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PRESCRIPTION PATTERN ANALYSIS OF ANTIHYPERTENSIVE DRUGS IN A TERTIARY CARE HOSPITAL

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Abstract

This review summarises published knowledge on how antihypertensive drugs are prescribed in hospital practice and how such prescribing is analysed, and it reports no new data. It outlines the disease burden and the guideline recommendations that frame prescribing, describes the drug-class patterns and combination use reported in tertiary care and population studies, and compares the indicators, classification systems and study designs used in prescription pattern analysis. Reports from different countries agree on a shift towards renin-angiotensin system blockers, calcium channel blockers and fixed-dose combinations, but studies are mostly cross-sectional, define indicators differently and seldom link prescribing to blood pressure control, which restricts their usefulness.

1. INTRODUCTION

High blood pressure is among the most common conditions seen in medical practice, and it is a leading modifiable cause of stroke, heart disease and kidney failure. Population surveys suggest that around a billion adults worldwide live with the condition, and that the proportion who are aware, treated and controlled is much lower in many countries than clinicians would like [1, 2]. Antihypertensive drugs are therefore among the most frequently prescribed medicines in both outpatient and inpatient care, and how

they are chosen has large consequences for outcomes and for health budgets. Cost matters because treatment is lifelong; a small

difference in the price of a daily tablet becomes large when multiplied by millions of patients.

A tertiary care hospital sees a particular mix of patients. Many arrive with complications or with several other diseases, such as diabetes, chronic kidney disease or heart failure, and some have hypertension that is hard to control. The prescriptions written in these settings differ from those of primary care, and they often serve as a model for prescribers elsewhere. Reviewing them can show whether practice follows guidelines, whether cost-effective products are used and where problems such as polypharmacy or inappropriate combinations arise [3, 4]. Teaching hospitals also train the next generation of prescribers, so their habits are passed on to the wider system.

This review draws together published trials, guidelines, drug utilisation studies and surveys to describe what is known about prescription patterns for antihypertensive drugs. It does not present a new audit or primary data. It begins with the burden of disease and the recommendations that guide treatment, then describes the patterns reported in hospital and population settings, the methods of analysis, the issues of combination therapy and adherence, and special groups. The final section looks at the limitations of the evidence and at what future work might add. Statements about numbers are limited to well-known findings, and reports of local audits are treated as illustrations, not as pooled estimates.

2. BURDEN OF DISEASE AND GUIDELINE FRAMEWORK

The link between blood pressure and vascular risk is continuous. Cohort data from the Framingham study showed that cardiovascular risk rises steadily with blood pressure, and that it is already higher in the high-normal range than in people with optimal pressure [5]. Prevalence is high in both rich and poor countries, and the early global analyses indicated that most affected adults lived in economically developing regions, where treatment and control lag behind [1, 2]. Studies from India reported that awareness, treatment and control were all low, with large differences between urban and rural populations [6, 7]. The gradient is steep enough that even small differences in average pressure across a population translate into many events.

Geographical differences are large and not always in the expected direction. A comparison of six European countries, Canada and the United States around the turn of the century found that prevalence was markedly higher in the European countries than in North America, and mean blood pressure differed correspondingly [8]. A large survey in communities across high-, middle- and low-income countries found that awareness, treatment and control were highest in high-income countries and lowest in low-income ones, with rural populations faring worse [7]. In India, reviews of community surveys have documented a steady rise in prevalence over several decades, higher in urban than rural adults, with awareness and control remaining poor [6]. Such differences determine what a tertiary centre sees and who it fails to reach.

Trial evidence supports treatment across a wide range of risk. A meta-analysis of 147 randomised trials found that blood pressure lowering reduced stroke and coronary events largely in proportion to the fall in pressure achieved, and that this was true for the major drug classes irrespective of baseline level [9]. A large meta-analysis of randomised trials confirmed that lowering blood pressure reduced the risk of major cardiovascular events, stroke, coronary events and heart failure [10]. The HYVET trial showed that indapamide-based treatment in people aged 80 or older reduced stroke and heart failure, which helped to settle doubts about treating the very old [11]. Those findings explain why guidelines focus on the size of the blood pressure reduction and the patient's overall risk, rather than on an ideal single drug.

Guidelines translate this evidence into recommendations on whom to treat and with what. The European guideline of 2023 and the American guideline of 2017 differ in the threshold at which diagnosis is made, but agree on the main points: lifestyle measures for all, drug therapy for those at higher risk or with sustained high readings, a preference for

combination therapy at the start in many patients, and a limited number of first-line classes [12, 13]. The World Health Organization guideline of 2021 offers a simplified approach for settings with limited resources, with a short list of drug classes and clear thresholds for starting treatment [14]. Earlier reports from the United States and Europe were more cautious about initial combinations and gave greater weight to thiazide diuretics [15, 16]. Differences between guidelines matter in practice, since a hospital may follow a national document that was written several years before the latest international advice.

3. REPORTED PRESCRIBING PATTERNS

Studies of drug use in hospitals and populations show a recognisable trajectory. In the United States, survey data across a decade recorded a rise in the proportion of treated adults who received renin-angiotensin system blockers and a continued high use of thiazide diuretics, with increasing use of combinations [17]. German data likewise showed growth in the use of angiotensin receptor blockers and calcium channel blockers over time, with improvement in the proportion of patients controlled [18]. The shift generally follows guideline changes and the arrival of cheap generics rather than new evidence about individual drugs [9, 12]. Reports of this kind are usually descriptive and do not claim that changes in prescribing caused better control.

Calcium channel blockers, usually amlodipine, are among the most commonly prescribed agents in many hospital studies from South Asia, followed by angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, beta-blockers and diuretics. The pattern reflects both local guidelines and the profile of patients, in whom coexisting diabetes or kidney disease favours renin-angiotensin blockade. Beta-blockers remain frequently used, often because of coexisting coronary disease or heart failure, although as first-line therapy for uncomplicated hypertension they are given a lesser role in current guidance [6, 12, 19]. The balance between classes therefore depends heavily on who is being treated. Single-pill products that include amlodipine have helped to raise its share in several settings.

The main classes and the points most often reported about each are summarised in table 1. Diuretics are valued for cost and evidence but are sometimes under-used, perhaps because of concerns about metabolic effects or because they are seen as old-fashioned [20, 21]. Renin-angiotensin blockers are widely used for their organ-protective profile, and monitoring of potassium and creatinine is part of safe use. Calcium channel blockers are well tolerated, though ankle oedema is a frequent complaint. Beta-blockers, centrally acting drugs and alpha-blockers are generally reserved for specific indications or for resistant hypertension [19]. The entries are deliberately brief and do not replace the full product information.

Inpatient prescribing carries its own features. Many patients are admitted for another reason and are given their usual antihypertensives, which are then continued, adjusted or withheld depending on the clinical situation, for example during sepsis, bleeding, acute kidney injury or surgery. Acute severe hypertension may call for parenteral agents such as labetalol, and guidelines caution against rapid, large falls in pressure in most patients because of the risk of ischaemia [12, 13]. A prescription review that includes both inpatient and outpatient orders therefore combines two situations that should not be judged by the same standard, and the setting needs to be stated in the report.

Table 1: Published findings on antihypertensive drug classes and prescribing patterns

Class or topic	Reported finding	Ref.
Thiazide-like diuretics chlorthalidone	Strong outcome evidence and low cost; sometimes under-used in practice.	[20, 21]
ACE inhibitors and ARBs renin-angiotensin blockade	Widely used for organ protection in diabetes and kidney disease; monitor potassium.	[17, 22]
Calcium channel blockers amlodipine	Commonly prescribed and well tolerated; ankle oedema frequent.	[19, 23]
Beta-blockers coexisting heart disease	Still frequently used but given a lesser first-line role in current guidance.	[12, 19]

Class or topic	Reported finding	Ref.
Fixed-dose combinations single pill	Better adherence and modest blood pressure gains than free combinations.	[24, 25]
Adherence prevalence and causes	A sizeable minority fail to take drugs as prescribed; regimen simplicity helps.	[26, 27]
WHO core indicators prescribing by generic name	Standard measures of rational use, not specific to hypertension.	[3, 4]
ATC and DDD classification and quantity	Allows comparison across places and times; DDD differs from the dose prescribed.	[28]
National registers large databases	Support analysis of trends and persistence of treatment.	[18, 29]
Older patients Beers criteria	Explicit lists flag drugs that raise risk of falls and hypotension.	[30]
Pregnancy less-tight control	Renin-angiotensin blockers avoided; labetalol and nifedipine preferred.	[31]

4. METHODS OF PRESCRIPTION PATTERN ANALYSIS

Most prescription pattern studies are cross-sectional and descriptive. Investigators collect prescriptions or case records over a defined period, extract demographic and clinical data, and tabulate the drugs prescribed by class, by number per patient and by combination. The WHO methodology for investigating drug use in health facilities defines core indicators, such as the average number of drugs per encounter, the percentage prescribed by generic name and the percentage from an essential list, and has become a standard reference [3, 4]. These indicators were developed for primary care and do not capture whether a particular hypertension regimen is correct. The period of data collection also matters, since admissions and prescribing may vary by season and with the timing of junior staff rotations.

Classification and quantification follow standard systems. The Anatomical Therapeutic Chemical system groups drugs by organ system and therapeutic use, so that the cardiovascular group can be broken into diuretics, beta-blockers, calcium channel blockers and agents acting on the renin-angiotensin system, and the defined daily dose provides a technical unit that allows consumption to be compared across places and times [28]. A defined daily dose is not necessarily the dose actually prescribed, however, and in hypertension the typical dose can differ substantially from it. Prescribed daily dose, when available, gives a better picture of real practice. The distribution of the evidence is shown in fig. 1. Where a hospital also records the indication, the analysis can be extended to compare prescribing in diabetic, renal and cardiac patients separately.

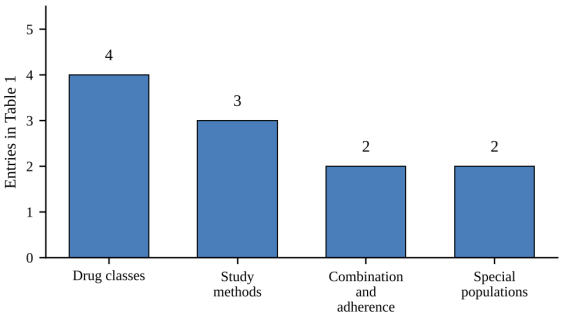


Fig. 1: Number of entries in table 1 by theme

Sampling and sample size need explicit justification. Studies often take consecutive prescriptions over a few months, which is simple but may be unrepresentative if clinics run on particular days for particular specialties. The unit of analysis should be defined in advance: a prescription may carry several antihypertensives, and a patient may have several prescriptions over the study period. Counting each prescription as independent when the same patient appears repeatedly overstates the precision of the result. The WHO indicator manual suggests minimum numbers of encounters for facility surveys, and these are a sensible lower bound for hospital audits as well [3, 4].

Data sources shape the questions that can be asked. Hospital audits based on paper charts are easy to start but small, whereas national prescribing registers contain millions of records and allow analysis of trends and of the persistence of treatment, as in the Swedish register [29]. Electronic health records fall between the two, with detail on diagnoses and blood pressure but variable quality. The choice influences the denominator: prescriptions, patients or visits. Without a diagnosis recorded alongside the drug, analysts cannot tell whether a beta-blocker

was given for hypertension, angina or arrhythmia, which weakens any statement about guideline adherence. Privacy and ethical approval need attention whatever the source, and routinely collected data should be anonymised before analysis.

Appropriateness assessment adds depth. Prescriptions can be compared with explicit criteria from guidelines, such as the preferred first-line classes, the avoidance of dual blockade with an angiotensin-converting enzyme inhibitor and an angiotensin receptor blocker, and the screening for contraindications [12, 13]. For older patients, explicit lists of potentially inappropriate medicines are used [30]. Reviewers sometimes use implicit judgement as well, which captures nuance but is less reproducible. Whatever approach is chosen, a clear statement of the criteria and of how disagreement was resolved is needed so that others can repeat the analysis. Inter-rater agreement, expressed as a kappa value, should be reported when more than one reviewer is used.

5. COMBINATION THERAPY AND ADHERENCE

Most patients need more than one drug to reach target. Trials such as ACCOMPLISH showed that the choice of combination can alter outcomes [23], and guidelines now advise starting with two agents in many patients, preferably as a single pill [12, 13]. A meta-analysis found that fixed-dose combinations improved adherence compared with free-drug regimens and led to modest gains in blood pressure and fewer discontinuations [24, 25]. Hospital prescription studies in recent years record a gradual rise in fixed-dose products, although the proportion remains below that seen in guideline-led systems. A single pill also reduces the number of dispensing items on each prescription, which is a practical advantage in a busy outpatient pharmacy.

Adherence is the quiet determinant of success. Biochemical testing of urine in treated patients with uncontrolled hypertension found that a sizeable minority were not taking their drugs as prescribed, and non-adherence was more likely with more complex regimens [26]. Prescribers can help by simplifying regimens, using once-daily drugs and counselling about side effects, and pharmacists can contribute through education and follow-up. A meta-analysis of randomised trials found that pharmacist interventions were associated with lower systolic and diastolic pressure [27]. Prescription audits rarely measure adherence directly, but they can show the complexity of regimens, which is a proxy. Cost to the patient is a major cause of non-adherence in settings where drugs are paid for out of pocket, so affordability should be part of any prescribing audit [7].

Cost-conscious prescribing is a theme in many hospital reports. Generic amlodipine, enalapril, atenolol and hydrochlorothiazide are inexpensive and available in most formularies, whereas some newer products cost many times as much with no proven outcome advantage over them. A reasonable audit question is therefore whether higher-cost choices were made for a documented reason, such as intolerance or a comorbid condition. Meta-analysis of trials suggests that the main classes lower blood pressure by similar amounts when given at standard doses, and differences in cardiovascular protection beyond the blood pressure effect are small [9, 19]. That finding gives formulary committees some room to prefer cheaper products where the clinical picture allows.

6. SPECIAL POPULATIONS

Older adults, who form a large part of the hospital population, need particular care. Trials show that treating hypertension in the elderly reduces stroke and cardiovascular events, but they are also prone to postural hypotension, falls and electrolyte disturbance, so lists of potentially inappropriate medicines recommend caution with some centrally acting drugs and alpha-blockers [11, 30]. Diabetic and renal patients are generally steered towards angiotensin-converting enzyme inhibitors or angiotensin receptor blockers because of evidence of organ protection, though blood pressure targets and combinations are debated [12, 13, 22]. Frailty and limited life expectancy complicate decisions, and trial participants are often

healthier than patients seen on a hospital ward.

Pregnancy places strict limits. Renin-angiotensin blockers are avoided because of fetal toxicity, and agents such as labetalol, nifedipine and methyldopa are the usual choices. A randomised trial of less-tight versus tight control in pregnancy found similar rates of pregnancy loss and high-level neonatal care with the less tight strategy, but more episodes of severe maternal hypertension, so the question of an ideal target remained open [31]. Women of childbearing age who are prescribed ACE inhibitors or ARBs in hospital should have contraception and pregnancy plans documented, a point that prescription audits can and should check [12, 31]. Postpartum prescribing also needs thought, particularly for women who are breastfeeding.

Children and adolescents with hypertension are seen less often in general adult hospitals, but secondary causes such as renal disease are more frequent in them. Dosing is by weight, and few drugs have paediatric licences, which parallels the wider problem of off-label prescribing in young patients. Prescription studies in adult hospitals usually exclude them, which is a reasonable choice but means the literature says little about this group. Specialist paediatric nephrology and cardiology services publish their own guidance on dosing and choice of drug, and these sources should be consulted for any child on treatment.

7. LIMITATIONS AND FUTURE DIRECTIONS

The prescription pattern literature has recognisable weaknesses. Most studies are small, single-centre and retrospective, they use different indicators and classification, and they seldom record blood pressure values or outcomes, so they describe what is prescribed but not whether it works. Convenience samples from outpatient clinics of a tertiary hospital may not represent the community. Differences in guideline adoption between countries and over time further limit comparisons, as does the practice of reporting prescribing by class without dose [3, 4, 18]. There is also a risk of publication bias, since audits that find nothing unusual are less likely to be written up.

Ethical and practical issues complete the picture. A prescription review does not involve intervention, but patient records are sensitive, and consent or waiver by an ethics committee is generally required. Prescribers who know that their work is being reviewed may change behaviour, which limits prospective audits, and retrospective ones depend on how complete the chart is. These are manageable problems and should be reported openly, so that readers can decide how much weight a given finding deserves [3]. Registration of the protocol before data collection, even informally, helps to avoid selective reporting.

Better studies would combine prescribing data with measurements of blood pressure control, adherence and adverse events, preferably over several years and with adjustment for case mix. Use of electronic records and national registers would allow larger samples and analysis of treatment persistence, as already done in some countries [17, 29]. Qualitative work with prescribers could explain why guideline-concordant drugs are not always used. Interventions such as feedback to prescribers or pharmacist review should be evaluated against control groups so that changes in prescribing can be linked to changes in outcomes [27]. Funding for such work is modest, but the data often exist in hospital systems already.

8. CONCLUSION

The published record shows that antihypertensive prescribing in hospitals has moved in step with guidelines and with the availability of inexpensive generics. Calcium channel blockers and renin-angiotensin system blockers are widely used, diuretics remain valuable but are often under-prescribed, and fixed-dose combinations are slowly becoming more common [12, 17, 20, 24]. The evidence from trials supports the broad direction, and the main classes lower the risk of vascular events when blood pressure falls [9, 10]. Taken at face value these patterns look sensible, although the studies cannot show that they produce better control.

As a basis for judging individual hospitals, however, the prescription pattern literature is thin. Studies are mainly descriptive, indicators and classification systems differ, and blood pressure control and adherence are seldom recorded [3, 4, 26]. Sound audits need explicit criteria, a clear denominator and some outcome data, ideally from larger electronic records. Used in that way, prescription pattern analysis remains a practical tool to identify where practice departs from guidance and where an intervention could help. Standard reporting items would make each new audit more useful to the next. Collaboration across hospitals would speed this.

9. ABBREVIATIONS

ACE-Angiotensin-converting enzyme, ARB-Angiotensin receptor blocker, ATC-Anatomical Therapeutic Chemical, DDD-Defined daily dose, ESC-European Society of Cardiology, ESH-European Society of Hypertension, WHO-World Health Organization, BP-Blood pressure, FDC-Fixed-dose combination

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11. AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

12. CONFLICT OF INTERESTS

Declared none

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