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Disparities in Kidney Transplant Outcomes: A Review

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Abstract

Sociocultural and socioeconomic disparities in graft survival, graft function, and patient survival in adult kidney transplant recipients are reviewed. Studies consistently document worse outcomes for black patients, patients with low income, and less education, whereas better outcomes are reported in Hispanic and Asian kidney transplant recipients. However, the distinct roles of racial/ethnic versus socioeconomic factors remain unclear. Attention to potential pathways contributing to disparities has been limited to immunological and nonimmunological factors, for which the mechanisms have yet to be fully illuminated. Interventions to reduce disparities have focused on modifying immunosuppressant regimens. Modifying access to care and health care funding policies for immunosuppressive medication coverage are also discussed. The implementation of culturally sensitive approaches to the care of transplant candidates and recipients is promising. Future research is needed to examine the mechanisms contributing to disparities in graft survival and to ultimately intervene effectively.

Keywords

Kidney transplantation; socioeconomic status; race/ethnicity; disparities; graft survival; patient survival; outcomes

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I. INTRODUCTION

Problem of Disparities in Kidney Transplant Outcomes

Kidney graft loss in the first 10 years following transplantation is a significant problem despite scientific advances in treating acute and chronic rejection. While short-term acute rejection has reached encouraging levels with 1-year survival rates surpassing 91%, long-term graft survival remains much lower.¹ Kidney transplantation is the treatment of choice for transplant-eligible patients with end-stage renal disease (ESRD) since it improves life expectancy, reduces morbidity, offers better quality of life,^{2, 3} and is more cost-effective than dialysis.⁴

The presence of sociocultural and socioeconomic (SES) disparities in transplant outcomes compounds the problem of inadequate long-term graft survival and constitutes a public health problem.⁵ Health disparities can be defined as “potentially avoidable differences in health (or in health risks that policy can influence) between groups of people who are more or less advantaged socially; these differences systematically place socially disadvantaged groups at further disadvantage on health.”⁶ The elimination of health disparities is a national healthcare priority.^{7, 8} Disparities in transplant outcomes can threaten public trust in transplantation, and can thereby reduce the public’s willingness to donate organs, which leads to a reduced number of available organs for transplantation.⁹ The organ shortage exacerbates disparities in access to transplantation and outcomes.¹⁰ Therefore, understanding and mitigating disparities and their contributing factors is essential to improve transplant outcomes.

This paper reviews the literature on disparities and factors contributing to sociocultural and socioeconomic disparities in kidney transplant outcomes. We focus on graft survival and patient survival as the key outcome measures in kidney transplantation. We assess available interventions designed to reduce disparities, and propose future research and policy mechanisms aimed to reduce disparities. We conclude by providing clinical practice recommendations.

Our review includes empirical studies and review articles written in English examining socioeconomic disparities in adult kidney transplant outcomes published between 1993–2008. We searched PubMed and Highwire (<http://highwire.stanford.edu/>) bibliographic databases and used Google Scholar, using the following search terms: kidney transplantation, renal transplantation, ESRD, graft survival, patient survival, graft function, outcomes, disparity(ies), health disparity, socioeconomic, inequity, inequality, racial, ethnic, gender, age, education, income, insurance, finance, cost, international, cross-cultural, geographic. We searched the reference lists of included articles for additional sources. We focus our review on studies conducted in the United States (U.S.) due to unique historical, cultural, economic, and policy contexts occurring in the U.S.

Disparities in Transplant Outcomes

The kidney transplant literature documents extensive sociocultural (racial/ethnic, gender, age, educational); socioeconomic (income, insurance); and geographic disparities in transplant outcomes. Most research concentrates on disparities by ethnic/racial groups, and focuses heavily on comparing non-Hispanic whites to blacks rather than comparing them to Hispanics and Asians or others. A pervasive assumption in the kidney transplant literature on disparities is the putative biological basis of ‘race,’ which has no genetic basis.¹¹ Despite this limitation, our review uses the terms ‘black,’ and ‘white’ recognizing that race is largely a social construct, and that each group overlaps with diverse ethnic backgrounds.

Repeatedly, studies demonstrate worse graft function and shorter graft survival in black kidney transplant recipients^{12–15} (see Table 1). For example, the half-lives of the transplanted kidney for deceased donor kidneys in black and white recipients are 8 years and 14 years, respectively.

16, 17 Blacks are also found to have higher rates of chronic allograft nephropathy compared to whites and other ethnic/racial groups. For instance, the mean time to chronic allograft nephropathy was shorter in black recipients than in white patients (18 vs. 37 months), although the incidence of chronic allograft nephropathy was comparable.¹⁸

Older studies reveal higher rates of graft survival among Hispanics and Asians than among whites, albeit with some inconsistency.^{19–21} While one older study concluded that blacks and Hispanics were independent predictors of graft failure compared to whites,²² other studies have reported equivalent renal graft survival and mortality rates between Hispanics and whites,^{19, 23, 24} and more recent studies demonstrate better patient and graft survival among Hispanics^{16, 25, 26} and Asians than whites.¹⁹ Non-black patients experience better patient survival than blacks.^{3, 5, 27} (Table 1).

Less research has examined disparities in transplant outcomes by other sociodemographic variables. Worse *graft survival* has been associated with patients who are male, age over 61,^{3, 16} being single (unmarried) patients,²⁹ have less education,^{30–33} and being unemployed.³⁴ Worse *patient survival* has been associated with older age,³⁵ less education,³³ unemployment,³⁴ and being female.³⁵

Kidney transplant outcomes correlate with income and insurance coverage. Graft survival is lower in patients with: lower income,³² less insurance coverage,³¹ or Medicare or Medicaid versus private insurance.^{33, 36} Recent research found that the duration of Medicare's coverage of immunosuppression affects graft survival differently by income level.³⁷ Yet income-related disparities in graft survival were eliminated among patients who received lifetime Medicare coverage based on age >65 years or disability.³⁷

Because race/ethnicity and SES are interrelated, it is difficult to determine their individual effects on graft survival. This has yet to be empirically determined.³⁸ When controlling for SES, race/ethnicity remains a significant factor affecting graft survival.^{22, 31, 39} Race and ethnicity clearly affect outcomes for blacks, however, outcomes by race/ethnicity can differ by SES. In contrast, when controlling for race/ethnicity, SES appears to be a more prominent factor affecting graft outcome.^{12, 40, 41}

Disparities in transplant outcomes also occur by geography. Specifically, a lower incidence of graft survival was found among kidney recipients living in the poorest compared to the richest areas,²² and living further from the closest transplant center,⁴² however, no significant difference in graft survival was found between rural and urban residents.⁴³

II. MECHANISMS CONTRIBUTING TO DISPARITIES

The causes of sociocultural and socioeconomic disparities in graft survival remain unclear. Relatively little research has focused on understanding the factors contributing to disparities and on reducing disparities in transplant outcomes.^{13, 44} The mechanisms contributing to sociocultural and sociodemographic disparities in graft outcomes are likely multifactorial,⁴⁵ and can be categorized into two groups: immunological factors and non-immunological factors. While immunological factors seem to play a greater role in early graft loss, nonimmunological factors seem to be more important in the development of allograft loss after 1 year.^{12, 38, 46}

Immunological Risk Factors

Racial differences in transplant outcomes have been attributed to biological, immune, genetic, metabolic and pharmacologic factors. Most of these biological reasons have been described in blacks and few focus on Hispanics. Higher immunological risk factors for blacks have been explained by greater variation in human leukocyte antigen polymorphisms,^{15, 47, 48} stronger

immune response,⁴⁷ requiring higher doses of immunosuppression,^{49–51} and different pharmacokinetics (absorption) of immunosuppressive drugs.^{52, 53} In Hispanic patients, 1-year graft survival was not affected by broad sensitization compared with blacks.⁵⁴ Additionally, it appears that Hispanics and Asians require less immunosuppression than whites.^{55, 56}

Non-immunological Risk Factors

Nonimmunologic factors identified to date include comorbidities, time on dialysis, donor characteristics, organ characteristics, socioeconomic status, medication adherence, access to care and health policies.^{5, 40, 57} Racial/ethnic groups have more comorbidities than whites;^{58, 59} and patients with comorbidities have an increased risk for all-cause mortality.³⁵ Compared to whites, blacks, Hispanics, and other ethnic/racial groups experience greater delays in referral to transplant centers, longer waiting times for transplantation, longer time on dialysis prior to transplantation, less frequent preemptive transplants, and are less likely to be transplanted.^{5, 60, 61} All of these factors are associated with adverse transplant outcomes.^{5, 14, 61}

With regard to donor characteristics, studies suggest that male recipients of male donor kidneys have better graft survival,⁶² and kidney recipients of black deceased donors have worse graft survival.⁶³

With regard to organ characteristics, blacks receive proportionately more deceased versus live donor kidneys,⁶⁴ and more expanded criteria donor than standard criteria donor kidneys;⁶⁵ both factors are associated with worse graft survival.⁶⁵

Blacks and Hispanics have been reported to be less adherent than whites^{12, 66–68} which is associated with lower graft survival.^{20, 46, 69} Yet other studies could not demonstrate this relationship after controlling for SES.^{68,70, 71} As the data are limited, the relationship between race, SES, adherence, and graft survival remains inconclusive.^{72,73}

Health policies on financing immunosuppression also serve as a mechanism contributing to disparities in graft survival in the U.S. and abroad, but they are minimally examined. Woodward's studies documented the disproportionately beneficial impact on low income groups of extending Medicare's coverage from 1 to 3 years in the U.S.^{37, 74} Yen and colleagues estimated that lifetime immunosuppressant coverage would improve graft survival in the fourth year post-transplant.⁷⁵

Health policies relating to the financing of transplantation vary by country.⁷⁶ A comparative study of healthcare systems and kidney transplant outcomes found that industrialized nations differ in the percentage of patients with functioning renal transplants according to the type of healthcare system.⁷⁷ Developing countries have especially poor outcomes compared to developed countries due to: 1) low priority placed on renal replacement therapy in two-tiered healthcare systems,⁷⁸ 2) shortages of nephrologists and transplant centers,⁷⁸ 3) absence of state-funded programs for renal replacement therapy or health insurance,^{78, 79} 4) discontinuing immunosuppression due to high costs,^{78, 80} 5) absence of cadaveric donation programs,⁷⁸ 6) lax selection criteria for recipients and donors, high rates of infection, and cardiovascular complications,⁸¹ and 8) lack of a national organized organ sharing network due to poor infrastructure.⁸⁰

III. INTERVENTIONS TO REDUCE DISPARITIES

Interventions

Inadequate attention has focused on reducing disparities in transplant outcomes. One intervention devised to reduce racial/ethnic disparities in transplant outcomes is to modify

immunosuppression regimens for different racial groups.⁴⁹ Close monitoring of the cyclosporine levels can narrow the disparity gap for blacks.⁸² However, it is unknown if adequate immunosuppression levels affect racial outcomes long-term.

Another intervention entails implementing a culturally sensitive approach through a comprehensive transplant program. Providing care that considers patients' and families' cultural beliefs, values, and social context is associated with a reduction in disparities in outcomes among Hispanics.⁸³

In an effort to reduce global disparities in transplantation, the Transplant Society established the Global Alliance for Transplantation in 2002, and instituted three programs.⁸⁴ The programs entail collecting global information, education, and developing professional guidelines for organ donation and transplantation.⁸⁴ The effects of these programs have yet to be assessed, however, promoting professional guidelines for transplantation is likely to improve outcomes. In addition, policy efforts to remove financial disincentives for donation may reduce disparities particularly among ethnic/racial groups.

Several factors may contribute to the paucity of interventions. First, the underlying mechanisms driving the disparities remain unclear. Second, the measurement of racial/ethnic groups remains difficult because race and ethnicity are commonly erroneously conflated in the transplant literature and refer to putatively biological or cultural concepts, respectively.¹¹ Third, recruiting a sufficiently large cohort of patients from diverse ethnic/racial backgrounds can be challenging due to their relatively smaller representation in the general public, albeit larger representation in the ESRD population. Fourth, interventions would need to address the difficulties in accessing and utilizing the healthcare system relating to language barriers, low rates of medical insurance coverage, low incomes, and limited knowledge of health services. Such interventions require a multi-level approach, i.e., recognizing cultural differences and tailoring patient care to the needs of individual patients, which has not been done in a systematic way.

Future research

Future research on disparities in transplant outcomes should be guided by the Agency for Healthcare Research and Quality's broader conceptualization of disparities, which accounts for population-based and health services-based factors as determinants of health disparities.⁸⁵ Population-based determinants include: health literacy, perceived racial discrimination, residential segregation, and acculturation. Health services-based determinants include: health beliefs, preferences, and behaviors.^{86, 87} This conceptualization will enable the analysis of a broader array of factors that have been shown to contribute to disparities in other conditions.

We propose future research on four domains: patient populations, mechanisms of disparities, measurement tools, and interventions to reduce disparities. As existing research on disparities in graft outcomes has primarily focused on blacks, little is known about graft survival rates for other ethnic/racial groups. Because of the increase in prevalence in ESRD among Hispanics⁸⁸ and other racial/ethnic groups, future research is needed to examine how other groups fare. Additionally, within-group comparisons are needed to assess how cultural factors bear upon outcomes.

We propose future research into the mechanisms of disparities, including health literacy,⁸⁹ geographic differences (residential segregation),⁹¹ and perceived discrimination in access to transplantation.⁹² Research showing disparities in kidney recipients' health literacy levels, which were related to creatinine levels,⁹⁰ suggests the need for better education about transplant self-care, the benefits of transplantation versus dialysis, and the process of gaining access to transplantation.

We also propose the development of new instruments to measure different mechanisms in the kidney transplant population. Recommendations include: designing health literacy instruments specifically for kidney recipients,⁹⁰ examining in-depth biological mechanisms contributing to disparities, and understanding the effect of environment, education, poverty, and lifestyle choices.⁹³

We propose three clinical and organizational interventions that may improve graft function or survival and ameliorate disparities through different social levels. At the micro-level, we recommend devising culturally competent educational programs to enhance medication adherence,⁹⁴ increase organ donation, and increase social support for kidney recipients. At the clinical practice level, we recommend that transplant programs provide patients with assistance in finding employment,⁹⁵ which has been shown to be cost-effective;⁹⁶ and enlist clinical pharmacists to provide counseling to patients about medication therapy to enhance adherence.⁹⁷

At the meso-level, we advocate for research investigating how the Chronic Care Model of chronic illness management may affect transplant outcomes. The Chronic Care Model is known to improve patient outcomes for other chronic illnesses and contain costs.⁹⁸ Greater attention to quality care indicators in transplantation may benefit all patients.⁹⁹ Lastly, at the macro-level, we recommend extending Medicare's coverage of immunosuppressants for the life of the kidney transplant.^{10, 100}

IV. CONCLUSION

Although considerable research has identified disparities in transplant outcomes, more research is needed to better understand the range of factors contributing to disparities, the underlying mechanisms, and to devise interventions to reduce disparities. In particular, the independent and interactional roles of socioeconomic status and racial/ethnic background in graft survival remain largely unclear and merit further investigation. Further research is needed to assess the independent role of the immunological and nonimmunological factors in multivariate analyses.

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REFERENCES

1. Magee CC, Pascual M. Update in renal transplantation. *Arch Intern Med* 2004;164:1373–1388. [PubMed: 15249346]
2. Laupacis A, Keown P, Pus N, Krueger H, Ferguson B, Wong C, et al. A study of the quality of life and cost-utility of renal transplantation. *Kidney Int* 1996;50:235–242. [PubMed: 8807593]
3. Wolfe RA, Ashby VB, Milford EL, Ojo AO, Ettenger RE, Agodoa LY, 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* 1999;341:1725–1730. [PubMed: 10580071]
4. Loubeau PR, Loubeau JM, Jantzen R. The economics of kidney transplantation versus hemodialysis. *Prog Transplant* 2001;11:291–297. [PubMed: 11871278]
5. Eckhoff DE, Young CJ, Gaston RS, Fineman SW, Deierhoi MH, Foushee MT, et al. Racial disparities in renal allograft survival: a public health issue? *J Am Coll Surg* 2007;204:894–902. discussion 02–3. [PubMed: 17481506]
6. Braveman P. Health disparities and health equity: concepts and measurement. *Annu Rev Public Health* 2006;27:167–194. [PubMed: 16533114]
7. National Institutes of Health. The health of the nation: Highlights of the healthy people 2000 Goals: 1995 Report on Progress. 1995

8. Nelson A. Unequal treatment: confronting racial and ethnic disparities in health care. *J Natl Med Assoc* 2002;94:666–668. [PubMed: 12152921]
9. Siminoff LA, Burant CJ, Ibrahim SA. Racial disparities in preferences and perceptions regarding organ donation. *J Gen Intern Med* 2006;21:995–1000. [PubMed: 16918748]
10. Gordon EJ. The ethics of Medicare policy: Increasing transplant access and survival. *DePaul Law Review* 2006;101–122.
11. Gordon EJ. What "race" cannot tell us about access to kidney transplantation. *Camb Q Healthc Ethics* 2002;11:134–141. [PubMed: 11901770]
12. Butkus DE, Meydrech EF, Raju SS. Racial differences in the survival of cadaveric renal allografts. Overriding effects of HLA matching and socioeconomic factors. *N Engl J Med* 1992;327:840–845. [PubMed: 1508243]
13. Isaacs RB, Nock SL, Spencer CE, Connors AF Jr, Wang XQ, Sawyer R, et al. Racial disparities in renal transplant outcomes. *Am J Kidney Dis* 1999;34:706–712. [PubMed: 10516353]
14. Meier-Kriesche HU, Ojo A, Magee JC, Cibrik DM, Hanson JA, Leichtman AB, et al. African-American renal transplant recipients experience decreased risk of death due to infection: possible implications for immunosuppressive strategies. *Transplantation* 2000;70:375–379. [PubMed: 10933166]
15. Opelz G, Pfarr E, Engelmann A, Keppel E. Kidney graft survival rates in black cyclosporine-treated recipients. Collaborative Transplant Study. *Transplant Proc* 1989;21:3918–3920. [PubMed: 2692250]
16. Gjertson DW. Determinants of long-term survival of adult kidney transplants: a 1999 UNOS update. *Clin Transpl* 1999;341–352. [PubMed: 11038653]
17. Hariharan S, Johnson CP, Bresnahan BA, Taranto SE, McIntosh MJ, Stablein D. Improved graft survival after renal transplantation in the United States, 1988 to 1996. *N Engl J Med* 2000;342:605–612. [PubMed: 10699159]
18. Hardinger KL, Stratta RJ, Egidi MF, Alloway RR, Shokouh-Amiri MH, Gaber LW, et al. Renal allograft outcomes in African American versus Caucasian transplant recipients in the tacrolimus era. *Surgery* 2001;130:738–745. discussion 45-7. [PubMed: 11602906]
19. Katznelson S, Gjertson DW, Cecka JM. The effect of race and ethnicity on kidney allograft outcome. *Clin Transpl* 1995;379–394. [PubMed: 8794281]
20. Saunders PH, Banowsky LH, Reichert DF. Survival of cadaveric renal allografts in Hispanic as compared with Caucasian recipients. *Transplantation* 1984;37:359–362. [PubMed: 6369665]
21. Chertow GM, Milford EL. Poorer graft survival in African-American transplant recipients cannot be explained by HLA mismatching. *Adv Ren Replace Ther* 1997;4:40–45. [PubMed: 8996619]
22. Press R, Carrasquillo O, Nickolas T, Radhakrishnan J, Shea S, Barr RG. Race/ethnicity, poverty status, and renal transplant outcomes. *Transplantation* 2005;80:917–924. [PubMed: 16249739]
23. Milgrom M, Gharagozloo H, Gomez C, Contreras N, Lopez E, Esquenazi V, et al. Results of renal transplantation in Miami analyzed by race. *Transplant Proc* 1989;21:3934–3936. [PubMed: 2609409]
24. Kasiske BL, Cohen D, Lucey MR, Neylan JF. Payment for immunosuppression after organ transplantation. American Society of Transplantation. *JAMA* 2000;283:2445–2450. [PubMed: 10815094]
25. Gjertson DW. A multi-factor analysis of kidney graft outcomes at one and five years posttransplantation: 1996 UNOS Update. *Clin Transpl* 1996;343–360. [PubMed: 9286581]
26. Caicedo JC, Butt Z, Halgrimson W, Preczewski L, Daud A. Outcomes after kidney transplantation in Hispanics. *American Journal of Transplantation* 2008;8:626.
27. Ojo AO, Hanson JA, Wolfe RA, Leichtman AB, Agodoa LY, Port FK. Long-term survival in renal transplant recipients with graft function. *Kidney Int* 2000;57:307–313. [PubMed: 10620213]
28. U.S. Renal Data System. *USRDS 2007 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*, National Institutes of Health. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases; 2007.
29. Naiman N, Baird BC, Isaacs RB, Koford JK, Habib AN, Wang BJ, et al. Role of pre-transplant marital status in renal transplant outcome. *Clin Transplant* 2007;21:38–46. [PubMed: 17302590]

30. Schaeffner ES, Mehta J, Winkelmayr WC. Educational level as a determinant of access to and outcomes after kidney transplantation in the United States. *Am J Kidney Dis* 2008;51:811–818. [PubMed: 18436092]
31. Chakkera HA, O'Hare AM, Johansen KL, Hynes D, Stroupe K, Colin PM, et al. Influence of race on kidney transplant outcomes within and outside the Department of Veterans Affairs. *J Am Soc Nephrol* 2005;16:269–277. [PubMed: 15563568]
32. Kalil RS, Heim-Duthoy KL, Kasiske BL. Patients with a low income have reduced renal allograft survival. *Am J Kidney Dis* 1992;20:63–69. [PubMed: 1621680]
33. Goldfarb-Rumyantzev AS, Koford JK, Baird BC, Chelamcharla M, Habib AN, Wang BJ, et al. Role of socioeconomic status in kidney transplant outcome. *Clin J Am Soc Nephrol* 2006;1:313–322. [PubMed: 17699222]
34. Petersen E, Baird BC, Barenbaum LL, Leviatov A, Koford JK, Shihab F, et al. The impact of employment status on recipient and renal allograft survival. *Clin Transplant* 2008;22:428–438. [PubMed: 18312443]
35. Gill JS, Abichandani R, Kausz AT, Pereira BJ. Mortality after kidney transplant failure: the impact of non-immunologic factors. *Kidney Int* 2002;62:1875–1883. [PubMed: 12371992]
36. Cho YW, Terasaki PI, Cecka JM. New variables reported to the UNOS registry and their impact on cadaveric renal transplant outcomes - a preliminary study. *Clin Transpl* 1995;405–415. [PubMed: 8794283]
37. Woodward RS, Schnitzler MA, Lowell JA, Spitznagel EL, Brennan DC. Effect of extended coverage of immunosuppressive medications by medicare on the survival of cadaveric renal transplants. *Am J Transplant* 2001;1:69–73. [PubMed: 12095042]
38. Krieger NR, Becker BN, Heisey DM, Voss BJ, D'Alessandro AM, Becker YT, et al. Chronic allograft nephropathy uniformly affects recipients of cadaveric, nonidentical living-related, and living-unrelated grafts. *Transplantation* 2003;75:1677–1682. [PubMed: 12777855]
39. Butkus DE, Dottes AL, Meydrech EF, Barber WH. Effect of poverty and other socioeconomic variables on renal allograft survival. *Transplantation* 2001;72:261–266. [PubMed: 11477350]
40. Koyama H, Cecka JM, Terasaki PI. Kidney transplants in black recipients. HLA matching and other factors affecting long-term graft survival. *Transplantation* 1994;57:1064–1068. [PubMed: 8165704]
41. Yeates K, Wiebe N, Gill J, Sima C, Schaubel D, Holland D, et al. Similar outcomes among black and white renal allograft recipients. *J Am Soc Nephrol* 2009;20:172–179. [PubMed: 18971374]
42. Kasiske BL, Snyder JJ, Skeans MA, Tuomari AV, Maclean JR, Israni AK. The geography of kidney transplantation in the United States. *Am J Transplant* 2008;8:647–657. [PubMed: 18294161]
43. Axelrod DA, Guidinger MK, Finlayson S, Schaubel DE, Goodman DC, Chobanian M, et al. Rates of solid-organ wait-listing, transplantation, and survival among residents of rural and urban areas. *JAMA* 2008;299:202–207. [PubMed: 18182602]
44. Gordon EJ, Prohaska T, Siminoff LA, Minich PJ, Sehgal AR. Can focusing on self-care reduce disparities in kidney transplantation outcomes? *Am J Kidney Dis* 2005;45:935–940. [PubMed: 15861361]
45. Smith SR, Butterly DW. Declining influence of race on the outcome of living-donor renal transplantation. *Am J Transplant* 2002;2:282–286. [PubMed: 12096792]
46. Hariharan S, McBride MA, Cherikh WS, Tolleris CB, Bresnahan BA, Johnson CP. Post-transplant renal function in the first year predicts long-term kidney transplant survival. *Kidney Int* 2002;62:311–318. [PubMed: 12081593]
47. Kerman RH, Kimball PM, Van Buren CT, Lewis RM, Kahan BD. Possible contribution of pretransplant immune responder status to renal allograft survival differences of black versus white recipients. *Transplantation* 1991;51:338–342. [PubMed: 1825242]
48. Milford EL, Ratner L, Yunis E. Will transplant immunogenetics lead to better graft survival in blacks? Racial variability in the accuracy of tissue typing for organ donation: the fourth American workshop. *Transplant Proc* 1987;19:30–32. [PubMed: 3471002]
49. Neylan JF. Immunosuppressive therapy in high-risk transplant patients: dose-dependent efficacy of mycophenolate mofetil in African-American renal allograft recipients. U.S. Renal Transplant Mycophenolate Mofetil Study Group. *Transplantation* 1997;64:1277–1282. [PubMed: 9371668]

50. Neylan JF. Racial differences in renal transplantation after immunosuppression with tacrolimus versus cyclosporine. FK506 Kidney Transplant Study Group. *Transplantation* 1998;65:515–523. [PubMed: 9500626]
51. Gaston RS, Hudson SL, Deierhoi MH, Barber WH, Laskow DA, Julian BA, et al. Improved survival of primary cadaveric renal allografts in blacks with quadruple immunosuppression. *Transplantation* 1992;53:103–109. [PubMed: 1733054]
52. Lindholm A, Welsh M, Alton C, Kahan BD. Demographic factors influencing cyclosporine pharmacokinetic parameters in patients with uremia: racial differences in bioavailability. *Clin Pharmacol Ther* 1992;52:359–371. [PubMed: 1330397]
53. First MR, Schroeder TJ, Monaco AP, Simpson MA, Curtis JJ, Armenti VT. Cyclosporine bioavailability: dosing implications and impact on clinical outcomes in select transplantation subpopulations. *Clin Transplant* 1996;10:55–59. [PubMed: 8652899]
54. Koyama H, Cecka JM. Race effects. *Clin Transpl* 1991:269–280. [PubMed: 1820122]
55. Baez Y, Giron F, Nino-Murcia A, Rodriguez J, Salcedo S. Experience with Alemtuzumab (Campath-1H) as induction agent in renal transplantation followed by steroid-free immunosuppression. *Transplant Proc* 2008;40:697–699. [PubMed: 18454990]
56. Katznelson S, Cecka JM. Immunosuppressive regimens and their effects on renal allograft outcome. *Clin Transpl* 1996:361–371. [PubMed: 9286582]
57. Gordon EJ, Caicedo JC. Ethnic advantages in kidney transplant outcomes: the Hispanic Paradox at work? *Nephrol Dial Transplant*. 2008
58. Cosio FG, Dillon JJ, Falkenhain ME, Tesi RJ, Henry ML, Elkhammas EA, et al. Racial differences in renal allograft survival: the role of systemic hypertension. *Kidney Int* 1995;47:1136–1141. [PubMed: 7783411]
59. Oriol R, Le Pendu J, Chun C. Influence of the original disease, race, and center on the outcome of kidney transplantation. *Transplantation* 1982;33:22–26. [PubMed: 7039019]
60. Epstein AM, Ayanian JZ, Keogh JH, Noonan SJ, Armistead N, Cleary PD, et al. Racial disparities in access to renal transplantation--clinically appropriate or due to underuse or overuse? *N Engl J Med* 2000;343:1537–1544. 2 p preceding 37. [PubMed: 11087884]
61. Kasiske BL, Snyder JJ, Matas AJ, Ellison MD, Gill JS, Kausz AT. Preemptive kidney transplantation: the advantage and the disadvantaged. *J Am Soc Nephrol* 2002;13:1358–1364. [PubMed: 11961024]
62. Kayler LK, Rasmussen CS, Dykstra DM, Ojo AO, Port FK, Wolfe RA, et al. Gender imbalance and outcomes in living donor renal transplantation in the United States. *Am J Transplant* 2003;3:452–458. [PubMed: 12694068]
63. Swanson SJ, Hypolite IO, Agodoa LY, Batty DS Jr, Hsieh PB, Cruess D, et al. Effect of donor factors on early graft survival in adult cadaveric renal transplantation. *Am J Transplant* 2002;2:68–75. [PubMed: 12095059]
64. Tankersley MR, Gaston RS, Curtis JJ, Julian BA, Deierhoi MH, Rhynes VK, et al. The living donor process in kidney transplantation: influence of race and comorbidity. *Transplant Proc* 1997;29:3722–3723. [PubMed: 9414902]
65. Chavalitdharmong D, Gill J, Takemoto S, Madhira BR, Cho YW, Shah T, et al. Patient and graft outcomes from deceased kidney donors age 70 years and older: an analysis of the Organ Procurement Transplant Network/United Network of Organ Sharing database. *Transplantation* 2008;85:1573–1579. [PubMed: 18551062]
66. Siegal B, Greenstein S. Compliance and noncompliance in kidney transplant patients: cues for transplant coordinators. *J Transpl Coord* 1999;9:104–108. [PubMed: 10703391]
67. Kiley DJ, Lam CS, Pollak R. A study of treatment compliance following kidney transplantation. *Transplantation* 1993;55:51–56. [PubMed: 8420064]
68. Rovelli M, Palmeri D, Vossler E, Bartus S, Hull D, Schweizer R. Noncompliance in renal transplant recipients: evaluation by socioeconomic groups. *Transplant Proc* 1989;21:3979–3981. [PubMed: 2609425]
69. De Geest S, Borgermans L, Gemoets H, Abraham I, Vlaminck H, Evers G, et al. Incidence, determinants, and consequences of subclinical noncompliance with immunosuppressive therapy in renal transplant recipients. *Transplantation* 1995;59:340–347. [PubMed: 7871562]

70. Didlake RH, Dreyfus K, Kerman RH, Van Buren CT, Kahan BD. Patient noncompliance: a major cause of late graft failure in cyclosporine-treated renal transplants. *Transplant Proc* 1988;20:63–69. [PubMed: 3291299]
71. Schweizer RT, Rovelli M, Palmeri D, Vossler E, Hull D, Bartus S. Noncompliance in organ transplant recipients. *Transplantation* 1990;49:374–377. [PubMed: 2305467]
72. Isaacs RB, Connors A Jr, Nock S, Spencer C, Lobo P. Noncompliance in living-related donor renal transplantation: the United Network of Organ Sharing experience. *Transplant Proc* 1999;31:19S–20S. [PubMed: 10372037]
73. Chisholm MA, Vollenweider LJ, Mulloy LL, Jagadeesan M, Wynn JJ, Rogers HE, et al. Renal transplant patient compliance with free immunosuppressive medications. *Transplantation* 2000;70:1240–1244. [PubMed: 11063348]
74. Woodward RS, Page TF, Soares R, Schnitzler MA, Lentine KL, Brennan DC. Income-related disparities in kidney transplant graft failures are eliminated by Medicare's immunosuppression coverage. *Am J Transplant* 2008;8:2636–2646. [PubMed: 19032227]
75. Yen EF, Hardinger K, Brennan DC, Woodward RS, Desai NM, Crippin JS, et al. Cost-effectiveness of extending Medicare coverage of immunosuppressive medications to the life of a kidney transplant. *Am J Transplant* 2004;4:1703–1708. [PubMed: 15367228]
76. Dor A, Pauly MV, Eichleay MA, Held PJ. End-stage renal disease and economic incentives: the International Study of Health Care Organization and Financing (ISHCOF). *Int J Health Care Finance Econ* 2007;7:73–111. [PubMed: 17653860]
77. Horl WH, de Alvaro F, Williams PF. Healthcare systems and end-stage renal disease (ESRD) therapies--an international review: access to ESRD treatments. *Nephrol Dial Transplant* 1999;(14):10–15. [PubMed: 10528707]
78. Jha V. End-stage renal care in developing countries: the India experience. *Ren Fail* 2004;26:201–208. [PubMed: 15354966]
79. Naicker S. End-stage renal disease in sub-Saharan and South Africa. *Kidney Int Suppl* 2003:S119–S122. [PubMed: 12864889]
80. Sakhuja V, Sud K. End-stage renal disease in India and Pakistan: burden of disease and management issues. *Kidney Int Suppl* 2003:S115–S118. [PubMed: 12864888]
81. Barsoum RS. Overview: end-stage renal disease in the developing world. *Artif Organs* 2002;26:737–746. [PubMed: 12197924]
82. Emovon OE, Op't Holt C, Browne BJ. Can a pharmacokinetic approach to immunosuppression eliminate ethnic disparities in renal allograft outcome? *Clin Transplant* 2002;(16):45–48. [PubMed: 12372043]
83. Caicedo JC, Butt Z, Halgrimson W, Preczewski L, Daud A. Outcomes after kidney transplantation in Hispanics. Hispanics (Caicedo Personal Communication 11-23-08) edn. *American Journal of Transplantation* 2008;8:626.
84. Groth CG, Chapman JR. The global alliance for transplantation. *Transplant Proc* 2006;38:356–357. [PubMed: 16549119]
85. Agency for Healthcare Research and Quality. Literacy and Health Outcomes. Summary. Evidence Report/Technology Assessment, Number 87. Department of Health and Human Services 2004 January;:259. #04-E007-1.
86. Sue S, Dhindsa MK. Ethnic and racial health disparities research: issues and problems. *Health Educ Behav* 2006;33:459–469. [PubMed: 16769755]
87. Stewart AL, Napoles-Springer AM. Advancing health disparities research: can we afford to ignore measurement issues? *Med Care* 2003;41:1207–1220. [PubMed: 14583684]
88. Peralta CA, Shlipak MG, Fan D, Ordonez J, Lash JP, Chertow GM, et al. Risks for end-stage renal disease, cardiovascular events, and death in Hispanic versus non-Hispanic white adults with chronic kidney disease. *J Am Soc Nephrol* 2006;17:2892–2899. [PubMed: 16959827]
89. Saha S. Improving literacy as a means to reducing health disparities. *J Gen Intern Med* 2006;21:893–895. [PubMed: 16881955]
90. Gordon EJ, Wolf MS. Health Literacy Among Kidney Transplant Recipients. *Prog Transplant*. 2009

91. Rodriguez RA, Sen S, Mehta K, Moody-Ayers S, Bacchetti P, O'Hare AM. Geography matters: relationships among urban residential segregation, dialysis facilities, and patient outcomes. *Ann Intern Med* 2007;146:493–501. [PubMed: 17404351]
92. Klassen AC, Hall AG, Saksvig B, Curbow B, Klassen DK. Relationship between patients' perceptions of disadvantage and discrimination and listing for kidney transplantation. *Am J Public Health* 2002;92:811–817. [PubMed: 11988452]
93. Higgins RS, Fishman JA. Disparities in solid organ transplantation for ethnic minorities: facts and solutions. *Am J Transplant* 2006;6:2556–2562. [PubMed: 16952299]
94. Russell CL. Culturally responsive interventions to enhance immunosuppressive medication adherence in older African American kidney transplant recipients. *Prog Transplant* 2006;16:187–195. quiz 96. [PubMed: 17007152]
95. Carter JM, Winsett RP, Rager D, Hathaway DK. A center-based approach to a transplant employment program. *Prog Transplant* 2000;10:204–208. [PubMed: 11216176]
96. Chang CF, Winsett RP, Gaber AO, Hathaway DK. Cost-effectiveness of post-transplantation quality of life intervention among kidney recipients. *Clin Transplant* 2004;18:407–414. [PubMed: 15233818]
97. Chisholm MA, Mulloy LL, Jagadeesan M, DiPiro JT. Impact of clinical pharmacy services on renal transplant patients' compliance with immunosuppressive medications. *Clin Transplant* 2001;15:330–336. [PubMed: 11678959]
98. Bodenheimer TE, Wagner H, Grumbach K. Improving primary care for patients with chronic illness. *JAMA* 2002;288:1775–1779. [PubMed: 12365965]
99. Englesbe MJ, Pelletier SJ, Kheterpal S, O'Reilly M, Campbell DA Jr. A call for a national transplant surgical quality improvement program. *Am J Transplant* 2006;6:666–670. [PubMed: 16539622]
100. Lockridge RS Jr. The direction of end-stage renal disease reimbursement in the United States. *Semin Dial* 2004;17:125–130. [PubMed: 15043614]

Table 1

Adjusted Kidney Graft Survival Rates (%) by Ethnicity and Race at 1-year, 3-years, and 5-years, from Deceased non-Expanded Criteria Donors (DD non-ECD), Deceased Expanded Criteria Donors (DD ECD), and Living Donors (LD)²⁸

	1-Year			3-Years			5-Years		
	DD	DD	LD	DD	DD	LD	DD	DD	LD
	non-	ECD		non-	ECD		non-	ECD	
	ECD			ECD			ECD		
Hispanic	93.5	83.5	96.0	86.0	76.2	90.6	74.4	62.5	83.7
Asian	94.5	88.0	97.7	84.8	74.5	93.0	78.2	64.8	87.0
White	91.3	84.5	95.1	82.4	70.3	88.8	72.1	55.2	81.0
Black	89.6	82.7	94.0	75.4	63.0	84.4	61.7	48.6	72.2

Table x

Risk Factors for Worse Graft Function by Type of Disparities

Sociocultural	Socioeconomic	Geographic
African American	Lower Income	Living in Poor Areas
Male	Less Insurance Coverage	Living Further from Transplant Center
Older Age	Medicare or Medicaid	
Unmarried	Low Socioeconomic Status	
Less Education		
Unemployed		

Table Y**Mechanisms Contributing to Disparities**

Immunological Factors
Biology
Immunity
Genetics
Metabolism
Pharmacology
Non-Immunological Factors
Comorbidities
Time on dialysis
Donor characteristics
Organ characteristics
Recipient characteristics
Socioeconomic status
Medication adherence, self-care
Health literacy
Access to care
Health policy regarding financing transplantation