Utilization Patterns of Antihypertensive Drugs Among the Chronic Kidney Disease Population in the United States: A Cross-sectional Analysis of the National Health and Nutrition Examination Survey

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ABSTRACT

Purpose: Antihypertensive drugs are prescribed to patients with chronic kidney disease (CKD) for their cardioprotective and renoprotective effects. Nationally representative information on the use of antihypertensive drugs among CKD patients is limited. The purpose of this study was to assess the utilization patterns of antihypertensive drugs among the CKD population (stages I–IV) in the United States.

Methods: We conducted a retrospective cross-sectional analysis of the National Health and Nutrition Examination Survey (NHANES) panels from 2005–2006, 2007–2008, and 2009–2010. The estimated glomerular filtration rate was calculated and kidney damage was assessed to identify participants with CKD. The demographic and clinical characteristics of the participants with CKD were reported, as were the antihypertensive drugs they used.

Findings: A total weighted sample of 116,231,361 participants representative of the CKD population in the United States (stages I–IV) was identified. Less than one half of the participants with CKD in the NHANES were using antihypertensive drugs. β-blockers were the most commonly used and angiotensin II receptor blockers were the least used antihypertensive agents among participants with CKD. Age ($\geq$70 years), awareness of hypertension or diabetes, and higher stage of CKD were associated with an increased likelihood of antihypertensive drug use among participants with CKD.

Implications: The results of our analyses suggest that antihypertensive drugs are underused in the CKD population, and the use of preferred agents (ie, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers) is low. Efforts should be directed toward emphasizing the importance of using antihypertensive drugs in the CKD population. (*Clin Ther.* 2015;37:188–196)

Key words: antihypertensive drugs, chronic kidney disease, medications acting on the renin-angiotensin system.

INTRODUCTION

Chronic kidney disease (CKD) is the ninth leading cause of death in the United States, and >10% of US adults are estimated to have CKD.[1,2] A patient experiencing CKD has weak kidneys that lead to hemodynamic overload, as well as metabolic and endocrine abnormalities that adversely affect the cardiovascular system.[3] This scenario increases the risk of cardiovascular disease (CVD) in CKD patients by 10 to 30 times compared with subjects without CKD[4]; hence, patients with CKD are considered to be at the highest risk for CVD.[5] Therefore, interventions that have a protective effect on cardiac and kidney function are necessary for patients with CKD.

Antihypertensive drugs are recommended for CKD patients with or without hypertension because these agents offer cardioprotective and renoprotective benefits.[6] The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) recommends a blood pressure (BP) goal of <130/80 mm Hg for CVD risk reduction in CKD. Strong evidence from the literature suggests that antihypertensive drugs are effective for attainment of BP goals.[7,8] Antihypertensive drugs are therefore used in CKD to: (1) lower BP in patients with hypertension; (2) reduce the risk of

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CVD in patients with and without hypertension; and (3) slow the progression of kidney disease in patients with and without hypertension.[6] One or more of the approved antihypertensive drug classes can be prescribed to CKD patients for their cardioprotective effect; however, angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs) are preferred because of their additional renoprotective effects.[9–12]

Despite the significance of antihypertensive drugs in CKD, little is known about their utilization patterns among patients with this disease. Few studies have reported the number of antihypertensive medications used and the BP control rate among patients with CKD.[13–17] One multicenter study assessed the utilization patterns of cardiovascular drugs among CKD patients (stages II–V) recruited from nephrology centers.[18] However, the study was not representative of the CKD population in the United States, and the patient sample did not include patients with stage I. The utilization patterns of antihypertensive drugs among CKD patients (including those with and without hypertension) in a general noninstitutionalized population in the United States are unknown.

The purpose of the present study, therefore, was to assess the utilization patterns of antihypertensive drugs among the CKD population in the United States. The proportion of antihypertensive drug users and the utilization proportions of the different classes of antihypertensive drugs were determined. In addition, we characterized the factors associated with the likelihood of antihypertensive drug use in this population.

PATIENTS AND METHODS

Data Source

This was a retrospective cross-sectional study of the 3 most recent 2-year panels of the National Health and Nutrition Examination Survey (NHANES), 2005–2006, 2007–2008, and 2009–2010.[19] The NHANES has been conducted regularly since the early 1960s for the purposes of determining the prevalence of major diseases and their risk factors, and the surveys reflect a nationally representative sample of the US population.[20] Participants are recruited based on race, sex, age, and income status by using a multistage sampling process. The survey includes 2 components: (1) health interviews, including respondent-reported data on demographic characteristics, health insurance, medications, hospital utilization, access to care, and disease conditions; and (2) health measurements, including physical and laboratory examinations conducted at mobile examination centers by trained professionals. Details of the survey methods have been published elsewhere by the Centers for Disease Control and Prevention.[21]

CKD Cohort Identification

The study population included NHANES participants aged $\geq$20 years with complete data on the physical and laboratory examinations. Participants with CKD were identified in a 2-step process. First, participants' estimated glomerular filtration rate (eGFR) was calculated by using the serum creatinine values available from the laboratory data. The Chronic Kidney Disease Epidemiology Collaboration formula was used; this formula allows calculation of age-, sex-, and race-adjusted eGFR.[22] In addition to eGFR, the spot urine albumin-to-creatinine ratio was used from the laboratory data for assessment of kidney damage ($>$17 mg/g for men or $>$25 mg/g for women indicates kidney damage at stages I and II), and this information was subsequently used to identify the early stages of CKD.[6] Second, participants were classified into CKD stages I through V by using the NKF KDOQI classification guidelines as follows: (1) kidney damage and eGFR $\geq$90 mL/min/1.73 m^2 (stage I); (2) kidney damage and 80 $\geq$ eGFR $\geq$60 ml/min/1.73 m^2 (stage II); (3) 59 $\geq$ eGFR $\geq$30 mL/min/1.73 m^2 (stage III); (4) 29 $\geq$ eGFR $\geq$15 mL/min/1.73 m^2 (stage IV); and (5) $<$15 mL/min/1.73 m^2 (stage V).[23] Participants with CKD stage V were excluded due to the possibility of unreliable estimates because these patients may be small in number, receiving dialysis, or institutionalized, and they are therefore underrepresented in the NHANES.

Characteristics of the CKD Cohort

Data regarding demographic characteristics (age, sex, and race) were obtained from the interview component. Awareness of hypertension and diabetes was determined from the BP and cholesterol questionnaire and the diabetes-specific questionnaire, respectively. Participants were asked to respond "yes/no" to the following questions: "Have you ever been told by a doctor or health professional that you had hypertension?" and "Have you ever been told by a doctor