

Analiza rada hrvatskih invazivnih kardioloških laboratorija od 2010. do 2014. godine

An Analysis of the Work of Croatian Invasive Cardiologic Laboratories between 2010 and 2014

Josip Lukenda^{*1},
Boris Starčević²,
Edvard Galić¹,
Tomislav Krčmar³,
Zrinka Biloglav⁴

¹Klinička bolnica "Sveti Duh", Zagreb, Hrvatska

²Klinička bolnica Dubrava, Zagreb, Hrvatska

³Klinički bolnički centar Sestre milosrdnice, Zagreb, Hrvatska

⁴Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja "Andrija Štampar", Zagreb, Hrvatska

¹University Hospital "Sveti Duh", Zagreb, Croatia

²University Hospital Dubrava, Zagreb, Croatia

³University Hospital Centre "Sestre milosrdnice", Zagreb, Croatia

⁴University of Zagreb, School of Medicine, Andrija Štampar School of Public Health, Zagreb, Croatia

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SAŽETAK: Uz napredak intervencijske kardiologije u Republici Hrvatskoj unatrag dva i pol desetljeća svrha je ovog rada bila analizirati broj i složenost perkutanih koronarnih intervencija (PCI) u pojedinih centrima. Od 2010. do 2014. u ukupno 13 centara prosječno su učinjena 9494 PCI-ja godišnje. Sedam centara svrstavamo u velike, Kliniku Magdalena s najvećim brojem PCI-ja svake godine i prosječnim godišnjim rastom od 6,2 % (s 1545 na 1941 PCI-ja), slijedi Klinički bolnički centar (KBC) Zagreb u kojem se bilježi prosječno godišnje smanjenje od 1,8 % (s 1474 na 1308), KBC Rijeka s prosječnim rastom od 15,8 % (s 1013 na 1632), Klinička bolnica (KB) Dubrava s najvećim prosječnim godišnjim smanjenjem od 5,7 % (s 1153 na 905) i KBC Sestre milosrdnice s prosječnim porastom od 2,3 % ali znatnim sniženjem broja PCI-ja u zadnjoj promatranoj godini (s 1082 na 815). Slijede KBC Split s prosječnim godišnjim porastom od 6,7 % (s 662 na 821) i KBC Osijek s porastom od 12,4 % (s 677 na 905). Pet centara svrstavamo u srednje velike: KB Merkur s prosječnim godišnjim smanjenjem od 3,7 % (s 670 na 506), dok se u ostalim centrima bilježi prosječni porast, u Općoj bolnici (OB) Slavonski Brod za 29,1 % (s 264 na 660), KB Sveti Duh za 7,5 % (s 306 na 382), u OB Zadar za čak 70,5 % (s 105 na 430), a u OB Dubrovnik za 32,4 % (s 84 na 232). Udio složenih zahvata na dvjema ili više žila u RH bio je 9,7 %. Najviši je bio u KBC-u Rijeka (18,2 %) i KB-u Dubrava (17,1 %), a slijede OB Zadar (15,3 %), KBC Split (11 %) i Klinika Magdalena (10,4 %). KBC Zagreb imao je udio sličan prosjeku (10,1 %), kao i OB Dubrovnik (8,6 %). Niže su udjele složenih zahvata imale KB Sveti Duh (7,9 %), KBC Sestara milosrdnica (6,9 %) i OB Slavonski Brod (6,3 %), a najniže KBC Osijek (3,5 %) i KB Merkur (1,7 %). Uz takav napredak intervencijske kardiologije i nakon što se uvede registar koronarnih intervencija i certificira centre i osoblje, sljedeći korak u RH trebalo bi biti uvođenje niza novih zahvata u bolesnika sa stečenim strukturnim i kongenitalnim bolestima srca koji su za sada još nedostavno razvijeni.

SUMMARY: With the advancements in interventional cardiology in the Republic of Croatia over the last two and a half decades, the goal of this study was to analyze the number and complexity of percutaneous coronary intervention (PCI) procedures in individual centers. Between 2010 and 2014, an average of 9,494 PCI procedures was performed annually in a total of 13 centers. Seven centers are classified as high-volume centers: the Magdalena Clinic with the highest number of PCI procedures performed annually, with an average annual increase of 6.2% (1545 to 1941 PCI over analyzed period), the University Hospital Centre (UHC) Zagreb with an average annual decrease of 1.8% in procedure numbers (1474 to 1308), UHC Rijeka with an average annual increase of 15.8% (1013 to 1632), University Hospital (UH) Dubrava with an average annual decrease of 5.7% (1153 to 905), and the UHC "Sestre milosrdnice" with an average annual increase of 2.3%; however this hospital experienced a decrease of procedures in the last year of period (1082 to 815). These are followed by the UHC Split with an average annual increase of 6.7% (662 to 821) and the UHC Osijek with an increase of 12.4% (677 to 905). Five centers are classified as medium-volume centers: the UH Merkur with an average annual decrease in PCI procedures of 3.7% (670 to 506), whereas the number of procedures increased in the rest of the medium-sized centers: in General Hospital (GH) Slavonski Brod by 29.1% annually (264 to 660), UH "Sveti Duh" by 7.5% annually (306 to 382), in the GH Zadar by as much as 70.5% annually (105 to 430), and in the GH Dubrovnik by 32.4% annually (84 to 232). In Croatia overall, the percentage of complex procedures on two or more vessels was 9.7%. It was highest in the UHC Rijeka (18.2%) and UH Dubrava (17.1%), followed by the GH Zadar (15.3%), UHC Split (11.0%), and the Magdalena Clinic (10.4%). The UHC Zagreb had a value similar to the national average (10.1%), as did the GH Dubrovnik (8.6%). Lower percentages of complex procedures were present in the UH "Sveti Duh" (7.9%), UHC "Sestre milosrdnice" (6.9%), and the GH Slavonski Brod (6.3%), whereas the lowest rate of complex procedures was found in the UHC Osijek (3.5%) and the UH Merkur (1.7%). With such advancements in coronary interventions and once the introduction of a registry of coronary interventions and certificates for centers and staff is completed, the next step in Croatia should be the introduction of a plethora of new procedures in patients with acquired or congenital structural heart diseases that are currently underdeveloped.

KLJUČNE RIJEČI: Hrvatska, koronarna angiografija, perkutane koronarne intervencije.

KEYWORDS: Croatia, coronary angiography, percutaneous coronary interventions.

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***ADDRESS FOR CORRESPONDENCE:** Josip Lukenda, Klinička bolnica "Sveti Duh", Sveti Duh 64, HR-10000 Zagreb, Croatia.

Phone: +385-1-3712-111 / E-mail: lukendaj@hotmail.com

ORCID: Josip Lukenda, <http://orcid.org/0000-0003-2740-1464> · Boris Starčević, <http://orcid.org/0000-0002-3090-2772>

Edvard Galić, <http://orcid.org/0000-0002-5707-0961> · Tomislav Krčmar, <http://orcid.org/0000-0003-4689-1673>

Zrinka Biloglav, <http://orcid.org/0000-0002-3245-001X>

Uvod

Analiza stopa perkutanih koronarnih intervencija (PCI) među temeljnim je odrednicama procjene stupnja razvoja kardiologije. Osim praćenja populacijskih i bolničkih epidemioloških podataka o kardiovaskularnim bolestima, ta je analiza temelj za planiranje materijalnih i ljudskih resursa u kardiologiji i zdravstvenom sustavu općenito.

Prijašnji podatci upućuju na znatan napredak intervencijske kardiologije u Republici Hrvatskoj (RH) u posljednjim dvama desetljećima. Tako je, primjerice, stopa PCI-ja 2010. godine iznosila 2102 na milijun stanovnika, što je više nego u zemljama članicama OECD-a (1808) ili EU21 (1910).^{1,2} Od 2010. do 2014. godine u 13 kardioloških intervencijskih centara u RH ukupni godišnji prosjek PCI-ja bio je 9494. Najveći udio intervencija imala je privatna Klinika Magdalena (18,6 %), a slijede ustanove u državnome vlasništvu: Klinički bolnički centar (KBC) Zagreb (13,8 %), KBC Rijeka (11,9 %) i Klinička bolnica (KB) Dubrava (11,3 %), dok preostalih osam centara pojedinačno ne prelazi 10 % intervencija.

Prema volumenu intervencija u velike centre ubrajamo sljedećih sedam (54 %): Kliniku Magdalena, KBC Zagreb, KB Dubrava, KBC Sestre milosrdnice, KBC Rijeka, KBC Split i KBC Osijek. U srednje velike centre ubrajamo sljedeća četiri (30,7 %): Kliničku bolnicu (KB) Merkur, Opću bolnicu (OB) Slavonski Brod, KB Sveti Duh, OB Zadar, kao i OB Dubrovnik, dok su se u OB Karlovac radili samo dijagnostički postupci.¹

Svrha je ovoga rada bila na temelju raspoloživih podataka Hrvatskog zavoda za zdravstveno osiguranje (HZZO) analizirati broj PCI-ja u intervencijskim centrima od 2010. do 2014. godine i procijeniti njihov stupanj složenosti. Riječ je o preliminarnom istraživanju jer je u pripremi Hrvatski registar kardioloških intervencija, koji će, osim preciznih brojčanih podataka, sadržavati međunarodno usporedive pokazatelje uspješnosti i složenosti intervencija.

Materijali i metode

Prikupljeni su podatci o broju PCI-ja prema računima za bolničko liječenje HZZO-a od 2010. do 2014. godine. Metodologija istraživanja, ograničenja te kriteriji razvrstavanja centara prema godišnjem broju PCI-ja u velike (više od 600) i srednje velike centre (od 200 do 600) opisani su prije.¹ Za potrebe ovoga rada svrstavanje u velike i srednje velike centre temeljilo se na prosječnome godišnjem broju intervencija od 2010. do 2014. godine ili na ispunjenju tih kriterija u posljednjim dvjema analiziranim godinama.

Pri analizi stupnja složenosti PCI-ja pod pojmom složenih zahvata razumijevani su zahvati šifrirani prema HZZO-u kao:

Introduction

Analyzing the rate of percutaneous coronary interventions (PCI) is one of the fundamental determinants in the assessment of the level of cardiologic development. In addition to collection of epidemiological data on cardiovascular diseases on the population and hospital levels, this analysis is the basis for planning the allocation of material and human resources in cardiology and the health care system in general.

Past data indicate significant progress in interventional cardiology in the Republic of Croatia (RC) over the last two decades. For instance, the PCI rate in 2010 was 2,102 per million inhabitants, which is more than an average in OECD member countries (1,808) or EU21 countries (1,910).^{1,2} In the period from 2010 to 2014, the total annual PCI average in 13 interventional cardiology centers in the RC was 9,494. The private Magdalena Clinic performed the highest number of PCI procedures among these centers (18.6%), followed by state-owned institutions: University Hospital Centre (UHC) Zagreb (13.8%), UHC Rijeka (11.9%), and University Hospital (UH) Dubrava (11.3%), whereas none of the remaining eight centers individually performed more than 10% of total procedures.

According to intervention volume, the following seven (54%) are classified as high-volume centers: Magdalena Clinic, UHC Zagreb, UH Dubrava, UHC "Sestre milosrdnice", UHC Rijeka, UHC Split, and UHC Osijek. Medium-volume centers group consists of the following four (30.7%): UH Merkur, General Hospital (GH) Slavonski Brod, UH "Sveti Duh", GH Zadar, and GH Dubrovnik, while the GH Karlovac performed only diagnostic procedures.¹

The aim of this study was to analyze the number of PCI procedures in interventional centers in the period from 2010 to 2014 and assess their complexity, based on data from the Croatian Health Insurance Fund (CHIF). This is only a preliminary study, since the Croatian Registry of Cardiologic Interventions is currently being prepared and will, in addition to precise numerical data, contain internationally comparable indicators of performance and intervention complexity.

Materials and Methods

Data on the number of PCI procedures were gathered according to the CHIF claims for hospital treatment from 2010 to 2014. The research methodology, study limitations, and criteria for center classification based on annual PCI procedures into high-volume (more than 600) and medium-volume (from 200 to 600) centers have been previously described.¹ In this study, we based the classification into high-volume and medium-volume centers on the average annual number of inter-

perkutana transluminalna angioplastika balonom (PTCA) dviju ili više koronarnih arterija (35305-00) i perkutano ume-tanje dvaju ili više transluminalnih stentova u više koronarnih arterija (35310-02). Takva razdioba složenosti koronarnih intervencija već je prije primjenjivana i rabi se u Nacionalnom registru Sjedinjenih Američkih Država (*CathPCI Registry*).³ Pri prikazu podataka primijenjena je deskriptivna statistika uključivo prosječni godišnji rast ili pad broja PCI-ja u odnosu na prethodnu godinu u promatranom razdoblju.

Rezultati

Od 2010. do 2014. godine sedam hrvatskih centara ispunjavaju kriterije velikoga centra: Klinika Magdalena, KBC Zagreb, KBC Rijeka, KB Dubrava, KBC Sestre milosrdnice, KBC Split, kao i KBC Osijek, koji je samo 2011. godine imao nešto manji broj PCI-ja (n = 526) (**slika 1**).

Tri su centra prosječno kao i svake analizirane godine imala srednje velik broj PCI-ja: KB Merkur, OB Slavovski Brod i KB Sveti Duh. OB Zadar imala je prosječno te nakon 2012. godine više od 200 zahvata godišnje, a OB Dubrovnik od 2013. godine (**slika 1**).

Klinika Magdalena svake je godine obavila najveći broj PCI-ja, uz prosječni godišnji porast od 6,2%. Među velikim centrima prosječni godišnji porast bilježe i KBC Rijeka (15,8%), KBC Osijek (12,3%) i KBC Split (6,7%), dok je smanjenje broja PCI-ja zabilježeno u KBC-u Zagreb (1,8%) i KB-u Dubrava (5,7%). KBC Sestara milosrdnica imao je najizrazitije smanjenje broja PCI-ja 2014. godine, ali ipak zabilježen je prosječni godišnji porast u promatranom razdoblju od 2,3%.

Relativan omjer PCI-ja u usporedbi s prethodnom godinom u velikim centrima prikazan je na **slici 2**. Svi centri 2012. godine bilježe porast, osim u KBC-u Rijeka. U 2013. godini omjeri su stabilni (92 – 117%), osim smanjenja omjera u KBC-a Sestre milosrdnice (-12%). U 2014. godini najuočljiviji je porast u

ventions from 2010 to 2014 or on the fulfillment of these criteria during the last two years of the study period.

When analyzing the complexity of PCI procedures, complex procedures were considered to be those under the following CHIF codes: percutaneous transluminal coronary angioplasty (PTCA) on two or more coronary arteries (CHIF code 35305-00) and percutaneous implantation of 2 or more transluminal stents into multiple coronary arteries (CHIF code 35310-02). This classification of complexity for coronary interventions has already been applied previously and is used in the National Cardiovascular Data Registry of the United States of America (the CathPCI Registry).³ Descriptive statistics were used to display the data, and also the average annual change, increase or decrease in numbers of PCI procedures compared to the previous year during the observed period.

Results

From 2010 to 2014, seven Croatian centers fulfilled the classification criteria for high-volume centers: Magdalena Clinic, UHC Zagreb, UHC Rijeka, UH Dubrava, UHC "Sestre milosrdnice", UHC Split, and UHC Osijek, where the number of PCI procedures was slightly below the high-volume threshold only in 2011 (n=526) (**Figure 1**).

Three centers had a medium number of PCI procedures both annually and on average: UH Merkur, GH Slavovski Brod, and UH "Sveti Duh". The GH Zadar had more than 200 procedures annually on average and after 2012, whereas the GH Dubrovnik had more than 200 procedures annually since 2013 (**Figure 1**).

The Magdalena Clinic had the highest number of PCI procedures performed in all years, with an average annual increase of 6.2%. Of the high-volume centers, an average annual increase in PCI numbers was noted in the UHC Rijeka (15.8%), the UHC Osijek (12.3%), and the UHC Split (6.7%), whereas an average annual decrease in the number of PCI procedures

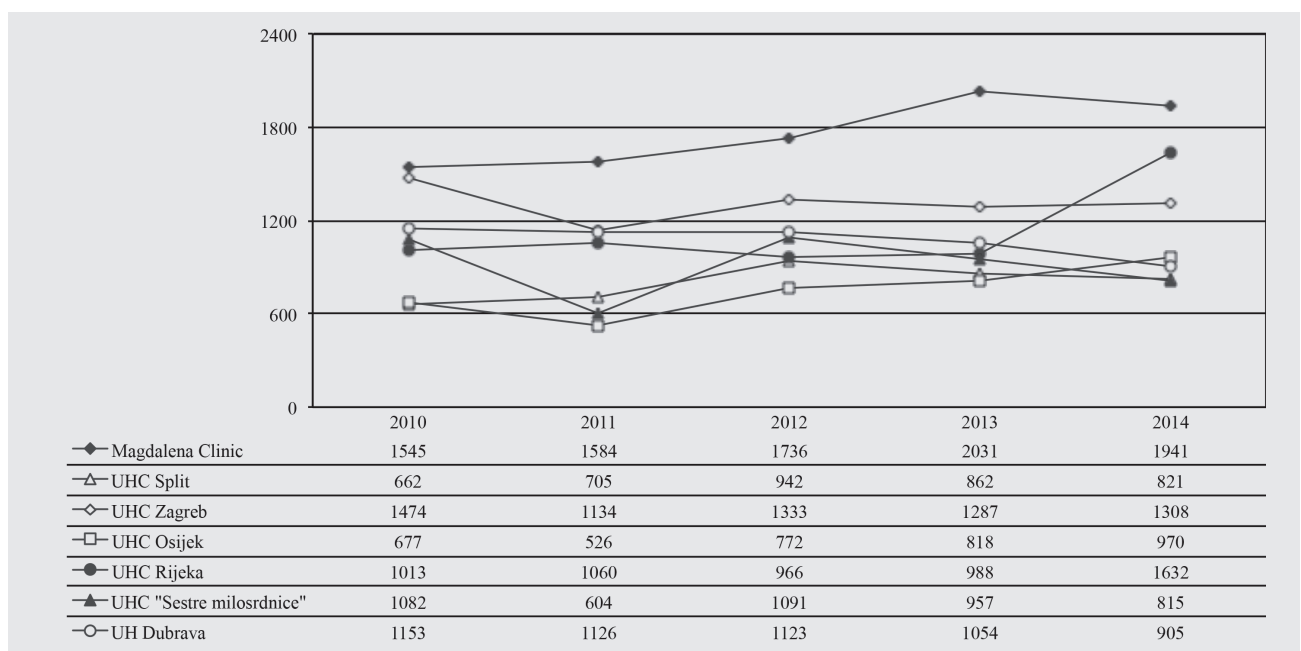


FIGURE 1. Percutaneous coronary interventions (PCI) in seven Croatian high-volume PCI centers in 2010–2014.

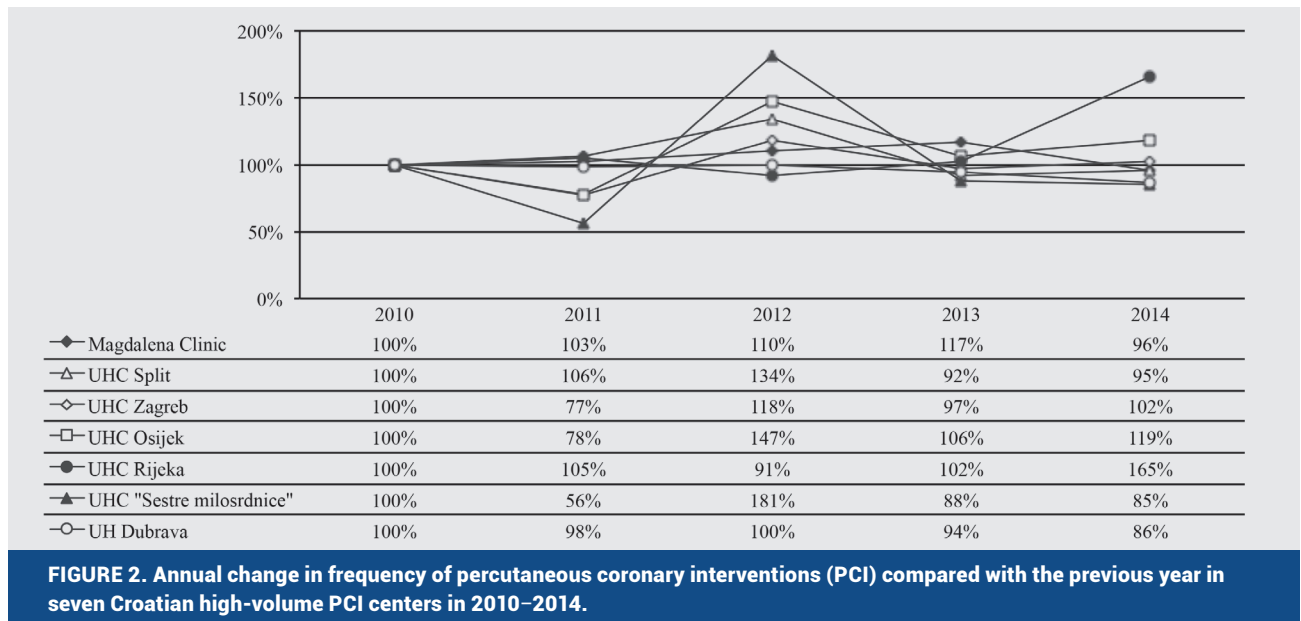


FIGURE 2. Annual change in frequency of percutaneous coronary interventions (PCI) compared with the previous year in seven Croatian high-volume PCI centers in 2010–2014.

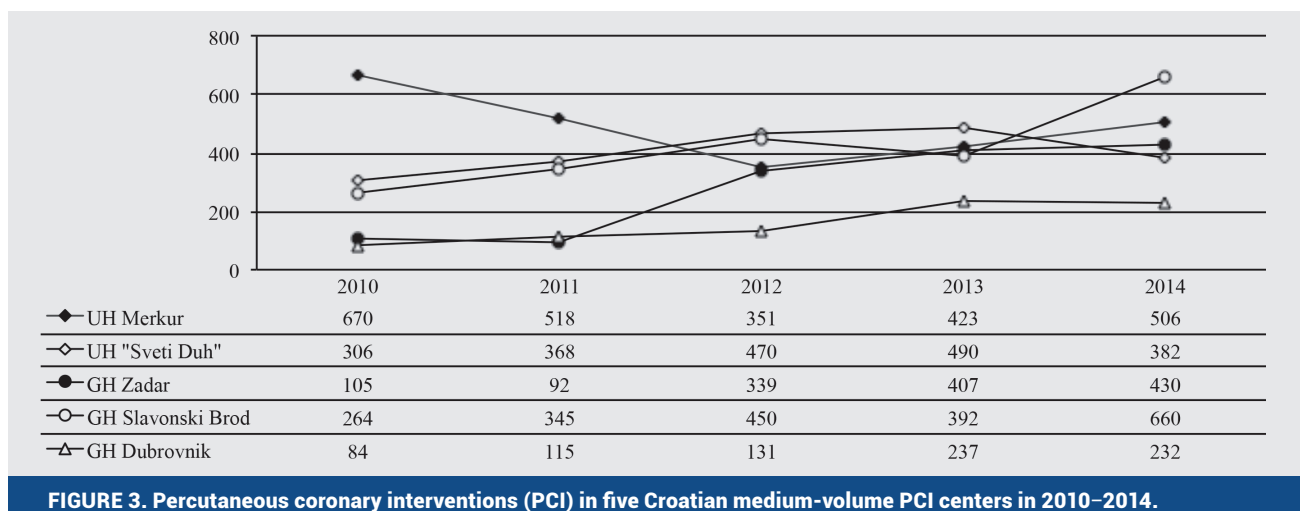


FIGURE 3. Percutaneous coronary interventions (PCI) in five Croatian medium-volume PCI centers in 2010–2014.

KBC-u Rijeka od 65 %, kao i daljnji pad u KBC-u Sestre milosrdnice (-15 %), ali i u KB Dubrava (-14 %).

Među srednje velikim centrima najveći godišnji broj PCI-ja na početku razdoblja imao je KB Merkur, i to na razini velikoga centra (n = 670), međutim, u toj skupini taj centar jedini bilježi prosječno godišnje smanjenje broja PCI-ja od 3,7 %. U svim drugim centrima bilježi se prosječni godišnji porast, u OB-u Zadar najviše u zemlji, za 75 % a 2012. godine broj intervencija prelazi 200. U OB-u Dubrovnik prosječni godišnji porast bio je 32,4 %, a prosječan godišnji broj PCI-ja tijekom razdoblja bio je, doduše, 160, ali posljednje dvije godine također prelazi 200 zahvata godišnje, prosječno 235. U OB-u Slavonski Brod prosječni godišnji porast bio je 29,1 %, a u KB-u Sveti Duh 7,5 %. Štoviše, KB Sveti Duh 2012. i 2013. godine imala je najveći broj PCI-ja u skupini, no slijedi znatan pad sljedeće, 2014. godine (**slike 3 i 5**).

Na **slici 4** prikazan je relativan omjer PCI-ja u usporedbi s prethodnom godinom u srednje velikim centrima. Zamjetan je izrazit porast u OB-u Zadar 2012. godine, u OB-u Dubrovnik 2013. godine i u OB-u Slavonski Brod 2014. godine.

was noted in the UHC Zagreb (1.8%) and the UH Dubrava (5.7%). The UHC "Sestre milosrdnice" had sharp decrease in PCI procedures performed in 2014, but the hospital experienced the average annual increase of 2,3% over observed period.

The relative ratio of PCI procedures in comparison with the previous year in high-volume centers is shown in **Figure 2**. All centers saw an increase in 2012, except the UHC Rijeka. The ratios were stable in 2013 (92-117%) except in the UHC "Sestre milosrdnice" (-12%). In 2014, the sharpest increase was seen in the UHC Rijeka, 65%, as well as a further decrease in the UHC "Sestre milosrdnice" (-15%) and decrease in the UH Dubrava (-14%).

Among the medium-volume centers, the UH Merkur had the highest number of annual PCI procedures at the start of the study period, at the level of a high-volume center (n=670); however, this center was the only one experiencing an average annual decrease in PCI procedures (3.7%). The number of interventions increased in all other centers. In the GH Zadar the average annual increase was 75%, and in 2012 the number

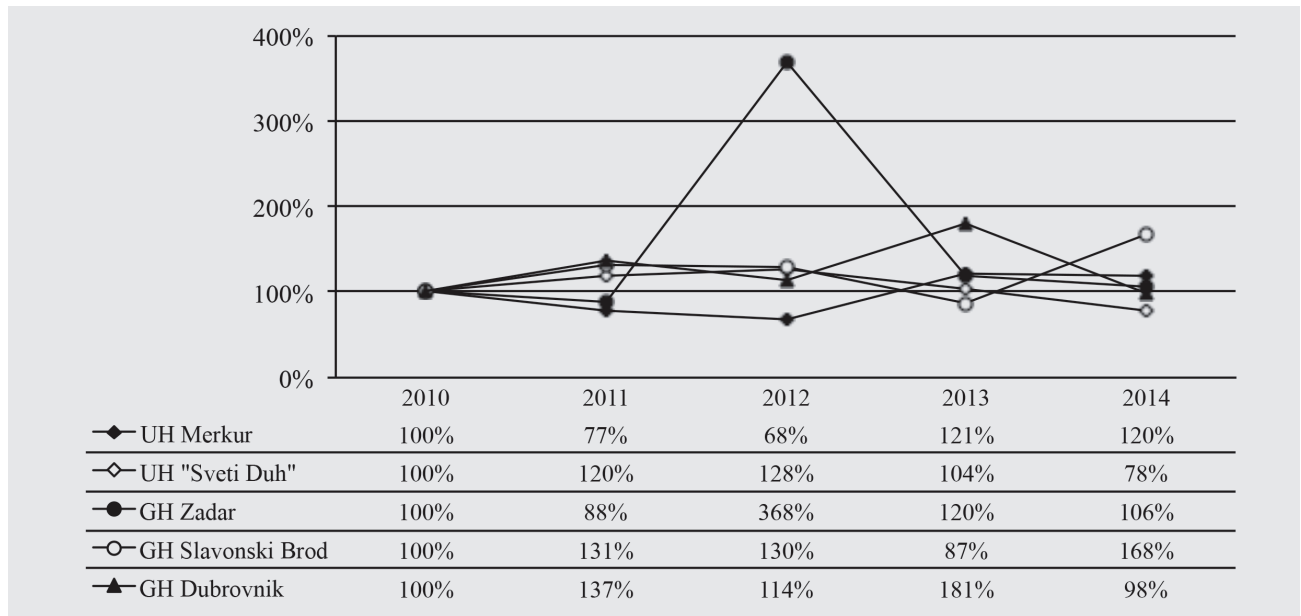


FIGURE 4. Annual change in frequency of percutaneous coronary interventions (PCI) compared with the previous year in five Croatian medium-volume PCI centers in 2010–2014.

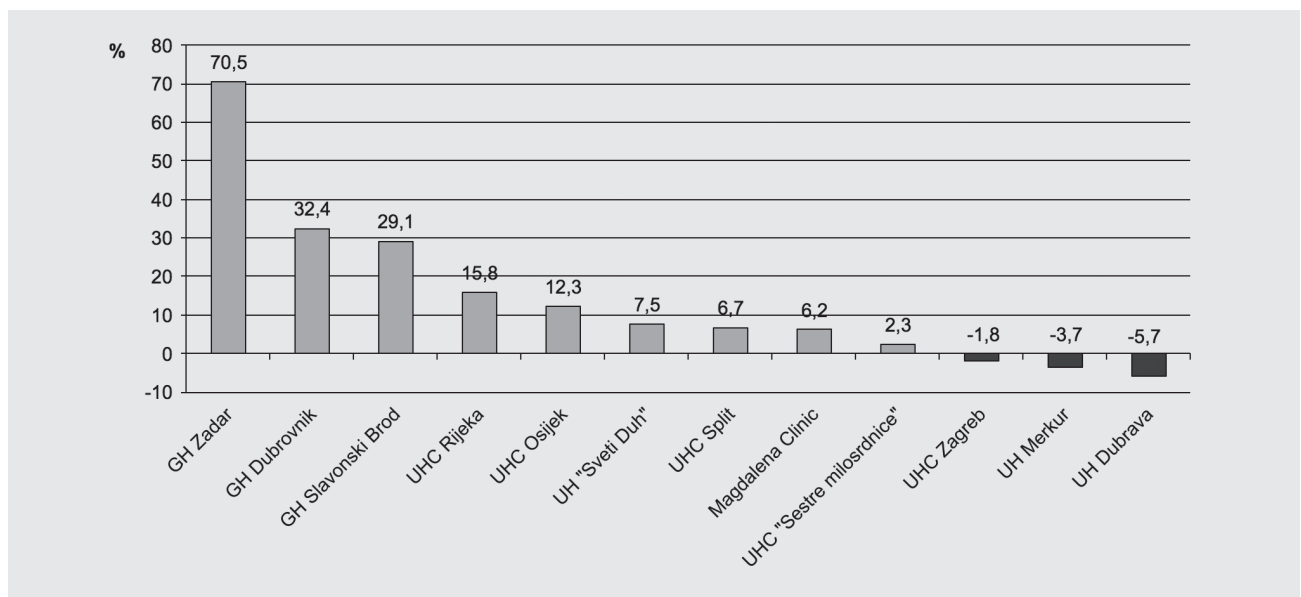


FIGURE 5. Average annual change in frequency of percutaneous coronary interventions (PCI) in Croatian PCI centers in 2010–2014.

Prosječan udio složenih PCI-ja od 2010. do 2014. godine u RH bio je 9,7 %. Najviše su takvih intervencija imali KBC Rijeka (18,2 %) i KB Dubrava (17,1 %). Udjele više od prosjeka bilježe OB Zadar (15,3 %), KBC Split (11,0 %) i Klinika Magdalena (10,4 %). Udjele slične prosjeku imali su KBC Zagreb (10,1 %) i OB Dubrovnik (8,6 %), dok su niže udjele imali KB Sveti Duh (7,9 %), KBC Sestre milosrdnice (6,9 %) i OB Slavonski Brod (6,3 %). Najniže udjele složenih zahvata imali su KBC Osijek (3,5 %) i KB Merkur (1,7 %) (slika 6).

U skupini velikih centara udio složenih PCI-ja u analiziranom je razdoblju rastao je u KBC-u Osijek, ostao sličan u KBC-

of procedures performed was over 200. In the GH Dubrovnik the average annual increase was 32%, and although the annual average of PCI procedures during the study period was only 160, it was higher than 200 for the last two studied years with an average of 235. The GH Slavonski Brod saw a 29.1% increase, while the UH "Sveti Duh" had an average annual increase of 7.5%. Moreover, the UH "Sveti Duh" had the highest number of PCI procedures in the medium-volume group in 2012 and 2013, but a sharp decrease in the next year, 2014 (Figures 3 and 5).

Figure 4 shows the relative ratio of PCI procedures in comparison with the previous year in medium-volume centers.

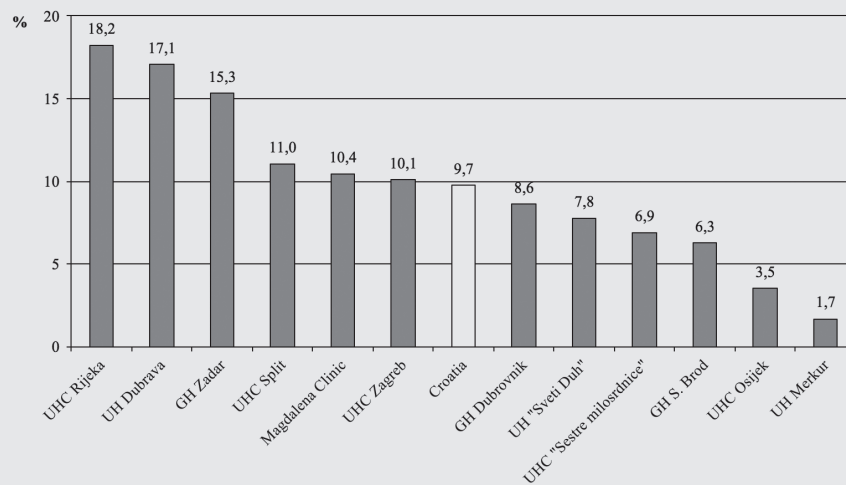


FIGURE 6. The frequency of percutaneous coronary interventions (PCI) on two or more vessels in Croatian PCI centers in 2010–2014.

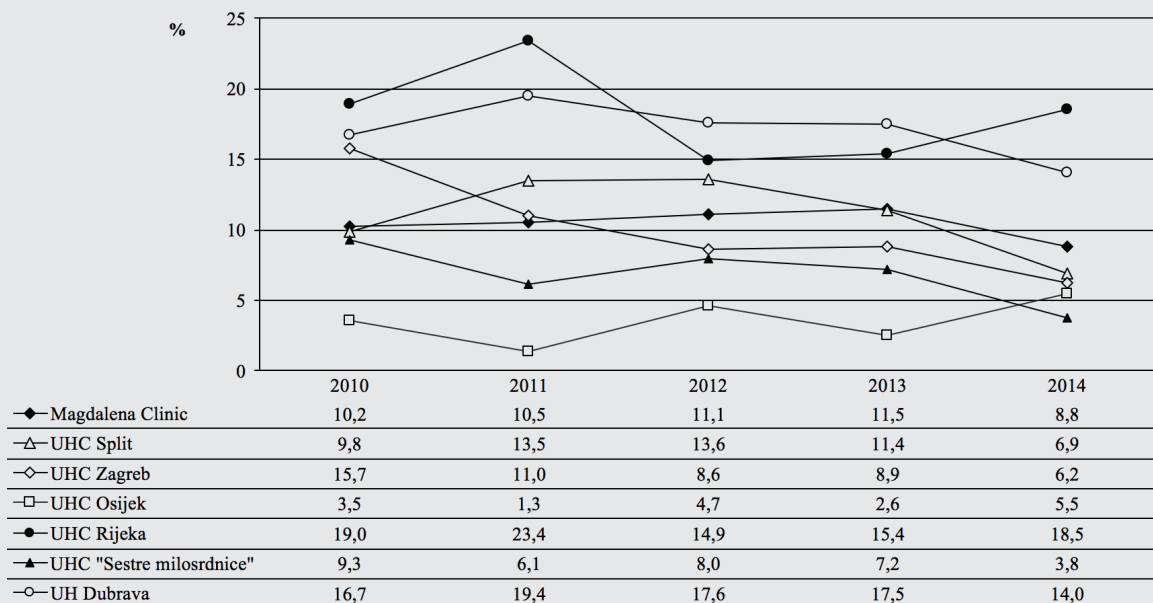


FIGURE 7. The frequency of percutaneous coronary interventions (PCI) on two or more vessels in Croatian high-volume PCI centers in 2010–2014.

u Rijeka i donekle u KB-u Dubrava, a smanjio se u KBC-u Split, dok se više nego prepolovio u KBC-u Zagreb i KBC-u Sestre milosrdnice (slika 7).

Udio složenih PCI-ja u srednje velikim centrima prikazan je na slici 8. Visok udio takvih zahvata imala je OB Zadar 2010. i 2011. godine, s padom u sljedećim godinama. Porast bilježi OB Slavonski Brod, dok je udio u OB-u Dubrovnik ostao sličan. Unatoč niskom ukupnom udjelu, KB Merkur ipak bilježi blagi porast, a KB Sveti Duh, kao i u slučaju ukupnoga broja zahvata, ima velike godišnje oscilacije i na kraju analiziranoga razdoblja najmanji udio složenih zahvata u zemlji od samo 1,8 %.

There was a notable increase in the GH Zadar in 2012, in the GH Dubrovnik in 2013, and the GH Slavonski Brod in 2014.

The average percentage of complex PCI procedures in the RC from 2010 to 2014 was 9.7%. These complex interventions were most common in the UHC Rijeka (18.2%) and the UH Dubrava (17.1%). Above-average rates of complex procedures were noted in the GH Zadar (15.3%), the UHC Split (11.0%), and the Magdalena Clinic (10.4%), whereas they were similar to average in UHC Zagreb (10.1%) and GH Dubrovnik (8.6%) and less common in the UH "Sveti Duh" (7.9%), UHC "Sestre milosrdnice" (6.9%), and GH Slavonski Brod (6.3%). Low rates of complex procedures were found in the UHC Osijek (3.5%) and the UH Merkur (1.7%) (Figure 6).

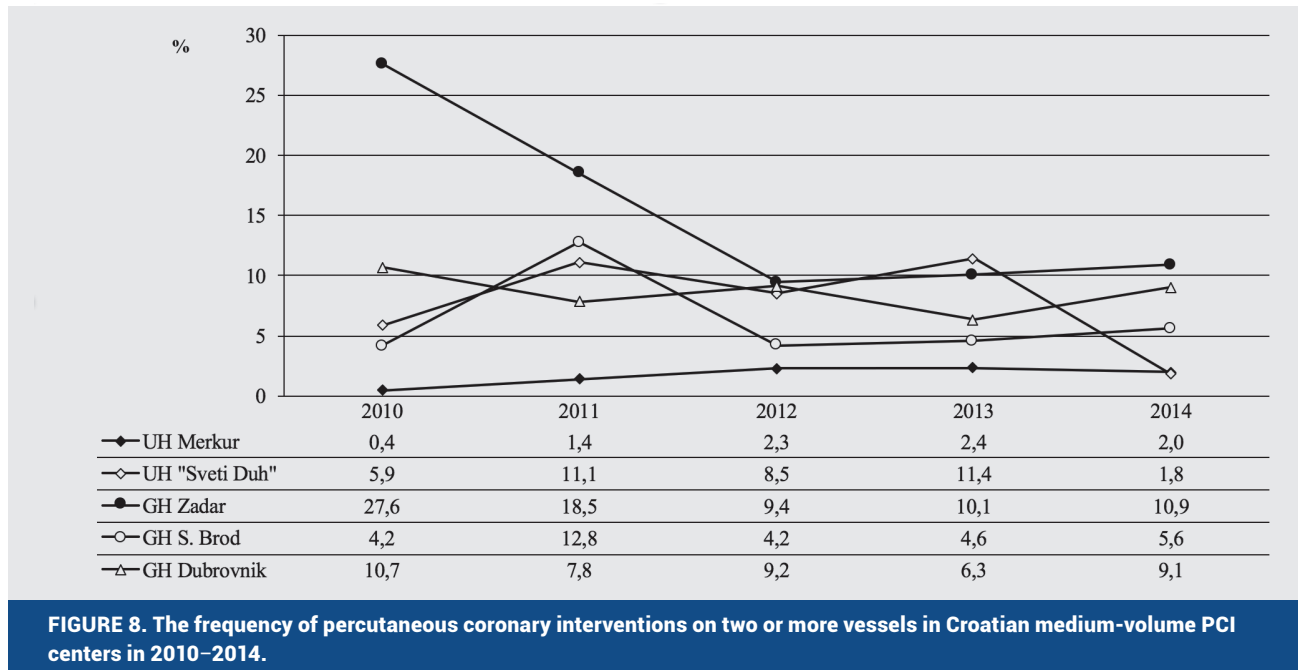


FIGURE 8. The frequency of percutaneous coronary interventions on two or more vessels in Croatian medium-volume PCI centers in 2010–2014.

Rasprava

Intervencijska kardiologija u RH unatrag dva i pol desetljeća izrazito je napredovala, što potvrđuju brojčani pokazatelji. Stopa PCI-ja od 474 na milijun stanovnika 2001. godine bila je dva i pol puta manja od europskoga prosjeka (1267), triput manja nego u Austriji (1494) te manja nego u tada analiziranim tranzicijskim zemljama: Republici Češkoj (1171), Sloveniji (599) i Mađarskoj (522).² Dva desetljeća poslije hrvatska stopa od 2102 PCI-ja na milijun stanovnika nadmašila je prosjek članica OECD-a (1808) i zemalja EU21 (1910). U Europi su te, 2010. godine više stope zabilježene samo u Njemačkoj, Belgiji, Austriji i Norveškoj. U analiziranom razdoblju, od 2010. do 2014. godine stopa PCI-ja porasla je za daljnjih 15 % i iznosila je u 2014. godini 2466 na milijun stanovnika.¹

U RH većinu centara, čak njih sedam (54 %), ubrajamo u velike, a pet (38 %) u srednje velike centre.¹ Najveći broj zahvata na teret HZZO-a u svim analiziranim godinama imala je privatna Klinika Magdalena, prosječno 1767 PCI-ja godišnje, s udjelom 18,6 % u RH. Tijekom analiziranog razdoblja zamjetna je decentralizacija razvoja intervencijske kardiologije. Tako, primjerice, obalni centri bilježe pozitivan trend, KBC Rijeka za prosječno 15,8 % godišnje (+619 PCI-ja godišnje), a KBC Split za 6,7 % (+159 PCI-ja godišnje). U Slavoniji se također bilježi porast, u KBC-u Osijek za prosječno 12,3 % godišnje (+295 PCI-ja godišnje), a u OB-u SlavonSKI Bod za prosječno 29,1 % (+396 PCI-ja godišnje). Međutim, tri velike zagrebačke bolnice bilježe negativan trend i prosječni godišnji pad broja PCI-ja: veliki PCI centri KBC Zagreb za 1,8 % (-166 PCI-ja godišnje) i KB Dubrava za 5,7 % (-247 PCI-ja godišnje), kao i srednje veliki PCI centar KB Merkur s padom od 3,7 % (-164 PCI-ja godišnje).

Kad uspoređujemo ukupan godišnji broj PCI-ja u sedam velikih centara s obzirom na prethodnu godinu zamjetan je ukupni pad u tim centrima od 11 % u 2011. godini, nakon čega slijedi 26 %-tni porast 2012. godine. Nakon toga slijedi razdoblje relativno stabilnog broja PCI-ja tih centara. Međutim, stabilan prosječan broj velikih centara uključuje velike oscilacije

In the high-volume center group, the rate of complex PCI procedures grew over the study period in the UHC Osijek, remained similar in the UHC Rijeka and to an extent in the UH Dubrava, and went down in the UHC Split as well as dropping by more than half in the UHC Zagreb and UHC "Sestre milosrdnice" (Figure 7).

The percentage of complex PCIs in medium-volume centers is shown in Figure 8. A high ratio of such procedures was noted in the GH Zadar in 2010 and 2011, with a drop in subsequent years. An increase was seen in the GH SlavonSKI Brod, whereas the rate remained similar in the GH Dubrovnik. Despite a low overall ratio of complex procedures, the UH Merkur still showed a small overall increase, whereas the UH "Sveti Duh", as with the total number of procedures, had significant yearly oscillations and experienced the lowest ratio of complex procedures in the country at the end of the study period, of only 1.8%.

Discussion

Interventional cardiology in the RC experienced significant progress over the last two and a half decades, which is supported by numerical indicators. The PCI rate of 474 per million inhabitants in 2001 was two and a half times lower than the European average (1,267), three times lower than in Austria (1,494), and lower than in the transitional countries analyzed at the time: the Czech Republic (1,171), Slovenia (599), and Hungary (522).² Two decades later, the Croatian PCI rate of 2,102 procedures per million inhabitants has surpassed the OECD member average (1,808) and that of EU21 countries (1,910). In 2010, higher rates in Europe were noted only in Germany, Belgium, Austria, and Norway. In the period analyzed in this study, 2010 to 2014, the PCI rate grew by a further 15%, amounting to 2,466 per million inhabitants in 2014.¹

Most centers in Croatia, as many as seven (54%), are classified as high-volume centers and five (38%) as medium-volume centers.¹ The private Magdalena Clinic had the largest number of procedures financed by CHIF in all analyzed ye-

nekih centara na godišnjoj razini. Primjerice, smanjenje od 44 % pa ponovni porast od 81 % u KBC-u Sestara milosrdnica ili nagli porast u KBC-u Rijeka za 65 % u 2014. godini. Razloge takvih velikih godišnjih oscilacija, kako pozitivnih, tako i negativnih, treba tražiti na lokalnoj razini. Mogla bi biti riječ o preraspodjeli sredstava unutar bolnica ili raspoređivanju invazivnih kardiologa na druge poslove, primjerice rad u općim kardiološkim ambulancama ili laboratorijima za neinvazivne pretrage, radi skraćivanja listi čekanja sukladno politici Ministarstva zdravlja. Također, ostaje procijeniti utjecaje uvođenja nacionalnog natječaja za javnu nabavu intervencijskog materijala, kao i promjene bolničkih uprava tijekom sanacije te njihovo stajalište prema intervencijskoj kardiologiji.

Od ukupno 47470 PCI-ja u RH od 2010. do 2014. godine, njih 18,5 % ili 8767 učinjeno je u pet srednje velikih centara. Ukupan volumen svih srednje velikih centara sličan je volumenu privatne Klinike Magdalena. Međutim, unatoč takvom udjelu, srednje veliki centri imaju iznimnu važnost u Hrvatskoj mreži za primarnu PCI pri pravodobnom zbrinjavanju bolesnika s akutnim koronarnim sindromom. Naime, u toj je mreži u posljednjih desetak godina zbrinuto više od 15000 bolesnika s akutnim infarktom miokarda s elevacijom ST segmenta (STEMI). Tijekom spomenutoga razdoblja u mrežu se uključivalo sve više centara i danas kardiolozi iz jedanaest PCI centara rade 24 sata / 7 dana, prosječno skrbe za 384000 stanovnika po centru i zbrinu 540 – 550 bolesnika s STEMI-jem na milijun stanovnika godišnje.⁴

U Hrvatsku mrežu za primarnu PCI nije uključen KB Merkur, koji je svrstan u srednje velike centre, premda je na početku razdoblja ispunjavao kriterij velikoga centra s 670 PCI-ja godišnje. Međutim, među srednje velikim centrima samo je u tom centru zabilježeno prosječno godišnje smanjenje broja PCI-ja (-3,7 %), dok ostali centri bilježe prosječan godišnji rast, u OB Zadar najviši u RH (70,5 %), a slijede OB Dubrovnik (32,4 %) i OB Slavonski Brod (29,1 %), koji se 2014. godine sa 660 zahvata približio kriteriju velikoga centra. Ostaje istražiti razloge smanjenja broja intervencija u KB Merkur i povećanja broja u drugim srednje velikim centrima, kao i razloge izrazitih fluktuacija u nekim centrima, primjerice u KB-u Sveti Duh, koji je 2012. i 2013. godine imao najveći broj PCI-ja u skupini, a 2014. godine taj se broj izrazito smanjio. Zamjetan je i izrazit porast broja PCI-ja u odnosu na prethodnu godinu u OB-u Zadar 2012. godine, u OB-u Dubrovnik 2013. godine i OB-u Slavonski Brod 2014. godine. Uz lokalnu bolničku politiku, prema usmenim kontaktima, porast je u nekim centrima djelomice objašnjiv dolaskom mlađih kolega sa specijalizacije, u drugim zapošljavanjem iskusnih kardiologa iz drugih centara te tehničkim kompletiranjem pojedinih laboratorija.

Važni parametri u budućemu nacionalnom registru kardioloških intervencija, uz precizan broj provedenih procedura, svakako će biti pokazatelji uspješnosti i kompleksnosti zahvata, što će omogućiti usporedbu s međunarodnim podacima, precizno vrednovanje rada te poboljšanje kliničke prakse. Sada složenost učinjenih PCI-ja možemo prosuditi isključivo po jednom kriteriju – udjelu istodobnih zahvata na dvjema ili više koronarnih arterija. Taj je kriterij poznat u literaturi te ga, osim drugih kriterija primjenjuje, primjerice, i nacionalni registar u Sjedinjenim Američkim Državama (*CathPCI Registry*).³ Usporedbe radi, udio takvih zahvata u SAD-u bio je 2010. godine 13,5 %, dok je u RH te godine učinjeno 11,1 % složenih zahvata, uz prosjek od 9,7 %

ars, at an average of 1,767 PCI procedures annually and 18.6% of total procedures in the RC. During the study period, there was notable decentralization in the development of interventional cardiology. For instance, coastal centers showed a positive trend: UHC Rijeka with average annual increase of 15.8% (+619 PCIs) and UHC Split with average annual increase of 6.7% (+159 PCIs). The Slavonia region also saw an increase in PCI rates, in the UHC Osijek with average annual increase of 12.3% (+295 PCIs) and in the GH Slavonski Brod with 29.1% (+396 PCIs). However, three large hospitals in Zagreb had a negative trend and a reduction in the number of PCI procedures: the UHC Zagreb with average annual decrease of 1.8% (-166 PCIs), the UH Dubrava with decrease of 5.7% (-247 PCIs), as well as medium-volume center the UH Merkur with the average annual decrease of 3.7% (-164 PCIs).

Comparing the total annual number of PCI procedures in the high-volume centers with the previous year, there is a notable drop in PCI procedures of 11% in 2011, followed by a 26% increase in 2012. This is followed by a period of relatively stable PCI numbers in these centers. However, stable average numbers in the high-volume centers include significant yearly oscillations in some centers on an annual basis. For instance, the UHC "Sestre milosrdnice" saw a 44% decrease followed by an 81% increase, and the UHC Rijeka had a 65% increase in 2014. The reasons for these large yearly oscillations, both positive and negative, are likely to be found at the local level. The oscillations could be the result of the redistribution of resources within hospitals or the allocation of invasive cardiologists to other tasks, for instance work in general cardiologic outpatient offices or laboratories for non-invasive testing, in order to reduce the waiting lists in line with the policies of the Ministry of Health. Furthermore, the influence of the introduction of a national tender for consumables for cardiologic interventions have yet to be assessed, as well as changes in hospital administration during the process of hospital financial recovery and their position towards interventional cardiology.

Of the total 47,470 PCI procedures in the RC from 2010 to 2014, 18.5% i.e. 8,767 were performed in five medium-volume centers. The total volume of all medium-volume centers is comparable to the volume of the private Magdalena Clinic. However, despite this ratio, medium-volume centers have an extremely important place in the Croatian Primary PCI Network in the treatment of patients with acute coronary syndrome. Over the last decade, more than 15,000 patients with ST-segment elevation myocardial infarction (STEMI) have been treated in this network. More and more centers joined the network over this period, and today cardiologists in eleven PCI centers work 24/7, caring for on average 384,000 inhabitants per center and annually treating and managing 540-550 patients with STEMI per million inhabitants.⁴

The Croatian Primary PCI Network does not include the UH Merkur, which is classified as a medium-volume center, despite the fact that at the start of the study period it fulfilled the criterion for a high-volume center with 670 PCI annually. However, this was the only medium-volume center with an average annual decrease in PCI procedures (of 3.7%), while all other centers showed average annual increase, highest in the GH Zadar (70.5%), followed by the GH Dubrovnik (32.4%) and GH Slavonski Brod (29.1%), which approached the criterion for a high-volume center with 660 procedures in 2014. The reasons for the reduction in the number of interventions in the CH Merkur and the

u petogodišnjem razdoblju. Najveći prosječni udio složenih zahvata među velikim centrima imao je KBC Rijeka (18,2 %), no ipak je više takvih zahvata 2012. i 2013. godine imala KB Dubrava. U srednje velikom centru OB-u Zadar tijekom analiziranoga razdoblja obavljeno je više složenih zahvata od hrvatskoga prosjeka (15,3 %), a na početku razdoblja 2010. godine čak 27,6 %. Neznatno više udjele složenih zahvata od prosjeka imali su Klinika Magdalena (10,4 %) i KBC Zagreb (10,1 %), a neznatno manje OB Dubrovnik (8,6 %). U tom razdoblju u KB-u Merkur uočava se trajno nizak udio složenih zahvata, uz znatno smanjenje ukupnoga broja procedura, a u KBC-u Osijek, unatoč stabilnom trendu povećanja broja procedura, udio složenih zahvata ostao je nizak. Možemo uočiti i drastično smanjenje udjela složenih zahvata u KB-u Sveti Duh, gdje ih je na kraju razdoblja bilo najmanje u zemlji, samo 1,8 %. Možemo pretpostaviti da utjecaj na udjele složenih zahvata u pojedinim centrima imaju, primjerice, stupanj educiranosti kadrova i raspoloživost potrošnoga materijala, no u razgovoru s kolegama nametnulo se i pitanje načina naplate bolničkog liječenja. Naime, neki centri pri pojedinačnim hospitalizacijama stabilnih bolesnika zahvate izvode samo na pojedinačnim žilama, što je povremeno financijski opravdano i povremeno jest u skladu s preporukama Europskoga kardiološkoga društva koje, nakon dijagnostičke procedure, preporučuje konzultaciju kardiološkog i kardiološko-kardiokirurškog tima prije provođenja revaskularizacije. Kako bi se kriteriji za takve zahvate ujednačili i bolesnicima pružila primjerena skrb, potrebno je na razini Radne skupine za intervencijsku kardiologiju donijeti stručnu odluku o takvim zahvatima.

Uvođenje nacionalnog registra kardioloških zahvata bit će kruna ove faze razvoja kardiologije u RH, koja se prema rezultatima u koronarnim intervencijama približila samom europskom vrhu. Daljnji će koraci, zasigurno, uključivati i standardizaciju, koja razumijeva utvrđivanje kriterija i certifikaciju institucija i stručnoga osoblja u laboratorijima. Međutim, kada govorimo o intervencijskoj kardiologiji u svijetu danas, treba istaknuti velik napredak u nizu novih zahvata u bolesnika sa stečenim strukturnim bolestima srca i bolesnika s kongenitalnim bolestima srca u odraslih, koji su, za razliku od koronarnih intervencija ili primjerice transplantacijske medicine, u nas još nedostatan razvijeni. Njihov je popis dugačak (**tablica 1**), a neke zemlje, primjerice SAD, već su utemeljile kriterije za certificiranje edukacijskih centara i stručnjaka za pojedine zahvate.⁵

Ustrojavanje timova za takve zahvate u nas bit će velik izazov ne samo za Hrvatsko kardiološko društvo i Radnu skupinu za intervencijsku kardiologiju nego i za Ministarstvo zdravstva, HZZO i ostale pružatelje zdravstvenih usluga. Važnu ulogu u planiranju imat će financijski resursi, s jedne, te razina kvalitete sveobuhvatne skrbi u pojedinim centrima, s druge strane, uključujući radiologiju, kardiokirurgiju i vaskularnu kirurgiju. Međutim, najvažniji čimbenici u planiranju jesu epidemiološki podatci, koji sada u nas nisu raspoloživi. Stoga ćemo se u početku morati koristiti europskim statistikama a istodobno razvijati vlastite registre za te dvije skupine bolesti. Na temelju tih podataka moći će se procijeniti koje zahvate neće biti razumno i isplativo raditi u nas i bolesnike na takve zahvate slati u druge svjetske centre, primjerice, prema osobnom mišljenju, transkateterska pulmonalna implantacija zalistka (TPVI), dok će za neke zahvate trebati dobro procijeniti imamo li uopće u RH potrebu za razvijanje jednog centra (npr. zatvaranje pulmonalnih vaskularnih malformacija i aortopulmonalnih ko-

increase in the other medium-volume centers are yet to be investigated, as well as the reasons for significant fluctuations in some centers, for instance the UH "Sveti Duh" that had the largest number of PCI procedures in the medium-volume group in 2012 and 2013, only for that number to drop sharply in 2014. There was also a noticeable increase in the number of PCI procedures in comparison with the previous year in 2012 in the GH Zadar, in the GH Dubrovnik in 2013, and in the GH Slavonski Brod in 2014. In addition to local hospital policies, according to personal contacts, this increase can be partially explained in some centers by the arrival of younger colleagues from their cardiology residence and in others by the employment of experienced cardiologists from other centers, and the technical completion of some laboratories.

In addition to a precise count of performed procedures, indicators of performance and intervention complexity will certainly be important parameters in the future national registry of cardiologic interventions, which will allow comparison with international data, precise evaluation of work, and improvement of clinical practice. Currently the complexity of the performed PCI procedures can be estimated solely on a single criterion – the ratio of concurrent procedures on two or more coronary arteries. This criterion is well-established in the literature and is for instance, in addition to other criteria, applied in the National Cardiovascular Data Registry of the United States of America (the CathPCI Registry).³ For the sake of comparison, the percentage of such procedures in 2010 in the US was 13.5%, whereas the percentage of complex procedures in the RC in the same year was 11.1%, with a five-year average of 9.7%. The highest average percentage of complex procedures among the high-volume centers was found in the UHC Rijeka (18.2%), but the UH Dubrava still had a higher percentage of such procedures in 2012 and 2013. During the study period, more complex procedures than the national average were performed in the GH Zadar (15.3%), and as much as 27.6% at the start of the period. Slightly higher-than-average complex procedure percentages were noted in the Magdalena Clinic (10.4%) and the UHC Zagreb (10.1%), while they were slightly lower than average in the GH Dubrovnik (8.6%). In this period, the UH Merkur saw a constant low percentage of complex procedures with a significant drop in total procedure numbers, while in the UHC Osijek, despite a stable trend of increasing procedure numbers, the percentage of complex procedures remained low. We can also note a drastic reduction in the percentage of complex procedures in the UH "Sveti Duh", which had the lowest percentage in the country at the end of the study period, only 1.8%. We can assume that the percentages of complex procedures in individual centers are influenced by, for instance, the level of staff education and availability of consumable resources, but conversations with colleagues also raised the question of charging for hospital treatment: some centers perform procedures on only individual vessels in separated hospitalisations, which is sometimes financially justified, and sometimes it is in line with the recommendations of the European Society of Cardiology, which recommends consultation of the cardiology and cardiology-surgery team after the diagnostic procedure and before the revascularization procedure. In order to equalize the criteria for such procedures and assure adequate care for these patients, it is necessary to reach a consensus on these procedures at the level of the Working Group on Interventional Cardiology.

TABLE 1. Common interventional procedures in adult structural and congenital heart disease.

Interventional procedures in acquired structural heart diseases	Interventional procedures in congenital adult heart diseases
Transseptal left heart catheterization	Closure of the patent foramen ovale
Balloon dilatation of the aortic valve and transcatheter aortic valve implantation (TAVI)	Closure of the atrial septal defect
Ventricular septal ablation	Closure of the patent ductus arteriosus
Mitral and tricuspid balloon valvuloplasty	Pulmonary valvuloplasty
Transcatheter mitral valve repair (TMVR) implantation	Closure of ventricular septal defect
Exclusion of left atrial auricule	Closure of coronary fistulas, pulmonary vascular malformations and aorto-pulmonary collaterals
Closure of the postinfarction ventricular septal defect	Angioplasty and stent implantation in the pulmonary artery and its branches and pulmonary veins
Closure of the paravalvular leaks	Angioplasty and stent implantation in aortic coarctation
Closure of ventricular pseudoaneurysm	Angioplasty and stent implantation in interatrial septum and Fontan fenestrations
Closure of the endovascular endoleaks	Transcatheter pulmonary valve implantation (TPVI)
Closure of aortal pseudoaneurysms and interventions on aneurysms (TEVAR, EVAR)	
Balloon pericardiectomy	
Stent implantation in pulmonary veins after atrial fibrillation ablation	

lateralu). Za neke pak zahvate možda će trebati samo jedan centar u zemlji, primjerice za ventrikulsku septalnu ablaciju. Međutim, već sada znatno kasnimo u razvoju nekih od zahvata navedenih u **tablici 1**. U takve zahvate ubrojili bismo balonsku dilataciju aortnog zalistka i transkatetersku implantaciju aortne valvule, transkateterske zahvate na mitralnoj valvuli i izolaciju aurikule lijevog atrija. Stoga bi trebalo žurno odrediti broj potrebnih centara, definirati koji će centri i timovi raditi te zahvate te ih dostatno educirati, opremiti i financirati. Takvim planiranjem na državnoj razini, u koje bi se uključilo Ministarstvo zdravstva, s jedne, i naše stručno društvo, s druge strane, izbjegli bi se gubitak vremena, gubitak resursa i moguća prijepori među centrima, kao i osobne nesuglasice.

The introduction of a national registry of cardiologic procedures will be the crowning achievement of this phase of the development of cardiology in Croatia, which has come close to the very best in Europe in coronary intervention results. Further steps will surely include standardization, which assumes the establishment of criteria and certification of institutions and laboratory staff. In contemporary interventional cardiology at the global level, there has been significant progress in a range of new procedures in patients with acquired structural heart diseases and patients with adult congenital heart disease, which are, as opposed to coronary interventions or transplantation medicine, still underdeveloped in our country. The list of these new procedures is long (**Table 1**), and some countries, such as the USA, established the criteria for the certification of education centers and professional for individual procedures.⁵

Forming teams to conduct these procedures in Croatia will represent a great challenge not only for the Croatian Cardiac Society and the Working Group on Interventional Cardiology, but also for the Ministry of Health, CHIF, and other providers of medical services. A significant role in planning will be taken up by financial resources on the one hand and the quality level of comprehensive care in individual centers on the other, including radiology, cardiac surgery, and vascular surgery. However, the most important factors in planning are epidemiological data, which are currently not available in Croatia. We will thus have to use European statistics at the start while simultaneously developing registries for these two groups of diseases. Based on these data, it will be possible to assess which procedures are not reasonable or cost-effective to perform in our country and send these patients to other centers abroad, such as, as an example and according to our personal opinion, transcatheter pulmonary valve implantation (TPVI), whereas other procedures will require a careful assessment of whether there is even a need to develop a single center for the procedure in the RC (for instance, closure of pulmonary vascular malformations and aortopulmonary collaterals). Other procedures will perhaps require only a single center in the country, for instance ventricular septal ablation. However, we are already significantly lagging in the development of some of the procedures listed in **Table 1**. Such procedures include balloon dilatation of the aortic valve and transcatheter aortic valve implantation, transcatheter mitral valve repair, and the exclusion of left atrial auricle. Thus, determining the number of necessary centers should be a priority, as well as defining which centers and teams will perform these procedures, and providing adequate education, equipment, and funding. Such planning at the state level, including the Ministry of Health on the one hand and our professional society on the other, would avoid loss of time and resources as well as possible controversies among centers and personal disagreements.

LITERATURE

- Lukenda J, Starčević B, Delić Brkljačić D, Biloglav Z. An Analysis of Cardiologic Interventional Procedures in Croatia between 2010 and 2014: Towards the Establishment of a National Registry. *Cardiol Croat.* 2016;11(3-4):142-150. DOI: <http://dx.doi.org/10.15836/ccar2016.142>
- Lukenda J, Kolaric B, Kolcic I, Pazur V, Biloglav Z. Cardiovascular diseases in Croatia and other transitional countries: comparative study of publications, clinical interventions, and burden of disease. *Croat Med J.* 2005;46:865-74. PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/16342338>
- Dehmer GJ, Weaver D, Roe MT, Milford-Beland S, Fitzgerald S, Hermann A, et al. A contemporary view of diagnostic cardiac catheterization and percutaneous coronary intervention in the United States: a report from the CathPCI Registry of the National Cardiovascular Data Registry, 2010 through June 2011. *J Am Coll Cardiol.* 2012;60(20):2017-31. DOI: <http://dx.doi.org/10.1016/j.jacc.2012.08.966>
- Babić Z, Pavlov M. Acute Coronary Syndrome in Croatia. *Cardiol Croat.* 2016;11(8):307-313. DOI: <http://dx.doi.org/10.15836/ccar2016.307>
- Ruiz CE, Feldman TE, Hijazi ZM, Holmes DR Jr, Webb JG, Tuzcu EM, et al. Interventional fellowship in structural and congenital heart disease for adults. *JACC Cardiovasc Interv.* 2010;3(9):e1-15. DOI: <http://dx.doi.org/10.1016/j.jcin.2010.08.010>