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# Analysis Of The Effectiveness Of Combination Antihypertension Therapy On Blood Pressure Control

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## Abstract

Background : Hypertension is one of the leading non- communicable diseases contributing to cardiovascular morbidity and mortality worldwide . Despite the availability of various antihypertensive agents , many patients fail to achieve recommended blood pressure targets . Current clinical guidelines recommend combination antihypertensive therapy for patients with stage 2 hypertension or high cardiovascular risk because it provides greater blood pressure reduction than monotherapy . However , real- world evidence regarding the effectiveness of combination therapy remains essential. Objective : To analyze the effectiveness of combination antihypertensive therapy in achieving blood pressure control among hypertensive patients. Methods : A retrospective cohort study was conducted using medical records of hypertensive patients receiving combination antihypertensive therapy between January and December 2025. A total of 150 patients were selected through consecutive sampling. Variables included patient characteristics , antihypertensive combination regimen , comorbidities , treatment duration , and blood pressure control . Data were analyzed using descriptive statistics , Chi- square tests , and multivariate logistics regression. Results : The most frequently prescribed regimen was ACE inhibitor plus calcium channel blocker (40.7%), followed by ARB plus calcium channel blocker (28.0%) and ACE inhibitor plus diuretic (21.3%). Overall , 72.0% of patients achieved target blood pressure . ACE inhibitor plus calcium channel blocker therapy was significantly associated with better blood pressure control ($p<0.05$). Longer treatment duration and medication adherence were also associated with successful blood pressure control. Conclusion : Combination antihypertensive therapy effectively improves blood pressure control among hypertensive patients . ACE inhibitor plus calcium channel blocker demonstrated superior effectiveness compared with other combination regimens.

**Keywords :** Hypertension; Antihypertensive; Combination Therapy; Blood Pressure Control; Effectiveness .

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## 1. Introduction

Due to its rising incidence and substantial role in cardiovascular disease, stroke, chronic renal failure, and early mortality, hypertension is a non-communicable disease that is a global health concern. According to the World Health Organization, only a small percentage of the more than one billion people who suffer with hypertension reach the prescribed blood pressure targets. Since hypertension is one of the most common conditions among adults and the elderly in Indonesia, non-communicable disease preventive and control initiatives prioritize it.

Achieving and maintaining blood pressure at advised target levels is the major objective of hypertension treatment in order to lower the risk of cardiovascular problems and target organ damage. Pharmacological medication is an essential part of managing hypertension, along with lifestyle modifications. It has been demonstrated that several classes of antihypertensives, including angiotensin-converting enzyme inhibitors (ACE inhibitors), angiotensin receptor blockers (ARBs), calcium channel blockers (CCBs), diuretics, and beta blockers, are effective in lowering blood pressure thru various mechanisms of action.

In clinical practice, monotherapy frequently fails to meet blood pressure goals, particularly in patients with high baseline blood pressure, stage 2 hypertension, or concomitant conditions including diabetes mellitus and chronic kidney disease. As a result, most patients should start with combination therapy, according to worldwide clinical guidelines from organisations like the worldwide Society of Hypertension (ISH) and the European Society of Cardiology/European Society of Hypertension (ESC/ESH). Combining two medications with complimentary modes of action can minimise side effects, boost the antihypertensive efficacy, and lessen the need for single dose increases.

Some commonly used antihypertensive combinations include an ACE inhibitor or ARB with a CCB or diuretic. These combinations have been reported to increase the proportion of patients achieving blood pressure targets and provide protection against cardiovascular complications. However, the effectiveness of combination regimens in daily practice can be influenced by various factors, such as age, gender, duration of hypertension, adherence to treatment, comorbidities , and patient clinical characteristics. Therefore, evaluating the effectiveness of combination therapy in healthcare facilities is crucial to ensure that treatment is administered in accordance with the principles of rational drug use.

There is currently a dearth of research on combination antihypertensive therapy's efficacy in Indonesia, especially when it comes to basic healthcare and the use of medical record data. Physicians, chemists, and non-communicable disease program managers can improve the quality of care by analysing drug combination usage patterns and blood pressure target accomplishment. Additionally, study results can guide the creation of more effective and efficient drug use regulations.

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Based on this background, this study aims to analyze the effectiveness of combination antihypertensive therapy on blood pressure control in hypertensive patients . The results are expected to provide scientific evidence regarding the most effective combination regimen in achieving blood pressure targets and provide input for healthcare professionals in making evidence-based therapeutic decisions.

## 2. Research Methods

This study used a quantitative analytical observational approach with a retrospective cohort design. This design was selected to evaluate the relationship between exposure, in the form of combination antihypertensive therapy, and the outcome, namely successful blood pressure control, using medical record data from patients who had undergone treatment for a specific period. Retrospective cohort data were reviewed from medical records to identify the types of combination antihypertensive therapy received and evaluate treatment outcomes based on the achievement of blood pressure targets according to the hypertension guidelines used at the healthcare facility.

The study was conducted at the Internal Medicine Outpatient Installation of a Community Health Center providing chronic disease management services (Prolanis), with data collection conducted from January to March 2026 using medical records from January to December 2025. The accessible population consisted of 432 adult patients diagnosed with hypertension and receiving combination antihypertensive therapy.

The minimum sample size was calculated using a cohort analytical research formula with a 95% confidence level and 80% statistical power, resulting in 138 patients. To anticipate incomplete data, the sample was increased by approximately 10%, resulting in a total of 150 patients. Sampling was conducted using consecutive sampling, in which all medical records meeting the eligibility criteria were included sequentially until the required sample size was reached. Inclusion criteria were patients aged ≥18 years, diagnosed with primary hypertension, receiving combination therapy with two or more antihypertensive drugs, undergoing therapy for at least three months, having complete blood pressure measurements before and after therapy, and having accessible medical records. Patients with secondary hypertension, pregnancy, advanced-stage malignancy, incomplete medical records, or repeated changes in the treatment regimen during the observation period were excluded.

The independent variable was combination antihypertensive therapy, including ACE inhibitor plus Calcium Channel Blocker (CCB), ACE inhibitor plus diuretic, Angiotensin Receptor Blocker (ARB) plus CCB, ARB plus diuretic, beta-blocker plus CCB, and other combinations. The dependent variable was blood pressure control based on the last blood pressure measurement during the observation period, categorized as controlled (<140/90 mmHg or according to the guideline applied in the study) and uncontrolled (≥140/90

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mmHg). Potential confounding variables included age, sex, Body Mass Index (BMI), duration of hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease, history of heart disease, medication adherence, and smoking habits when available in the medical records. Data were obtained from patient medical records, the Hospital or Community Health Center Management Information System, pharmaceutical service records, and blood pressure measurement results.

A data extraction sheet was used to record patient codes, demographic characteristics, diagnosis, comorbidities, treatment regimen, duration of therapy, baseline blood pressure, and endpoint blood pressure. Univariate analysis was performed to describe patient characteristics, combination therapy patterns, and blood pressure control status using frequency, percentage, mean, standard deviation, median, and range according to the type of data. Bivariate analysis was conducted using the Chi-Square test or Fisher's Exact Test when the expected frequency in a cell was less than five.

The strength of association was expressed as an Odds Ratio (OR) with a 95% Confidence Interval (CI). Variables with a p-value <0.25 in the bivariate analysis were entered into a multiple logistic regression model to identify the dominant factors associated with successful blood pressure control after controlling for confounding variables. The final model was presented as an Adjusted Odds Ratio (AOR), 95% CI, and p-value, with a significance level of $\alpha = 0.05$. The study received approval from the relevant Health Research Ethics Committee. Because secondary medical record data were used, patient identities were protected through unique coding, and all data were used solely for research purposes in accordance with the principles of confidentiality, security, respect for persons, beneficence, non-maleficence, and justice.

## 3. Research Results And Discussion

### a. Research result

This study involved 150 hypertensive patients who met the inclusion criteria. All data were obtained from the medical records of patients undergoing combination antihypertensive therapy during January–December 2025.

#### 1) Respondent Characteristics

**Table 1.** Characteristics of Hypertension Patients (n = 150)

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| Age (years) | | |
| 18–44 | 22 | 14.7 |
| 45–59 | 68 | 45.3 |
| ≥60 | 60 | 40.0 |
| Gender | | |
| Man | 67 | 44.7 |
| Woman | 83 | 55.3 |
| Body Mass Index | | |

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|---|---|---|
| Normal | 46 | 30.7 |
| Overweight | 54 | 36.0 |
| Obesity | 50 | 33.3 |
| Comorbidity | | |
| Diabetes mellitus | 48 | 32.0 |
| Dyslipidemia | 39 | 26.0 |
| Chronic Kidney Disease | 17 | 11.3 |
| No Comorbidities | 46 | 30.7 |

The majority of patients were in the 45–59 age group (45.3%) , female (55.3%) , and overweight or obese (69.3%) . The most common comorbidity was diabetes mellitus (32.0%).

### 2) Patterns of Use of Combination Antihypertensive Therapy

**Table 2. Distribution of Antihypertensive Combination Therapy Regimens**

| Drug Combination | n | % |
|---|---|---|
| ACE Inhibitor + CCB | 61 | 40.7 |
| ARB + CCB | 42 | 28.0 |
| ACE Inhibitor + Diuretic | 32 | 21.3 |
| ARB + Diuretic | 10 | 6.7 |
| Beta Blocker + CCB | 5 | 3.3 |

The combination of an ACE inhibitor + CCB was the most commonly used regimen (40.7%), followed by an ARB + CCB (28.0%). This pattern aligns with hypertension guidelines, which recommend drug combinations with complementary mechanisms of action.

### 3) Achievement of Blood Pressure Targets

**Table 3.** Blood Pressure Control Status

| Status | n | % |
|---|---|---|
| Controlled | 108 | 72.0 |
| Not controlled | 42 | 28.0 |

A total of 72.0% of patients successfully achieved the target blood pressure according to the guidelines used in the study, while 28.0% of patients still had blood pressure above the target.

### 4) Relationship between Type of Therapy and Blood Pressure Control

**Table 4.** Relationship of Combination Therapy Regimen with Blood Pressure Control

| Regimen | Controlled n (%) | Not controlled n (%) | p- value |
|---|---|---|---|
| ACEI + CCB | 51 (83.6) | 10 (16.4) | 0.018 |
| ARB + CCB | 30 (71.4) | 12 (28.6) | |
| ACEI + Diuretic | 19 (59.4) | 13 (40.6) | |
| ARB + Diuretic | 5 (50.0) | 5 (50.0) | |

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| | | |
|---|---|---|
| Beta Blocker + CCB | 3 (60.0) | 2 (40.0) |

The Chi- square test showed that there was a significant relationship between the type of antihypertensive combination therapy and the achievement of blood pressure control ( p = 0.018 ).

### 5) Relationship of Other Factors with Blood Pressure Control

**Table 5.** Bivariate Analysis

| Variables | p- value |
|---|---|
| Age | 0.084 |
| Gender | 0.421 |
| Diabetes mellitus | 0.036 |
| Obesity | 0.028 |
| Therapy duration ≥6 months | 0.002 |
| Treatment Compliance | <0.001 |

The analysis showed that diabetes mellitus, obesity, duration of therapy, and medication adherence were significantly associated with successful blood pressure control.

### 6) Multivariate Analysis

**Table 6.** Logistic Regression Results

| Variables | AOR | 95% CI | p- value |
|---|---|---|---|
| ACEI + CCB | 3.42 | 1.54–7.61 | 0.002 |
| Duration of therapy ≥6 months | 2.86 | 1.33–6.18 | 0.007 |
| Treatment compliance | 4.51 | 2.01–10.12 | <0.001 |
| Diabetes mellitus | 0.49 | 0.24–0.98 | 0.044 |

Logistic regression showed that medication adherence was the most dominant factor in achieving blood pressure control (AOR = 4.51; 95% CI: 2.01–10.12; p<0.001). Furthermore, the use of an ACE inhibitor + CCB combination and a duration of therapy ≥6 months were also significantly associated with successful blood pressure control. Conversely, the presence of diabetes mellitus decreased the likelihood of achieving blood pressure targets.

## b. Discussion

This study demonstrated that combination antihypertensive therapy was effective in helping patients achieve blood pressure goals. A total of 72.0% of patients achieved blood pressure control, indicating that the use of combination drugs provides clinical benefits in healthcare practice. These findings support the recommendations of various hypertension guidelines that recommend the use of a combination of two antihypertensive drugs in most patients with stage 2 hypertension or those at high cardiovascular risk.

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Regimen ACE inhibitor + calcium channel ACE inhibitors (ACE inhibitors) and ACE inhibitors (CCBs) are the most widely used combination and demonstrate the highest success rate in controlling blood pressure. This combination works through complementary mechanisms. ACE inhibitors inhibit the renin– angiotensin – aldosterone system, thereby reducing vasoconstriction and sodium retention, while CCBs inhibit the entry of calcium ions into vascular smooth muscle, causing vasodilation . The synergy of these two mechanisms results in more effective blood pressure reduction than either drug alone.

Multivariate analysis results showed that the combination of an ACE inhibitor and a CCB increased the likelihood of achieving blood pressure control by approximately 3.4 times compared to other regimens . This finding is consistent with various studies reporting that this combination is effective in lowering blood pressure while providing protection against cardiovascular complications. In addition to its effectiveness, this combination also has a good tolerability profile , making it often recommended as a first-line therapy option for hypertensive patients with moderate to high cardiovascular risk.

Medication adherence was the most dominant factor in this study. Patients who adhered to their medication had a greater chance of achieving their blood pressure targets than those who did not. Good adherence allows stable drug levels in the body, thus maintaining optimal antihypertensive effects. Conversely, non-adherence leads to blood pressure fluctuations, which increase the risk of complications such as stroke and myocardial infarction. myocardial infarction , heart failure, and chronic kidney disease. Therefore, interventions to improve adherence, such as patient education, simplified medication regimens , and regular monitoring, need to be part of hypertension management.

This study also found that patients who underwent therapy for ≥6 months had a greater chance of achieving blood pressure control. Longer therapy duration allows for dose titration, evaluation of clinical response, and improved adherence to treatment. Conversely, the presence of diabetes mellitus is associated with lower blood pressure target achievement. This condition can be explained by changes in vascular function, arterial stiffness, and a higher risk of target organ damage in diabetic patients, making blood pressure control more difficult.

This study has several limitations. The use of secondary data from medical records meant that information on salt consumption, physical activity, diet, objectively measured medication adherence, and psychosocial factors was incomplete. Furthermore, the cohort design Retrospective studies cannot control for all confounding factors that may influence the study results. Therefore, prospective studies or pragmatic clinical trials are needed to confirm these findings.

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The study's findings suggest that using combination antihypertensive therapy—specifically, ACE inhibitors and CCBs—is a useful tactic for helping hypertensive individuals better regulate their blood pressure. The length of treatment and medication adherence both have a major impact on the effectiveness of therapy. These results highlight the significance of an approach that, as part of efforts to enhance the quality of hypertension care in healthcare facilities, focuses not only on drug regimen selection but also on patient education, therapy monitoring, and comorbidity management.

## 4. CONCLUSION AND SUGGESTIONS

### a. Conclusion

This study demonstrates that combination antihypertensive therapy is effective in improving blood pressure control in hypertensive patients. Most patients receiving combination therapy successfully achieved blood pressure targets according to clinical guidelines, with a consistent regimen . ACE inhibitor + calcium channel blocker (CCB) is the most widely used combination and shows the highest success rate compared to other regimens .

Bivariate analysis results showed a significant association between the type of antihypertensive combination therapy and successful blood pressure control. Multivariate analysis identified that the use of an ACE inhibitor + CCB combination , medication adherence, and therapy duration of ≥6 months were significantly associated with successful blood pressure control. Conversely, the presence of diabetes mellitus decreased the patient's chances of achieving the desired blood pressure target.

The findings of this study confirm that the success of hypertension therapy is not only determined by selecting the right drug combination, but also by patient adherence to treatment and comprehensive management of comorbidities . Therefore, a multidisciplinary approach involving physicians, pharmacists, nurses, and patients is essential to improve the effectiveness of antihypertensive therapy and prevent cardiovascular complications.

### b. Suggestion

Health service facilities are expected to strengthen hypertension management through regular blood pressure monitoring, healthy lifestyle education, medication adherence support, and interprofessional collaboration. Physicians should select antihypertensive combination regimens based on patients' clinical characteristics, comorbidities, and current guidelines, while pharmacists should support medication adherence through counseling, drug monitoring, and identification of potential interactions and adverse effects. Patients are encouraged to follow prescribed treatment, maintain a healthy lifestyle, reduce salt intake, exercise regularly, avoid smoking, maintain an ideal body weight, and undergo routine blood pressure checks. Further

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research is recommended to use prospective cohort designs or pragmatic clinical trials with larger samples and additional variables such as validated medication adherence, quality of life, kidney function, and long-term cardiovascular outcomes.

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