Kidney International, Vol. 68 (2005), pp. 914–924

PERSPECTIVES IN RENAL MEDICINE

Unraveling the racial disparities associated with kidney disease[1]

KEITH C. NORRIS and LAWRENCE Y. AGODOA

Department of Medicine, Charles R. Drew University and the Geffen School of Medicine at UCLA, Los Angeles, California; and National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, Maryland

Unraveling the racial disparities associated with kidney disease.
In the United States, chronic kidney disease (CKD), and in particular end-stage renal disease (ESRD), represent a growing problem. Many other countries also have an increasing number of ESRD cases. Racial/ethnic disparities have been documented globally in the prevalence, incidence, and treatment of CKD, most extensively in the United States, but also in the United Kingdom, Australia, and New Zealand, among others. In many circumstances, these disparities are of a negative nature, that is, certain racial/ethnic groups fare worse than their white counterparts with respect to the treatment or outcome of CKD. However, in a few circumstances, they are of a positive nature, such as the survival advantage seen in minorities with ESRD compared with whites. The reasons for racial disparities in the prevalence, incidence, and treatment of CKD are not fully understood, although they are explained partly by coexisting medical conditions and modifiable risk factors, such as socioeconomic, lifestyle, and cultural. It is likely, however, that the complete picture incorporates a complex interaction between these sociocultural, genetic, and environmental factors. In a global society that prides itself on a high level of sensitivity and equality, there is an ethical and moral imperative to address the continuing racial/ethnic disparities in CKD and many of the factors underlying this epidemic. We review data highlighting the racial/ethnic disparities that exist in the incidence and treatment of CKD, with particular emphasis on ESRD. A better understanding of both the negative and positive racial/ethnic disparities may yield important insights, which can inform future research strategies and improve health outcomes for all patients afflicted with CKD.

Chronic kidney disease (CKD), and the subsequent progression to end-stage renal disease (ESRD), impose a relentless socioeconomic burden on patients, society, and the health care system. Over the last decade, the number of ESRD patients in the United States grew at an exponential rate, doubling from 201,454 in 1991 to 406,081 in 2001. Although this growth rate has begun to slow, projections to the end of this decade are sobering, with over 700,000 patients estimated to be receiving ESRD treatment by 2010: 404,406 white, 241,591 African Americans, and 78,570 other [1]. The continued growth of the ESRD population has substantial public policy implications. Moreover, it is estimated that one in nine Americans, more than 20 million individuals, has CKD, but most are unaware of their condition [2]. Another 20 million Americans are at increased risk of developing kidney disease. The costs associated with ESRD are substantial, with an estimated global cost of $76,515 per patient-year [3], with a total cost of treating ESRD in the United States of $22.8 billion in 2001 [4], and Medicare costs expected to increase to almost $40 billion by 2010 [5].

It has long been recognized that ESRD is more common in certain racial/ethnic groups [6–8]. These disparities have been extensively reported in the United States, with African Americans having the highest reported incidence and prevalence of treated ESRD [Third National Health and Nutrition Examination Survey (NHANES III, 1988-1994)] [9]. The African American population is not an exception; American Indians, Alaskan Natives, Asians, Native Hawaiians and other Pacific Islanders, and Hispanics all have higher incidence and prevalence rates of treated ESRD than whites. Similar racial/ethnic disparities have been reported in other countries, including the United Kingdom, Australia, and New Zealand [10–12].

A persistently elevated serum creatinine level is an indicator of CKD and an independent predictor of CKD progression [abstract; Norris K, et al, *J Am Soc Nephrol* 14:190A, 2003]. The highest levels of serum creatinine are seen in men, African Americans, and the elderly. African Americans, Native Americans, Asian Americans, and Hispanics are respectively 3.9, 2.7, 1.6, and 1.5 times more likely than white Americans to develop ESRD (Fig. 1) [4, 13, 14]. An increase in both the prevalence and recognition of CKD coupled with a growing and aging population contribute significantly to the relentless rise in the occurrence of ESRD. The burden that this places on certain racial/ethnic groups, in particular, and society as a whole, is of great concern. Indeed, the

[1] **See Editorial by Pugsley, p. 1364.**

Key words: chronic kidney disease, culture, dialysis, end-stage renal disease, ethnic groups, racial disparities, socioeconomic, transplantation.

Received for publication September 28, 2003
and in revised form May 26, 2004, and October 13, 2004
Accepted for publication May 6, 2005

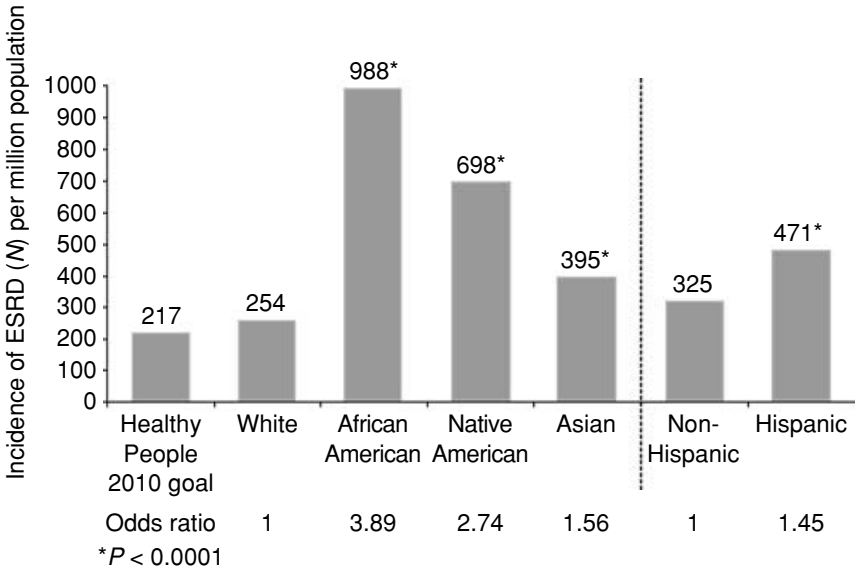

Fig. 1. The incidence of reported end-stage renal disease (ESRD) in the United States in 2001, by race and ethnicity adjusted for age and gender [4]. Data from the United States Renal Data System 2003.

Healthy People 2010 Initiative has made the reduction of racial/ethnic disparities associated with CKD a central United States national health priority [15]. As noted above, the potential reasons for racial/ethnic inequalities in CKD are multifactorial [16, 17]. A concerted effort will therefore be required to unravel the factors underlying these disparities.

RACIAL DISPARITIES IN THE RISK FACTORS FOR CKD

Excess prevalence of key risk factors for CKD in racial/ethnic minorities plays an important role in the excess rate of ESRD in these groups. Higher rates of diabetes mellitus, hypertension, and glomerulonephritis, and other factors such as dietary and lifestyle, influence the progression of CKD, and the response to treatment. Recognition of these risk factors can lead to more proactive preventive and early treatment strategies.

Diabetes mellitus

It is estimated (NHANES III, 1988-1994) that 8% of adults in the United States have type 2 diabetes mellitus [18], and the incidence of this disease is increasing [4]. The number of cases of diabetes mellitus, and consequently diabetic nephropathy, is also rising progressively worldwide [19]. Diabetic nephropathy occurs in about one third of patients with diabetes mellitus, and is the most common cause of ESRD in most industrialized nations accounting for nearly half of new ESRD cases [4, 20].

Relative to the non-Hispanic white population, the incidence of diabetes mellitus is, respectively, 1.6, 1.5, and 2.3 times higher in African American, Hispanic, and Native American populations. Not surprisingly, substantial racial disparities exist in the incidence of diabetes-related

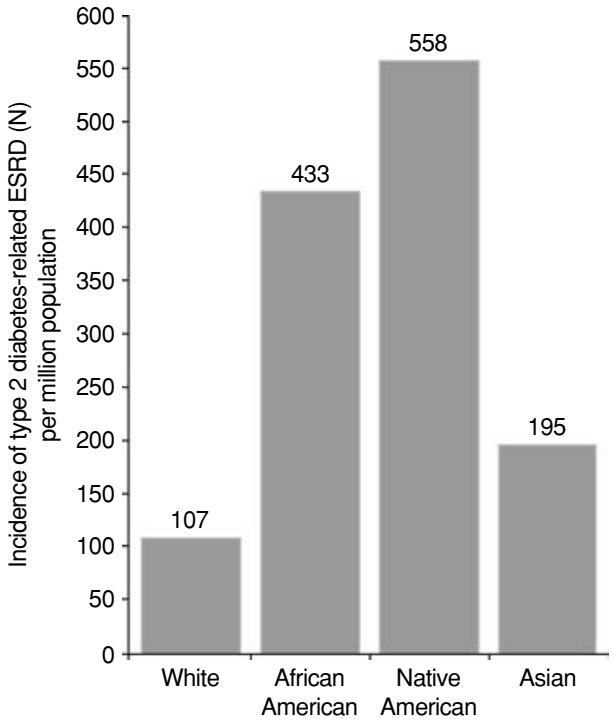

Fig. 2. The incidence of reported type 2 diabetes–related end-stage renal disease (ESRD) in the United States by race; combined data for 1998–2001 [4]. Rates adjusted for gender. Data from the United States Renal Data System 2003.

ESRD, with Native Americans suffering from the highest rates (Fig. 2) [4, 18]. In addition to having a greater incidence of diabetes mellitus, the onset of albuminuria appears to present much earlier in the course of diabetes mellitus in African Americans compared with white Americans. Thaler et al [21] and Goldschmid et al [22] reported that as many as 25% of African Americans

may show albuminuria less than a year after diabetes mellitus has been diagnosed, suggesting delayed diagnosis or more aggressive disease progression.

Data from the TransPacific Renal Network, reported in 2000, indicated that diabetes mellitus may account for over 55% of incident ESRD in Asian Americans and other Pacific Islanders [23], a figure that exceeds the United States national average [24, 25]. Furthermore, Grandinetti et al [26] reported the prevalence of diabetes mellitus among Native Hawaiians may be as high as 22% in some rural communities, a rate three times the prevalence seen in United States whites [26]. They hypothesized that these communities have a genetic susceptibility to diabetes mellitus which is unmasked as the result of obesity arising from a high-fat Western diet and physical inactivity [27]. Indeed, this "thrifty" genotype, which allows the body to compensate for cycles of physical activity/rest and feast/famine by storing fuel in periods of starvation, could lead to obesity and type 2 diabetes mellitus given a Westernized, sedentary lifestyle. The thrifty genotype is thought to occur at higher rates among those racial/ethnic groups who previously thrived in environments with deficient or inconsistent food sources [28, 29].

Hypertension

Hypertension may be associated with arteriolar nephrosclerosis and impaired kidney function. It is both a risk factor for, and complication of, CKD [30, 31]. Indeed, in 2000, 27% of all incident ESRD patients in the United States had hypertension reported as their primary cause of ESRD [32]. Recent data from the 1999-2000 NHANES noted that while African Americans (34%) have higher rates of hypertension than whites (29%) or Hispanics (21%), the rate of blood pressure control is dramatically lower (<140/90 mm Hg) in Hispanics at 18%, in comparison with 28% for African Americans and 33% for whites [33]. In addition, the incidence of hypertension associated with CKD is substantially higher among African Americans than whites [4, 34, 35]. In 1997, the 16-year findings from the Multiple Risk Factor Intervention Trial (MRFIT) showed that, among hypertensive patients, the incidence of all-cause ESRD per 100,000 person-years of hypertension was 16.38 for African Americans, but only 3.00 for white Americans [34]. Other factors such as the higher rate of low birth weight among African Americans compared with whites, and the associated low nephron count, may predispose to hypertension and kidney disease [36]. As a significant relationship exists between ESRD and low birth weight in African Americans, differences in fetal development in African Americans may contribute to the racial disparity in ESRD.

Dietary factors and lifestyle

A high caloric, high carbohydrate, and high salt diet with low potassium, magnesium, and calcium intake are risk factors for hypertension; in particular, a high salt diet is a risk factor for the development of hypertension. An increased sensitivity to high levels of dietary sodium could also help explain the more rapid deterioration of kidney function seen in hypertensive African Americans compared with white Americans [37, 38].

Physical inactivity and obesity also contribute to excessive rates of diabetes mellitus, hypertension, and ultimately CKD [39], and are disproportionately high in racial/ethnic minorities. The prevalence of physical inactivity is particularly high in African American females at 55% compared with 36% for white females, 44% for African American males, and 33% for white males [40]. Obesity and overweight prevalence rates were also highest among African American females (77%, compared with 57% for white females, 61% for African American males, and 67% for white males) [40]. More than half of African American females aged 40 years or older were obese and more than 80% were overweight. Also significant is the finding that 20% of African American children aged 6 to 11 years and 24% of African American adolescents aged 12 to 19 years were overweight [40]. The future health consequences of these high levels of obesity and overweight are likely to be staggering; therefore, health programs should focus on reducing excessive caloric intake and increasing physical activity.

Glomerulonephritis and immunoglobulin A nephropathy

Glomerulonephritis is a well-established risk factor for CKD and immunoglobulin A (IgA) nephropathy is the most common form of primary glomerulonephritis. The prevalence of IgA nephropathy varies among racial groups, being more common in Native Americans from New Mexico [41] and the Chinese population [42], and rare in African Americans. While the rate of glomerulonephritis-related ESRD is second only to diabetes among indigenous Australians, there does not appear to be a specific increase in IgA nephropathy [43]. IgA nephropathy is associated with immune complex deposition, glomerulosclerosis, interstitial fibrosis, and tubular atrophy [44]. The exact causes of IgA nephropathy and the pathogenesis of the disease are unknown, although it may be associated with respiratory tract infections [45] and liver disease, including heavy alcohol intake [46–48].

In 2000, glomerulonephritis was a major cause of ESRD among Filipino patients in Hawaii undergoing dialysis, accounting for 24% of cases [23]. This figure was twofold higher than in the continental United States ESRD population. This higher prevalence of glomerulonephritis may be related to the higher rates of IgA nephropathy among Asians worldwide.

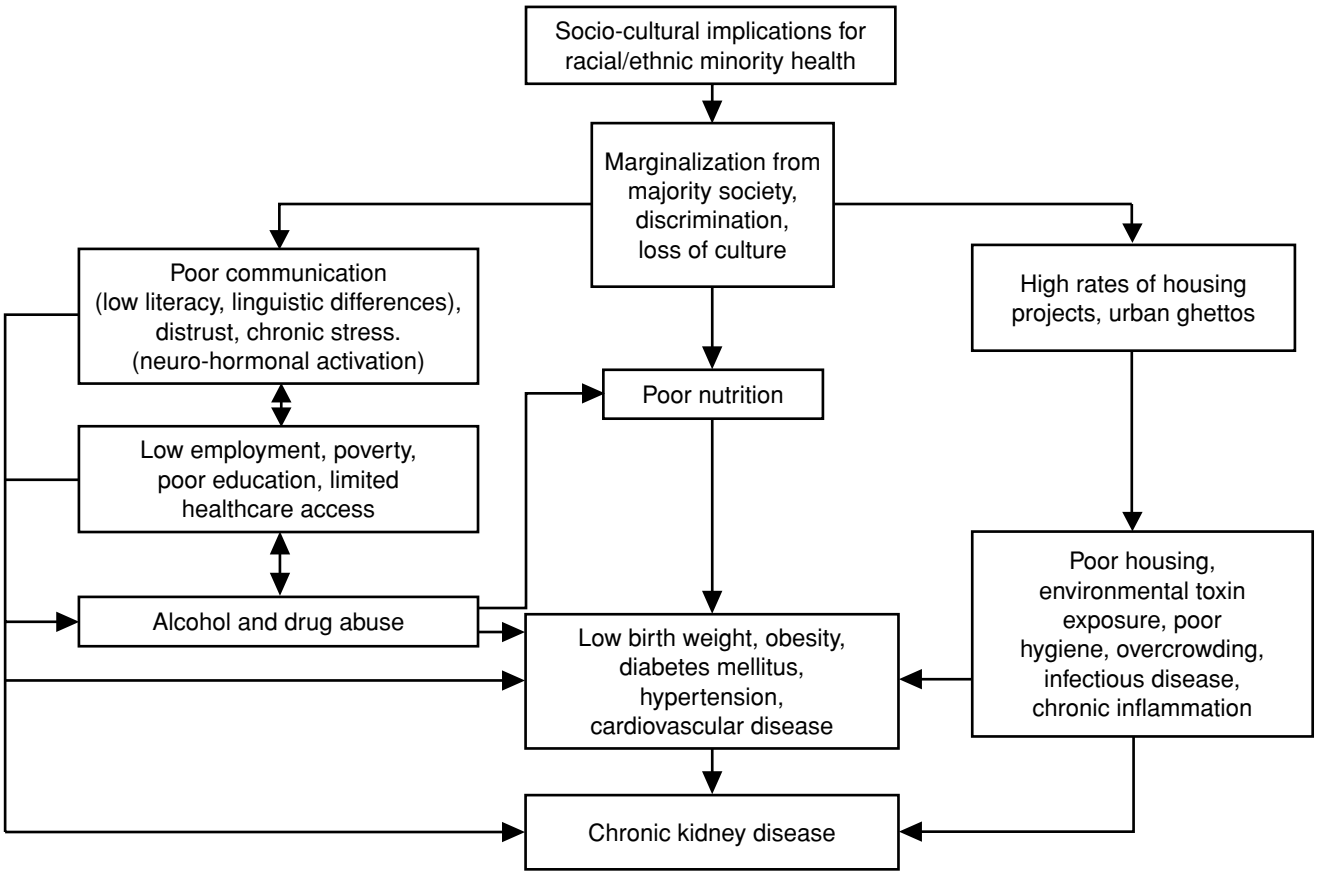

Fig. 3. Sociocultural influences on racial/ethnic minority health with implications for chronic kidney disease (CKD) [49]. Modified from Cunningham (*BMJ* 2003).

RACIAL DISPARITIES IN THE TREATMENT OF CKD

Socioeconomic factors

Socioeconomic status has been shown to have a significant impact on the incidence and treatment of ESRD [16, 17]. Socioeconomic factors, such as low income, poor education, residence in a low-income areas, and consequently poor access to health care, are strong predictors for the development of ESRD (Fig. 3) [49–52].

In 1995, Hajnal [53] noted that, of people living in areas of urban poverty in the United States, 67% were African American, 20% were Hispanic, and 12% were white. Furthermore, the proportion of nonelderly African American and Hispanic populations considered to be below the federal poverty level ($14,128 for a family of three in 2001) was 31% and 29%, respectively, compared with 11% of the white population [54]. Poverty is often associated with suboptimal housing settings (redlining), often leading to excess exposure to toxic dumps and environmental toxins such as lead. Studies have shown that environmental exposure to lead is associated with an increased risk of hypertension and impaired renal function [55, 56]. The NHANES III study found that compared with whites African Americans have higher blood lead concentrations, which are associated with elevated blood pressure and hypertension [57].

Reduced socioeconomic status negatively influences access to health care, access to kidney transplants, and mortality in patients with ESRD [58–63]. In 2001, 55% of Hispanic and 45% of African American populations were uninsured or received publicly funded health care, compared with 22% of the white population [54]. Hence, the poorest individuals, despite having the greatest need for medical care, often receive the least. Delayed referral of patients with CKD to specialist care limits the potential for timely intervention that could slow disease progression or prevent complications, and is associated with prolonged hospital stays, increased expense, and higher mortality rates [64, 65]. In the United States, racial/ethnic minorities are much less likely than whites to be referred to a nephrologist and undergo renal replacement therapy in a timely manner [64, 66]. This is due, at least in part, to socioeconomic factors, such as poverty and lack of health insurance [67–69]. However, the findings of a recent population-based study indicate that the situation is likely to be more complex; Powe et al showed that socioeconomic status and race did not adversely affect receipt

of treatment for CKD after adjusting for insurance status, suggesting an interdependence between these factors [70]. This same study identified younger age and residence in a highly populated area as factors that may increase the relative odds of receiving treatment. Poor socioeconomic status has been shown to have a strongly negative effect on survival in African Americans, but not for whites. The adjusted relative risk of death decreased for African Americans by 3% per $1000 increase in yearly income ($P < 0.01$) [63].

Culture

Culture plays an important role in forming attitudes to health care, including how illness is perceived, and what form treatment should take [71]. For instance, cultural differences mean that Japanese, Filipino, and Native Hawaiian populations are more likely to have attitudes towards illness and health care that may conflict with those of Western medicine. These attitudes may rely on spiritual and religious beliefs rather than a dependence on modern pharmacology, and hence there may be skepticism towards Western medical practices. Accordingly, patients from these populations may be less inclined to receive Western medications and health care [72, 73]. Similar attitudes exist for Alaskan Natives, Native Americans, Hispanics, and African Americans [71, 74]. Cultural beliefs may also affect lifestyle factors, such as dietary behavior, physical activity patterns, and attitude toward body size and weight, thereby contributing to increased rates of overweight and obesity common among racial and ethnic minorities.

Cultural beliefs may also limit the number of minority kidney donors [75, 76]. For example, the attitudes of Native Americans are due, at least in part, to spiritual beliefs, which hold that the body must be whole after death to enter the spirit world. Indeed, a recent study, conducted in Maryland, showed that African Americans were three times less likely than their white counterparts to be listed as donors on their driver's licenses [77]. Evidence suggests that there is greater willingness among Native Americans to be a living rather than a cadaveric donor (81% versus 54%, respectively) [75]. There is greater willingness to donate when the potential donor is approached by a health care worker from their own culture, has had personal experience of ESRD, or is educated and understands the disease. Physicians need to be aware of the cultural barriers that may exist and how they impact on the treatment of CKD and ESRD.

Pharmacologic intervention

Studies of inhibitors of the renin-angiotensin-aldosterone system (RAAS) reported before 2001 included too few African American patients to demonstrate an improvement in CKD or cardiovascular outcomes for this subgroup [78, 79]. Furthermore, there was evidence of a reduced hypertensive response among African Americans receiving RAAS inhibitor monotherapy, and a lesser reduction in mortality among African Americans with left ventricular hypertrophy [80, 81]. Therefore, hypertensive African American patients were thought to be unlikely to show improved clinical outcomes with RAAS inhibitors. However, the African American Study of Kidney Disease and Hypertension (AASK) showed that RAAS inhibitors can significantly improve clinical outcomes in African Americans with hypertensive nephropathy [82]. AASK patients treated with the angiotensin-converting enzyme (ACE) inhibitor, ramipril, showed a lower rate of clinical renal events and death and a lower incidence of new-onset type 2 diabetes mellitus. The outcome from the AASK is an important one given the high incidence of hypertensive ESRD in the African American population, and the fact that data from previously reported studies had led to low usage of RAAS inhibitors as primary therapy in this high-risk subgroup. This low rate of RAAS inhibitor use among African Americans may contribute to the disproportionate burden of CKD among African Americans compared with whites.

Unfortunately, the rate of ACE inhibitor–related serious side effects is greater in racial/ethnic minorities [83]. Thus, inclusion of minorities in studies of angiotensin receptor blockers (ARBs) is of critical importance. Recent studies of the ARBs irbesartan [84] and losartan [85] involved higher numbers of racial/ethnic minorities: 13% African Americans and 5% Hispanics in the former and 15% African Americans and 18% Hispanics in the latter. Although the numbers were insufficient to perform separate subanalyses, the results of these studies with modest minority enrollment demonstrating enhanced outcomes in participants receiving ARBs suggest that they are safe and effective for minority subgroups.

Dialysis

Late referral to a nephrologist, which is common among minority groups, is associated with the use of synthetic grafts rather than autologous arteriovenous fistulas as the choice of vascular access [86]. This may be one reason why African Americans are more likely than white Americans to have synthetic grafts for vascular access prior to hemodialysis, despite the higher rates of thrombosis and infection associated with such devices [86].

A lower than required dose of hemodialysis (with respect to dialyzer clearance per unit of time) is associated with increased mortality when all demographic groups are evaluated together. African American patients are more likely than white patients to receive a lower than required dose of hemodialysis (a mean Kt/V of 1.36 versus 1.40, respectively) and the reasons for this are not

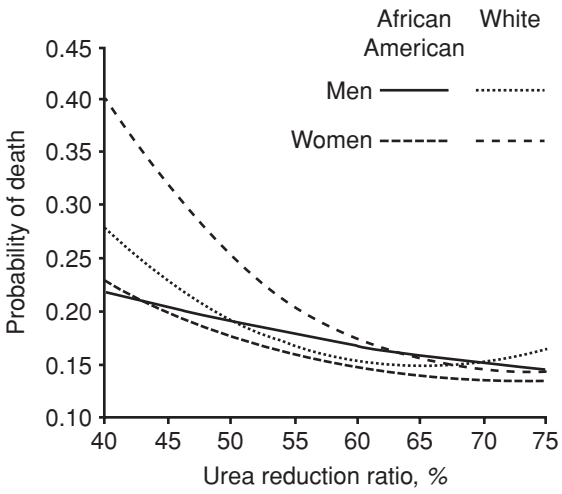

Fig. 4. Probability of death by race and gender for urea reduction ratio in the United States [87]. Reprinted with permission from the American Medical Association (*JAMA* 280:1764–1768, 1998). Copyright (©) 1998, American Medical Association. All rights reserved.

known [87, 88]. However, survival outcomes for African Americans appear to be less sensitive to lower doses of hemodialysis compared with white patients who have a lesser tolerance to lower urea reduction ratios (URR) (Fig. 4) [87, 88]. In at least one study it was proposed that the lower URR in African Americans may be a consequence of a larger urea distribution volume as these patients had, on average, greater body weights, total body volume, body surface area, serum albumin levels, and serum creatinine levels than white Americans [87]. Other factors may include selective survival, increased access to medical care, and increased physician/health care provider interaction following the initiation of renal replacement therapy associated with the provision of insurance through Medicare.

Surprisingly, racial/ethnic minorities with ESRD on dialysis live longer than their white counterparts [4]. Several possible reasons for this have been proposed, including survival bias, lower rates of renal replacement therapy for minorities with more severe versus less severe comorbidity, and selection of healthier white patients for transplant compared with minorities [89]. Nevertheless, the precise reason for this finding remains undetermined [16]. Understanding the reasons underlying these differences could have an important impact on strategies to improve survival outcomes for all dialysis patients.

Transplantation

Given the predominantly white donor population in the United States, ethnic minority ESRD patients are at an obvious disadvantage in their chances of receiving a suitable kidney. This situation is compounded by lower levels of organ donation among minority groups due, at least in part, to many of the cultural factors discussed earlier [75, 90, 91]. African Americans are much less likely than whites to have been referred for evaluation at a transplant center, placed on a waiting list, or have received a transplant [92]. These racial/ethnic differences in access to transplantation remained significant even after adjustment for patient preference, health status, sociodemographic factors, perceptions of care, and comorbidities [92]. A survey of nearly 300 nephrologists in four regions of the United States showed that physicians believed that this reduced referral rate was due to patient preference, availability of living donors, failure to complete evaluations, and comorbid conditions [93]. Approximately 50% of the nephrologists surveyed reported that comorbidities and inability to complete pretransplant evaluations were the major reasons accounting for differences in referral rates [93]. This is supported by previous research, which showed that African American patients were less likely than white patients to be considered appropriate candidates for transplantation (9% versus 21%, respectively) and were more likely to have had an incomplete workup (47% versus 39%) [90]. The most common reasons why patients were considered inappropriate for transplantation were a body mass index over 35, presence of an active infection and presence of extrarenal, noncardiac comorbidities. Among patients considered suitable for a transplant, African Americans are less likely than white patients to actually receive a transplant (17% versus 52%, respectively) [90]. It has been suggested that these differences may be the result of institutional racism. Indeed the Institute of Medicine concluded in their recent report on the racial and ethnic disparities in health care that "although myriad sources contribute to these disparities, some evidence suggests that bias, prejudice, and stereotyping on the part of health care providers may contribute to differences in care" [94]. A study by Alexander and Sehgal [61] showed that cadaveric transplant rates between African Americans and whites vary considerably (rate per 100 patient-years 5.1 versus 11.6, respectively) (Fig. 5). African Americans were much less likely than whites to complete the final three steps of the transplant process, being definitely interested in transplantation (odds ratio 0.68), completing the pretransplant workup (odds ratio 0.56), and moving up the waiting list and receiving a transplant (odds ratio 0.50) [61]. A recent study, which examined the effect of human leukocyte antigen (HLA) typing on the allocation of cadaveric kidney transplants in white and nonwhite patients, found that the current policy regarding HLA matching is another factor that contributes to the reduced transplantation rate among nonwhites [95]. Current policy gives priority to candidates with no HLA A, B, or DR mismatches, followed by candidates with the fewest mismatches at the HLA B and DR loci. This policy is based on the graft survival rate of first cadaver kidney

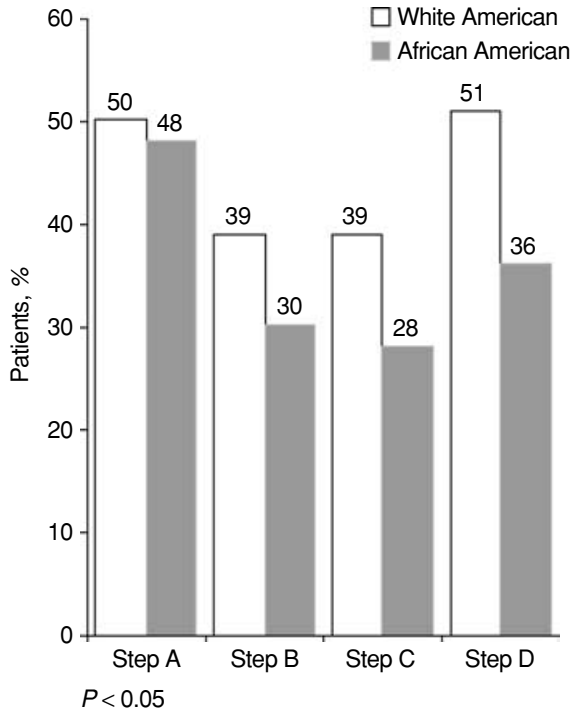

Fig. 5. The proportion of successful African American and white American cadaveric transplant patients by stage in the United States [61]. Definitions of steps in the transplant process: Step A, medically suitable and possibly interested; Step B, definitely interested; Step C, pretransplant workup complete and on waiting list; and Step D, moved up waiting list and received transplant. Data from Alexander and Sehgal (*JAMA* 1998).

transplants with a complete mismatch (six HLA A + B + DR mismatches) being 17% lower than that of grafts with no mismatch [96], and the racial distribution of these loci happens to result in whites receiving transplants more frequently. A recent modeling of the risk of graft failure by race and HLA DR and HLA B suggested that maintaining HLA DR matching and eliminating HLA B matching as a priority would improve the racial equality in transplant allocation while having little effect on graft loss.

Another factor contributing to the racial differences in transplantation access rates is the belief of physicians that transplantation prolongs survival less compared with dialysis for African Americans than whites [93]. Although a greater survival benefit from renal transplantation has been observed in whites compared with African Americans, the average survival benefit of transplantation relative to dialysis is significant for both patient groups [97]. If physicians perceive the survival benefit to be less in African Americans they may be less likely to advocate this treatment option. Physician bias may also result in ineffective communication with patients and a lack of information exchange between physician and patient regarding treatment choices [93].

It has been reported previously that African Americans who receive a renal transplant are 1.8 times more likely to suffer long-term graft failure than whites or other ethnic groups, such as Hispanics and Native Americans [90, 97–99]. This rate of graft failure was not due to differences in haplotype matching or socioeconomic factors, such as disparities in insurance status. The introduction of newer, more effective immunosuppressive therapies represents an important advance in achieving improved patient outcomes and reducing the existing disparities. In a study of 120 African Americans and 65 whites who received renal transplants with tacrolimus-based immunosuppression and were followed for 34 months, Hardinger et al [100] reported no difference in 5-year actuarial patient and graft survival rates. However, the mean time to chronic allograft nephropathy was shorter in African American recipients (18 versus 37 months, respectively) ($P = 0.03$). In another study of 57,926 patients who had received a renal transplant and the immunosuppressive mycophenolate mofetil, 3-year patient survival and death-censored graft survival rates were similar for African American and white renal transplant recipients [101].

Racial differences in transplantation rates are also seen in the predominantly ethnic population of Hawaii, whose inhabitants have a greatly reduced likelihood of receiving kidney transplants compared with patients living in the continental United States [4]. Similarly, indigenous peoples in Australia and New Zealand are less likely to undergo renal transplantation and have higher posttransplant mortality rates compared with nonindigenous populations [11, 12].

ADDRESSING THE RACIAL DISPARITIES IN CKD

Innovative initiatives are required that will target individuals at greatest risk of CKD to ensure they receive appropriate and timely intervention to slow or eliminate progression to ESRD. These initiatives may help reduce the dramatic racial disparities in ESRD. A recent analysis by Rodriguez and colleagues noted significant differences in serum creatinine values across three Latino subgroups, Mexican Americans, mainland Puerto Ricans, and Cuban Americans. Indeed, Puerto Ricans (odds ratio 1.74) and Cuban Americans (odds ratio 4.59) were significantly more likely than Mexican Americans to have an estimated GFR <60 mL/min/1.73 m^2, highlighting the need for additional studies to assess renal function and CKD among Latino subgroups to better understand which populations are truly at increased risk [102].

Screening programs to identify individuals at risk of CKD and provide early treatment and advice would likely help reduce the number of ESRD cases. Such an approach is particularly pertinent where diet, nonadherence

to pharmacologic treatment, and other modifiable factors play a role. Access to healthcare and timely referral to a nephrologist for those with a low socioeconomic status would be improved by increased funding for publicly available health care for CKD. Unfortunately, the shortage in the nephrology workforce and the growing ESRD population, which will be sustained by the aging United States population, contribute to the limitations in providing optimal early CKD care [103]. This situation needs to be addressed through enhanced CKD education for primary care providers with the strategic integration of consultative services and a collaborative patient centered approach.

Education directed toward patients and physicians is important for overcoming the many cultural differences in health beliefs and behaviors that contribute to both the risk and progression of CKD. Adherence to referral and treatment for CKD may be improved when patients feel they receive health recommendations in a respectful and culturally considerate manner. Increasing the number of minority physicians practicing within their own communities may further help reduce some of these cultural barriers.

Physician education is also required to improve patient access to transplantation. The critical reexamination and updating of transplant allocation policies may reduce the racial imbalance currently seen in transplant allocation. In addition, the administration of newer, more powerful immunosuppressive agents reduces the concerns of suboptimal graft survival among minorities. Identifying and understanding the psychosocial barriers to the access of renal transplantation and how they affect specific steps within the transplant process should help to improve transplantation rates for minorities. It is also especially important to increase patient education regarding transplantation and reinforce the need for increased kidney donation from cadaveric and living donors within minority communities.

To address the educational deficit that exists with regard to kidney diseases, the National Institute of Diabetes Digestive and Kidney Diseases has recently launched the National Kidney Disease Education Program [104]. The first priority for outreach efforts is among African American communities. Pilot studies involving African American adults and primary care providers were conducted in four communities in the United States (Atlanta, Baltimore, Cleveland, and Jackson). This education program aims to raise awareness of the risk factors and seriousness of CKD, the importance of testing those at high risk, and the availability of treatment to prevent or slow kidney failure. It also aims to increase access to kidney disease information and educational materials. In conjunction with the pilot program, a random phone survey was carried out in 2017 African Americans aged 30 years and older in seven urban areas to assess their awareness of CKD. Although 90% of the respondents had heard of CKD and 67% knew someone with ESRD, only 8% identified CKD as a negative health outcome of unchecked hypertension, and only 17% identified it as a negative health outcome of unchecked diabetes. This survey showed that in the African American community awareness of CKD is high but knowledge of the magnitude of the illness, its lack of symptoms, its predisposing risk factors, and strategies for prevention and treatment are very low [abstract F-PO1031; Hostetter T, et al, *J Am Soc Nephrol* 14:289A, 2003]. The findings of this study are being used to develop and implement the national "You Have the Power to Prevent Kidney Disease" campaign. These and similar educational efforts also support the development and validation of emerging CKD therapies by improving the likelihood of minority recruitment into clinical trials.

CONCLUSION

The racial/ethnic disparities in the incidence, prevalence, and treatment of ESRD are well documented and vary between different minority groups. Despite the progress made, the causes of CKD and the racial/ethnic disparities therein, are not fully understood. Although modifiable risk factors, such as diet, access to medical care and socioeconomic status contribute to a large proportion of ESRD cases, many risk factors, including emerging biomarkers, remain to be discovered. Additional factors, such as suboptimal diabetes management, inadequate blood pressure control, and underutilization of RAAS inhibitors among minorities, may also contribute to increased rates of CKD progression to ESRD. Further medical research to better understand the multiple factors contributing to CKD disparities, such as barriers to transplantation and mechanisms of increased hemodialysis survival among minorities, will benefit clinical outcomes not only for minority patients, but for all patients with kidney disease. However, to improve the care of disenfranchised communities globally, simultaneous efforts to address lingering social injustices and institutional forms of racism that perpetuate limited educational opportunities, socioeconomic imbalances, and limited access to healthcare are needed to ensure the contributions of advancing medical care will have a clinically relevant impact on improving patient outcomes.

ACKNOWLEDGMENTS

Dr. Norris is supported in part by NIH grants MD00182, RR11145 and RR019234. The authors would like to acknowledge the editorial support of Thomson Gardiner-Caldwell London in the preparation of this manuscript.

Reprint requests to Professor Keith C. Norris, M.D., Department of Medicine, Charles R. Drew University, Hawkins Building, Room 3080, 1731 East 120th Street, Los Angeles, CA 90059.
E-mail: knorris@ucla.edu

REFERENCES

1. Gilbertson D, Solid C, Xue JL, *et al*: *Projecting the U.S. ESRD Population to 2030*, Bethesda, MD, United States Renal Data System, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2003 (*http://www.usrds.org/2003/pres/html/5U_ASN_projections_files/v3_document.htm*)
2. National Kidney Foundation - K/DOQI: Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification and Stratification. *Am J Kidney Dis* 39:S1–S266, 2002
3. Ploth DW, Shepp PH, Counts C, *et al*: Prospective analysis of global costs for maintenance of patients with ESRD. *Am J Kidney Dis* 42:12–21, 2003
4. United States Renal Data System: *USRDS 2003 Annual Data Report: Atlas of End-Stage Renal Disease in the United States*, Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2003
5. Trivedi HS, Pang MM, Campbell A, *et al*: Slowing the progression of chronic renal failure: Economic benefits and patients' perspectives. *Am J Kidney Dis* 39:721–729, 2002
6. Easterling RE: Racial factors in the incidence and causation of end-stage renal disease (ESRD). *Trans Am Soc Artif Intern Organs* 23:28–33, 1977
7. Rostand SG, Kirk KA, Rutsky EA, *et al*: Racial differences in the incidence of treatment for end-stage renal disease. *N Engl J Med* 306:1276–1279, 1982
8. Ferguson R, Grim CE, Opgenorth TJ: The epidemiology of end-stage renal disease: The six-year South-Central Los Angeles experience, 1980–85. *Am J Public Health* 77:864–865, 1987
9. Jones CA, McQuillan GM, Kusek JW, *et al*: Serum creatinine levels in the US population: Third National Health and Nutrition Examination Survey [published erratum appears in *Am J Kidney Dis* 35:178, 2000]. *Am J Kidney Dis* 32:992–999, 1998
10. UK Renal Registry: The Fifth Annual Report of The UK Renal Registry 2002 (*http://www.renalreg.com/home.htm*) (accessed June 11, 2003)
11. McDonald SP, Russ GR, Kerr PG, *et al*: ESRD in Australia and New Zealand at the end of the millennium: A report from the ANZDATA registry. *Am J Kidney Dis* 40:1122–1131, 2002
12. McDonald SP, Russ GR: Current incidence, treatment patterns and outcome of end-stage renal disease among indigenous groups in Australia and New Zealand. *Nephrology* 8:42, 2003
13. Xue JL, Ma JZ, Louis TA, *et al*: Forecast of the number of patients with end-stage renal disease in the United States to the year 2010. *J Am Soc Nephrol* 12:2753–2758, 2001
14. Reddan DN, Szczech LA, Klassen PS, *et al*: Racial inequity in America's ESRD program. *Semin Dial* 13:399–403, 2000
15. National Institutes of Health: *Chronic Kidney Disease*, 2nd ed., 2001 (*http://www.healthypeople.gov*) (accessed October 2003)
16. Powe NR: To have and have not: Health and health care disparities in chronic kidney disease. *Kidney Int* 64:763–772, 2003
17. Nicholas S, Agodoa LY, Norris K: Ethnic disparities in the prevalence and treatment of kidney disease. *Nephrol News Issues* 18:29–30, 32, 34, 2004
18. Harris MI, Flegal KM, Cowie CC, *et al*: Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988-1994. *Diabetes Care* 21:518–524, 1998
19. King H, Aubert RE, Herman WH: Global burden of diabetes, 1995-2025: Prevalence, numerical estimates, and projections. *Diabetes Care* 21:1414–1431, 1998
20. Ritz E, Orth SR: Nephropathy in patients with type 2 diabetes mellitus. *N Engl J Med* 341:1127–1133, 1999
21. Thaler LM, El-Kebbi IM, Ziemer DC, *et al*: High prevalence of albuminuria among African-Americans with short duration of diabetes. *Diabetes Care* 21:1576–1577, 1998
22. Goldschmid MG, Domin WS, Ziemer DC, *et al*: Diabetes in urban African-Americans. II. High prevalence of microalbuminuria and nephropathy in African-Americans with diabetes. *Diabetes Care* 18:955–961, 1995
23. Tanner SDM: *Selected Demographics 2000*, San Raphael, TransPacific Renal Network, 2000
24. Maskarinec G: Diabetes in Hawaii: Estimating prevalence from insurance claims data. *Am J Public Health* 87:1717–1720, 1997
25. Fujimoto W: Diabetes in Asian and Pacific Islander Americans, in *Diabetes in America*, 2nd ed., edited by Harris MI, Cowie CC, Stern MP, *et al*, Bethesda, MD, National Diabetes Data Group, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1995, pp 661–681
26. Grandinetti A, Chang HK, Mau MK, *et al*: Prevalence of glucose intolerance among Native Hawaiians in two rural communities. Native Hawaiian Health Research (NHHR) Project. *Diabetes Care* 21:549–554, 1998
27. Hawaii State Diabetes Control Program: *Adult Diabetes in Hawaii: A Surveillance Report*, Honolulu, Hawaii Department of Health, 2000
28. Chakravarthy MV, Booth FW: Eating, exercise, and "thrifty" genotypes: Connecting the dots toward an evolutionary understanding of modern chronic diseases. *J Appl Physiol* 96:3–10, 2004
29. Neel JV: Diabetes mellitus: A "thrifty" genotype rendered detrimental by "progress"? *Am J Hum Genet* 14:353–362, 1962
30. Klag MJ, Whelton PK, Randall BL, *et al*: Blood pressure and end-stage renal disease in men. *N Engl J Med* 334:13–18, 1996
31. Freedman BI, Iskandar SS, Appel RG: The link between hypertension and nephrosclerosis. *Am J Kidney Dis* 25:207–221, 1995
32. United States Renal Data System: *USRDS 2001 Annual Data Report: Atlas of End-Stage Renal Disease in the United States*, Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2001
33. Hajjar I, Kotchen TA: Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. *JAMA* 290:199–206, 2003
34. Klag MJ, Whelton PK, Randall BL, *et al*: End-stage renal disease in African-American and white men. 16-year MRFIT findings. *JAMA* 277:1293–1298, 1997
35. Coresh J, Wei GL, McQuillan G, *et al*: Prevalence of high blood pressure and elevated serum creatinine level in the United States: Findings from the third National Health and Nutrition Examination Survey (1988-1994). *Arch Intern Med* 161:1207–1216, 2001
36. Lackland DT, Egan BM, Fan ZJ, *et al*: Low birth weight contributes to the excess prevalence of end-stage renal disease in African Americans. *J Clin Hypertens (Greenwich)* 3:29–31, 2001
37. Aviv A, Hollenberg NK, Weder AB. Sodium glomerulopathy: Tubuloglomerular feedback and renal injury in African Americans. *Kidney Int* 65:361–368, 2004
38. Falkner B: Differences in blacks and whites with essential hypertension: biochemistry and endocrine. State of the art lecture. *Hypertension* 15:681–686, 1990
39. Stengel B, Tarver-Carr ME, Powe NR, *et al*: Lifestyle factors, obesity and the risk of chronic kidney disease. *Epidemiology* 14:479–487, 2003
40. American Heart Association: *Heart Disease and Stroke Statistics 2004 Update*, Dallas, TX, American Heart Association, 2003
41. Hoy WE, Hughson MD, Smith SM, *et al*: Mesangial proliferative glomerulonephritis in southwestern American Indians. *Am J Kidney Dis* 21:486–496, 1993
42. Li L: End-stage renal disease in China. *Kidney Int* 49:287–301, 1996
43. Stewart JH, McCredie MR, McDonald SP: The incidence of treated end-stage renal disease in New Zealand Maori and Pacific Island people and in Indigenous Australians. *Nephrol Dial Transplant* 19:678–685, 2004
44. D'Amico G: The commonest glomerulonephritis in the world: IgA nephropathy. *Q J Med* 64:709–727, 1987
45. Bene MC, Faure GC: Mesangial IgA in IgA nephropathy arises from the mucosa. *Am J Kidney Dis* 12:406–409, 1988
46. Cecchin E, De Marchi S: Alcohol misuse and renal damage. *Addict Biol* 1:7–17, 1996
47. Amore A, Coppo R, Roccatello D, *et al*: Experimental IgA nephropathy secondary to hepatocellular injury induced by dietary deficiencies and heavy alcohol intake. *Lab Invest* 70:68–77, 1994

48. Wang NS, Wu ZL, Zhang YE, *et al*: Role of hepatitis B virus infection in pathogenesis of IgA nephropathy. *World J Gastroenterol* 9:2004–2008, 2003
49. Cunningham C, Stanley F: Indigenous by definition, experience, or world view. *BMJ* 327:403–404, 2003
50. Ferguson R, Morrissey E: Risk factors for end-stage renal disease among minorities. *Transplant Proc* 25:2415–2420, 1993
51. Krop JS, Coresh J, Chambless LE, *et al*: A community-based study of explanatory factors for the excess risk for early renal function decline in blacks vs whites with diabetes: The Atherosclerosis Risk in Communities study. *Arch Intern Med* 159:1777–1783, 1999
52. Perneger TV, Whelton PK, Klag MJ: Race and end-stage renal disease. Socioeconomic status and access to health care as mediating factors. *Arch Intern Med* 155:1201–1208, 1995
53. Hajnal ZL: The nature of concentrated urban poverty in Canada and the United States. *Can J Sociol* 20:497–528, 1995
54. The Henry J. Kaiser Family Foundation: *Key Facts Race, Ethnicity and Medical Care*, 2003
55. Staessen JA, Lauwerys RR, Buchet JP, *et al*: Impairment of renal function with increasing blood lead concentrations in the general population. The Cadmibel Study Group. *N Engl J Med* 327:151–156, 1992
56. Pirkle JL, Kaufmann RB, Brody DJ, *et al*: Exposure of the U.S. population to lead, 1991–1994. *Environ Health Perspect* 106:745–750, 1998
57. Vupputuri S, He J, Muntner P, *et al*: Blood lead level is associated with elevated blood pressure in blacks. *Hypertension* 41:463–468, 2003
58. Perneger TV, Klag MJ, Whelton PK: Race and socioeconomic status in hypertension and renal disease. *Curr Opin Nephrol Hypertens* 4:235–239, 1995
59. Kasiske BL, London W, Ellison MD: Race and socioeconomic factors influencing early placement on the kidney transplant waiting list. *J Am Soc Nephrol* 9:2142–2147, 1998
60. Wolfe RA, Ashby VB, Milford EL, *et al*: Differences in access to cadaveric renal transplantation in the United States. *Am J Kidney Dis* 36:1025–1033, 2000
61. Alexander GC, Sehgal AR: Barriers to cadaveric renal transplantation among blacks, women, and the poor. *JAMA* 280:1148–1152, 1998
62. Garg PP, Diener-West M, Powe NR: Income-based disparities in outcomes for patients with chronic kidney disease. *Semin Nephrol* 21:377–385, 2001
63. Port FK, Wolfe RA, Levin NW, *et al*: Income and survival in chronic dialysis patients. *ASAIO Trans* 36:M154–M157, 1990
64. Kausz AT, Obrador GT, Arora P, *et al*: Late initiation of dialysis among women and ethnic minorities in the United States. *J Am Soc Nephrol* 11:2351–2357, 2000
65. Eadington DW: Delayed referral for dialysis. *Nephrol Dial Transplant* 11:2124–2126, 1996
66. Ifudu O, Dawood M, Iofel Y, *et al*: Delayed referral of black, Hispanic, and older patients with chronic renal failure. *Am J Kidney Dis* 33:728–733, 1999
67. Freeman HE, Corey CR: Insurance status and access to health services among poor persons. *Health Serv Res* 28:531–541, 1993
68. Mort EA, Edwards JN, Emmons DW, *et al*: Physician response to patient insurance status in ambulatory care clinical decision-making. Implications for quality of care. *Med Care* 34:783–797, 1996
69. Horner RD, Oddone EZ, Matchar DB: Theories explaining racial differences in the utilization of diagnostic and therapeutic procedures for cerebrovascular disease. *Milbank Q* 73:443–462, 1995
70. Powe NR, Tarver-Carr ME, Eberhardt MS, *et al*: Receipt of renal replacement therapy in the United States: A population-based study of sociodemographic disparities from the second national health and nutrition examination survey (NHANES II). *Am J Kidney Dis* 42:249–255, 2003
71. Cross T, Bazron B, Dennis K, *et al*: *Towards a Culturally Competent System of Care* (vol 1), Washington, Georgetown University Child Development Center, CASSP, Technical Assistance Center, 1989
72. Pukui MK, Haertig EW, Lee CA: *Nana I Ke Kumu (Look to the Source)* (vol II), Honolulu, Hui Hanai, 1979
73. Tanabe MKG. *Cross-Cultural Caring: A Handbook for Health-Care Professionals in Hawaii*, Honolulu, Transcultural Health Care Forum, John A. Burns School of Medicine, University of Hawaii, 1980
74. Boulware LE, Ratner LE, Sosa JA, *et al*: Determinants of willingness to donate living related and cadaveric organs: identifying opportunities for intervention. *Transplantation* 73:1683–1691, 2002
75. Danielson BL, LaPree AJ, Odland MD, *et al*: Attitudes and beliefs concerning organ donation among Native Americans in the upper Midwest. *J Transpl Coord* 8:153–156, 1998
76. Callender CO, Bey AS, Miles PV, *et al*: A national minority organ/tissue transplant education program: The first step in the evolution of a national minority strategy and minority transplant equity in the USA. *Transplant Proc* 27:1441–1443, 1995
77. Boulware LE, Ratner LE, Cooper LA, *et al*: Understanding disparities in donor behavior: Race and gender differences in willingness to donate blood and cadaveric organs. *Med Care* 40:85–95, 2002
78. Lewis EJ, Hunsicker LG, Bain RP, *et al*: The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy. The Collaborative Study Group. *N Engl J Med* 329:1456–1462, 1993
79. Randomised placebo-controlled trial of effect of ramipril on decline in glomerular filtration rate and risk of terminal renal failure in proteinuric, non-diabetic nephropathy. The GISEN Group (Gruppo Italiano di Studi Epidemiologici in Nefrologia). *Lancet* 349:1857–1863, 1997
80. Exner DV, Dries DL, Domanski MJ, *et al*: Lesser response to angiotensin-converting-enzyme inhibitor therapy in black as compared with white patients with left ventricular dysfunction. *N Engl J Med* 344:1351–1357, 2001
81. Carson P, Ziesche S, Johnson G, *et al*: Racial differences in response to therapy for heart failure: Analysis of the vasodilator-heart failure trials. Vasodilator-Heart Failure Trial Study Group. *J Card Fail* 5:178–187, 1999
82. Wright JTJ, Bakris G, Greene T, *et al*: Effect of blood pressure lowering and antihypertensive drug class on progression of hypertensive kidney disease: Results from the AASK trial. *JAMA* 288:2421–2431, 2002
83. Gibbs CR, Lip GY, Beevers DG: Angioedema due to ACE inhibitors: Increased risk in patients of African origin. *Br J Clin Pharmacol* 48:861–865, 1999
84. Lewis EJ, Hunsicker LG, Clarke WR, *et al*: Renoprotective effect of the angiotensin-receptor antagonist irbesartan in patients with nephropathy due to type 2 diabetes. *N Engl J Med* 345:851–860, 2001
85. Brenner BM, Cooper ME, de Zeeuw D, *et al*: Effects of losartan on renal and cardiovascular outcomes in patients with type 2 diabetes and nephropathy. *N Engl J Med* 345:861–869, 2001
86. Astor BC, Eustace JA, Powe NR, *et al*: Timing of nephrologist referral and arteriovenous access use: the CHOICE Study. *Am J Kidney Dis* 38:494–501, 2001
87. Owen WF, Jr., Chertow GM, Lazarus JM, *et al*: Dose of hemodialysis and survival: Differences by race and sex. *JAMA* 280:1764–1768, 1998
88. Health Care Financing Administration: *1998 Annual Report: End-Stage Renal Disease Core Indicators Project*, Baltimore, MD, Department of Health and Human Services, Health Care Financing Administration, Office of Clinical Standards and Quality, 1998
89. Gaylin DS, Held PJ, Port FK, *et al*: The impact of comorbid and sociodemographic factors on access to renal transplantation. *JAMA* 269:603–608, 1993
90. Epstein AM, Ayanian JZ, Keogh JH, *et al*: Racial disparities in access to renal transplantation–clinically appropriate or due to underuse or overuse? *N Engl J Med* 343:1537–1544, 2000
91. Narva A, Stiles S, Karp S, *et al*: Access of Native Americans to renal transplantation in Arizona and New Mexico. *Blood Purif* 14:293–304, 1996
92. Ayanian JZ, Cleary PD, Weissman JS, *et al*: The effect of patients' preferences on racial differences in access to renal transplantation. *N Engl J Med* 341:1661–1669, 1999

93. Ayanian JZ, Cleary PD, Keogh JH, *et al*: Physicians' beliefs about racial differences in referral for renal transplantation. *Am J Kidney Dis* 43:350–357, 2004
94. Institute of Medicine: *Unequal Treatment: What Healthcare Providers Need to Know About Racial and Ethnic Disparities in Healthcare*, Washington, DC, National Academy of Sciences, March 2002
95. Roberts JP, Wolfe RA, Bragg-Gresham JL, *et al*: Effect of changing the priority for HLA matching on the rates and outcomes of kidney transplantation in minority groups. *N Engl J Med* 350:545–551, 2004
96. Opelz G, Wujciak T, Dohler B, *et al*: HLA compatibility and organ transplant survival. Collaborative Transplant Study. *Rev Immunogenet* 1:334–342, 1999
97. Wolfe RA, Ashby VB, Milford EL, *et al*: Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med* 341:1725–1730, 1999
98. Isaacs RB, Nock SL, Spencer CE, *et al*: Racial disparities in renal transplant outcomes. *Am J Kidney Dis* 34:706–712, 1999
99. Opelz G, Wujciak T, Schwarz V, *et al*: Collaborative transplant study analysis of graft survival in blacks. *Transplant Proc* 25:2443–2445, 1993
100. Hardinger KL, Stratta RJ, Egidi MF, *et al*: Renal allograft outcomes in African American versus Caucasian transplant recipients in the tacrolimus era. *Surgery* 130:738–745; discussion 745–737, 2001
101. Meier-Kriesche HU, Ojo AO, Leichtman AB, *et al*: Effect of mycophenolate mofetil on long-term outcomes in African American renal transplant recipients. *J Am Soc Nephrol* 11:2366–2370, 2000
102. Rodriguez RA, Hernandez GT, O'Hare AM, *et al*: Creatinine levels among Mexican Americans, Puerto Ricans, and Cuban Americans in the Hispanic Health and Nutrition Examination Survey. *Kidney Int* 66:2368–2373, 2004
103. Neilson EG, Hull AR, Wish JB, *et al*: The Ad Hoc Committee Report on Estimating the Future Workforce and Training Requirements for Nephrology. The Ad Hoc Committee on Nephrology Manpower Needs. *J Am Soc Nephrol* 8:S1–S4, 1997
104. National Kidney Disease Education Program: A pilot site initiative for African Americans fact sheet (*http://www.nkdep.nih.gov/pdf_ppt/nkdep_initiative.pdf*) (accessed March 2004)