Research   **Open Access**

Change of Blood Pressure Control and Related Factors in Three Types of Heart Failure Based on the Jnc 7, 8 Hyprertension Guidelines

Hong Seok Lee[1]*, Belen Nunez[1], Ferdinnd Visco[2], Savi Mushiyev[2] and Gerald Pekler[2]

[1]Department of Medicine, Metropolitan Hospital, New York Medical College, New York, NY, USA

[2]Division of Cardiology, Department of Medicine, Metropolitan Hospital, New York Medical College, New York, NY, USA

*Corresponding author: Hong Seok Lee, Department of Medicine, Metropolitan Hospital, New York Medical College, New York, NY, USA, Tel: 212 423 8456; Fax: 212 423 6338; E-mail: lhscd11@gmail.com

Abstract

The Joint National Committee (JNC) 8 hypertension guidelines were released in 2014 targeting higher blood pressure (BP) goals and it may allow the less antihypertensive medications. We will determine how BP was affected in different types of heart failure according to JNC 7, 8.732 patients enrolled in our heart failure program were analyzed retrospectively. And 688 patients who had been followed since March, 2014 were included. Based on ACC/AHA guidelines, heart failure is classified as a reduced ejection fraction (HFrEF, EF < 40), preserved ejection fraction (HFpEF, EF > 50) and heart failure with an improved ejection fraction (HFpEF (i), EF ≥ 40). 70.6% (486/688) patients were controlled based on the new guidelines, on the contrary, previous guideline revealed 58.7% BP control. Mean systolic BP was 128.9 ± 18 mmHg in heart failure with reduced EF and 125.1 ± 17 mmHg in heart failure with preserved EF. Obesity [Odds ratio (OR): 0.119, 95%, Confidence Interval (CI): 0.048-0.284], ACE inhibitor [OR: 2.659, 95% CI: 1.500-3.415] and Diuretics [OR: 1.904, 95%, CI: 1.068-3.394] were noted to significantly differentiate the controlled versus the uncontrolled BP group in reduced EF group. And obesity (BMI ≥ 30) was associated with BP control in HFrEF [OR: 0.180, 95% CI: 0.090-0.341]. The control rate according to JNC 8 was more increased compared to one based on JNC 7 even with the same medication. In each type of heart failure, there were medication related differences of risk factors related to BP control by two different guidelines. Patients may need change types of medication to control BP according to types of heart failure.

Keywords Hypertension; Types of heart failure; Type of medication; Control; Blood pressure

Introduction

Blood pressure has a great effect on heart failure prognosis [1]. Heart failure is resulted from several modifiable risk factors such as uncontrolled blood pressure (BP) [2]. It has also been reported that the higher the systolic blood pressure (SBP), the less ejection fraction in heart failure patients [3]. Patients with with different types of heart failure is treated differently in comparison to ones with benign hypertension [4]. Adequate BP control in heart failure patients is crucial to reduce the cardiovascular mortality and morbidity [5]. One study demonstrated that patients with uncontrolled hypertension experienced microvascular and macrovascular complications, for example, peripheral vascular disease, myocardial infarction and stroke [6,7]. The Joint National Committee (JNC) 8 hypertension guidelines in 2014 was targeting for higher blood pressure goals and they could use less antihypertensive medications [8]. The diagnostic criteria has been changed from JNC- 7 to JNC 8, however, optimal blood pressure management in heart failure patients has not been reported. To prevent and reduce the cardiovascular complication, it is important to understand the current control rate and management of risk factors related to hypertension in a heart failure population. So, the risk factors related to blood pressure control need to be evaluated again for better control. Especially, in heart failure patients, using proper medications is an important factor to control blood pressure because hypertension increases cardiac work and then can affect prognosis [5,9]. In terms of outcomes of heart failure, obesity was reported to

have positive relationship with controlled blood pressure [7]. The purpose of this study was to investigate changed risk factors associated with controlled blood pressure among different types of heart failure when the guidelines were changed from JNC 7 to JNC 8.

Methods

The study protocol was approved by the Institutional Review Board at New York Medical College (Westchester, NY). All patients with a diagnosis of heart failure and hypertension in medical records were identified from March, 2014. All patients' medical records were stored in a heart failure cohort study's secure folder and all patients were discussed in a heart failure meeting. We excluded those who did not follow up or were discharged from the cardiology clinic. Blood pressure goal of less than 150/90 mmHg for patients 60 years of age or older who did not have diabetes or chronic kidney disease. Patients 18 to 59 years of age without major comorbidities, and those 60 years of age or older who had diabetes, chronic kidney disease, or both conditions, the new blood pressure goal is less than 140/90 mmHg [10]. Based on ACC/AHA guidelines [11], heart failure is classified as three types of heart failures. They are heart failure with a reduced ejection fraction (HFrEF, EF < 40), a preserved ejection fraction (HFpEF, EF > 50) and heart failure with an improved ejection fraction (HFpEF (i), EF ≥ 40). HFrEF was also referred as systolic HF and HFpEF was called as diastolic HF. HFpEF (i) has been recognized that a subset of patients with HFpEF previously had HFrEF. Obesity was defined according to NCEP-ATP III [12]. The number of normal weight (BMI < 25 kg/m^2), overweight (30 kg/m^2 > BMI ≥ 25 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) were counted respectively. The

proportions of heart failure subjects with controlled BP were ascertained for selected biochemical results, and comorbidities. The number of classes of BP-lowering medications, including angiotensin converting enzyme inhibitors (ACEi) or angiotensin receptor blockers (ARB), beta-blockers, calcium channel blockers (CCB), aldacton and diuretics, was also reported. In addition, history cardiac catheterization or ICD (Implatable cardioverter defibrillator) was acquired from electronic medical record. BP was measured three times on the right arm while the individual was at rest in a seated position for at least 5 minutes using a mercury sphygmomanometer (Baumanometer; Baum, Copiague, NY). We checked their blood pressure three times. The final BP value was obtained by averaging the values of the second and third BP measurements. The timing of blood pressure control was defined by blood pressure at the last visit of clinic. To rule out coarctation of the aorta, echocardiogram was performed because it leads to different management for blood pressure.

Statistical Analysis

All data were given as actual numbers with percentage. The demographic characteristics of the study were presented according to control of blood pressure in a heart failure program. Significant associations between the characteristics of subjects that were related to their control of hypertension were analyzed. A multiple logistic regression analysis was used to assess significant associations between the characteristics of subjects that were related to their control of hypertension. Variables with a P < 0.25 in the univariate test were selected as candidates for the multivariate model along with age and sex. Adjustments were made for patient age, sex, comorbidities and anthropometric characteristics. Statistical analyses were performed using the SAS (Version 9.4; SAS Institute, Cary, NC). A P value < 0.05 was considered statistically significant.

Characteristics	JNC 7 guidelines			JNC 8 guidelines		
	Controlled Blood pressure	Uncontrolled Blood pressure	P-value	Controlled blood pressure	Uncontrolled Blood pressure	P-value
Sex						
Male	244(60.4)	174(62.3)		300(61.7)	118(58.4)	
Female	160(39.6)	110(38.7)	0.818	186(38.3)	84(41.6)	0.334
Age(years)						
≥65	192(47.5)	108(53.5)		230(47.3)	70(61.4)	
65-45	194(48.0)	86(42.6)		236(48.6)	44(38.6)	
<45	18(4.5)	8(4.0)	0.575	20(4.1)	0(0.0)	0.554
DM						
Yes	174(43.1)	136(48.9)		214(44.0)	96(47.5)	
No	230(56.9)	148(52.1)	0.211	272(56.0)	106(52.5)	0.401
Ethnicity						
African American	154(38.1)	110(38.7)		186(38.3)	78(38.6)	
Hispanic	214(52.9)	158(55.6)		260(53.5)	112(55.5)	
Asian	30(7.4)	8(2.8)		34(7.00)	4(2.0)	
Caucasian	6(1.6)	8(2.8)	0.044	6(1.23)	8(4.0)	0.008
Ejection fraction(%)						
≥55	52(13.3)	28(10.0)		62(13.1)	18(9.1)	
40-55	88(22.5)	48(17.1)		104(21.9)	32(16.2)	
<40	252(64.3)	204(72.9)	0.064	308(65.0)	148(74.8)	0.047
DM						
Yes	174(43.1)	136(47.9)		214(44.0)	96(47.5)	
No	230(56.9)	148(52.1)	0.211	272(56.0)	106(52.5)	0.402
CKD						
Yes	78(19.3)	52(18.3)	0.234	60(12.3)	20(9.9)	0.542

No	326(80.7)	232(81.7)		426(87.7)	192(90.1)	
ESRD on HD						
Yes	28(7.0)	8(2.8)		30(6.2)	16(3.0)	
No	376(93.1)	276(97.2)	0.017	456(93.8)	196(97.0)	0.085
BMI(kg/m2)						
≥35	48(19.2)	48(16.9)		66(13.6)	30(14.9)	
35-30	46(18.0)	56(19.7)		58(11.9)	44(21.8)	
25-30	138(35.9)	98(34.5)		168(34.6)	68(33.7)	
<25	172(27.0)	82(28.9)	0.004	194(39.9)	60(29.7)	0.004
LDL(mg/dl)						
≥100	108(26.7)	60(21.1)		126(25.9)	42(20.8)	
<100	296(73.3)	224(78.9)	0.153	360(74.1)	160(79.2)	0.153
TG(mg/dl)						
≥150	104(23.9)	64(25.7)		116(23.9)	52(25.7)	
<150	300(76.1)	220(74.3)	0.602	370(76.1)	150(74.3)	0.602
HDL						
Male ³ 40 mg/dl, Female ³ 50 mg/dl	176(43.6)	108(56.4)	0.814	202(41.6)	82(40.6)	0.814
Male < 40 mg/dl, Female < 50 mg/dl						
	228(56.4)	176(43.6)		284(58.4)	120(59.4)	
Cardiac Cath						
Yes	216(53.5)	150(52.8)		262(53.9)	104(51.5)	
No	188(46.5)	134(48.2)	0.867	224(46.1)	98(48.5)	0.517
ICD insertion						
Yes	68(16.8)	48(16.9)		82(16.9)	34(16.8)	
No	336(83.2)	236(83.1)	0.989	404(83.1)	168(83.2)	0.989
Aspirin						
Yes	272(67.3)	208(73.2)		328(67.5)	152(72.3)	
No	132(32.7)	76(26.8)	0.096	158(32.5)	50(24.8)	0.044
CCB						
Yes	94((23.7)	96(33.8)		124(25.5)	66(32.7)	
No	310(76.7)	188(66.2)	0.002	362(74.5)	136(67.3)	0.055
Insulin						
Yes	100(24.8)	74(26.1)		120(24.7)	54(26.7)	
No	304(75.3)	210(73.9)	0.698	366(75.3)	148(73.3)	0.574
ACE or ARB						
Yes	246(60.9)	106(39.3)	<0.001	282(58.0)	70(34.7)	0.001

No	158(39.1)	178(62.7)		204(42.0)	132(65.4)	
Diuretics						
Yes	234(57.9)	144(50.7)		284(58.4)	94(46.5)	
No	170(42.1)	140(49.3)	0.061	202(41.6)	108(53.5)	0.004
Alactone						
Yes	57(14.1)	80(28.1)		58(11.9)	79(23.8)	
No	347(85.9)	204(71.9)	0.256	428(88.1)	123(76.2)	0.138
Anti-lipid						
Yes	290(71.8)	172(60.6)		340(70.0)	122(60.4)	
No	114(28.2)	112(39.4)	0.002	146(30.0)	80(39.6)	0.015
Beta-blocker						
Yes	308(76.2)	204(71.8)		362(74.5)	150(74.3)	
No	96(23.8)	80(28.1)	0.192	124(25.5)	52(25.7)	0.95
Isordil/Hydralazine						
Yes	28(6.1)	38(13.3)		34(5.7)	32(15.8)	
No	376(93.9)	246(86.6)	0.211	452(94.3)	170(84.2)	0.126
Cocaine history						
Yes	44(10.9)	38(13.4)		56(11.5)	26(12.9)	
No	360(89.1)	246(86.2)	0.322	430(88.5)	176(87.1)	0.619
Compliance						
Yes	114(28.2)	84(28.7)		136(28.0)	62(30.7)	
No	290(71.8)	200(70.4)	0.698	350(72.0)	140(69.3)	0.475
Smoking						
Yes	94(28.2)	64(22.5)		84(17.3)	74(36.6)	
No	310(71.8)	220(77.5)	0.235	402(82.7)	128(63.4)	0.526

Table 1: General characteristics in heart failure patients.

Abbreviations: CCB: Calcium Channel Blocker; ACEi: Angiotensin-Converting Enzyme Inhibitors; ARB: Angiotensin II Receptor Blockers; ICD: Implantable Cardioverter Defibrillator; Cardic Cath: Cadiac Catherizaation

	HFrEF		HFpEF		HFpEF (i)	
	JNC7	JNC8	JNC7	JNC8	JNC7	JNC8
Rate of BP control (%)	55.3% (252/456)	67.5% (308/456)	64.2% (88/136)	76.5% (104/136)	65% (52/80)	77.5% (62/80)
Mean SBP ± SD (mmHg)	127.1+17		129.0+21		124.4+18	
Mean DBP ± SD (mmHg)	70.9+11.5		74.6+13		68.5+9.96	

Table 2: Mean blood pressure and blood pressure control rate in categorized heart failure groups.

Abbreviations: BP: Blood Pressure; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SD: Standard Deviation; HFrEF: Heart

Failure with Reduced Ejection Fraction, EF < 40; HFpEF: Heart Failure with Preserved Ejection Fraction, EF > 50; HFpEF (i): Heart Failure with an Improved Ejection Fraction, EF ≥ 40.

	HFrEF	HFpEF	HFpEF (i)
B-blockers	75.4% (344/456)	72.1% (98/136)	72.5% (58/80)
ACEi or ARB	50.4% (230/456)	51.5% (70/136)	52.5% (42/80)
CCB	28.1% (128/456)	26.5% (36/136)	25% (20/80)
Diuretics	56.1% (256/456)	54.4% (74/136)	50% (40/80)
Aldactone	26.3% (82/456)	29.4 (40/136)	18.7% (15/80)
Isordil/Hydralazine	10.5% (48/456)	8.8% (12/136)	7.5% (6/80)

Table 3: Medication lists in categorized heart failure groups.

Abbreviations: B-blocker: Beta-Blocker; ACEi: Angiotensin-Converting Enzyme Inhibitors; ARB: Angiotensin II Receptor Blockers; CCB: Calcium Channel Blocker; HFrEF: Heart Failure with Reduced Ejection Fraction, EF < 40; HFpEF: Heart Failure with Preserved Ejection Fraction, EF > 50; HFpEF (i): Heart Failure with an Improved Ejection Fraction, EF ≥ 40.

Results

General characteristics between blood pressure controlled group and uncontrolled group of heart failure patients

In this study, there were significantly related factors for control of blood pressure in a heart failure population based on different guidelines (Table 1). Ethnicity, BMI (Body Mass Index), hemodialysis, CCB, ACEi or ARB, and anti-lipid medication were related to controlled blood pressure based on JNC 7. Aspirin, ACEi or ARB, diuretics, anti-lipid medication and BMI were associated with blood pressure control using JNC 8 guidelines. African American and Hispanic population were dominant in this study (Table 1). Overall, 486 subjects (70.6%) of 688 total study population were identified having controlled blood pressure according to JNC 8, however, 58.7% (404 out of 688) had controlled blood pressure based on JNC 7. Specifically, 55.3% (based on JNC 7) vs 67.5% (based on JNC 8) in HFrEF , 64.2% (based on JNC 7) vs 76.5% (based on JNC 8) in HFpEF, 65% (based on JNC 7) vs 77.5% in HFpEF (i) (based on JNC 8) patients had controlled blood pressure (Table 2). Mean systolic blood pressure in HFrEF, HFpEF and HFpEF (i) was 127.1 mmHg, 129.0 mmHg and 124.4 mmHg respectively (Table 2).

Treatment of hypertension in patients with heart failure with a reduced ejection fraction (HFrEF), a preserved ejection fraction (HFpEF) and an improved ejection fraction (HFpEF (i))

Most of patients with HFrEF, HFpEF and HEpEF (i) took beta-blockers in our study group, in addition to that, around 50% of patient used ACEi or ARB and diuretics. Aldactone and CCB were used in only approximately 20% patients in our population (Table 3).

Factors associated with controlled blood pressure in a heart failure population

Table 4 showed associated factors for controlled blood pressure according to types of heart failure using two different guidelines. Odds ratio greater than one in Table 4 represents less control of hypertension. In HFrEF, individuals with intake of ACEi or ARB, diuretics, and anti-lipid medication were more likely have uncontrolled blood pressure according to JNC 7 guidelines using the multiple logistic regression analysis (Table 4). Similar risk factors by JNC 7 were associated with uncontrolled blood pressure except anti-lipid medication by JNC 8. HFpEF subjects taking aspirin were likely to have uncontrolled blood pressure according to JNC8. In HFpEF (i), anti-lipid medication was significantly associated with uncontrolled of blood pressure by JNC 7,8. Beta-blocker had statistically significant association with control of blood pressure applying JNC 8.

	HFrEF		HFpEF		HFpEF (i)	
	Control of blood pressure Adjusted OR (95% CI) Based on JNC 7	Control of blood pressure Adjusted OR (95% CI) Based on JNC 8	Control of blood pressure Adjusted OR (95% CI) Based on JNC 7	Control of blood pressure Adjusted OR (95% CI) Based on JNC 8	Control of blood pressure Adjusted OR (95% CI) Based on JNC 7	Control of blood pressure Adjusted OR (95% CI) Based on JNC 8
ACEi or ARB	3.01 (1.99-4.55)*	3.48 (2.21-5.47)*	1.88 (0.81-4.33)	1.53 (0.55-4.25)	3.34 (0.90-12.31)	4.82 (0.97-7.07)
Beta-blocker	1.56 (0.96-0.21)	1.16 (0.70-1.93)	0.77 (0.31-1.93)	0.81 (0.28-2.33)	0.44 (0.10-1.91)	0.07 (0.01-0.62) *
Diuretics	1.63 (1.06-2.50)*	2.16 (1.37-3.41)*	1.06 (0.49-2.28)	1.35 (0.54-3.34)	1.09 (0.33-3.60)	1.61 (0.39-6.66)
Anti-lipid Medication	1.65 (1.03-2.65)*	1.32 (0.80-2.14)	1.22 (0.49-3.07)	1.86 (0.65-5.29)	6.61 (1.88-23.24) *	4.76 (1.73-5.89) *
Obesity (BMI≥30)	0.18 (0.09-0.34) *	0.16 (0.08-029) *	0.51 (0.22-1.16)	0.42 (0.17-1.08)	0.36 (0.05-2.61)	0.11 (0.01-1.05)
Aspirin	0.53 (0.37-0.96) *	0.58 (0.35-0.96) *	0.50 (0.21-1.20)	0.17 (0.05-0.60) *	0.91 (0.19-4.26)	1.60 (0.25-10.3)

Table 4: Factors associated with controlled blood pressure in categorized heart failure groups.

Abbreviations: ACEi: Angiotensin-Converting Enzyme Inhibitors: ARB: Angiotensin II Receptor Blockers; HFrEF: Heart Failure with Reduced Ejection Fraction, EF < 40; HFpEF: Heart Failure with Preserved Ejection Fraction, EF > 50; HFpEF (i): Heart Failure with an Improved Ejection Fraction, EF ≥ 40.

Odds ratios were adjusted by variables of p-value < 0.10 in the univariate tests along with age and sex.

Discussion

This is a study to analyze the difference between JNC 7 and JNC 8 guidelines in terms of the control of blood pressure and risk factors in different types of heart failure. In this study, 70.6% of heart failure patients had controlled blood pressure according to JNC 8 guidelines, which means the control rate was more increased compared to one based on JNC 7 guidelines with the same medication. JNC 8 guidelines are advising less use of anti-hypertensive medication, therefore, this study population may need less intensive treatment for the blood pressure because the control rate is improved based on JNC 8 guideline [8]. It is also expected to decrease medical cost and increase patients' satisfaction for elderly or disable patients with comorbidities. Even if there is no need for frequent visit, however, it needs to monitor cardiovascular complication because many patients for whom the target blood pressure is now more permissive are at high cardiovascular risk [13].

In addition to that, the types of heart failure should be taken into consideration for control of hypertension by medication [3]. In HFrEF, their control rate was lower than those of HFpEF and HFpEF (i) subjects (Table 2). To prevent pathologic remodelling [14], HFrEF needs more strict therapy than other groups, however, the benefit of treating to these lower levels of blood pressure with antihypertensive drugs is not established based multiple studies [15]. In addition, the agents demonstrated to lower blood pressure have not always conferred a mortality benefit [10,16,17]. Therefore, we need more study for optimal blood pressure treatment in heart failure in the future.

The risk factors for blood pressure control were not quite different even if their control rates among each group (HFrEF, HFpEF and HFpEF (i)) were different applying two different guidelines (Table 4). Mostly, risk factors related to BP control were medications. HFrEF patients taking ACEi or ARB and diuretics were more likely to have uncontrolled blood pressure (Table 4). It could not be explained that the ACEi or ARB intake is the cause of uncontrolled blood pressure from retrospective analysis. It may suggest that patients taking ACEi or ARB needs medication reconciliation to improve their blood pressure control. African American patients taking ACEi and ARB have a lesser antihypertensive response than Caucasian [18], which might be consistent with our study. The reason is that African Americans is main proportion of our subjects (approximately 40%), therefore, ACEi or ARB was associated with uncontrolled blood pressure (Table 4). ACEi or ARB has been reported to improve survival of heart failure patients [18,19], so it is generally recommended. It needs further scientific explanation why this finding in our study is contradictory to previous study. The benefits of controlling blood pressure in heart failure patients are dependent on the types of agents [3], therefore, patients in our population may need more individualized medication based for better control.

Diuretics such as lasix, hydrochlorothiazide (HCTZ) were used to decrease the intracardiac filling pressure to lower blood pressure [20]. In our study population, for HFrEF patients, diuretics had negative association with controlled blood pressure, however, there was no definite cause and effect relationship. Thiazide-type diuretics were reported to have cardioprotective effect using meta-analysis, however, the data of diuretics in our study were not differentiated between thiazide- type diuretics (i.e. hydrochlorothiazide) and thiazine-like diuretics (i.e. Lasix and metolazone) [21]. It may need further study in the future study.

Aspirin can reduce the hemodynamic improvement associated with ACEi in advanced HF [22] because aspirin can impair vasodilation effect of ACEi [22], however, aspirin was associated with controlled blood pressure in HFpEF and HFrEF in our study (Table 4). It seems to be opposite to previous study in the view of the role of aspirin blocking ACEi effect [22]. It might suggest that counteraction of aspirin on ACEi is relatively low in HFpEF and HFrEF of our study. In HFpEF, achieving regression of left ventricular hypertrophy (LVH) was accepted as a therapeutic goal, however, still optimal treatment agents were not confirmed [15]. So, Aspirin's role for blood pressure is still unclear.

Anti-lipid medications were included to check risk factors related to blood pressure control based on previous studies. They have antihypertensive effect on patients with higher blood pressure and low HDL cholesterol [23]. Also, statins may exert a favorable effect on blood pressure by improving endothelial-mediated vasodilatation [24] and were also reported to provide substantial reduction of blood pressure [25]. In our study, the effect was contradictory to previous results, which can be investigated in the future.

Our study showed that patients having obesity (BMI ≥ 30) were more likely to have blood pressure control in HFrEF patients of our study (Table 4), which might suggest obesity may play a role in protective effect on cardiovascular disease. It could be paradoxically associated with blood pressure control. There were still controversial reports in relationship between obesity and control of blood pressure. There were several hypotheses that leaner patients with heart failure have been shown to have elevated levels of tumor necrosis factor and inflammatory cytokines compared with obese patients, which increased cardiovascular complication such as uncontrolled blood pressure [26]. Adipose tissue has been shown to make soluble tumor necrosis factor receptor that is thought to neutralize the deleterious effects of tumor necrosis factor alpha on the myocardium in patients with heart failure [27,28].

In summary, the present study result represents that blood pressure control rate is increased as per JNC8 compared to JNC 7. These results are consistent with the intention of JNC 8 which was designed for higher blood pressure goals and less attempt with trial of medications. Three types of heart failure have different risk factors to control blood pressure [3]. In our study, different types of medications were associated with control of blood pressure in each heart failure type. Patients who were enrolled in our heart failure program may need to change medications based on risk factors and types of heart failure.

Limitation

The limitations of our study include its cross-sectional design, and thus, no causal relationships could be obtained. To confirm the relationship between BP control and risk factors, long-term prospective trial studies are necessary.

Disclosure

The authors declared no conflict of interest.

References

1. Lip GYSF, Overvad K, Rasmussen LH, Larsen TB (2015) Blood pressure and prognosis in patients with incident heart failure: the Diet, Cancer and Health (DCH) cohort study Clin Res Cardiol 104: 1088-1096.

2. Fox CS (2010) Cardiovascular disease risk factors, type 2 diabetes mellitus, and the Framingham Heart Study. Trends Cardiovasc Med 20: 90-95.

3. Mant J, Al Mohammad A, Swain S, Laramée P (2011) Management of chronic heart failure in adults: synopsis of the National Institute For Health and clinical excellence guideline. Ann Intern Med 155: 252-259.

4. Manickavasagam S, Merla R, Koerner MM, Fujise K, Kunapuli S, et al. (2009) Management of hypertension in chronic heart failure. Expert Rev Cardiovasc Ther 7: 423-433.

5. Dunlay SM, Weston SA, Jacobsen SJ, Roger VL (2009) Risk factors for heart failure: a population-based case-control study. Am J Med 122: 1023-1028.

6. Assmann G, Schulte H (1989) Diabetes mellitus and hypertension in the elderly: concomitant hyperlipidemia and coronary heart disease risk. Am J Cardiol 63: 33H-37H.

7. De Schutter A, Lavie CJ, Patel DA, Milani RV (2013) Obesity paradox and the heart: which indicator of obesity best describes this complex relationship? Curr Opin Clin Nutr Metab Care 16: 517-524.

8. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, et al. (2014) 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA 311: 507-520.

9. [No authors listed] (1992) Effect of enalapril on mortality and the development of heart failure in asymptomatic patients with reduced left ventricular ejection fractions. The SOLVD Investigattors. N Engl J Med 327: 685-691.

10. Kent ST, Shimbo D, Huang L, Diaz KM, Kilgore ML, et al. (2014) Antihypertensive medication classes used among medicare beneficiaries initiating treatment in 2007-2010. PLoS One 9: e105888.

11. Yancy C, Jessup M, Bozkurt B, Butler J, Casey D, et al. (2013) 2013 ACCF/AHA guideline for the management of heart failure: executive summary: a report of the American College of Cardiology Foundation/ American Heart Association Task Force on practice guidelines. Circulation 128: 1810-1852.

12. Clearfield M, Pearce M, Nibbe Y, Crotty D, Wagner A (2014) The "New Deadly Quartet" for cardiovascular disease in the 21st century: obesity, metabolic syndrome, inflammation and climate change: how does statin therapy fit into this equation? Curr Atheroscler Rep 16: 380.

13. Borden WB, Maddox TM, Tang F, Rumsfeld JS, Oetgen WJ, et al. (2014) Impact of the 2014 expert panel recommendations for management of high blood pressure on contemporary cardiovascular practice: insights from the NCDR PINNACLE registry. J Am Coll Cardiol 64: 2196-2203.

14. Burchfield JS, Xie M, Hill JA (2013) Pathological ventricular remodeling: mechanisms: part 1 of 2. Circulation 128: 388-400.

15. Klingbeil AU, Schneider M, Martus P, Messerli FH, Schmieder RE (2003) A meta-analysis of the effects of treatment on left ventricular mass in essential hypertension. Am J Med 115: 41-46.

16. Georgiopoulou VV, Kalogeropoulos AP, Butler J (2011) Dilemmas of blood pressure management for heart failure prevention. Circ Heart Fail 4: 528-533.

17. Dunlay SM, Weston SA, Jacobsen SJ, Roger VL (2009) Risk factors for heart failure: a population-based case-control study. Am J Med 122: 1023-1028.

18. Shekelle PG, Rich MW, Morton SC, Atkinson CSW, Tu W, et al. (2003) Efficacy of angiotensin-converting enzyme inhibitors and beta-blockers in the management of left ventricular systolic dysfunction according to race, gender, and diabetic status: a meta-analysis of major clinical trials. J Am Coll Cardiol 41: 1529-1538.

19. Levy D, Kenchaiah S, Larson MG, Benjamin EJ, Kupka MJ, et al. (2002) Long-term trends in the incidence of and survival with heart failure. N Engl J Med 347: 1397-1402.

20. Guglin M (2012) Congestion is the driving force behind heart failure. Curr Heart Fail Rep 9: 219-227.

21. Chen P, Chaugai S, Zhao F, Wang DW (2015) Cardioprotective Effect of Thiazide-Like Diuretics: A Meta-Analysis. Am J Hypertens 28: 1453-1463.

22. Hall D, Zeitler H, Rudolph W (1992) Counteraction of the vasodilator effects of enalapril by aspirin in severe heart failure. J Am Coll Cardiol 20: 1549-1555.

23. Bautista LE (2009) Blood pressure-lowering effects of statins: who benefits? J Hypertens 27: 1478-1484.

24. John S, Schneider M, Delles C, Jacobi J, Schmieder R (2005) Lipid-independent effects of statins on endothelial function and bioavailability of nitric oxide in hypercholesterolemic patients. Am Heart J 149: 473.

25. Chopra V, Choksi PU, Cavusoglu E (2007) Beyond lipid lowering: the anti-hypertensive role of statins. Cardiovasc Drugs Ther 21: 161-169.

26. Feldman AM, Combes A, Wagner D, Kadakomi T, Kubota T, et al. (2000) The role of tumor necrosis factor in the pathophysiology of heart failure. J Am Coll Cardiol 35: 537-544.

27. Lavie C, De Schutter A, Patel D, Romero Corral A, Artham S, et al. (2012) Body composition and survival in stable coronary heart disease: impact of lean mass index and body fat in the "obesity paradox". J Am Coll Cardiol 60: 1374-1380.

28. Mohamed-Ali V, Goodrick S, Bulmer K, Holly JM, Yudkin JS, et al. (1999) Production of soluble tumor necrosis factor receptors by human subcutaneous adipose tissue in vivo. Am J Physiol 277: E971-975.