



Cost Variation in Commonly Prescribed Anti-Hypertensive Drugs and Implications for Peri-Operative Management: A Cross-Sectional Analysis

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ABSTRACT:

Background

Hypertension is one of the most common chronic co morbidities in surgical patients. Uncontrolled perioperative blood pressure is associated with haemodynamic instability, myocardial ischemia, stroke, and delayed recovery. In low- and middle-income countries, the cost of medicines can influence adherence and consequently peri-operative risk. Understanding price variation between brands of the same antihypertensive drug may therefore provide insights for clinicians and policymakers.

Methods

A cross-sectional study was undertaken using data from the April–June 2024 edition of the Current Index of Medical Specialties (CIMS) and the National Pharmaceutical Pricing Authority (NPPA) database. All oral antihypertensive drugs and fixed-dose combinations (FDCs) available in India during this period were identified. For each formulation, the maximum retail price (MRP) for an equivalent pack size was recorded. Cost ratio, price difference and percentage cost variation were calculated using standard formulas.



Descriptive statistics were compiled using Microsoft Excel 2021. Since the journal uses a numeric citation style, references are cited in square brackets in the order they appear.

Results

Thirty-six drugs (26 single agents and 10 FDCs) comprising 80 individual formulations met the inclusion criteria. Price variation was substantial across most drug classes. Among angiotensin-receptor blockers, candesartan 8 mg showed the highest cost variation (582.6 %) whereas losartan 25 mg had the lowest (29.2 %). In calcium channel blockers, cilnidipine 10 mg varied by 190.4 % whereas nifedipine 5 mg varied by only 2.6 %. Beta-blockers such as nebivolol 5 mg showed 111.3 % variation, while metoprolol succinate 25 mg varied by 4 %. Among FDCs, telmisartan + hydrochlorothiazide (HCTZ) had a 388.9 % variation, whereas atenolol + amlodipine varied by 20.8 %. Table 1 summarizes the maximum and minimum price variations for each drug class.

Conclusion

Marked inter-brand price variation exists for many commonly prescribed antihypertensives in India. Such disparities have potential implications for patient adherence, peri-operative haemodynamic control and healthcare equity. Regulatory measures, wider prescribing of generics, and increased price transparency are needed to minimize variability and ensure affordable access to essential antihypertensive therapy.

INTRODUCTION

Hypertension affects more than one quarter of the adult Indian population and is particularly prevalent in older age groups. In the peri-operative setting, uncontrolled hypertension is a well-recognised risk factor for intra-operative haemodynamic instability, myocardial ischaemia, stroke and acute kidney injury. Effective pre-operative blood pressure control depends on consistent use of anti hypertensive medication. However, in low and middle-income countries, the high cost of branded medicines may lead to poor adherence, resulting in unstable peri-operative blood pressure.

The Indian pharmaceutical market is characterised by multiple brands of the same drug, often priced very differently. Although the National Pharmaceutical Pricing Authority sets ceiling prices for essential medicines, previous reports have highlighted wide cost disparities between the cheapest and most expensive brands. Even short-term interruption of antihypertensives prior to surgery can cause abrupt changes in blood pressure, posing challenges to anaesthesia providers and increasing peri-operative risk. Despite its clinical relevance, few studies have quantified cost variation of antihypertensives from a peri-operative perspective.

This study aims to measure the brand-to-brand cost variation of commonly used oral antihypertensive drugs in India and to discuss the potential implications for

peri-operative haemodynamic stability and anaesthesia safety.

MATERIALS AND METHODS

Study design and setting

This observational, cross-sectional study was conducted in the Department of Anaesthesiology at Bidar Institute of Medical Sciences between May and July 2024 following approval from the Institutional Ethics Committee (IEC approval number: 270/BRIMS/IEC/2024, dated 22/02/2024). The study adhered to the ethical principles of the Declaration of Helsinki.

Inclusion and exclusion criteria

All single-agent and fixed-dose combination oral antihypertensive drugs of identical strength and dosage form, manufactured by different pharmaceutical companies and available in identical pack sizes, were included. Drugs produced by the same manufacturer in multiple strengths or formulations without complete or verifiable MRP data were excluded.

Data collection

Drug names and formulations were identified using prescribing patterns from outpatient clinics and standard treatment guidelines. Maximum retail prices (MRPs) were extracted from the April– June 2024 edition of CIMS, a widely used reference for pharmaceutical



pricing in India. Ceiling prices were verified using the NPPA database. All prices were cross-checked with a licensed retail pharmacy. Ultimately, 36 drugs (26 single agents and 10 FDCs) comprising 80 formulations were included.

Cost calculations

For each formulation, the following metrics were calculated:

- **Price difference (₹)** = MRP of the most expensive brand – MRP of the cheapest brand.
- **Cost ratio** = MRP of the most expensive brand ÷ MRP of the cheapest brand.
- **Percentage cost variation (%)** = ((MRP of the most expensive brand – MRP of the cheapest brand) ÷ MRP of the cheapest brand) × 100.

Analysis was conducted using Microsoft Excel 2021 and results were presented descriptively. Drugs were grouped into classes (ACE inhibitors, angiotensin-receptor blockers [ARBs], beta-blockers, calcium channel blockers, diuretics, alpha blockers/centrally acting agents and fixed-dose combinations). Only variations greater than 100 % were considered clinically significant.

RESULTS

Overall variation

Substantial price variation was found across most antihypertensive classes. The highest variation among single agents was observed with the ARB candesartan 8 mg (582.6 %), followed by the alpha-blocker prazosin 2.5 mg (344.4%). The lowest variation occurred with the calcium channel blocker nifedipine 5 mg (2.6%). Among FDCs, telmisartan+HCTZ showed a 388.9% variation, while atenolol + amlodipine varied by 20.8 %.

Class-wise analysis

Table 1 summarizes the maximum and minimum percentage cost variation for each drug class. ACE inhibitors showed moderate variation, ranging from 13.3% for ramipril 15 mg to 165.4% for enalapril 10 mg. ARBs exhibited the widest spread (29.2 % for losartan 25 mg vs 582.6 % for candesartan 8 mg). Beta-blockers ranged from 4 % (metoprolol succinate 25 mg) to 111.3

% (nebivolol 5 mg). Calcium channel blockers varied from 2.6 % (nifedipine 5 mg) to 190.4 % (cilnidipine 10 mg). Diuretics showed 30% (spironolactone 50 mg) to 88.3% (torsemide 10 mg) variation, while alpha blockers and centrally acting agents ranged from 78 % to 344.4 %. For FDCs, the lowest and highest variations were 20.8 % (atenolol + amlodipine) and 388.9 % (telmisartan+HCTZ), respectively. In addition to **Table 1**, visual summaries were constructed to aid interpretation. **Figure 1** shows the maximum and minimum percentage cost variation for each antihypertensive class, highlighting the widespread among ARBs and FDCs. **Figure 2** depicts the overall distribution of cost variation across formulations, with most drugs clustering below 100% but several extreme outliers approaching 600 %. **Figure 3** summarizes the study methodology— from data collection and inclusion criteria through cost calculations to analysis—and **Table 2** lists the top five highest and lowest cost variations along with the corresponding drugs.

Table 1: Visual summaries were constructed to aid interpretation

Drug class	Number of formulation	Maximum	Minimum	Example drugs
ACE inhibitors	4	165.4 % (enalapril 10 mg)	13.3 % (ramipril 15 mg)	Captopril, enalapril, lisinopril, ramipril
Angiotensin-receptor	7	582.6 % (candesartan 8 mg)	29.2 % (losartan 25 mg)	Losartan, telmisartan, olmesartan, valsartan
Beta-blockers	5	111.3 % (nebivolol 5 mg)	4.0 % (metoprolol Succinate 25 mg)	Atenolol, bisoprolol, carvedilol, metoprolol
Calcium channel blockers	6	190.4 % (cilnidipine 10 mg)	2.6 % (nifedipine 5 mg)	Amlodipine, cilnidipine,



		e 10m g)	5mg)	nifedipine, diltiazem
Diuretics	2	88.3 % (torasemid e 10m g)	30.0 % (spironolact one 50 mg)	Hydrochlor othiazide, torasemide
Alpha blockers/c entrally acting agents	2	344.4 % (prazosin 2.5mg)	78.0 % (clonidine 100µg)	Prazosin, clonidine
Fixed-dose combinati ons (FDCs)	10	388.9 % (telmisarta n+HC TZ)	20.8 % (atenolol+a mlodi pine)	Telmisarta n+HC TZ, losartan+ HCTZ, amlodipin e+atenolol

Study methodology overview

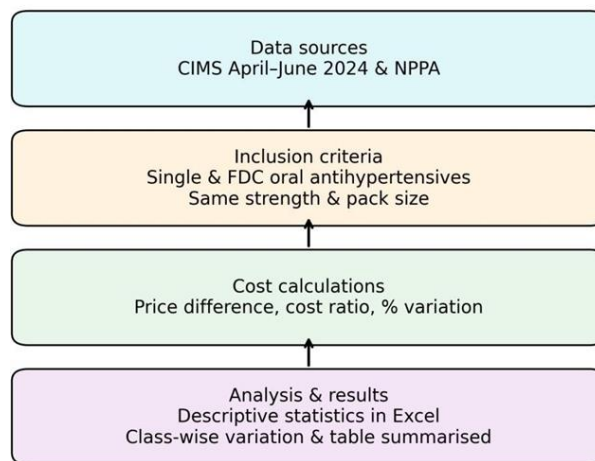


Figure3. Study methodology overview

Table2. Top five highest and lowest percentage cost variations among antihypertensive formulations

Category	Drug	Formulation/ dose	Cost variation(%)
Highest	Candesartan	8 mg	582.57
Highest	Amlodipine +Losartan	5 mg +50 mg	470.58
Highest	Diltiazem	120 mg	468.50
Highest	Furosemide	40 mg	435.71
Highest	Carvedilol	3.125 mg	344.44
Lowest	Nifedipine	5 mg	2.56
Lowest	Prazosin	5 mg	5.71
Lowest	Indapamide	2.5 mg	12.68
Lowest	Candesartan	4 mg	25.67
Lowest	Bisoprolol	2.5 mg	46.03

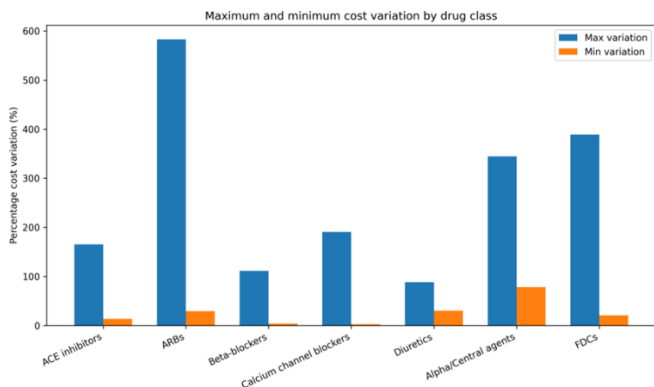


Figure1. Bar chart showing maximum and minimum cost variation by class

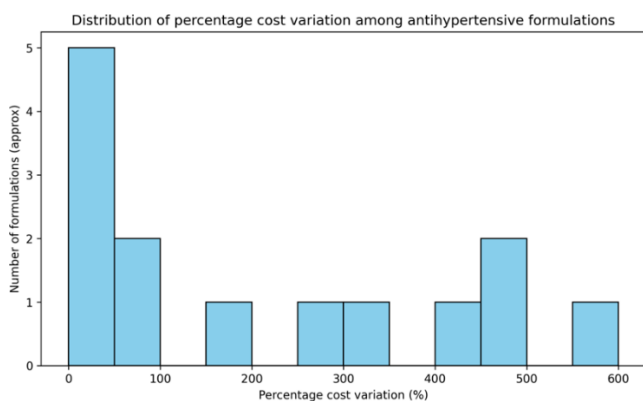


Figure2. Histogram of cost variation distribution

DISCUSSION

This study demonstrates marked price variation among commonly prescribed antihypertensive drugs in India. The variation was particularly striking among ARBs and certain FDCs. While modest differences in price may reflect manufacturing costs and market



competition, variations exceeding 100 % are difficult to justify and may significantly affect patient adherence.

Comparison with previous studies

Prior studies of the Indian pharmaceutical market have reported similar trends, with high variation in prices of cardiovascular drugs. Our findings are consistent with those analyses but focus specifically on perioperative implications. The high variation observed with candesartan and telmisartan + HCTZ is concerning because these drugs are frequently prescribed for resistant hypertension. The very low variation seen with nifedipine suggests that price regulation can be effective when enforced.

Implications for peri-operative care

Adherence to antihypertensive therapy is crucial to maintain stable intra- and post-operative blood pressures. Sudden discontinuation or irregular dosing due to cost constraints may lead to hypertensive or hypotensive crises during anaesthesia. Ensuring that affordable generics are available and prescribing them preferentially can reduce the risk of peri-operative haemodynamic instability. Anaesthesiologists should be aware of potential cost barriers and consider

peri-operative continuation of antihypertensives wherever possible, adjusting the regimen only when clinically indicated.

Although our analysis was not designed to correlate cost variation with prescribing frequency, anecdotal evidence suggests that formulations with the highest variation—such as candesartan and certain FDCs—are often newer or less commonly prescribed, whereas widely used drugs like nifedipine or atenolol show minimal variability. Future studies could explore whether promoting generic versions of high-variation drugs improves adherence and peri-operative outcomes.

Regulatory and policy considerations

The NPPA's mandate to cap prices of essential medicines has only partially reduced price variation. Strengthening regulatory oversight, promoting generic substitution, and requiring manufacturers to disclose pricing structures could reduce disparities. Clinicians and pharmacists should educate patients about cost-effective alternatives.

Strengths and limitations

This study analysed a comprehensive list of antihypertensives using up-to-date pricing data and applied standard cost metrics. However, it is limited by reliance on printed price lists and single-point MRP data; actual prices may vary across regions and pharmacies. Future research should incorporate data from multiple retail sources and consider patient-level purchase prices. The study also did not assess clinical outcomes related to adherence, which would require prospective follow-up.

CONCLUSION

Substantial inter-brand price variation exists for many commonly prescribed antihypertensive drugs in India. The greatest disparities were observed among ARBs and certain fixed-dose combinations. These variations may compromise patient adherence and increase peri-operative risk. Encouraging generic prescribing, enhancing price regulation and raising awareness among clinicians can help ensure affordable access to essential antihypertensive therapy.

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