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Application of the American College of Cardiology (ACC/AHA) 2017 Guideline for the Management of Hypertension in Adults and Comparison with the 2014 Eighth Joint National Committee Guideline

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Abstract

Objectives: This study aims to compare the 2017-ACC/AHA hypertension guideline with 2014-JNC-8 guideline in regard to the number of patients who are eligible for treatment and to determine the physicians' adherence and the financial impact of implementing the new guideline.

Methods: A cross-sectional observational study was conducted on adult patients who attended the hospital outpatient setting in UAE during January 1, 2018 till February 28, 2018. Adults who are diagnosed with hypertension and those with blood pressure (BP) levels based on two or more readings obtained on two or more different occasions were screened for inclusion into this study and cardiovascular diseases (CVD) risk was calculated. The two guidelines were compared with respect to the number of patients diagnosed with hypertension and eligible for treatment. Results were extrapolated to the UAE population. Financial impact of applying the 2017-ACC/AHA guideline was also evaluated.

Results: In comparison with the JNC-8, the 2017-ACC/AHA guideline would increase the proportion of patients diagnosed with hypertension among UAE adults from 40.8% to 76.3% and the number of UAE adults recommended for antihypertensive medications would rise from 2.42 million (32.1%) to 4.71 million (62.5%). Among UAE adults, almost 4.42 million (58.6%) and 0.76 million (10.1%) would have BP above the target according to the 2017-ACC/AHA and JNC-8 guidelines, respectively. The expected increase in the cost of anti-hypertension medications prescribed for the new labeled cases according to 2017-ACC/AHA but not JNC-8 would reach 1.8 billion AED/year. For those who were recommended for antihypertensive medications, who had BP above target, the additional cost would reach 3.5 billion AED/year.

Conclusions: The current study reveals marked increase in the proportion of patients diagnosed with hypertension in concordance with the 2017-ACC/AHA guideline. This is also will be associated with almost double the number of UAE adults recommended for antihypertensive medications. The poor compliance with the 2017-ACC/AHA reflects the concern regarding the increase risk of adverse events.

Keywords: Hypertension, ACC/AHA (American College of Cardiology / American Heart Association) guideline, JNC 8 (The Eighth Joint National Committee) guideline

1. Introduction

Until recently, the guideline of the eighth joint national committee (JNC-8) was the

recommended guideline for the management of hypertension [1]. In 2017, the ACC/AHA and 9 other specialty organizations published an updated hypertension guideline that contains new

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definition of the blood pressure level targets which is lower than the previous guidelines and many other changes. Consequently, increased the number of candidates people for monitoring and treatment [2,3].

As a matter of fact, the number of hypertensive patients who are already treated with antihypertensive drugs will require more aggressive treatment to bring their BP level to the target. Subsequently, many patients should receive combinations or poly-therapy that lead to potentially use expensive antihypertensive drugs. Accordingly, the incidence of adverse events will likely to be increased with such treatment regimen [3,4]. Based on several clinical trials, adverse events were more common and more serious with intensive therapy. These include hypotension, acute renal failure, syncope and electrolyte disturbance that may cause loss of benefit of treatment and discontinuation of therapy [5–9].

The main study question is whether the new recommendations are feasible in clinical practice? For that reason, this study had been conducted to compare the 2017-ACC/AHA guideline with the most recent JNC Guideline (JNC-8, 2014) [1,4] with regard to the number of patients who are eligible for treatment with antihypertensive and to determine the financial impact of implementing the new guideline. Adherence of physicians to the new guideline was also examined.

2. Methodology

2.1. Subjects

A cross-sectional observational study of adult patients who visited a hospital outpatient setting (internal medicine and Cardiology clinics) in United Arab Emirates (UAE) during January 1, 2018 till February 28, 2018 (n = 1196). Patients' information had been collected through Hospital Information System (HIS). Adults who are already diagnosed with hypertension (as documented in HIS) and also adults with two or more blood pressure reading obtained on two or more different occasions were included in this study. Tourists were excluded, as they do not represent UAE population. CVD risk was calculated using the Pooled Cohort Risk Equation [10].

The analysis was restricted to those who were aged 18 years old and older and met the criteria of enrollment (n = 400, 33.4%). Participants who didn't meet the inclusion criteria were excluded (n = 796). Reasons for exclusion were: two or more BP

List of abbreviations

ACC/AHA	American College of Cardiology/American Heart Association
JNC-8	The Eighth Joint National Committee
AED	United Arab Emirates Dirham
UAE	United Arab Emirates
CVD	Cardiovascular Disease
BP	Blood Pressure
CAD	Coronary Artery Disease
SPSS	Statistical Package for Social Sciences
NESH-UAE	National Epidemiological Study of Hypertension in the United Arab Emirates
ASCVD	Atherosclerosis Cardiovascular Disease
LVH	Left Ventricular Hypertrophy
CI	Confidence Interval
eGFR	Estimated Glomerular Filtration Rate
HDL	High Density Lipoprotein
LDL	Low Density Lipoprotein
BMI	Body Mass Index
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
NPI	Non-Pharmacological Intervention

readings on two or more different occasions were not available (n = 568) and patient who were tourists (n = 228).

This study was approved by the Research Ethics Committee of the hospital (CR/2018/27).

2.2. Statistical analysis

All data were entered and analyzed using SPSS version 22 (IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). Descriptive statistics were used for measuring the frequencies and percentages. Chi-square test was used to compare the frequencies. A *p* value of 0.05 was considered statistically significant, using 95.0% confidence interval of differences.

The following outcomes were investigated in this study:

- A. The two guidelines were compared with regard to the following:
 1. The proportions of patients were compared for whom antihypertensive therapies would be recommended (i.e., eligible persons) on the basis of the two sets of guidelines.
 2. The proportions of patients who had above-goal BP according to the two sets of guidelines were also recorded and compared.
- B. Cost Implication of Applying the 2017-ACC/AHA Guideline

Table 1. Estimation of the cost an additional antihypertensive medication prescribed in United Arab Emirates Dirhams.

No of antihypertension drug classes used	No. of patients	Medication cost/patient/month ^a	Cost of additional drug cost/patient/month
1	66 (38.8%)	65.6 ± 34.4 AED	65.6 AED
2	50 (29.4%)	125.2 ± 35.6 AED	62.6 AED
3	32 (18.8%)	199.9 ± 64.6 AED	66.6 AED
4	22 (13%)	269.3 ± 50.8 AED	67.3 AED
Total	170 (100%)	134.7 ± 83.4 AED	262.1 AED
Mean value of the cost of each additional antihypertensive drug =			65.5 ± 2.07 AED

^a Mean value of the estimated medications cost for each patient per month. AED: United Arab Emirates Dirham.

The additional cost of hypertension treatment due to the expanding of disease definition “according to the 2017-ACC/AHA guideline” was estimated by calculating the average cost of one antihypertensive medication for the study patients based on the UAE average market value. Table 1 also illustrates how we calculated the average cost of adding one medication for each patient per month.

According to Table 1 the average cost of an additional antihypertensive medication would be nearly 65.5 United Arab Emirates Dirham (AED) per month per medication (786 AED per year). Table 2 illustrates the list of antihypertensive medications used during the study and their cost.

- C. The results were extrapolated to produce UAE population estimates and the financial impact of applying the 2017-ACC/AHA guideline on the whole population was also evaluated. The extrapolation of this study data to the 7.54 million UAE adults between the ages of 18 and 75 years based on the National Epidemiological Study of Hypertension in the United Arab Emirates (NESH-UAE), Dubai Heart Center - survey report 2014 - Dubai Health Authority (DHA) and UAE National Bureau of statistics of UAE population [11–15]. Of whom, 40.8% (n = 3.07 million UAE adults) had history of hypertension based on the 2014 JNC-8 guideline.
- D. Adherence of physicians to the new guideline was determined by determining the percentage of patients who were receiving treatment based on the 2017-ACC/AHA guideline recommendations.

3. Results

3.1. Demographic and clinical characteristics of the study sample

Demographic and clinical characteristics of the study sample are shown in Tables 3 and 4. Out of all subjects, there were 238 male patients (59.5%-mean age 49 years, SD = 10) and 162 female patients (40.5%-mean age 50 years, SD = 13). Out of those

with history of any disease (80%-320 patients), 206 patients (51.5%) were diagnosed with hypertension, 196 patients (49%) had diabetes mellitus and 172 patients (43%) had dyslipidemia. Nevertheless, from those who had history of hypertension, only 170 patients (82.5%; 114 males and 56 females) were on antihypertensive medications. Of whom, 66 patients (32%; 38 males and 28 females) were on one class of antihypertensive medication, 50 patients (24.3%; 34 males and 16 females) were on two classes of antihypertensive medications and 54 patients (26.2%; 42 males and 12 females) were on three or more classes of antihypertensive medications. Whereas, 36 patients (17.5%; 18 males and 18 females) were on non-pharmacological intervention for treatment of hypertension.

Additionally, 52 patients (13%; 38 males and 14 females) had history of clinical atherosclerosis cardiovascular disease (ASCVD). Out of all participants without history of clinical ASCVD, 140 participants (35%; 38 males and 102 females) had estimated 10 years CVD risk less than 5%, 72 participants (18%; 54 males and 18 females) had estimated 10 years CVD risk between 5% and less than 10% and 136 participants (34%; 108 males and 28 females) had estimated 10 years CVD risk equal to or more than 10%.

3.2. The proportions of patients for whom antihypertensive therapies would be recommended

The number of patients with hypertension were increased to 358 (89.5%) according to ACC/AHA guideline as compared to 216 (54%) according to JNC-8 guideline which represented a 65.7% increase in patients who were categorized as hypertensive patients (Table 5). There is a significant increase in number of hypertensive patients implementing ACC/AHA guideline $X^2(df = 1) = 124.3, p < 0.0001$.

According to JNC-8 guideline 108 (27%) patients were labeled as stage 1 hypertension and require mono-therapy with an antihypertensive medication. In comparison, according to the 2017-ACC/AHA guideline, 244 (61%) patients were labeled as stage 1 hypertension and advised to be treated either with

Table 2. List of antihypertensive medications used during the study.

Brand name used	Generic name	Price/28's tablet in AED
Diovan 80 mg	Valsartan	138
Concor 2.5 mg	Bisoprolol	23.5
Lasix 40 mg	Furosemide	20
Aldactone 25 mg	Spirolactone	19
Norvasc 5 mg	Amlodipine	89
Concor 5 mg	Bisoprolol	34
Coaprovel 300/25 mg	Irbesartan/Hydrochlorothiazide	126.5
Twynsta 80/10 mg	Telmisartan/Amlodipine	147
Physiotens 0.4 mg	Moxonidine	72
Concor plus 5/12.5 mg	Bisoprolol/Hydrochlorothiazide	36.5
Micardis 80/12.5 mg	Telmisartan/Hydrochlorothiazide	125
Norvasc 10 mg	Amlodipine	178
Triplixam 10/2.5/10 mg	Perindopril/Indapamide/Amlodipine	199
Tenormin 50 mg	Atenolol	29.5
Micardis 80/25 mg	Telmisartan/Hydrochlorothiazide	109.5
Zestoretic 20/12.5 mg	lisinopril/Hydrochlorothiazide	90.5
Hyzaar 50/12.5 mg	Losartan/Hydrochlorothiazide	88.5
Triplixam 5/1.25/5 mg	Perindopril/Indapamide/Amlodipine	188.5
Dilatrend 6.25 mg	Carvedilol	28
Coveram 10/10 mg	Perindopril/Amlodipine	162
CoDiovan 160/12.5 mg	Valsartan/Hydrochlorothiazide	156
Esidrex 25 mg	Hydrochlorothiazide	14.5
CoAprovel 300/12.5 mg	Irbesartan/Hydrochlorothiazide	126.5
Coversyl 5 mg	Perindopril	80
Aprovel 150 mg	Irbesartan	99.5
Zestril 5 mg	Lisinopril	29.5
Nebilet 5 mg	Nebivolol	73.5
Fortzaar 100/25 mg	losartan/hydrochlorothiazide	88.5
Coveram 5/10 mg	Perindopril/Amlodipine	152.5
Twynsta 80/5 mg	Telmisartan/Amlodipine	147
Atacand 16 mg	Candesartan	92.5
Coveram 5/5 mg	Perindopril/Amlodipine	151
Coveram 10/5 mg	Perindopril/Amlodipine	156
Atacand 4 mg	Candesartan	63.5
Zestril 10 mg	Lisinopril	66
Aprovel 300 mg	Irbesartan	117
Bipreterax 5/1.25 mg	Perindopril/Indapamide	90
Concor 10 mg	Bisoprolol	45.5
Micardis 40 mg	Telmisartan	97
Tritace 10 mg	Ramipril	118
Coversyl 10 mg	Perindopril	123.5
The average cost increase in AED for each class:		
Angiotensin converting enzyme inhibitor (ACEI):		83.4
Angiotensin receptor blocker (ARB)		101.25
Diuretics (D)		17.83
Calcium channel blocker (CCB)		133.5
Beta blocker		39
Combination ACEI + CCB		155.38
Combination ARB + D		117.22
Combination ARB + CCB		147
Combination ACEI + CCB + D		193.75

non-pharmacological intervention with or without mono-antihypertensive therapy. Of whom, 136 patients (34%) had diabetes mellitus, and/or estimated 10 years CVD risk more than 10% and/or chronic kidney disease and they were advised to receive non-pharmacological and pharmacological treatment. Contrarily, those who had estimated 10 years CVD risk score less than 10%, no diabetes and no

chronic kidney disease (n = 108; counted for 27%) were advised to receive a non-pharmacological interventions as initial strategy (Table 5).

Therefore, out of the 244 patients, at least additional 70 patients will need antihypertensive regimen according to the new guidelines (66 patients already treated and 108 are recommended for non-pharmacological interventions as initial

Table 3. Demographic, clinical characteristics and proportions of those with no prior diagnosis of hypertension based on their BP level.

	BP Categories (n = 194)					Total
	<120/<80	120-129/<80	130-139/80-89	140-159/90-99	≥160/≥100	
Total participants	28 (14.4%)	14 (7.2%)	142 (73.2%)	6 (3.1%)	4 (2.1%)	194 (48.5%)
Population characteristics						
Age:	40.4 ± 13.2	45.4 ± 14.9	46.2 ± 10.4	53 ± 2.6	56 ± 2.8	
Gender:						
Male	2 (1%)	6 (3.1%)	92 (47.4%)	2 (1%)	4 (2.1%)	106 (54.7%)
Female	26 (13.4%)	8 (4.1%)	50 (25.8%)	4 (2.1%)	0	88 (45.3%)
Smoking	4 (2.1%)	4 (2.1%)	52 (26.8%)	2 (1%)	2 (1%)	64 (32.9%)
SBP, mmHg	111.5 ± 6.1	122.4 ± 2.6	128.4 ± 7.8	144.3 ± 1.9	151 ± 7.0	
DBP, mmHg	71.6 ± 5.4	72.1 ± 5.2	83.7 ± 2.9	89.3 ± 6.5	100 ± 1.1	
Total cholesterol	168.2 ± 37.9	195.1 ± 44.3	193.4 ± 40.8	160.3 ± 13.3	160 ± 46.6	
HDL	46.8 ± 10.3	46.1 ± 9.1	41.7 ± 9.5	38.1 ± 3.6	38.2 ± 5.6	
LDL	107.1 ± 39.4	116.1 ± 27.8	124.2 ± 36.1	88.3 ± 16.1	100.5 ± 48.7	
Dyslipidemia and on statin	4 (2.1%)	0	32 (16.5%)	4 (2.1%)	4 (2.1%)	44 (22.6%)
Diabetes and on diabetic medications	2 (1%)	2 (1%)	60 (30.9%)	6 (3.1%)	4 (2.1%)	74 (38.1%)
Albuminuria	4 (2.1%)	4 (2.1%)	10 (5.2%)	2 (1%)	1 (0.5%)	21 (10.8%)
eGFR:	96.2 ± 25.7	91.1 ± 28.9	95.9 ± 16.4	85.1 ± 15.3	87.5 ± 23.3	
BMI:	26.9 ± 5.1	27.5 ± 4.6	29.1 ± 5.2	32.4 ± 7.5	26.4 ± 3.3	
Mean of estimated 10 years risk of CVD ^a :	1.97 ± 1.5	5.08 ± 4.9	7.72 ± 5.2	8.96 ± 6.4	21.9 ± 17.5	
<5%	26 (13.4%)	8 (4.1%)	68 (35.1%)	2 (1%)	0	104 (53.7%)
5% - < 10%	0	4 (2%)	34 (17.5%)	2 (1%)	2 (1%)	42 (21.6%)
≥10%	0	2 (1%)	40 (20.6%)	2 (1%)	2 (1%)	46 (23.7%)
History of CVD	2 (1%)	0	0	0	0	2 (1%)

^a Mean risk is calculated among the participants without history of CVD.

Table 4. Demographic, clinical characteristics and proportions of those with history of hypertension based on their BP level.

	BP Categories (n = 206)					Total
	<120/<80	120-129/<80	130-139/80-89	140-159/90-99	≥160/≥100	
Total participants	12 (5.8%)	10 (4.8%)	120 (58.2%)	48 (23.3%)	16 (7.7%)	206 (51.5%)
Population characteristics						
Age:	56.8 ± 10.9	50.8 ± 11.3	51.4 ± 10.6	59.5 ± 12.6	50.3 ± 8.3	
Gender:						
Male	8 (3.9%)	10 (4.8%)	72 (34.9%)	30 (14.5%)	12 (5.8%)	132 (64.1%)
Female	4 (1.9%)	0	48 (23.3%)	18 (8.7%)	4 (1.9%)	74 (35.9%)
Smoking	6 (2.9%)	2 (0.9%)	32 (15.5%)	18 (8.7%)	6 (2.9%)	64 (31.1%)
SBP, mmHg	111.8 ± 6.1	123.2 ± 3.2	131.4 ± 7.2	145.5 ± 6.9	160.2 ± 10.5	
DBP, mmHg	69.8 ± 6.9	78.4 ± 6.1	82.3 ± 4.9	82.9 ± 10.7	99.1 ± 5.1	
Total cholesterol	180.5 ± 53.03	175.2 ± 50.7	200.2 ± 49.5	183.04 ± 34.6	193.4 ± 46.4	
HDL	34.8 ± 12.7	37.7 ± 7.7	41.1 ± 8.7	39.2 ± 10.3	42.1 ± 9.1	
LDL	112.1 ± 34.4	118.4 ± 39.7	125.6 ± 39.5	120.2 ± 28.5	124.1 ± 35.1	
Dyslipidemia and on statin	6 (2.9%)	8 (3.9%)	78 (37.8%)	30 (14.6%)	6 (2.9%)	128 (62.1%)
Diabetes and on diabetic medications	4 (1.9%)	8 (3.9%)	74 (35.9%)	32 (15.5%)	4 (1.9%)	122 (59.2%)
Albuminuria	2 (0.9%)	3 (1.5%)	12 (5.8%)	15 (7.3%)	10 (4.9%)	42 (20.4%)
eGFR:	83.8 ± 9.1	87.6 ± 30.6	90.7 ± 23.1	75.8 ± 26.5	91.8 ± 13.4	
BMI:	29.6 ± 3.4	31.3 ± 6.1	31.6 ± 7.01	30.1 ± 7.3	27.1 ± 2.8	
Mean of estimated 10 years risk of CVD ^a :	13.2 ± 4.4	11.3 ± 4.2	13.3 ± 10.4	22.3 ± 12.3	14.4 ± 8.6	
<5%	0	0	30 (14.6%)	4 (1.9%)	2 (0.9%)	36 (17.5%)
5% - < 10%	4 (1.9%)	2 (0.9%)	16 (7.8%)	6 (2.9%)	2 (0.9%)	30 (14.6%)
≥10%	0	4 (1.9%)	50 (24.2%)	28 (13.6%)	8 (3.9%)	90 (43.7%)
History of CVD	8 (3.9%)	4 (1.9%)	24 (11.6%)	10 (11.7%)	4 (1.9%)	50 (24.2%)
On non-pharmacological intervention	2 (0.9%)	0	22 (10.7%)	12 (5.8%)	0	36 (17.5%)
On non-pharmacological intervention and antihypertensive medication	10 (11.7%)	10 (11.7%)	98 (47.5%)	36 (17.5%)	16 (7.8%)	170 (82.5%)

^a Mean risk is calculated among the participants without history of CVD.

Table 5. Blood pressure control according to the 2017-ACC/AHA guideline in comparison with JNC-8 guideline (n = 400).

	2017-ACC/AHA guideline (n = 358, 89.5%)				JNC-8 guideline (n = 216, 54%)			
	Stage 1 hypertension (lifestyle modification)	Stage 1 hypertension (lifestyle modification and drug therapy)	Stage 2 hypertension (require combination drug therapy)	Met the target	Stage 1 hypertension (lifestyle modification and drug therapy)	Stage 2 hypertension (require combination drug therapy)	Met the target	
No. of patients (%)	108 (27%)	136 (34%)	114 (25.5%)	22 (6.2%)	108 (27%)	108 (27%)	148 (68.5%)	
Type of intervention:								
On non-pharmacological intervention (NPI)	108 (30.2%)			2 (0.55%)	42 (19.5%)	4 (1.8%)	24 (11.2%)	
On 1 antihypertension class + NPI		136 (38%)		6 (1.7%)	66 (30.6%)		56 (25.9%)	
On 2 antihypertension classes + NPI			55 (15.3%)	6 (1.7%)		50 (22.1%)	38(17.6%)	
On 3 or more classes + NPI			59 (16.5%)	8 (2.2%)		54 (25%)	30 (13.8%)	
Concordance with guidelines	36 (10.0%)	66 (18.4%)	104 (29.0%)		66 (30.6%)	104 (28.1%)		

*NPI: non-pharmacological intervention.

**All percentages are within the total number of patients.

strategy). Those on non-pharmacological interventions (n = 108) will also likely require treatment in the future.

Based on the 2017-ACC/AHA guideline 114 (28.5%) patients were labeled as stage 2 hypertension and advised for combination antihypertensive therapy. While, only 108 (27%) patients were labeled as stage 2 hypertension according to JNC-8 guidelines (Table 5).

There is a significant difference in number of patients recommended for antihypertensive medications between the two sets of the guidelines $X^2(df = 1) = 9.08, p = 0.003$.

3.3. The proportions of patients who had above-goal BP according to the two sets of guidelines

According to JNC-8 guideline 31.5% (n = 68) of the patients had above the BP target, compared to 93.8% (n = 336) of the patients had above-target BP according to the 2017-ACC/AHA guideline (Table 5). Of whom, 29.6% (n = 106) are recommended for non-pharmacological intervention as initial strategy. On the other hand, seventy patients are not receiving medications and need monotherapy as indicated above. A combination medications are recommended for those who did not meet the target and already receiving antihypertensive (n = 160); 60 patients from stage 1 and 100 patients from stage 2 (Table 5). There is a significant increase in the proportion of patients who had above goal BP based on the ACC/AHA guideline compare to the JNC-8 guideline $X^2(df = 1) = 251.4, p = 0.0001$.

3.4. Cost Implication of Applying the 2017-ACC/AHA guideline

Based on the calculation in Tables 1 and 2, the cost of medications would be increased by approximately 4585 AED per month [70*65.5 AED] and 55,020 AED per year for those who were newly labeled as hypertensive patients (n = 70) and recommended to start antihypertensive medications according to the 2017-ACC/AHA guideline.

Additionally, the cost would be increased by almost [160*65.5AED = 10,480 AED per month] (125,760 AED per year) for those who advised for intensive therapy (n = 160) to meet the goal according to 2017-ACC/AHA guideline.

3.5. Extrapolation of results to UAE population

Figure 1 shows the summary of the comparison between the 2017-ACC/AHA and JNC-8 guidelines regarding the extrapolated number of UAE adults'

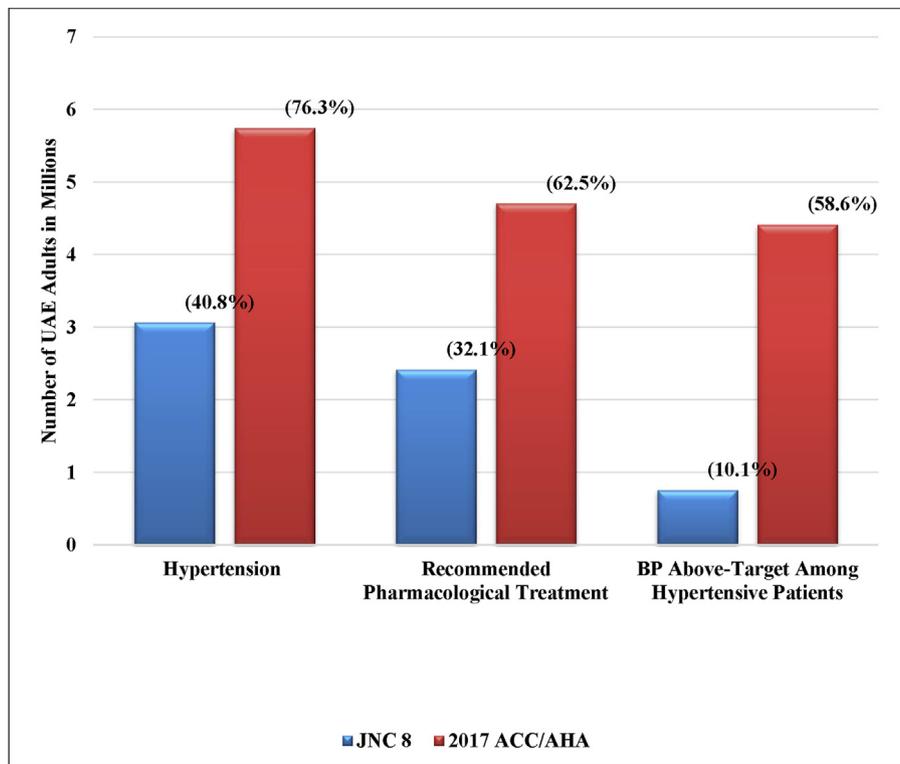


Fig. 1. Summary of the comparison between the 2017-ACC/AHA and JNC-8 guidelines regarding the extrapolated number and percentage of UAE adults population who met the definition of hypertension, number and percentage of UAE adults population recommended for antihypertensive medications and number and percentage of hypertensive patients who had BP above target. The data are present in million ($n = 7.54$ millions).

population who would meet the definition of hypertension, number of UAE adults' population who would be recommended for antihypertensive medications and number of hypertensive patients who would have BP above target.

Accordingly, 5.75 (76.3% of 7.54 million adult) million UAE adults would meet the criteria for hypertension according to 2017-ACC/AHA guideline compared with 3.07 (40.8%) million UAE adults met the definition of JNC-8 guideline (see method section). Of whom, 4.71 (62.5%) million UAE adults would be recommended to use antihypertensive medications in addition to non-pharmacological intervention. Whereas, 1.04 (13.8%) million would meet the criteria for treatment with non-pharmacological interventions. An additional 2.29 (30.4%) million UAE adults would be recommended for antihypertensive medication according to the 2017-ACC/AHA guideline in comparison with the JNC-8 guideline.

Furthermore, Among UAE adults who are recommended to use antihypertensive medications, 4.42 (58.6% of UAE adults, $N = 7.54$ millions) million would have BP above the target according to the 2017-ACC/AHA guideline whereas 0.76 (10.1% of UAE adults, $N = 7.54$ millions) million would have

BP above the target according to the JNC-8 guideline.

The expected increase in the cost of antihypertension medications prescribed for the new labeled cases ($n = 2.29$ million) that need pharmacological treatment in UAE according to ACC/AHA guideline but not JNC-8 would reach 149.99 million AED per month (1.8 billion AED/year). For those who were recommended for antihypertensive medications according to ACC/AHA guideline, who had BP above the target ($N = 4.42$ million), the cost would approximately reach 289.51 million AED per month (3.5 billion AED/year) for additional medications to control blood pressure. While, it would cost only 49.78 million AED per month (597.36 million AED per year) ($N = 0.76$ millions) according to the 2014 JNC-8 guideline.

3.6. Adherence of physicians to the 2017-ACC/AHA guideline recommendations

Among all participants, 57.4% ($n = 206$) of the patients were in concordance with the 2017-ACC/AHA guideline recommendations. Of whom, 10% ($n = 36$) were on non-pharmacological intervention. While, 47.4% ($n = 170$) were on antihypertensive

medications. Contrarily, 78.7% (n = 170) of the patients were in consistency with the JNC-8 guideline. Of whom, 30.6% (n = 66) were on non-pharmacological with or without mono-antihypertensive treatment. While, 48.1% (n = 104) were on intensive antihypertensive medications. Based on that, the compliance with the JNC-8 was significantly higher reflecting greater physicians' adherence with it (Table 5).

4. Discussion

Based on this study, the proportion of patients with hypertension was increased by 65.7% according to the 2017-ACC/AHA guideline; half of them were advised to be treated with pharmacological therapy. This study showed high percentage (93.8%) of the patients who had above-goal BP according to the 2017-ACC/AHA compared to JNC-8 guidelines (31.5%), which in turn reflected the poor compliance of the physicians with the new guidelines. The reasons behind this are that the guideline was still recent and physicians were hesitant to apply the new recommendations and use antihypertensive for lower blood pressure values. In comparison, Muntner P et al. (2018) demonstrated a notable increase in the prevalence of hypertension (13.7%) and a small increase in the percentage of US adults who were recommended for antihypertensive medications (1.9%) according to the 2017-ACC/AHA guideline compared with the JNC-7 guideline. In the same study, 14.4% of US adults taking antihypertensive medication had a BP above the goal defined by the 2017-ACC/AHA guideline, whereas they would have met the BP goal according to the JNC-7 guideline [3].

The majority of hypertensive patients (68.5%) had well-controlled blood pressure and most of those patients were on 2 or more antihypertensive medications according to JNC-8 guideline. While, if the recommendation of the 2017-ACC/AHA guideline has to be followed then the number of hypertensive patients who had well-controlled blood pressure will dramatically drop to (6.2%) which necessitates adding additional antihypertensive medication to the patients' treatment plan.

The study results indicate that the 2017-ACC/AHA guideline recommend much more aggressive therapy. However, the incidence of adverse events was higher in the intensive treatment group like hypotension, syncope, electrolyte disturbance, injurious fall and acute renal failure [16–18]. Although, several studies had reported risk reduction of coronary heart disease (CHD), stroke mortality and end stage renal disease with lower BP

levels than that in the guidelines [19–22]. However, Shen L et al. (2013) illustrated that the efficacy of BP reduction in subjects was not clarified [20].

Other studies reported that treatment of prehypertension with antihypertensive medications particularly the angiotensin converting enzyme inhibitor (ramipril), angiotensin receptor blocker (candesartan), low dose chlorthalidone and amiloride were well tolerated and reduced the risk of incident of stage 1 hypertension [23–25]. Additionally, in patients with pre-existing coronary artery disease (CAD), hypertension or left ventricular hypertrophy (LVH), a J-curve effect had been observed between a diastolic BP of 70–80 mmHg as well as a systolic BP less than 130 mmHg “The J-curve effect describes an inverse relation between low blood pressure (BP) and cardiovascular complications” [26].

While the ACCORD study that was conducted by Cushman W et al. (2010) in patient with type 2 diabetes at higher risk for cardiovascular events, reducing the SBP to less than 120 compared to less than 140 was not associated with reduction in the outcome of fatal and nonfatal major cardiovascular events [27]. Moise N et al. (2016) illustrated that adding intensive goals for high risk patients remained consistently cost effective in men, but not in women [28].

The National Institute for Health and Care Excellence (Nice) has estimated the number of patients advised to take pills for early signs of high blood pressure will be tripled under the new guidance of the 2017-ACC/AHA guidelines [29].

The new target goals and the use of ASCVD risk score in the definition of stage 1 and 2 hypertension would substantially increase the number of hypertensive patients in the population. On the other hand, such changes will lead to more pharmacologic interventions and more aggressive therapy to achieve the lower blood pressure targets and that, will be accompanied by considerable adverse events, discontinuation and possibly reduction in patients' quality of life. Such issues should not be masked by the overwhelming benefits [6,30–33]. Giving these factors and the substantial increase in the number of patients who would require antihypertensive, the long-term impact should be the goal of future studies in the UAE.

This study had several strengths; the study was conducted after the implication of the 2017-ACC/AHA guideline where the compliance of the physicians with this guideline could be evaluated. The measurement of BP was done on several visits with fixed approach of BP measurement which reflected higher accuracy. It highlighted the differences

between 2017-ACC/AHA and JNC-8 guidelines and estimated the expected cost resulted from applying such guidelines.

4.1. Study limitations

One of the limitations of this study is that it is conducted in one study site. However, in order to maximize study generalizability, we screened all patients admitted to the study site during the study period and included all eligible patients. On the other hand, demographic characteristics are similar to those reported in studies investigating cardiovascular disease in UAE taking into account that we screened patients attending outpatients' clinic. Therefore, we expect the study sample to be similar to the UAE population.

5. Conclusions

The adherence with the 2017-ACC/AHA guideline would markedly increase the proportion of hypertension in the UAE adults' population. The percentage of UAE adults recommended for lifestyle modification as a first line for management of hypertension would considerably rise. The recommendation for anti-hypertension medications in addition to non-pharmacological interventions would substantially increase and significantly increase the cost of medications.

The study also reveals poor compliance with the 2017-ACC/AHA, which may be due to the concern regarding the increase risk of adverse events with more aggressive pharmacological therapy.

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Author contribution

Mohammad Majed AlAhmad: Conception and design of Study, Literature review, Acquisition of data, Analysis and interpretation of data, Research investigation and analysis, Data collection, Drafting of manuscript, Revising and editing the manuscript critically for important intellectual contents, Data preparation and presentation. **Rami Beiram:** Conception and design of Study, Analysis and interpretation of data, Research investigation and analysis, Drafting of manuscript, Revising and editing the manuscript critically for important intellectual contents. **Salah AbuRuz:** Analysis and interpretation of data, Research investigation and

analysis, Drafting of manuscript, Revising and editing the manuscript critically for important intellectual contents, Supervision of the research, Research coordination and management, Funding for the research.

Conflict of interest

We "Authors" declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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