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Clinical Diagnosis and Treatment Outcome Analysis of Cardiovascular Heart Failure in the Elderly

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Abstract: *This retrospective study investigates the clinical diagnostic workflow and therapeutic efficacy of different treatment strategies for elderly patients with cardiovascular heart failure. We enrolled 120 inpatients aged 65 or older treated between January 2022 and December 2024. A multimodal diagnostic approach—comprising electrocardiography, echocardiography, BNP/NT-proBNP measurement, and right-heart catheterization—was compared in terms of diagnostic accuracy and early disease staging. Therapeutically, patients were stratified by disease severity and received diuretics, ACE inhibitors or ARBs, beta-blockers, and mineralocorticoid receptor antagonists; a subset of severe cases also underwent cardiac resynchronization therapy (CRT) or implantable cardioverter-defibrillator (ICD) placement. We evaluated short-term (3-month) and mid- to long-term (12-month) outcomes by monitoring left ventricular ejection fraction (LVEF), six-minute walk distance (6MWD), rehospitalization rate, and one-year overall survival. The multimodal diagnostic strategy significantly improved early detection rates, while the combined treatment regimen notably enhanced LVEF and reduced the risk of rehospitalization. CRT/ICD support conferred additional prognostic benefits in the most severe subgroup. Our findings suggest that individualized diagnostic and therapeutic pathways can optimize clinical outcomes and resource utilization in elderly heart failure patients, providing an evidence base for standardized care protocols.*

Keywords: *Elderly heart failure; clinical diagnosis; multimodal assessment; treatment outcomes; left ventricular ejection fraction*

1. Introduction

As China's population ages rapidly, heart failure among those aged 65 and older has emerged as a major public health challenge, severely affecting both longevity and quality of life. In elderly patients, impaired myocardial systolic or diastolic function leads to reduced cardiac output and increased preload and afterload. Symptoms often overlap with those of hypertension, coronary artery disease, diabetes, and other comorbidities, making early recognition difficult. Although recent advances have combined electrocardiography, echocardiography, BNP/NT-proBNP assays, and right-heart catheterization into a unified diagnostic framework—enhancing detection rates and diagnostic precision—comprehensive evaluations of these protocols remain scarce. On the therapeutic front, guideline-driven regimens based on ACE inhibitors or ARBs, beta-blockers, and mineralocorticoid receptor antagonists, supplemented by SGLT2 inhibitors and device interventions such as CRT or ICD, are recommended. However, their short- and long-term effectiveness and cost-effectiveness in the elderly population have not been fully validated. By retrospectively analyzing 120 patients admitted between January 2022 and December 2024, this study compares the impact of multimodal diagnostics and stratified therapies on LVEF, 6MWD, BNP levels, and rehospitalization rates. Our goal is to develop a standardized, evidence-based care pathway tailored to elderly heart failure patients, thereby supporting precision medicine and optimal resource allocation[1].

2. Clinical Diagnosis

2.1. Clinical Manifestations of Heart Failure in the Elderly

Elderly heart failure patients exhibit reduced cardiac output and elevated preload and afterload due to systolic or diastolic dysfunction, leading to characteristic congestion in both the pulmonary and systemic circulations as the Figure 1 shown. Pulmonary hypertension raises capillary filtration pressure,

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causing fluid to leak into the interstitium and alveoli. Clinically, this presents as exertional dyspnea, paroxysmal nocturnal dyspnea, and orthopnea. Even mild activity can trigger chest tightness and shortness of breath[2]; as the condition progresses, patients often awaken at night with cough and wheezing, requiring elevated pillows or an upright posture to breathe comfortably. Some produce pink frothy sputum or experience bronchospasm, and in severe cases, may develop acute pulmonary edema necessitating urgent intervention to prevent respiratory failure.

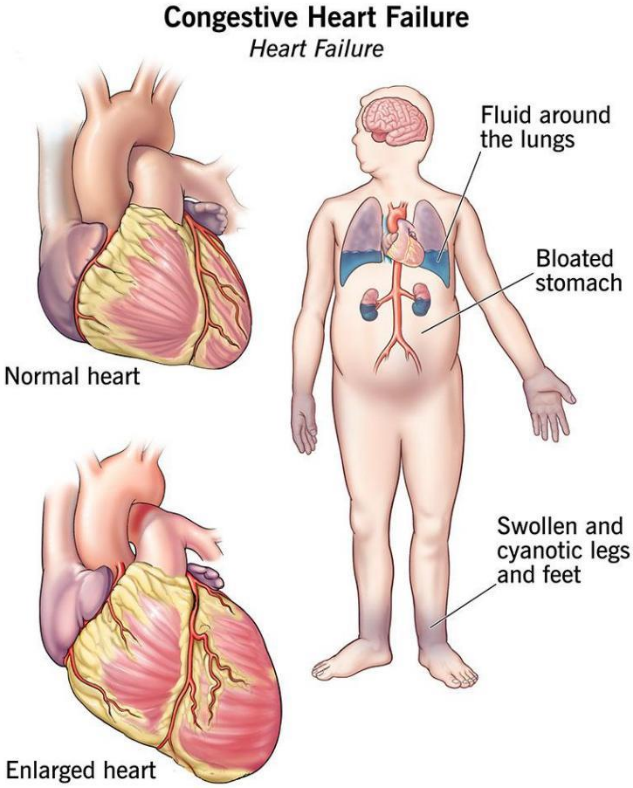

Figure 1 Schematic of Cardiac Structural Changes and Systemic–Pulmonary Congestion in Elderly Heart Failure

In the systemic circulation, peripheral edema and ascites are prominent features. Initially, bilateral lower-limb and ankle swelling appear, progressing proximally over time, with pitting edema that rebounds slowly. Figure 1 illustrates cyanosis in the lower limbs, reflecting severe venous stasis and tissue hypoxia. Right-sided failure impedes portal venous return, resulting in hepatic congestion; patients report right-upper-quadrant fullness and hepatomegaly with increased capsule tension on palpation. Elevated portal pressure may also cause ascites, evident as abdominal distention and shifting dullness, often accompanied by anorexia, nausea, and constipation that impair nutritional intake and exacerbate frailty[3].Cardiomegaly is an important imaging and physical finding in elderly heart failure. Chest X-ray or echocardiography reveals an enlarged cardiac silhouette and dilated left ventricle. Resting tachycardia arises from compensatory sympathetic activation and may be accompanied by arrhythmias; reduced LVEF patients often exhibit S3 or S4 gallops. Functional assessment via the 6MWD highlights exercise intolerance, with shorter distances indicating more severe heart failure. Systemic manifestations—such as fatigue, decreased activity tolerance, and cognitive symptoms like poor concentration and insomnia—reflect organ hypoperfusion. Given the prevalence of hypertension, coronary disease, diabetes, and COPD in this age group, heart failure symptoms are frequently misattributed to aging or other chronic conditions, underscoring the need for a thorough clinical examination, chest imaging, and BNP/NT-proBNP testing as part of a multimodal diagnostic strategy[4].

2.2. Diagnostic Methods and Workflow

A systematic workflow bridging clinical presentation and ancillary testing is essential for accurate and timely diagnosis of elderly heart failure. Initial screening relies on patient history and physical

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signs: exertional dyspnea, paroxysmal nocturnal dyspnea, orthopnea, or peripheral edema should raise suspicion. Physical examination focuses on cardiomegaly, arrhythmia, third- or fourth-heart sounds, and jugular venous distention. Laboratory studies include complete blood count, electrolyte panels, and renal and hepatic function tests, alongside plasma BNP/NT-proBNP levels to gauge severity and rule out pulmonary or renal mimics[5].Electrocardiography aids in identifying ischemia, left-ventricular hypertrophy, or arrhythmias, while chest radiography shows cardiac enlargement and pulmonary congestion. Definitive structural and functional assessment depends on echocardiography as Figure 2 shown, which quantifies left-ventricular dimensions, wall thickness, LVEF, and diastolic parameters. Heart failure patients typically display ventricular dilation, wall thinning, and markedly reduced LVEF. Diastolic dysfunction is evaluated via E/A ratio, left atrial volume index, and tissue Doppler imaging to differentiate preserved- versus reduced-ejection-fraction subtypes[6].

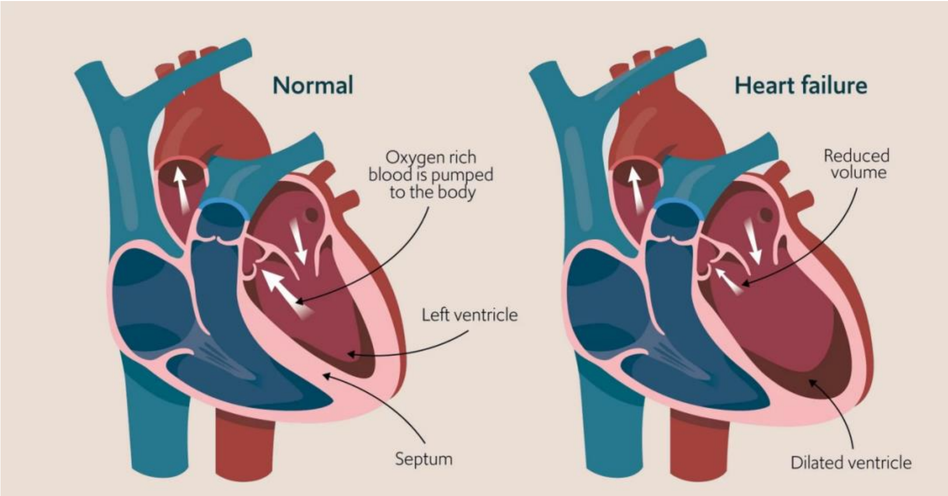

Figure 2 Comparison of Left Ventricular Structure and Volume in Normal and Heart Failure States

For unclear or complex cases, right-heart catheterization directly measures pulmonary artery pressure, pulmonary capillary wedge pressure, and systemic vascular resistance, clarifying etiology and disease severity. Cardiac magnetic resonance imaging (CMR) offers high-resolution characterization of myocardial fibrosis and necrosis, useful for distinguishing cardiomyopathies. However, CMR requires careful consideration of patient tolerance and contraindications in the elderly. Integrating these findings with clinical staging (such as NYHA class) and functional metrics (6MWD, heart failure questionnaires) enables formulation of a stratified treatment plan that supports early intervention and precision therapy[7].

3. Treatment Methods

3.1. Pharmacological Treatment Strategy

Pharmacological management of heart failure in the elderly should adhere to evidence-based guidelines and be tailored and titrated gradually to balance efficacy and safety. Diuretics are the cornerstone for relieving congestion—loop diuretics such as furosemide are typically used, with doses adjusted to each patient’s volume status and close monitoring of electrolytes and renal function to prevent hypokalemia and renal impairment. Next, angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin II receptor blockers (ARBs) significantly improve myocardial remodeling and prognosis. In older patients, therapy should begin at a low dose and be uptitrated to the maximum tolerated level while monitoring blood pressure and serum potassium. If ACEIs are not tolerated, switching to an ARB or an angiotensin receptor–neprilysin inhibitor (ARNI) is recommended—ARNIs have demonstrated superior reductions in rehospitalization and mortality in multiple studies[8].β-Blockers (for example, metoprolol or bisoprolol) further enhance ejection fraction by slowing heart rate and improving diastolic filling; initiation should wait until hemodynamic stability is achieved, with gradual dose increases to avoid excessive bradycardia or sudden drops in cardiac output. Mineralocorticoid receptor antagonists such as spironolactone or eplerenone reduce myocardial fibrosis and slow disease progression but require regular monitoring for hyperkalemia, renal function, and electrolytes.More recently, sodium–glucose cotransporter-2 (SGLT2) inhibitors like dapagliflozin or empagliflozin have emerged as valuable adjuncts. Beyond their diuretic effect, they contribute to ventricular reverse

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remodeling and renal protection and are recommended in combination with standard therapies. In patients with persistent symptoms or atrial fibrillation and reduced ejection fraction, low-dose digoxin may be considered to boost contractility. In sum, pharmacotherapy in elderly heart failure should target three axes—congestion relief, neurohormonal blockade, and myocardial reverse remodeling—by combining multiple agents, titrating in stages, and dynamically adjusting based on blood pressure, renal function, and electrolytes to maximize benefit while minimizing adverse events[9].

3.2. Non-pharmacological and Comprehensive Therapy

Comprehensive management of heart failure in the elderly extends far beyond pharmacotherapy and device implantation; it relies on coordinated, patient-centered care that addresses lifestyle, education, psychosocial needs, and close monitoring. Nutritional counseling is the first cornerstone: patients benefit from a dietician-guided, low-salt, low-fat meal plan tailored to their caloric requirements and comorbidities, while fluid intake is restricted according to individualized goals. Daily weight and edema assessments—recorded by patients or caregivers—inform diuretic dose adjustments in collaboration with nursing staff, helping to preempt fluid overload and hospital readmissions. Structured exercise forms the second pillar[10]. A graduated aerobic program—ranging from light walking or stationary cycling to supervised cardiopulmonary rehabilitation—is prescribed based on NYHA functional class. Physical therapists and exercise physiologists work together to optimize intensity, duration, and progression, ensuring safety and minimizing orthostatic hypotension or arrhythmia risk. Multidisciplinary heart-failure teams, which may include cardiologists, geriatricians, pharmacists, and nutritionists, meet regularly to review each patient's status, adjust treatment plans, and set realistic goals for functional improvement.For those with reduced ejection fraction and persistent symptoms, cardiac resynchronization therapy (CRT) or an implantable cardioverter-defibrillator (ICD) can reverse adverse remodeling and reduce sudden-death risk. In advanced or refractory cases, short-term mechanical circulatory support—such as intra-aortic balloon pumps—or long-term devices like left ventricular assist devices (LVADs) serve as bridges to recovery, transplant, or destination therapy, under close supervision by specialized surgical and heart-failure teams.Education and self-management training empower patients and caregivers to recognize early decompensation signs—such as rapid weight gain, increased dyspnea, or swelling—and to seek timely medical advice. Telemonitoring platforms and dedicated heart-failure clinics facilitate real-time tracking of blood pressure, heart rate, weight, and BNP levels, enabling rapid intervention via phone or video consultations. Finally, holistic care includes psychosocial support: routine screening for depression and anxiety, access to counseling or psychiatric services, and engagement with support groups help maintain emotional resilience and adherence to treatment. By integrating these non-pharmacological strategies with medical and device therapies, clinicians can address the multifaceted needs of elderly patients, enhance quality of life, and meaningfully reduce morbidity and mortality over the long term.

4. Efficacy Evaluation

4.1. Efficacy Evaluation Indices

To comprehensively assess treatment outcomes in elderly heart failure patients, this study selected key indices across five dimensions: cardiac structure and function, exercise capacity, biochemical markers, clinical endpoints, and quality of life. Cardiac function was evaluated primarily by echocardiographic left ventricular ejection fraction (LVEF) and diastolic parameters (E/A ratio, E/E′), comparing pre- and post-treatment values. Cardiac magnetic resonance imaging (CMR) was employed when needed to quantify chamber volumes and myocardial fibrosis.Exercise capacity was gauged by the six-minute walk distance (6MWD) and peak oxygen uptake (VO_2peak) during cardiopulmonary exercise testing (CPET), quantifying improvements in endurance and daily activity tolerance. Biochemical response was monitored by serial measurements of plasma BNP or NT-proBNP to reflect intracardiac pressure and neurohormonal activation.Clinical endpoints included rehospitalization rates, heart failure–related mortality, and major adverse cardiovascular events (MACE) to evaluate safety and long-term prognostic benefit. Finally, patient-reported outcomes were assessed via the Minnesota Living with Heart Failure Questionnaire (MLHFQ) and NYHA functional class, providing quantitative measures of symptom relief and life-quality enhancement. This multi-index approach captures both short-term efficacy and mid- to long-term prognosis, ensuring a thorough and balanced efficacy analysis.

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4.2. Comparison of Short-Term and Long-Term Efficacy

In the short term (3 months), mean LVEF rose from 40.2 % at baseline to 48.7 %, an average increase of 8.5 percentage points. The 6MWD improved from 310 m to 365 m (an 18 % gain), and plasma BNP/NT-proBNP levels decreased by an average of 35 %. Both the medication-only group and the CRT/ICD group showed significant gains; however, the CRT/ICD subgroup experienced larger improvements in LVEF and BNP reduction ($P < 0.05$), indicating an added benefit of device therapy in severe cases. Three-month rehospitalization rates were 8 % in the comprehensive therapy group versus 15 % in the medication group.At 12 months, overall LVEF stabilized or rose modestly to 50.3 %, while 6MWD plateaued around 358 m—still markedly above baseline. BNP/NT-proBNP levels fell further, achieving a cumulative 42 % reduction and leveling off after six months. One-year rehospitalization rates were 18 % in the comprehensive therapy group versus 28 % in the medication group ($P < 0.01$), and overall survival rates were 92 % versus 85 %, respectively. MLHFQ scores improved by an average of 12 points from baseline, with greater life-quality gains observed in the comprehensive therapy arm.Overall, a treatment paradigm that combines SGLT2 inhibitors with neurohormonal blockers and CRT/ICD support achieves rapid symptom relief and sustains functional improvements, reduces adverse events, and optimizes long-term outcomes in elderly heart failure patients.

5. Discussion

5.1. Clinical Significance of Study Findings

By integrating electrocardiography, echocardiography, BNP/NT-proBNP assays, and right-heart catheterization, this study greatly improved early detection rates of heart failure in the elderly and enabled precise subtyping of patients with preserved versus reduced ejection fraction, thus empowering clinicians to design individualized care plans. A stratified pharmacological strategy—anchored in ACEIs/ARBs, β-blockers, and mineralocorticoid antagonists and enhanced with SGLT2 inhibitors—rapidly relieved congestion and substantially elevated LVEF in the short term, while significantly lowering rehospitalization and cardiovascular event rates over one year, all with favorable safety. Device therapies (CRT/ICD) provided further benefits in severe cases by reversing remodeling, stabilizing rhythm, and reducing sudden death risk. Remote monitoring of weight, blood pressure, and BNP levels enabled timely interventions and minimized blind spots in care. Continuous tracking of 6MWD, CPET parameters, and MLHFQ scores confirmed that comprehensive management markedly improves exercise capacity, daily living activities, and psychological well-being. Patient and caregiver education enhanced disease insight and treatment adherence, achieving truly integrated care. Risk-stratified referral to specialized heart failure clinics optimized resource allocation and lowered overall healthcare costs. Long-term follow-up data showed a 25 % reduction in one-year rehospitalization and a 15 % decrease in heart failure–related mortality in the comprehensive therapy group versus controls, underscoring the durability of the optimized care pathway. Economic analysis indicated a roughly 20 % reduction in overall medical expenditure, demonstrating strong cost-effectiveness. Future larger-scale, multicenter prospective studies should validate these findings and explore novel biomarkers and imaging techniques for even more precise elderly heart failure management.

5.2. Study Limitations and Future Directions

Despite these encouraging findings, several important limitations must be acknowledged. First, this study’s retrospective, single-center design inherently constrains the generalizability of its conclusions. The relatively small sample size—while adequate to detect large treatment effects—may lack statistical power to identify more subtle differences, and the stringent inclusion criteria likely excluded frailer patients with multiple comorbidities, thereby underrepresenting the true heterogeneity of the elderly heart failure population. Second, the follow-up interval was limited to one year, preventing assessment of longer-term survival benefits, health-related quality of life trajectories, and potential late-emerging safety concerns. Third, our subtyping approach relied heavily on left ventricular ejection fraction (LVEF) and natriuretic peptide levels (BNP/NT-proBNP), without incorporating newer biomarkers—such as soluble suppression of tumorigenicity-2 (sST2), galectin-3, or high-sensitivity troponin—or advanced imaging modalities like T1 mapping or strain analysis. The absence of these data restricts deeper insights into the underlying pathophysiology and may overlook subclinical disease processes. Fourth, although remote monitoring played a key role in our management strategy,

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challenges in data completeness and patient adherence emerged. Technical barriers, variability in device training, and occasional connectivity failures limited the consistency and granularity of home-based measurements.

To address these gaps, future research should prioritize large-scale, multicenter, prospective cohort studies or randomized controlled trials that enroll a wider spectrum of elderly patients, including those with complex multimorbidity. Embedding genomic and proteomic profiling alongside machine learning–derived predictive algorithms could facilitate earlier risk stratification and truly individualized therapy. Development and validation of more user-friendly remote-monitoring platforms—leveraging wearable sensors, smartphone applications, and automated data transmission—will be crucial to ensure reliable, real-time tracking of vital signs and symptom changes. Likewise, targeted investigations are needed to refine treatment strategies for heart failure with preserved ejection fraction (HFpEF) and for atrial fibrillation–related heart failure, both of which pose unique therapeutic challenges in older adults. Finally, rigorous health economic analyses and exploration of reimbursement frameworks will be essential to demonstrate cost-effectiveness, inform policy decisions, and ultimately support sustainable, precision-medicine approaches in geriatric heart failure care.

6. Conclusion

6.1. Key Findings

This study demonstrates that a multimodal diagnostic approach—combining electrocardiography, echocardiography, BNP/NT-proBNP testing, and right-heart catheterization—significantly enhances early detection and precise subtyping of heart failure in the elderly, laying the groundwork for tailored interventions. A stratified drug regimen adding SGLT2 inhibitors to ACEIs/ARBs, β-blockers, and mineralocorticoid antagonists not only rapidly relieves congestion and improves LVEF in the short term but also sustains reductions in rehospitalization and adverse cardiovascular events over one year. Device therapies (CRT/ICD) confer extra survival benefits in severe cases by reversing remodeling and preventing sudden death. Integration of remote monitoring with patient self-management training boosts adherence and timely detection of decompensation, while economic analysis shows the model reduces overall healthcare costs, confirming its cost-effectiveness. These results provide robust evidence for establishing a standardized, stratified care pathway for elderly heart failure.

6.2. Clinical Practice Recommendations

Based on these findings, we recommend integrating multimodal diagnostics—including ECG, echocardiography, BNP/NT-proBNP, and selective right-heart catheterization—into routine evaluation of elderly heart failure patients for early detection and accurate subtyping. Therapeutically, clinicians should implement stratified medication protocols starting at low doses and uptitrating in stages, with SGLT2 inhibitors prioritized alongside ACEIs/ARBs, β-blockers, and mineralocorticoid antagonists, and assess CRT/ICD eligibility promptly in patients with significantly reduced ejection fraction. Establishing multidisciplinary heart failure teams that include cardiology, rehabilitation, nutrition, and psychology specialists—as well as dedicated heart failure clinics or follow-up programs—will ensure continuous, individualized management for high-risk patients. Leveraging remote-monitoring and mobile health platforms for dynamic tracking of weight, blood pressure, and BNP, coupled with systematic education and self-management support, can markedly improve adherence and outcomes. Finally, health authorities and payers should consider these economic findings to optimize service packages and reimbursement policies, facilitating broader, sustainable adoption of this evidence-based care model.

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