas Children's Heart Center® Boasts State-of-the Art Cardiac Catheterization Laboratories

*By, Daniel J. Penny, MD*

Today, increasing numbers of heart conditions can be treated with minimally-invasive catheter-based interventions. Texas Children's Heart Center® is ranked No. 1 nationally in Pediatric Cardiology and heart surgery by *U.S. News & World Report*, and is the largest program in the region to offer interventional cardiac catheterization for infants, children and adolescents. The interventional cardiology team performs 1,200 cardiac catheterization procedures annually.

Texas Children's Heart Center celebrated a milestone in its storied history on Sept. 26 when 11-year-old Colin Rankin was the first patient to undergo a cardiac catheterization procedure in one of our new Charles E. Mullins Cardiac Catheterization Laboratories in the Lester and Sue Smith Legacy Tower, the hospital's new home for heart, intensive care and surgery. This also marked the first combined cardiac MRI-catheterization procedure in Texas Children's Hospital's history. The procedure was performed by pediatric interventional cardiologist, Dr. Athar M. Qureshi.

"A combined cardiac MRI-catheterization procedure is just one way in which technology in our new home will further improve patient outcomes, and patient and family experiences," said Qureshi.

Each state-of-the-art lab has 1,000-square-feet of space and includes a control room where clinicians operate the lab's equipment and document patient care. One of the labs is also equipped with an integrated MRI, allowing for easier access to imaging for the patient and cardiologists.

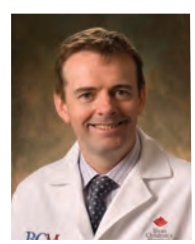
This exciting milestone will help us continue to provide the highest-quality cardiac care possible to our patients and their families. We know this new, state-of-the-art tower will only enhance their experience and allow for even greater access to the care for which Texas Children's is known.

Joining the current cardiac catheterization team, led by Dr. Henri Justino, on the morning of the inaugural case was Dr. Charles E. Mullins. The cardiologist who is credited with pioneering the use of catheters celebrated with those who are proudly carrying on his legacy in the field of cardiac catheterization. Mullins advanced the procedure from a diagnostic one to the current state, in which many congenital heart defects are treated through interventional transcatheter techniques.

Mullins was recruited to Texas Children's by Dr. Dan McNamara and performed numerous cardiac catheterization procedures during his illustrious 45-year career, most of them in the space at Texas Children's that now proudly displays his name. He retired from the hospital in 2006.

Smith Legacy Tower adds 640,000-square-feet to Texas Children's sprawling Texas Medical Center campus.

To learn more about Texas Children's Heart Center, visit: www.texaschildrens.org/heart.



**Daniel J. Penny, MD**
*Chief of Pediatric Cardiology*

*Texas Children's Hospital*
*6621 Fannin St.*
*Houston, TX 77030 USA*

**Academic Pediatric Cardiologist**
**(With expertise in Heart failure/Cardiac transplant/Mechanical Circulatory Support)**

The Division of Pediatric Cardiology at Louisiana State University Health Sciences Center, at the Children's Hospital of New Orleans, is seeking a Pediatric Cardiologist to serve as a subspecialist in Pediatric Heart Failure, Cardiac Transplant and Mechanical Circulatory Support with potential subspecialty leadership opportunities to join its growing program. The Heart Center faculty includes a team of 13 full-time pediatric cardiologists with subspecialty expertise in Non-invasive and Fetal Imaging, Electrophysiology, Interventional Cardiology, Adult Congenital Heart Disease and Cardiac Intensive Care. In addition, the Heart Center Staff includes three Cardiovascular Surgeons.

The Heart Center is proud to be part of the only freestanding Children's Hospital in New Orleans and Louisiana, and the top academic heart program in the state. It has recently received leadership commitment by a nationally-known pediatric cardiologist beginning in the spring of 2019. Academic appointment will be at the rank of Assistant Professor, Associate Professor or Full Professor (non-tenure or tenure tracks), and will be determined by the candidate's credentials and experience. The successful candidate must have demonstrated excellence in heart failure, cardiac transplant and mechanical circulatory support. The physician will be responsible for building a heart failure program and working with our surgeons and intensivists with the intention of developing Heart Center expertise in cardiac transplant and mechanical circulatory support.

Position offers competitive benefits, and a compensation package commensurate with training and experience.

Children's Hospital resides in New Orleans' historic and vibrant uptown area. Our campus is currently undergoing a $300 million physical revitalization and transformation, and at the same time expanding new multispecialty outpatient campuses in the city and region. The Heart Center program provides services for patients throughout the state of Louisiana, including 260 CV surgeries, 275 cardiac catheterizations, 5000 ambulatory visits, and 5500 ECHOs annually. There is a dedicated 20 bed CICU with dedicated in-house attending coverage and a recently completed state of the art hybrid catheterization suite. The incoming Heart Failure specialist would be responsible for integrating heart failure services and resources into the new Children's Hospital clinical infrastructure.

Required Qualifications:

- MD or MD/PhD or equivalent
- Board certified/board eligible (or equivalent) in Pediatric Cardiology
- Must have demonstrated excellence in heart failure, cardiac transplant and mechanical circulatory support.
- Licensed to practice medicine in the State of Louisiana before start date

The LSUHSC School of Medicine in New Orleans encourages women and minority candidates to submit applications for this position.

The School of Medicine does not participate in sponsoring faculty candidates for the Department of Health and Hospitals' Conrad 30 Program

Applicant Instructions

Interested candidates should submit a cover letter, C.V. and list of references electronically. Apply online: https://lsuh.sc/jobs/?id=3289

LSU Health is an Equal Opportunity Employer for females, minorities, individuals with disabilities and protected veterans

# Medical News, Products & Information

*Compiled and Reviewed by Kate Baldwin, Senior Editor of Special Projects*

**Research Shows Importance of Second Pediatric Blood-Pressure Screening**

Nearly one-quarter of children and teens who had their blood pressure screened at a primary care appointment showed a reading in the hypertensive range, but less than half of those readings could be confirmed after the blood pressure was repeated, according to a new Kaiser Permanente study released today in The Journal of Clinical Hypertension. The research shows the importance of taking a second blood pressure reading for those ages 3 to 17 years when the first reading is elevated.

"Pediatricians don't diagnose hypertension in children very often, but if it is there, we want to find it," said Robert James Riewerts, MD, Regional Chief of Pediatrics for the Southern California Permanente Medical Group. "This study is important because it demonstrates the best path to accurately diagnose hypertension in a child or teen. Taking a second blood pressure reading is something all linicians must consider when the initial reading is elevated."

Blood pressure in youth varies considerably and can be affected by factors such as a child's anxiety. Also, determining high blood pressure in children or teens is more difficult to do than in adults because what is considered high varies based on age, gender and height.

Since this study was conducted, Kaiser Permanente in Southern California has put alerts on its electronic health records to alert clinicians when a second blood pressure reading is recommended. Also, decision-support tools were added to help clinicians determine when further evaluation is recommended.

Researchers found that for patients ages 3 to 17 years:

- 24.7% had at least one blood pressure reading in the hypertensive range.
- Fewer than half of the children who had their blood pressure screened would be correctly classified based solely on their first blood pressure reading of the appointment.
- 2.3% of youth have sustained hypertension over time.

**Big-Data Study Pinpoints More Than 150 Genes Associated with Atrial Fibrillation and Develops Genetic Risk Score**

Newswise - Drawing on genomic data from more than one million individuals, researchers from the University of Michigan have led a large collaborative effort to discover as-yet unknown genetic risk factors for atrial fibrillation: an irregular, often rapid heart rate affecting millions of Americans and more than 30 million people worldwide. Atrial fibrillation increases one's risk for blood clots, stroke, heart failure, and death.

By performing one large genome-wide association study (GWAS) comprising data from six smaller studies, scientists identified 151 candidate genes for atrial fibrillation. Many of the genes identified are important for fetal development of the heart, implying that genetic variation predisposes the heart to atrial fibrillation during fetal development, or, that the genetic variation could reactivate genes in the adult heart that normally only function during fetal development.

The results of the study have been published in Nature Genetics ("Biobank-driven genomic discovery yields new insight into atrial fibrillation biology").

The increased understanding the study yields of the biological processes underlying atrial fibrillation could lead to better treatment and prevention. "We are hopeful that additional molecular biology experiments will determine how to create sustained regular heart rhythms by studying the genes we and others have identified," said study author Cristen Willer, PhD, Associate Professor at Michigan Medicine and head of U-M's Willer lab.

If atrial fibrillation is detected early, it is possible to prevent complications such as stroke and heart failure. Current treatment options for atrial fibrillation are limited; however, they include serious side effects, and are rarely curative. The genetic variants uncovered in this study could potentially improve both early detection and treatment. By identifying genes important for atrial fibrillation, researchers constructed a risk score to help identify high-risk individuals and monitor them accordingly, which "may have important implications for precision health and prevention of cardiovascular disease," said Dr. Willer.

Of the 151 genes identified as important for atrial fibrillation, 32 are likely to interact with existing drugs not necessarily developed to treat atrial fibrillation. This study lays the groundwork for follow-up experiments to test whether any of the identified drugs could prevent or terminate atrial fibrillation.

This study used data from multiple biobanks from around the world, including UM's Michigan Genomics Initiative (MGI), UK Biobank, Norway's HUNT study, DiscovEHR, Iceland's deCODE Genetics, and AFGen Consortium. This big-data, precision-health approach yielded insights that may not have been discoverable using a smaller dataset.

"Discovery of novel genetic variants and genes important for atrial fibrillation was only possible because we combined information from multiple biobanks from around the world in a large collaborative effort," said first author Jonas Bille Nielsen, MD, PhD, a cardiovascular researcher at U-M. "Combining the advantages of each of the data sources helped us to better understand the biology underlying atrial fibrillation [and]… revealed the risk score we constructed is very specific for atrial fibrillation. By combining multiple independent data sources, we also found that people with early-onset atrial fibrillation have a higher genetic burden of atrial fibrillation compared with people who develop the disease later in life."

The study's researchers acknowledge that their findings, while significant, need further confirmation, but are hopeful that this work will form the foundation for future experiments to understand the biology behind atrial fibrillation, and to identify tailored, more effective treatment options for the condition.

"As scientists, we need to continue to focus on the goal--helping patients with cardiovascular disease--and collaborate toward that goal," said Dr. Willer. "That's exactly what happened here, with the additional benefit of helping train the next generation of cardiovascular geneticists, like first author Jonas Nielsen."

---

**Drugs for Heart Failure are Still Under-prescribed, Years After Initial Study**

*Findings*: A UCLA-led study found that many people with heart failure do not receive the medications recommended for them under guidelines set by the American College of Cardiology, American Heart Association and Heart Failure Society of America.

The research also found that doctors frequently prescribe medications at doses lower than those recommended by the guidelines, especially for older people, those with kidney disease, those with worsening symptoms or those who were recently hospitalized for heart failure. Further study is needed to determine why people in those four groups specifically were prescribed lower-than-recommended doses.

The study, which looked at the three categories of heart failure medications, found that between 27% and 67% of patients were not prescribed the recommended drugs. And when patients did receive the medications, they were generally at a lower-than-recommended dose. Less than 25% of patients simultaneously received all three medication types, and only 1 percent received the target doses of all three medication types.

*Background*: About 5.7 million people in the United States have heart failure, according to a 2016 report by the American Heart Association. Heart failure is associated with a lower quality of life and frequent hospitalizations, and it contributes to more than 300,000 deaths each year in the U.S. In half of people with heart failure, the disease is caused by a weak heart muscle that prevents the heart from ejecting a normal amount of blood with each heartbeat, a condition called reduced ejection fraction.

Several medications have been proven in large clinical trials to help people with heart failure and reduced ejection fraction live longer and feel better. Research conducted between 2007 and 2009 showed that many patients were not receiving the recommended doses of these medications. The new study sought to determine if there have been improvements in prescribing practice, as well as, which patients are most likely to receive less medication than recommended.

*Method*: The study included 3,518 patients from 150 primary care and cardiology practices who were enrolled in the Change the Management of Patients with Heart Failure registry, or CHAMP-HF, a study of adult outpatients who were diagnosed with heart failure with reduced ejection fraction.

*Impact*: The results suggest that use and dosing of heart failure medications has not improved over the past decade. The report says new strategies are needed to more effectively achieve and maintain recommended doses of heart failure medications and that there is a substantial opportunity to improve dosing of heart failure medications, which would improve the care and outcomes for people with heart failure.

*Authors*: The study's senior author is Dr. Gregg Fonarow of the David Geffen School of Medicine at UCLA. The first author is Dr. Stephen Greene of Duke University. Other authors are listed in the journal article.

---

**Leading Heart Surgery Societies Call for Improved Strategies to Treat Rheumatic Heart Disease**

*Declaration Details Global Initiative for People Living with RHD*

Newswise - Experts from the world's major heart surgery organizations—including The Society of Thoracic Surgeons (STS), the American Association for Thoracic Surgery (AATS), the Asian Society for Cardiovascular and Thoracic Surgery (ASCVTS), and the European Association for Cardio-Thoracic Surgery (EACTS)—are calling for urgent action to develop and implement effective strategies for treating rheumatic heart disease (RHD), which affects 33 million people and kills 320,000 annually. The joint statement, known as the "Cape Town Declaration," was published online today in The Annals of Thoracic Surgery and eight other journals.

The statement originated during a December 2017 conference in Cape Town, South Africa, arranged to commemorate the 50th anniversary of the world's first successful heart transplant operation. The conference was attended by representatives from STS, AATS, ASCVTS, and EACTS, as well as from numerous other national and pan-national heart surgery organizations, including the Australian and New Zealand Society of Cardiac and Thoracic Surgeons, the Brazilian Society of Cardiovascular Surgery, and the World Heart Foundation.

"The Cape Town Declaration represents the first truly worldwide initiative on rheumatic heart disease and involves every major cardiothoracic surgical organization throughout the globe," said STS President Keith S. Naunheim, MD. "While this may only be the first step, we look forward to a joint effort that involves not just surgical organizations but industry, regulatory agencies, legislative bodies, and charitable foundations. Only through such a coordinated effort can we hope to roll back the tide of global rheumatic heart disease."

RHD accounts for a major proportion of cardiovascular disease in children and young adults in low- and middle-income countries. It most often begins in childhood as strep throat. Left untreated, strep can progress to rheumatic fever and then RHD, which is characterized by one or more damaged heart valves. Although virtually eliminated in Europe and North America, RHD remains a leading cause of cardiovascular mortality in Africa, the Middle East, Central and South Asia, the South Pacific, and impoverished pockets of developed nations.

"The global burden of mortality from what is essentially a treatable disease remains underrecognized by different factions of society, including many health care providers," said AATS President David H. Adams, MD. "The Cape Town Declaration is a call to arms to work together to treat those currently suffering from RHD and hopefully to one day shift the focus to prevention through access to appropriate antibiotic treatments of streptococcal infections."

Currently, the only effective treatment for RHD is open heart surgery; however, this life-saving operation is not readily available in the affected regions. In those populations most vulnerable to RHD, the need for heart surgery is estimated at 300 operations per 1 million people. However, there is a serious shortage of both heart surgeons and hospitals that perform cardiac surgery in those areas most susceptible to the disease; for example, there is only one cardiac center per 33 million people in Africa. Furthermore, valve reconstruction as opposed to valve replacement in rheumatic disease is often possible and associated with better survival after surgery, and these techniques need to be broadly expanded through educational efforts in affected regions.

"The majority of people in the developing world are still lacking access to quality cardiac surgery," said Friedhelm Beyersdorf, MD, Editor-in-Chief of the *European Journal of Cardio-Thoracic Surgery*. "The recent 50$^{th}$ anniversary of the world's first heart transplantation in Cape Town should be the turning point."

## PEDIATRIC CARDIOLOGY
## YALE UNIVERSITY SCHOOL OF MEDICINE

**The Section of Pediatric Cardiology at the Yale University School of Medicine and Yale New Haven Children's Hospital is recruiting a BE/BC pediatric cardiologist with major interest, expertise and experience in non-invasive cardiac imaging at the Assistant Professor level. The ideal candidate has received advanced training in advanced cardiac imaging with major interest, expertise and leadership in Cardiac Imaging at the Assistant or Associate Professor level.**

**This individual will join a division of dedicated faculty and advanced nursing practitioners to provide congenital heart care and cardiovascular imaging to patients throughout the state and region. The Section has an active research program with numerous opportunities for participation in basic, translational, and clinical research.**

**The successful candidates will receive a faculty appointment in the Yale Department of Pediatrics at the academic level commensurate with experience and qualifications. Yale University and the Department of Pediatrics offer an excellent benefits package. The greater New Haven and Connecticut Shoreline area offers an excellent quality of life with immense cultural and recreational opportunities.**

**Review of applications will begin immediately and will continue until the position is filled.**

**Interested applicants should submit Curriculum Vitae, Cover Letter and 3 references electronically to:**

**http://apply.interfolio.com/41531**

**Yale University is an equal opportunity, affirmative action employer. Women, minorities, persons with disabilities and protected veterans are encouraged to apply. Review of applications will begin immediately and continue until the position is filled.**

ASCVTS President Shinichi Takamoto, MD, PhD, agreed. “We need a coordinated international effort, which draws upon the experience of fighting this disease in Asia, Africa, and elsewhere in the world, to make true progress in eliminating RHD.”

Previou efforts to address RHD have focused on prevention and, while important, have failed to eradicate the disease, meaning that surgery likely will remain an integral part of RHD treatment for several generations. The declaration signatories are proposing a comprehensive solution with two principal aims:

- To establish an international coalition of individuals from cardiac surgery societies and representatives from industry, cardiology, and government to evaluate and endorse the development of cardiac care in low- to middle-income countries.
- To advocate for the training of cardiac surgeons and other key specialized caregivers at identified and endorsed centers in low- to middle-income countries.

More specifically, the declaration sets forth that the proposed international coalition should include two representatives each from STS, AATS, ASCVTS, and EACTS, along with one person from the device manufacturing industry and another from the World Heart Foundation. This group will be responsible for establishing criteria for the clinical care and training centers, as well as selecting and endorsing the centers. In addition, the declaration states that providers should receive training relevant to the conditions and resource-constrained settings that they can expect to encounter in their own countries. The statement also calls for the identification and endorsement of up to three clinical care and training centers to form a program nucleus as quickly as possible.

In addition to *The Annals of Thoracic Surgery*, the Cape Town Declaration will be published simultaneously in the following journals: *Asian Cardiovascular and Thoracic Annals*, *Cardiovascular Journal of Africa, Chinese Circulation Journal, European Journal of Cardio-Thoracic Surgery, Journal of Thoracic and Cardiovascular Surgery, Polish Journal of Cardiothoracic Surgery, South African Medical Journal, and the South Africa Heart Journal.*

---

### Key Discovery Made in Genetic Make-Up of Heart Condition Linked to Sudden Cardiac Death

Newswire - A new study published in Circulation, a peer-reviewed journal of the American Heart Association and led by a cardiologist at the Peter Munk Cardiac Centre at Toronto General Hospital has found evidence that only one of the 21 genes normally associated with Brugada Syndrome, a serious genetic heart condition associated with the risk of sudden arrhythmic death, is a definitive cause of the condition.

“The global impact of this important research is significant for scientists, medical professionals and patients who are genetically pre-disposed or who have been diagnosed with this potentially-fatal heart condition,” says Dr. Barry Rubin, Medical Director, Peter Munk Cardiac Centre, University Health Network. “The evidence-based findings of our internationally-recognized, multi-disciplinary team of researchers could dramatically alter both the diagnostic and treatment pathway for patients with Brugada Syndrome as well as other genetic-based conditions.”

The study’s findings came as the result of evaulations conducted by the Clinical Genome Resource (ClinGen) expert panel led by Dr. Michael Gollob, cardiologist, Peter Munk Cardiac Centre and Chair, Peter Munk Centre of Excellence in Molecular Medicine. ClinGen is supported by the National Institutes of Health (NIH) in the United States.

“Our research examined the genetic evidence for 21 genes reported as single gene causes for Brugada Syndrome,” says Dr. Gollob “Remarkably, 20 of 21 genes were classified as disputed evidence, indicating that genetic evidence to support causation of this disease by these specific genes was lacking,” he says.

Researchers found that only the SCN5A gene, first discovered 20 years ago for Brugada Syndrome, was deemed a definitive cause of the condition. The study also highlights the risks associated with the genetic testing of genes that lack sufficient evidence for disease causation.

“Clinically, evaluating genes that lack validity for disease causality creates a risk of misinterpreting the relevance of genetic changes in these genes and may lead to inappropriate diagnostic conclusions and treatment in patients”, says Dr. Gollob. “Our conclusions from this study are surely not unique to Brugada Syndrome. Invalid or questionable gene-disease associations are likely common for many diseases across multiple medical disciplines”, he says.

“This ClinGen report highlights the importance and value of ClinGen’s efforts to standardize and improve the databases used by laboratories to guide testing decisions and the interpretation of test results,” said Jonathan Berg, MD, PhD, FACMG whose group leads theClinGen Cardiovascular Genomics Clinical Domain Work Group under which this Expert Panel completed their work on determining which genes are actually associated with Brugada Syndrome.

Based on their findings, the authors recommend that an evidence based evaluation of reported gene-disease associations should be completed prior to the testing of genes in patient care.

# CONGENITAL CARDIOLOGY TODAY

**Founder & Senior Editor**
Tony Carlson
Tony@cct.bz

**Publisher & Editor-in-Chief**
Richard Koulbanis
RichardK@cct.bz

**Co-Founder & Medical Editor**
John W. Moore, MD, MPH
Dr.John@cct.bz

**Senior Editor of Special Projects**
Kate Baldwin
Kate@cct.bz

**Article Editor**
Caryl Cornell

**Staff Editor**
Virginia Dematatis
Loraine Watts

# NeoHeart

## Cardiovascular Management of the Neonate

## MARCH 27-29, 2019

**Hyatt Regency Huntington Beach**
21500 Pacific Coast Hwy | Huntington Beach, CA

JOIN US FOR THE PREMIER CONFERENCE THAT BRINGS TOGETHER NICU, CVICU, CARDIOLOGY, CT SURGERY, & ANESTHESIOLOGY

***Want more education?***
Stay through Saturday, March 30 and attend the 3rd annual
**Pacific Coast Fetal Cardiology: An Interactive and Case-Based Educational Symposium**
*For more details visit www.choc.org/pcfc*

CHOC Children's     Neonatal Heart Society

WWW.CHOC.ORG/NEOHEART2019