CHAPTER

17

Hypertension

Sally Campoy

Key Concepts

1. High blood pressure is the second leading cause of chronic kidney disease (CKD) requiring kidney replacement therapy (KRT) in the United States, making up about 25% of all cases. Hypertension is prevalent across the entire CKD continuum including kidney transplant.
2. Hypertension is the result of sustained elevated pressure over time that is associated with vascular constriction, vascular remodeling, and structural changes that lead to increased vascular resistance.
3. Risk factors that have a strong association with developing hypertension include advancing age, genetics, diabetes, hyperlipidemia, and the modifiable dietary and lifestyle risk factors of high sodium diet, excessive alcohol use, obesity, and physical inactivity.
4. The prevalence of hypertension in patients on peritoneal dialysis is less than hemodialysis. Improved fluid control related to more frequent dialysis contributes to better blood pressure control.
5. Management of hypertension begins with a trial of lifestyle modifications. Drug therapy should be started if the systolic blood pressure remains above 140 mmHg in patients younger than 60 years or above 150 mmHg in patients 60 years and older or if the diastolic pressure remains above 90 mmHg after a trial of lifestyle modifications.
6. The choice of drug for first-line therapy is determined by the desired degree of blood pressure reduction, patient characteristics, and preexisting conditions, as well as current clinical guideline evidence of decreased cardiovascular risk, drug efficacy, safety, and tolerability.
7. Special considerations for blood pressure management of the patient on hemodialysis include achievement of dry weight status, timing of administration of antihypertensive agents in relation to the dialysis treatment, dialyzability of the drug, and intradialytic blood pressure changes as a result of ultrafiltration.
8. Use of ambulatory blood pressure monitoring has become the gold standard to confirm hypertension in dialysis patients. This monitoring allows for assessment of blood pressure over time, correlating better with left ventricular hypertrophy and all-cause mortality.

Hypertension is defined as blood pressure greater than 140/90 mmHg based upon the average of two or more measured readings at each of two or more office visits after an initial screen (James et al., 2014). High blood pressure (BP) is the leading modifiable risk factor for cardiovascular disease, kidney disease, and stroke. It is the one of the most common reasons for adult office visits to clinicians and for use of prescription drugs.

The National Health and Nutrition Examination Survey (NHANES) data from 2007 to 2008 identified a 28% to 30% prevalence of hypertension in the 18-years-and-older population of the United States, which estimates to approximately 65 million hypertensives in the adult population in the United States (Egan, Zhao, & Axon, 2010). While the prevalence of high blood pressure has increased when compared to prevalence rates in the 1988–1994 NHANES–III data, it has remained unchanged since 2000, according to successive NHANES findings (CDC, 2015; Egan et al., 2010; Yoon, Burt, Louis, & Carroll, 2012).

Health and social disparities exist in the identification, treatment, and control of hypertension. Data estimates that approximately 8% of U.S. adults have undiagnosed hypertension with higher percentage of undiagnosed and uncontrolled hypertension among non-Hispanic Blacks and Mexican Americans (Yoon et al., 2015).

While hypertension awareness, treatment, and control have increased over the years, only half of adults with hypertension controlled their blood pressure at less than140/90 in 2009–2010 (Yoon et al., 2012), which does not meet the Healthy People 2020 goal of 62.1% (Egan et al., 2010; Office of Disease Prevention and Health Promotion, 2010). Uncontrolled hypertension rates among treated adults remains at 30%, which are seen in those who are older, males, non-Hispanic Blacks, Hispanics, and those with other comorbidities, such as diabetes mellitus, kidney disease, and obesity (Egan et al., 2011; Wang & Vasan, 2005).

Hypertension is the second leading cause of chronic kidney disease (CKD) requiring kidney replacement therapy (KRT) in the United States, making up approximately 25% of all cases (USRDS, 2015). It is also a complication of CKD and associated with faster rates of progression in people with diabetes and/or proteinuria when blood pressure is uncontrolled (KDIGO, 2013). High blood pressure is prevalent

CHAPTER

22

Cardiorenal and Hepatorenal Syndromes

Cynthia L. Russell • Dana Aholt

Key Concepts

1. To decrease inconsistency and confusion, the Acute Dialysis Quality Initiative (ADQI) defines cardiorenal syndrome as disorders of the heart and kidneys, whereby acute or chronic dysfunction in one organ may induce acute or chronic dysfunction of the other.
2. Cardiorenal syndrome (CRS) is classified into five subtypes, which designate the originating organ dysfunction and also categorize according to the acute or chronic nature of the organ dysfunction.
3. Type 1 CRS most often appears in acute decompensated heart failure, and patients may present with four different hemodynamic profiles termed *wet* or *dry* (the degree of perfusion) and *warm* or *cold* (the degree of congestion).
4. Type 3 CRS pathophysiology is related to the cause of the acute kidney injury (AKI), such as contrast-induced AKI, drug-induced AKI, major surgery, cardiac surgery, rhabdomyolysis, and postobstructive uropathy.
5. Biomarkers, objectively measured and evaluated indicators specific to heart failure and kidney injury, are increasingly important in diagnosing CRS.
6. Hepatorenal syndrome (HRS) is defined as acute kidney injury in the presence of either acute liver failure or chronic liver disease, where there is no identifiable cause of the kidney injury.
7. HRS is classified into two types. Type 1 involves rapid deterioration in kidney function with a relatively graver prognosis than type 2, which tends to present with a steady but moderate deterioration in kidney function.
8. HRS may be caused by bacterial infections, diarrhea and vomiting, diuretics, gastrointestinal bleeding, or large-volume paracentesis without adequate blood volume expansion. Half of the cases of HRS are spontaneous.
9. Liver transplantation is an option for treating HRS. ADQI recommendations are for liver transplant alone for type 1 HRS less than 4 weeks in duration, and combination liver–kidney transplant for those at risk for nonrecovery of kidney function.

Cardiorenal Syndrome

Cardiorenal syndrome (CRS) is a comprehensive term that describes the interaction of many diseases related to both the heart and the kidney. Whether the original source is cardiac or kidney dysfunction, the result is a condition known as cardiorenal syndrome (Ronco & DiLullo, 2014). Cardiac disease can often lead to deteriorating kidney function; the opposite is also true, whereby decreased kidney function leads to cardiac dysfunction or disease. Diseases of the heart and kidney are singularly common within our population and often coexist, leading to significant morbidity and mortality. As diagnosis and treatment can be long and complex, the cost of care can also be significant (House et al., 2010).

Definition

A consensus definition was developed to decrease inconsistency and confusion as well as to develop multidisciplinary approaches to identification and treatment. A collaborative conference, Acute Dialysis Quality Initiative (ADQI), with leading experts in nephrology, critical care, cardiac surgery, cardiology, and epidemiology, resulted in a common definition and classification term of *cardiorenal syndromes*. The term was defined as "disorders of the heart and kidneys whereby acute or chronic dysfunction in one organ may induce acute or chronic dysfunction of the other" (House et al., 2010, p. 1418).

In addition, five subtypes of the cardiorenal syndromes were identified and defined: acute cardiorenal syndrome (type 1), chronic cardiorenal syndrome (type 2), acute renocardiac syndrome (type 3), chronic renocardiac syndrome (type 4), and secondary cardiorenal syndrome (type 5) (House et al., 2010). The updates in the definition and classification system allowed a more unified approach to development of prevention and therapeutic strategies that may reduce organ damage (Ronco & Ronco, 2012).

CHAPTER

25

Depression in Chronic Kidney Disease

Carol S. Lieser

Key Concepts

1. Depression is the most common psychiatric disorder in patients with chronic kidney disease (CKD) and occurs at a rate four times greater than in those without any medical conditions. The reported prevalence rates of depression in patients with CKD range from 21.4% to 26.5% in stages 1–4 and 22.8% to 39.3% in stage 5.
2. The causes of depression are considered to be one-third genetic and two-thirds environmental. No single gene has been identified that can lead to depression.
3. Heightened levels of inflammation, such as seen in CKD, are associated with an increased risk of depression.
4. In addition to andedonia, an individual must have at least four additional symptoms to meet diagnosis criteria for depression. Among these are weight changes, appetite changes, alterations in sleep, poor focus, poor concentration, feelings of guilt, reduced energy, reduced psychomotor movement, and thoughts of suicide.
5. The criteria for making a diagnosis of depression is consistent for all age groups, yet there may be variations in presenting signs and symptoms in children and older adults.
6. Patients should be aware that most medications for depression will require 4 to 6 weeks of consistent use at an optimal dose before symptoms might be expected to leave.
7. There is a dearth of research available that clearly describes dose variation for the stages of chronic kidney disease and during hemodialysis. Most antidepressant medications are metabolized by the liver, but they may have metabolites that are excreted by the kidneys.
8. An interesting finding from the FREEDOM Study (Following Rehabilitation, Economics and Everyday-Dialysis Outcome Measurements) revealed the benefit of increased frequency of dialysis for those with co-occurring depression.
9. Nonpharmacologic approaches that may be beneficial for treating depression in individuals with CKD include cognitive behavioral therapy, exercise, and yoga.

Depression is one of the most common mental health disorders in the world. Defined as a feeling of sadness or sense of loss of enjoyment and pleasure, one of these two characteristics combines with various somatic and cognitive problems that affect the person's ability to function (American Psychiatric Association [APA], 2013).

According to the National Institute of Mental Health (NIMH), in 2013, an estimated 15.7 million adults ages 18 or older in the United States had at least one major depressive episode in the past year (NIMH, 2013). This represented 6.7% of all U.S. adults. In 2013, 10.7 percent of the population ages 12 to 17 (2.6 million youths) had a major depressive episode during the past year. In the same year, 7.7% of the population ages 12 to 17 (1.9 million youths) had past-year major depressive episodes with severe impairment in one or more areas of their life (Substance Abuse and Mental Health Services Administration [SAMHSA], 2014).

According to the World Health Organization (WHO, 2010), major depression also carries the heaviest burden of disability among mental and behavioral disorders, accounting for 3.7% of all U.S. disability-adjusted life years (DALYs), and 8.3% of all U.S. years lived with disability (YLDs) (Lepine & Briley, 2011). Depression is the most common psychiatric disorder in those with chronic kidney disease (Young et al., 2010) and occurs in these individuals at a rate four times greater than in those without any medical conditions (Zalai, Szeifert, & Novak, 2012).

Chronic kidney disease (CKD) is a progressive problem that affects about 10% of the world's population (Palmer et al., 2013b). Marked by kidney damage and a gradually deteriorating kidney function that is often permanent, this condition is divided into five stages measured by variable glomerular filtration rate (GFR) such as in stage 1, where the GFR is more than 90 mL/min/1/73 m^2, to stage 5, where the GFR is less than 15 mL/minute/1.73 m^2 (Andrade & Sesso, 2012).

Untangling depression from the basic physiologic symptoms of CKD itself is often a challenge. Yet this is an important process. Evidence reveals that individuals with chronic diseases are prone to depression (Olver & Hopwood, 2012). Those with CKD are found to have even more problems with depression than in other chronic illnesses (Kellerman, Christensen, Baldwin, & Lawton, 2010; Palmer et al., 2013a)

CHAPTER

37

The Wearable Artificial Kidney

Nancy Colobong Smith

Key Concepts

1. The goal of developing the wearable artificial kidney (WAK) is to truly improve the quality of life for patients currently dialyzing on conventional hemodialysis by freeing them from the burdens and limitations of thrice weekly dialysis.
2. Similar to standard dialysis circuits, the WAK has both blood and dialysate circuits. The blood circuit consists of an access, blood tubing, blood pump, heparin pump, and air detector that has a blood volume of approximately 65 mL.
3. Sorbent technology is used to regenerate dialysate. Sorbent technology was initially developed by NASA in the 1960s to purify waste water and human effluent to minimize water transportation during manned space travel.
4. Three auxiliary micropumps on the dialysate circuit control the addition of electrolytes, sodium bicarbonate, and ultrafiltration which is initially set at 50 mL/hour.
5. After leaving the dialyzer, dialysate flows through a series of three sorbent cartridges that adsorb ammonium, small and medium-size solutes, and organic compounds. After adding an electrolyte solution of calcium, magnesium acetate, and sodium bicarbonate, the regenerated dialysate travels back to the dialyzer.
6. During the WAK study, the sorbents were tested hourly for ammonia, which would alert staff that the sorbents required changing. Two out of seven patients in the study required sorbent exchange after 8–10 hours.
7. For nephrology nurse members of the research team, critical thinking and flexibility were essential skills because, in addition to other challenges, some of the manufactured components did not function as designed during the study.
8. During previous studies in Europe, one patient experienced needle dislodgment. Therefore, in the U.S. study, all patients used a functioning double-lumen, tunneled, central venous catheter for vascular access.
9. An additional technical challenge to be resolved is the limited capacity of the degassing chambers to manage carbon dioxide production.

The prevalence of chronic kidney disease (CKD) in the general population of the United States is approximately 14%, affecting more than 26 million people (United States Renal Data System [USRDS], 2015). Of those with CKD, more than 600,000 individuals have progressed to CKD stage 5, requiring kidney replacement therapy (KRT). For those whose lives are dependent on dialysis, the dream of therapy options that are portable, convenient, and can improve quality of life has been elusive in becoming a reality.

Roberts (1993) describes the introduction of the REDY (regenerative dialysis sorbent) system in a 1976 lecture entitled *The Future of Dialysis,* which predicted reduced hemodialysis (HD) burden, decreased peritonitis rates, and introduction of the concept of a wearable artificial kidney (WAK). Although there have been improvements in the quality of care provided to individuals requiring KRT in the last 50 years, the quest continues for dialysis with less burden and improved quality of life.

The WAK combines components familiar to those who provide dialytic care with sorbent technology introduced in the REDY machine in a portable package. Initial studies performed in the United Kingdom and Italy demonstrated safety and clearance when worn for 6 to 8 hours (Davenport et al., 2007; Gura, Ronco, & Davenport, 2008; Gura et al., 2009). In 2014, the U.S. Food and Drug Administration (FDA) approved a trial to provide 24-hour treatments to 10 patients in the United States. A multidisciplinary research team was co-led by inventor Victor Gura, MD, and Jonathan Himmelfarb, MD, director of the Kidney Research Institute (KRI).

This chapter will describe the technology used in the WAK, the most recent trial, and the potential significance of this innovation for individuals living with CKD as well as for nephrology nurses.

Making the Wearable Artificial Kidney a Reality

Early Innovations

Necessity is the mother of invention. (Plato)

To understand current innovations in dialysis technology, it is beneficial to understand the early dialysis technology that serves as the foundation of our current practice.