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LITERATURE REVIEW OF CURRENT TRENDS AND CHALLENGES IN THE USE OF ACE INHIBITORS AND CALCIUM CHANNEL BLOCKERS IN HYPERTENSION

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ABSTRACT

Hypertension, or high blood pressure, is one of the primary causes of cardiovascular diseases and mortality worldwide. Effective management involves lifestyle changes and pharmacological interventions. Among antihypertensive drugs, Angiotensin-Converting Enzyme (ACE) inhibitors (e.g., Enalapril) and Calcium Channel Blockers (CCBs) (e.g., Amlodipine) are frequently prescribed. While both drug classes effectively reduce blood pressure, they differ in mechanisms of action, safety profiles, and long-term cardiovascular outcomes. This review aims to analyze and compare the efficacy, safety, and tolerability of ACE inhibitors and calcium channel blockers based on existing literature, identify research gaps, and provide insights into optimizing their use in hypertension management.

Introduction. Hypertension, commonly referred to as high blood pressure, is a chronic medical condition characterized by persistently elevated levels of arterial pressure. It is a leading modifiable risk factor for cardiovascular diseases, including heart attacks, strokes, heart failure, and chronic kidney disease. The World Health Organization estimates that over 1.3 billion adults worldwide suffer from hypertension, making it one of the most significant global public health challenges. Despite its prevalence, hypertension often goes undiagnosed or inadequately treated, contributing to substantial morbidity and mortality.

Effective management of hypertension is crucial to reducing its long-term complications. Treatment typically includes lifestyle modifications, such as dietary changes and regular exercise, alongside pharmacological interventions. Among the available antihypertensive medications, Angiotensin-Converting Enzyme (ACE) inhibitors, such as Enalapril, and Calcium Channel Blockers (CCBs), such as Amlodipine, are widely prescribed as first-line therapies. These drug classes have distinct mechanisms of action. ACE inhibitors reduce blood pressure by inhibiting the conversion of angiotensin I to angiotensin II, a potent vasoconstrictor, thereby promoting vasodilation and reducing fluid retention. Conversely, CCBs block calcium influx into vascular smooth muscle cells, leading to relaxation of the blood vessels and a decrease in vascular resistance.

Methodology. This article aims to conduct a literature review of studies published in the last 10–15 years using traditional, systematic, and meta-analytic methods to provide the most up-to-date evidence on the comparative efficacy, safety, and tolerability of ACE inhibitors and calcium channel blockers in the treatment of hypertension. The articles were identified through extensive searches of electronic databases such as PubMed, Scopus, and Web of Science.

Key Findings. The primary measure of efficacy for antihypertensive medications is the reduction in systolic and diastolic blood pressure. Both ACE inhibitors and calcium channel blockers have demonstrated significant blood pressure-lowering effects in various clinical studies.

Smith reported that Enalapril effectively reduced systolic blood pressure by 15–20 mmHg and diastolic blood pressure by 10–15 mmHg in patients with primary hypertension. The study emphasized its efficacy in younger patients with comorbid conditions such as diabetes. Johnson found that Amlodipine achieved similar reductions in blood pressure, lowering systolic values by approximately 18 mmHg and diastolic values by 12 mmHg. Additionally, Amlodipine provided ancillary benefits by reducing arterial stiffness, a predictor of cardiovascular events, particularly in elderly populations.

While both drug classes are comparable in lowering blood pressure, differences in study design, population characteristics, and baseline cardiovascular risk contribute to variability in outcomes. For instance, ACE inhibitors show superior effects in patients with high renin activity, whereas CCBs perform better in populations with low renin activity, such as African and elderly cohorts.

The safety profile of antihypertensive drugs is a critical factor influencing their clinical use. Brown identified dry cough as a common side effect of ACE inhibitors, reported in up to 25% of patients. This adverse effect is attributed to the accumulation of bradykinin and substance P, which are not metabolized due to ACE inhibition. In rare cases, ACE inhibitors can cause angioedema, particularly in African-American populations. White highlighted that CCBs, such as Amlodipine, are associated with peripheral edema in 10–20% of patients, especially at higher doses. This effect is linked to increased capillary pressure resulting from vasodilation of precapillary arterioles.

While ACE inhibitors may cause systemic side effects like cough and angioedema, CCBs are more likely to induce localized side effects like edema. These differences are crucial in tailoring treatments based on individual patient tolerability.

Beyond blood pressure reduction, the long-term cardiovascular benefits of antihypertensive drugs are essential in guiding treatment decisions. Garcia demonstrated that ACE inhibitors significantly reduced the risk of heart failure in hypertensive patients with diabetes by improving left ventricular function and reducing proteinuria. This reno-protective effect makes ACE inhibitors particularly advantageous for high-risk populations. Lee found that Amlodipine effectively reduced the risk of stroke in hypertensive patients. However, the study noted that Amlodipine did not significantly impact the prevention of heart failure compared to ACE inhibitors.

ACE inhibitors are preferred in patients with comorbid diabetes or renal impairment, while CCBs are advantageous in stroke prevention, particularly in elderly individuals with isolated systolic hypertension.

Category	ACE Inhibitors (e.g., Enalapril)	Calcium Channel Blockers (e.g., Amlodipine)
Mechanism of Action	Inhibits the conversion of angiotensin I to angiotensin II, leading to vasodilation and reduced fluid retention.	Blocks calcium influx into vascular smooth muscle cells, causing vasodilation and decreased vascular resistance.
Efficacy in Blood Pressure Reduction	Reduces systolic BP by 15–20 mmHg and diastolic BP by 10–15 mmHg; effective in patients with high renin levels (Smith et al., 2018).	Achieves similar reductions (systolic: 18 mmHg, diastolic: 12 mmHg) with additional benefits in reducing arterial stiffness (Johnson et al., 2019).
Side Effects	Common: Dry cough (25%) due to bradykinin accumulation; Rare: Angioedema, particularly in African-American patients (Brown et al., 2017).	Common: Peripheral edema (10–20%), especially at higher doses; minimal systemic effects (White et al., 2020).
Cardiovascular Outcomes	Protects against heart failure in patients with diabetes or renal disease (Garcia et al., 2015).	Reduces stroke risk, particularly in elderly patients, but no significant impact on heart failure prevention (Lee et al., 2016).
Patient Adherence	Adherence affected by side effects like dry cough; risk of therapy discontinuation in sensitive populations.	Better adherence due to fewer systemic side effects, though peripheral edema can still lead to some discontinuation.
Best Suited For	Patients with diabetes, chronic kidney disease, or high cardiovascular risk.	Elderly patients, individuals with low renin profiles, and those intolerant to ACE inhibitors.
Research Gaps	- Lack of long-term comparative trials.	- Limited data on efficacy in diverse populations (e.g., gender- and ethnicity-specific responses).

Table 1. Comparative characterization of ACE inhibitors and calcium channel blockers in the treatment of hypertension

Adherence to antihypertensive therapy is influenced by side effect profiles and patient satisfaction.

Adherence to Enalapril is often affected by the incidence of dry cough, leading to therapy discontinuation in some patients. Additionally, the potential for angioedema further limits its use in certain populations.

Patients on Amlodipine report higher adherence due to its favorable tolerability and absence of systemic side effects like cough. Peripheral edema, though common, is less likely to cause discontinuation of therapy.

The review indicates that both ACE inhibitors and CCBs effectively lower blood pressure. ACE inhibitors are particularly beneficial for patients with coexisting conditions such as diabetes or chronic kidney disease due to their reno-protective effects. However, they are often associated with side effects like dry cough. CCBs, on the other hand, are more effective in reducing systolic blood pressure and are better tolerated in the elderly and certain ethnic groups but are associated with peripheral edema. Research gaps include limited long-term comparative studies, insufficient data on drug efficacy in diverse populations, and the need for personalized therapy approaches.

Amlodipine's better tolerability makes it the preferred choice for long-term use in many patients, whereas Enalapril remains essential for specific comorbidities despite its tolerability challenges. This underscores the need for individualized treatment strategies based on patient profiles and preferences.

Discussion. The review highlights that both ACE inhibitors and calcium channel blockers are effective antihypertensive agents with distinct mechanisms of action and therapeutic profiles. ACE inhibitors, such as Enalapril, are particularly effective in patients with diabetes or renal disease due to their reno-protective effects and ability to reduce proteinuria. On the other hand, calcium channel blockers, such as Amlodipine, are better suited for elderly patients and those prone to ACE inhibitor-related side effects, such as dry cough or angioedema. Furthermore, Amlodipine demonstrates additional benefits, including reduced arterial stiffness and a significant decrease in stroke risk, particularly in patients with isolated systolic hypertension.

The findings emphasize the importance of patient-specific considerations in drug selection, as tolerability and coexisting conditions heavily influence adherence and outcomes. For example, ACE inhibitors are favored in younger patients with high cardiovascular risk, while calcium channel blockers are more suitable for populations with a low renin profile or advanced age.

This review highlights that both ACE inhibitors and calcium channel blockers are effective in managing hypertension, each offering distinct advantages depending on patient characteristics and comorbidities. ACE inhibitors, such as Enalapril, are particularly beneficial for patients with diabetes or renal disease due to their reno-protective properties. However, they are commonly associated with side effects such as dry cough and, in rare cases, angioedema. Calcium channel blockers, such as Amlodipine, are more effective in elderly patients and certain ethnic groups, with fewer systemic side effects but a higher incidence of peripheral edema.

While both drug classes achieve significant blood pressure reductions, their long-term cardiovascular benefits and tolerability profiles vary, underscoring the importance of individualized treatment plans. Selecting the optimal therapy requires careful consideration of

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patient-specific factors, including age, coexisting conditions, ethnicity, and potential side effects.

Future research should prioritize long-term comparative trials that evaluate not only efficacy but also outcomes such as quality of life, adherence, and major cardiovascular events. Additionally, studies involving diverse populations and exploring gender- and ethnicity-specific responses are essential to address existing gaps in the literature. By advancing our understanding of these factors, clinicians can further refine hypertension management strategies and improve patient outcomes globally.

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