Dialysis Facility and Patient Characteristics Associated with Utilization of Home Dialysis

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Background and objectives: Nonmedical factors influencing utilization of home dialysis at the facility level are poorly quantified. Home dialysis is comparably effective and safe but less expensive to society and Medicare than in-center hemodialysis. Elimination of modifiable practice variation unrelated to medical factors could contribute to improvements in patient outcomes and use of scarce resources.

Design, setting, participants, & measurements: Prevalent dialysis patient data by facility were collected from the 2007 ESRD Network’s annual reports. Facility characteristic data were collected from Medicare’s Dialysis Facility Compare file. A multivariate regression model was used to evaluate associations between the use of home dialysis and facility characteristics.

Results: The utilization of home dialysis was positively associated with facility size, percent patients employed full- or part-time, younger population, and years a facility was Medicare certified. Variables negatively associated include an increased number of hemodialysis patients per hemodialysis station, chain association, rural location, more densely populated zip code, a late dialysis work shift, and greater percent of black patients within a zip code.

Conclusions: Improved understanding of factors affecting the frequency of use of home dialysis may help explain practice variations across the United States that result in an imbalanced use of medical resources within the ESRD population. In turn, this may improve the delivery of healthcare and extend the ability of an increasingly overburdened medical financing system to survive.


The United States is set to experience historic change in healthcare access after enactment of the health reform bill in 2010. One goal of the reform is to provide citizens equitable and affordable access to health coverage. Efficient allocation of the resultant health resources must be considered in context to the current array of available healthcare services. Balanced against efficient allocation is the need to contain costs without impeding timely and appropriate access to healthcare services.

Since its inception in 1973, the Medicare ESRD Program has provided covered patients with kidney failure access to life-sustaining treatment. Costs have soared far beyond original expectations and continue to escalate. In 2006, the 1.1% of Medicare beneficiaries with ESRD consumed 7.4% of Medicare expenditures (1). Healthcare services such as those for ESRD that consume a disproportionate share of healthcare expense face increased scrutiny.

Cost-containment appears to be an important consideration for the Centers for Medicare and Medicaid Services because recent ESRD program modifications are required by Congress to remain budget neutral. One option for managing dialysis costs may be to expand the use of home dialysis therapies. Global and U.S. data confirm that home dialysis is the least costly option to payers when one accounts for dialysis patients’ total healthcare costs (1,2).

The percentage of patients receiving home dialysis in the United States and in many nations around the world is small and has decreased over the past decade (3). Possible causes for the decline have been the focus of much speculation. Most evidence comes from evaluations of the decline in peritoneal dialysis (PD) use, because similar evidence for home hemodialysis (HHD) is not available. A well documented literature review proposed that among the principal reasons PD use has been in decline was the rapid expansion of in-center hemodialysis (ICHD) capacity and the aging of the ESRD population (4). Objective evidence of the root causes of the decline in PD comes from a survey of PD practice recently conducted among medical directors of all New England dialysis centers (5). Factors associated with reduction in utilization of PD were categorized as patient, physician, or facility related. Specific examples of patient and physician factors were provided. Detail around facility-related factors was not provided, but it was reported that issues related to facility “structure or functioning” (5). No conclusions regarding utilization of HHD can be made from the aforementioned work because HHD was not in their scope.

It has been nearly 15 years since associations between facility characteristics and the probability that facilities make available any home dialysis modality, HHD, continuous ambulatory PD,
or continuous cycling PD were described (6). During that interval, many significant changes in the U.S. dialysis environment have occurred. Today, there are nearly 5000 dialysis units in the United States. Chain membership has grown from 20% of all dialysis facilities in 1992 to 79% in 2008, and the fraction of facilities that are for-profit has reached 81% (7).

Given the dearth of published information reporting relationships between a facility’s operational characteristics and the percentage of patients to whom they provide home dialysis treatment options, we sought to perform such an analysis to update and expand on the previous facility report. Other factors associated with a patient’s decision to choose between home dialysis and in-center dialysis, including predialysis education, are beyond the scope of our data but are discussed elsewhere (8–10).

Materials and Methods

We performed a multivariate regression analysis to estimate the association of dialysis facility and associated population-level patient characteristics on the percentage of prevalent dialysis patients receiving PD or hemodialysis (HD) at home (Table 1). The analysis was conducted at the dialysis facility level and applied zip code data to evaluate variances in patient populations among facilities. The percentage of patients receiving home dialysis was calculated by dividing a facility’s total point-prevalent home dialysis patients by their total point-prevalent dialysis patients. Data on the number of point-prevalent in-center and home dialysis patients alive on December 31, 2007 were extracted from the ESRD Networks’ 2007 Annual Reports. Information on dialysis facility characteristics was obtained from Medicare’s Dialysis Facility Compare (DFC) database. This database is refreshed on an ongoing basis; the refresh date for data used in our study was May 19, 2008. The level of urbanization or rurality associated with dialysis providers’ zip code locations was obtained from the University of Washington’s Rural Health Research Center. Despite the period disparity, zip-code-level population data were obtained from the 2000 U.S. Census.

Several facility characteristic variables from the DFC database were tested in the model. The for-profit status of the dialysis facility, chain ownership status, operation of a late shift (defined as starting at 5:00 p.m. or later) and facility size of ≥62 patients were included as dichotomous variables. A facility size breakpoint of 62 patients was used because it was the median number of patients across all facilities. For-profit and chain ownership status were included as separate variables because they are not mutually exclusive. The number of years since a dialysis facility became Medicare certified was also evaluated.

An ICHD capacity variable was included as an independent variable. This capacity variable was calculated by dividing the total number of point-prevalent ICHD patients by the number of hemodialysis stations, multiplied by 4 if no late shift was present or by 6 if the clinic had a late shift, and then multiplied by 100. In the United States, a typical dialysis facility has approximately four hemodialysis patients per machine (1). Because most patients dialyze 3 times per week for approximately 4 hours per treatment, two patients can be treated per day and four per week on a given machine in a typical center using two patient shifts per day. The number of patients per machine may increase if the number of patient dialysis shifts per day increases. For this analysis, we accepted conventional perception that as the number of patients per machine increases...

Table 1. Data sources and variables

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>percent of facility’s dialysis population on HHD or PD</td>
<td>2007 ESRD Network Annual Report</td>
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</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Data Source</th>
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<tbody>
<tr>
<td>facility operates as a for-profit business or not</td>
<td>DFC</td>
</tr>
<tr>
<td>facility owned or managed by a chain organization</td>
<td>DFC</td>
</tr>
<tr>
<td>facility has a late shift (operating at 5:00 p.m. or later)</td>
<td>DFC</td>
</tr>
<tr>
<td>RUCA code, 1.0 = least rural, 10.6 = most rural</td>
<td>University of Washington; <a href="http://depts.washington.edu/uwruca/download.html">http://depts.washington.edu/uwruca/download.html</a></td>
</tr>
<tr>
<td>facilities with a total number of treated dialysis patients ≥62</td>
<td>2007 ESRD Network Annual Report</td>
</tr>
<tr>
<td>capacity—total number of ICHD patients divided by the total number of HD stations multiplied by 4 if no late shift or 6 if the facility has a late shift and then multiplied by 100</td>
<td>2007 ESRD Network Annual Report and DFC</td>
</tr>
<tr>
<td>percent of dialysis facility population aged 18 to 54 years</td>
<td>2007 ESRD Network Annual Report</td>
</tr>
<tr>
<td>percent black population in the provider zip code</td>
<td>2000 U.S. Census Bureau</td>
</tr>
<tr>
<td>land area of provider zip code in square miles</td>
<td>2000 U.S. Census Bureau</td>
</tr>
<tr>
<td>population per square mile in the zip code</td>
<td>2000 U.S. Census Bureau</td>
</tr>
<tr>
<td>years since the dialysis facility was certified</td>
<td>DFC</td>
</tr>
<tr>
<td>percent of dialysis facility’s 18- to 54-year-old population working full- or part-time</td>
<td>2007 ESRD Network Annual Report</td>
</tr>
</tbody>
</table>
increases beyond four, capacity per machine is being utilized more intensely. However, we excluded as an outlier providers reporting more than eight hemodialysis patients per station.

Several variables were analyzed at the zip code level to better explore the use of home dialysis. Because the DFC file contains the zip code of the dialysis facility, other variables that may affect home dialysis use were merged into this database. A Rural-Urban Commuting Area (RUCA) score was included as a crude estimation of the extent of rurality of a given zip code. RUCA scores range from 1.0 (least rural) to 10.6 (most rural). The scores are based on the size of cities and towns and their functional relationships as measured by work commuting flows. Until recently, many have intuitively expected that patients living remotely from their dialysis facility would be more likely to choose dialysis treatment in their home. A variable to capture the area of the zip code in square miles was also included. Similarly, a population density variable was created by dividing a zip code’s total population by the land area of the zip code with the expectation that more dense populations are more likely to have more convenient access to a dialysis facility.

The percent of the dialysis population 18 to 54 years of age within a facility was identified. This age range typifies a working age population. The percent of the facility’s dialysis patients aged 18 to 54 years who were employed full- or part-time was also identified. It is believed that as the percent of the dialysis population employed increases, the percent of dialysis patients receiving home dialysis also increases (11). Finally, the proportion of black patients in the zip code sample was identified. It has previously been demonstrated that dialysis facilities use less home dialysis when a greater percent of their patients are black (12).

A P value <0.05 was required for a variable to remain in the multivariate linear regression model used to estimate the effect of these variables on home dialysis use. Interaction and quadratic terms were tested for inclusion in the model. All analyses were performed in SAS version 9.1.

Results

Data from 4653 dialysis facilities, or 92.1% of the facilities in the 2007 ESRD annual network reports, were included in the analysis (Table 2). Excluded were 399 dialysis clinics in the ESRD annual reports that did not have a match in DFC or were missing other crucial information (e.g., zip-code-level data). The mean percent of dialysis patients on home dialysis across all facilities was 7.05%, ranging from 0% to 100% within individual facilities. The average HD capacity was 82%. Nearly 20% of facilities had a dialysis late shift. Approximately 80% of facilities were owned or managed by a chain whereas 82% were for-profit. Late shifts were available in 23% of independent clinics compared with 18.7% of chains (P = 0.0033); 28.1% of non-for-profit clinics compared with 17.6% of for-profit clinics had a late shift (P < 0.00001).

The average number of years since a facility had received Medicare certification was 12.6 years. Across all facilities, 31% of the dialysis population was between 18 and 54 years of age and 20% of this working-age dialysis population was employed. On average, across zip codes, 15.9% of the population was black (median 5.7%). The average RUCA score was 2.5 (median score 1.0), implying that the average provider was located in a fairly urban setting. The average facility was in a zip code with an area of approximately 95 mi² (range <1 to nearly 4100). On average, there are approximately 1.2 facilities per zip code, but no more than 7 dialysis facilities in a single zip code. Finally, the mean and median population density among zip codes was 3134 and 878 people, respectively.

Of the variables tested, only the for-profit variable was NS and therefore not included in the final model (Table 3). The adjusted R² for the regression model was 0.3460. Larger dialysis facility size, more years of facility certification, or a higher population of working patients in a facility were associated with significantly higher provision of home dialysis. As a facility’s percentage of patients between the ages of 18 to 54 years old increased, so did the percentage of patients receiving home dialysis. Each 1% increase in this age group resulted in a 0.13% increase in the percentage of patients receiving home dialysis therapy. Different age cuts were not possible because of the source of our data.

Facilities located in a more rural area, a geographically larger zip code area, or high-population-density zip codes were associated with lower use of home dialysis. The presence of a late shift was negatively associated with the percent of patients on home dialysis. The average facility with a late shift had a 4.4% lower rate of patients on home dialysis compared with those without a late shift. Each absolute 1% increase in the black population within a zip code was associated with an absolute 0.03% decline in the percent of patients on home dialysis.

Discussion

Medical and nonmedical factors are reported to contribute to a decision to start a patient on home dialysis (13). Nonmedical factors can be patient or facility specific. We addressed only nonmedical factors, identifying several dialysis-facility characteristics as associated with differences in the use of home dialysis. A facility with ≥62 patients was the characteristic associated with the largest magnitude (8.2%) of increase in home dialysis use.

Table 2. Variable description

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (Median)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home dialysis, %</td>
<td>7.05 (0)</td>
<td>0 to 100</td>
</tr>
<tr>
<td>For-profit, %</td>
<td>81.7</td>
<td>Yes, no</td>
</tr>
<tr>
<td>HD capacity, %</td>
<td>82.3 (81.3)</td>
<td>0 to 8</td>
</tr>
<tr>
<td>Have late shift, %</td>
<td>19.5</td>
<td>Yes, no</td>
</tr>
<tr>
<td>Black race, %</td>
<td>15.9 (5.7)</td>
<td>0.02 to 98.5</td>
</tr>
<tr>
<td>Owned by chain, %</td>
<td>80.3</td>
<td>Yes, no</td>
</tr>
<tr>
<td>Facility size, %</td>
<td>51.0</td>
<td>Yes, no</td>
</tr>
<tr>
<td>Patients work, %</td>
<td>20.0 (16.7)</td>
<td>0 to 100</td>
</tr>
<tr>
<td>Age, % 18 to 54 years old</td>
<td>31.1 (30.8)</td>
<td>1.82 to 100</td>
</tr>
<tr>
<td>Years certified</td>
<td>12.6 (10.6)</td>
<td>0.07 to 41.8</td>
</tr>
<tr>
<td>Land area, mi²</td>
<td>95 (28)</td>
<td>0.88 to 4067</td>
</tr>
<tr>
<td>Population density, as population per square mile</td>
<td>3134 (878)</td>
<td>2 to 128,567</td>
</tr>
<tr>
<td>RUCA score</td>
<td>2.5 (1.0)</td>
<td>1.0 to 10.6</td>
</tr>
</tbody>
</table>
Although many have expected that home dialysis would be more common in rural settings because of less convenient access to the dialysis facility, the opposite was found, validating previous reports. In 2006, the known distribution of incident HHD patients living in urban locations was 87% compared with 9.9% in rural locations (3.5% unknown), substantially different from 1992 when 34.7% of HHD patients were located in rural areas (1). Similarly, O’Hare et al. (14) reported ICHD to be the predominant dialysis modality for patients living in urban and rural settings. In addition, they reported that rural dialysis facilities were less likely than urban dialysis facilities to offer PD or make HHD or PD training available. Agraharkar et al. (15) speculated that geographic location also affected the number of patients receiving and continuing on PD. This may indicate there are insufficient patients, resources, or infrastructure to support and sustain a home dialysis program in some rural areas.

Facilities with a late shift or those with a higher uncommitted capacity had a lower percentage of patients on home dialysis. Adding dialysis shifts increases facility capacity. One may reasonably ask the question if facilities with a late shift are motivated to preferentially fill now available ICHD chairs. This would maximize utilization of a facility’s fixed investment costs for overhead, staff, and capital equipment (16). Supporting evidence comes from the 1990s, when after a rapid growth in new dialysis centers, it was believed payment incentives supported such capacity utilization practice (3).

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There was no association between profit status and the use of home dialysis; however, facilities owned by chain organizations had smaller percentages of home dialysis patients compared with nonchain-owned centers. For-profit is not synonymous with chain, but complete elucidation of the difference is beyond our scope and the reader is referred elsewhere for clarification (17). Our results, as related to PD, parallel those of Mehrotra and colleagues (17) who demonstrated that the odds ratio for incident patients to be on PD was consistently lower in three of five large dialysis organizations compared with smaller organizations. They did not address the effect on HHD. In the previous facility work by Kendix (6), the results were mixed. For-profit facilities had a higher probability than nonprofit facilities to provide continuous ambulatory PD, but there was no difference for HHD or continuous cycling PD. Overall, he found that chains were less likely to provide any of the three home dialysis modalities.

We found a significant inverse association between home dialysis use and the percent black population within a zip code. For every 1% increase in the black population, the percent of patients treated with home dialysis in a facility declined by 0.03. Choices for Healthy Outcomes in Caring for ESRD study results were similar. Black patients were considerably less likely than white patients to receive PD (10). Recent data directionally corroborate this finding. In 2006, approximately 8.6% of white compared with 5.1% of black prevalent dialysis patients were treated with PD, and 0.8% of white compared

### Table 3. Multivariate linear regression results

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
<th>Impact on Home Use</th>
<th>Coefficient (SE)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facility related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive association with use of home dialysis (increased utilization)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of patients in the facility ≥62</td>
<td>True</td>
<td>More</td>
<td>8.22 (0.5015)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>years Medicare certified</td>
<td>Each additional year</td>
<td>More</td>
<td>0.09 (0.0231)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Negative association with use of home dialysis (reduced utilization)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operate a late shift</td>
<td>True</td>
<td>Less</td>
<td>−4.40 (0.5403)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>owned by chain</td>
<td>True</td>
<td>Less</td>
<td>−3.16 (0.4850)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ICHD treatment capacity</td>
<td>Each additional 1% increase in capacity</td>
<td>Less</td>
<td>−0.86 (0.0228)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>rural location</td>
<td>Each 1-unit increase in RUCA score</td>
<td>Less</td>
<td>−0.48 (0.0988)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>land area (within zip code)</td>
<td>Each 1-mi² increase</td>
<td>Less</td>
<td>−0.003 (0.0012)</td>
<td>0.005</td>
</tr>
<tr>
<td>population density (within zip code)</td>
<td>Each 1-unit increase</td>
<td>Less</td>
<td>−0.06 (0.0235)</td>
<td>0.008</td>
</tr>
<tr>
<td><strong>Patient related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive association with use of home dialysis (increased utilization)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 to 54 years old</td>
<td>Each 1% increase</td>
<td>More</td>
<td>0.13 (0.0191)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>employed 18- to 54-year-olds</td>
<td>Each 1% increase</td>
<td>More</td>
<td>0.17 (0.0248)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Negative association with use of home dialysis (reduced utilization)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>black race</td>
<td>Each 1% increase</td>
<td>Less</td>
<td>−0.03 (0.0091)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Percent on home dialysis is the dependent variable (0 to 100).
with 0.6% of black prevalent hemodialysis patients were
dialyzed at home (1).

Facilities with a higher percentage of full- or part-time
employed patients at a dialysis facility were associated with an
increase in the percentage of patients receiving home dialysis.
This finding is similar to several other studies (6,10,12,18–23).

We are unable to further define an answer for the question of
whether dialysis choice influences employment status or if
employment status influences dialysis choice. This question
was recently explored elsewhere (16,21). Age may or may not
be associated with working status.

Limitations of our analysis should be noted. We were unable
to include information on patient-specific characteristics (e.g.,
education level and income) or clinical factors (e.g., co-morbid-
ities) because this information was not available within our
data sources. Other factors such as the supply of nurses and
nephrologists were not included in the model. In addition,
much of our zip-code-level data are from 2000, which is 7 years
older than our dialysis facility information. Neighboring zip
code characteristics may play a role in affecting the percent of
facilities’ dialysis population being on home dialysis. On the
other hand, our analysis did include over 90% of all Medicare-
certified dialysis facilities that operated in 2007. Finally, we do
not find the RUCA score to be sensitive enough to distinguish
the difference between changes in population density typically
associated with rural and urban areas as perceived by the
average person.

We identified facility and patient population characteristics
associated with variations in use of home dialysis therapies.
Several of these factors are identified in other studies
(6,10,12,18–24). Our findings should not be interpreted to infer
a cause-and-effect relationship. An emerging reality is that
dialysis facility profit margins will likely decrease from the
effects of reimbursement changes in the Medicare ESRD Pro-
gram and from adjustments private payers will likely make that
parallel Medicare changes. New approaches to control increas-
ing costs and improve use of limited resources need to be
identified and implemented. Recognition that some facility fac-
tors associated with home dialysis utilization are modifiable
may be one of these.

Two modifiable factors stand out in our analysis: facility
size and the unused HD capacity available in the facility. If
the available ICHD capacity expands too rapidly, there may
be financial pressure to first use the open capacity. This
may limit home dialysis options for patients. Expanded use of
home dialysis therapies would enable more ESRD patients to
be treated effectively in a constrained budget-neutral envi-
ronment (25).

Additional studies are needed to further determine the po-
tential for and magnitude of clinical and nonmedical factors on
home dialysis use at the facility level.

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**Disclosures**

All authors are employees of Baxter Healthcare Corporation.

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