Abstract

The heart and kidneys have a long history of parallels. Their history can be traced back to ancient Chinese medicine, where the heart represents fire as a 'yang' organ, symbolizing a person's innermost thoughts and desires. In the Bible, the kidneys are discussed multiple times as a symbol of a person's innermost thoughts and desires. In the context of modern medicine, the heart and kidneys have a long history of parallels. The prevalence of chronic kidney disease (CKD) in the United States is estimated at 20% in patients over 65 years of age, with a lifetime risk estimated at 30%, and it is the leading cause of hospitalization in those over 65 years of age.1 Within five years of diagnosis, approximately 50% of heart failure patients die.2 About 20% to 60% of patients who have heart failure also have chronic renal disease.3 The interaction between the cardiac and renal systems is of considerable interest in improving the management of renal failure.

Epidemiology

The prevalence of symptomatic chronic heart failure (CHF) in the United States is estimated at 2% in patients over 65 years of age, with a lifetime risk estimated at 30%, and it is the leading cause of hospitalization in those over 65 years of age.1 Within five years of diagnosis, approximately 50% of heart failure patients die.2 About 20% to 60% of patients who have heart failure also have chronic renal disease.3 The interaction between the cardiac and renal systems is of considerable interest in improving the management of CHF.

Pathophysiology

The exact pathophysiology for CRS is not completely understood; however, there are a variety of mechanisms believed to play a role in its pathogenesis. Some of these mechanisms include: the role of autonomic nervous system activity, which affects the cardiovascular system; the role of cytokines, which contribute to the development of renal and cardiac dysfunction; and the role of oxidative stress, which contributes to the development of both renal and cardiac dysfunction.

Classification and Subtypes

Five subtypes of this broad definition were identified:

- Recognizing each of the five different subcategories of CRS Syndromes is important in understanding how the care would be different for a patient based on which category they fall into.

Type I (Acute CRS)

- Acute Cardiorenal Syndrome (Type I CRS) is characterized by unexpected deterioration of cardiac function resulting in acute kidney injury (AKI).4 Cure and Bongart (2011) stated that “acute cardiac events contributing to AKI include acute decompenated heart failure (ADHF), acute coronary syndromes (ACS), cardiogenic shock, and cardiac surgery-associated acute kidney output syndromes.

Type II (Chronic CRS)

- Chronic Cardiorenal Syndrome (Type II CRS) is defined by chronically impaired renal function in the absence of acute cardiac events.5 The term “chronic cardiorenal syndrome” encompasses a number of different conditions and may include chronic LV dysfunction, arterial hypertension, congestive heart disease, persistent anuric, and chronic ischemic heart disease.

Type III (Acute Renocardiac Syndrome)

- Acute Renocardiac Syndrome (Type III CRS) is the abrupt worsening of renal function causing an acute cardiac disease.6 Renal dysfunction complexes include acute kidney ischemia or glomerulonephritis, which can cause cardiac dysfunction, such as heart failure, arrhythmias, and ischemic heart disease.

Type IV (Chronic Renocardiac Syndrome)

- Chronic Renocardiac Syndrome (Type IV CRS) is a condition in which the primary CKD contributes to a decrease in cardiac function. This can lead to “cardiac remodelling,” left ventricular diastolic dysfunction or hypertrophy, and an increased risk for cardiovascular events, such as myocardial infarction heart failure, or stroke.7

Type V (Secondary CRS)

- Secondary CRS (Type V CRS) is a condition in which a systemic illness, acute or chronic, leads to dysfunction of both the cardiac and renal system.

The Role of Ultrasound in CRS

Visualizing the effects of CRS on the body can be very beneficial in patient management. Imaging of the kidneys and the heart is an essential factor in the diagnosis and treatment of CRS. Two of the most essential imaging modalities in this regard are renal ultrasounds and echocardiograms. Other imaging modalities such as CT, MRI, and Nuclear Medicine also play roles in diagnosis and management of CRS.

Renal US shows the progression of the renal disease. Two main characteristics to determine acute vs chronic renal disease:

1. Renal size
2. Echogenicity of the renal parenchyma

Classification of the renal parenchyma:
- Slight reduction of kidney size and parenchyma, cortical hyperechogenicity
- Reduction kidney size and parenchyma, strong cortical hyperechogenicity
- Renocardiac Syndrome (Type II CRS) is defined by chronic impaired renal function in the absence of acute cardiac events.
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Pathogenesis

In traditional Chinese medicine, the heart and kidneys are described clinically within medical texts. The kidneys represent water and are a ‘yin’ organ, and the heart represents fire and is a ‘yang’ organ. Renocardiac Syndrome (Type II CRS) is defined by chronic impaired renal function in the absence of acute cardiac events. Chronic renal syndromes: workgroup statements from the 7th Renocardiac Syndrome Consensus Workgroup. International Journal of Nephrology. 2011; 1:19-36.

Treatment and Prognosis of CRS

The coexistence of heart failure and renal insufficiency, or CRS, has an extremely poor prognosis.8 Strategies for diagnosing patients who develop CRS include renal biomarkers monitoring to guide therapy, use of continuous diuretic infusions, aldactonone or novel therapy with udenosine or renoprotective receptor agonists.9

When diagnosing CRS it is important to note that there is no correlation between serum creatinine and Glomerular filtration rate.10 Besides a decline in renal function (eGFR), a fall in GFR is more important for the prognosis in heart failure patients.11 Measurement of serum creatinine is also not reliable in terms of prognosis. The effects of parvalbumin levels on CRF has decreased GFR or creatinine clearance despite their normal levels of serum creatinine.12 Therefore GFR is a more sensitive indicator to provide a general sense of a patient’s prognosis.

Diabetes were the initial treatment for CRS patients. They are still considered an essential part of managing these patients especially in the beginning. Data from the Acute Decompensated Heart Failure National Registry (ADHERE) revealed that 80% of patients enrolled in this registry were on diuretic therapy at the time of presentation and 80% were treated acutely with an intravenous diuretic during their admission for acute decompensated heart failure (ADHF).13 Although diuretics provide short-term symptomatic relief and are widely used for management of CRS they have their drawbacks. Diuretic use lowers renin-angiotensin activity, decreases systemic vascular resistance, and lowers left ventricular function.14 Diuretic therapy can worsen renal function, which worsens the prognosis in patients with CRS.

The ADHERE database also enrolled noncritically ill patients who were admitted to the hospital for ADHF.15 ADHERE tried to determine the cause of renal dysfunction in these patients with ADHF to determine if treatment can influence outcomes.16 They determined that renal dysfunction in patients with heart failure is complex and often multifactorial in origin but may be reversible in some patients.17 Reducing angiotensin II levels with angiotensin-converting enzyme (ACE) inhibitors may preserve renal function.18 However, patients with advanced renal disease are not a target for ACE inhibitor induced renovascular arterial dilation.19 Therefore, ADHERE determined that ACE inhibitor therapy is probably used when the patient is volume overloaded.

The combination of any renal insufficiency paired with heart failure is commonly associated with a very poor prognosis. The complex pathophysiology of CRS makes management of the disease a clinical challenge.20 Patients should be continuously hemodynamically monitored.21 Knowing a patient’s blood pressure and filling pressure is essential in continuous management of the disease. Because cardiac and renal function are interrelated to each other, CRF can have a poor prognosis. A rise in serum creatinine clearance in patients with ADHF is associated with a worse survival prognosis.22 If an increase or decrease in serum creatinine clearance is not accompanied by oliguria, edema, hypotension, or anuric to diuretics the prognosis is very poor.23 Many current therapies for managing CRS were developed for renal failure, making treatment for this syndrome difficult. There is no single guideline for the treatment of CRS because each patient has a different medical history, risk profile, and combination of comorbidities.24