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WHAT IS NEW IN CARDIOVASCULAR MEDICINE?

Senka Mesihović-Dinarević

Department of Medical Sciences
Academy of Sciences and Arts of Bosnia and Herzegovina
Bistrik 7, 71000 Sarajevo
Bosnia and Herzegovina
e-mail: *dsenka@bih.net.ba*

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Abstract

The rapid pace of change continues to be a hallmark in cardiovascular medicine and many see that pace accelerating in adult cardiovascular medicine as well as in paediatric cardiology medicine. Cardiovascular medicine is an area of clinical practice with a continually rapid expansion of knowledge, guidelines, best practices and new technology. Cardiovascular diseases are the leading cause of mortality in the world and cause major costs for the health sector and economy. Primary care clinicians are challenged to optimally manage a multitude of diseases including congestive heart failure, coronary artery disease, valvular diseases, arrhythmias, lipid disorders, and hypertension. Multimodality imaging techniques are being used more frequently as their utility is better appreciated. Echocardiography has been the mainstay approach, cardiac computerized tomography and magnetic resonance imaging provide a good imaging alternative for patients with multiple complex surgeries. 3D printing has seen a rapid growth in use for planning treatments for patients with congenital heart disease. Simulation using 3D models is emerging as a fundamental resource for teaching procedural techniques and a new standard of care. Artificial intelligence holds the greatest potential for revolutionizing medicine. Innovative technologies in the world of cardiovascular health are expanding every day: wearable computing technologies, bioresorbable stents, leadless pacemaker, valve-in-valve procedure, protein patch for heart muscle growth and others. As a part of lifelong learning process for all professionals in cardiovascular medicine, the imperative is to have continuity of reviewing novelties, with results data from numerous researches in order to treat patient according to best practices and evidence-based medicine.

Key words: cardiovascular, medicine, up-to-date

Introduction

Cardiovascular diseases /CVD/ as a part of cardiovascular medicine, remain the biggest cause of deaths worldwide and cause major costs for health sector and economy (1). Although during the last two decades, rates of cardiovascular mortality declined in many developed countries, they have grown in low and middle income countries. The percentage of premature deaths caused by cardiovascular diseases is in the range of 4% in developed countries and 42% in undeveloping countries. Around 17.9 million people died from CVD in 2016, representing 31% of total deaths. Of these deaths, 85% were due to heart attack and stroke. Of the 17 million premature deaths (under 70 years of age) due to non-communicable diseases in 2015, 82% were in low- and middle-income countries, and 37% are caused by CVD's (2). The majority of cardiovascular diseases can be prevented by addressing behavioural risk factors such as tobacco use, unhealthy diets and obesity, physical inactivity and harmful use of alcohol, through strategic approach in the whole population. Therefore, cardiovascular medicine is a vast area of clinical practice with a continually rapid expansion of knowledge, guidelines, best practices and new technology. Primary care clinicians are challenged to optimally manage a multitude of diseases involving the cardiovascular system, including heart failure, arrhythmias and the circulation affected by abnormal cholesterol metabolism and hypertension. The rapid pace of change continues to be a hallmark in cardiovascular *adult and paediatric cardiology medicine* and many see that pace accelerating.

In the section of *Adult Cardiology* we are going *to review* a few novelties which would be of interest *for primary care practitioners*.

Atrial Fibrillation represents an irregular and often rapid heartrate that can increase risk of strokes, heart failure and other heart-related complications. In Alamneh EA et al from 2016, authors discussed a greater use of direct oral anticoagulants /DOACs/ over warfarin (3). Increased use of DOACs, particularly rivaroxaban, among patients with atherosclerotic disease as a result of the COMPASS study, showed fewer cardiovascular events in patients with peripheral artery disease (PAD) who received low-dose rivaroxaban plus daily aspirin twice daily, compared with aspirin alone (4). Similar results are anticipated from a second trial, VOYAGER PAD (5). These studies are helping to understand the role of very low-dose DOACs in the prevention of thrombotic adverse events in patients with coronary artery disease and PAD.

Artificial intelligence (AI) is defined as the ability of computer systems to perform tasks humans usually perform. Machine learning, while often used interchangeably with AI, is actually a subset of AI in which algorithms, mathematical models and/or computer systems are used to optimize the performance of a given task (6). The *Six broad* areas in which AI will advance the cardiovascular field are: *1. Novel drug discovery/development*. AI is increasingly being used to refine the selection of potential therapies by searching for patterns in molecular biology, structure-function, and clinical trial databases. *2. Precision medicine.* With AI, genetic, environmental and lifestyle data can be quickly assessed to determine who is most likely to benefit from certain interventions. *3. Integration of data from varied sources*. AI enables data from varied sources, such as wearables, social media, the electronic health record, to be integrated into models that can predict the trajectory of both health and disease. *4. Improved efficiency.* AI can help reduce provider dissatisfaction and burnout by minimizing repetitive tasks, prioritizing HER (Health Electronic Record) - based alerts or messages, improving and automating image interpretation in the catheterization or echocardiography laboratory, and presenting a "preferred" treatment plan based on integration of varied data sources. *5. Remote monitoring.* AI can strain out clinically actionable data from the trillions of data bytes collected by wearable devices. *6. Increasing the value of delivered care*. Artificial intelligence is an ideal population tool, given its ability to better predict individuals at greater or lesser risk of developing chronic diseases or related complications, tailoring preventive therapies and allocating limited resources to those most likely to benefit from them. No emerging technology has more promise than AI. There are dozens of articles about the potential for AI in health care and an increasing number of scientific publications. But, overall, almost nothing has yet made its way into clinical practice. One likely reason is that many startup and established tech companies underestimated the complexity of healthcare data and the need to provide strong evidence that the use of AI would improve efficiency and outcomes. It's therefore important that clinicians insist on strong data before relying on AI.

Another aspect of novelty discussed in cardiovascular medicine is the *Patient-Generated Data:* The first "wearable" in cardiovascular medicine dates back to the 1800s, when a watch with a second hand was used to measure heart rate (6). Today, however, wearables are more likely to be patient initiated, measuring everything from heart rate and rhythm to blood pressure, sleep quality and duration, and physical activity (7, 8). There is particular interest in the ability of wearables to affect clinical outcomes in cardiovascular

disease. A major trial evaluating the potential of specialized software for the Apple Watch to detect abnormal heart rhythms is underway. The Apple Heart Study, a virtual, prospective, single-arm pragmatic study has enrolled more than 400,000 participants. The primary outcome is the proportion of participants with an irregular pulse detected by the watch who are diagnosed with AF on subsequent ambulatory ECG patch monitoring. A secondary outcome is to estimate the rate of initial contact with a healthcare provider within three months after the patient is notified of a pulse irregularity (8). To date, data on clinical outcomes from mHealth devices are primarily based on case studies. For instance, Martin and his colleagues recently reported on the case of a woman with paroxysmal AFib whose Apple Watch/Kardia Band detected tachycardiomyopathy, enabling early detection and treatment and likely preventing significant morbidity (9-11). This represents the beginnings of mHealth being integrated into clinical care.

Valvular Heart Disease is characterized by damage to or a defect in one of the four heart valves: the mitral, aortic, tricuspid or pulmonary. The results of the COAPT trial reported in 2018 should have significant implications for the field of valvular heart disease in 2019 (12, 14). The study, which showed that treatment with the *MitraClip combined with guideline-directed medical therapy (GDMT)*, effectively reduced MR and was associated with marked clinical benefits, answered one of the lingering, unanswered question in the field. Is secondary mitral regurgitation simply a marker of a patient with a poor prognosis or a target for intervention/therapy? The results will encourage efforts to "fix MR" in patients with heart failure and secondary MR. The key will be how to do this in a safe, effective and durable manner (13). Other study results expected in 2019 include those from *two trials* comparing *transcatheter aortic valve replacement (TAVR) with surgical aortic valve replacement (SAVR)* in low-risk patients (12, 13, 15). Most people anticipate that TAVR will be noninferior to SAVR, thus opening the door for FDA approval of TAVR to extend to low-risk patients, although several lingering questions remain, including its use in patients with bicuspid valve disease and valve durability. Authors anticipate that if TAVR is noninferior to SAVR, the field of transcatheter approaches for aortic valve will widen and many patients will be eligible for this ground-breaking therapy, which is less invasive and kinder for patient's recovery. Another question in 2019 is whether the FDA will approve *Boston Scientific's Lotus valve* for high-risk and prohibitive risk patients, and how the availability of a third TAVR valve on the market will affect practice patterns (16). Authors predict a greater attention on *tricuspid*

valve disease. Given the lack of medical therapies for advanced tricuspid valve regurgitation, transcatheter tricuspid therapies offer the possibility of a therapy option where no good therapy currently exists (17).

In the update in cardiovascular medicine *for primary care physicians* the topic on *Aortic Disease* evaluates *Fluoroquinolone* use and the potential risk for aortic aneurysm or dissection (18). Based on observational studies suggesting an association between fluoroquinolone use and aortic aneurysm or dissection, the US Food and Drug Administration issued a warning in December 2018 highlighting the association and recommended avoiding fluoroquinolones in patients with known aortic aneurysms or those with risk factors for aneurysm such as Marfan's syndrome, Ehlers-Danlos syndrome, peripheral atherosclerotic vascular diseases, hypertension, and/or advanced age. When considering fluoroquinolone use, we take this uncertainty into account and weigh the overall risks and benefits in each patient.

Arrhythmias: heart arrhythmia, also known as dysrhythmia or irregular heartbeat, is a group of conditions in which the heartbeat is irregular, too fast or too slow. About 80% of sudden cardiac death is the result of ventricular arrhythmias. Arrhythmias may occur at any age but are more common among older population. Most arrhythmias can be effectively treated. The method of cardiac rhythm management depends firstly on whether the patient is stable or unstable. Treatments may include physical manoeuvres, medications, medical procedures such as pacemaker, electricity conversion, or electro- or cryo-cautery. Radiofrequency catheter ablation (RFA) of recurrent sustained monomorphic ventricular tachycardia (SMVT) results in fewer *implantable cardioverter-defibrillator (ICD*) shocks and reduced need for antiarrhythmic drug therapy, but the optimal technique is unknown. The result was similar all cause mortality as in ICD implanted group (19). In a 2019 systematic review of 17 nonrandomized studies, patients who underwent *combined epicardial / endocardial versus endocardial RFA* had lower rates of recurrent VT (20). Subset analysis suggested the benefit was confined to those with ischemic cardiomyopathy or arrhythmogenic right ventricular cardiomyopathy. Additional data are required, ideally from randomized trials comparing the two techniques, prior to recommending combined epicardial /endocardial over endocardial RFA for all patients with recurrent SMVT. For patients in atrial fibrillation undergoing *transvenous cardiac implantable electronic device (CIED)* insertion, continued warfarin therapy has been shown to be safer than interrupted warfarin with heparin bridging among patients with the highest thromboembolic risk (>5 percent per year). Safety data, however, are

limited for patients treated with direct oral anticoagulants (DOACs) rather than warfarin (21). In BRUISE CONTROL-2, which included patients undergoing transvenous CIED insertion with CHA2DS2-VASc scores ≥2 who were taking a DOAC for chronic anticoagulation, the incidence of the primary outcome (clinically significant pocket hematoma requiring prolonged hospital stay, interruption of anticoagulation therapy, or surgery for hematoma removal) was the same (2.1 percent) for patients randomized to device insertion while on continued DOAC therapy and for those in whom the DOAC was stopped (22). While these data are promising, additional studies are needed prior to routinely recommending uninterrupted DOAC use during transvenous CIED implantation.

Despite effective interventional and medical therapies for *myocardial infarction (MI),* the risk of early post-MI sudden cardiac death (SCD) remains, especially in patients with severely reduced left ventricular ejection fraction (LVEF). Data conflict on the utility of an implantable cardioverter-defibrillator (ICD) early post-MI. *A wearable cardioverter-defibrillator (WCD)* has been suggested as temporary therapy for patients at high risk for SCD. The randomized VEST trial in patients with an acute MI and LVEF ≤35 percent compared use of a WCD (begun within seven days of hospital discharge) plus usual medical treatment to standard medical treatment alone (23). Over an average follow-up of 84 days, the primary outcome of arrhythmic death was not different for the two groups. Compliance with medical therapy was excellent in both groups, likely contributing to fewer than expected events, while compliance with WCD usage was markedly lower than expected. Among patients with LVEF ≤35 percent who are less than 40 days post-MI, authors discuss the benefits and risks of WCD use and offer it to highly motivated patients who would be candidates for ICD implantation after 40 days.

Another myocardial disease, *acute myocarditis* has been evaluated in the section of *cardiovascular imaging techniques*, discussing several points: the challenge to diagnose acute myocarditis given its varied clinical manifestations. *Cardiovascular magnetic resonance (CMR)* is a key noninvasive test for acute myocarditis as it enables identification of the location and extent of myocardial involvement, but the optimum CMR protocol for identification of acute myocarditis has not been established. A systematic review and meta-analysis included 22 studies comparing the diagnostic accuracy of CMR techniques for acute myocarditis (24). These findings will help refine CMR protocols for the diagnosis of acute myocarditis. Limited data are available on the agreement between left ventricular ejection fraction (LVEF) measurements

by various cardiac imaging modalities. The largest available study of *inter-modality variability of LVEF* analysed core lab data from an international trial enrolling patients with coronary artery disease and reduced LVEF including *echocardiograms, single-photon emission computed tomography, and cardiac magnetic resonance (CMR) imaging* (25). Correlation between LVEF determined by quantitative versus visual echocardiographic methods was greater than the correlation between LVEF assessed by different modalities (such as biplane echocardiography versus CMR). In paired comparisons of LVEF by differing imaging modalities, approximately half fell within range of five absolute percentage points. These observations demonstrate a significant limitation of using LVEF thresholds to guide clinical management and suggest that serial follow-up of a given patient may be best accomplished using a consistent imaging modality. Most published studies suggest that *coronary computed tomography angiography (CCTA) and stress testing (with stress imaging)* are associated with comparable long-term clinical outcomes in stable patients with suspected coronary artery disease (CAD) and in patients with acute chest pain. In the SCOT-HEART trial, which compared standard care (contemporary medical therapy and diagnostic testing at the discretion of the treating physician) with standard care plus CCTA in over 4100 patients with stable chest pain, patients randomized to CCTA with standard care had a reduction in the primary endpoint of CAD death or non-fatal myocardial infarction (2.3 versus 3.9 percent) over an average follow-up of 4.8 years (26). However, in contrast to prior studies comparing CCTA with stress testing, 85% of patients underwent stress electrocardiography (ECG) alone, with only 9 percent subsequently undergoing a stress test with imaging. Ongoing studies of CCTA should provide additional guidance regarding its optimal role in the diagnosis of patients with chest pain and suspected CAD.

Pulmonary hypertension is elevated blood pressure in the pulmonary artery (PA) averaging 25 mm Hg or above at rest. Elevated PA pressure (PAP) can be caused by abnormalities in the precapillary pulmonary arterioles, called pulmonary arterial hypertension (PAH), or by abnormalities that increase left atrial pressure resulting in back pressure on the pulmonary circulation, called pulmonary venous hypertension (PVH). Although the etiology and pathophysiology of PAH and PVH are distinct, they are similar in that both cause elevated PA pressure that inevitably leads to right ventricular (RV) dilation and remodeling, followed by RV failure and death if RV compensation can no longer sustain normal cardiac function. PAH is often characterized by a progressive and sustained increase in pulmonary vascular resistance

that eventually may lead to RV failure. It can be a life-threatening condition if untreated. Therapy for pulmonary hypertension is targeted at the underlying cause and its effects on the cardiovascular system, with success rates varying according to the aetiology. Pulmonary Arterial Hypertension or PAH is a subgroup of PH caused by narrowing of the blood vessels in the lungs. In contrast, PAH occurs in isolation and is very rare. There is a difference between pulmonary hypertension (PH) and pulmonary arterial hypertension (PAH). Pulmonary arterial hypertension (PAH) is a specific subgroup of pulmonary hypertension (PH). The definition of PH is more inclusive than the definition of PAH, meaning that the specific hemodynamic measurements used to define PAH do not apply to PH. For select patients with *pulmonary arterial hypertension (PAH),* advanced therapy including endothelin receptor antagonists (bosentan or macitentan) is widely accepted, but consensus is lacking for those with PAH and congenital heart disease, including Eisenmenger syndrome. In the MAESTRO trial, including over 200 patients with Eisenmenger syndrome with World Health Organization (WHO) functional class II to IV, macitentan versus placebo resulted in a similar mean change in six-minute walk distance (6MWD), but reduced pulmonary vascular resistance (27). In the smaller prior BREATHE-5 trial, bosentan improved both of these measures relative to placebo. Authors continue to use endothelin receptor antagonists for patients with PAH and congenital heart disease given improvement in hemodynamic parameters, although an effect on clinical outcomes has not been established.

Heart Failure (HF) is a complex clinical syndrome that results from any structural or functional impairment of ventricular filling or ejection of blood. We evaluate novel different methods of treatment. Sacubitril-valsartan (an angiotensin receptor-neprilysin inhibitor) is indicated *in ambulatory patients* with *heart failure* with reduced ejection fraction, but its safety and efficacy in patients with acute heart failure have not been determined (28). *Left ventricular assist devices* are increasingly used to manage *end-stage heart failure*, but device-related complications include stroke. In the MOMENTUM 3 trial, over 300 patients were randomly assigned to implantation with a fully magnetically centrifugal flow pump or an axial flow pump (29). While stroke rates were similar in the two groups during the first six months, strokes were less frequent from six months to two years in the centrifugal flow pump group. A stroke event was associated with reduced two-year survival regardless of the subtype or the initial severity of neurological impairment. This

finding illustrates the impact of device selection and complications on long-term outcomes.

Another topic is *Hypertension,* one of the risk factors for development of cardiovascular diseases. Numerous epidemiological studies have found an association between incrementally higher blood pressure in middle-aged and older adults and the risk of cardiovascular disease in middle-aged and older adults; fewer data are available for the outcomes of *high blood pressure among young adults.* Two large prospective cohort studies of adults younger than 40 years at baseline found that increments in blood pressures >120/>80 mmHg, compared with a blood pressure <120/<80 mmHg, were associated with increasing risk for coronary heart disease and stroke later in life (30, 31). These studies support that hypertension, defined by the 2017 ACC/AHA guidelines as blood pressure ≥130/≥80 mmHg, is an important risk factor for cardiovascular disease, including in young adults. The American Heart Association updated their statement on detection, evaluation, and management of *resistant hypertension* (uncontrolled hypertension despite prescription of three or more antihypertensive medications) (31). The most notable change from prior guidelines relates to the diagnosis of true resistant hypertension. True resistance must be distinguished from pseudo resistance by confirming that blood pressure is above goal when measured in the office using proper technique, by then confirming uncontrolled hypertension with out-of-office measurements (ie, ambulatory blood pressure monitoring or home blood pressure monitoring), and by considering and excluding nonadherence to antihypertensive therapy.

Innovative technologies in the world of cardiovascular health are expanding daily, such as: wearable computing technologies, bioresorbable stents, leadless pacemaker, valve-in-valve procedure, protein patch for heart muscle growth and others (34).

In the current era, *multimodality imaging techniques* are being used more frequently as their utility is better appreciated (32). Echocardiography has been the mainstay approach, and cardiac computerized tomography and magnetic resonance imaging provide a good imaging alternative for patients with multiple complex surgeries. 3D printing has seen a rapid growth in use for planning treatments for patients with congenital heart disease. Simulation using 3D models is emerging as a fundamental resource for teaching procedural techniques and a new standard of care.

In the section of Paediatric cardiology we evaluate treatment of congenital heart defects which are the most common type of birth defects, occurring

in about 1 percent of all live births. A large number of these defects require surgery, especially those in the category of complex congenital heart disease, requiring multiple operations (33). While there have been great advances in surgical technique and outcome, there still remains significant morbidity and mortality, especially in the setting of those requiring multiple operations. A major reason for this is the significant variation in anatomic abnormalities in patients with congenital heart disease, especially in those individuals requiring repeated procedures. As we stated earlier, 3D printing has seen a rapid growth in use for planning treatments for patients with congenital heart disease and carries hope for improving quality, efficiency and outcomes of these procedures. The current paradigm of the practice is to identify pts with complex anatomy who may require repeated procedures that carry significant risk. Life-size models by 3D printing using different materials can be used by the surgeon who can then immediately contemplate the approach and the technical feasibility of the anticipated procedure. The use of 3D-printed models can be used to tailor education to different learners, to effectively teach complex cardiac anatomy to radiology, cardiology and cardiovascular surgery fellows. Training in procedural techniques has been traditionally time-consuming and has the potential to be implicated in procedural complications. Simulation using 3D models is emerging as a fundamental resource for teaching procedural techniques for trainees acquiring advanced skill sets in the field and is similarly being used within practice as a new standard of care. 3D-printed models are also effective *tools for communication* within health care teams and with patients. Within the practice, specific 3D models used to explain disease processes and planned procedures enhance patient understanding and facilitate shared decision-making and informed consent, which ultimately improves patient satisfaction (37). In the paediatric cardiovascular medicine there were three major revolutionary innovations and paradigm shifts in congenital heart disease (CHD) interventions over the last half-century (35, 37). These innovations were: 1. the heart-lung (cardiopulmonary bypass) machine, 2. neonatal cardiac surgery, and 3. transcatheter therapy**.** There are multiple evolving areas of expertise that will potentially shape congenital cardiovascular specialty over the following decades. *The first* is the creation of the *Adult Congenital Heart Disease subspecialty* (36). With up to 90 percent of CHD patients surviving to adulthood in the current era, the coming years will likely see a significant increase in the prevalence of acquired heart disease in this population. Well-coordinated specialized multidisciplinary care from providers with skills in both paediatric and adult medicine will become critical for

the prevention and management of acquired heart disease as well as the long-term sequelae of CHD in this population. *Second,* one of the downstream problems of an aging CHD population is an *increase in the average number of surgical reinterventions in a lifetime, and the need for multiple reoperations in patients with complex anatomy* will invariably result in increase in surgical morbidity and or mortality. Transcatheter valve therapy is now increasingly being used to mitigate or delay the need for multiple high-risk surgical reoperations. The application of this therapy is significantly limited by the anatomic variability of the CHD population making most patients ineligible candidates. The ongoing improvement in the design of valve prostheses and delivery systems specifically engineered to accommodate the anatomic variability of this population will potentially increase the number of patients eligible for this therapy in the years to come. *Third,* the *advances in imaging techniques* (CT, MRI, echocardiography) that include 3-dimensional imaging and the ability to print models and evaluate anatomy in a virtual environment allows a more thorough preparation for a complex intervention. In addition, the ability to practice the actual procedure in advance of the operation provides an effective model for education and may help reduce morbidity and mortality for complex or infrequently performed percutaneous or open surgical procedures. *Fourth,* the *demand for cardiac replacement therapy* will continue to rise as the CHD population ages and the prevalence of end-stage heart failure increases. Unfortunately, the limited availability of *donor heart organs* and pre-sensitization from prior operations have resulted in a huge mismatch between the supply of cardiac allografts and the rising demand due to end-stage heart failure. With the ongoing improvements in the newer generation of *ventricular assist devices* authors anticipate that the use of ventricular assist device as destination therapy for CHD patients with end-stage heart failure may become the standard of care in the near future. Lastly, *stem cell therapy* is an emerging field with many exciting ongoing research studies. For heart failure patients, the urgent need for heart transplantation exceeds the availability of donor hearts. Therefore, cell transplantation has emerged as an interesting and potential solution. The clinical application of stem cell therapy, though still at the preliminary stage, is very promising for slowing down the progression to end-stage heart disease or even potentially reversing myocyte damage from previous insult (38).

Conclusion

During past decades, we have witnessed the birth and exponential growth of cardiovascular interventions in adults and children. More importantly, the coming decades will likely result in more revolutionary innovations in this field. As a part of lifelong learning process for all professionals in cardiovascular medicine, the imperative is to have continuity of reviewing novelties, with research results in order to treat patients according to best practices and evidence-based medicine.

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NOVINE U KARDIOVASKULARNOJ MEDICINI

Sažetak

Brzi tempo promjena i dalje je jedno od obilježja u kardiovaskularnoj medicini, a mnogi primjećuju da se taj tempo ubrzava i u kardiovaskularnoj medicini za odrasle kao i u dječijoj kardiološkoj medicini. Kardiovaskularna medicina je područje kliničke prakse s kontinuirano brzim širenjem znanja, smjernica, najboljih praksi i novih tehnologija. Kardiovaskularne bolesti su vodeći uzrok smrtnosti u svijetu i uzrokuju velike troškove za zdravstveni sektor i ekonomiju. Kliničari primarne njege suočavaju se s izazovom da optimalno upravljaju brojnim bolestima, uključujući kongestivno zatajenje srca, koronarnu bolest arterija, valvularne bolesti, aritmije, poremećaje lipida i hipertenziju. Multimodalne tehnike snimanja koriste se sve češće jer se njihova korisnost sve više cijeni. Ehokardiografija predstavlja osnovni pristup, a srčana kompjuterizovana tomografija i snimanje magnetnom rezonancom pružaju dobru alternativu za snimanje pacijenata s višestrukim složenim operacijama. 3D štampa bilježi brzi rast upotrebe u planiranju tretmana za pacijente s urođenom srčanom bolešću. Simulacija korištenjem 3D modela razvija se kao temeljni resurs u podučavanju proceduralnih tehnika i novih standarda njege. Umjetna inteligencija ima najveći potencijal za revoluciju u medicini. Inovativne tehnologije u svijetu kardiovaskularnog zdravlja šire se svakim danom: nosive računalne tehnologije, bioresorbilni stentovi, bezopasni pejsmejkeri, valve-in-valve procedure, proteinski flasteri za rast srčanog mišića i druge. U sklopu procesa cjeloživotnog učenja za sve stručnjake kardiovaskularne medicine, imperativ je dosljedno praćenje noviteta, uz rezultate brojnih istraživanja, kako bi se pacijenti mogli liječiti u skladu s najboljim praksama i medicinom zasnovanom na dokazima.

Ključne riječi: kardiovaskularno, medicina, ažurnost