A review on prescribing patterns of antihypertensive drugs

Noah Jarari 1, Narasinga Rao 2, Jagannadha Rao Peela 3*, Khaled A. Ellafi 4, Srikumar Shakila 3, Abdul R. Said 3, Nagaraja Kumar Nelapalli 5, Yupa Min 6, Kin Darli Tun 7, Syed Ibrahim Jamallulu 8, Avinash Kousik Rawal 9, Ranjani Ramanujam 10, Ramesh Naidu Yedla 11, Dhiphil Kumar Kandregula 12, Anuradha Argi 13 and Laxmi Teja Peela 14

Abstract

Hypertension continues to be an important public health concern because of its associated morbidity, mortality and economic impact on the society. It is a significant risk factor for cardiovascular, cerebrovascular and renal complications. It has been estimated that by 2025, 1.56 billion individuals will have hypertension. The increasing prevalence of hypertension and the continually increasing expense of its treatment influence the prescribing patterns among physicians and compliance to the treatment by the patients. A number of national and international guidelines for the management of hypertension have been published. Since many years ago, diuretics were considered as the first-line drugs for treatment of hypertension therapy; however, the recent guidelines by the Joint National Commission (JNC8 guidelines) recommend both calcium channel blockers as well as angiotensin-converting enzyme inhibitors as first-line drugs, in addition to diuretics. Antihypertensive drug combinations are generally used for effective long-term management and to treat comorbid conditions. This review focuses on the antihypertensive medication utilization, their cost factors, adherence to treatment by patients, and physicians’ adherence to guidelines in prescribing medications in different settings including Indian scenario. The antihypertensive medication prescribing pattern studies help in monitoring, evaluation and necessary modifications to the prescribing habits to achieve rational and cost-effective treatment. Additionally, periodic updating of recommended guidelines and innovative drug formulations, and prescription monitoring studies help in rational use of antihypertensive drugs, which can be tailored to suit the patients’ requirements, including those in the developing countries.

Background

Hypertension is the most common modifiable risk factor for cardiovascular diseases (CVD), stroke and renal failure [1]. It is the second leading cause of chronic kidney disease (CKD). It is estimated that more than one billion adults are hypertensive worldwide and this figure is projected to increase to 1.56 billion by the year 2025, which is an increase of 60 % from 2000. Cardiovascular diseases and Hypertension are accounting for loss of 4 % gross domestic product for low and middle income countries annually which is amounting 500 billion USD [2]. Clinical evidence suggests that lowering blood pressure (BP) with antihypertensive drugs reduces the risk of myocardial infarction, stroke, heart failure, revascularization procedures and end-stage renal diseases in hypertensive patients [3].

The increasing prevalence of hypertension has been attributed to population growth, ageing and behavioral risk factors, such as unhealthy diet, excess use of alcohol, sedentary lifestyle, obesity, and exposure to persistent stress. A whopping 9.4 million deaths occur worldwide every year because of hypertension [4], with it being responsible for about 50 % of mortality due to heart disease and stroke [5]. Epidemiological studies demonstrated that prevalence of hypertension is increasing rapidly in India, varying from 4 to 15 % in urban and 2-8 % in rural population [6, 7].

Several guidelines have been developed worldwide for the management of hypertension, and these serve as reference standards for clinical practitioners. However,
many clinicians practice their own prescribing pattern in treating hypertensive patients according to their clinical experience. Primary care physicians need to be empowered in appropriate and evidence-based management of hypertension. A review of these prescribing patterns and guideline-based use of antihypertensive medications can give better insights into the concept of personalised, yet cost-effective pharmacological management of hypertension.

**Hypertension pharmacotherapy and guidelines**

Antihypertensive drugs are prescribed mainly to reduce the morbidity and mortality caused by hypertension and its complications. Many a time, patients require more than one drug for effective control of hypertension. Various classes of antihypertensive drugs like diuretics, inhibitors of the renin-angiotensin system, calcium channel blockers (CCB) and beta blockers (BB) have been shown to reduce complications of hypertension and may be used for initial drug therapy [8].

Since the need to improve the control of hypertension is well acknowledged, several guidelines on its classification and management have been developed. Some of the bodies which have developed guidelines are American Society of Hypertension/ International Society of Hypertension (ASH/ISH), Joint National Committee (JNC) on Detection, Evaluation, and Treatment of High Blood Pressure, European Society of Hypertension (ESH)/European Society of Cardiology (ESC), National Institute for Health and Care Excellence (NICE) and Japanese Society of Hypertension. The JNC 8 guidelines published in 2014 are the most recent guidelines for the management of hypertension in different clinical settings. These guidelines were developed based on a systematic review of literature to help clinicians, especially the primary care physicians [3]. Despite these guidelines, and also evidence showing that hypertension is a major public health concern, many clinicians fail to assess BP routinely, and in those with a diagnosis of hypertension, do not start treatment or titrate the dosage of the drugs effectively [9]. The available guidelines recommend different goal BP levels and drug treatment options according to patients’ individual clinical need (see Table 1).

Studies have shown that the application of guidelines to clinical practice improve the treatment outcomes. According to a retrospective study by Jackson et al. on 19,258 patients, applying JNC-7 guidelines to practice helped in achieving better BP control. Blood pressure control in the before-JNC 7 cohort was 40.8 % vs. 49.3 % in the after-JNC 7 cohort \( (p < 0.0001) \) [10].

In another study conducted to assess whether the publication of JNC 6 (1997) and WHO/ISH (1999) guidelines, and the development of new drugs improved BP control, follow-up of 150 patients from 1991 to 2001 showed that BP control increased from 31 % initially, to 43 % in 1996 and finally to 57 % in 2001. Both younger and older patients showed similar improvement during these 10 years. The authors concluded that improved BP control was because of increased use of ACEIs and CCBs, lifestyle modifications and improved awareness about the disease condition and the need for effective management [11]. Jeschke et al. demonstrated that antihypertensive therapy prescribed by physicians specialized in complementary and alternative medicine (CAM) in Germany complied with the German Hypertension Society guidelines. Most patients were treated with conventional antihypertensives like BBs and ACEIs. A thiazide diuretic with ACEI was the most frequent combination prescribed [12].

**Evaluating prescribing pattern of antihypertensive drugs**

There have been several studies evaluating the prescribing pattern of antihypertensive drugs worldwide. Over the past 20 years, there has been a consistent increase in the use of ACEIs, ARBs and CCBs and many robustly conducted clinical studies have showed no consistent differences in antihypertensive efficacy, side effects and quality of life within these drug classes [13]. This has been supported by a retrospective time series data from 2007 to 2012 noted that the consumption of antihypertensive drugs in China nearly doubled [14]. The most frequently prescribed antihypertensive drug classes were CCBs and ARBs, with prescriptions of the latter increasing most rapidly [14].

Liu and Wang demonstrated that in 6,536 newly-diagnosed cases of uncomplicated hypertension, CCBs and BBs were the most prescribed antihypertensive medications. Surprisingly, the prescription rate of thiazide diuretics which are the least expensive, and well-known first-line antihypertensive therapy was low (8.3 % monotherapy and 19.9 % overall) [15].

Joseph et al. used Phadke’s criterion for assessment of appropriateness of prescribing. They observed that most patients were being treated with two or more drugs and CCBs were most frequently prescribed antihypertensive medicines. Similar to other studies, 67.92 % of the patients were prescribed more than one drug, with the most commonly used combination being CCB + BB + alpha-blocker (7.55 %). Based on Phadke’s evaluation criteria, 87.27 % of prescriptions were found rational [16].

In another drug utilization study, 645 prescriptions were analyzed. A total of 697 antihypertensive drugs prescribed, of which 33.57 % were ARBs, 16.79 % ACEIs, 13.63 % were BBs and 11.91 % CCBs. About 32 % of the antihypertensives prescribed were from the essential medicine list [17].

In a National Health and Nutrition Examination Survey conducted on subjects aged ≥18 years, it was
observed that combination therapy regimens helped to achieve BP goals, with single-pill fixed dose combination (FDC) and multiple-pill combinations being associated with a 55% and 26% increased likelihood of BP control, respectively when compared to monotherapy. A significant increase in the use of multiple antihypertensive agents from 36.8% to 47.7% (p < 0.01), with an increased use of thiazide diuretics, BBs, ACEIs, and ARBs by 23%, 57%, 31%, and 100%, respectively was observed [18].

Al-Drabah et al. observed that majority of subjects in their study were prescribed monotherapy, followed by two drugs. A few others required three of more drugs. While ACEIs were the most commonly prescribed monotherapy, diuretics were the most commonly prescribed drugs in combination therapy. The researchers further observed that target BP control was not achieved in most patients which imply that monotherapy may not be sufficient for achieving adequate BP control in majority of the patients [19]. The notable findings of various studies have been presented in Table 2. As per our knowledge, there is no recent data on international variation in prescribing antihypertensive drugs, which can help clinicians to keep them updated with the recent trends.

**Antihypertensive drug utilization and adherence**

Antihypertensive medication utilization, adherence to treatment by patients, and physicians’ adherence to guidelines in prescribing medications have been studied in different settings. Many of them have noted full, partial or no-adherence in some studies. Studies suggest that formulators of guidelines should evolve treatment protocols which needs less frequent monitoring by physician, so as to suit developing countries patients. Globally, all guidelines address that guidelines are just to guide but physicians need to follow a patient-centric approach. Treatment strategies for developing countries, where access to health care system is less compared to developed countries, need to be simple, economic and

| Table 1 | Guideline comparisons of goal BP and initial drug therapy for adults with hypertension |
|---------|-------------------------------------------------|
| Guideline | Population | Goal BP, mmHg | Initial drug treatment options |
| JNC 8: 2014 Hypertension Guideline [3] | General ≥60 y | <150/90 | Nonblack: thiazide-type diuretic, ACEI, ARB, or CCB; black: thiazide-type diuretic or CCB |
| | General <60 y | <140/90 |  |
| | Diabetes | <140/90 |  |
| | CKD | <140/90 | ACEI or ARB |
| ESH/ESC 2013 [42] | General nonelderly | <140/90 | Diuretic, BB, CCB, ACEI, or ARB |
| | General elderly <80 y | <150/90 |  |
| | General ≥80 y | <150/90 |  |
| | Diabetes | <140/85 | ACEI or ARB |
| | CKD no proteinuria | <140/90 |  |
| | CKD + proteinuria | <130/90 |  |
| Canadian Hypertension Education Program (CHEP) 2014 [43] | General <80 y | <140/90 | Thiazide, BB (age <60y), ACEI (nonblack), or ARB |
| | General ≥80 y | <150/90 |  |
| | Diabetes | <130/80 | ACEI or ARB with additional CVD risk |
| | CKD | <140/90 | ACEI or ARB |
| American Diabetes Association (ADA) 2013 [44] | Diabetes | <140/80 | ACEI or ARB |
| Kidney Disease: Improving Global Outcome (KDIGO) 2012 [45] | CKD, no proteinuria | ≤140/90 | ACEI or ARB |
| | CKD + proteinuria | ≤130/80 |  |
| NICE 2011 [46] | General <80 y | <140/90 | <55 y: ACEI or ARB |
| | General ≥80 y | <150/90 | ≥55 y or black: CCB |
| International Society for Hypertension in Blacks (ISHIB) 2010 [47] | Black, lower risk | <135/85 | Diuretic or CCB |
| | Target organ damage or CVD risk | <130/80 |  |
| Korean Society of Hypertension Guidelines for the Management of Hypertension 2013 [48] | Elderly (>65 years) | <140/90 | ACEIs, CCBs and diuretics; BBs should be limited to special scenarios |
| | Diabetes | <140/85 |  |
| | Stroke, CAD and CKD | 140/90 | Combination therapy of ARBs, CCBs and diuretics |
forced time bound titration by the primary care physician and not by the specialist or the tertiary care physician, in order to reach maximum number of patients.

A study conducted in India pointed to a common trend that the study patients were on multiple therapies with at least two antihypertensive drugs. This pattern is recommended by guidelines, which state that small doses of different classes of antihypertensive drug are more beneficial than a high dose of one [20]. In a recent study, it has been noted that in India, the antihypertensive utilization pattern is in accordance with the international guidelines for treatment of hypertension. There is considerable use of different antihypertensive drug combinations and such practice has a positive impact on the overall BP control [21].

In a meta-analysis, Murphy et al. noted that no consistent differences were observed in the rates of utilization or adherence to drugs for CVDs or diabetes in subjects living in urban and rural settings [22]. Odili et al. studied the role of physicians in the overall management of hypertension and their adherence to JNC 7, WHO/ISH and ESH guidelines. They concluded that physicians in this study fairly complied with hypertension management guidelines. However, they did not appear to recommend lifestyle modification to their patients [23]. On the contrary, a study conducted in Malaysia, observed that doctors poorly adhered to Malaysian Clinical Practice Guideline (CPG) in hypertensive patients with diabetes and left ventricular hypertrophy. A better hypertension control was seen with ACEIs and guidelines-adherent therapy [24].

In another study by Abdulameer et al., 85.30 % of the prescriptions were in accordance to guidelines [25]. It was observed that the treatment approach for cardiac complicated hypertension followed JNC 7 guidelines, except the lack of add-on therapy practice (ARBs, aldosterone antagonist). The prescribing practice was found in compliance with the Eritrean National treatment guideline 2003 [26]. In a multicenter study, it was noted that even though physicians self-reported that they were aware of and implement hypertension guidelines in daily practice, a significantly lower agreement rate between physicians’ practice and European guidelines was detected. It was also found that more than one-fourth of high risk hypertensive patients remained untreated, half of them remained uncontrolled, and almost 40 % of low-risk patients received medications unreasonably [27].

Interestingly, in another study, multifaceted comprehensive implementation of a hypertension guideline did not exert an impact on general practitioners’ prescribing of antihypertensive drugs for drug-treated patients with hypertension, even though the participating general practitioners rated themselves as highly motivated to treat according to the guidelines [28].

Table 3 summarizes the observations of above quoted studies. It can be noted that physicians seemed to be well-aware of clinical trials on compliance with hypertension treatment, which showed the compliance rates were good with monotherapy, average with two separate drugs (pills), poor when more than two pills were used and hence switched over from monotherapy to single pill FDC. This strategy will offset the side-effects of maximum dose of one class of drug, simultaneously attracting the synergistic effects of different classes of drugs at low doses. The other advantages of single pill FDC being low cost compared to multiple pills of different classes of drugs apart from better compliance.

**Cost implications in antihypertensive drugs Use**

The cost of medications has always been a barrier to an effective treatment. The increasing prevalence of hypertension and the continually increasing expense of its treatment influence the prescribing patterns among physicians and compliance to the treatment by the patients. In developing countries like India, unlike developed countries, patients are not covered by insurance schemes.
and are paying out of their pockets for their healthcare. Therefore, they would benefit if physicians provide better services based on rational and cost-effective drug prescription [29].

According to a cost analysis study by Rachana et al., alpha-blockers were the highest ranked in terms of cost utilized per year followed by ACEIs, ARBs, CCBs, BBs and diuretics in the same order. Thus they found diuretics to be the most cost-effective antihypertensive to be prescribed [30]. Similarly, Amira et al. observed that diuretics were the most cost-effective drugs for hypertension [31]. Additionally, the cost of drugs varied based on the type of hospitals, whether government or private, according to a study by Rimoy et al., the costs of nifedipine, bendrofluazide and frusemide were about five to six times higher in private hospitals than at the government-owned pharmacies [8].

Noteworthy is that adherence to guidelines while prescribing antihypertensive drugs results in substantial savings in prescription costs [32]. The presence of comorbidities further adds to the problem of increased economic burden. Osibogun and Okwor demonstrated a statistically significant association between co-morbid conditions and higher prescription costs with 73.7 % and 63.2 % of those with diabetes and renal disease respectively having prescription costs in the high cost group (p < 0.05) [33]. The cost implication findings from the above studies are summarized in Table 4.

### Use of antihypertensives in special population

The management of hypertension needs special attention in patient population such as, elderly, pediatrics, pregnant women, and hypertension associated with comorbidities. Often it qualifies for combination therapy to achieve target BP levels. There are several studies, which evaluated the prescription pattern of antihypertensive drugs in such patient population. In a prospective, observational study conducted on geriatric antihypertensive patients, it was noted that the most common drug classes prescribed were CCBs (37 %) and ACEIs (21 %), and amlodipine was the most commonly prescribed drug (37 %). The most common antihypertensive FDC prescribed was telmisartan + hydrochlorothiazide (15 %) and most common two drug combination therapy was amlodipine + atenolol (7 %) [34]. In another study by Fadare et al., antihypertensive drugs accounted for 30.6 % of the total prescriptions of 220 elderly patients. The authors opined that physicians should be specifically trained regarding prescribing to the geriatric population [35].

An observational and cross-sectional prospective prescription audit study was carried-out to evaluate antihypertensive drug prescription patterns, rationality and adherence to JNC 7 guidelines in postmenopausal women. It was noted that ARBs were frequently prescribed as monotherapy and 31.6 % of patients were on a two-drug combination. Majority of the prescriptions

### Table 3 Observations from different studies highlighting antihypertensive drug utilization and adherence

| Author Name          | Number of subjects involved | Observation/Remarks                                                                                                                                 |
|----------------------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Xavier et al. [20]   | 380 patients                | Small doses of different classes of antihypertensive drug are more beneficial than a high dose of one                                                                                                    |
| Shipra et al. [21]   | 22 prescription pattern monitoring studies | Antihypertensive utilization pattern is in accordance with the international guidelines different antihypertensive drug combinations in practice has a positive impact on the overall BP control |
| Murphy et al. [22]   | 51 studies                  | No significant differences in urban versus rural settings                                                                                           |
| Odili et al. [23]    | 501 case notes              | Fair compliance with stated guidelines                                                                                                             |
| Ahmad et al. [24]    | 13 doctors for 320 hypertensive patients | Doctors poorly adhered to Malaysian Clinical Practice Guideline (CPG)-2008 in hypertensive patients with diabetes and LVH. A better hypertension control was seen with ACEIs and guidelines-adherent therapy |
| Abdulameer et al. [25]| 303 Cardiac complicated hypertension | 85.30 % adherence to guidelines                                                                                                                     |

### Table 4 Cost implication findings from various studies

| Author Name          | Number of subjects involved | Mono-/combination therapy prescribed | Observation/Remarks                                                                                     |
|----------------------|-----------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------|
| Rachana et al. [30]  | 300 prescriptions           | Mono (48.94 %), CCB                  | Costliest - Alpha-blocker                                                                             |
| Amira and Okubadejo  | 225 black patients          | CCB                                  | Cost effective - Diuretic                                                                             |
| Rimoy [8]            | 600 patients                | Diuretics                            | Govt. shops drugs 5–6 times cheaper than private shops                                               |
| Fisher and Avorn [32]| 133,624 patients            | Combination (CCB + ACEI)             | Adherence to guidelines result in savings                                                            |
| Osibogun and Okwor   | 147 prescriptions           | Diuretics 79.6 %                     | Co-morbid conditions had high cost prescriptions                                                       |
showed non-adherence as per recommendations for pre-
hypertension. The study concluded that except polyphar-
macy, antihypertensive prescription trends largely adhere
to existing guidelines and are rational [36].

Though there is a scarcity of sufficient data in Indian
context, some authors have evaluated antihypertensive
medication use in hypertensive diabetes mellitus pa-
tients. In a cross-sectional study, Dhanaraj et al. ob-
served that ACEIs were most commonly prescribed
antihypertensives (59 %) and most of the patients (55 %)
were on multiple drug therapy. In this study, although
prescribing pattern of antihypertensives was in accord-
ance with guidelines, there still remained a significant
number of patients with uncontrolled hypertension [37].
In a similar patient population, Janagan et al. observed
that most of the patients received more than one an-
tihypertensive (75.2 %), with a combination of ACEIs
and thiazide diuretics being the most common. This
pattern was compliant with JNC7 guidelines [38].
Hussain et al. conducted a retrospective, randomized,
non-interventional study in 117 subjects to evaluate
patterns of drug therapy among diabetic hypertensive
patients with other complications. It was found that
the most common drug administered for diabetes was
metformin, whereas for hypertension, it was telmisar-
tan. There was a positive relationship between fasting
blood glucose and systolic blood pressure. The not-
able gap in the present prescribing pattern was found
to be underutilization of diuretics [39].

Adolescent hypertensives seem to be undertreated,
with only 23 % of them receiving antihypertensive
prescription, according to a study by Yoon et al. Fur-
ther, ACEIs were the most frequently prescribed
monotherapy [40].

In a study by St. Peter et al. on hypertensive subjects
on dialysis, the prescription patterns varied by dialysis
modality in the initial six months. Further, it was ob-
served that majority of patients who were on BBs, drugs
inhibiting the renin angiotensin system, and dihydropyri-
dine CCBs at 6 months of dialysis did not take prescrip-
tions for these drugs by month 24. Additionally, the
specific drugs prescribed varied based on factors like
race/ethnicity, age and presence of comorbidities [41].

The key observations of the studies discussed are sum-
marized in Table 5.

### Table 5: Observations of antihypertensives use in special population from various studies

| Author Name | Number of Subjects Involved | Observation/Remarks |
|-------------|-----------------------------|---------------------|
| Altaf et al. [34] | 100 geriatric patients | The drug class most commonly prescribed was CCBs and the anti-hypertensive drug combinations were considerable, and this practice impacted positively on the overall BP control. |
| Fadare et al. [35] | 220 elderly patients | Antihypertensives accounted for 30.6 % prescriptions |
| Tondon et al. [36] | 500 prescriptions to PMW | Adherence rates to JNC-7 were adequate in Stage 1, hypertensive emergency and urgency. It was inadequate in pre-hypertension and Stage 2 hypertension. |
| Dhanaraj et al. [37] | 1186 hypertensive patients with type 2 DM patients | Adhered to guidelines |
| Janagan et al. [38] | 85 hypertensive patients with type 2 DM | Prescription pattern was in accordance with the JNC 7 recommended treatment of hypertension with type 2 DM |
| Hussain et al. [39] | 117 hypertensive patients with type 2 DM | Most common drug used was telmisartan. A positive relationship between fasting blood glucose and SBP observed. Underutilization of diuretics was noted. |
| Yoon et al. [40] | 4296 adolescent hypertensives | Only 23 % received antihypertensive prescription |
| St. Peter et al. [41] | 13072 adult patients on dialysis | Considerable proportions of patients with prescriptions for BBs, renin angiotensin system agents, and dihydropyridine CCBs in month 6 no longer had prescriptions for these medications by month 24. |

### Conclusion

The continued challenges in the management of hyper-
tension still need special attention. A number of national
and international guidelines for the management of hyper-
tension have been published highlighting mono- or
combination therapy according to the BP levels and associated
comorbidity. Worldwide, hypertension treatment stra-
 tegies have varied widely over time in terms of initial drug
choice from diuretic to ACEI/ARB/CCB, from mono-
therapy to low dose combination single pill therapy.
National health policy makers should consider evaluation
and treatment of hypertension as a right in public health
system for better outcomes in terms of morbidity and
mortality from hypertension. The evaluation pattern,
patient adherence to the treatment, physician adherence
to hypertension management guidelines, cost implications
and other data concerning comorbid conditions have been
explored in many clinical studies. Inspite of these data and
published guidelines, inconsistencies exist towards treat-
ment approach, because of which physicians sometimes
have to individualize the therapy, based on specific patient
characteristics and response to treatment. In developing
countries like India, more systematic studies are required
on the evaluation of prescribing patterns and guideline-
based antihypertensive medications’ use, which can be
tailored to suit the patients’ requirements.
Competing interest

The authors declare that they have no competing interests.

Authors’ contributions

NJ initiated the theme and provided references, NR given intellectual contribution being physician, JS is main coordinated the manuscript and corresponding author, KE provided intellectual cardiology content, SS gave major contribution in writing manuscript, RN given physician advices to manuscript, DK has given major guidelines in metabolic aspect, AA helped in typing and online access to various journals and LT helped in typing and language corrections. All authors read and approved the final manuscript.

Acknowledgement

I acknowledge my sincere thanks to Quest International University for giving full access to the online journals and providing reference books and journals in Library. My sincere thanks to the staff of department of Pharmacology to give resources including journals and study materials. I also extend my gratitude to the department of Medicine, Andhra Medical College, Visakhapatnam to facilitate my coauthors by providing relevant materials and case histories.

Author details

1. Department of Pharmacology, University of Benghazi, Benghazi, Libya.
2. Department of Medicine, Andhra Medical College, Visakhapatnam, India.
3. Department of Biochemistry, Quest International University Perak, 227 The Teng Seng Plaza, Level 2, Jalan Raja Permaisuri Bainun, Ipoh, Perak, Malaysia.
4. Libyan Cardiac Society, Department of Cardiology, Benghazi Medical Center, Benghazi University, Benghazi, Libya.
5. Department of Physiology, Quest International University Perak, Ipoh, Malaysia.
6. Department of Pathology, Quest International University Perak, Ipoh, Malaysia.
7. Department of Pathology, Management and Science University, Selangor, Malaysia.
8. Department of Clinical Medicine, Hospital Raja Permaisuri Bainun, Ipoh, Malaysia.
9. Department of Biochemistry, St. Mathews Medical University, Grand Cayman, Cayman Islands.
10. Department of Pharmacology, Dr Ambethkar Medical College, Bengaluru, India.
11. Department of Medicine, Rangaraya Medical College, Kakinada, India.
12. Department of Endocrinology, Andhra Medical College, Visakhapatnam, India.
13. Department of Human Genetics, Andhra University, Visakhapatnam, India.
14. Great Eastern Medical School, SriRakshakula, India.

Received: 26 June 2015 Accepted: 8 January 2016

References

1. Go AS, Mozaffarian D, Roger VL, American Heart Association Statistics Committee and Stroke Statistics Subcommittee, et al. Heart disease and stroke statistics – 2014 update: A report from the American Heart Association. Circulation. 2013;129(2):28–292.
2. World Health Organization (WHO). A global brief on hypertension. Available at: http://www.who.int/cardiovascular_diseases/publications/global_brief_hypertension/en/. Accessed on: 02 Jan 2015.
3. James PA, Oparil S, Carter BL, Eighth Joint National Committee (JNC 8) Members, et al. 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), Supplemental Content. JAMA. 2014;311:507–20.
4. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9853):2283–320.
5. Causes of Death 2008 [online database]. Geneva, World Health Organization (http://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf).
6. Gupta R, Gupta VP. Hypertension epidemiology in India: lessons from Jaipur Heart Watch. Current science. 2009;97(3):349–55.
7. Sandoz T, Emani VK. Survey of prescription pattern of anti-hypertensive drugs in hypertensives and hypertension associated diabetics. Int J Pharm Bio Sci. 2010;1(4):23–6.
8. Rimoy GH, Justin-Temu M, Nilay C. Prescribing Patterns and Cost of Antihypertensive Drugs in Private Hospitals in Dar es Salaam, Tanzania. East Cent Afr J Pharm Sci. 2008;11:69–73.
9. Kotchen TA. The Search for Strategies to Control Hypertension. Circulation. 2010;122:1141–3.
10. Jackson JH, Sobolisk J, Kriemen R, Wong KS, Frech-Tamas F, Ntengegole B. Blood pressure control and pharmacotherapy patterns in the United States before and after the release of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) Guidelines. J Am Board Fam Med. 2008;21:52–21.
11. Ohta Y, Tsuchihashi T, Fuji K, Matsumura K, Ohy A, Uezono K, et al. Improvement of blood pressure control in a hypertension clinic: A 10-year follow-up study. J Hum Hypertens. 2004;18:273–8.
12. Jeschke E, Thomas O, Horst CV, Matthias K, Angelina B, Claudia MW, et al. Evaluation of prescribing patterns in a German network of CAM physicians for the treatment of patients with hypertension: A prospective observational study. BMC Fam Pract. 2009;10:78.
13. Gaceres MC, Moyano F, Farinas H, Cobaleda J, Pijero A, Darado P, et al. Trends in Antihypertensive Drug Use in Spanish Primary Health Care 1990–2012. AdvPharmacoeconomics Drug Saf. 2013;13:172.
14. Xu H, He Y, Xu L, Yan X, Dai H. Trends and patterns of five antihypertensive drug classes between 2007 and 2012 in China using hospital prescription data. Int J Clin Pharm. 2015;37:430–7.
15. Liu PH, Wang JD. Antihypertensive medication prescription patterns and time trends for newly-diagnosed uncomplicated hypertension patients in Taiwan. BMC Health Serv Res. 2008;8:133.
16. Joseph S, Verghese N, Thomas L. A study on prescribing pattern of antihypertensive medications in a tertiary care hospital in Malabar region. Der Pharmacia Lettre. 2014;6(4):132–1.
17. Beg MA, Dutta S, Varma A, Kant R, Bawa S, Anjoom M, et al. Study on drug prescribing pattern in hypertensive patients in a tertiary care teaching hospital at Dehradun, Uttarakhand. Int J Med Sci Public Health. 2014;3(8):922–6.
18. Gu Q, Burt VL, Dillon CF, Yoon S. Trends in antihypertensive medication use and blood pressure control among United States adults with hypertension: The National Health and Nutrition Examination Survey, 2001 to 2010. Circulation. 2012;126(17):2105–14.
19. Xavier D, Noby M, Pradeep J, Prem P. Letter to the editor. Pattern of drug use in hypertension in a tertiary hospital: A cross sectional study in the inpatients ward. Indian J Pharmacol. 2001;33:456–7.
20. Shipra J, Prerna U, Jaswant G, Kumar A, Pushpawati J, Vikas S, et al. A systematic review of prescription pattern monitoring studies and their effectiveness in promoting rational use of medicines. Perspect Clin Res. 2015;6:86–90.
21. Murphy GK, McAllister FA, Weir DL, Tjosvold L, Ertich DT. Cardiovascular medication utilization and adherence among adults living in rural and urban areas: A systematic review and meta-analysis. BMC Public Health. 2014;14:544.
22. Odili VI, Oghagbon OK, Ugwa NA, Ochei UM, Agbomo OE. Adherence to international guidelines in the management of hypertension in a tertiary hospital in Nigeria. Trop J Pharm Res. 2008;7(2):945–52.
23. Ahmad N, Hassan Y, Tangisuran B, Meng OL, Abd Aziz N, Khan AH. Guidelines adherence and hypertension control in an outpatient cardiology clinic in Malaysia. Trop J Pharm Res. 2012;11(6):665–72.
24. Abdulmaleer SA, Sahih MN, Asiz NA, Hassan Y, Abdul HA, Razazz A, et al. Physician adherence to hypertension treatment guidelines and drug acquisition costs of antihypertensive drugs at the cardiac clinic: A pilot study. Patient Preference and Adherence. 2012;6:101–8.
25. Shobana J, Semere M, Sied M, Eyo T, Rruso M. Prescribing pattern of anti-hypertensive drugs among hypertension patients with cardiac complications in Eritrea. Lat Am J Pharm. 2013;32(5):745–8.
26. Thedodorou M, Stafylas P, Kourlab G, Kaitelidou D, Mianiadakis N and Papademetrou V. Physicians’ perceptions and adherence to guidelines for the management of hypertension: a national, multicentre, prospective study. Int J Hypertens. 2012;Article ID 503821. doi: 10.1155/2012/503821. Epub 2012 Nov 28.
28. Sipila R, Helin-Salmivaara A, Korhonen MJ, Ketola E. Change in antihypertensive drug prescribing after guideline implementation: A controlled before and after study. BMC Family Practice. 2011;12:87.
29. Karve AV, Chattar KB. Cost analysis study of oral antihypertensive agents available in Indian market. Int J Basic Clin Pharmacol. 2014;3:749–83.
30. Manchana PR, Anuradha HV, Shivamurthy MC. Antihypertensive prescribing patterns and cost analysis for primary hypertension: A retrospective study. J Clin Diagn Res. 2014;8(9):HC19–22.
31. Amira CO, Okubadejo NU. Antihypertensive pharmacotherapy in a developing economy: pattern, acquisition costs and conformity to international guidelines in a tertiary-care setting. J Human Hypertens. 2006;20:894–7.
32. Fischer MA, Avorn J. Economic implications of evidence-based prescribing for hypertension: can better care cost less? JAMA. 2004;291(15):1850–6.
33. Osibogun A, Okwor T. Anti-Hypertensive prescription and cost patterns in an outpatient department of a teaching hospital in Lagos State Nigeria. Op J PrevMedPrev Med. 2014;4:156–63.
34. Aftaf M, Rashheed A, Mufjaba A, Mohammed S. Drug utilization evaluation of antihypertensives in geriatric patients in a tertiary care hospital. Int J Pharm Pharm Sci. 2014;4(9):261–4.
35. Fadare JO, Agboola SM, Opeke OA, Alabi RA. Prescription pattern and prevalence of potentially inappropriate medications among elderly patients in a Nigerian rural tertiary hospital. Ther Clin Risk Manag. 2013;9:115–20.
36. Tandon VR, Sharma S, Mahajan S, Mahajan A, Khajuria V, Mahajan V, et al. Antihypertensive drug prescription patterns, rationality, and adherence to Joint National Committee-7 hypertension treatment guidelines among Indian postmenopausal women. J Mid-life Health. 2014;5:78–83.
37. Dhanaraj E, Raval A, Yadav R, Bhanisai A and Tiwari P. Prescription pattern of antihypertensive agents in T2DM patients visiting tertiary care centre in North India. Int J Hypertens. 2012; Article ID S20915. doi:10.1155/2012/ S20915. Epub 2012 Dec 18.
38. Janagan T, Kavitha R, Sridevi SA, Veerendra V. Prescription pattern of antihypertensive drugs used in hypertensive patients with associated type2 diabetes mellitus in a tertiary care hospital. Int J Pharm Res Rev. 2014;3(1):1–5.
39. Hussain Z, Sana A, Mohammed S, Razaq MA. Patterns of drug therapy among diabetic hypertensive patients with other complications. Int J Pharm Pharm Sci. 2014;6(6):270–6.
40. Yoon EY, Cohn L, Rocchini A, Kershaw D, Freed G, Ascione F, et al. Antihypertensive prescribing patterns for adolescents with primary hypertension. Pediatr. 2012;129(1):e1–8.
41. St. Peter WL, Sozio SM, Shaft T, Ephaim PL, Luly J, McDermott A, et al. Patterns in blood pressure medication use in US incident dialysis patients over the first 6 months. BMC Nephrol. 2013;14:249.
42. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J. 2013;34(28):2159–219.
43. Canadian Hypertension Education Program (CHEP) 2014 Recommendations. Hypertension treatment. Available at: http://www.hypertension.ca/en/chep. Accessed on: 02 Jan 2015.
44. American Diabetes Association. Standards of medical care in diabetes—2013. Diabetes Care. 2013;36 suppl 1:S11–66.
45. Kidney Disease; Improving Global Outcomes (KDIGO) Blood PressureWork Group. KDIGO clinical practice guideline for the management of blood pressure in chronic kidney disease. Kidney Int Suppl. 2012;2(9):337–14.
46. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J. 2013;34(28):2159–219.
47. National Institute for Health and Clinical Excellence. Hypertension (CG127). Available at: http://www.nice.org.uk/guidance/cg127. Accessed on: 02 Jan 2015.
48. Flack JM, Sica DA, Bakris G, et al. International Society on Hypertension in Blacks. Management of high blood pressure in Blacks: an update of the International Society on Hypertension in Blacks consensus statement. Hypertension. 2010;56(3):780–00.
49. Shin J, Park JB, Kim K, Kim JH, Yang DH, Pyun WB, et al. 2013 Korean Society of Hypertension guidelines for the management of hypertension. Part I - epidemiology and diagnosis of hypertension. Clin Hypertens. 2015;21:1.