Influence of Vascular Access Type on Sex and Ethnicity-Related Mortality in Hemodialysis-Dependent Patients

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Abstract

**Objectives:** To determine whether sex- and ethnicity-based mortality differences in patients dependent on hemodialysis (hemodialysis patients) are because of prevalence of vascular access type.

**Methods:** Southern California Permanente Medical Group Renal Database, which contained 5821 chronic hemodialysis patients between 2000 and 2008, was studied.

**Results:** Mean age of the patients was 62 years, and 59% were male. Of the 64.0% of patients, 33% were white; 32%, Hispanic; 23%, African American; 9%, Asian/Pacific Islander; and 3%, other race or ethnicity. Predominant access type over the course of the study was arteriovenous fistula (AVF) in 73%, arteriovenous graft (AVG) in 12%, and tunneled catheter in 14%. There was a higher percentage of AVF in whites (71%) than in African Americans (63%). Risk of death was independently increased by age (hazard ratio [HR], 1.04; 95% confidence interval [CI], 1.04-1.05), male sex (HR, 1.33; 95% CI, 1.22-1.45), diabetes (HR, 1.22; 95% CI, 1.12-1.33), use of an AVG (HR, 1.51; 95% CI, 1.34-1.71) or a tunneled catheter (HR, 6.45; 95% CI, 5.78-7.20). Compared with whites, African-American race decreased the risk of death (HR, 0.63; 95% CI, 0.56-0.70), as did Asian/Pacific Islander (HR, 0.58; 95% CI, 0.49-0.69), Hispanic (HR, 0.58; 95% CI, 0.51-0.65), and other race (HR, 0.67; 95% CI, 0.52-0.86).

**Conclusion:** Age, sex, race or ethnicity, access type, and diabetes are independent risk factors for mortality in hemodialysis patients. After controlling for potential confounders, when compared with whites, minorities all demonstrate significantly decreased risk of mortality. African Americans had reduced mortality risk despite a lower prevalence of arteriovenous fistula compared with whites. Male sex increased mortality. Differences in mortality between sexes and ethnicities in this population cannot be accounted for by differences in type of dialysis access.

Introduction

The number of patients dependent on hemodialysis (hemodialysis patients) in the US continues to increase, with more than 360,000 individuals receiving this therapy in 2009.1 There are 3 options for hemodialysis access: arteriovenous fistula (AVF), arteriovenous graft (AVG), and tunneled hemodialysis catheter. An AVF is created by surgically connecting a vein to an artery, usually in the upper extremity, and consists of all native tissue. An AVG uses a prosthetic tube graft as the conduit between an artery and a vein, usually in the upper extremity. A tunneled catheter has exposed ports for connecting to the hemodialysis machine and is usually tunneled subcutaneously into the subclavian vein or internal jugular vein. As patient volumes have increased and additional experience has been acquired in the management of these patients, a number of factors have been identified that influence outcomes and survival in particular.

Long-term all-cause mortality in the hemodialysis population has been found to vary on the basis of sex, ethnicity, medical comorbidities, and age.5,7 Male sex, the presence of diabetes, and advanced age have all been associated with decreased survival in hemodialysis patients.7,8 Ethnic differences have also been observed, with African-American, Asian, and Hispanic...
hemodialysis patients all being shown to have a survival advantage over non-Hispanic white hemodialysis patients.\textsuperscript{2,3,5,7} The cause of these differences in mortality is unclear.

Since the early 2000s, there has also been increasing awareness of the impact of the type of dialysis access on morbidity and survival in the dialysis population. Variability in access patency, infection rates, and mortality among types of hemodialysis accesses is well established, with AVF being superior to AVG in all three of these outcome measures and tunneled catheter being the most inferior.\textsuperscript{8,13} The National Kidney Foundation Kidney Disease Outcome Quality Initiative guidelines and the Fistula First Breakthrough Initiative are a result of these observations.\textsuperscript{14-16} Although data are limited in this area, it seems unlikely that variability in outcomes of type of access explains the mortality differences seen between different ethnic groups because African-American hemodialysis patients have been found to have a lower prevalence of AVF than do non-Hispanic white hemodialysis patients.\textsuperscript{17,18} Whether this difference in prevalence is related to biologic, socioeconomic, or other factors is not known.

Outcomes of various procedures in other areas of vascular surgery, including endovascular abdominal aortic aneurysm repair and lower extremity revascularization, have been shown to vary on the basis of ethnicity and sex.\textsuperscript{19,22} These associations are not well defined in the area of dialysis access surgery. Thus, the purpose of this study was to examine the relationships between mortality, vascular access type, sex, and ethnicity in a large health maintenance organization’s dialysis population. The Kaiser Permanente (KP) Southern California (KPSC) patient population is ideally suited for this analysis because of its large size, heterogeneous patient population, relatively standard practice patterns, and low patient turnover. Additionally, the Kidney Disease Outcome Quality Initiative guidelines were adopted early by Kaiser Permanente, and there is a very high prevalence of AVF throughout our hemodialysis patient population. Thus, the impact on mortality in a population where autogenous fistula prevalence exceeds the goal of the Fistula First Initiative can be fully assessed.

**Methods**

A retrospective review of the prospectively recorded Southern California Permanente Medical Group Renal Database was performed from January 2000 through July 2009. All new hemodialysis patients, with no prior dialysis history, who were enrolled in the Renal Program from January 2000 through December 2008 were included. All causes of renal failure were included. Patients were excluded who changed from hemodialysis to peritoneal dialysis, underwent transplantation before January 2000, no longer required dialysis during the study period, and/or had missing data points.

The primary outcome measure was mortality. Follow-up began on the date of first hemodialysis and ended with any mortality or a censoring event (renal transplant during the study period, expiration of Health Plan membership, relocation out of the Southern California area, or end of study period, whichever occurred first). Variables obtained from the database included age, sex, race, most frequently used access type during the follow-up period, and diabetes. Primary hemodialysis access type for each patient was defined as the hemodialysis access type that the patient used for most of the follow-up time. Geospatial Entity Object Coding (Geocoding) was used to link members’ address data to census geographic areas (block, block group, and tract). The percentage with household income $50,000 or greater and the percentage with education below 12 years was obtained through this method.

![Figure 1. Adjusted survival by ethnicity.](image)

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 9</th>
<th>Year 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>1938</td>
<td>1515</td>
<td>1001</td>
<td>656</td>
<td>386</td>
<td>218</td>
<td>108</td>
<td>44</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>African American</td>
<td>1320</td>
<td>1091</td>
<td>810</td>
<td>565</td>
<td>397</td>
<td>259</td>
<td>147</td>
<td>77</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1884</td>
<td>1581</td>
<td>1186</td>
<td>841</td>
<td>612</td>
<td>415</td>
<td>252</td>
<td>116</td>
<td>47</td>
<td>15</td>
</tr>
<tr>
<td>Asian/PI</td>
<td>511</td>
<td>413</td>
<td>306</td>
<td>222</td>
<td>152</td>
<td>97</td>
<td>60</td>
<td>38</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>168</td>
<td>140</td>
<td>101</td>
<td>79</td>
<td>48</td>
<td>33</td>
<td>18</td>
<td>9</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Survival curves were adjusted by age, gender, race/ethnicity, diabetes, percentage of years of education less than 12 years. PI = Pacific Islander.
Statistical analyses were performed using SAS Enterprise Guide 4.3, (SAS Institute Inc, Cary, NC). Summary results were presented as mean (standard deviation), median, and range for continuous variables and as frequency (percentage) for categorical variables. Univariate analysis was performed using the χ² test and the Cox proportional hazard model. Multivariate Cox proportional hazard model was applied to assess the factors independently associated with survival. The multivariate model included age, sex, race or ethnicity, vascular access type, diabetes, household income, and education. Interactions were examined between access type and all other variables in the model as well as race and all other variables in the model. Both crude and adjusted hazard ratios (HRs) were reported with 95% confidence intervals (CI). The survival curves were constructed using Kaplan-Meier estimators, and the log-rank test was performed to assess for differences. The number at risk for the survival curves is the number of patients still alive who have not been censored.

Results

During the study period, 8621 patients were in the renal database. Of these, 989 had started hemodialysis before January 2000 and were excluded. Another 918 patients were using peritoneal dialysis or were predialysis. Sixty-six were pediatric patients or in the expansion area that is no longer covered by KP. Additionally, 475 patients recovered renal function and no longer required dialysis, moved out of the Southern California area before January 2000, or had their KP Health Plan membership expire before January 2000. Finally, 352 patients had missing data on sex, race, income, and/or education. After all these patients were excluded, 5821 patients remained.

The mean age of the patients was 62. Of the 5821 patients, 59% were male and 61% were diabetic. Thirty-three percent were non-Hispanic white; 32%, Hispanic; 23%, African American; 9%, Asian/Pacific Islander; and 3%, other race.

The predominant vascular access over the course of the study was AVF in 73%, AVG in 12%, and a tunneled catheter in 15% (Table 1). The distribution of access type varied by ethnicity and sex (Table 2). Patients with an AVF used an AVF for 86% of the total follow-up time. Patients with an AVG used an AVG for 84% of the total follow-up time. Patients with a tunneled catheter used a catheter for 96% of the total follow-up time. The hemodialysis access procedures were performed at 12 KPSC Medical Centers. All access procedures were performed by vascular surgeons.

Survival for whites was significantly lower than that of the other ethnicities.
(p < 0.001; Figure 1). On the basis of vascular access type, the survival for patients who had a tunnel catheter was significantly lower than that of patients who had an AVF or an AVG (p < 0.001; Figure 2). On univariate analysis, the risk of death was increased by age (HR, 1.05; 95% CI, 1.05-1.05), use of an AVG vs AVF (HR, 1.60; 95% CI, 1.42-1.80), or use of a tunnel catheter vs AVF (HR, 6.45; 95% CI, 5.78-7.20). The annual household income did not have any influence on survival using multivariate analysis. Education less than 12 years had a small statistically significant, but not clinically significant, effect on survival. Compared with non-Hispanic whites, African-American race decreased the risk of death (HR, 0.63; 95% CI, 0.56-0.70), as did Asian/Pacific Islander race (HR, 0.49; 95% CI, 0.42-0.58), Hispanic ethnicity (HR, 0.45; 95% CI, 0.40-0.50), and other race (HR, 0.56; 95% CI, 0.42-0.72), as shown in Table 3. By multivariate analysis, the risk of death was independently increased by age (HR, 1.04; 95% CI, 1.04-1.05), male sex (HR, 1.33; 95% CI, 1.22-1.45), diabetes (HR, 1.22; 95% CI, 1.12-1.33), use of an AVG vs AVF (HR, 1.51; 95% CI, 1.34-1.71), or use of a tunnel catheter vs AVF (HR, 6.45; 95% CI, 5.78-7.20). The annual household income did not have any influence on survival using multivariate analysis. Education less than 12 years had a small statistically significant, but not clinically significant, effect on survival (Table 3). Compared with non-Hispanic whites, African-American race decreased the risk of death (HR, 0.63; 95% CI, 0.56-0.70), as did Asian/Pacific Islander race (HR, 0.58; 95% CI, 0.49-0.69), Hispanic ethnicity (HR, 0.58; 95% CI, 0.51-0.65), and other race (HR, 0.67; 95% CI, 0.52-0.86). None of the interactions examined were statistically significant.

**Discussion**

The effect of race and ethnicity on outcomes of hemodialysis access types has been poorly studied. Despite the clearly demonstrated survival benefit of minority ethnicity in hemodialysis patients, the reasons for this finding remain unknown. The present study confirms the earlier findings that minority ethnicity in hemodialysis patients confers significantly improved survival over that seen in white hemodialysis patients. Previous reports have also noted that, in particular, Hispanic hemodialysis patients have a survival advantage over non-Hispanic hemodialysis patients. Similarly, Asian hemodialysis patients have improved outcomes compared with non-Asian hemodialysis patients. A small amount of data exists with regard to the cause of these survival discrepancies. One study showed that the lower mortality in minority groups could not be explained by differences in demographic characteristics, comorbidities, or nutritional parameters such as body mass index and serum albumin. Although our study did not include body mass index or serum albumin, we did not find a clinically significant difference in survival.

**Table 3. Association between clinical characteristics and mortality: unadjusted and adjusted hazard ratios and 95% confidence intervals (CI)**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Crude hazard ratio (95% CI)</th>
<th>p value*</th>
<th>Adjusted hazard ratio (95% CI)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.051 (1.047-1.054)</td>
<td>&lt;0.0001</td>
<td>1.044 (1.041-1.048)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.057 (0.973-1.149)</td>
<td>0.1895</td>
<td>1.333 (1.223-1.453)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>0.559 (0.501-0.623)</td>
<td>&lt;0.0001</td>
<td>0.625 (0.557-0.702)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>0.489 (0.415-0.577)</td>
<td>&lt;0.0001</td>
<td>0.583 (0.494-0.689)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.447 (0.404-0.496)</td>
<td>&lt;0.0001</td>
<td>0.576 (0.514-0.646)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Other</td>
<td>0.557 (0.431-0.721)</td>
<td>&lt;0.0001</td>
<td>0.666 (0.515-0.862)</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Access type most used during follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVF</td>
<td>1.601 (1.421-1.803)</td>
<td>&lt;0.0001</td>
<td>1.514 (1.340-1.711)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>AVG</td>
<td>6.889 (6.196-7.658)</td>
<td>&lt;0.0001</td>
<td>6.448 (5.778-7.196)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TC</td>
<td>1.046 (0.962-1.137)</td>
<td>0.2965</td>
<td>1.22 (1.12-1.33)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.001 (0.999-1.004)</td>
<td>0.1662</td>
<td>1.000 (0.997-1.002)</td>
<td>0.7664</td>
</tr>
<tr>
<td>Percentage with household income ≥ $50,000</td>
<td>0.995 (0.993-0.997)</td>
<td>&lt;0.0001</td>
<td>1.004 (1.001-1.007)</td>
<td>0.0181</td>
</tr>
</tbody>
</table>

*The p values were obtained from Cox proportional hazard model.
AVF = arteriovenous fistula; AVG = arteriovenous graft; TC = tunnel catheter.
find that minority race or ethnicity was an independent predictor of improved survival compared with non-Hispanic whites when controlling for age, sex, access type, diabetes, household income of ≥$50,000, and education below 12 years. This represents a paradox because other authors have demonstrated that mortality caused by cardiovascular disease is highest in African Americans. Any explanation that has been proposed for this phenomenon is that African Americans have a higher risk of death in the early stages of chronic kidney disease, such that those who survive long enough to reach dialysis dependence are the healthiest of the group and thus have a survival advantage. Annual income and education less than 12 years did not have any influence on survival in our univariate and multivariate analyses. Other authors have also investigated socioeconomic factors as a cause for the difference in mortality among ethnic or racial groups and found that there were no mortality differences among income level groups. Abundant data exist that AVF is the most reliable and durable dialysis access method. Similarly, tunneled catheter has repeatedly been shown to result in the worst patient outcomes. Both AVG and tunneled catheter are associated with an increased risk of death in hemodialysis patients, compared with AVF. This study clearly confirms those earlier reports but is the first to examine the impact of dialysis access type on the observed mortality differences seen on the basis of sex and ethnicity. The results in this large database show that patients who were dialyzed by AVG had a nearly 50% increased risk of mortality over those dialyzed by AVF and that patients dialyzed by tunneled catheter had a 6.5-fold increased risk of mortality over AVF. Despite the significantly lower prevalence of AVF in African Americans, African Americans still had a 40% reduced risk of mortality compared with whites in the multivariate analysis. This suggests that type of dialysis access is not responsible for ethnicity-related mortality differences in this population. The lower prevalence of AVF in the African-American population in our study is not explainable because of the limitations of our database but is worthy of further investigation.

Our results also showed that male hemodialysis patients have a 32% increased risk of mortality compared with female hemodialysis patients. This is consistent with previously published results. Similarly, diabetes increased the risk of mortality by 20%, which has also been demonstrated by other authors.

The major weakness of this study is that it is limited by the data points available from the database. There are multiple other patient factors that would be useful to include in the multivariate analysis, such as coronary artery disease, peripheral vascular disease, and smoking history, but were not included in the database. Furthermore, a host of other patient factors that would be very difficult to measure, including dietary influences and social-family support, may have an effect on survival. Ultimately, we cannot conclusively determine cause and effect from this type of study. We have demonstrated associations of certain exposures with risk of mortality; however, further study is required to determine whether the identified exposures are a direct cause of mortality or merely markers for other risk factors.

**Conclusion**

Age, male sex, AVG, tunneled catheter access, and diabetes were independent predictors of mortality in hemodialysis patients. After we controlled for these variables, when compared with non-Hispanic whites, African Americans, Asian/Pacific Islanders, and Hispanics all demonstrated significantly decreased risk of mortality. African Americans had a reduced mortality risk despite a significantly lower prevalence of AVF compared with non-Hispanic whites. This would suggest that type of dialysis access is not responsible for sex- and race- or ethnicity-related mortality differences in this population. Further investigation is needed to determine the cause of these variations in mortality risk.

**Disclosure Statement**

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**References**


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Phenomena Termed Uremic

A large proportion of the phenomena termed uremic are, as Volhardt and Foster pointed out almost 40 years ago, vascular in origin, consequences of hypertension, arterial disease, and heart failure. Others are results, not of retention of waste products, but of failure of the conservative functions of the kidneys. If their true nature were more frequently analyzed in detail and corrective measures instituted for each, therapy would be greatly advanced. The term uremia has a defeatist ring that fosters complacency or routine procedures rather than thoughtful action.

— John Punnett Peters, 1887-1955, physician and professor of medicine

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