

Interconnected Challenges: Addressing the Bidirectional Relationship between Heart Failure and Cognitive Impairment through Targeted Intervention Strategies

Shahd Elshabka

American International School of Jeddah, Jeddah, Saudi Arabia
Email: shahdelshabka7@gmail.com

How to cite this paper: Elshabka, S. (2024) Interconnected Challenges: Addressing the Bidirectional Relationship between Heart Failure and Cognitive Impairment through Targeted Intervention Strategies. *Open Journal of Nursing*, 14, 608-616.
<https://doi.org/10.4236/ojn.2024.1411044>

Received: October 21, 2024
Accepted: November 11, 2024
Published: November 14, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

This paper examines the bidirectional relationship between heart failure (HF) and cognitive impairment, underscoring the need for integrated intervention strategies to address these interconnected conditions effectively. Cognitive deficits often hinder the effective management of HF, leading to poorer treatment adherence and health outcomes, while the physiological stress of HF can further impair cognitive function, creating a complex interplay that complicates patient care. This study highlights the effectiveness of angiotensin-converting enzyme (ACE) inhibitors and cardiac resynchronization therapy (CRT) in improving both cardiac and cognitive functions. By targeting the underlying physiological and neurobiological mechanisms of HF, these therapies enhance patient outcomes, leading to better adherence to treatment regimens and overall quality of life. Furthermore, the findings suggest that regular cognitive assessments should be integrated into HF management protocols, enabling early identification of cognitive impairment and timely intervention. Incorporating ACE inhibitors and CRT into standard care practices not only addresses the complexities of managing HF and cognitive decline but also fosters a holistic approach to patient health. Ultimately, this multifaceted strategy has the potential to significantly improve health outcomes, enhance the quality of care, and support sustainable management of patients with heart failure and cognitive impairment.

Keywords

Heart failure, Cognitive Impairment, Bidirectional Relationship, Angiotensin-Converting Enzyme Inhibitors, Cardiac Resynchronization Therapy (CRT), Cognitive Function, Disease Management, Interventional

1. Introduction

Cognitive impairment is a prevalent issue among patients with heart failure (HF), with estimates indicating that between 22% and 36% of individuals attending heart failure clinics experience this condition (Van Nieuwkerk *et al.*, 2023) [1]. The relationship between heart failure and cognitive decline is bidirectional, creating a cyclical pattern of exacerbation where each condition negatively influences the other. This interplay complicates disease management, as cognitive deficits can hinder adherence to treatment regimens and self-care activities, while physiological demands, such as reduced blood flow of heart failure, may contribute to further cognitive deterioration. For example, heart failure results in reduced blood flow due to the heart's inability to pump effectively. This decreased perfusion can impair brain function, leading to cognitive deficits that make it challenging for patients to manage their health. Consequently, this cognitive impairment can worsen heart failure as patients struggle to adhere to treatment regimens and self-care practices. Research conducted by Columbia University has revealed that heart failure can lead to a small calcium leak in neurons, a factor that plays a significant role in the development of cognitive impairment (Dridi *et al.*, 2023) [2]. In heart failure, the balance of calcium ions within cells is disrupted due to altered function of calcium channels, impaired calcium pumps, and dysfunctional sodium-calcium exchangers. This disruption leads to excessive intracellular calcium levels, which can impair neuronal signaling and contribute to cognitive decline. As a result, the physiological stress of heart failure not only affects cardiac function but also adversely impacts brain health. Understanding the dynamics between heart failure and cognitive health is crucial for developing effective intervention strategies that address both conditions simultaneously. The goal is to enhance the overall quality of care for affected patients and improve clinical outcomes. In the context of managing both heart failure and cognitive impairment, two prominent intervention strategies have gained attention: angiotensin-converting enzyme (ACE) inhibitors and cardiac resynchronization therapy (CRT).

2. ACE Inhibitors and Its Role in Managing Heart Failure and Cognitive Impairment

Angiotensin-converting enzyme (ACE) inhibitors are a cornerstone of heart failure management and have shown potential benefits in addressing cognitive impairment in affected patients. By reducing the workload on the heart and improving hemodynamics, ACE inhibitors help to relieve the symptoms of heart failure, which can indirectly benefit cognitive function. In a study of 1,220 heart failure patients, 30% receiving ACE inhibitors showed increased AMT scores at discharge compared to 22% not on these medications ($p = 0.001$). Among 10,861 individuals

without heart failure, 19% starting ACE inhibitors improved cognitively versus 18% not treated ($P = 0.675$), with tests indicating that the impact of ACE inhibitors on cognitive performance varied by heart failure diagnosis ($P = 0.011$) (“ACE Inhibitor Therapy and Cognitive Function in Heart Failure Patients,” 2005) [3]. This research clearly demonstrates through data that ACE inhibitors are effective in improving both heart function and cognitive function. A separate study indicates that the use of ACE inhibitors is associated with improved cognitive function in patients with heart failure, independent of blood pressure changes. The same study also noted that the degree of cognitive enhancement appears to be greater with higher doses of ACE inhibitors and extended treatment periods (Goh *et al.*, 2022) [4]. ACE inhibitors potentially improve cognitive function by enhancing blood circulation to the brain, ensuring that neural tissues receive adequate oxygen and nutrients. Given this heart improvement, cognitive function improves as well, which is a significant advantage.

These studies convey that the effective treatment of heart failure with ACE inhibitors not only enhances cardiac performance but also fosters cognitive health, leading to an overall improvement in the quality of life for patients. This dual benefit underscores the importance of incorporating ACE inhibitors into the standard care protocol for patients with heart failure, thereby addressing both the physical and cognitive challenges these individuals face.

3. Cardiac Resynchronization Therapy and Its Role in Managing Heart Failure and Cognitive Impairment

Cardiac Resynchronization Therapy (CRT) has emerged as a vital intervention for patients with heart failure (HF). By delivering coordinated electrical impulses to both ventricles, CRT enhances cardiac efficiency, leading to improved blood flow and a reduction in heart failure symptoms. This improvement is important for cognitive function, as better circulation supports brain health. Research indicates that patients undergoing CRT often experience fewer hospital admissions, contributing to greater adherence to treatment plans and improved self-management of their condition. Studies from the National Library of Medicine show that patients with heart failure who are eligible for CRT experience significant benefits, including increased survival rates, enhanced quality of life, and a notable reduction in heart failure symptoms, all of which positively affect cognitive functionality (Foley *et al.*, 2009) [5]. Additionally, research published in the International Journal of Cardiology found that CRT is linked to improved functional and cognitive outcomes after just six months of treatment (Fumagalli *et al.*, 2016) [6]. These findings suggest that CRT may play a significant role in slowing the progression of disability and frailty in heart failure patients. The evidence supports that CRT is effective not only for managing heart failure symptoms but also serves as a valuable approach for addressing cognitive impairment in these patients. By improving cardiac function, CRT enhances overall patient well-being, promoting both physical and cognitive health. This multifaceted benefit positions CRT as a

critical component in the comprehensive management of heart failure.

Furthermore, the integration of CRT into treatment protocols has the potential to optimize patient outcomes, particularly in terms of cognitive preservation and overall quality of life. Clinicians are encouraged to consider CRT as part of a holistic approach to heart failure management, particularly in patients exhibiting signs of cognitive decline. This underscores the necessity of including CRT in standardized care pathways within heart failure clinics, ensuring that patients have access to interventions that can significantly improve both their cardiovascular and cognitive health. As the body of research grows, it becomes increasingly clear that CRT represents a promising path for enhancing the quality of care for individuals living with heart failure and cognitive impairment.

4. Why Do Both of the Strategies Work?

Both ACE inhibitors and cardiac resynchronization therapy (CRT) target the underlying mechanisms of heart failure and its association with cognitive impairment through distinct but complementary pathways. ACE inhibitors primarily work by reducing the workload on the heart, thereby improving hemodynamics and promoting better blood flow throughout the body. This enhanced circulation is vital for maintaining cognitive function, as it ensures that brain cells receive adequate oxygen and essential nutrients. The resulting increase in cerebral perfusion directly correlates with improved cognitive capabilities, enabling patients to engage more effectively in daily activities and adhere to treatment regimens.

CRT enhances the coordination of heart contractions, leading to more efficient cardiac output. By optimizing the timing of ventricular contractions, CRT not only alleviates heart failure symptoms but also contributes to enhanced blood flow to vital organs, including the brain. This improvement in cardiac function has been shown to correlate with better cognitive performance in heart failure patients, as the brain benefits from increased oxygenation and nutrient delivery. The dual impact of CRT—both on cardiac efficiency and cognitive health—underscores its importance in a holistic treatment strategy for patients suffering from these interconnected conditions.

The interaction between cardiovascular health and cognitive function is complex, as the brain is highly sensitive to fluctuations in blood flow and oxygenation. When heart failure occurs, the physiological demands placed on the cardiovascular system can significantly compromise cerebral perfusion, leading to cognitive decline. Consequently, effective management of heart failure can have profound implications for cognitive outcomes. By targeting the physiological burdens imposed by heart failure, both ACE inhibitors and CRT aim to address the cognitive deficits that often accompany this condition. For example, reducing the workload on the heart and improving hemodynamics, which can lead to reduced cerebral perfusion and subsequent cognitive decline, ACE inhibitors help ensure that vital organs, including the brain, receive adequate blood flow. This enhancement in cerebral circulation is crucial, as it provides essential oxygen and nutrients necessary

for optimal neuronal function. As a result, the cognitive deficits often associated with heart failure may be mitigated, allowing patients to better adhere to treatment regimens and improve their overall quality of life.

The simultaneous focus on improving heart functionality while addressing cognitive aspects of patient care can lead to better overall health outcomes. In this regard, healthcare providers must recognize the significance of employing ACE inhibitors and CRT as essential components of comprehensive heart failure management. By doing so, they can enhance the quality of life for patients, improve adherence to treatment, and create better clinical outcomes across both cardiovascular and cognitive domains. Ultimately, the effective integration of these therapies serves not only to alleviate the symptoms of heart failure but also to support the cognitive health of patients, paving the way for a more sustainable approach to managing their overall well-being.

5. Case Studies

A limited number of studies have explored how heart failure (HF) treatments influence cognitive performance in patients. One notable retrospective analysis involving 1220 patients found that the use of angiotensin-converting enzyme (ACE) inhibitors was linked to improved cognitive function, with an odds ratio (OR) of 1.57 (95% confidence interval [C.I.]: 1.18 - 2.08). This improvement was positively correlated with higher doses and longer treatment durations. Another study indicated that digoxin also contributed to cognitive enhancement, especially in older patients, with an OR of 1.69 (95% CI: 1.20 - 2.38) (Dardiotis *et al.*, 2012) [7]. This study summarizes that the optimal management of heart failure through ACE inhibitors shows promise in enhancing cognitive function. Encouraging patients to engage in cognitive and physical activities can further improve their cognitive performance and overall quality of life.

A case study done regarding CRT treatment examined 101 patients with Implantable Cardioverter Defibrillators (ICDs) and 71 patients with Cardiac Resynchronization Therapy Defibrillators (CRT-D), ultimately including 45 in the CRT-D group and 29 in the ICD control group. CRT-D recipients were significantly older (65 ± 10) years than ICD patients ((58 ± 11) years; $P = 0.008$), with both groups primarily affected by ischaemic heart disease or non-ischaemic cardiomyopathy. Over a six-month follow-up, CRT-D patients showed significant improvements in NYHA functional class (from 2.5 ± 0.6 to 2.1 ± 0.5 ; $P < 0.001$) and walking distance, enhancing their 6-minute walk test results ($F = 12.3$; $P = 0.001$) and reducing Minnesota Living with Heart Failure Questionnaire scores ($F = 6.6$; $P = 0.012$). While both groups had normal initial cognitive function as indicated by Mini-Mental State Examination scores, CRT-D patients exhibited significant cognitive improvements compared to ICD recipients ($F = 4.3$; $P = 0.043$) (Duncker *et al.*, 2015) [8]. Overall, the study underscores the superior benefits of CRT-D therapy in enhancing both functional status and cognitive performance in heart failure patients. This study highlights the significant benefits of Cardiac Resynchronization

Therapy Defibrillators (CRT-D) in improving functional status and cognitive performance in heart failure patients over a six-month follow-up. These findings underscore CRT-D therapy's effectiveness in enhancing both physical health and cognitive outcomes for individuals with heart failure, suggesting it plays a crucial role in improving overall quality of life.

Table 1. Relationship between heart failure and cognitive impairment.

Aspect	Heart Failure	Cognitive Impairment	Intervention Strategies
Definition	A condition where the heart can't pump effectively	Decline in cognitive function affecting daily life	Cardiac Resynchronization Therapy (CRT) and ACE Inhibitors
Prevalence	Affects 6.2 million adults in the U.S.	22% to 36% in HF patients	Cardiac Resynchronization Therapy (CRT) and ACE Inhibitors
Bidirectional Relationship	Exacerbates cognitive decline	Impairs adherence to HF treatment	---
Mechanisms of Interaction	Reduced cerebral perfusion	Impaired neural function due to HF-related factors	---
Impact on Quality of Life	Increased symptoms and hospitalizations	Diminished ability to perform daily activities	---
Pharmacological management	ACE inhibitors and CRT enhance heart function	Potential cognitive benefits observed	---
Outcomes	Improved symptoms and reduced hospital admissions	Possible enhancement in cognitive performance	---
Research Findings	Studies show ACE inhibitors and CRT are linked to cognitive improvement	Increased blood flow leads to better cognitive function	---

Table 1 shows the relationship between heart failure and cognitive impairment, which is characterized by several interconnected aspects. Heart failure, defined as a condition where the heart cannot pump effectively, affects approximately 6.2 million adults in the U.S., while cognitive impairment is prevalent in 22% to 36% of heart failure patients. This bidirectional relationship exacerbates cognitive decline and impairs adherence to heart failure treatment. Mechanistically, reduced cerebral perfusion due to heart failure leads to impaired neural function, which in turn affects daily activities and quality of life. Pharmacologically, both ACE inhibitors and cardiac resynchronization therapy (CRT) are indicated as effective intervention strategies that enhance heart function while potentially improving cognitive outcomes. Overall, the table highlights the critical need for integrated approaches to manage these interrelated conditions effectively (see **Table 1**).

Key Takeaways based on **Table 1**:

- ACE inhibitors and CRT: They enhance blood flow and heart function which lead to better cognitive function.
- Future Directions: Emphasize integrated care and regular cognitive assessments in HF management.

6. Future Challenges

Despite the established benefits of angiotensin-converting enzyme (ACE) inhibitors and cardiac resynchronization therapy (CRT) in improving both heart failure (HF) and cognitive impairment (CI), several challenges remain in optimizing their implementation in clinical practice. One significant challenge is the need for healthcare providers to routinely incorporate cognitive assessments into heart failure management. Many clinicians currently overlook cognitive function, which can lead to the underdiagnosis of CI, ultimately impacting patient outcomes. Standardizing cognitive screening protocols during HF consultations can help identify patients who may benefit from targeted interventions, thereby improving their quality of life.

Furthermore, access to ACE inhibitors and CRT can vary based on socioeconomic factors, potentially leaving some patients without these beneficial therapies. Addressing these disparities is crucial to ensure equitable healthcare delivery, allowing all patients the opportunity to benefit from these effective treatments. The integration of technology, such as telemedicine, also presents a significant opportunity to enhance patient management. By using remote monitoring tools, healthcare providers can better support patients on ACE inhibitors and CRT, improving adherence to treatment plans and facilitating timely interventions when needed. This technology can help bridge gaps in care, especially for those in underserved areas.

Additionally, there is a pressing need to educate healthcare professionals about the intricate relationship between cardiovascular health and cognitive function. Increased awareness of how ACE inhibitors and CRT can positively impact cognitive outcomes is essential for encouraging a more holistic approach to patient care. Such education can empower clinicians to consider cognitive health as an integral component of HF management, leading to better overall management of both HF and CI. Finally, ongoing research into the barriers to access and implementation of these therapies is critical. Investigating patient perspectives and clinician challenges in prescribing and managing these interventions can provide valuable insights for developing more effective care strategies. By addressing these multifaceted challenges through standardized practices, technological integration, and comprehensive education, the healthcare system can significantly enhance the management of patients with heart failure and cognitive impairment, ultimately leading to improved health outcomes and quality of life for this vulnerable population.

Figure 1 illustrates how each intervention strategy effectively reduces cognitive impairment while enhancing heart function. It highlights the distinct mechanisms of action, showing how angiotensin-converting enzyme (ACE) inhibitors alleviate the heart's workload, improving hemodynamics and promoting better blood flow. This enhanced circulation is crucial for delivering oxygen and nutrients to the brain, supporting cognitive health. Similarly, cardiac resynchronization therapy (CRT) optimizes the timing of heart contractions, leading to improved cardiac

output and better perfusion of vital organs, including the brain. By showcasing the interconnectedness of these strategies, the figure emphasizes the importance of a holistic approach in managing patients with both heart failure and cognitive impairment, ultimately leading to better health outcomes and an improved quality of life (shown in **Figure 1**).

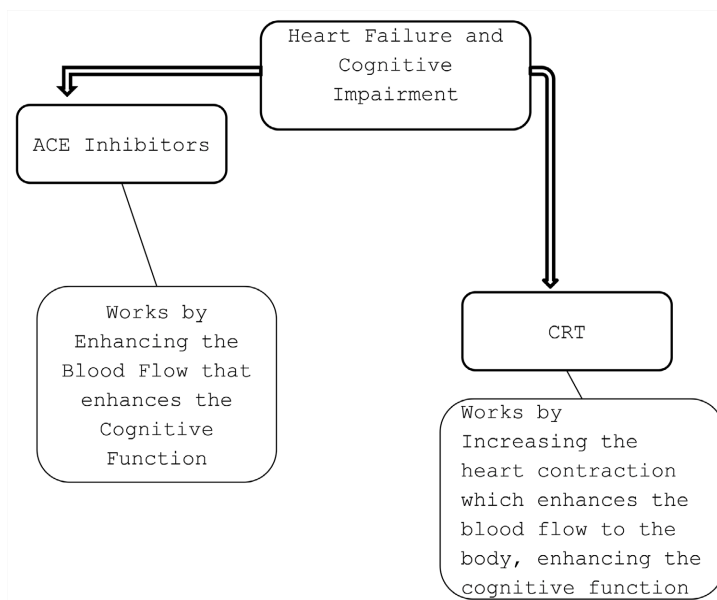


Figure 1. How each strategy works.

7. Conclusions

Effectively addressing the intertwined challenges of heart failure (HF) and cognitive impairment (CI) necessitates multifaceted and comprehensive approaches that include both angiotensin-converting enzyme (ACE) inhibitors and cardiac resynchronization therapy (CRT). These established strategies alleviate the diverse symptoms associated with heart failure, thereby enhancing both cardiac and cognitive functions. This dual benefit can lead to improved adherence to treatment regimens and overall patient well-being. The integration of these interventions into standard care practices represents a significant advancement in managing heart failure, as both therapies target the underlying mechanisms contributing to the bidirectional relationship between heart failure and cognitive impairment.

Healthcare providers should prioritize these strategies, recognizing their potential to improve patient outcomes and overall quality of life. A more holistic and patient-centered model of care can better support individuals in managing both heart failure and cognitive impairment, paving the way for enhanced health outcomes and a sustainable approach to patient care. Understanding the intricate interplay between these two conditions will facilitate the development of targeted interventions aimed at improving patient quality of life.

In conclusion, the relationship between heart failure and cognitive impairment is a significant area for ongoing inquiry. A comprehensive understanding of the

mechanisms involved, alongside effective management strategies, can enhance the overall well-being of heart failure patients. By focusing on interventions that address both cardiovascular and cognitive health, healthcare systems can mitigate the impacts of cognitive decline and improve outcomes for this patient population.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- [1] van Nieuwkerk, A.C., Delewi, R., Wolters, F.J., Muller, M., Daemen, M. and Biessels, G.J. (2023) Cognitive Impairment in Patients with Cardiac Disease: Implications for Clinical Practice. *Stroke*, **54**, 2181-2191. <https://doi.org/10.1161/strokeaha.123.040499>
- [2] Dridi, H., Liu, Y., Reiken, S., Liu, X., Argyrousi, E.K., Yuan, Q., *et al.* (2023) Heart Failure-Induced Cognitive Dysfunction Is Mediated by Intracellular Ca²⁺ Leak through Ryanodine Receptor Type 2. *Nature Neuroscience*, **26**, 1365-1378. <https://doi.org/10.1038/s41593-023-01377-6>
- [3] (2005) ACE Inhibitor Therapy and Cognitive Function in Heart Failure Patients. *Nature Clinical Practice Cardiovascular Medicine*, **2**, 180. <https://doi.org/10.1038/ncpcardio0172>
- [4] Goh, F.Q., Kong, W.K.F., Wong, R.C.C., Chong, Y.F., Chew, N.W.S., Yeo, T., *et al.* (2022) Cognitive Impairment in Heart Failure—A Review. *Biology*, **11**, Article 179. <https://doi.org/10.3390/biology11020179>
- [5] Foley, P.W.X., Leyva, F. and Frenneaux, M.P. (2009) What Is Treatment Success in Cardiac Resynchronization Therapy? *Europace*, **11**, v58-v65. <https://doi.org/10.1093/europace/eup308>
- [6] Fumagalli, S., Pieragnoli, P., Ricciardi, G., Mascia, G., Mascia, F., Michelotti, F., *et al.* (2016) Cardiac Resynchronization Therapy Improves Functional Status and Cognition. *International Journal of Cardiology*, **219**, 212-217. <https://doi.org/10.1016/j.ijcard.2016.06.001>
- [7] Dardiotis, E., Giamouzis, G., Mastrogiannis, D., Vogiatzi, C., Skoularigis, J., Triposkiadis, F., *et al.* (2012) Cognitive Impairment in Heart Failure. *Cardiology Research and Practice*, **2012**, Article ID: 595821. <https://doi.org/10.1155/2012/595821>
- [8] Duncker, D., Friedel, K., König, T., Schreyer, H., Lüsebrink, U., Duncker, M., *et al.* (2015) Cardiac Resynchronization Therapy Improves Psycho-Cognitive Performance in Patients with Heart Failure. *Europace*, **17**, 1415-1421. <https://doi.org/10.1093/europace/euv005>