

Ehokardiografija danas – hrvatski izazovi

Echocardiography Today – Croatian Challenges

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CITATION: *Cardiol Croat.* 2014;9(11-12):523-526. | **DOI:** <http://dx.doi.org/10.15836/ccar.2014.523>

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Ehokardiografija se od svojih početaka do danas, uz pomoć brojnih tehnoloških dostignuća i znanstvenih spoznaja, razvila u vrlo složenu i detaljno protokoliranu pretragu s brojnim najsloženijim i zahtjevnim analizama i izračunima¹.

Napredak ehokardiografskih metoda i cjelokupnoga oslikavanja srca omogućio nam je mnogo bolje, brže i racionalnije dijagnosticiranje, zbrinjavanje i liječenje kardioloških bolesnika. Gotovo je nemoguće kompleksnost ove pretrage sagledati u postojećim normativima koji datiraju iz 1992. god. i od tada nisu dopunjeni niti s jednim postupkom i metodom, iako su se u međuvremenu preporuke i pravila struke vezane za ehokardiografiju u cijelosti višestruko izmijenili, a razvile su se i posve nove moderne metode^{2,3}.

Za ilustraciju, čak i naziv pretrage u važećem popisu dijagnostičko-terapijskih postupaka, Hrvatskoga zavoda za javno zdravstvo⁴ (tzv. DTP): *Ehokardiografija s dopler ehokardiografijom* je daleko izvan sadašnjeg vremena i trebalo bi ga promijeniti u „Standardna transtorakalna ehokardiografija” jer je to naziv koji se koristi za ovu pretragu u stručnim krugovima, kako u našoj zemlji tako i u Europi i cijelom svijetu. Naime, ultrazvučni pregled srca u svrhu ispitivanja strukture srca, funkcije srca, protoka krvi kroz srce s osnovnom hemodinamikom neizostavno koristi doplersku ehokardiografiju (uključujući obojani, pulsni i kontinuirani dopler) i bez nje ne može biti cjelovit⁵. U određivanje bolesti srčanih zalistaka, funkcije miokarda i urođenih srčanih bolesti i okolnih struktura potrebno je koristiti sve standardne metode: jednodimenzijanski, dvodimenzijanski prikaz (nužan za analizu struktura i njihova točna mjerenja) i doplersku ehokardiografiju. **Pretraga nije cjelovita**

Due to many technological and scientific discoveries, echocardiography has developed into a complex diagnostic examination with a detailed protocol that uses numerous highly complex and demanding analyses and calculations¹.

The development of echocardiographic methods and heart imaging in general has allowed better, faster, and more rational diagnosis and treatment of patients with cardiac problems. It is almost impossible to describe the complexities of this examination in the framework that dates back to 1992 and has never been expanded with a single procedure and method since then, despite the fact that the recommendations and guidelines of echocardiography have undergone several changes in the meantime and new modern methods have been developed^{2,3}.

To illustrate this, even the term used for this examination is outdated in the list of diagnostic and therapeutic procedures of the Croatian Institute of Public Health⁴: *“Echocardiography with Doppler echocardiography”* is far behind the times, and should be changed to “Standard transthoracic echocardiography” which is the term used in professional circles both in Croatia and abroad. Along with basic hemodynamics, an ultrasound examination of the heart assessing the function and blood flow of the heart necessarily uses Doppler echocardiography (including continuous wave Doppler, pulsed Doppler, and color flow imaging) and is not complete without it⁵. Assessing heart valve disease, myocardial function and hereditary diseases of the heart and surrounding structures, congenital heart diseases must include all the standard methods: one- and two-dimensional imaging (necessary for structure analysis and

RECEIVED:
December 8, 2014

ACCEPTED:
December 10, 2014



ako se jedna od ovih standardnih metoda izostavi, stoga ehokardiografija podrazumijeva korištenje doplerske ehokardiografije, u protivnom se ne može zvati ehokardiografija. Postoji orijentacijski „pogled na srce“ u domeni općeg internista za postavljanje tek nekoliko urgentnih dijagnoza, ali se pri tome ne koristi doplerska ehokardiografija, što zasigurno nije standardna transtorakalna ehokardiografija i ne može se smatrati istom pretragom.

U skladu s razvojem tehnologije i medicine, posebice napretka u kardiologiji i ehokardiografiji, ultrazvuk srca se u potpunosti izmijenio u odnosu na sastavnice i postojeći naziv, a razvile su se brojne nove metode i pretrage koje se danas svakodnevno rade (npr. dopler miokarda, trodimenzijska ehokardiografija, deformacija miokarda *speckle tracking*, itd.).

S obzirom na razvoj ehokardiografije u svijetu i kod nas, potrebno je ovu vrijednu i nezaobilaznu kardiološku pretragu vrednovati prema preporukama stručnih društava u Europi i svijetu i razlikovati nekoliko kategorija pretrage u odnosu na potrebne vremenske, stručne, kadrovske i tehničke normative te u skladu s tim i vrednovati postojeće troškove.

U dijagnostičkom postupku kompleksnih bolesnika koriste se vrlo kompleksne dijagnostičke pretrage koje uključuju hemodinamska mjerenja i napredene ehokardiografske metode, to su: dopler miokarda, stres ehokardiografija, 2D *strain* oslikavanje, optimiranje resinkronizacijskog elektrostimulatora, trodimenzijska ehokardiografija³. To su metode koje spadaju u složene ehokardiografske postupke i zahtijevaju više vremena, visoke kadrovske i tehničke normative, vrlo složenu i zahtjevnu analizu (za ilustraciju zahtjevnija i od magnetske rezonancije) te ih stoga treba posebno izdvojiti. Upravo zbog toga stručno društvo, Američko društvo za ehokardiografiju postavilo je kategorizaciju ehokardiografskog pregleda u nekoliko kategorija ovisno o zahtjevnosti (orijentacijski, jednostavni i složeni ehokardiografski pregled).

S obzirom na gore navedeno, kao i povijesne ostatke u normativima, vrlo važno je prije svega provesti **standardiziranje osnovnog ehokardiografskog pregleda**. U skladu s preporukama stručnog Ehokardiografskog udruženja (EACVI, prema engl. *European Association of Cardiovascular Imaging*)¹ i razvojem kardiološke dijagnostike Radna skupina za ehokardiografiju i slikovne metode u kardiologiji Hrvatskoga kardiološkog društva, zalaže se za standardiziranje ehokardiografskog pregleda što je prvi korak ka ujednačenoj i usporedivoj kvaliteti ehokardiografskih nalaza i njihovoj primjenjivosti vrijednosti te primjeni odgovarajućih normativa i vrednovanju rada medicinskog osoblja, u konačnici u cilju dobiti i zaštite bolesnika.

Standardizirana ehokardiografija današnjeg vremena trebala bi neizostavno sadržavati sljedeće:

- **kontinuirano bilježenje elektrokardiograma**. Elektrokardiogram omogućuje vremensko određivanje različitih djelova srčanog ciklusa što je neophodno za točna mjerenja. Bez elektrokardiograma mjerenja struktura i doplerskih parametara su netočna i dovode do krive interpretacije nalaza.
- **bilježenje disanja – respiracija** tijekom ehokardiografije preko elektroda na prsnom košu. Ehokardiografija nije potpuna ako se ne ispita utjecaj respiracije na osnovna hemodinamska zbivanja u srcu, prema preporukama ehokardiografskih

precise measurement) and Doppler echocardiography. **The examination is not complete if any of these standard methods is omitted**. Thus, echocardiography includes the use of Doppler echocardiography by definition, and cannot be called echocardiography without it. A basic orientational “heart viewing” is sometimes performed to establish a few urgent diagnoses, but it does not include Doppler echocardiography and thus surely cannot be considered identical to standard transthoracic echocardiography.

As technology and medicine developed, in particular due to advancements in cardiology and echocardiography, heart ultrasounds have changed completely in terms of their components and terminology, and new methods and tests have been developed that are now used routinely (e.g. Doppler myocardial imaging, three-dimensional echocardiography, speckle tracking, etc.).

Due to advancements in echocardiography both in Croatia and abroad, this valuable and irreplaceable cardiologic examination should be evaluated based on international expert recommendations. Several categories of echocardiography must be differentiated, depending on the time, expertise, staff, and technical requirements, evaluating existing expenses appropriately.

In diagnosing complex patients, very complex diagnostic methods must be used. These include hemodynamic measurements and advanced echocardiographic procedures, which are: Doppler myocardial imaging, stress echocardiography, 2D strain imaging, optimization of the electrostimulator, and three-dimensional echocardiography³. These are complex echocardiographic procedures that require more time, high expertise and technical requirements, and complex analysis (even more so than magnetic resonance imaging, for instance), and must thus be considered individually. This is why the American Society of Echocardiography categorizes echocardiographic examinations based on their complexity (orientational, simple, and complex).

Considering all the above, it is extremely important to **standardize the basic echocardiographic examination**. In line with the recommendations of the *European Association of Cardiovascular Imaging*¹ and the development of cardiac diagnostics, the Working Group on Echocardiography and Cardiac Imaging Modalities of the Croatian Cardiac Society supports the standardization of echocardiographic examination as the first step to achieving consistent high quality echocardiographic results and their practicable application. This includes applying appropriate guidelines and evaluating medical personnel, with the interests of the patients and the overarching goal.

Standardization of modern echocardiography should include the following:

- **Continuous electrocardiographic monitoring**. An electrocardiogram enables timing of the various parts of the heart cycle, which is crucial for accurate measurement. Without the electrocardiogram, structure imaging and Doppler parameters will be incorrect, and lead to improper interpretation of the results.
- **Respiration monitoring** during echocardiography using electrodes on the thorax. According to the recommendations from echocardiographic societies¹, electrocardiography is not complete without an assessment of the influence of respiration on

udruženja¹. Neizostavno je za utvrđivanje hitnosti u nekim vitalno ugroženim stanjima bolesnika.

- svaki izmjereni i izračunani podatak tijekom ehokardiografskog pregleda trebao bi biti **dostupan u pisanom ili arhiviran u digitalnom obliku**. U tu svrhu svaki ehokardiografski pregled trebao bi se arhivirati u digitalnom obliku prema preporučenom protokolu Europskog i Američkog ehokardiografskog udruženja koji definira sadržaj i kvalitetu arhiviranog zapisanog materijala, tehničke i fiziološke uvjete, a uključuje sve slikovne (kino i zamrznute) i kvantitativne podatke¹. (Propisani i preporučeni protokol Radne skupine za ehokardiografiju i Europskog udruženja za ehokardiografiju propisuju sadržaj pretrage, uvjete, potrebne metode i sadržaj nalaza)
- **rad liječnika specijalista/subspecijalista u naknadnoj obradi i analizi** iz pohranjenih kino-petlji i slika. Određivanje hemodinamike u zadanim vremenskim intervalima srčanog ciklusa ehokardiografiju bitno razlikuje od svih drugih sonografskih metoda i čini je vrlo kompleksnom pretragom u kojoj je znanje, vještina i rad specijalista od osobitog značaja, kao npr. kod MR srca, CT-a i sl. To su rad na mjerenjima, izračunima fizikalnih veličina osnovne hemodinamike, kompjutorskoj rekonstrukciji prikaza svih ispitivanih struktura, mjerenju volumnih parametara u svim dijelovima srčanog ciklusa, pohrana na pokretne medije za potrebe bolesnika, direktno pisanje nalaza na radnoj stanici od strane specijalista. Raspon dodatnog utrošenog vremena nakon pretrage minimalno je 30 minuta, a u kompleksnih bolesnika nekad doseže i više sati. (Podrazumijeva pripremna mjerenja i izračunavanje složenih bročanih pokazatelja za kvantificiranje valvularnih grešaka, patoloških spojeva, pokazatelja funkcionalne sposobnosti klijetke prema preporukama Europskog udruženja za ehokardiografiju)
- Minimalni vremenski normativ za standardiziran ehokardiografski pregled treba biti 30-40 minuta, a interval narudžbe bolesnika ne smije biti kraći od tog vremena.

Prema važećim pravilnicima HZZO-a za dijagnostičke postupke⁴ za bolesnike u izvanbolničkoj zdravstvenoj zaštiti cijena pretrage je manja od najniže cijene iste usluge u zemljama istočne Europe, a višestruko manja od cijena u ostalim zemljama u Europi, npr. Velika Britanija, Francuska, Švedska (100-150€), Slovenija (70€), Belgija (70€), Rumunjska (70€). Cijena ehokardiografije u Hrvatskoj je tako mala da ne **pokriva troškove** svih sastavnih dijelova ehokardiografije koja se danas provodi, a rad liječnika i ehokardiografskog tehničara je zanemaren.

Na primjer, nisu pokriveni troškovi jednodimenzijskog prikaza ili *M-mode* koji je isključen iz ovog DTP postupka 2008. godine. Jednodimenzijski prikaz sastavni je dio pretrage i ne može biti zamijenjen ni jednim drugim prikazima u skladu sa svim pravilima i preporukama stručnih udruženja, stoga se ovaj prikaz neizostavno koristi pri svakoj ehokardiografskoj pretrazi. U opisu postupka za dvodimenzionalnu ehokardiografiju u knjizi vremenskih i kadrovskih normativa navodi se da „...metoda daje jednake informacije kao 1D ehokardiografija u dvije dimenzije“. Ovim se naglašava kako se ista struktura prikazuje u dvije dimenzije te nikako ne podrazumijeva da su podatci dobiveni ovim dvjema metodama isti! Naime, jednodimenzijska ehokardiografija ima vremensku rezoluciju (1000 Hz) koja se ne može postići drugim metodama i jedina omogu-

basic hemodynamic events in the heart. It is crucial to determine the level of urgency in some lethal states.

- Every measurement and piece of data obtained during echocardiography must be **archived and readily available**. Electrocardiographic examinations should be archived in digital format according to the recommended protocols of the European and American echocardiography associations, which define the contents and quality of the archived data as well as the technical and physiological conditions, including all image and quantitative data¹. (The recommended protocol of the Working Group on Echocardiography and the European Association of Echocardiography prescribes the contents of the examination as well as the conditions, methods, and contents of the results).
- **The expertise of a specialist/subspecialist in the subsequent analysis** of the images. Determining the hemodynamics in the set intervals of the heart cycle sets echocardiography apart from other sonographic methods and makes it a very complex procedure in which the knowledge and expertise of a specialist are vital, just as in magnetic resonance imaging of the heart, computed tomography, etc. The job of the specialist includes performing the measurements, calculating the physical parameters of the basic hemodynamics, digital reconstruction of the structures in question, volume parameters in all phases of the heart cycle, archiving the data on portable data carriers for the patient's use, and directly writing down the results at the workstation. The additional time spent after the examination is at least 30 minutes, and can range to several hours in complex cases. (Included are measurement preparations and calculating complex numeric variables for quantifying valve defects, pathological compounds, and indicators of the functional abilities of the ventricle according to the recommendations of the European Association of Echocardiography)
- The minimal timeframe for a standardized echocardiographic examination must be 30-40 minutes; patient appointment intervals must not be shorter than that.

According to the Croatian Health Insurance Fund's current guidelines⁴, the health insurance price of diagnostic procedures for outpatients is lower than the lowest prices for the same procedures in Eastern European countries, and several times lower than other European countries, e.g. Great Britain, France, Sweden: (€100-150); Slovenia: (€70), Belgium (€70), Romania (€70). The price of echocardiography in Croatia is so low it **does not cover the costs** of all integral elements of modern echocardiography, and the work of physicians and echocardiography technicians is neglected.

For instance, the costs of one-dimensional imaging or *M-mode*, excluded from the Croatian Institute of Public Health's outline of the procedure in 2008, are not covered by the price. One-dimensional imaging is an integral part of the procedure and cannot be replaced with other types of imaging while adhering to expert rules and guidelines, so it is always used in echocardiographic examinations. Concerning two-dimensional imaging, the time and staff guidebook says that "... *that method gives the same data as 1D echocardiography in two dimensions*". This emphasizes that the same structure is being shown in two dimensions, and does not imply that the data acquired using these two methods will be the same! This is because one-dimensional echocardiography has a temporal resolution (1000

čuje pravilna i dovoljno precizna standardna mjerenja, određivanje vremenskih intervala, morfološku i dinamsku analizu⁶.

Osim što je standardna ehokardiografija uzdignuta na potpuno novu razinu dijagnostike i izvanrednih mogućnosti, usporedo su uzignuti i kriteriji stručnosti kardiologa koji izvode pretragu s preporukom akreditiranja ehokardiografskih kompetencija i vještina na nacionalnoj ili europskoj razini što je uvjet akreditacije laboratorija pri Europskom ehokardiografskom udruženju^{7,8}.

Poseban izazov ehokardiografskoj stručnoj zajednici predstavlja održavanje primjerene kvalitete pretrage u eksponencijalno rastućim (opravdanim i neopravdanim) potrebama za ehokardiografskim pregledom⁹. U svrhu pružanja usluge u medicinski prihvatljivom vremenu, a s ciljem pružanja najbolje kardiološke skrbi i izbjegavanja ozbiljne zdravstvene štete za bolesnika, potrebno je poštovati **medicinske prioritete**. Na taj način se odgovarajući dijagnostički postupak provodi u svrhu brzog i racionalnog dijagnosticiranja bolesti, usprkos ograničenim mogućnostima pretrage, a troškovi racionaliziraju.

Jedan od mogućih načina povećanja maksimalnog broja postupaka koji je uopće moguće izvršiti u zadanim uvjetima jest uključivanje i drugih visokoobrazovanih kadrova u proces ehokardiografskog pregleda po uzoru na Veliku Britaniju ili Sjedinjene Američke Države. Naime, visoko stručno i racionalno upravljanje tehnološkim i ljudskim resursima podrazumijeva hijerarhiju kadrova u provođenju postupka rada. Tako dio pretrage koji se odnosi na pohranjivanje standardiziranog protokola može obavljati visokoeduciran ehokardiografski tehničar, dok se kardiolog uključuje u dijagnostički postupak pri zahtjevnim mjerenjima, rekonstrukcijama i postavljanju dijagnoze te pisanju nalaza.

Hz) which is not achievable using other methods, and is the only way to get accurate and adequately precise standard measurements as well as determine time intervals and morphological and dynamic analysis⁶.

In parallel with the advancement of echocardiography to completely new diagnostic levels and capabilities, the criteria of expertise for cardiologists performing the procedure have risen as well, due to the recommended accreditation of echocardiographic competence and skills at the national or European levels, which is a requirement for laboratory accreditation by the European Association of Echocardiography^{7,8}.

An additional challenge for the echocardiographic society is maintaining appropriate examination quality in the face of exponential growth of the (justified and unjustified) demand for echocardiographic examinations⁹. **Medical priorities** must be considered in order to perform services in an acceptable time-frame with the goal of providing the best cardiologic care and avoiding serious health issues for the patients. In this way, the appropriate diagnostic procedures are performed in order to quickly and rationally establish a diagnosis despite the limited examination options and prohibitive costs.

One of the possible ways to increase the maximum number of procedures that can be performed in the given circumstances is including other highly-educated professionals in the process of echocardiographic examination, in line with the examples of Great Britain and the USA; a high level of expertise in the management of technological and human resources incorporates a hierarchy system among the staff performing the procedure. Thus, the part of the procedure related to standardized protocol archiving can be performed by a highly educated echocardiographic technician while the cardiologist focuses on difficult measurements, reconstruction, diagnosis, and analysis.

Slike na naslovnici ovog broja ustupljene ljubaznošću Laboratorija za ehokardiografiju Kliničkog bolničkog centra Zagreb – Referentni centar Ministarstva zdravlja za ehokardiografiju. Prolaps mitralne valvule, transezofagijska ehokardiografija – "multiplane", 3D i 3D Kolor-doplerske rekonstrukcije.

Figures on cover by courtesy of Echocardiographic Laboratory University Hospital Centre Zagreb – Referral Centre for Echocardiography, Croatian Ministry of Health. Mitral valve prolapse, Transesophageal echocardiography – multiplane, 3D and 3D Color Doppler reconstructions.

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