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Source / Izvornik: **Acta clinica Croatica, 2020, 59, 641 - 648**

Journal article, Published version

Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

<https://doi.org/10.20471/acc.2020.59.04.10>

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:184:956509>

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Download date / Datum preuzimanja: **2025-01-22**



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MANAGEMENT OF HYPERLIPIDEMIA IN VERY HIGH AND EXTREME RISK PATIENTS IN CROATIA: AN OBSERVATIONAL STUDY OF TREATMENT PATTERNS AND LIPID CONTROL

Hrvoje Pintarić^{1,2}, Marijana Knezović Florijan², Ian Bridges³, Robert Steiner⁴,
Luka Zaputović⁵ and Davor Miličić⁶

¹University of Zagreb, School of Dental Medicine, Zagreb, Croatia;

²Sestre milosrdnice University Hospital Centre, Department of Internal Medicine, Zagreb, Croatia;

³Amgen Ltd., Cambridge, United Kingdom;

⁴Osijek University Hospital Centre, Department of Cardiology, Osijek, Croatia;

⁵Rijeka University Hospital Centre, Rijeka, Croatia;

⁶University of Zagreb, School of Medicine, Department of Cardiovascular Diseases,
Zagreb University Hospital Centre, Zagreb, Croatia

SUMMARY – Our observational study evaluated current management of elevated low-density lipoprotein cholesterol (LDL-C) in adult secondary prevention patients (all very high risk (VHR) by European guidelines) attending specialist clinics across Croatia. Data were collected retrospectively from patient records for the preceding 12 months. The subset judged to be at extreme risk (ER; American Association of Clinical Endocrinologists (AACE) criteria; n=48) were compared with the remaining patients (VHR group; n=41). All patients were receiving statins (75.6% VHR/81.3% ER at high-intensity), with only a minority receiving concomitant lipid-lowering treatment (7.3% VHR/16.7% ER). Median (Q1, Q3) LDL-C levels at the last visit were 1.9 (1.6, 2.4) mmol/L for VHR and 2.1 (1.5, 3.1) mmol/L for ER, with only 41.5% (95% CI 26.3-57.9) of VHR patients and 27.1% (15.3-41.9) of ER patients attaining their LDL-C targets (<1.8 mmol/L and <1.42 mmol/L, respectively). Thus, we found that a substantial proportion of VHR and ER secondary prevention patients being treated across Croatia had LDL-C levels exceeding the targets recommended in the European and newer AACE guidelines, but not all were receiving high-intensity statins. Identification of ER patients and their lipid patterns may help optimize usage of high-intensity statin treatment, alone or along with newer treatments, for better control of elevated LDL-C.

Key words: *Hyperlipidemia; Secondary prevention; High-risk patients; Very high-risk patients; Extreme risk patients*

Introduction

Dyslipidemia is a primary major risk factor for atherosclerotic cardiovascular disease (ASCVD), the

leading cause of death and disability in the developed world¹. Lipid-lowering therapy (LLT) aimed at reducing elevated low-density lipoprotein cholesterol (LDL-C), the dominant form of atherogenic cholesterol, substantially reduces the risk of cardiovascular (CV) events in the primary and secondary prevention settings²⁻⁴. Statin drugs have provided the backbone of LLT for several decades.

Correspondence to: *Hrvoje Pintarić, MD, PhD*, School of Dental Medicine, University of Zagreb, Gundulićeva 5, HR-10000 Zagreb, Croatia

E-mail: pintaric.hrvoje@gmail.com

Received October 1, 2019, accepted August 28, 2020

Given that the degree of risk reduction is proportional to the magnitude of LDL-C reduction⁵, the European Society of Cardiology/European Atherosclerosis Society (ESC/EAS)^{6,7} have set specific LDL-C targets for patients with hyperlipidemia, according to their CV risk. In 2011, an LDL-C target of <2.5 mmol/L was recommended for high risk (HR) and <1.8 mmol/L for very high risk (VHR) patients⁶, with the HR goal being subsequently revised to <2.6 mmol/L in 2016⁷. More recently, a new risk category, extreme risk (ER), has been defined in guidelines from the American Association of Clinical Endocrinologists (AACE) and American College of Endocrinology (ACE) as “progressive atherosclerotic cardiovascular disease (ASCVD) after achieving LDL-C <1.8 mmol/L; established clinical CV disease in patients with diabetes mellitus, chronic kidney disease (CKD) stage 3/4, or heterozygous familial hypercholesterolemia (FH); history of premature ASCVD (male aged <55 years and female aged <65 years)”⁸. Individuals falling into this category have a significantly increased risk of a major or fatal ASCVD event over the next 4-5 years. An LDL-C target of <1.42 mmol/L has been advocated for such patients⁸, on the basis of findings from large studies such as IMPROVE-IT (examining outcomes in subjects with acute coronary syndrome: Vytarin *vs.* simvastatin)⁹ and FOURIER (further cardiovascular outcomes research with PCSK9 inhibition in subjects with elevated risk)¹⁰, showing that lowering LDL-C to the levels below previous targets provided additional outcome benefits.

Data from observational studies and surveys in Western Europe and the US indicate that LDL-C targets are not being met in a substantial proportion of patients treated for dyslipidemia^{11,12}. A retrospective/prospective observational study was conducted to explore the management of dyslipidemia across several Central/Eastern European countries and Israel, with a focus on treatment patterns and LDL-C target achievements¹³. Here we present results for the Croatian subpopulation.

Patients and Methods

Briefly, this regional study was a retrospective/prospective non-interventional, observational study that enrolled adult patients diagnosed with hyperlipidemia who were receiving LLT and attending a specialist (cardiologist, diabetologist) and/or internist for rou-

tine visit¹³. Patients receiving LLT in the course of an interventional clinical trial were excluded. Data were collected from individual patient medical records for 12 months prior to enrolment (retrospective phase; all countries) and up to 6 months following enrolment (prospective phase; in Romania, Poland and the Czech Republic only). Patients were required to have at least 2 LDL-C values and valid LLT documentation (type of medication and dose) for the retrospective data collection period and provided informed consent where required by local regulations.

Our Croatian centers enrolled only VHR patients, classified according to the European guidelines⁶. Individuals who fulfilled the criteria for the newly defined ER category proposed by AACE/ACE⁸ were identified and their data compared with the remaining patients (designated as the VHR group).

Objectives

The primary study objective was to estimate the proportion of patients achieving recommended LDL-C target levels of <1.8 mmol/L for VHR⁶ and <1.42 mmol/L for ER⁸. Secondary objectives included LDL-C levels over time; use of statins and other LLT (type, dose, frequency) over time; CV events; clinical characteristics (demographics, medical history including CV events, symptoms of statin intolerance, hospitalizations); and parameters of clinical management of patients. No formal hypothesis was tested.

Study sample size

It was planned to enroll a total of 80-150 subjects *per* country in the regional study, based on the projected 50% of subjects achieving the primary outcome measure (achievement of ESC/EAS LDL-C targets). Thus, a sample size of 80 patients would enable the percentage to be estimated with 95% confidence interval (CI) with a half-width of 11.0%, with a corresponding half-width of 8.0% for a sample size of 150 patients.

Data analysis

Summary statistics only are presented for categorical variables (frequency and percentage in category, with 95% CI) and continuous variables (number of subjects, mean, median, standard deviation or standard error, interquartile range, minimum, and maximum). There was no data imputation.

Table 1. Study population (N=89)

Characteristic	Patients, n (%)	
	Very high risk (n=41)	Extreme risk (n=48)
Male/female	35 (85.4%) /6 (14.6%)	34 (70.8%) /14 (29.2%)
Age (yrs), mean (range)	66.1 (56-78)	64.3 (46-82)
Weight (kg), mean (range)	88.9 (57-173) [n=32]	85.0 (49-125) [n=38]
Current smoker	9 (22.0%)	10 (20.8%)
Diabetes	6 (14.6%)	24 (50.0%)
STEMI	12 (29.3%)	13 (27.1%)
Statin-intolerant ^a	1 (2.4%)	2 (4.2%)
Time from diagnosis ^b		
<1 year	9 (22.0%)	13 (27.1%)
≥1 to <2 years	2 (4.9%)	2 (4.2%)
≥2 to <3 years	1 (2.4%)	1 (2.1%)
≥3 to <4 years	0 (0%)	1 (2.1%)
≥4 to <5 years	1 (2.4%)	1 (2.1%)
≥5 years	8 (19.5%)	12 (25.0%)
Unknown	20 (48.8%)	18 (37.5%)

STEMI = ST-elevation myocardial infarction; ^asymptoms of statin intolerance; ^btime elapsed from diagnosis of hyperlipidemia to study enrolment.

Table 2. Lifestyle factors in study population

Parameter	Category	Patients, n (%)		
		All (N=89)	Very high risk (n=41)	Extreme risk (n=48)
Former smoker	Yes	28 (31.5%)	12 (29.3%)	16 (33.3%)
	No	26 (29.2%)	11 (26.8%)	15 (31.3%)
	Unknown	35 (39.3%)	18 (43.9%)	17 (35.4%)
Current smoker	Yes	19 (21.3%)	9 (22.0%)	10 (20.8%)
	No	70 (78.7%)	32 (78.0%)	38 (79.2%)
Alcohol ≥3 units/day	No		41 (100.0%)	48 (100.0%)
Low calorie diet	Yes	41 (46.1%)	19 (46.3%)	22 (45.8%)
	No	33 (37.1%)	15 (36.6%)	18 (37.5%)
	Unknown	15 (16.9%)	7 (17.1%)	8 (16.7%)
Low cholesterol diet	Yes		26 (63.4%)	32 (66.7%)
	No		8 (19.5%)	8 (16.7%)
	Unknown		7 (17.1%)	8 (16.7%)
Physical activity	Little/None	56 (62.9%)	27 (65.9%)	29 (60.4%)
	Light (1-3 days/week)	19 (21.3%)	6 (14.6%)	13 (27.1%)
	Moderate (3-5 days/week)	13 (14.6%)	7 (17.1%)	6 (12.5%)
	Very active (6-7 days/week)	1 (1.1%)	1 (2.4%)	0 (0%)

Results

Study population

A total of 89 patients, mean age 65.1 (range 46-82) years, were enrolled between December 2016 and March 2017 at four different sites. All were secondary prevention patients, including 30 patients with concomitant diabetes and 25 patients with ST-segment elevation myocardial infarction. There were no FH patients. Forty-eight patients met the criteria for ER⁸, leaving 41 patients in the VHR group. Patient characteristics are summarized in Table 1, while lifestyle risk factors are listed in Table 2. CV events (n=1-7) were recorded in 72 (80.9%) patients, including 33 (80.5%) VHR and 39 (81.3%) ER patients during the observation period. During this period, 77 (86.5%) patients were hospitalized, including 35 (85.4%) VHR and 42 (87.5 %) ER patients, most commonly because of myocardial infarction (n=18; 20.2%) or coronary revascularization (n=14; 15.7%).

Lipid-lowering therapies

All patients were receiving statins, mostly as monotherapy (VHR 92.7%/ER 83.3%), with very few receiving concomitant LLT (fibrates: VHR 4.9%/ER 14.6%

Table 3. Summary of mono- and combined lipid-lowering therapies (LLT)*

Treatment	Patients, n (%)	
	Very high risk (n=41)	Extreme risk (n=48)
Statin	38 (92.7%)	40 (83.3%)
Statin + ezetimibe	1 (2.4%)	1 (2.1%)
Statin + fibrates**	2 (4.9%)	7 (14.6%)
Total	41 (100%)	48 (100%)

*Anytime during the observation period. Each subject is included only once (e.g., if they received statin monotherapy for part of the observation period and statin + ezetimibe for another part, they are included under statin + ezetimibe); **fenofibrate or gemfibrozil.

Table 4. Summary of statin use by type and dose*

Type	Dose (mg)	Very high risk, n (%)		Extreme risk, n (%)	
		First visit	Last visit	First visit	Last visit
	10			1 (2.18%)	1 (2.18%)
Atorvastatin	20	1 (2.4%)	3 (7.3%)	3 (6.3%)	2 (4.2%)
	40	5 (12.2%)	7 (17.1%)	5 (10.4%)	6 (12.5%)
	80	0 (0%)	8 (19.5%)	3 (6.3%)	7 (14.6%)
Fluvastatin	40	1 (2.4%)	0 (0%)	0 (0%)	0 (0%)
	80	1 (2.4%)	0 (0%)	0 (0%)	0 (0%)
Rosuvastatin	10	1 (2.4%)	0 (0%)	1 (2.1%)	3 (6.3%)
	20	3 (7.3%)	0 (0%)	4 (8.3%)	3 (6.3%)
	40	2 (4.9%)	2 (4.9%)	1 (2.1%)	0 (0%)
Simvastatin	10	1 (2.4%)	0 (0%)	0 (0%)	0 (0%)
	20	1 (2.4%)	0 (0%)	0 (0%)	0 (0%)

*Data were missing from analysis for approximately 50% of patients. Patients may have been taking >1 statin. Separate analysis showed that 31 (75.6%) very high risk patients and 39 (81.3%) extreme risk patients were taking high-intensity statins (atorvastatin 40-80 mg or rosuvastatin 20-40 mg/day) at some point during the study.

or ezetimibe: VHR 2.4%/ER 2.1%) (Table 3); 75.6% of VHR and 81.3% of ER patients were taking high-intensity statins (atorvastatin 40-80 mg or rosuvastatin 20-40 mg/day) at some point during observation (Table 4).

Thirteen patients (14.6%: 6 VHR/7 ER) had a switch in LLT during observation and another 13 patients (14.6%; 5 VHR/8 ER) had modifications in dose and/or frequency, mostly because of insufficient lipid-lowering effect, as shown in Table 5. Four patients (all ER) discontinued their LLT for various reasons.

LDL-C and other lipid parameters

As shown in Figure 1, median (Q1, Q3) LDL-C levels were 2.5 (2.0, 3.8) mmol/L at the first and 1.9 (1.6, 2.4) mmol/L at the last visit of observation for

VHR. The respective levels were 2.4 (1.7, 3.7) mmol/L and 2.0 (1.5, 3.1) mmol/L for ER. Detailed LDL-C and other lipid data (total and HDL-cholesterol and triglycerides) are shown in Table 6.

During observation, only 17 (41.5%; 95% CI 26.32-57.89) VHR patients and 13 (27.1%; 15.28-41.85) ER patients were found to have LDL-C levels within the target ones (<1.8 mmol/L and <1.42 mmol/L, respectively) (Fig. 2).

Median LDL-C, total and HDL-cholesterol at the last visit were compared between VHR and ER patients in post-hoc analysis. Only HDL-C showed a (marginally) significant difference between the two

Table 5. Most common reasons for switching/changing/discontinuing lipid-lowering therapy (LLT)

Status and reason*	Patients, n (%)	
	Very high risk (n=41)	Extreme risk (n=48)
Switched to other LLT (including statins)	6 (14.6%)	7 (14.6%)
Insufficient lipid-lowering effect	3 (50.0%)	3 (42.9%)
Modified dose and/or frequency	5 (12.2%)	8 (16.7%)
Insufficient lipid-lowering effect	3 (60.0%)	3 (37.5%)
Discontinued	0 (0%)	4 (8.3%)

*Reasons expressed as % of status total; all reasons with >1 patient are shown.

Table 6. Lipid levels (mmol/L) at first and last visit of the observation period

Parameter	Visit		Very high risk	Extreme risk	
LDL-C	First	n	41	48	
		Median	2.510	2.350	
	Last	25 th percentile (Q1)	1.980	1.705	
		75 th percentile (Q3)	3.800	3.715	
		Min	1.3	0.7	
		Max	6.9	5.8	
		n	41	48	
		Median	1.900	2.030	
		25 th percentile (Q1)	1.600	1.530	
		75 th percentile (Q3)	2.400	3.070	
		Min	0.8	0.52	
		Max	4.4	4.6	
	HDL-C	First	n	41	48
			Mean	1.190	1.070
Last		Median	1.140	0.995	
		SD	0.2969	0.3120	
		25 th percentile (Q1)	1.000	0.815	
		75 th percentile (Q3)	1.400	1.380	
		Min	0.70	0.50	
		Max	2.20	1.70	
		n	37	45	
		Mean	1.138	1.023	
		Median	1.100	1.000	
		SD	0.2868	0.3134	
25 th percentile (Q1)		1.000	0.800		
75 th percentile (Q3)		1.300	1.200		
Min	0.60	0.50			
Max	2.17	1.80			
Total cholesterol	First	n	40	47	
		Mean	4.840	4.638	
	Last	Median	4.675	4.270	
		SD	1.4478	1.5719	
		25 th percentile (Q1)	3.600	3.400	
		75 th percentile (Q3)	5.850	5.500	
		Min	3.00	2.30	
		Max	9.00	8.40	
		n	37	46	
		Mean	3.694	3.993	
		Median	3.500	3.700	
		SD	0.8590	1.2131	
	25 th percentile (Q1)	3.200	3.300		
	75 th percentile (Q3)	3.900	4.800		
Min	2.10	1.70			
Max	6.30	7.10			
Triglycerides	First	n	41	47	
		Mean	1.590	1.877	
	Last	Median	1.600	1.600	
		SD	0.4538	0.9145	
		25 th percentile (Q1)	1.300	1.200	
		75 th percentile (Q3)	1.800	2.500	
		Min	0.84	0.60	
		Max	2.76	4.10	
		n	38	47	
		Mean	1.384	1.708	
		Median	1.275	1.450	
		SD	0.6239	0.9253	
	25 th percentile (Q1)	1.100	1.000		
	75 th percentile (Q3)	1.500	2.400		
Min	0.50	0.40			
Max	4.40	4.30			

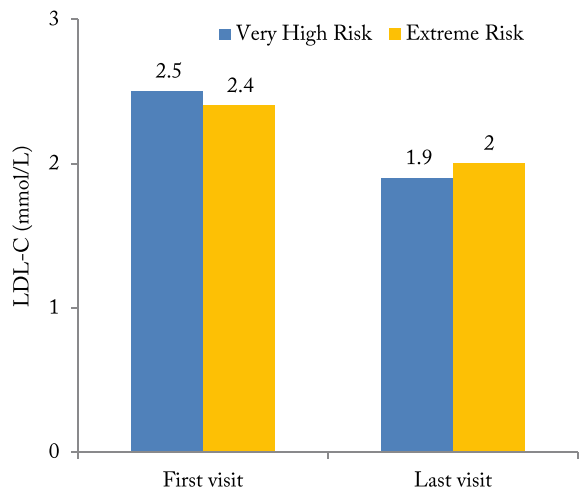


Fig. 1. Median LDL-C levels (mmol/L) at first and last visit of the observation period according to cardiovascular risk category (bars indicate Q1 and Q3).

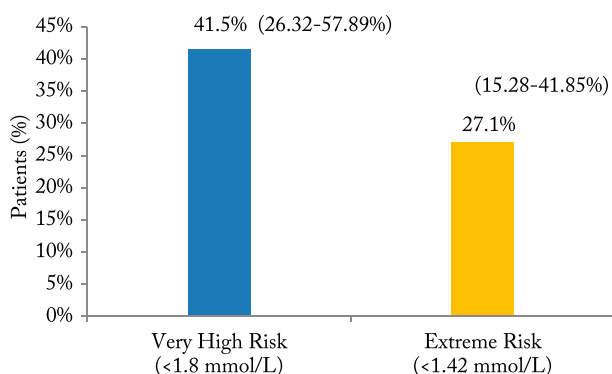


Fig. 2. Achievement of ESC/EAS and AACE-defined LDL-C targets by cardiovascular risk category at any time during the observation period. Results shown as percentage of patients in category with two-sided 95% confidence intervals in brackets.

subgroups (1.1 in VHR vs. 1.0 mmol/L in ER; p=0.051) (Table 7).

Adverse events

Only three (<1%) patients were listed as having symptoms of statin intolerance (statin-associated muscle symptoms (SAMS) or hepatotoxicity).

Discussion

This observational study explored patterns of management and LDL-C target achievement in VHR

Table 7. Lipid levels at last visit

Parameter (mmol/L)	Statistics	Very high risk (N=41)	Extreme risk (N=48)
LDL-C	N	41	48
	Mean	2.02	2.32
	Median	1.90	2.03
	SD	0.68	1.01
	Q1	1.60	1.53
	Q3	2.40	3.07
	Min	0.80	0.52
	Max	4.40	4.60
	p-value*	0.30	
HDL-C	N	41	48
	Mean	1.14	1.02
	Median	1.10	1.00
	SD	0.30	0.31
	Q1	1.00	0.80
	Q3	1.30	1.20
	Min	0.60	0.50
	Max	2.17	1.80
	p-value*	0.05	
Triglycerides	N	41	48
	Mean	1.39	1.78
	Median	1.30	1.47
	SD	0.61	1.05
	Q1	1.10	1.00
	Q3	1.50	2.40
	Min	0.50	0.40
	Max	4.40	5.30
	p-value*	0.28	
Total cholesterol	N	40	47
	Mean	3.71	3.99
	Median	3.50	3.70
	SD	0.84	1.20
	Q1	3.20	3.30
	Q3	4.10	4.80
	Min	2.10	1.70
	Max	6.30	7.10
	p-value*	0.29	

*Extreme risk vs. very high risk.

secondary prevention patients with dyslipidemia in Croatia.

Although all patients were receiving statins, mostly at high intensity (75.6% VHR/81.3% ER), only a minority were receiving concomitant LLT (7.3% VHR/16.7% ER; either ezetimibe or fenofibrate/gemfibrozil). The most common reason for discontinuing or changing LLT during observation was insufficient lipid-lowering effect. Overall, less than half of our patients ($n=42$, 47.2%; 95% CI 36.5–58.1%) were found to have LDL-C levels <1.8 mmol/L during observation. These proportions were slightly better than those from the main regional study¹³, in which 42.0% (39.1%–45.0%) of VHR patients achieved <1.8 mmol/L. However, our study population differed from the main regional study in that we did not include any FH patients. Approximately half of our patients met the criteria for ER⁸ and less than 30% of this subgroup met their very stringent target of <1.42 mmol/L. It seems likely that such a category will be included in future ESC guidelines.

Underdosing and statin discontinuation/poor adherence to therapy, which can be a consequence of statin intolerance, are recognized as the key contributors to inadequate LDL-C reduction in patients with dyslipidemia and have been linked to poorer clinical outcomes^{7,14}. Detailed expert guidelines for diagnosis and management of SAMS are now available and it is hoped that improving awareness of these issues among physicians and patients will have a beneficial effect on statin adherence¹⁵. Other potential reasons for failure to reach LDL-C targets include reimbursement/financial issues leading to suboptimal treatment, and extremely high baseline LDL-C levels.

The approval in 2015 of the proprotein convertase subtilisin-kexin type 9 inhibitors (PCSK9i) evolocumab and alirocumab, which improve LDL-receptor (LDLR) recycling and increase LDLR availability on hepatocyte cell surfaces¹⁶, has provided new options for treatment of dyslipidemia. Adding PCSK9i can lower LDL-C by additional 60% in patients who are already receiving maximal statin therapy^{10,17–20}, and outcome data have shown that this translates into a significantly reduced risk of CV events^{10,21}. To date, PCSK9i have been well tolerated, with few patients discontinuing treatment due to adverse events^{10,18,20}. European guidelines recommend that PCSK9i may be considered for VHR patients with ASCVD, including

those with progressive ASCVD or diabetes with target organ damage or a major CV risk factor or severe FH without ASCVD but severely elevated LDL-C despite maximal statin/ezetimibe therapy²². None of our Croatian patients were receiving these agents.

Limitations of our observational study included small size of some subgroups, such as the statin intolerance group. Changes in LDL-C levels should be interpreted with caution, given the variable duration of LLT, as well as the lack of predefined timepoints for LDL-C measurements. There also were some missing data, e.g., on lifestyle risk factors.

Conclusions

Our findings indicate that a substantial proportion of VHR and ER secondary prevention patients being treated across Croatia have LDL-C levels exceeding the targets recommended in European and newer AACE/ACE guidelines. Despite this, not all patients are receiving high-intensity statins as recommended. Identification of ER patients and their lipid patterns may help optimize the usage of high-intensity statin treatment, alone or in combination with newer treatments, for better control of elevated LDL-C.

Data availability. The datasets used and/or analyzed during the study are available from the corresponding author on reasonable request. Qualified researchers may request data from Amgen clinical studies. Complete details are available at: <http://www.amgen.com/datasharing>.

Acknowledgments

The study was supported by Amgen. Joshua David of Quartesian, Bangalore, provided statistical analysis. Julia Balfour of Northstar Medical Writing and Editing, Dundee, UK, provided medical writing support (with financial support from Amgen).

The authors wish to thank the following participating centers, their patients and staff: Sestre milosrdnice University Hospital Centre, Department of Cardiovascular Diseases, Zagreb; Zagreb University Hospital Centre, Department of Cardiovascular Diseases, Zagreb; Osijek University Hospital Centre, Department of Cardiology, Osijek; and Rijeka University Hospital Centre, Department of Cardiology, Rijeka.

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Sažetak

LIJEČENJE HIPERLIPIDEMIJE U BOLESNIKA
S VRLO VISOKIM I EKSTREMNO VISOKIM RIZIKOM U HRVATSKOJ

H. Pintarić, M. Knezović Florijan, I. Bridges, R. Steiner, L. Zaputović i D. Miličić

Ova opservacijska studija analizirala je trenutno liječenje povišenih vrijednosti LDL kolesterola (LDL-C) u bolesnika koji su liječeni zbog hiperlipidemije u okviru sekundarne prevencije (prema europskim smjernicama svi su pripadali u skupinu bolesnika s vrlo visokim rizikom) i kontrolirali su se kod specijalista diljem Hrvatske. Podaci su prikupljeni retrospektivno tijekom 12 mjeseci iz bolesničke medicinske dokumentacije. Skupina bolesnika za koju je procijenjeno da je u ekstremno visokom riziku (ER; AACE kriteriji; n=48) uspoređivana je sa skupinom s visokim rizikom (VHR skupina; n=41). Svi bolesnici su primali statine (75,6% bolesnika s VHR/81,3% bolesnika s ER liječeno je visokim dozama statina), dok je manjina bolesnika istodobno primala i drugu terapiju za snižavanje lipida (7,3% VHR/ER 16,7%). Kod posljednjeg posjeta medijan vrijednosti LDL-C (Q1, Q3) u skupini VHR iznosio je 1,9 (1,6, 2,4) mmol/L, dok je u skupini ER iznosio 2,1 (1,5, 3,1) mmol/L. Samo 41,5% (95% CI 26,3-57,9) bolesnika s VHR i 27,1% (15,3-41,9) bolesnika s ER imali su razine LDL-C unutar ciljne razine (<1,8 mmol/L i <1,42 mmol/L). Rezultati studije pokazuju kako unatoč mjerama sekundarne prevencije velik broj visokorizičnih bolesnika i bolesnika s ekstremnim rizikom ima razine LDL-C koje premašuju ciljne vrijednosti preporučene u europskim i novijim AACE smjernicama, ali usprkos navedenom mnogi bolesnici nisu liječeni statinima u visokoj dozi. Identifikacija bolesnika s ekstremnim rizikom i njihovih lipidnih obrazaca mogla bi povećati upotrebu visokih doza statina, samostalno ili u kombinaciji s novijim lijekovima, radi bolje kontrole povišenog LDL-C

Ključne riječi: *Hiperlipidemija; Sekundarna prevencija; Bolesnici s visokim rizikom; Bolesnici s vrlo visokim rizikom; Bolesnici s ekstremno visokim rizikom*