Hemodialysis in a Satellite Unit: Clinical Performance Target Attainment and Health-Related Quality of Life

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Summary
Background and objectives In Canada, patients are increasingly receiving hemodialysis (HD) in satellite units, which are closer to their community but further from tertiary care hospitals and their nephrologists. The process of care is different in the satellites with fewer visits from nephrologists and reliance on remote communication. The objective of this study is to compare clinical performance target attainment and health-related quality of life (HRQOL) in patients receiving HD in satellite versus in-center units.

Design, setting, participants, and measurements The London Health Sciences Centre in London, Ontario, Canada, has both tertiary care center and satellite HD units. All eligible patients who received dialysis treatment at one of these units as of July 24, 2008, were enrolled into a cross-sectional study (n = 522). Patient attainment of hemoglobin, albumin, calcium-phosphate (Ca-P) product, Kt/V, and vascular access targets were compared. Participants were also administered the Kidney Disease Quality of Life Short-Form questionnaire.

Results Satellite patients were more likely to attain clinical performance targets for albumin (adjusted odds ratio [OR] = 4.87 [95% confidence interval [CI]: 2.13 to 11.14]), hemoglobin (OR = 1.59 [95% CI: 1.08 to 2.35]), and Ca-P product (OR = 2.02 [95% CI: 1.14 to 3.60]), as well as for multiple targets (P < 0.05). HRQOL scores were largely similar between groups.

Conclusions Patients receiving HD in a satellite unit were just as likely, or more likely, to demonstrate attainment of clinical performance targets as those dialyzing in-center, while maintaining a similar HRQOL. This supports the increased use of satellite units to provide care closer to the patient’s community.


Introduction
Conventional hemodialysis (HD) usually involves spending approximately 3 to 4 hours, three times a week attached to a dialysis machine, plus additional time and energy to travel to and from the dialysis unit. Because of the demanding nature of chronic HD treatment, the large burden of comorbidities, and the considerable effect ESRD has on patients’ occupational and social roles, patients on chronic HD typically report a decreased health-related quality of life (HRQOL) (1–5). Past studies have demonstrated that modifying a patient’s treatment experience, either through a regimen increasing patient independence or through decreasing travel time to dialysis clinics, can improve reported HRQOL (6,7).

In the province of Ontario, dialysis services were expanded in the mid-1990s to include community-based satellite units to improve geographic accessibility (8). The care of patients at satellites are provided by nephrologists practicing in tertiary care centers, often at a distance from the satellite unit. This includes communication with dialysis nurses with use of the telephone, fax, and telehealth, as well as regular visits to the satellite unit by the nephrologist and allied health team. Patients normally begin treatment in the tertiary care “in-center” unit, and if the patient meets the criteria for satellite dialysis, are transferred to the unit closest to their home (9,10). With the rapidly growing demand for HD services and limited hospital resources, satellites now provide care to patients with similar burdens of disease as in-center units (9).

A study comparing in-center units and satellite units in England and Wales found that most aspects of clinical performance and HRQOL were similar between in-center and satellite patients (11). However, satellite patients reported superior ratings of patient satisfaction, as well as reduced mean travel times, dialysis adequacy, adverse event rates, and hospitalization rates. Bernstein et al. (12) found that patients receiving HD treatment in satellite units in Manitoba attained superior survival outcomes relative to their in-center counterparts, but did not report on HRQOL or performance target attainment. Additionally, we have previously demonstrated that satellite patients reported less dialysis-associated physical stress, as well as decreased travel time and cost (9).
The objectives of this study were to compare clinical performance target attainment and HRQOL between satellite and in-center patients in a regional HD program in Ontario, Canada.

Materials and Methods

Patient Population

This observational, cross-sectional study used a convenience sample of chronic HD patients who were part of the London Health Sciences Centre Regional Hemodialysis Program as of July 2008. This program consists of three in-center hospital dialysis units, as well as nine community-based satellite units across Southwestern Ontario ranging from 1 to 210 km away from the in-center units, with most between 50 and 150 km away. Patients were eligible to enroll in this study if they met the following inclusion criteria: on conventional, chronic HD 2 to 4 times per week for at least 3 months; able to provide informed consent; and able to speak English. Patients were excluded if they were receiving HD treatment transiently, or for acute renal failure. Eligible patients were grouped into either the in-center or satellite cohort depending on where they received treatment as of July 24, 2008. This study was approved by the Research Ethics Board at the University of Western Ontario.

Data Collection

Patient characteristics—such as demographics, medical and dialysis history, mobility status, and laboratory parameters—were obtained from a combination of existing electronic records that were initially populated by chart review. Data from electronic records were compared with patient charts in a random selection of 20% of participants to confirm data accuracy. If a discrepancy was noted, the chart was considered the reference standard.

Each patient’s burden of general health problems were quantified using the Liu et al. Comorbidity Index, which was designed for use on dialysis patients (13). Scores can range from 0 to 24, with a higher score indicating a greater burden of comorbidities.

To assess facility-level characteristics and procedures for delivery of care, the Canadian Organ Replacement Register (CORR) 2005 Facility Survey was distributed to and completed by facility managers. This questionnaire covers such issues as facility resources, procedures, available treatments, unit staffing, and rules concerning unit eligibility.

Outcome Measurements

Attainment of clinical performance measures for each patient was based on meeting the following targets, which have been associated with decreased mortality and hospitalization (14,15): a serum albumin ≥34.5 g/L, a serum hemoglobin ≥110 g/L, a calcium-phosphate (Ca-P) concentration product ≤4.44 mmol/L² (or ≤55 mg²/dl²), a Kt/V ≥ 1.2, and the presence of a functioning arteriovenous fistula. An albumin target of 34.5 g/L was used instead of 40 g/L to account for regional differences in test norms because of the use of the bromocresol purple and Beckmann methods of test analysis (16). All clinical performance data were collected from electronic records. For albumin, hemoglobin, and Ca-P product, the three most recent monthly laboratory results were averaged to minimize the effects of monthly fluctuations. The most recent reading before baseline was used for Kt/V. A functional fistula was defined as one that was being used for dialysis as of July 2008.

Patient quality of life was assessed using the Kidney Disease Quality of Life Short-Form (KDQOL-SF) (17). Consisting of 80 questions, the questionnaire includes the Medical Outcomes Short Form-36 (SF-36), a widely-used assessment of global quality of life, as well as questions specific to ESRD. The SF-36 can be broken down into the physical component summary and a mental component summary (18). The topics covered by the subscales of the KDQOL-SF have been previously described (17,18). Subscale scores can range from 0 to 100, with a higher score indicating a superior quality of life. Lower KDQOL-SF component scores have been associated with higher risks of mortality and hospitalization (19).

Dialysis unit managers or members of the research team approached each patient about filling out the questionnaire using a standard script to ensure consistent patient recruitment methods. The survey was then self-administered. Patients who requested assistance with the questionnaire were administered the survey in an interview format.

Statistical Analyses

Descriptive statistics were used to summarize study participant characteristics. Two-sample t tests were used to compare continuous variables for each group, whereas χ² tests were used for categorical variables. A complete case analysis was used for the comparison of all patient characteristics, covariates, and clinical performance targets. The approach for dealing with missing questions on the KDQOL-SF is summarized by Hays et al. (20).

Logistic regression was used to compare clinical performance target attainment between satellite and in-center patients (21). A marginal generalized estimating equation extension was applied to account for potential clustering of results from the same dialysis center. Satellite and in-center patients were compared on the proportion attaining individual targets, as well as a total number of targets. Linear regression was used to compare adjusted HRQOL between satellite and in-center patients. As above, a generalized estimating equation extension was used to account for the potential of correlated outcomes (21).

For all multivariable analyses, potential confounders were identified from previous literature. Age, sex, race, and comorbidity index scores were forced into each model. An operational criterion for confounding was used, whereby additional covariates were included in the final model if their inclusion led to a 10% change or more in the effect estimate. Additionally, the Benjamini and Hochberg False Discovery Rate method was used to account for multiple testing (22).

Two sensitivity analyses were also conducted. First, we excluded in-center patients that did not meet the eligibility requirements of dialyzing in a satellite, and compared satellite patients to in-center patients eligible to dialyze in a satellite. Second, because the HRQOL questionnaires were administered over the course of a year, some patients
transferred from one center type to another. As such, a second sensitivity analysis was conducted whereby patients were assigned to the HD unit in which they dialedyzed 4 weeks before the survey completion (which corresponds with the timeframe covered in the questionnaire).

All statistical analyses were performed in SAS 9.1 (SAS Institute, Cary, NC). Associations with $P < 0.05$ were considered to be statistically significant.

Results

The number of patients who were receiving HD treatment as of July 24, 2008, enrolled in the study, and completed the questionnaire for in-center and satellite patients is depicted in Figure 1. Overall, clinical performance measures were collected for 522 patients, whereas 277 completed the quality of life questionnaires.

Table 1 compares patient characteristics of in-center and satellite patients. Patients in satellites were slightly younger and had a lower prevalence of congestive heart failure and cerebrovascular disease, a moderately but statistically signif-

![Flow diagram of the number of patients receiving hemodialysis (HD) treatment as of July 24, 2008, enrolled in the study, and completed the questionnaire for in-center and satellite patients. PD, peritoneal dialysis; HRQOL, health-related quality of life.](image)

Table 2 summarizes the facility characteristics of the three in-center and nine satellite units that were ascertained from the CORR 2005 Facility Survey. Notable differences between in-center and satellite units include the number of HD stations, the nurse-to-patient ratio, health professional availability, frequency of nephrology visits, and the presence of eligibility criteria to dialyze at satellite units.
Clinical Performance Target Attainment

All 522 patients contributed data for each performance measure. Table 3 lists the percentage of those in both in-center and satellite groups that met each clinical performance target, as well as the unadjusted and adjusted odds ratios of target attainment. Satellite patients had statistically significant higher odds of attaining albumin (adjusted odds ratio [OR] = 4.87, 95% confidence interval [CI]: 2.13 to 11.14), hemoglobin (OR = 1.59, 95% CI: 1.08 to 2.35), and Ca-P product performance targets compared with in-center patients.
Table 2. Summary of facility characteristics as reported by unit administrative clerks to the CORR 2005 Facility Profile and supplemental questions for participating in-center and satellite units

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>In-Center Units (n = 3)</th>
<th>Satellite Units (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of HD stations</td>
<td>Range from 23 to 35</td>
<td>Range from 6 to 9</td>
</tr>
<tr>
<td>Nurse-to-patient ratio</td>
<td>2.5:1</td>
<td>3:1</td>
</tr>
<tr>
<td>Arrangement of HD supported</td>
<td>Total care only</td>
<td>Total care and self-care</td>
</tr>
<tr>
<td>Patients allowed to operate dialysis machines</td>
<td>At 1 site only</td>
<td>Yes</td>
</tr>
<tr>
<td>Home HD training facilities present?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Facilities for temporary visitors</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Health professional available</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>dietitian/nutritionist</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>social worker</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>physiotherapist</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>nurse practitioner</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>pharmacist</td>
<td>At 2 of 3 sites</td>
<td>No</td>
</tr>
<tr>
<td>Frequency of nephrology visits</td>
<td>Weekly or biweekly</td>
<td>Monthly</td>
</tr>
<tr>
<td>Eligibility criteria to dialyze at facility</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Frequency of urea kinetic modeling for patients</td>
<td>Once every 3 months</td>
<td>Once every 3 months</td>
</tr>
<tr>
<td>Screening for Hep B/Hep C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>HIV testing</td>
<td>Only for specific indication</td>
<td>Only for specific indication</td>
</tr>
<tr>
<td>Isolation room present</td>
<td>At 2 of 3 sites</td>
<td>No</td>
</tr>
</tbody>
</table>

*To dialyze at a satellite unit in Southwestern Ontario, patients must be able to maintain a stable blood pressure during HD treatment that does not require monitoring >1 to 2 times per hour; have an HD access that provides consistently adequate blood flow; have no new, unresolved, active medical problems without a clearly defined course of follow-up; and consistently receive their treatment in a reclining chair as opposed to a bed. CORR, Canadian Organ Replacement Register; Hep, hepatitis.

Table 3. Percentage of patients attaining each performance target, as well as unadjusted and adjusted ratio OR (95% CI) of performance target attainment comparing satellite to in-center patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% of Patients Attaining Target</th>
<th>Unadjusted</th>
<th>Adjusted a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>In-Center 15.4, Satellite 51.2</td>
<td>5.76 (3.80–8.72), 4.87 (2.13–11.14)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>In-Center 55.8, Satellite 67.2</td>
<td>1.62 (1.14–2.32), 1.59 (1.08–2.35)</td>
<td>0.01</td>
</tr>
<tr>
<td>Ca-P product</td>
<td>In-Center 75.8, Satellite 84.7</td>
<td>1.77 (1.14–2.76), 2.02 (1.14–3.60)</td>
<td>0.01</td>
</tr>
<tr>
<td>Kt/V</td>
<td>In-Center 91.2, Satellite 93.5</td>
<td>1.40 (0.73–2.68), 1.38 (0.66–2.90)</td>
<td>0.39</td>
</tr>
<tr>
<td>Functional AVF</td>
<td>In-Center 28.5, Satellite 40.1</td>
<td>1.68 (1.17–2.42), 1.11 (0.42–2.92)</td>
<td>0.84</td>
</tr>
</tbody>
</table>

*aAdjusted for age, gender, race, comorbidity index score, and clustering effect. Ca-P, calcium-phosphate; OR, odds ratio; CI, confidence interval, AVF, arteriovenous fistula.

Table 4 lists the percentage of those in both in-center and satellite groups that met a total number of clinical performance targets, as well as the unadjusted and adjusted odds ratios of multiple target attainment. Satellite patients had statistically significant higher odds of attaining two (OR = 4.74, 95% CI: 1.59 to 14.15), four (OR = 3.45, 95% CI: 1.62 to 7.33), or five performance targets (OR = 5.96, 95% CI: 2.81 to 12.65). Conclusions remained unchanged after adjustment for multiple testing.

Health-Related Quality of Life

Patients that completed the questionnaire significantly differed from those that refused or did not return it only in that they had, on average, a higher comorbidity index score (5.1 versus 4.2, P = 0.005), and were more likely to have a diagnosis of chronic obstructive pulmonary disease (22.0% versus 8.4%, P < 0.001). Patients that completed the questionnaire significantly differed from all patients that did not complete the questionnaire only in that they were more likely to have a diagnosis of chronic obstructive pulmonary disease (22.0% versus 13.6%, P = 0.013).

Table 5 shows the mean subscale and component summary scores individually for in-center and satellite-based patients, as well as the unadjusted and adjusted differences (diff.) in mean scores. Although in-center patients demonstrated a general trend of higher adjusted scores on most sections, the difference was only statistically significant for the Role-Physical (adjusted diff. = 14.9, P < 0.001), Role-Emotional (adjusted diff. = 15.6, P = 0.009), and Symp-
subsets, as well as for the Physical Component Summary (adjusted diff. = 1.2, $P = 0.049$). However, satellite patients reported a statistically significant superior score for the Dialysis Staff Encouragement section (adjusted diff. = 5.0, $P = 0.004$). After compensation for multiple testing, only the adjusted differences in the Role-Physical and Dialysis Staff Encouragement subscales remained statistically significant.

Missing data for each HRQOL subscale was <4%, with the exception of Sexual Function, which was missing for 90% of respondents. The Sexual Function scale is unique, however, in that only patients who have been sexually active in the previous 4 weeks are prompted to complete the section.

### Sensitivity Analyses

After comparison of satellite patients with satellite-eligible in-center patients ($n = 169$), results for clinical performance target attainment, as well as the adjusted differences in mean scores on most subscales of the HRQOL questionnaire, were quite similar to that of the main analyses. However, the superior mean score for in-center patients reached statistical significance for the Effects of Kidney Disease (adjusted diff. = 7.1, $P = 0.017$) and Sexual Function (adjusted diff. = 25.2, $P =$...
Comparisons of HRQOL scores based on assignment of scores to the site of questionnaire completion produced mostly similar conclusions. However, the adjusted difference on the Physical Component Score was no longer statistically significant, whereas the superior mean score for in-center patients on the Effects of Kidney Disease subscale reached statistical significance (adjusted diff. = 7.4, \( P = 0.032 \)).

Discussion

This study highlights important differences and similarities among patients dialyzing in satellite units and in-center. First, a greater proportion of satellite patients attained several individual performance targets, as well as multiple targets, compared with those dialyzing in-center. Adjustment for comorbidities, patient characteristics, and restricting comparisons to satellite-eligible patients did not change these results. Second, in-center patients surprisingly had a general trend toward higher HRQOL, particularly on the Role-Physical and Role-Emotional subscales, whereas satellite patients reported a higher rating of Dialysis Staff Encouragement. Third, in-center and satellite patients differed in the proportion with certain comorbidities, as well as certain measures of dialysis history and mobility. These results provide further assurance that patients dialyzing at a distance from their nephrologists are receiving adequate care and meeting or exceeding performance targets.

Although this is the first study to compare clinical performance target attainment between in-center and satellite patients, as well as the first to compare HRQOL using the KDQOL-SF between Canadian in-center and satellite patients, some of the findings correspond well with previous research. Bernstein et al. (12) have reported superior survival outcomes in patients receiving HD treatment in satellite units compared with in-center patients in a Canadian program in Manitoba. In terms of HRQOL, both Roderick et al. (11) and Diamant et al. (9) found similar scores between in-center and satellite HD patients on most questionnaire domains. Additionally, Roderick et al. also reported a significantly higher score on the Dialysis Staff Encouragement subscale for satellite patients. The greater scores on the Role-Physical and Role-Emotional subscales reported by in-center patients have not been duplicated in other studies, however.

There are a few possible explanations as to why a trend of superior clinical performance was observed among satellite-based patients. As identified in previous literature (9), satellite-based patients have reported continuity with staff as an advantage of receiving HD in a satellite unit. Additionally, it is possible that the chosen covariates did not entirely adjust for the differences between satellite and in-center patients, leading to a degree of residual confounding. In other words, patients cared for in satellite units may have been “inherently” healthier or more functional than those treated in-center.

In terms of HRQOL, a superior score on the Dialysis Staff Encouragement subscale reported by satellite patients may have also been a consequence of continuity of care, familiarity with unit staff, and consistent arrangement of delivery of care. However, the superior Role-Physical and Role-Emotional scores reported by in-center patients were not expected, and may be a result of differing social and family roles and expectations that were not accounted for in the collected data.

According to Samsa et al. (23), the minimal clinically important difference on the SF-36 questionnaire (which serves as the core of the KDQOL-SF) is 3 to 5 units. Thus, the differences in mean Role-Physical and Dialysis Staff Encouragement subscale scores reached both statistical and clinical significance after adjustment for multiple testing. The fact that there were a number of clinically significant adjusted differences between satellite and in-center patients for certain domains that did not reach statistical significance may be explained, in part, by a lack of statistical power when adjusting for correlated outcomes.

There are a few limitations relating to the use of clinical performance targets as outcome measures in this study. First, the performance indicators used act as surrogate measures for “hard outcomes” such as mortality and hospitalization. Although there is considerable evidence linking the performance targets with mortality, as well as their incorporation into clinical practice guidelines, there is some controversy as to their effectiveness in acting as measures of ongoing patient performance on HD. Furthermore, some patients died before they could fill out the HRQOL questionnaire. Because low HRQOL scores have previously been linked to an increased risk of mortality (19), it is possible that the HRQOL results from patients who completed the questionnaire are somewhat skewed. Additionally, because of the cross-sectional nature with which HRQOL is measured, this study provides little insight into temporal changes in clinical performance or HRQOL in the study population. However, previous literature has demonstrated that, with the exception of the first 3 months after treatment initiation, HRQOL remains relatively stable over time in chronic HD patients, with a slight decrease in scores observed only for certain subscales comprising the physical HRQOL component (24–26).

The mean SF-36 subscale and component scores among study participants are quite similar to Canadian HD norms (27), whereas the kidney disease domain scores are similar to patients in selected countries participating in DOPPS (3). This lends support to the notion that, although this study was performed at an academic center and its affiliated dialysis clinics in Southwestern Ontario and had relatively few enrolled individuals from visible minority groups, the results are generalizable to the Canadian HD population, as well HD patients in other nations, provided their centers have similar models of care.

Conclusions

Patients dialyzing in satellite units, at a distance from their nephrologists, have similar or improved performance targets as compared with patients dialyzing in-center, with a similar reported HRQOL.

Disclosures

None.
References


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