Analiza intervencijskih kardioloških zahvata u Hrvatskoj od 2010. do 2014. godine: ususret uvođenju nacionalnog registra

An Analysis of Cardiologic Interventional Procedures in Croatia between 2010 and 2014: Towards the Establishment of a National Registry

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SAŽETAK: Iako intervencijska kardiologija u Hrvatskoj unatrag dvaju desetljeća bilježi napredak, ne nalazimo analizu broja intervencijskih kardioloških zahvata na nacionalnoj razini. Cilj je rada bila analiza broja koronarnih angiografija (CA) i perkutanih koronarnih intervencija (PCI) u razdoblju od 2010. do 2014. godine. Analizirani su dijagnostičko-terapijski postupci iz računa hospitaliziranih bolesnika u Hrvatskoj koji se odnose na CA i PCI u 13 hrvatskih centara. U promatranom je razdoblju prosječna stopa CA bila 4390 na milijun stanovnika godišnje uz porast od 8,5 % u promatranom razdoblju. Prosječna stopa PCI-ja bila je 2208 uz porast od 15 %. Omjer PCI/CA porastao je s 0,48 na 0,52. Od 47 470 PCI-ja učinjenih u Hrvatskoj od 2010. do 2014. godine 18,6 % učinjeno je u Klinici za kardiovaskularne bolesti Magdalena, 13,8 % u Kliničkom bolničkom centru (KBC) Zagreb, 11,9 % u KBC-u Rijeka i 11,3 % u Kliničkoj bolnici Dubrava, dok su ostali centri imali udjele manje od 10 %. Prema broju PCI-ja, sedam hrvatskih centara (54 %) ubrajamo u velike centre, a četiri (30,7 %) među srednje velike centre. Opća bolnica Dubrovnik od 2013. godine ima dovoljan godišnji broj PCI-ja (> 200), dok Opća bolnica Karlovac radi samo CA. Rezultati upućuju na izniman uspjeh hrvatske intervencijske kardiologije u zadnja dva desetljeća. Hrvatska je 2010. godine imala višu stopu PCI-ja od prosjeka članica Organizacije za ekonomsku suradnju i razvoj (OECD) i 21 zemlje članice Europske unije i veći prosječan godišnji rast (26,8 %) od svih analiziranih zemlja, osim Rumunjske. Stopa PCI-ja bila je viša od većine europskih zemalja, osim Njemačke, Belgije, Austrije i Norveške. Za daljnju analizu uspješnosti intervencijskih zahvata i planiranje daljnjeg razvoja nužno je formiranje unificiranoga Hrvatskog registra kardioloških procedura.

SUMMARY: Although there has been progress in interventional cardiology in Croatia over the last two decades, there has been no analysis of interventional cardiologic procedures at the national level. The aim of this article was to analyze of the number of coronary angiographies (CA) and percutaneous coronary interventions (PCI) in the period from 2010 to 2014. Diagnostic and treatment procedures were analyzed based on the CA and PCI hospital claims of Croatian patients in 13 Croatian centers. The average rate of CA in the observed period was 4 390 per million population annually, with a growth of 8.5% over the observed period. The average rate of PCI was 2 208 with an increase of 15%. The PCI/CA ratio grew from 0.48 to 0.52. Of the 47 470 PCI procedures performed in Croatia between 2010 and 2014, 18.6% were performed in the Magdalena Special Hospital for Cardiovascular Surgery and Cardiology, 13.8% in the University Hospital Centre Zagreb, 11.9% in the University Hospital Centre Rijeka, and 11.3% in the University Hospital Dubrava, while other centers had shares below 10%. Based on PCI numbers, 7 Croatian centers (54%) can be classified as high volume centers, and 4 (30.7%) as medium volume centers. The Dubrovnik General Hospital since 2013 had a sufficient annual number of PCIs (>200), while the Karlovac General Hospital only performed CA. Results indicate that Croatian interventional cardiology has achieved a great success over the last two decades: in 2010, Croatia already had an above-average rate of PCIs compared with the Organization for Economic Co-operation and Development and 21 countries of the European Union, as well as a larger annual growth (26.8%) than all analyzed countries except Romania. PCI rates were higher than most European countries except Germany, Belgium, Austria, and Norway. Further analysis of the success of interventional procedures and further development plans require the formation of a unified Croatian Registry of Cardiologic Procedures.

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

KEYWORDS: coronary angiography, percutaneous coronary intervention, Croatia.

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Uvod

Stope smrtnosti od kardiovaskularnih bolesti (KVB) tijekom zadnjeg desetljeća smanjile su se u većini europskih zemalja, međutim, i dalje su vodeći uzrok smrtnosti uzrokujući gotovo polovicu ukupnog mortaliteta ili više od 4 milijuna smrti u Europi godišnje. Sama koronarna bolest srca (KBS) uzrokuje gotovo 1,8 milijuna ili 20 % smrti u Europi godišnje, i to usprkos zabilježenom padu mortaliteta koji je u osam europskih zemalja dramatičan i veći i od 50 %. I Hrvatska u zadnjem desetljeću bilježi znatan pad stope mortaliteta od KVB-a od 30 %, što, nažalost, nije slučaj sa stopama mortaliteta od KBS-a koja se u muškaraca smanjila za samo 4 %, a u žena čak povećala za 2 %. Dobno standardizirane stope mortaliteta 2012. godine u Hrvatskoj još su uvijek bile visoke u europskim okvirima, u muškaraca 202,8/100 000, a u žena 123,8/100 000, za razliku, primjerice, od Austrije i Slovenije, gdje su stope gotovo upola manje, za muškarce 125,5 i 94,9/100 000, a za žene 65,3 i 40,5/100 000.[1,2]

Unatrag dvaju desetljeća intervencijska kardiologija u Hrvatskoj znatno je napredovala, dijagnostički i terapijski. Od 1993. do 2001. godine stopa intervencijskih kardioloških zahvata izrazito je porasla, primjerice stopa koronarografija (CA) povećala se 6,15 puta, s 279 na 1716, a stopa perkutanih koronarnih intervencija (PCI) čak 15 puta, s 38 na 565 na milijun stanovnika. Stope navedenih zahvata u to su vrijeme bile niže od prosjeka zemalja članica Europskoga kardiološkog društva (ESC), kao i nekih ekonomski razvijenijih zemalja, primjerice Austrije, no nisu se statistički znatno razlikovale od stopa drugih tranzicijskih zemalja poput Slovenije i Mađarske pa ni od Republike Češke.[3]

Usprkos znatnom napretku intervencijske kardiologije, pretragom baza podataka ne nalazimo precizne analize broja intervencijskih kardioloških zahvata u Hrvatskoj od početka 2000-tih godina do danas. Cilj je ovoga rada bila analiza broja CA i PCI učinjenih u Hrvatskoj od 2010. do 2014. godine i usporedba s rezultatima drugih zemalja.

Pacijenti i metode

Za svakoga hospitaliziranog bolesnika u Republici Hrvatskoj na kraju liječenja šifriraju se, s jedne strane, dijagnoze, a, s druge, dijagnostičko-terapijski postupci (DTP), na temelju čega Hrvatski zavod za zdravstveno osiguranje (HZZO) obračunava troškove liječenja sukladno dijagnostičko-terapijskim skupinama (DTS).[4] Za potrebe ovoga istraživanja prikupljeni su podatci o broju intervencijskih kardioloških postupaka (CA i PCI) koji su šifrirani u fakturama za bolničko liječenje pojedinih bolesnika i ispostavljeni HZZO-u u razdoblju od 2010. do 2014. godine. HZZO je odabran kao izvor podataka jer u Hrvatskoj još uvijek nije utemeljen nacionalni registar kardioloških intervencija kojim bi se sustavno i jednoznačno prikupljali podaci na nacionalnoj razini. Analizirali smo DTP-e svih hospitaliziranih bolesnika u Hrvatskoj koji se odnose na zahvate u intervencijskoj kardiologiji, na CA (**tablica 1**) i PCI (**tablica 2**).

Trinaest centara u Hrvatskoj radi invazivne kardiološke zahvate: klinički bolnički centri (Zagreb, Sestre milosrdnice, Split, Rijeka, Osijek), kliničke bolnice (Dubrava, Sveti Duh i Merkur), Klinika Magdalena, opće bolnice (Zadar, Slavonski Brod, Dubrovnik i Karlovac). Podjela centara na srednje velike

Introduction

Mortality rates from cardiovascular diseases (CVD) have decreased over the last decade in most European countries, but they are still the leading cause of death, accounting for almost half of the total mortality i.e. more than 4 million deaths in Europe annually. Coronary heart disease (CHD) alone causes almost 1.8 million (20%) deaths in Europe annually, despite a dramatic reduction in mortality of over 50% in eight European countries. Croatia has also seen a significant 30% drop in CVD mortality over the last decade, but unfortunately that is not the case with CHD, where mortality for men has fallen by only 4% and actually increased in women by 2%. Age-standardized mortality rates in 2012 in Croatia were still high for European ranges, at 202.8/100 000 for men and 123.8/100 000 for women, as opposed to for instance Austria or Slovenia where mortality rates are lower by half, 125.5 and 94.9/100 000 for men and 65.3 and 40.5/100 000 for women, respectively.[1,2]

Interventional cardiology in Croatia has seen significant progress over the last two decades both in diagnostics and treatment. Between 1993 and 2001 the number of interventional cardiologic procedures went up sharply; for instance, the coronarography (CA) rate increased by 6.15 times, to 1 716 from 279, and the rate of percutaneous coronary interventions (PCI) by as much as 15 times, from 38 to 565 per million inhabitants. The rates of the above procedures in that period were below the average of member-states of the European Cardiac Society (ESC) and some economically more developed countries such as Austria, but did not differ significantly from other transitional countries such as Slovenia and Hungary or even the Czech Republic.[3]

Despite significant advances in interventional cardiology, database searches did not yield precise data on the number of interventional cardiologic procedures in Croatia since 2000 till today. The goal of this study was to analyze the number of CA and PCI performed in Croatia from 2010 to 2014 and compare the results with other countries.

Patients and Methods

For every hospitalized patient in the Republic of Croatia, the diagnosis and diagnostic-therapeutic procedures (DTP) are coded on the claim at the end of the hospital stay. Based on this data, the Croatian Health Insurance Fund (CHIF) calculates the treatment expenses commensurate to the diagnostic-therapeutic groups (DTS) they fall under.[4] This study used data on the number of interventional cardiologic procedures (CA and PCI) coded in the claims for hospital treatment of individual patients and delivered to the CHIF in the period from 2010 to 2014. CHIF was selected as a data-source since a national registry for systematic and non-ambiguous data collection at the national level has not yet been established in Croatia. We analyzed the DTPs of all hospitalized patients in Croatia that were relevant to procedures in interventional cardiology, CA (**Table 1**) and PCI (**Table 2**).

Invasive cardiologic procedures are performed in thirteen centers in Croatia: university hospital centers (Zagreb, Sisters of Charity, Split, Rijeka, Osijek), university hospitals (Dubrava, Sveti Duh, and Merkur), clinics (Magdalena), and general hospitals (Zadar, Slavonski Brod, Dubrovnik, and Karlovac). Classifying centers into medium and high volume based on the annual number of PCI performed is a topic of discussion in the literature, but this

TABLE 1. Croatian Health Insurance Fund's codes for diagnostic-therapeutic groups procedures which include coronary angiography (CA).

Code	CA
38215-00	coronary angiography
38218-00	coronary angiography and left heart catetherisation
38218-01	coronary angiography and right heart catetherisation
38218-02	coronary angiography and both side heart catetherisation

i velike na temelju godišnjega broja PCI-ja predmet je rasprava u literaturi, no mi smo se za potrebe ovoga istraživanja vodili preporukama Američkog odbora, prema kojima je potreban najmanji godišnji broj PCI-ja 200 po jednom centru zbog potvrđene povezanosti manjega broja intervencija s lošijim terapijskim ishodima.[5] Srednje velikim centrima označili smo one s 200 do 600 PCI-ja, a velikim centrima one s više od 600 PCI-ja godišnje jer je meta-analizom dokazano da povećanje broja intervencija iznad 600 godišnje nije povezano s boljim ishodom intervencija.[6]

Za prikaz rezultata primijenjena je deskriptivna statistika.

Rezultati

Od 2010. do 2014. godine prosječan godišnji broj CA u Hrvatskoj iznosio je 19 305, a stopa 4390 na milijun stanovnika godišnje. U tom je razdoblju broj CA porastao za 8,5 %. Tijekom istoga razdoblja prosječan godišnji broj PCI-ja bio je 9494, a stopa 2208 na milijun stanovnika godišnje uz zabilježeni trend porasta broja PCI-ja od 15 %. Omjer broja PCI/CA porastao je s 0,48 u 2010. godini na 0,52 u 2014. godini (**tablica 3** i **slika 1**).

Od 47 470 PCI-ja učinjenih u Hrvatskoj od 2010. do 2014. godine najveći udio od 18,6 % ili ukupno 8837 zahvata učinjeno je u Klinici Magdalena. Slijede KBC Zagreb s udjelom od 13,8 % (6536 PCI-ja), KBC Rijeka s 11,9 % (5659 PCI-ja) i KB Dubrava s udjelom od 11,3 % (5361 PCI). Ostali su centri imali udjele manje od 10 % (**slika 2**).

Prosječan godišnji broj PCI-ja po centrima za razdoblje od 2010. do 2014. godine prikazan je na **slici 3**. Ukupno sedam centara (54 %) ubrajamo u velike centre (Magdalena, KBC Zagreb,

TABLE 2. Croatian Health Insurance Fund's codes for diagnostic-therapeutic groups procedures which include coronary percutaneous intervention (PCI).

Code	PCI
35304-00	percutaneous transluminal angioplasty with baloon (PTCA) of 1 coronary artery
35305-00	percutaneous transluminal angioplasty with baloon (PTCA) of 2 or more coronary arteries
35310-00	percutaneous implantation of 1 transluminal stent in 1 coronary artery
35310-0	percutaneous implantation of 2 or more transluminal stents in 1 coronary artery
35310-02	percutaneous implantation of 2 or more transluminal stents in more coronary arteries

study used the guidelines of the ACC/AHA Task Force which requires at least 200 PCI annually per center due to the established association between a lower number of interventions and poorer treatment outcomes.[5] Medium volume centers were defined as those with 200 to 600 PCI, and high volume centers as those with more than 600 PCI annually, since meta-analysis has shown that increasing the number of interventions above 600 per year is not associated with significantly improved intervention outcomes.[6]

Descriptive statistics were used to report the results.

Results

In the period between 2010 and 2014, the average annual number of CA procedures in Croatia was 19 305, at a rate of 4 390 per million inhabitants. The number of CA procedures in that period grew by 8.5%. In the same period, the average annual number of PCI was 9 494, and the rate was 2 208 per million inhabitants annually, with a growth trend of PCI numbers of 15%. The ratio of PCI/CA grew from 0.48 in 2010 to 0.52 in 2014 (**Table 3**, **Figure 1**).

Of the 47 470 PCI performed in Croatia from 2010 to 2014, 18.6% percent or a total of 8 837 procedures were performed at the Magdalena Special Hospital for Cardiovascular Surgery and Cardiology. Next were the University Hospital Centre Zagreb had a share of 13.8% (6 536 PCI), University Hospital Centre Rijeka with 11.9% (5659 PCI), and the University Hospital Dubrava with 11.3% (5 361 PCI). Other centers had shares below 10% (**Figure 2**).

The average number of PCI per center for the period between 2010 and 2014 is shown in **Figure 3**. A total of 7 centers (54%)

TABLE 3. Coronary angiograms (CA), percutaneous coronary interventions (PCIs) and PCI/CA ratios in Croatia in the 2010 - 2014 period.

	2010	2011	2012	2013	2014	mean
PCI	9 039	8 177	9 706	9 946	10 602	9 494
CA	18 806	19 709	18 607	18 851	20 555	19 305
PCI/CA	0,48	0,41	0,52	0,53	0,52	0,49

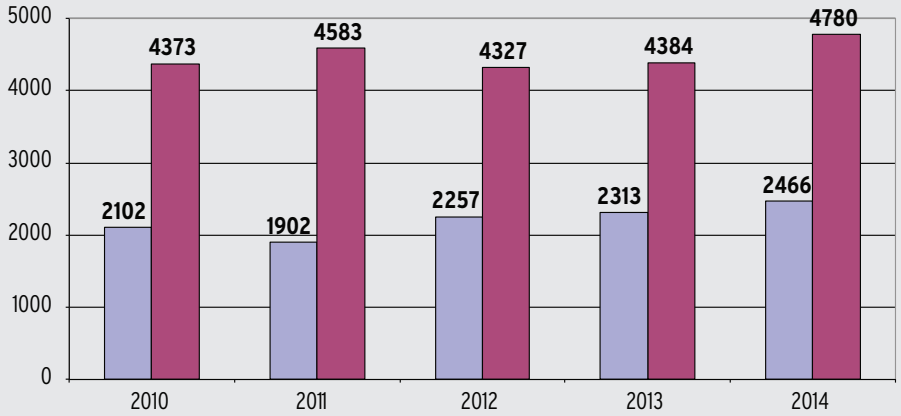

FIGURE 1. Coronary angiograms (red columns) and percutaneous coronary interventions (blue columns) per million population in Croatia in the 2010-2014 period.

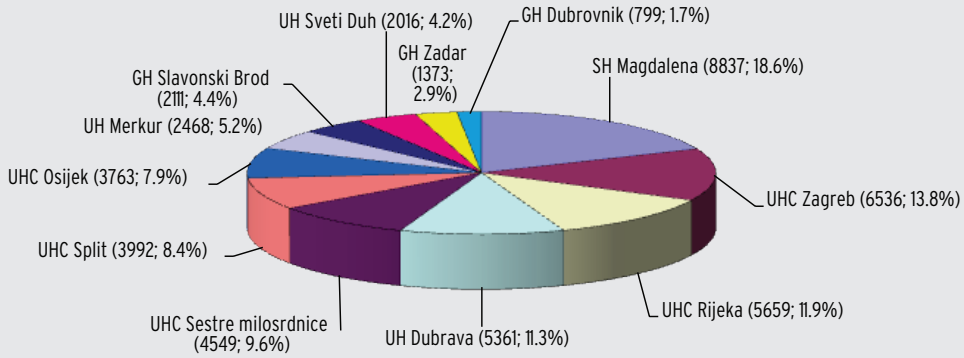

FIGURE 2. Absolute numbers and percentages of PCIs in Croatian centers in five year period (2010-2014).

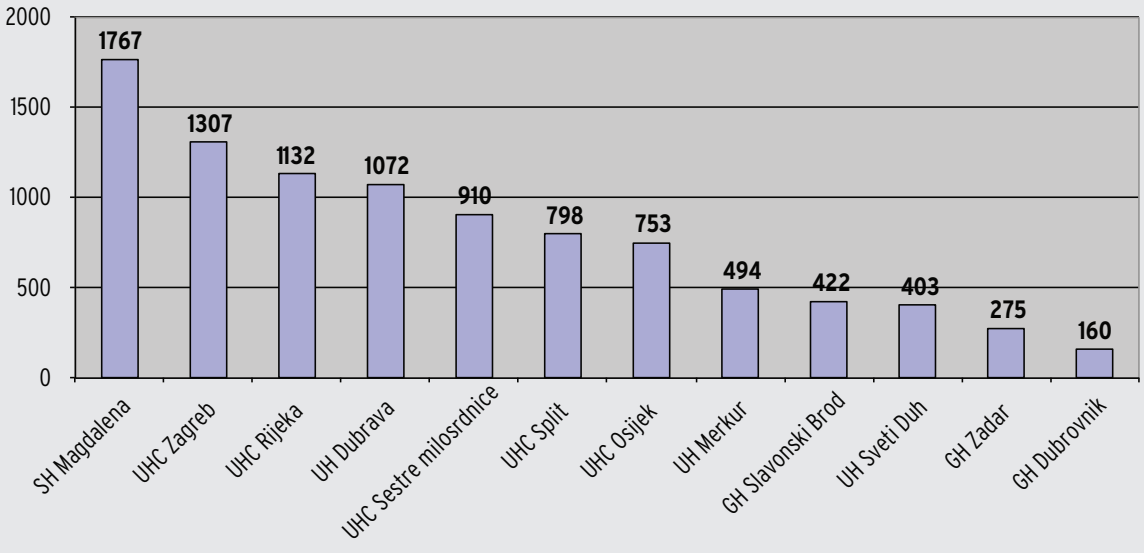

FIGURE 3. Mean annual number of PCIs in the Croatian centers in the 2010-2014 period.

KBC Rijeka, KB Dubrava, KBC Sestre milosrdnice, KBC Split i KBC Osijek), dok se četiri centra (30,7 %) ubrajaju u srednje velike centre (KB Merkur, OB Slavonski Brod, KB Sveti Duh i OB Zadar). OB Dubrovnik u petogodišnjem razdoblju nema dovoljan prosječan godišnji broj PCI-ja (> 200), međutim, ispunjava taj kriterij od 2013. godine. U OB-u Karlovac radili su se CA, no nisu PCI-ji.

Podatci o broju intervencijskih kardioloških zahvata za 34 zemlje članice Organizacije za ekonomsku suradnju i razvoj (*The Organisation for Economic Co-operation and Development*, OECD) za 2009. i 2010. godinu objavljeni su u posebnim izvješćima na temelju kojih je načinjena **tablica 4** i u nju su dodani naši podatci za Hrvatsku.[7,8] Stopa PCI-ja u Hrvatskoj 2010. godine bila je 2102 zahvata na milijun stanovnika i u usporedbi s podatcima OECD-a razvidno je da od navedenih zemalja veću stopu od Hrvatske imaju samo Njemačka, Belgija, Austrija i Norveška koje bilježe stope od 2380 do 6240 na milijun stanovnika godišnje. Stopa u Hrvatskoj bila je nešto veća nego u Republici Češkoj (2050), a niže stope imale su sve ostale analizirane europske zemlje sa stopama PCI-ja od 530 do 1970 na milijun stanovnika godišnje.

Rasprava

Broj CA-a u Hrvatskoj tijekom proteklih dvaju i pol desetljeća rastao je u nekim razdobljima gotovo eksponencijalno. Tako je

can be classified as high volume centers (Magdalena Special Hospital for Cardiovascular Surgery and Cardiology, University Hospital Centre Zagreb, University Hospital Centre Rijeka, University Hospital Dubrava, University Hospital Centre "Sestre milosrdnice", University Hospital Centre Split, and University Hospital Centre Osijek), while four centers (30.7%) can be classified as medium volume centers (University Hospital Merkur, Slavonski Brod General Hospital, University Hospital "Sveti Duh", and Zadar General Hospital). The Dubrovnik General Hospital did not have a sufficient annual PCI average (>200) over the five-year period, but has fulfilled that criterion since 2013. The Karlovac General Hospital performed CA, but not PCI.

Data on the number of interventional cardiologic procedures for 34 member-states of the Organisation for Economic Co-operation and Development (OECD) for 2009 and 2010 were published in special reports, and are compared with our own data in **Table 4**.[7,8] The PCI rate in Croatia in 2010 was 2 102 PCI per million inhabitants, and in comparison with OECD data it is clear that only Germany, Belgium, Austria, and Norway have higher PCI rates than Croatia at between 2 380 and 6 240 per million inhabitants annually. The Croatian PCI rate was somewhat higher than that of the Czech Republic (2 050), while all other analyzed European countries had lower PCI rates, ranging from 530 to 1 970 per million inhabitants annually.

TABLE 4. Percutaneous coronary interventions per million population in 2010 for OECD countries and Croatia.

Germany	6240
Belgium	4690
USA*	3770
Austria	2400
Norway	2380

Croatia**	2102
Czech R.	2050

Luxembourg	1970
Iceland	1980
Slovenia	1930
France*	1940
EU21	1910
Estonia	1820
Sweden	1800
Greece	1770
Hungary	1720
Netherlands	1700
Switzerland	1640
Denmark	1580
Spain	1360
Finland	1320
Italy	1310
Portugal	1180
U. Kingdom	940
Ireland	900
Poland	870
Romania	530

Israel*	190
OECD*	1808
Australia*	1590
New Zealand*	1170
Canada*	1050
Chile*	70
Mexico*	20

* data are from 2009
** data for Croatia are from Figure 2

u razdoblju od 1993. do 2001. godine zabilježen izraziti porast stopa CA-a od čak 615 %. Prema rezultatima ovoga istraživanja porast se nastavio od 2001. do 2010. godine s povećanjem od 250 %, s 1716 na 4373 na milijun stanovnika.[3] Od 2010. do 2014. nastaje usporenje porasta koji je ukupno 8,5 % u petogodišnjem razdoblju uz konačnu stopu od 4780 na milijun stanovnika. Usporedba stopa s drugim zemljama ograničena je izrazitim diskontinuitetom objavljivanja rezultata za pojedine zemlje. Tako je primjerice u 2007. godini na Islandu učinjeno 5437, a u Švedskoj 4022 CA na milijun stanovnika.[9] Inače, 2004. godine prosjek zemalja članica ESC-a iznosio je 3928 CA i 1553 PCI-ja na milijun stanovnika godišnje.[10] Stope PCI-ja u Hrvatskoj bilježe čak izraženiji porast. Od 1993. do 2001. godine stopa PCI-ja porasla je čak 1500 %, s 38 na 565 na milijun stanovnika, a od 2001. do 2010. godine stopa se povisila za daljnjih 270 % i iznosila je 2102 na milijun stanovnika. U petogodišnjem razdoblju uključenom u ovo istraživanje zabilježen je porast stope od 15 % koja je 2014. godine iznosila 2466 na milijun stanovnika. Spomenuti rezultati upućuju na izniman uspjeh hrvatske intervencijske kardiologije jer je Hrvatska 2010. godine imala veću stopu PCI-ja od prosjeka članica OECD-a (1808 PCI-ja) ili zemalja EU21 (1910 PCI-ja). Prosječan godišnji rast stope PCI-ja za Hrvatsku od 2001. do 2010. godine od 26,8 % uvjerljivo je veći nego prosjek zemalja EU21 (9,4 %) i veći od svih zemalja uključenih u podatke OECD-a, osim Rumunjske.[7,8] Prema istim podatcima, samo četiri europske zemlje imale su 2010. godine veću stopu PCI-ja od Hrvatske: Njemačka, Belgija, Austrija i Norveška, dok je Hrvatska imala nešto veću stopu čak i od Republike Češke (**tablica 4**). Međutim, podatke OECD-a treba interpretirati s oprezom jer se često ne podudaraju s podatcima nacionalnih registara pojedinih zemalja zbog različite metodologije prikupljanja podataka. Primjerice, Irska je prema podatcima OECD-a, 2010. godine imala stopu od 900 PCI-ja, dok je, prema podatcima Irskog registra, stopa iznosila 1770 na milijun stanovnika.[11] Kod drugih zemalja, primjerice Španjolske, podatci OECD-a i nacionalnog registra u cijelosti se podudaraju.[12] Spomenuti španjolski registar u 2010. godini pokazuje manju stopu CA od Hrvatske, 2945 *vs.* 4373 na milijun stanovnika, što je slučaj i s PCI-ima, Španjolska 1398, a Hrvatska 2102 na milijun stanovnika.[12] Prema referencijama iz istog registra na kraju našega promatranog razdoblja, 2014. godine, Španjolska je imala 2693 CA i 1447 PCI-ja, a Hrvatska 4780 CA i 2466 PCI-ja na milijun stanovnika.[13]

Tijekom 2000-ih godina nedostaju godišnji podatci o stopama kardioloških intervencija u Hrvatskoj. Anegdotalno su prezentirani podatci za pojedine godine kao primjerice oni na sastanku nacionalnih radnih skupina za intervencijsku kardiologiju ESC održanom 2009. godine, gdje su prikazani rezultati za 2007. i 2008., a za neke zemlje za 2006. i 2005. godinu. Tada su hrvatski predstavnici iznijeli podatak o 890 PCI-ja na milijun stanovnika, no metodologija istraživanja i prikupljanja podataka nije precizno objašnjenja, a rezultati ovog istraživanja upućuju na to da je tada taj broj bio podcijenjen.[14] I prije toga poslani su pozivi vodstvu kardiološkoga društva za osnivanje ujedinjenog registra koronarnih zahvata u Hrvatskoj u svrhu daljnjeg napretka struke.[3] Nažalost, u desetljeću koje je uslijedilo, kao ni do danas u Hrvatskoj nije utemeljen niti je započeo s radom takav registar, štoviše, nije bilo ni aproksi-

Discussion

The number of CA procedures in Croatia over the past two and a half decades has, in some periods, grown almost exponentially. In the period between 1993 and 2001, for instance, there was a startling increase in CA rates of as much as 615%. The results of this study show that growth continued from 2001 to 2010 with an increase of 250%, from 1 716 to 4 363 per million inhabitants.[3] From 2010 to 2014 there was a slowdown in the growth, which was 8.5% in total over the five-year period, with a final rate of 4 780 per million inhabitants. Rate comparisons with other countries are limited by significant discontinuities in results publication for individual countries. For example, 5 437 CA procedures were performed per million inhabitants in Iceland and 4 022 in Sweden in 2007.[9] Notably, the average for ESC member states in 2004 was 3 928 CA and 1 553 PCI per million inhabitants annually.[10] PCI rates in Croatia had an even greater growth trend. Between 1993 and 2001 PCI rates grew by as much as 1500%, from 38 to 565 per million inhabitants, and between 2001 and 2010 the rate grew by another 270% to 2 102 per million inhabitants. Over the five-year period analyzed in this study a growth of 15% was noted, amounting to 2 466 per million inhabitants in 2014. The above results indicate a notable success of Croatian interventional cardiology, since in 2010 Croatia had a higher PCI rate than the OECD member-state average (1 808 PCI) or the members of EU21 (1 910 PCI). The average growth of the PCI rate in Croatia between 2001 and 2010 of 26.8% was significantly higher than the EU21 average (9.4%) and higher than that of any country in the OECD data except Romania.[7,8] According to those data, only four European countries had a higher PCI rate in 2010 than Croatia: Germany, Belgium, Austria, and Norway, while Croatia had a somewhat higher rate even compared with the Czech Republic (**Table 4**). However, OECD data should be interpreted tentatively, since there is often an inconsistency with data from national registries of individual countries due to different data-gathering methodologies. Ireland, for instance, had a PCI rate of 900 in 2010 according to OECD data, whereas according to the Irish registry the rate was 1 770 per million inhabitants.[11] For other countries, such as Spain, OECD and national registry data match completely.[12] The Spanish national registry for 2010 shows a lower CA rate than Croatia, 2 945 vs. 4 373 per million inhabitants, as well as a lower PCI rate at 1 398 in Spain and 2 102 per million inhabitants in Croatia.[12] At the end of our observed period in 2014, Spain had 2 693 CA and 1 447 PCI procedures per million inhabitants, while Croatia had 4 780 CA and 2 466 PCI.[13]

There is insufficient annual data on cardiologic intervention rates in Croatia for the first decade of the 21st century. Data for individual years has been presented anecdotally, such as for example at the meeting of national working groups for interventional cardiology of the ESC in 2009, when data for 2007 and 2008 was presented, and also for 2006 and 2005 for some countries. On that occasion, Croatian representatives presented data indicating 890 PCI per million inhabitants, but the methodology of that study and data acquisition was unclear, and the results of our study indicate that the number was an underestimate.[14] Even prior to this, there were calls for the leadership of the cardiologic society to establish a unified registry of coronary procedures in Croatia to facilitate advancements in the Croatian cardiology development.[3] Unfortunately, no such registry has been organized in the ensuing

mativnih analiza broja kardioloških intervencijskih zahvata, osim analize rezultata Hrvatske mreže za primarni PCI.[15]

Globalno gledano, stagnacija broja koronarnih intervencija nakon razdoblja porasta u razvijenim zemljama, poput SAD-a, objašnjava se uspjehom u provođenju preventivnih mjera za KBS. Teško je odrediti u kojoj je mjeri razlika u broju koronarnih intervencija pojedinih zemalja određena različitom prevalencijom KBS-a, a u kojoj mjeri različitim resursima i načinom organizacije rada te indikacijama za provođenje dijagnostičkih i terapijskih postupaka u pojedinim zemljama i centrima za PCI. Kada, prema dostupnim podatcima, promatramo dinamiku porasta koronarnih intervencija u Hrvatskoj, zamjetno je da je od 1993. do 2010. godine Hrvatska imala trend koji nalazimo u zemljama u razvoju s višestrukim povećanjem broja intervencija u manje od 10 godina, dok razvijene zemlje bilježe porast od oko 5 % godišnje ili pak stagnaciju stope koronarnih intervencija.[16] Čimbenici koji općenito pridonose povećanju broja koronarnih intervencija s jedne su strane povećanje financiranja u području kardiologije na lokalnoj i nacionalnoj razini, povećanje broja centara i osposobljenih intervencijskih kardiologa, a, s druge, to su i epidemiološki i demografskih čimbenici, incidencija bolesti i starenje populacije. U Hrvatskoj je porast broja intervencija, zasigurno, djelomično objašnjiv povećanjem izdvajanja za kardiologiju, povećanjem broja centara, porastom udjela velikih centara i vjerojatnim povećanjem broja intervencijskih kardiologa. Iz prikazanih je rezultata razvidno da svi hrvatski centri, uključujući i OB Dubrovnik nakon 2013. godine, ispunjavaju osnovni uvjet za samostalan rad, više od 200 PCI-ja godišnje, dok se u samo jednom centru rade isključivo dijagnostički zahvati (OB Karlovac). Gotovo 85 % hrvatskih centara ispunjava kriterije za centre sa srednje velikim i velikim brojem zahvata. Primjerice, u Španjolskoj u 2014. godini 59 % centara (62/106) ne radi više od potrebnih 200 PCI-ja godišnje, a čak 25 % (26/106) radi manje od 50 PCI-ja u godini dana.

U literaturi nalazimo istraživanja koja pokazuju da pojedini centri unatoč relativno malom broju zahvata godišnje mogu imati izvrsne mjerljive rezultate intervencija. Međutim, kako u Hrvatskoj nije utemeljen registar kardioloških intervencija, ne raspolažemo pokazateljima uspješnosti, kao što su, primjerice, učestalost velikih kardiovaskularnih događaja, bolnički, mjesečni i godišnji mortalitet, uporaba potrošnih materijala, periproceduralna i postproceduralna farmakoterapija, postotak stentova koji otpuštaju lijek (DES), uporaba intravaskularnog ultrazvuka (IVUS) ili frakcijske rezerve protoka (FFR) kod intervencija te bilježenje komplikacija, što bi omogućilo usporedbu s međunarodnim podatcima, vrjednovanje rada i poboljšanje kliničke prakse. S druge strane, u Hrvatskoj je od epidemioloških podataka raspoloživa samo mortalitetna statistika, za razliku od istraživanja incidencije KVB-a i mjera učinkovitosti liječenja te stoga dinamiku svake bolesti pa tako i KBS-a treba objašnjavati uzimajući u obzir ta ograničenja. Međutim, može se reći da, u slučaju Hrvatske, relativna stagnacija porasta broja koronarnih intervencija nakon 2010. godine vjerojatno nije objašnjiva smanjenjem prevalencije KBS-a jer, iako Hrvatska u zadnjem desetljeću bilježi znatan pad stope mortaliteta od KVB-a od 30 %, to nije slučaj sa stopama mortaliteta od KBS-a, koje su se u muškaraca smanjile za samo 4 %, a u žena čak povisile za 2 %. Ipak,

decade, and there were not even any approximate estimates of the number of cardiologic procedures, other than the result analysis of the Croatian Network for Primary PCI.[15]

Globally speaking, the trend towards stagnation in the number of coronary interventions after a period of growth in developed countries such as the USA is explained by the success in introducing preventive CHD measures. It is hard to distinguish to what extent the difference in the number of coronary interventions in particular countries is determined by the prevalence of CHD, as opposed to differences in resources and organization, as well as indications for diagnostic and treatment procedures in different countries and PCI centers. Looking at the dynamics of the growth in the number of coronary interventions in Croatia based on the available data, it is notable that between 1993 and 2010 Croatia experienced the same trend we find in developing countries – a several-fold increase in less than 10 years – whereas developed countries show a growth of approximately 5% per year or stagnation in the rate of coronary interverntions.[16] Factors that generally contribute to an increase in the number of coronary interventions are increased financing for the field of cardiology at the local and national levels as well as an increase in the number of centers and trained interventional cardiologists on the one hand, and demographic and epidemiologic factors such as disease incidence and the aging of the population on the other. In Croatia's case, the increase in the number of interventions is certainly partially explainable by increased financing for cardiology, an increase in the number of centers and the number of high volume centers, and a likely rise in the overall number of interventional cardiologists. The data above shows that all Croatian centers, including the Dubrovnik General Hospital since 2013, fulfill the basic criterion for independent functioning of more than 200 PCI annually, with only once center exclusively performing diagnostic procedures (the Karlovac General Hospital). Almost 85% of Croatian centers satisfy the criteria for centers with medium or high volume of procedures. In Spain in 2014, for instance, 59% of the centers (62/106) did not perform the necessary >200 PCI annually, and as many as 25% (26/106) performed less than 50 PCI per year.

The literature contains studies that show that individual centers can have outstanding measurable intervention results despite a relatively low number of procedures per year. However, since a register of cardiologic interventions has not been established in Croatia, we do not have success indicators available, such as for instance the prevalence of major cardiovascular events, hospital, monthly, and annual mortality, use of consumables, periprocedural and postprocedural pharmacotherapy, drug-eluting stent (DES) penetration, intravascular ultrasound (IVUS) usage, or fractional flow reserve (FFR) measurements during interventions and data on complication incidence, which would allow a comparison with international data, quality evaluation, and improvement in clinical practice. Of epidemiological data, only mortality statistics are available in Croatia, as opposed to studying the incidence of CVD and treatment effectiveness. Thus, the dynamics of the incidence of all diseases including CHD must be interpreted with these limitations in mind. However, we can still conclude that the relative stagnation in the increase in coronary interventions in 2010 is likely not explainable by a reduction in the prevalence of CHD, since although Croatia has seen a significant drop in CVD mor-

prekid porasta stope mortaliteta i zabilježeni minimalni pad, barem za muškarce, vjerojatno se može pripisati izvanrednim rezultatima intervencijskih kardiologa jer se u Hrvatskoj još ne bilježe značajniji rezultati u provođenju preventivnih mjera, ponajprije u smanjenju pušenja[17], a vjerojatno ni dijabetesa, arterijske hipertenzije, dislipidemije, tjelesne aktivnosti te drugih čimbenika rizika. Navedeni čimbenici udruženi sa sve izraženijim starenjem populacije zasigurno će još duži niz godina podupirati pozitivan trend porasta stope kardioloških intervencija u Hrvatskoj.

Budući da desetljeće i pol nije bilo objavljenih sustavnih podataka o stopama CA i PCI-ja, odlučili smo se za ovaj prikaz temeljen na računima HZZO-a kao jedinom trenutačno dostupnom izvoru podataka svjesni činjenice da pri takvom prikazu postoje brojna ograničenja i sustavne pogreške istraživanja koji su mogli utjecati na konačne rezultate. Kao prvo, HZZO osiguranjem obuhvaća 96 % populacije, što ostavlja oko 170 000 državljana neosigurano.[18] S druge strane, nekim neosiguranim osobama ipak se plate troškovi liječenja iz posebnog fonda HZZO-a te neki od njih u slučaju CA-a ili PCI-ja, također završe kao registrirani kroz fakture HZZO-a, no takvi su bolesnici vjerojatno ravnomjerno distribuirani po cijeloj zemlji. Nadalje, određeni broj stranih državljana podvrgnut je kardiološkim intervencijama u Hrvatskoj, pri čemu do pristupanja Hrvatske Europskoj uniji (EU) nisu registrirani u HZZO-u putem DTS-a. Nakon pristupanja EU-u strani državljani iz EU-a registriraju se putem HZZO-a, a ostali ne.[19] To je djelomice moglo umanjiti konačne brojke, navlastito centara na obali. Međutim, najveća odstupanja i greške vjerojatno su se pojavile pri šifriranju računa u samim centrima za PCI. Neke su od njih bile sustavne i nelogične te su korigirane osobnim kontaktom, kao, primjerice, dvostruko šifriranje koronarografija u KBC-u Osijek sa šiframa 38215-00 i 38218-00 te je u osobnom kontaktu s laboratorijem broj sveden na polovicu, koji je ocijenjen kao realan. Za nelogičan broj od 3053 šifrirane koronarografije u 2010. i 4232 u 2011. godini u KB-u Merkur nije bilo razložnog objašnjenja ni nakon kontakta s centrom te su ta dva podatka isključena iz analize, što je smanjilo ukupni broj CA. Nadalje, moguće je da se u pojedinih bolesnika povremeno pri šifriranju PCI-ja nije istodobno šifrirala i CA, što također smanjuje ukupni broj CA-a. Prema HZZO-u, u slučaju PCI-ja, posebno se šifrira izolirana PTCA, a posebno implantacija stentova. Prema tome, kao PTCA šifriraju se samo dilatacije bez implantacije stenta, a u slučaju predilatacije nakon kojih je implantiran stent, šifrira se samo implantacija stenta. Međutim, vrlo je vjerojatno da su neki centri u istog bolesnika povremeno istodobno šifrirali PTCA u smislu predilatacije i implantaciju stenta kao dvije zasebne intervencije, što je, zasigurno, povećalo ukupne brojeve PCI-ja prikazanih u ovom istraživanju, kao i brojeve pojedinih centara. I konačno, neke su bolnice povremeno fakturirale PCI, iako se u njihovim institucijama takvi zahvati ne rade i vjerojatno je bila riječ o premještajima bolesnika iz centara za PCI koji sami nisu fakturirali provedene zahvate. U promatranom je razdoblju takvih faktura bilo ukupno 80 (0,17 %), a njih nismo uzimali u obzir pri institucionalnim proračunima, no jesmo kod ukupnog broja zahvata u Hrvatskoj.

Usprkos ograničenjima, rezultati ovoga istraživanja upućuju na to da se unatoč nepostojanju registra koronarnih intervencija

tality of 30% over the last decade, this has not been the case with CHD where mortality has fallen by only 4% in men, and actually increased by 2% in women. However, the stagnation and minimal drop in mortality, at least in men, is likely attributable to the exceptional results of interventional cardiologists, since there have been no significant results from preventative measures in Croatia, primarily in smoking cessation[17] and most likely also in diabetes, arterial hypertension, dyslipidemia, physical activity, and other risk factors. These factors, combined with an aging population, will certainly support a positive trend in the number in cardiologic interventions in Croatia for years to come.

Since there have been no published systematic studies on the CA and PCI rates in Croatia, we undertook this study based on CHIF claims as the only currently available source of data, aware of the fact that this approach has many limitations and systemic research errors that may have influenced the final results. Firstly, CHIF provides insurance to 96% of the population, leaving approximately 170 000 citizens uninsured.[18] On the other hand, a special CHIF sub-fund sometimes still covers treatment costs for uninsured persons, causing them to be present in CHIF claims, but such patients are most likely evenly distributed across the country. Furthermore, a certain percentage of foreign citizens undergo cardiologic interventions in Croatia, but would not have been registered in the CHIF DTS prior to Croatia's admission to the European Union (EU). After joining the EU, EU citizens register via the CHIF, but others do not.[19] This might have contributed to a reduction in the perceived total of the procedures, especially in centers along the tourist-frequented coast. However, the most significant deviations and errors are likely a result of claims coding in the PCI centers themselves. Some coding practices were systematic and illogical and were corrected for through personal contacts, such as for example double coding for coronarographies in the University Hospital Centre Osijek with the codes 38215-00 and 38218-00, which after personally contacting the laboratory resulted in the final procedure estimate being cut in half. There was no explanation for the unlikely 3 053 coronarography codes in 2010 and 4 432 in 2011 at the University Hospital Merkur even after contacting the center, so those two data-points were excluded from the analysis, which will have reduced the total number of procedures in the results. Furthermore, it is possible that for individual patients receiving both PCI and CA, CA was not separately coded on the claim, which may have reduced the total number of CA procedures. CHIF requires percutaneous transluminal coronary angioplasty (PTCA) to be coded separately from stent implantation in PCI cases. Thus only dilatations without stent implantation are coded as PTCA, and in cases of pre-dilatation followed by stet implantation, only stent implantation is coded. However, it is very likely that some centers occasionally coded a PTCA procedure on the claim in the same patients twice, once as predilatation and once as stent implantation, which would have driven total PCI numbers up as well as the individual counts of the centers themselves. Finally, some hospitals occasionally billed PCI even though the procedure was not being performed in their institutions, likely due to the procedure being performed at a PCI center the patient was transferred from that did not bill the procedure themselves. In the observed period there were 80 (0.17%) such claims, which we eliminated from

vencija, nemogućnosti utvrđivanja broja intervencijskih kardiologa s licencom te financijskim ograničenjima postignuća hrvatskih intervencijskih kardiologa, promatrana s obzirom na broj procedura, mogu ubrojiti u sam vrh europske intervencijske kardiologije. Međutim, sustavna i precizna analiza kvantitete i kvalitete kardioloških intervencija moguća je samo na temelju individualne registracije svakoga pacijenta u mrežni obrazac koji bi svakom centru za PCI omogućio jednostavan, valjan i pravodoban upis podataka. Radna skupina za intervencijsku kardiologiju Hrvatskoga kardiološkog društva izrazila je općenito stajalište da je došlo vrijeme za unificirani Hrvatski registar kardioloških postupaka, što iziskuje dodatna financijska sredstva. Uspjeh registra provediv je samo uz dogovor o obveznosti upisivanja podataka za svakog bolesnika. S druge strane, potrebno je definiranje osoblja koje bi bilo zaduženo za unos podataka, u sklopu svojega radnog vremena ili angažiranjem izvanbolničkog osoblja za čiji bi rad trebalo pronaći dodatna sredstva.

the procedure count for individual institutions but included in the total number of procedures performed in Croatia.

Despite these limitations, the results of this study indicate that, despite the lack of a registry for coronary interventions, the undetermined number of licensed interventional cardiologists, and financial limitations, the achievements of Croatian interventional cardiology, based on the number of procedures performed, are on par with the very top in European interventional cardiology. However, systematic and precise quality and quantity analysis for cardiologic interventions would become possible only with the individual registration of every patient in a web-form that would allow every PCI center to perform simple, valid, and timely data archiving. The Working Group for Interventional Cardiology of the Croatian Cardiac Society has issued a general statement that it is time to create a unified Croatian registry of cardiologic procedures, which requires additional funding. Success in forming the registry requires a consensus on mandatory data archiving for every patient. On the other hand, it will be necessary to define personnel dedicated to such data archiving during their working hours or hire personnel from outside the hospital, which would require additional funds.

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