Hemodialysis Patient Experience and the In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) Survey: An In-depth Evaluation of Survey Response and Clinical Outcomes

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Abstract

Background

The In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey is the only patient-reported outcome measure currently used to evaluate patient experience across all in-center hemodialysis facilities in the US. Since mandatory implementation in 2014, response rates have been very low while the financial and public reporting importance of this measure has been increasing. Despite this, there has been no real-world evaluation of non-response or factors associated with better reported experience.

Methods

All Dialysis Clinic Inc. (DCI) patients nationally who met eligibility for the survey were included. Patient-level demographic, clinical and treatment related characteristics were obtained from DCI's electronic medical record. These data were merged with patient-level survey response status and survey scores. Multivariable logistic regression was performed to evaluate characteristics associated with non-response. Cox proportional hazards models were used to evaluate survey response status and long-term clinical outcomes. Lastly, multivariable logistic regression was performed to evaluate characteristics associated with higher experience scores within six domains.

Results

Non-responders to the ICH CAHPS survey were generally younger, non-white, male sex, more socio-economically disadvantaged, sicker, and less adherent to dialysis treatments. Survey responders had a lower risk of dying or being hospitalized and had a higher likelihood of receiving a kidney transplant. Older age and telephone administration of the

survey were consistently associated with higher experience scores while other characteristics varied depending on the ICH CAHPS patient experience domain being evaluated.

Conclusions

Current ICH CAHPS survey results are generated from a select group of patients with more favorable long-term clinical outcomes and therefore lack generalizability. Certain demographic, clinical and treatment related characteristics are associated with higher scores. Further qualitative research is needed to understand the drivers of survey response and better patient experience before survey results can be used for quality improvement.

Dedication

I want to dedicate this work to my family. Without their never-ending love and support (despite my already being a trainee for the 9 years before starting this program) I would not have been able to complete this Master's program.

Acknowledgements

I want to acknowledge the immense amount of help I received from my mentoring team; I would not have been able to complete this work without them! In particular I want to acknowledge all the guidance, support and mentoring that I have received (and continue to receive) since my intern year from Dan Weiner. He has spent countless number of hours training me both as a nephrologist and a researcher. He is my role model for someone who humbly does it all-an incredible and dedicated clinician, educator, scientist, and administrator. I also want to acknowledge the Division of Nephrology at Tufts Medical Center for encouraging and supporting me throughout my studies. I want to acknowledge all the incredible instructors I had in the CTSI program who taught me how to think, analyze, and write like a researcher. Finally, I want to acknowledge Dialysis Clinic Incorporated and all of their patients; without their clinical and survey data none of this important work would have been possible.

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List of Abbreviations

Activities of daily living (ADL)
Agency for Healthcare Research and Quality (AHRQ)
Body mass index (BMI)
Centers for Medicare and Medicaid Services (CMS)
Dialysis Clinic, Incorporated (DCI)
End Stage Renal Disease Quality Incentive Program (ESRD QIP)
ESRD Seamless Care Organization (ESCO)
Health Effectiveness Data and Information Set (HEDIS)
Hemodialysis (HD)
Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS)
Hazard ratio (HR)
In-center hemodialysis (ICH)
In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS)
Intra-class correlation (ICC)
Medicare Improvements for Patients and Providers Act (MIPPA)
Medicare Managed Care (MMC)
National Institutes of Health National Institute of Diabetes, Digestive and Kidney Diseases (NIH NIDDK)
National Quality Forum (NQF)
Nephrologists' Communication and Caring (NCC)
Providing Information to Patients (PIP)
Quality of Dialysis Center Care and Operations (DCO)

Chapter 1: Introduction

In-center hemodialysis (ICH) is the most common treatment option for patients with end-stage renal disease (ESRD) in the United States. The prevalence of patients being treated with ICH has grown annually, rising to approximately 430,000 people as of the end of 2014 at a total annual cost of approximately $26 billion.[1,2] Similar to other health care environments, The Triple Aim[3] of reducing cost, improving health and improving patient experience applies to ICH. While there has been a proliferation of quality of care measures over the past decade that apply to easily measurable items like anemia management and dialysis dose, evaluation of patient experience only recently has been included in dialysis quality payment systems.

The In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey was developed by the Agency for Healthcare Research and Quality (AHRQ) and The Centers for Medicare and Medicaid Services (CMS) in an effort to standardize assessment of patient experience among ICH patients.[4] This survey was incorporated as the first patient-reported outcome measure into the pay-for-performance reimbursement system used to pay dialysis facilities for ICH in 2014.[5] Prior to 2014, the quality metrics evaluated in this reimbursement system included only clinical and laboratory measures.

Although implementation of this survey was a milestone in the evolution of this pay-for-performance system, generalizability and applicability of survey results remains uncertain. Response rates to the survey have been declining over time (with the most

recent estimate of 30% in 2016)[6] raising concern for possible response bias. At the same time there has been no published literature assessing drivers of better experience scores to allow use of survey results for quality improvement. In spite of this, the importance of ICH CAHPS survey scores is projected to increase soon along with the financial consequences for dialysis providers, particularly for those participating in comprehensive ESRD care models.[7]

In its current form, the ICH CAHPS survey consists of 62 questions grouped into three global rating scores that evaluate the nephrologist, the dialysis facility staff, and the dialysis facility and three composite scores that evaluate Nephrologists' Communication and Caring (NCC), Quality of Dialysis Center Care and Operations (DCO), and Providing Information to Patients (PIP).[8] Facilities receive one score for each global rating domain and for each composite domain that pools all of the patient responses from a facility. Patient-level survey response status or survey scores are only available to CMS; specifically, dialysis providers have been prohibited by regulation from receiving patient-level survey data since 2014.

Two peer-reviewed studies represent the entirety of the published literature available on the evaluation of the ICH CAHPS survey.[9,10] Response rate during initial field testing by the survey developers was only 46% (N=1,454), and data from this testing were not used to assess for response bias or to evaluate factors associated with higher survey scores.[9] A subsequent independent analysis of this survey included 819 ICH patients selected by nephrologists from across the US.[10] Data from this study were used primarily for

psychometric evaluation of the survey and secondarily, using inadequate statistical methods, to assess patient-level and facility-level characteristics associated with better scores.

Despite these limitations and the knowledge gaps described above, ICH CAHPS survey administration is mandatory in all US in-center hemodialysis facilities with more than 10 patients treated in a calendar year. ICH patients older than 18 years who have received dialysis at their facility for more than 3 months are eligible to receive this survey twice yearly. ICH CAHPS survey results are impactful at multiple levels. Poor scores could contribute to up to 2% lower Medicare reimbursement to dialysis facilities paid under the standard ESRD bundle, while public reporting of scores could impact perceptions of facility quality. For clusters of facilities participating in a comprehensive ESRD care model, below average performance on ICH CAHPS has the potential to result in a loss of shared savings related to that metric. Accordingly, providers are pushed to change their practices based on underperforming areas identified by this survey despite low and potentially biased response rates, lack of data on interventions that are proven to improve patient experience, and presence of significant heterogeneity between patients and their care expectations.

In this thesis we provide the first in-depth evaluation of the ICH CAHPS survey using real world data from 2012 from a national sample of ICH patients receiving care at the largest not-for-profit dialysis provider in the US, Dialysis Clinic, Incorporated (DCI).

Chapter 2: Evaluation of non-response to the In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) Survey

2.1 Background

Patient experience is an integral part of patient-centered care. Multiple factors influence patient experience, including characteristics of the facility, interactions with care teams, patient expectations, and response to or complications of treatment. Interest in measuring patient experience dates to Health Effectiveness Data and Information Set (HEDIS) measures evaluating this in the early 1990s in the United States[11]. However, response bias and low response rates complicate measurement of patient experience[12,13].

The US Agency for Healthcare Research and Quality (AHRQ) developed consumer assessment surveys starting in the 1990s. The Centers for Medicare and Medicaid Services (CMS) in conjunction with AHRQ began developing the In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey in 2004[4]. After field testing in 2005, ICH CAHPS was endorsed by the National Quality Forum (NQF) in 2007 and was incorporated into the End Stage Renal Disease Quality Incentive Program (ESRD QIP) as the first patient reported outcome measure in 2014[5,9,14]. Mandatory twice yearly survey administration began in 2016, and facilities with at least 30 annual responses are subject to financial penalties for lower patient experience scores.

Critically, there may be informative differences among patients who complete and do not complete the ICH CAHPS survey that may result in misrepresentation of overall patient experience at a dialysis facility; however, despite its incorporation into value-based payments several years ago, little is known about characteristics of responders and non-

responders. Response rates during development and validation of ICH CAHPS were only 46%[9], despite conditions being optimized during this development process. Response rates have continued to drop since the ICH CAHPS has been implemented in the clinical setting, even while the financial and public reporting importance of this assessment of patient experience has increased[7,15]. As in other areas of medicine, understanding presence of bias and the subsequent generalizability of a test is of utmost importance when interpreting test results and prior to implementing change. No such large-scale published evaluation of this survey has been performed, even though this evaluation is critical for interpreting a facility's ICH CAHPS results since facilities across the US vary widely in the populations they serve. Accordingly, we performed the first step in the evaluation of non-response bias by exploring patient characteristics associated with non-response to the ICH CAHPS survey administered in 2012 to patients treated at Dialysis Clinic, Inc. (DCI) facilities nationally.

2.2 Methods

2.2.1 Study Population

Per 2012 AHRQ guidelines, ICH CAHPS eligible patients consisted of all in-center HD patients at least 18 years old who had been at their facility for at least 3 months. Responses from eligible patients were deemed usable only if patients indicated receiving no proxy help and at least 50% of pre-defined key questions were answered (Table 6.1.1)[16].

2.2.2 Survey

The ICH CAHPS survey administered in 2012 had 58 questions and was available in English and Spanish. Responses were grouped into three composite scores and three global rating scales. The three composite scores were '*Nephrologists' Communication and Caring*', '*Quality of Dialysis Center Care and Operations*', and '*Providing Information to Patients*'; these composite scores were derived from questions that used either '*never/sometimes/usually/always*' responses or '*yes/no*' responses. The three global rating scales rated nephrologists, dialysis center staff, and the dialysis facility on a scale of 0-10 (with 0 being worst and 10 being best). The remaining survey questions asked about demographic characteristics, comorbid medical conditions, and whether or not help was received in answering the survey questions.

2.2.3 Survey Administration

Dialysis facilities were required to select third party vendors to administer the ICH CAHPS survey. DCI's survey vendor followed AHRQ guidelines for survey administration, data collection, and data submission. Before the survey administration period, DCI in-center HD facilities received staff and patient education materials describing AHRQ survey administration requirements. AHRQ requirements did not allow dialysis provider, facility staff or physician involvement in survey administration or in the collection of results. As instructed by the survey vendor, on August 3, 2012 DCI created a data file of eligible patients from its electronic medical information system containing mailing addresses, telephone numbers, and primary language. Approximately 10 days later, the survey vendor mailed patients a pre-notification letter on DCI

letterhead, signed by a member of the DCI executive team. The letter informed patients that they would receive a survey regarding the care they received at their dialysis facility and that their responses were very important. One week later, ICH CAHPS surveys were mailed to all potentially eligible patients by the survey vendor. Patients were instructed to mail completed surveys directly back to the survey vendor in pre-paid and addressed envelopes. Two weeks after the first survey mailing, the survey vendor sent a reminder letter to non-responders to the first mailing, and another copy of the survey 30 days after the first survey mailing. In October, the survey vendor contacted patients who had not replied to either of the mailed surveys by telephone up to three times over a 4-week period.

2.2.4 Study Design

DCI has over 200 dialysis facilities nationally. Their survey vendor provided patient-level data from the 2012 survey period to DCI exclusively for quality improvement and research purposes under a signed Respondent Identifiable Information Disclosure Agreement. A member of the DCI information technology team who was independent from the research team merged survey data to individual patient DCI electronic medical data and de-identified the dataset. The primary study outcome was non-response to the ICH CAHPS survey. In primary analyses, only surveys meeting AHRQ's definition of usable (no proxy help and answers to at least 50% of pre-defined key questions) were included (Figure 1). In secondary analyses, survey response was defined using an "expanded usable" criteria which included AHRQ usable surveys as well as surveys without 50% of pre-defined key questions answered and surveys indicating proxy help

(Figure 6.1). For surveys indicating proxy help, we only included surveys where the patient checked off receiving help from a family member or friend and checked off any of the following describing the help they received: “Read the questions to me,” “Wrote down the answers I gave,” or both. This definition is more consistent with current ICH CAHPS scoring rules.

To account for missing data, we performed multiple imputation of missing covariates for use in sensitivity analyses. Following imputation, we compared patients with AHRQ usable responses to non-responders (Figure 6.2), and we compared the “expanded usable” group of responders to non-responders (Figure 6.3). The study was approved by the Tufts Medical Center Investigational Review Board.

2.2.5 Clinical Characteristics

Patient clinical characteristics ascertained from DCI medical records included patient demographics, medical records, clinical variables, information on HD treatments, and functional assessments. Since the precise date of survey completion is not known, all covariate data were taken from August 2012 (when eligible patients were identified by DCI and information was sent to the survey vendor). All laboratory analyses were performed at the central DCI laboratory in Nashville, TN. For missing August laboratory data, we used the last non-missing value within three months prior to August 2012. Specifically for missing vascular access data in August, we used the most frequently used vascular access in May, June and July 2012. Unexcused absence was defined as missing an entire HD treatment that was not rescheduled and for which a reason (e.g.

hospitalization) was not available; shortened treatments were defined as at least one treatment being shorter than prescribed by 15 minutes or more, and hospitalizations were defined as any hospital stay. Body mass index (BMI) was calculated using the last estimated dry weight ordered by the patient's nephrologist. Data on functional covariates including ability to ambulate, ability to transfer, falls in the past month, activities of daily living (ADL) score, and nursing home residence were obtained from the nursing assessment most proximate to the survey administration period. The ADL score was derived from 8 questions from the nursing assessment evaluating the patient's ability to bathe, dress, feed, use the toilet, shop for groceries, prepare meals, do housework, and take medications; 1 point was given for each activity that the patient could independently perform, and 0 points were given if assistance of any type was needed.

2.2.6 Statistical Analysis

We used a random intercept two-level logistic regression model with patients nested within dialysis facilities to model the probability of non-response using the AHRQ definition. The Intra-class correlation (ICC) was calculated using the latent variable model approach[17]. The unobserved patient variable follows a logistic distribution with individual level variance V_I equal to $\pi^2/3$. On this basis, the ICC is calculated as $ICC=V_A/(V_A+\pi^2/3)$ where V_A is the facility residual variance on the logistic scale. Models were fitted sequentially starting with a parsiminous model using primarily demographic data; subsequent models added clinical and functional data. Secondary analyses used the same covariates in the "expanded usable" cohort defined above. Multivariate multiple imputation for missing covariates was performed using chained

equations, averaging five models using Rubin's rule[18]. The imputation model included response status and variables listed in Table 1, with the exception of ability to ambulate, ability to transfer, history of falls, ADL score, and nursing home residence. To account for the multilevel nature of the data, the imputation model included dummy variables for each dialysis facility. We checked for functional forms of all continuous variables using restricted cubic splines in the rms package in R. There were no statistically significant deviations from linearity for any continuous variable. To measure the overall importance of each variable in the multivariable model, we plotted the ranked Chi-squared minus degrees of freedom for each variable[19]. Analyses were performed using SAS Enterprise Guide (Version 7.12, Cary, NC) and R language (version 3.3.1, R Foundation for Statistical Computing, Vienna Austria).

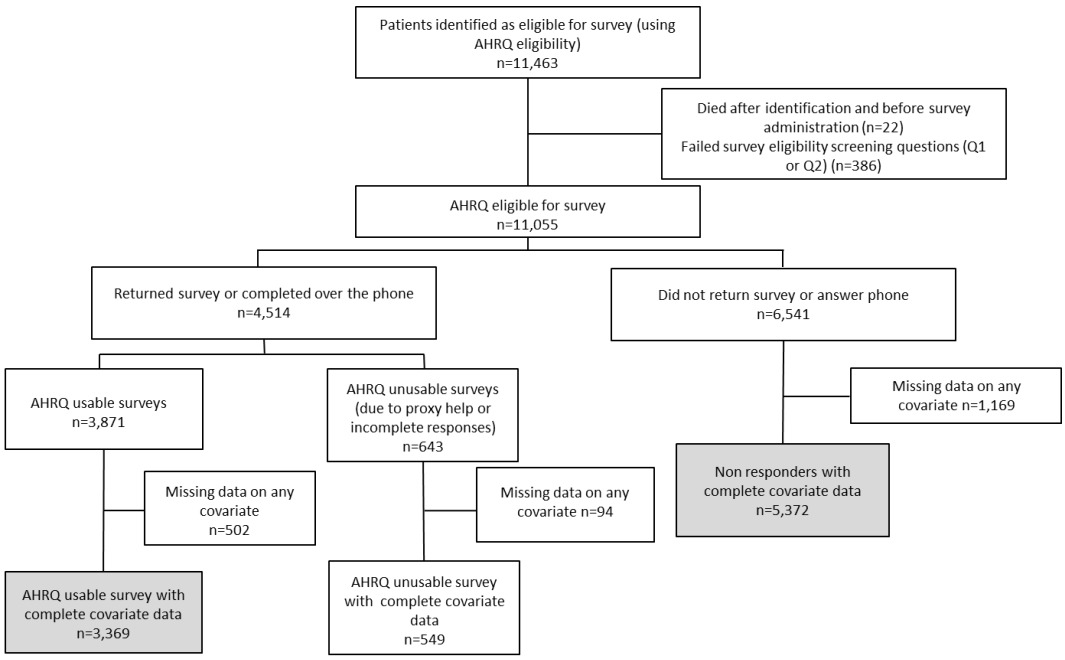
2.3 Results

2.3.1 Study Population

There were 11,463 patients initially identified by DCI as meeting AHRQ-defined eligibility for the ICH CAHPS survey. Of these, 22 died during the survey administration period and 386 were deemed ineligible based on responses to eligibility screening questions in the survey meant to confirm ongoing in-center HD treatments at their HD facility for at least 3 months. The latter was probably a combination of incorrect initial identification, modality switch after identification, and inaccurate response from patients to the screening questions. Among 11,055 AHRQ eligible patients, 6,541 (59%) did not return the survey or answer phone calls from the vendor. Of these non-responders, an additional 1,169 (18%) patients were excluded in our primary analysis because of

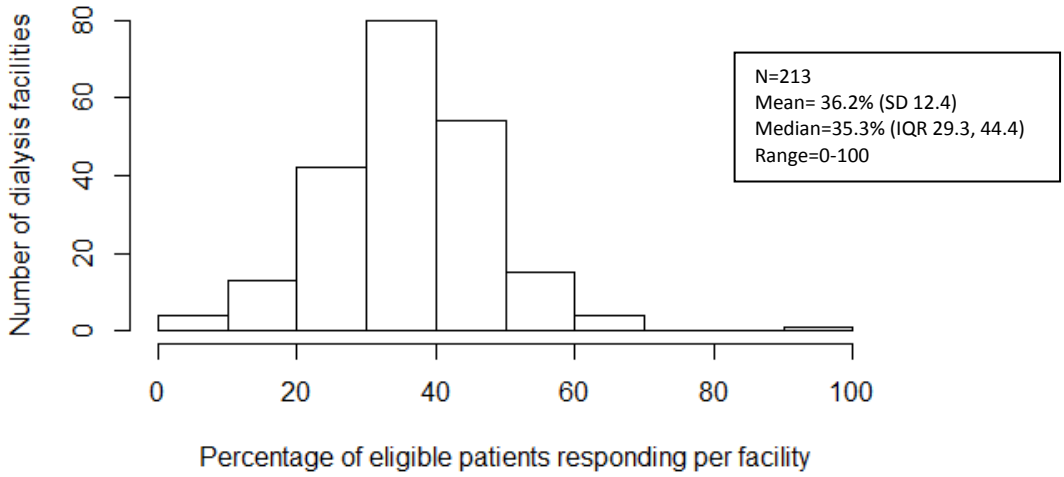
missing data on at least one covariate (Figure 2.1). The response rate per facility ranged from 0-100% of eligible patients (Figure 2.2). Of the 4,514 (41%) patients who completed the survey, 643 (14%) responses could not be scored because of indicating proxy help or not completing at least 50% of the AHRQ key questions. Of all patients who provided any response, 596 (13%) were excluded in our primary analysis because of missing data on at least one covariate.

Figure 2.1: Flow diagram



*Patients in the gray boxes above are compared to each other for the primary analysis

Figure 2.2: Distribution of Response Rates per Facility



2.3.2 Primary Analyses

Non-responders, based on AHRQ criteria, differed from responders and from those who had incomplete responses or proxy help in demographic, clinical, and functional characteristics (Table 2.1). In adjusted analyses, non-responders as compared to responders were more likely to be men, non-white, younger, single, dual Medicare/Medicaid eligible, less educated, and non-English speaking. Non-responders had longer ESRD vintage, were more likely to be inactive on the kidney transplant list, and had lower BMI and lower serum albumin. Non-responders had worse functional status, more hospitalizations, missed treatments, and shortened treatments (Table 2.2). Race, serum albumin concentration, and education level were the three most influential variables predicting non-response (Figure 2.3).

Table 2.1: Baseline characteristics

	Total (n=9290)	AHRQ usable surveys (n=3369, 36%)	Proxy help/ incomplete responses (n=549, 6%)	AHRQ non-responses (n=5372, 58%)
Age	61.1 ± 14.8	62.1 ± 13.9	68.0 ± 13.1	59.8 ± 15.3
Female Sex	4068 (43.8%)	1547 (45.9%)	215 (39.2%)	2306 (42.9%)
Race				
Black	4126 (44.4%)	1294 (38.4%)	188 (34.2%)	2644 (49.2%)
White	4486 (48.3%)	1917 (56.9%)	340 (61.9%)	2229 (41.5%)
Other	678 (7.3%)	158 (4.7%)	21 (3.8%)	499 (9.3%)
Hispanic	637 (6.9%)	176 (5.2%)	39 (7.1%)	422 (7.9%)
Cause of ESRD				
Diabetes	4015 (43.2%)	1357 (40.3%)	286 (52.1%)	2372 (44.2%)
Hypertension	2630 (28.3%)	960 (28.5%)	149 (27.1%)	1521 (28.3%)
Other	2645 (28.5%)	1052 (31.2%)	114 (20.8%)	1479 (27.5%)
Marital status				
Married	3555 (38.3%)	1465 (43.5%)	295 (53.7%)	1795 (33.4%)
Divorced/ Separated	1947 (21.0%)	694 (20.6%)	76 (13.8%)	1177 (21.9%)
Widowed	1476 (15.9%)	476 (14.1%)	104 (18.9%)	896 (16.7%)
Single	2312 (24.9%)	734 (21.8%)	74 (13.5%)	1504 (28.0%)
Education Level				
Grade School	1221 (13.1%)	271 (8.0%)	127 (23.1%)	823 (15.3%)
High School	5679 (61.1%)	2082 (61.8%)	354 (64.5%)	3243 (60.4%)
College/ Post Graduate	2390 (25.7%)	1016 (30.2%)	68 (12.4%)	1306 (24.3%)
English speaker	8992 (96.8%)	3326 (98.7%)	528 (96.2%)	5138 (95.6%)
Nursing home resident	682 (7.3%)	92 (2.7%)	40 (7.3%)	550 (10.2%)
Insurance				
Medicare/ Medicaid	3303 (35.6%)	959 (28.5%)	179 (32.6%)	2165 (40.3%)
Medicare only	3646 (39.3%)	1533 (45.5%)	233 (42.4%)	1880 (35.0%)
Medicaid only	533 (5.7%)	153 (4.5%)	22 (4.0%)	358 (6.7%)
Other	1808 (19.5%)	724 (21.5%)	115 (21.0%)	969 (18.0%)
Active on transplant waitlist	1048 (11.3%)	456 (13.5%)	37 (6.7%)	555 (10.3%)
Vascular access				

Fistula	5765 (62.1%)	2198 (65.2%)	349 (63.6%)	3218 (59.9%)
Graft	1974 (21.3%)	703 (20.9%)	127 (23.1%)	1144 (21.3%)
Catheter	1551 (16.7%)	468 (13.9%)	73 (13.3%)	1010 (18.8%)
Albumin (g/dL)	3.8 ± 0.4	3.9 ± 0.4	3.8 ± 0.4	3.8 ± 0.4
Hemoglobin (g/dL)	11.1 ± 1.2	11.2 ± 1.1	11.2 ± 1.0	11.1 ± 1.2
Kt/V	1.62 ± 0.28	1.63 ± 0.27	1.65 ± 0.28	1.61 ± 0.29
BMI (kg/m^2)	28.4 ± 7.6	29.2 ± 7.6	28.0 ± 7.0	28.0 ± 7.5
Unexcused absences	1638 (17.6%)	476 (14.1%)	52 (9.5%)	1110 (20.7%)
Treatments shortened	4632 (49.9%)	1481 (44.0%)	204 (37.2%)	2947 (54.9%)
Hospitalizations	1303 (14.0%)	336 (10.0%)	59 (10.8%)	908 (16.9%)
ESRD vintage (months)	40.4 (19.5, 76.4)	37.6 (18.2, 72.1)	39.5 (18.6, 76.8)	42.5 (20.8, 78.5)
ESRD vintage > 12 months before current facility	2057 (22.1%)	711 (21.1%)	103 (18.8%)	1243 (23.1%)
Ability to ambulate	7105 (76.5%)	2858 (84.8%)	359 (65.4%)	3888 (72.4%)
Ability to transfer	7820 (84.2%)	3047 (90.4%)	415 (75.6%)	4358 (81.1%)
Falls	894 (9.6%)	312 (9.3%)	75 (13.7%)	507 (9.4%)
ADL score	5.7 ± 2.6	6.5 ± 2.1	4.4 ± 2.6	5.4 ± 2.8

Data shown as mean ± SD or median (25^{th}, 75^{th} percentiles) or n (%). BMI: Body mass index; ESRD: End-stage renal disease; ADL: Activities of daily living

Table 2.2: Multivariable logistic regression models predicting non-response

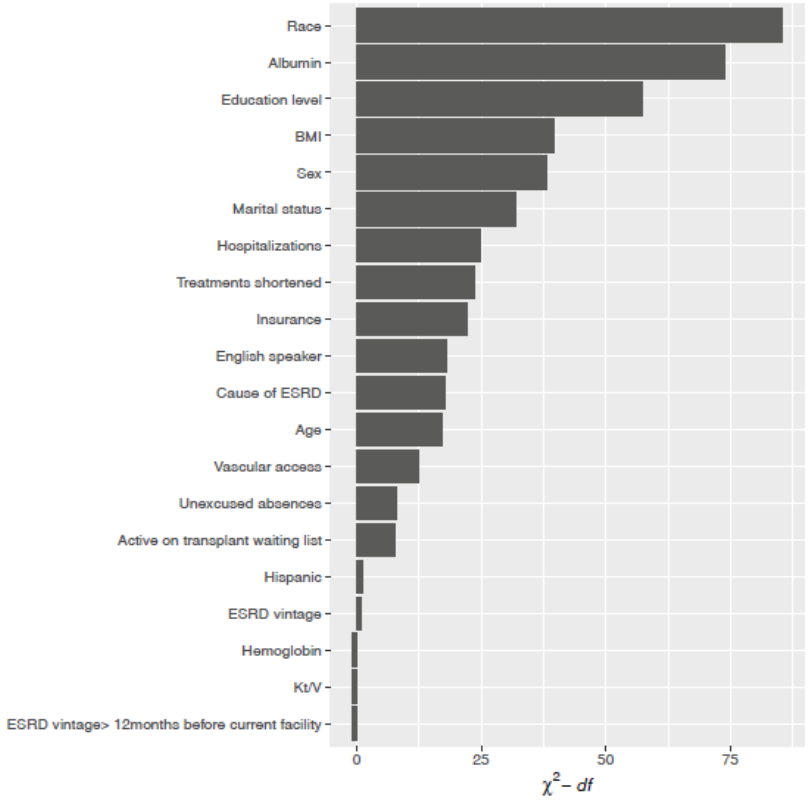
		Model 1	Model 2	Model 3
ICC		0.008	0.007	0.008
Age (per 5 years)		0.98 (0.96, 1.00)	**0.96 (0.94, 0.98)**	**0.90 (0.88, 0.92)**
Female Sex		**0.76 (0.69, 0.83)**	**0.73 (0.66, 0.80)**	**0.70 (0.63, 0.77)**
Race:	White	**0.64 (0.58, 0.71)**	**0.66 (0.59, 0.73)**	**0.60 (0.54, 0.67)**
	Other	1.20 (0.97, 1.47)	1.20 (0.97, 1.49)	1.15 (0.92, 1.43)
	Black	Ref	Ref	Ref
Hispanic ethnicity		1.17 (0.95, 1.45)	1.16 (0.93, 1.43)	1.20 (0.96, 1.49)
Insurance:	Medicare/Medicaid	**1.36 (1.19, 1.55)**	**1.27 (1.11, 1.45)**	1.07 (0.93, 1.23)
	Medicare only	0.96 (0.85,	0.96 (0.85,	0.95 (0.84,

	1.08)	1.08)	1.08)
Medicaid only	1.22 (0.97, 1.53)	1.10 (0.87, 1.38)	0.90 (0.71, 1.14)
Other	Ref	Ref	Ref
Marital status: Married	**0.85 (0.74, 0.96)**	**0.87 (0.77, 1.00)**	**0.87 (0.76, 0.99)**
Divorced/separated	0.96 (0.84, 1.10)	0.94 (0.82, 1.08)	1.01 (0.87, 1.16)
Widowed	**1.32 (1.11, 1.56)**	**1.34 (1.12, 1.59)**	**1.35 (1.13, 1.61)**
Single	Ref	Ref	Ref
Education: Grade school	**2.01 (1.69, 2.38)**	**1.97 (1.65, 2.34)**	**1.90 (1.59, 2.27)**
High school	**1.18 (1.06, 1.30)**	**1.14 (1.03, 1.27)**	**1.15 (1.04, 1.28)**
College or more	Ref	Ref	Ref
English speaker	**0.49 (0.34, 0.70)**	**0.45 (0.31, 0.65)**	**0.47 (0.32, 0.68)**
Hospitalization in last month		**1.43 (1.24, 1.65)**	**1.38 (1.19, 1.60)**
Active on transplant waitlist		**0.81 (0.70, 0.93)**	0.91 (0.79, 1.06)
BMI (per 2 kg/m^2)		**0.96 (0.95, 0.97)**	**0.96 (0.95, 0.97)**
Cause ESRD: Diabetes		**1.30 (1.16, 1.45)**	**1.15 (1.02, 1.29)**
Hypertension		1.09 (0.97, 1.23)	1.10 (0.97, 1.25)
Other		Ref	Ref
Vascular access: Catheter		**1.29 (1.13, 1.47)**	1.06 (0.93, 1.22)
Graft		1.00 (0.89, 1.12)	0.96 (0.86, 1.09)
Fistula		Ref	Ref
Hemoglobin (per 0.5 g/dL)		0.99 (0.97, 1.01)	0.99 (0.97, 1.01)
Albumin (per 0.2 g/dL)		**0.89 (0.87, 0.92)**	**0.94 (0.92, 0.97)**
Kt/V (per 0.2)		1.00 (0.96, 1.04)	0.99 (0.95, 1.02)
ESRD vintage (per 12 months)		**1.02 (1.00, 1.04)**	**1.02 (1.00, 1.04)**
ESRD vintage > 12 months before current facility		0.96 (0.85, 1.09)	0.93 (0.82, 1.06)
Unexcused absences in last month		**1.22 (1.07,**	**1.26 (1.11,**

		1.38)	**1.43)**
Treatments shortened in last month		**1.26 (1.15, 1.38)**	**1.26 (1.14, 1.38)**
Ability to ambulate			**0.83 (0.69, 1.00)**
Ability to transfer			1.15 (0.93, 1.41)
Falls in last month			0.93 (0.79, 1.09)
Nursing home resident			**1.77 (1.37, 2.29)**
ADL score (per 1 increase)			**0.83 (0.80, 0.85)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with non-response. Associations with $p<0.05$ are in bold. BMI: Body mass index; ESRD: End-stage renal disease; ADL: Activities of daily living

Figure 2.3: Ranking of variable contribution for determining non-response



Derived using data from model 2 (without functional covariates) shown in table 2. ESRD: End stage renal disease; ADL: Activities of daily living; BMI: Body mass index

2.3.3 Secondary Analyses

We included 549 survey responses with complete covariate data that either indicated receiving proxy help or did not respond to at least 50% of AHRQ pre-defined key questions (Figure 6.1). Overall, these 549 patients differed from AHRQ-defined responders in several demographic, clinical, and functional characteristics (Table 1). By including these surveys, we gained an average of 5% more responses for most demographic covariates (Figure 6.4). Factors that predict non-response to the survey were similar to primary analyses when including this expanded response group (Table 6.2).

2.3.4 Sensitivity Analyses

The majority of missing data was on functional covariates (Table 6.3). Patients with missing covariate data were more often black and had shorter ESRD vintage (Table 6.4). Models using multiple imputation for missing data had similar results to the primary and secondary analyses (Tables 6.5 and 6.6).

2.4 Discussion

In a large national in-center HD population, non-responders to the ICH CAHPS survey differed substantially from responders. Specifically, non-responders were more likely to be men, non-white, younger, single, dual Medicare/Medicaid eligible, less educated, non-English speaking, inactive on the transplant list, and had longer ESRD vintage, lower BMI and lower serum albumin, worse functional status, and more hospitalizations, missed treatments, and shortened treatments. These results demonstrate significant underrepresentation of important groups of in-center HD patients, broadly spanning

individuals with fewer socioeconomic advantages and greater illness burden. It is possible that these results could introduce biases into facility-level ICH CAHPS survey results, particularly given low overall response rates.

CAHPS surveys are widely used in US medical settings to evaluate patient experience, with other CAHPS surveys targeting hospitals, nursing homes and other settings. The ICH CAHPS is unique as it evaluates facilities with a relatively low number of patients per facility and with longstanding patient-facility relationships rather than discreet episodes. There is limited published literature on characteristics of non-responders to other CAHPS surveys. Most importantly, previous assessments use only limited patient-reported characteristics unlike our study where we use extensive characteristics gathered using reliable data sources rather than patient self-report. Even so, similar to our findings, analysis of Medicare Managed Care (MMC) CAHPS survey from 1997 and 1999 found significantly higher non-response rates in participants who were male and non-white[20]. Likewise, analysis of the Hospital CAHPS (HCAHPS) pilot survey data from 2002-2003 also found male sex, younger age, and non-white race to be significantly associated with non-response[21]. Finally, in a large sample of Medicare CAHPS participants from 2007 there were significantly higher non-response rates in participants who were men, non-white, and dual eligible for Medicare and Medicaid[22].

To our knowledge, this is the only non-CMS dataset linking individual patient-level clinical data to ICH CAHPS responses, and this is the first study assessing the differences in characteristics, including laboratory variables and treatment characteristics, between

responders and non-responders. Previous published work on the ICH CAHPS survey is restricted to reports on the development and testing of this survey, where there was a response rate of only 46% and there was no published evaluation of non-responders[9,10]. Although supervision of ICH CAHPS administration was transferred from AHRQ to CMS in 2014, the current survey remains similar to the one administered in 2012, with the major exception that limited assistance is now allowed, consistent with the 'expanded usable' criteria used in secondary analyses in this manuscript.

Payers increasingly are moving towards value based purchasing models, with performance metrics critical to quantify value. Before the addition of ICH CAHPS as a performance metric, the ESRD QIP was composed of only clinical and laboratory measures, most of which were not specifically patient-centered outcomes [23]. Patient experience measures have been widely implemented in other areas of healthcare, and use of the ICH CAHPS survey represents an important milestone for in-center HD; however, attempts to address patient-centered care using a patient-reported outcome measures with very low response rates may be problematic. Paradoxically, we found that non-responders tended to be patients who are disproportionately represented in the US ESRD population as compared to the general population (specifically younger, black, male, and diabetics).[1] These differences in characteristics associated with non-response raise the possibility of response bias; however further research is needed in evaluating whether or not these characteristics are also associated with experience scores and will thereby bias facility performance ratings and performance-based payments as well as misrepresent the key areas needed for intervention to improve patient experience.[24]

Unfortunately, the specific reasons for non-response remain unknown. Neither the former AHRQ nor the current CMS administration process collects reasons for non-response unless it is due to incorrect contact information. Comorbid conditions common among dialysis patients include physical, cognitive, and visual impairments that may limit the ability of HD patients to respond to a survey themselves. Accordingly, and particularly in view of the survey's length (currently 62 questions), the decision by AHRQ to not allow assistance may have had important implications. Using a less restrictive method of classifying survey completion, more consistent with current CMS guidance, we were able to include approximately 5% more responses across most demographic characteristics; notably, inclusion of these surveys did not change the predictors of non-response.

Our results may have substantial implications for dialysis facilities if characteristics associated with non-response are also associated with experience scores. Starting in calendar year 2016 (and reflected in 2018 payments to facilities), survey results are a clinical performance measure and carry greater weight within the ESRD QIP. Future plans by CMS include increasing further the weight of this measure within the QIP.[7]

An important strength of this study is that it documents new information about the real-world administration of the ICH CAHPS survey. Additionally, this study provides information that can no longer be gathered since survey vendors are now barred from providing patient-level data to dialysis facilities. Other strengths include having a large number of survey responses from a national dialysis provider linked to extensive facility gathered patient-level demographic, clinical, and functional data. Limitations include not

knowing the precise date of survey completion during the survey administration period, which required the use of proximate covariate data. As with most surveys, we do not have information on reasons for non-response.

ICH CAHPS survey response rates remain low overall (only 33% in 2015 despite allowing limited assistance with survey completion[15]), a fact that, when viewed with our study results, raises concern about biases in responses. Future studies should provide ongoing evaluation into the presence of response bias with this survey. Additionally, CMS and dialysis providers will have to find ways to engage populations that have a greater likelihood of non-response, specifically patients with greater illness burden and fewer socioeconomic advantages, in order to improve the generalizability and utility of surveys of patient experience.

2.5 Conclusion

There are significant differences between ICH CAHPS survey non-responders and responders which could potentially affect results. Further work should evaluate causes of non-response and interventions to increase response rates in an attempt to increase generalizability of survey results.

2.6 Declarations

Ethics approval and consent to participate

This study was approved by the Tufts Medical Center Investigational Review Board

Consent to publish

Not applicable

Availability of data and materials

The data that support the findings of this study are available from DCI but restrictions apply to the availability of these data, which were used under agreement for the current study, and so are not publicly available.

Competing interests

The authors declare that they have no competing interests.

Funding

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Authors' Contributions

TD was involved in the study design, data analysis, and wrote the manuscript drafts. HT, MG, JF, EL, KM, DM, DW, and MR were all involved the study design, data analysis, and editing drafts.

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We thank the DCI patients who complete these very important surveys and DCI personnel who compiled the dataset. We also thank Lorien Dalrymple, MD, MPH for her help in designing this study and contributions to early work on this project.

Chapter 3: In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) Survey Response and Long-term Clinical Outcomes

Dad T, Tighiouart H, Grobert ME, Lacson Jr E, Meyer KB, Weiner DE, Richardson MM. To be Submitted to *J Am Soc Nephrol.*

3.1 Significance statement

The ICH CAHPS survey is the only patient-reported outcome measure currently used for value-based reimbursement for dialysis in the United States. Since survey introduction in 2012, response rates have dropped, raising concern over generalizability and applicability of survey results. This study shows that survey response is associated with lower risk for mortality and hospitalization and higher likelihood of kidney transplantation. These results raise concern over the generalizability of survey results and highlight the need to improve response rates especially from patients who are most vulnerable to having poor outcomes to best understand dialysis patient experience.

3.2 Introduction

With high rates of kidney failure and high costs of dialysis, the US Centers for Medicare and Medicaid Services (CMS) moved to a value-based purchasing model with the introduction of the End Stage Renal Disease Quality Incentive Program (ESRD QIP) in 2012.[5,25] The In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey, developed by CMS and the Agency for Healthcare Research and Quality (AHRQ) in 2005, was the first patient-reported quality metric added to the ESRD QIP.[4] After introduction of this survey into the ESRD QIP in 2014, mandatory twice yearly reporting began in calendar year 2016 and survey results began impacting dialysis facility reimbursement in payment year 2018.

Response rate to the ICH CAHPS survey was 46% during development and has since fallen to 31%.[6,9] Given these declining response rates, there is concern about the

generalizability of survey results. Our previous cross-sectional analyses showed that ICH CAHPS survey responders are generally healthier, socioeconomically more advantaged, and more adherent to hemodialysis treatment than non-responders.[26] To our knowledge, there has been no attempt by either AHRQ or CMS to address survey non-response either through qualitative research to understand the reasons behind non-response or through trials of interventions aimed at reducing non-response. This problem is compounded by regulatory changes enacted in 2014 that prohibit dialysis providers from obtaining patient-level survey results for independent research.

Despite these concerns, the importance of the ICH CAHPS survey has grown. Initially, facilities received QIP credit for simply administering the ICH CAHPS survey. Starting in 2016, however, ICH CAHPS survey scores impacted facility reimbursement, with substantial influence on ESRD Seamless Care Organization (ESCO) shared savings and planned future inclusion in the CMS star rating system for dialysis facilities.[5,7,27]

There is no prior evaluation of response status to the ICH CAHPS survey and long-term clinical outcomes. Using robust and extensive data from a large real-world national sample of in-center hemodialysis patients from Dialysis Clinic Incorporated (DCI) facilities, we examine the relationship between ICH CAHPS survey response status and mortality, hospitalization, and kidney transplantation.

3.3 Methods

3.3.1 Study Population

In-center hemodialysis (ICH) patients who were 18 years and older and had been at their facility for at least 3 months were eligible for the ICH CAHPS survey in 2012. According to AHRQ guidelines, surveys with at least 50% of pre-defined key questions answered that indicated no receipt of proxy help with survey completion were eligible for scoring. We included patients from DCI facilities across the country that were eligible for the survey at the start of August 2012 and remained ICH patients at DCI through the end of the survey period in October 2012. We included surveys that satisfied AHRQ guidelines for completion.

3.3.2 Study Design

In this longitudinal study our primary analysis was the relationship between response status to the 2012 ICH CAHPS survey and the time to death. Secondary analyses evaluated time to first hospitalization and time to kidney transplantation. Patient-level survey results were obtained by DCI for research purposes only under a Respondent Identifiable Information Disclosure Agreement with DCI's vendor. A member of the DCI information technology, not affiliated with the research team, provided merged and de-identified data to the authors. Follow up time starts the day after the end of the survey administration period (October 22, 2012) to avoid immortal time bias. Patients were censored when they reached an event, left DCI, or at the end of the follow up period (January 18th, 2018). To account for competing risks, we performed a sensitivity analysis using the combined endpoint of death or hospitalization and performed a sensitivity

analysis using competing risks models to account for death when evaluating the outcome of kidney transplantation.

3.3.3 Survey

The ICH CAHPS survey administered in 2012 had 58 questions and was available in English and Spanish.[8] Three questions rated the nephrologist, the dialysis staff, and the dialysis facility (on a 0-10 scale, with 10 being the best). The remaining questions were used to compile 3 composite scores: Nephrologists' Communication and Caring (NCC), Quality of Dialysis Center Care and Operations (DCO), and Providing Information to Patients (PIP).

3.3.4 Survey Administration

At the beginning of August 2012, DCI provided its survey vendor with a list of eligible patients along with their contact information. Patients were sent a pre-notification letter by the vendor about 10 days later informing them about the upcoming survey, followed by mailing of the ICH CAHPS survey 1 week later. Patients were instructed to mail the survey directly back to the vendor after completion. Initial survey non-responders received a reminder letter in the mail 2 weeks later, followed by another copy of the ICH CAHPS survey. Patients who still had not responded were contacted by phone up to 3 times and invited to complete the survey over the phone. Survey administration period extended from August 1st, 2012 to October 22nd, 2012. Dialysis facility staff were not allowed to discuss the survey with the patients or help them complete the survey.

3.3.5 Covariates

Covariates thought to be either confounders or related to the outcome were chosen *a priori* based on the prior literature and clinical knowledge. All covariate data was obtained from the DCI electronic medical record system. Since the actual date of survey completion is not known, all covariate data were obtained from the month the survey administration began (August, 2012). Any covariate data that were missing in August prompted a 3-month look back, and the most proximate value was used. Body Mass Index (BMI) was calculated using the most the recent estimated dry weight set by the patient's nephrologist. Hospitalization for any reason during survey administration was defined as any hospital stay greater than 1 day between August 1st and October 22nd. 'Treatment shortened' was defined as having any treatment that was 15 minutes shorter than prescribed for any reason. 'Unexcused absence' was defined as having missed any treatment without rescheduling and without a reason such as a hospitalization.

3.3.6 Outcomes

Outcome data was obtained from the DCI electronic medical record system through January 18th, 2018. Hospitalization was defined as any hospital stay greater than 1 day. Patients who withdrew from hemodialysis were censored at the date of their last treatment and, for the purpose of analysis, were grouped with patients known to have died. In each analysis patients were censored after reaching the primary endpoint or at the end of follow up. Patients were also censored when they transferred out of DCI care, stopped hemodialysis due to recovery of kidney function, or were lost to follow up. Those receiving more than one transplant or having more than one hospitalization were

censored at the time of their first event for analyses evaluating transplant or hospitalization, respectively.

3.3.7 Statistical Analysis

Univariate associations between ICH CAHPS response status and each outcome were assessed using Kaplan-Meier estimates to control for varying lengths of study follow-up. Time-to-event analyses were performed for each of the outcomes using multivariable Cox proportional hazards models with random intercepts to account for clustering at the dialysis facility level. Models were fitted sequentially starting with a parsimonious model with only demographic variables followed by addition of clinical and treatment related variables. The association between continuous variables and each of the outcomes was explored; variables with non-linear associations were analyzed either using splines or by changing the variable to a categorical variable. ESRD vintage was truncated at 100 months prior to evaluation. The assumption of proportional hazards between the covariate of interest and outcome was evaluated using Schoenfeld Residuals. Sensitivity analyses to account for missing data were performed after imputing values for continuous covariates by averaging the median sex and age values and by including patients with missing categorical covariate data by creating a new "missing" level per covariate. All analyses were performed using R, Version 1.1.414 (R Foundation for Statistical Computing).

3.4 Results

3.4.1 Study Population

DCI dialysis facilities were spread across 28 states throughout the US in 2012 providing a nationally representative sample (Figure 6.8). Of the 11,055 patients eligible in 2012, 10,395 (94%) remained DCI in-center hemodialysis (ICH) patients at the end of the ICH CAHPS survey administration period (Figure 3.1). Of the 660 excluded patients, most either died or transferred from DCI to a different dialysis provider (Table 6.7). Included patients were on average 61 years old with median ESRD vintage of 40 months; 44% were women and 45% were black (Table 3.1). Overall responders were older, more likely to be women, more likely to be married, and more educated than non-responders. Responders were also more likely to be active on the transplant list, have arteriovenous fistulas for vascular access, have shorter ESRD vintage, and have better treatment adherence. Roughly 20% of the patients were hospitalized during survey administration; responders were less likely to have been hospitalized than non-responders (Table 3.1).

Figure 3.1: Flow diagram

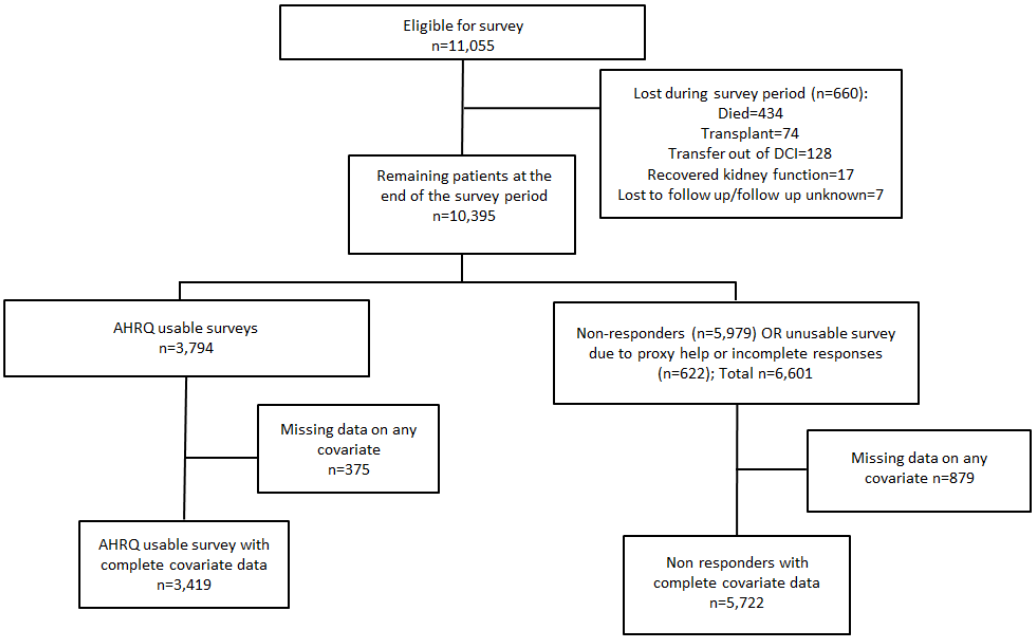


Table 3.1: Baseline demographics stratified by response status

		Total (n=9,141)	Responders (n=3,419)	Non-Responders (n=5,722)
Age (years)		61.0 ± 14.7	62.1 ± 13.8	60.3 ± 15.2
Female Sex		4022 (44.0)	1574 (46.0)	2448 (42.8)
Race:	Black	4090 (44.7)	1316 (38.5)	2774 (48.5)
	White	4386 (48.0)	1940 (56.7)	2446 (42.7)
	Other	665 (7.3)	163 (4.8)	502 (8.8)
Insurance: Medicare/Medicaid		3258 (35.6)	970 (28.4)	2288 (40.0)
	Medicare only	3581 (39.2)	1566 (45.8)	2015 (35.2)
	Medicaid only	533 (5.8)	153 (4.5)	380 (6.6)
	Other	1769 (19.4)	730 (21.4)	1039 (18.2)
Marital status:	Married	3499 (38.3)	1477 (43.2)	2022 (35.3)
	Divorced/separated	1920 (21.0)	710 (20.8)	1210 (21.1)
	Widowed	1426 (15.6)	488 (14.3)	938 (16.4)
	Single	2296 (25.1)	744 (21.8)	1552 (27.1)
Education:	Grade school	1193 (13.1)	272 (8.0)	921 (16.1)
	High school	5570 (60.9)	2106 (61.6)	3464 (60.5)
	College or more	2378 (26.0)	1041 (30.4)	1337 (23.4)
Hospitalized during survey administration		2090 (22.9)	591 (17.3)	1499 (26.2)

Active on transplant waitlist	1030 (11.3)	460 (13.5)	570 (10.0)
BMI (per 2 kg/m^2)	28.5 ± 7.5	29.2 ± 7.6	28.1 ± 7.4
Cause ESRD: Diabetes	3950 (43.2)	1384 (40.5)	2566 (44.8)
Hypertension	2585 (28.3)	970 (28.4)	1615 (28.2)
Other	2606 (28.5)	1065 (31.1)	1541 (26.9)
Vascular access: Catheter	1462 (16.0)	465 (13.6)	997 (17.4)
Graft	1955 (21.4)	716 (20.9)	1239 (21.7)
Fistula	5724 (62.6)	2238 (65.5)	3486 (60.9)
Albumin (per 0.2 g/dL)	3.8 ± 0.4	3.9 ± 0.4	3.8 ± 0.4
Kt/V (per 0.2)	1.62 ± 0.28	1.63 ± 0.27	1.62 ± 0.29
ESRD vintage (months)	40.3 (19.5, 76.3)	37.5 (18.2, 72.0)	41.9 (20.5, 78.3)
Treatment shortened in last month	4537 (49.6)	1497 (43.8)	3040 (53.1)
Unexcused absences in last month	1575 (17.2)	477 (14.0)	1098 (19.2)

Data shown as mean ± SD or median (25th, 75th percentiles) or n (%). BMI: Body mass index; ESRD: End-stage renal disease.

3.4.2 Primary and Secondary Analyses

Over median follow-up of 33 months, 4,588 (50.2%) patients died. Median survival was 52.7 months for responders and 42.2 months for non-responders (Figure 3.2). Following multivariable adjustment, responders had a lower risk for death (HR 0.80; 95% CI 0.75, 0.85) (Table 3.2). During the period of follow-up, 7,638 (83.6%) patients were hospitalized at least once. Median time to first hospitalization was 40.3 months for responders and 33.7 months for non-responders (Figure 3.3). After multivariable adjustment, responders had a lower risk of hospitalization (HR 0.88; 95% CI 0.84, 0.93) (Table 3.2). In sensitivity analyses this association persisted using a composite outcome of death or hospitalization (HR 0.82; 95% CI 0.78, 0.87) (Figure 6.9). During follow-up, a total of 789 (8.6%) patients received a kidney transplant. Responders were more likely to receive a transplant than non-responders (10.6% vs 7.5%; Figure 3.4), a result that was robust to multivariable adjustment (HR 1.17; 95% CI 1.01, 1.36) (Table 3.2). Competing

risks models evaluating transplant and accounting for death showed similar results (HR 1.15; 95% CI 0.99, 1.34).

Table 3.2: Multivariable association between survey response status and outcomes

Outcome	Number of events	Univariate	Model 1	Model 2	Model 3
Death	4588	0.79 (0.74,0.84)	0.68 (0.64,0.73)	0.79 (0.74,0.84)	0.80 (0.75,0.85)
Hospitalization	7638	0.88 (0.84,0.92)	0.80 (0.77,0.84)	0.87 (0.83,0.92)	0.88 (0.84,0.93)
Transplant	789	1.28 (1.12,1.48)	1.39 (1.20,1.61)	1.18 (1.01,1.37)	1.17 (1.01,1.36)

*Model 1: Adjusted for age, sex, race, insurance type, marital status, and education level
**Model 2: Adjusted for covariates in model 1 and hospitalization during survey administration, transplant waitlist status, BMI, cause of ESRD, vascular access type, serum albumin, Kt/V, ESRD vintage
***Model 3: Adjusted for covariates in model 1 and 2 and treatments shortened in last month and unexcused absences in last month
Data shown as hazard ratio (HR) (95% CI). HR above 1.00 is associated with higher likelihood of the outcome. BMI: Body mass index; ESRD: End-stage renal disease

Figure 3.2: Kaplan-Meier plot of survival

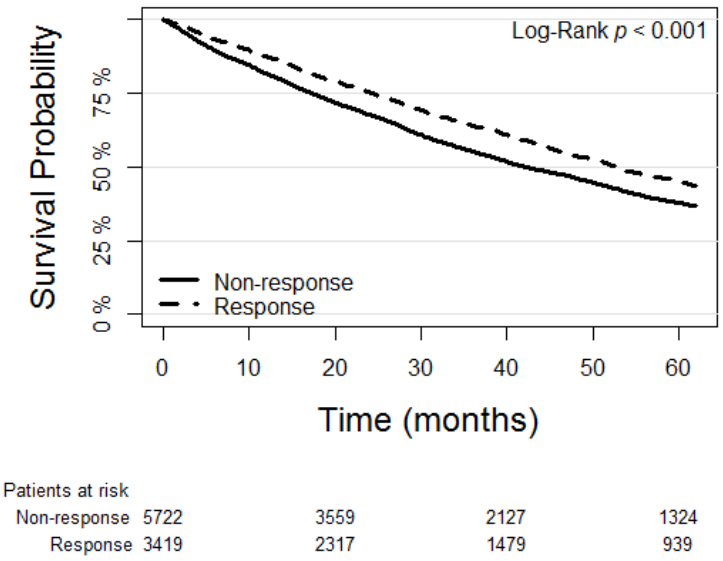
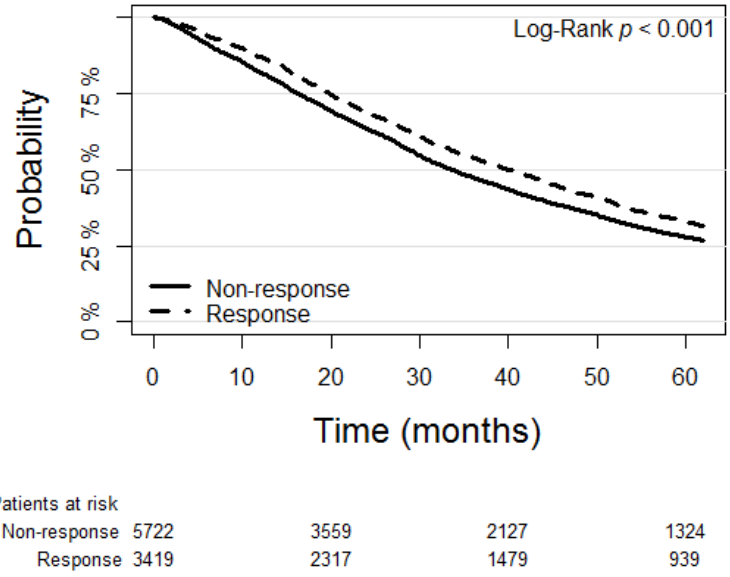
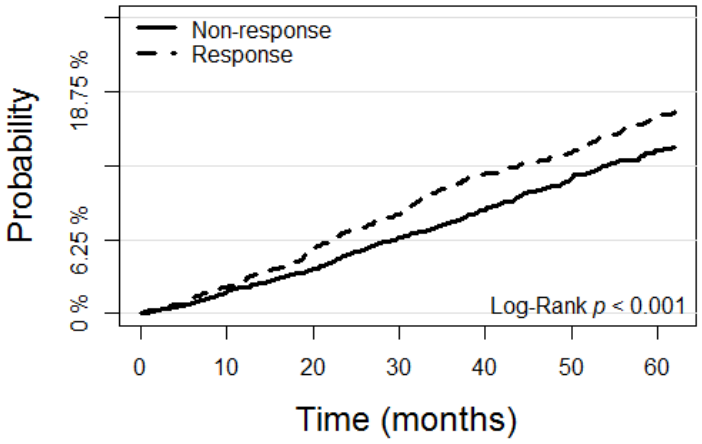


Figure 3.3: Kaplan-Meier plot of hospitalization



Patients at risk				
Non-response	5722	3559	2127	1324
Response	3419	2317	1479	939

Figure 3.4: Kaplan-Meier plot of transplant



Patients at risk				
Non-response	5722	3559	2127	1324
Response	3419	2317	1479	939

3.4.3 Missing Data

Overall, 1,254 (12%) of patients had missing data on at least one covariate and were not included in primary and secondary analyses. Non-responders were more likely to having missing data than responders (13.3% vs 9.9%) and most of the missing data were either demographic characteristics or kidney transplant waitlist status (Tables 6.8 and 6.9). Demographic characteristics and long-term outcomes were similar between those with and without missing data (Tables 6.10 and 6.11). Results were similar in sensitivity analyses that included patients with missing data (Death HR 0.80, 95% CI 0.75, 0.85; hospitalization HR 0.88, 95% CI 0.84, 0.92; transplant HR 1.20, 95% CI 1.04, 1.39).

3.5 Discussion

In a generalizable population of US hemodialysis patients, responders to the ICH CAHPS survey of patient experience have a lower risk of mortality and hospitalization and a higher likelihood of kidney transplantation than non-responders. These associations were robust across sensitivity analyses. These findings raise concern about survey result generalizability and use for quality improvement activities and quality assessment since experiences of higher risk patients are less likely to be captured. Finally, these findings highlight the critical need to better capture patient-reported outcomes from more vulnerable patients.

To our knowledge, this analysis represents the only longitudinal assessment of clinical outcomes among both ICH CAHPS responders and non-responders. The ICH CAHPS survey is one of several patient experience CAHPS surveys currently used in the US to evaluate different areas of healthcare and health plans. The association between response

status and long-term outcomes for these other CAHPS surveys has not been previously been assessed to our knowledge. However, cross-sectional data from hospital and Medicare CAHPS data has shown non-response to be associated with male sex, non-while race, younger age, and lower socioeconomic status.[20-22]

Increasingly payers are moving towards value-based purchasing or pay-for-performance payment models within the context of rising healthcare costs.[28] Payment for dialysis underwent such a change in 2011 with the advent of the ESRD QIP. Quality metrics within the QIP, chosen largely by policy makers, were initially largely clinical and laboratory based.[29,30] The 2014 introduction of the ICH CAHPS as the first standardized and mandatory metric assessing patient reported outcomes was an important step in making QIP measures more patient-centered. Despite the importance of the topic, the ICH CAHPS instrument itself as well as the survey administration process has been subject to controversy given declining response rates and concern over selection bias. Unfortunately, to date, there is no published research, either qualitative or quantitative, assessing or addressing reasons for non-response. This state is unlikely to improve as research using patient-level ICH CAHPS data has not been allowed since 2014.

Our study has several strengths. This is the first analysis examining response status to this survey and long-term outcomes. We have a large nationally representative sample of "real world" hemodialysis patients along with extensive dialysis facility gathered data with over 5 years of follow up data. Our outcomes are important and our analytic models use multivariable adjustment to account for patient factors and also address clustering at

the dialysis facility level. This study is also unlikely to be duplicated as patient-level survey data cannot be obtained since regulatory changes made in 2014.

Our study also has several limitations. There was a small amount of missing covariate data; however, sensitivity analyses showed similar results. Reasons for non-response were not collected by AHRQ and are unknown. Finally, baseline data were assigned at the first month of survey administration since the actual date of survey completion within the survey administration period is unknown.

Our work shows that outcomes are worse among ICH CAHPS non-responders, suggesting that current survey results may not generalizable, and, in particular, may be missing many of the more vulnerable patients. Improving the response rates in these at-risk patients is vital for survey results to be sufficiently robust to inform policy making, quality improvement and facility and provider rankings. At present, the ICH CAPHS survey focuses on the experience of one third of the patients with the best clinical outcomes, potentially missing a critical opportunity to gather more informative data. These results highlight a critical need for initiatives to encourage patient engagement at the facility level, efforts that may not only improve responsiveness to attempts to elicit patient-reported outcome reporting but may also help overcome barriers to poor treatment adherence. Finally, qualitative work looking at reasons for non-response would be instructive in our understanding of broader health related or socioeconomic obstacles these patients face.

3.6 Author contributions

K.B.M., D.E.W, and M.M.R. designed the study. T.D., H.T., D.E.W, and M.M.R analyzed the data. T.D. drafted the manuscript and H.T., M.E.G., E.L., K.B.M., D.E.W., and M.M.R. revised the manuscript. All authors approved the final version of the manuscript.

3.7 Acknowledgements and Financial Disclosures

We thank the DCI patients who complete these very important surveys and DCI personnel who compiled the dataset. The authors report no financial conflicts of interest. Dr. Dad is funded by T32-DK007777 from the National Institutes of Health National Institute of Diabetes, Digestive and Kidney Diseases (NIH NIDDK) and by the Paul Teschan Research Fund (2017-12) through Dialysis Clinic Inc. This project was also supported by the National Center for Advancing Translational Sciences, National Institutes of Health (UL1TR001064). Ms. Grobert and Dr. Lacson are employees of Dialysis Clinic, Inc (DCI), a not-for-profit provider of dialysis services while Drs. Meyer, Weiner and Richardson receive support paid to their institution for work they perform with DCI. Patient characteristic data were obtained by DCI for routine clinical purposes. The NIH NIDDK, National Center for Advancing Translational Sciences, and DCI did not have any role in the analysis or interpretation of data or in writing of this manuscript.

Chapter 4: Patient characteristics associated with higher In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey scores

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4.1 Significance statement

The ICH CAHPS survey is administered twice yearly to in-center hemodialysis patients to assess patient experience. Little is known about drivers of better survey scores. This manuscript provides a unique examination of relationship of patient demographic, clinical, and treatment characteristics to survey scores. Older age and telephone (vs mail) administration of the survey were consistently associated with higher global rating scores, while shortened treatments were associated with lower global rating scores. Telephone administration was also consistently associated with higher composite scores, while other characteristics like older age, transplant listing and shortened treatments were variably associated with scores depending on each composite. This study gives us new insights into real-world patient characteristics and their relationship with better in-center hemodialysis patient experience.

4.2 Introduction

Dialysis patients comprise only 1% of the Medicare population, but account for 6 to 7% of Medicare costs.[25] To advance the Triple Aim[3] of improving patient experience, improving the health of populations, and reducing healthcare costs, the Centers for Medicare and Medicaid Services (CMS) instituted a value-based purchasing system called the End Stage Renal Disease Quality Incentive Program (ESRD QIP) in 2012. This system set forth dialysis facility performance standards, the results of which are publicly reported and tied to payment penalties.[5]

The Medicare Improvements for Patients and Providers Act (MIPPA) of 2008 mandated that a QIP metric should assess patient satisfaction.[31] Before MIPPA enactment, CMS had begun development of a survey to assess hemodialysis (HD) patient experience; this work resulted in the In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems (ICH CAHPS) survey, which was incorporated into the QIP in 2014.[5] The ICH CAHPS survey is part of a family of CAHPS patient experience surveys developed by the Agency for Healthcare Research and Quality (AHRQ) to evaluate different parts of the healthcare system.[32] In its current form, the survey asks in-center HD patients 62 questions evaluating their experience with their nephrologist, dialysis staff, and dialysis facility.[8] Mandatory biannual reporting for this measure started in 2016.

Little is known about what leads to better patient experience as reflected by higher ICH CAHPS scores. Since 2014, regulation has barred dialysis providers from obtaining patient-level survey results, which are essential to understanding these relationships. We performed a unique evaluation of the association between patient characteristics and ICH CAHPS survey scores using patient-level data from individuals treated at the largest not-for-profit dialysis provider in the United States, Dialysis Clinic Incorporated (DCI) in 2012.

4.3 Methods

4.3.1 Study Population

All US in-center HD patients at least 18 years-old and treated at their facility for at least 3 months were eligible for the 2012 ICH CAHPS survey. HD providers identified vendors

for survey administration according to AHRQ guidelines. Surveys were defined as 'complete' if at least 50% of predefined key questions were answered and if the patient reported receiving no assistance in survey completion. We included results from surveys administered August-October 2012 to all eligible HD patients from all DCI facilities.

Study design:

We compared patient characteristics, as documented in the DCI medical information system, with patient-level ICH CAHPS survey scores. A member of the DCI information technology team, who was independent from the research team, merged survey data with individual patient characteristics. De-identified data were subsequently sent to the authors. The study was approved by the Tufts Medical Center Investigational Review Board and underwent review by the DCI Administrative Review Office. DCI had signed a Respondent Identifiable Information Disclosure Agreement with the vendor, allowing DCI to receive the survey data exclusively for research purposes. This agreement predated the incorporation of ICH CAHPS into the ESRD QIP and the regulatory prohibition on reporting of patient-level data to dialysis providers.

4.3.2 Survey

In 2012, ICH CAHPS was available in English and Spanish. The questionnaire included 58 questions that informed three composite scores and three global ratings. Composite scores for Nephrologists' Communication and Caring (NCC), Quality of Dialysis Center Care and Operations (DCO), and Providing Information to Patients (PIP) were derived from questions with either yes/no or never/sometimes/usually/always responses (Table 1). Global ratings for the nephrologist, dialysis staff, and dialysis facility used a 10-point scale (0 being worst and 10 being best). The final result for each survey consisted of three composite and three global rating scores. Keeping with AHRQ scoring guidelines, we

excluded surveys that did not fulfill the minimum key question requirement and those that indicated proxy help in survey completion. Administration and management of the ICH CAHPS survey was transferred from AHRQ to CMS in 2014.

4.3.3 Survey Administration

DCI provided its survey vendor with contact information for all patients who met eligibility criteria at the start of the survey period. About 10 days later, the vendor mailed a pre-notification letter informing patients of the upcoming survey and of its importance. The ICH CAHPS survey was mailed to patients the following week. Patients who did not respond within two weeks were sent a reminder letter, followed by another copy of the survey one month after the first survey. Patients were instructed to mail the completed survey directly back to the vendor. Up to three telephone calls were made over a 4-week period to invite non-responders to complete the survey by telephone. Dialysis facility staff were prohibited from any involvement, including discussing the survey with patients and caregivers.

4.3.4 Covariates

Covariates were chosen a priori and included patient-level demographic, clinical and treatment characteristics collected routinely by DCI. Since the exact date of survey completion by each patient within the 3-month survey administration period is not known, all patient data (including demographics, clinical, and treatment characteristics) were obtained from the month the survey period started. Any missing data prompted a 3-month look back, from which the most recent value was used. Unexcused absence was defined as missing an entire HD treatment without rescheduling and without a reason such as hospitalization. Shortened treatment was defined as a delivered treatment that

was at least 15 minutes shorter than prescribed. Hospitalization included hospital stays for any reason. Body mass index (BMI) was calculated using the estimated dry weight set by the patient's nephrologist at the start of the survey period. ESRD vintage > 12 months before current facility was evaluated to identify patients new to a dialysis facility but having been on HD for at least 1 year, since patients who switch facilities might answer differently depending on the reason for switching.

4.3.5 Outcomes

Global rating and composite scores were converted into dichotomous outcomes based on whether or not each value fell within the "top box", corresponding to CMS' preferred responses.[33] In 2012 the top box for global ratings was a score of 8-10 which was subsequently changed to 9-10 in 2014. We used 9-10 to define top box for our primary analysis (Table 1), while sensitivity analyses were also performed using the 2012 top box definition (8-10) for global ratings (Table 6.12). Composite scores are derived from a mix of questions that have either two-level or four-level responses, which are coded either 'Yes=1, No=0' for two-level responses and 'Always=4, Usually=3, Sometimes=2, Never=1' for four-level responses; since the DCO composite has a mix of both types of questions, 2 level responses were recoded as Yes=4 and No=1 to facilitate calculation of the composite score. The top box for composite scores is defined as the highest attainable score after averaging responses to each question within a composite; we used an average equal to 4 for the NCC and DCO composites and 1 for the PIP composite (Table 4.1). Missing responses within a composite were handled using CMS' current approach, which reduces the number of total questions in the denominator while calculating the average

score. At least 50% of the questions within a composite had to be answered by the patient to trigger calculation of a composite score to obtain a reliable score.

Table 4.1: Survey scoring domains and 'primary study outcomes

Domain	Number of questions	Response options	Primary study outcome ('Top Box' outcome)
Nephrologists' Communication and Caring (NCC)	6	Never/sometimes/usually/always (5) Yes/no (1)	Average equal to 4
Quality of Dialysis Center Care and Operations (DCO)	17	Never/sometimes/usually/always (14) Yes/no (3)	Average equal to 4
Providing Information to Patients (PIP)	9	Yes/no (9)	Average equal to 1
Nephrologist rating	1	0-10 (0 worst and 10 best)	9-10
Dialysis staff rating	1	0-10 (0 worst and 10 best)	9-10
Dialysis facility rating	1	0-10 (0 worst and 10 best)	9-10

4.3.6 Statistical Analysis

We used logistic regression models with random intercepts to account for possible clustering at the HD facility level. As is calculated by CMS, who reports all of the domains, study outcomes were attainment of top box score for each of the 3 global rating scores and 3 composite scores (6 separate outcomes). For the primary analysis we used patients with complete covariate data. A sensitivity analysis was performed using multiple imputation for missing covariate data (Table 6.12) with models refitted and averaged using Rubin's rule.[18] Since patients who responded by phone by definition were mail non-responders, we performed a sensitivity analysis using only mail responders. A two-sided alpha of 0.05 was considered significant, and all analyses were done using SAS Enterprise Guide (Version 7.12, Cary, NC) and R language (version 3.3.1, R Foundation for Statistical Computing, Vienna Austria).

4.4 Results

4.4.1 Study Population

Of 11,055 eligible patients in 2012, 3,871 (35%) responded and met criteria for completion of at least 50% of the key survey questions and independent completion of ICH CAHPS (Figure 4.1). Patients were distributed across the country with good geographic representation (Figures 6.12 and 6.13). Of responders, 502 (13%) had missing data on at least one covariate and were excluded in primary analyses. Excluded patients were more often black and had shorter ESRD vintage (Table 4.2). Of the remaining 3,369 patients, over 90% provided sufficient responses for at least one of the six outcomes. Within this population, mean age was 61 years, 46% were women, and 17% responded by telephone (Table 2 and Tables 6.13-6.18).

Figure 4.1: Flow Diagram

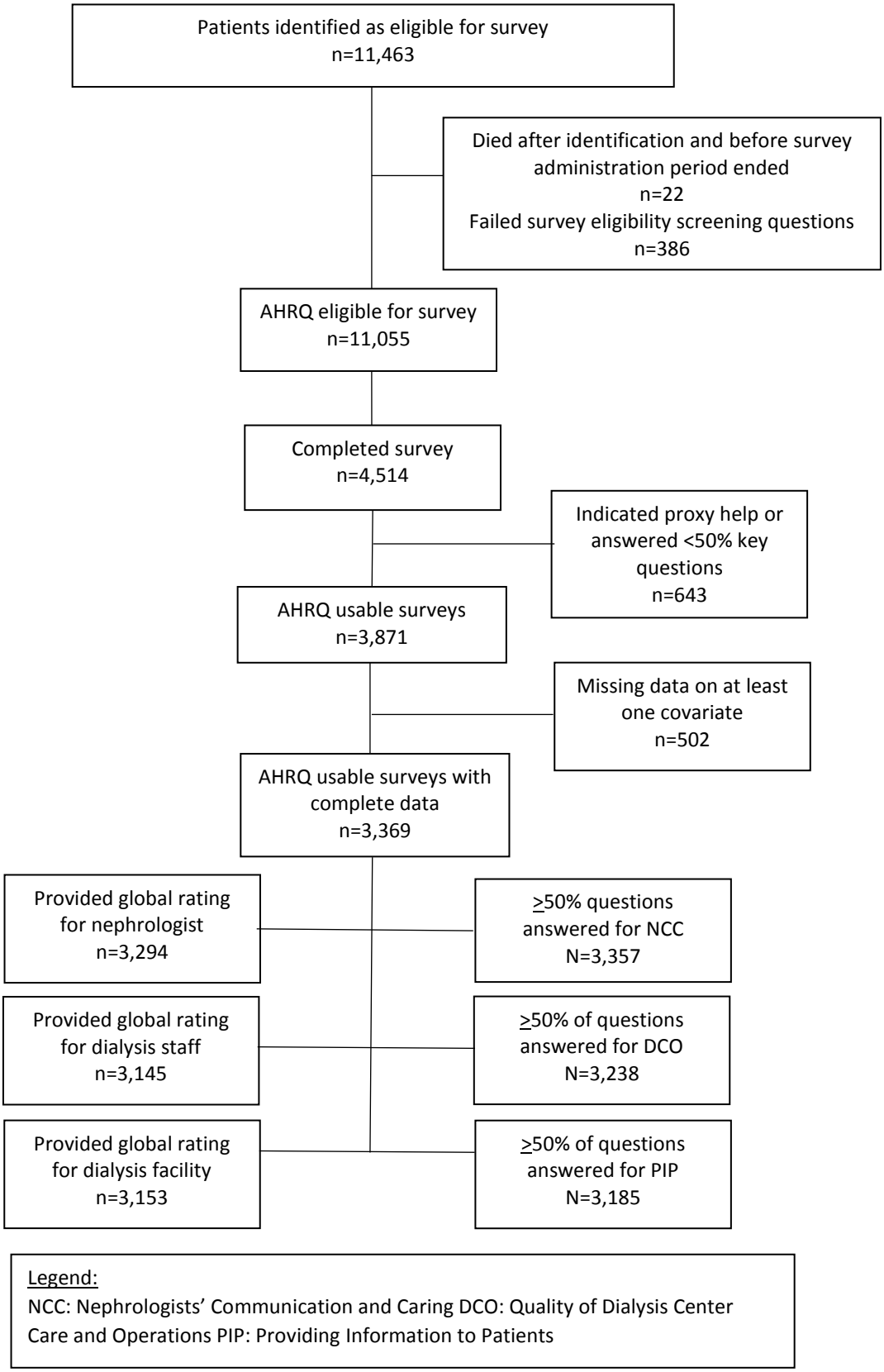

Table 4.2: Study population

	Population analyzed (n=3,369)	Excluded due to missing data (n=502)
Age (years)	62.1 ± 13.9	61.3 ± 13.4
Female	1547 (45.9)	242 (48.2)
Race		
Black	1294 (38.4)	216 (48.0)
White	1917 (56.9)	212 (47.1)
Other	158 (4.7)	22 (4.9)
Hispanic Ethnicity	176 (5.2)	26 (6.0)
Cause of ESRD		
Diabetes	1357 (40.3)	193 (38.8)
Hypertension	960 (28.5)	150 (30.1)
Other	1052 (31.2)	155 (31.1)
Marital status		
Married	1465 (43.5)	160 (41.1)
Divorced/Separated	694 (20.6)	75 (19.3)
Widowed	476 (14.1)	68 (17.5)
Single	734 (21.8)	86 (22.1)
Education Level		
Grade School	271 (8.0)	33 (8.5)
High School	2082 (61.8)	221 (56.8)
College/Post Graduate	1016 (30.2)	135 (34.7)
English speaker	3326 (98.7)	373 (99.5)
Insurance		
Medicare/Medicaid	959 (28.5)	114 (25.9)
Medicare only	1533 (45.5)	226 (51.3)
Medicaid only	153 (4.5)	15 (3.4)
Other	724 (21.5)	86 (19.5)
Active on transplant waitlist	456 (13.5)	56 (16.5)
Vascular access		
Fistula	2198 (65.2)	322 (64.3)
Graft	703 (20.9)	95 (19.0)
Catheter	468 (13.9)	84 (16.8)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.1	11.3 ± 1.2
Kt/V	1.63 ± 0.27	1.59 ± 0.27
BMI (kg/m^2)	29.2 ± 7.6	29.5 ± 7.9
Unexcused absences	476 (14.1)	62 (12.4)

Treatments shortened	1481 (44.0)	221 (44.0)
Hospitalization	336 (10.0)	39 (7.8)
ESRD vintage (months)	37.6 (18.2, 72.1)	29.3 (13.3, 63.9)
ESRD vintage > 12 months before current facility	711 (21.1)	99 (19.7)
Ability to ambulate	2858 (84.8)	301 (80.3)
Ability to transfer	3047 (90.4)	321 (85.6)
Falls	312 (9.3)	29 (7.7)
ADL score	8 (5, 8)	8.0 (5.0, 8.0)
Response mode		
Mail	2800 (83%)	419 (83.5)
Telephone	569 (17%)	83 (16.5)

*Individuals excluded due to missing data on at least 1 covariate. Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

4.4.2 Associations with Global Ratings

In multivariable analyses, older age and telephone administration versus mail were associated with significantly higher global ratings of nephrologists. Patients who spoke English, had higher hemoglobin concentrations, and whose treatments were shortened gave their nephrologists lower global ratings. Older age, Medicaid insurance only, and telephone administration were associated with higher global ratings of dialysis staff, whereas shortened treatments were associated with lower ratings. Older age, higher Kt/V, and telephone administration were associated with significantly higher global ratings for the dialysis facility, while shortened treatments were associated with lower ratings (Table 4.3 and Figure 6.12).

4.4.3 Associations with Composite Scores

Being active on the transplant list and higher Kt/V were significantly associated with higher scores for Nephrologists' Communication and Caring (NCC) in multivariable analyses, whereas shortened treatments were associated with lower scores. Lower educational level and telephone administration were significantly associated with higher Quality of Dialysis Center Care and Operations (DCO) scores, while being active on the transplant list, longer ESRD vintage, and unexcused absences were associated with lower DCO scores. Lastly, being active on the transplant list and telephone administration were significantly associated with higher scores for Providing Information to Patients (PIP), while older age, and black race were associated with lower PIP scores (Table 4.3 and Figure 6.12).

4.4.4 Sensitivity Analyses

Among the 502 (13%) individuals with missing covariate data, most missing data were on functional covariates, which were used for exploratory analyses only. Overall results were similar after multiple imputation for missing covariates (Tables 6.19-6.24), after changing the global rating top box score to 8-10 to be consistent the scoring methodology used prior to 2014 (Tables 6.25-6.27), and after removing telephone responders from the analysis (Table 6.28). Additionally, intraclass coefficients were very low in each model making clustering of results at the facility level less likely.

Table 4.3: Multivariable association of characteristics with higher scores

	Nephrologist Rating (N=3294)	Staff Rating (N=3145)	Dialysis Facility Rating (N=3153)	NCC Score (N=3357)	DCO Score (N=3238)	PIP Score (N=3185)
ICC	0.07	0.09	0.07	0.03	0.06	0.03
Age, per 5 years	**1.06 (1.02, 1.11)**	**1.09 (1.04, 1.14)**	**1.10 (1.05, 1.15)**	1.01 (0.98, 1.05)	1.04 (0.99, 1.09)	**0.87 (0.84, 0.90)**
Female	1.00 (0.82, 1.21)	0.85 (0.68, 1.05)	0.82 (0.66, 1.02)	1.18 (1.00, 1.38)	0.89 (0.71, 1.12)	1.03 (0.87, 1.22)
Race, black vs white	1.06 (0.86, 1.31)	0.91 (0.72, 1.16)	0.88 (0.69, 1.11)	1.11 (0.93, 1.32)	0.87 (0.68, 1.12)	**0.81 (0.67, 0.98)**
Race, other vs white	0.72 (0.47, 1.11)	0.98 (0.59, 1.62)	0.93 (0.56, 1.56)	0.79 (0.54, 1.16)	0.64 (0.36, 1.13)	1.32 (0.90, 1.93)
Ethnicity, Hispanic vs non-Hispanic	1.19 (0.75, 1.88)	0.94 (0.56, 1.57)	1.19 (0.70, 2.04)	0.95 (0.64, 1.41)	1.19 (0.71, 1.97)	0.74 (0.49, 1.11)
Insurance, Medicare/Medicaid vs Medicare only	1.00 (0.79, 1.26)	0.97 (0.75, 1.25)	1.05 (0.81, 1.36)	1.07 (0.88, 1.30)	1.10 (0.84, 1.45)	0.91 (0.74, 1.12)
Insurance, Medicaid only vs Medicare only	0.99 (0.64, 1.53)	**1.70 (1.00, 2.86)**	1.16 (0.71, 1.90)	0.96 (0.65, 1.42)	1.24 (0.73, 2.10)	0.86 (0.58, 1.28)
Insurance, Other vs Medicare only	0.98 (0.78, 1.24)	0.94 (0.72, 1.23)	0.98 (0.75, 1.28)	1.06 (0.87, 1.29)	1.12 (0.86, 1.45)	0.91 (0.74, 1.12)
Marital status, married vs single	0.96 (0.75, 1.24)	1.12 (0.85, 1.48)	1.06 (0.80, 1.41)	1.22 (0.98, 1.53)	1.26 (0.92, 1.72)	1.21 (0.96, 1.52)
Marital status, divorced/separated vs single	0.97 (0.74, 1.26)	0.97 (0.72, 1.29)	0.94 (0.71, 1.26)	1.16 (0.92, 1.45)	1.08 (0.78, 1.50)	1.00 (0.79, 1.27)
Marital status, widowed vs single	1.18 (0.83, 1.69)	1.38 (0.92, 2.06)	1.32 (0.87, 2.00)	1.07 (0.80, 1.43)	1.16 (0.78, 1.73)	1.23 (0.90, 1.67)
Education level, grade school vs college or more	1.15 (0.79, 1.67)	1.19 (0.77, 1.84)	1.23 (0.79, 1.93)	1.14 (0.84, 1.54)	**1.66 (1.12, 2.46)**	1.18 (0.86, 1.63)
Education level, high school vs college or more	1.10 (0.91, 1.34)	1.13 (0.91, 1.41)	1.09 (0.88, 1.36)	1.10 (0.93, 1.29)	**1.41 (1.11, 1.78)**	1.09 (0.92, 1.30)

English speaker	**0.20 (0.04, 0.87)**	0.94 (0.33, 2.70)	0.85 (0.27, 2.69)	1.46 (0.69, 3.09)	1.76 (0.68, 4.59)	1.32 (0.62, 2.84)
Hospitalization	0.92 (0.69, 1.23)	0.98 (0.70, 1.37)	0.90 (0.64, 1.26)	1.03 (0.80, 1.32)	0.74 (0.51, 1.06)	1.00 (0.77, 1.31)
Active on transplant waitlist	1.23 (0.95, 1.61)	1.07 (0.80, 1.42)	0.91 (0.69, 1.21)	**1.24 (1.00, 1.55)**	**0.68 (0.48, 0.95)**	**1.36 (1.08, 1.70)**
BMI, per 2 kg/m^2	1.02 (1.00, 1.05)	1.01 (0.98, 1.04)	1.02 (0.99, 1.05)	1.00 (0.98, 1.02)	0.97 (0.95, 1.00)	1.02 (0.99, 1.04)
Cause ESRD, diabetes vs. other	0.88 (0.71, 1.09)	1.02 (0.79, 1.30)	0.98 (0.77, 1.26)	0.92 (0.77, 1.11)	0.93 (0.72, 1.19)	1.05 (0.87, 1.28)
Cause ESRD, hypertension vs. other	0.95 (0.75, 1.20)	1.09 (0.84, 1.42)	0.99 (0.76, 1.29)	0.93 (0.77, 1.14)	1.03 (0.79, 1.34)	1.20 (0.98, 1.48)
Vascular access, catheter vs. fistula	0.91 (0.70, 1.18)	0.87 (0.65, 1.17)	0.90 (0.67, 1.21)	0.90 (0.72, 1.13)	1.32 (0.99, 1.75)	1.00 (0.79, 1.26)
Vascular access, graft vs. fistula	1.00 (0.79, 1.25)	1.11 (0.86, 1.44)	1.21 (0.93, 1.57)	0.92 (0.77, 1.11)	0.98 (0.75, 1.27)	1.18 (0.97, 1.44)
Hemoglobin, per 0.5 g/dL	**0.95 (0.92, 0.99)**	0.98 (0.94, 1.03)	0.97 (0.93, 1.01)	1.00 (0.96, 1.03)	0.99 (0.95, 1.04)	0.99 (0.96, 1.03)
Albumin, per 0.2 g/dL	0.99 (0.94, 1.04)	0.95 (0.89, 1.00)	0.94 (0.89, 1.00)	1.01 (0.97, 1.06)	1.03 (0.97, 1.09)	1.03 (0.99, 1.08)
Kt/V, per 0.2	1.03 (0.96, 1.11)	1.04 (0.96, 1.13)	**1.09 (1.00, 1.18)**	**1.09 (1.02, 1.15)**	1.06 (0.98, 1.15)	0.95 (0.89, 1.02)
ESRD vintage, per 12 months	1.01 (0.98, 1.05)	0.97 (0.93, 1.01)	0.97 (0.93, 1.00)	1.00 (0.97, 1.03)	**0.95 (0.92, 0.99)**	0.99 (0.96, 1.02)
ESRD vintage > 12 months before current facility	0.91 (0.71, 1.16)	0.90 (0.69, 1.18)	1.05 (0.80, 1.39)	1.15 (0.93, 1.41)	0.79 (0.58, 1.08)	0.86 (0.69, 1.07)
Unexcused absences	0.82 (0.64, 1.04)	0.84 (0.64, 1.09)	0.84 (0.64, 1.10)	0.95 (0.76, 1.17)	**0.69 (0.50, 0.96)**	0.86 (0.69, 1.08)
Treatments shortened	**0.71 (0.59, 0.85)**	**0.77 (0.63, 0.95)**	**0.74 (0.60, 0.91)**	**0.75 (0.64, 0.87)**	0.90 (0.73, 1.11)	0.87 (0.74, 1.02)
Telephone administration vs mail	**1.51 (1.17, 1.94)**	**1.70 (1.28, 2.27)**	**1.91 (1.42, 2.58)**	1.21 (0.99, 1.48)	**1.96 (1.53, 2.51)**	**1.43 (1.17, 1.75)**

Data shown as odds ratio (OR) (95% CI) adjusted for all other variables in the table. Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. NCC: Nephrologists' Communication and Caring; DCO: Quality of Dialysis Center Care and Operations; PIP: Providing Information to Patients; ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason

4.5 Discussion

In this national sample of in-center hemodialysis respondents to the ICH CAHPS survey, older age and telephone administration of the survey were consistently associated with higher global ratings, while shortened treatments were associated with lower global ratings for self-reported patient experience. Telephone administration of the survey was consistently associated with higher composite scores for self-reported patient experience. Other factors like older age, transplant listing and shortened treatments were variably associated with self-reported patient experience depending on whether facility quality and operations, nephrologists' communication and caring, or provision of information were being assessed showing that patients differentiate their experience dependent on the composite area being evaluated.

Prior literature examining patient characteristics associated with ICH CAHPS scores comprises one small study in which 404 patients, selected by nephrologists, self-reported their demographic and clinical characteristics.[10] In unadjusted univariate analyses, black race was associated with lower dialysis facility global ratings. Another study of Medicare CAHPS responses from a group of dialysis patients before ICH CAHPS had been developed showed self-reported black race and lower education to be associated with lower rating of care and with lower physician communication scores.[34] Our evaluation of patient satisfaction at DCI facilities in 2011, using an internally developed DCI survey, showed white race, older age, shorter dialysis vintage, fewer shortened treatments and fewer missed treatments to be associated with higher scores.[35]

We found demographic characteristics associated with ICH CAHPS scores to include age, race, and educational level. Older age was consistently associated with higher ratings

for nephrologists, dialysis staff, and dialysis facilities but with a lower PIP composite score. Since questions comprising the PIP composite rely more on recall of information or on patient teaching than other questions, this association may reflect the increased prevalence of cognitive impairment among older dialysis patients.[36-38] It is possible that older patients would benefit from receiving dialysis related information differently, perhaps in smaller chunks reinforced over an extended period of time. For reasons that are not readily apparent, black race was associated with lower PIP composite score, and lower education was associated with higher DCO composite score. Counter-intuitively, education level was not associated with the PIP score. Qualitative research examining attitudes towards nephrologists, dialysis staff, and dialysis facilities may generate hypotheses to explain lower global rating scores among younger patients.

Clinical characteristics associated with ICH CAHPS scores include being active on the transplant list, longer ESRD vintage and unexcused absences or shortened treatments. Interestingly being active on the transplant list was associated with higher NCC and PIP composite scores but with a lower DCO composite score. This could be a reflection of the added communication through transplant clinic visits and additional discussions that these patients have with caregivers compared to those who are inactive or ineligible for kidney transplant as well as possible disappointment with remaining on dialysis while transplant is a looming option. Longer ESRD vintage may be associated with increased level of comfort, if not tolerance, of the dialysis environment. Shortened treatments or unexcused absences were associated lower scores across all categories, with most reaching statistical significance. This result with respect to adherence raises the possibility of a bidirectional if not cyclical relationship, whereby poor care experience

leads to poor adherence, while physician and staff reaction to non-adherence could strain the relationship and worsen the care experience. It also may suggest other common factors linking worse adherence and worse experience such as unaddressed pain, depression and lower health literacy.[39,40] These relationships suggest that interventions for such patients could result in substantial benefit, particularly in view of the association of worse adherence with an increased risk of adverse patient outcomes, including death.[41,42]

A larger dialysis dose, as measured by Kt/V_{urea} was associated with higher dialysis global facility ratings and with higher NCC composite scores. While it is possible that this reflects a biologic effect, the absence of an association of dialysis dose with mental, emotional, or social functioning as measured by the SF-36 makes this interpretation somewhat implausible.[43] Rather, it is more likely that the association of dose with global facility ratings and NCC composite scores reflects positive reinforcement that patients receive after reviewing achievement of the desired dialysis dose each month or an overall reflection of patient health.

Finally, telephone rather than mail administration was associated with higher scores on all three global rating scales and on all of the composite scores except for NCC. This finding is consistent with prior literature showing more positive responses to CAHPS surveys when they were administered over the telephone rather than by mail.[44-46] This finding is important, because dialysis providers get to choose which mode of administration is used by their vendor for this survey, and since telephone administration adds substantially to the cost of survey administration.

In view of the influence of patient characteristics on ICH CAHPS scores, CMS in 2015 began to use internal monitoring data to adjust facility scores on the basis of survey administration mode and a limited number of patient-reported characteristics.[33] This adjustment changes yearly and is not subject to peer review. Additionally, current CMS adjustment uses a limited number of patient-reported characteristics, some of which overlap with ones we found to be significantly associated with scores (including age, mode of survey administration, education level, language, and ESRD vintage). Importantly, they do not adjust for clinical characteristics that vary among facilities such as transplant eligibility, hemodialysis adequacy, or treatment adherence.

Our study has several strengths, including multivariable analysis of patient-level ICH CAHPS survey responses from a large national sample of HD patients, using detailed clinical and demographic information collected by the dialysis facility. No previous literature describes the characteristics associated with higher ICH CAHPS survey scores after multivariable adjustment. Because, beginning in 2014, CMS barred dialysis facilities from obtaining patient-level ICH CAHPS survey results, such an analysis is possible only using data collected in 2012 and 2013 (prior to ICH CAHPS incorporation into the ESRD QIP). To the best of our knowledge, DCI is the only dialysis provider to obtain these patient-level survey results prior to the regulatory prohibition, making this endeavor unique. We show robust results across models and several sensitivity analyses including one utilizing the older AHRQ top box definition that was in use until 2013.

Limitations to this study include missing data and application of CMS' facility-level scoring method to our patient-level survey results. As with other survey data, low response rates[6] raise concern for selection bias. Finally, we do not have appropriately

timed data on other patient surveys (KDQOL or SF36) to correlate to ICH CAHPS results.

Patient experience surveys are a vital part of any value-based purchasing model to ensure quality of care. Our findings are particularly relevant to the dialysis community because surveys completed from 2016 onwards are tied to facility reimbursements in 2018 and beyond, and can be anticipated to carry increasing weight in CMS' quality program for dialysis facilities.[7] Additionally, the breadth of these surveys will increase pending the development of a home dialysis CAHPS version. With this increasing prominence and absence of interventions shown to improve scores, our findings lay the groundwork for dialysis providers to enhance efforts to understand drivers of better HD experience. This work is timely since this survey has been in mandatory use for four years already without any knowledge of how to improve experience scores. This work is also unique since regulatory prohibition does not allow patient-level survey data to be obtained since 2014. Our work combined with further qualitative work with dialysis patients will help elucidate possible interventions that could improve experience scores moving forward.

4.6 Author contributions

K.B.M., D.E.W, and M.M.R. designed the study. T.D., H.T., D.E.W, and M.M.R analyzed the data. T.D. drafted the manuscript and H.T., M.E.G., E.L., K.B.M., D.E.W., and M.M.R. revised the manuscript. All authors approved the final version of the manuscript.

4.7 Acknowledgements and Financial Disclosures

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Chapter 5: Discussion

Our work represents the first in-depth analysis of ICH CAHPS survey data from a cohort of real world ICH patients. In our cross-sectional analyses, we found non-response to be associated with younger age, male sex, non-white race, and longer ESRD vintage. Non-response was also associated with indicators of lower socioeconomic status, poorer health, and poorer adherence to treatment. In our longitudinal analyses, non-response was associated with higher risk of death and hospitalization along with lower likelihood of receiving a kidney transplant. Among survey responders we found demographic factors including age, race, and education level and clinical factors including transplant waitlist status, dialysis adequacy, ESRD vintage, and treatment adherence to be associated with survey scores. Finally, the mode of survey administration (telephone vs. mail) was also associated with survey scores.

The ICH CAHPS survey is the only standardized and mandatory patient-reported outcome measure used in the value-based payment system used by CMS to reimburse dialysis facilities. It remains an integral measure to ensure that quality of care, as perceived by patients, is not being neglected in the interest of cost savings. Like other measures currently in use, it also presents patients and payers with a comparison among facilities and allows facilities to benchmark their performance to track improvement. Patient experience scores from this survey also shape policy at the payer and provider level. Not surprisingly, the importance of this quality measure within the current payment system has been increasing over time and is projected to increase even more in the next few years.[5,7,29] Results from this survey will also soon be incorporated into the current star rating system used by CMS to rate facilities.[27] Presently, dialysis providers can lose

up to 2% of their reimbursement from CMS or in a comprehensive ESRD care model substantial decreases in shared savings based on underperformance on quality metrics. This includes ICH CAHPS survey results which are compared to yearly national goals that are set by CMS.

Despite the importance of patient experience, there is concern about the assessment of patient experience using the ICH CAHPS survey. Specifically, generalizability of the results is of concern in light of steadily dropping response rates. Applicability of survey results is also unclear making quality improvement difficult. There is minimal prior literature addressing these two areas. The possibility of response bias being present was not assessed during initial field testing of this survey.[9,12,24] The only subsequent evaluation of the ICH CAHPS survey revealed similar overall characteristics between survey responders and non-responders; however, this evaluation was not ideal with a small sample size, patients selected by nephrologists, and evaluation based on a limited number of patient self-reported characteristics.[10] This latter study also reported associations between patient/facility-level characteristics and higher scores.[10] However, in addition to the limitations of this study already mentioned, the statistical analysis was inadequate with only univariate and unadjusted associations assessed.

Results from our in-depth analysis of the ICH CAHPS survey are important. The latest estimate in 2016 showed that only 1 in 3 patients were responding to the survey.[6] Our cross-sectional analyses show certain demographic, socioeconomic, and clinical characteristics to be significantly associated with non-response. On longitudinal follow-up, non-responders have worse clinical outcomes than responders. These results raise serious concern about generalizability of ICH CAHPS survey data that undermine the

ability to use survey data for purposes of shaping policy, comparing facilities, and benchmarking individual facility performance. Additionally, these results raise concern over applicability of results towards quality improvement since responses are missing disproportionately from the most vulnerable ICH patients who would likely benefit the most from interventions aimed at improving quality. Our analysis of patient-level characteristics associated with higher survey scores lays the groundwork for directed work in the future to further understand factors that improve experience with a goal to ultimately provide specific interventions applicable to dialysis facilities.

Results from our analyses are also unique. Previous work has not evaluated characteristics associated with non-response or response status and long term clinical outcomes. Real world ICH patient characteristics associated with better experience scores has also not been assessed. Importantly, such detailed analyses can no longer be performed due to the regulatory prohibition on dialysis providers obtaining patient-level survey data that has been in place since 2014.[47]

Since national implementation of this survey, there has been limited work done by CMS to improve response rates. Survey administration was increased from yearly to twice yearly in 2014 with little effect on response rates, possibly due to the increased burden on patients. Importantly, reasons for non-response have not been appraised nor have new interventions to increase response rates been tested. Applicability of survey responses to aid in quality improvement has also not been investigated. However, CMS internally monitors survey responses nationally and uses these data to produce case-mix adjusted facility scores in place of raw scores.[33] Although this is important to reduce the likelihood of penalizing facilities based on their patient-mix and to mitigate efforts by facilities to

cherry pick patients, it does not provide facilities much insight into ways to improve patient experience nor does it encourage further evaluation into why experience differs based on patient characteristics. Furthermore, there has been no qualitative work done looking at ICH patient perceptions of experience in relation to the questions making up the ICH CAHPS survey.

Strengths of our work include robust and detailed dialysis provider gathered patient characteristics including factors such as treatment adherence. Other strengths include the large size of the patient population being studied with over 5 years of follow up data and outcomes. Analyses include multivariable adjustment along with accounting of clustering at the dialysis facility level. Weaknesses include a small amount of missing data; however results overall remain unchanged in sensitivity analyses. All baseline data were obtained from the first month of the survey administration period since the actual data of survey completion is not recorded. Finally, as mentioned earlier, reasons for non-response were not collected by the survey administrators.

In conclusion, the ICH CAHPS survey is an important measure within the value-based reimbursement used to pay dialysis providers. This in-depth analysis of the survey raises concern over the generalizability and applicability of survey results. Providers can use data from our analyses to increase outreach to patients who are more likely to be non-responders and to those who are likely to report poorer ICH experience. Additionally, our work lays the foundation for future qualitative work assessing patient barriers to response and patient attitudes towards factors that improve ICH experience.

Chapter 6: Appendix:

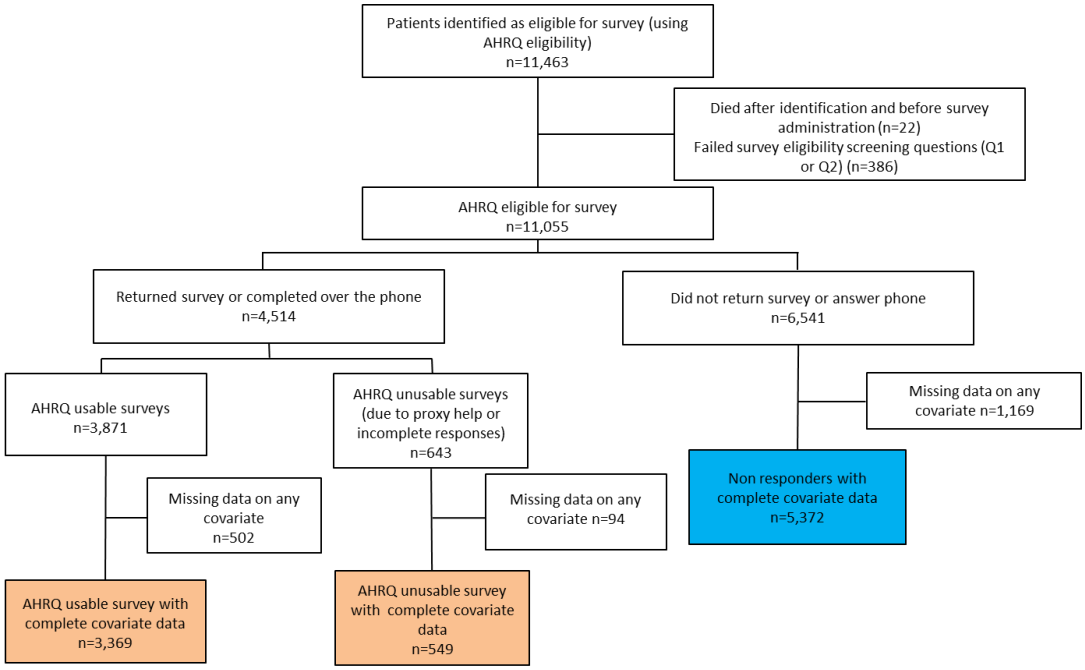
6.1 Supplementary material for chapter 2

Table 6.1: Key questions from the 2012 ICH CAHPS survey

Question number	Question wording
1	Where do you get your dialysis treatments?
2	How long have you been getting dialysis at this dialysis center?
8	Using any number from 0 to 10, where 0 is the worst kidney doctors possible and 10 is the best kidney doctors possible, what number would you use to rate the kidney doctors you have now?
20	In the last 3 months, which one did they use most often to connect you to the dialysis machine?
23	In the last 3 months, did any problems occur during your dialysis?
32	Using any number from 0 to 10, where 0 is the worst dialysis center staff possible and 10 is the best dialysis center staff possible, what number would you use to rate your dialysis center staff?
35	Using any number from 0 to 10, where 0 is the worst dialysis center possible and 10 is the best dialysis center possible, what number would you use to rate your dialysis center?
37	Are you eligible for a kidney transplant?
41	In the last 12 months, were you ever unhappy with the care you received at the dialysis center or from your kidney doctors?
45	In general, how would you rate your overall health?
46	In general, how would you rate your overall mental or emotional health?
47	Are you being treated for high blood pressure?
48	Are you being treated for diabetes or high blood sugar?
49	Are you being treated for heart disease or heart problems?
50	What is your age?
51	Are you male or female?
52	What is the highest grade or level of school that you have completed?
53	Are you of Hispanic or Latino origin or descent?
54	What is your race? Please mark one or more.
55	What language do you mainly speak at home?
56	Did someone help you complete this survey?

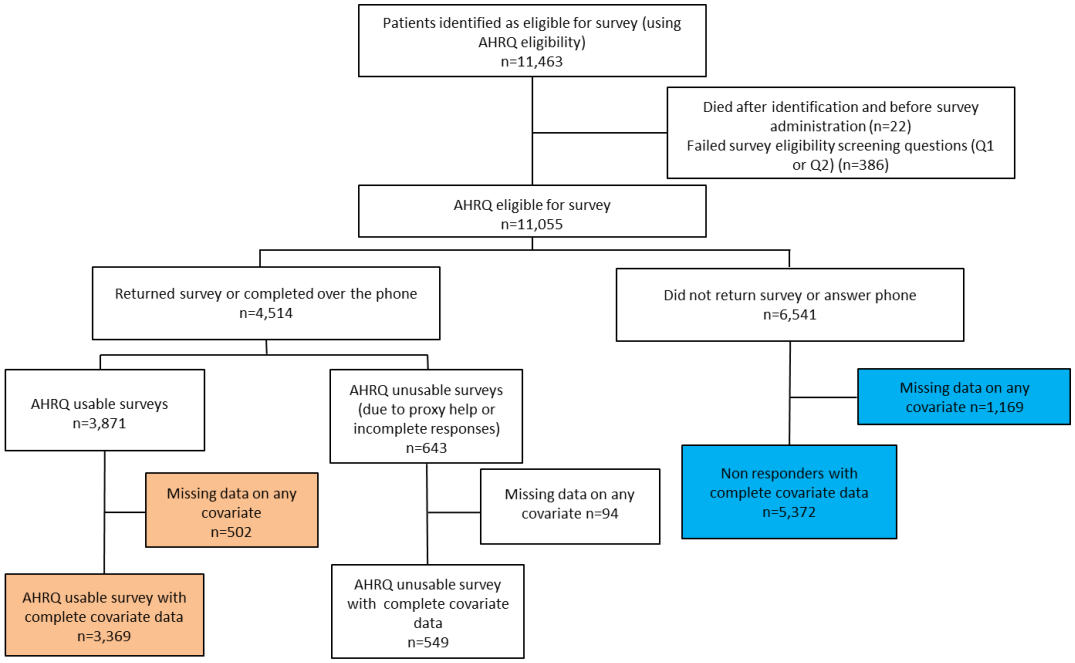
*Responses to at least 12 of these questions were required for the survey to be deemed usable

Figure 6.1: Flow diagram for secondary analysis



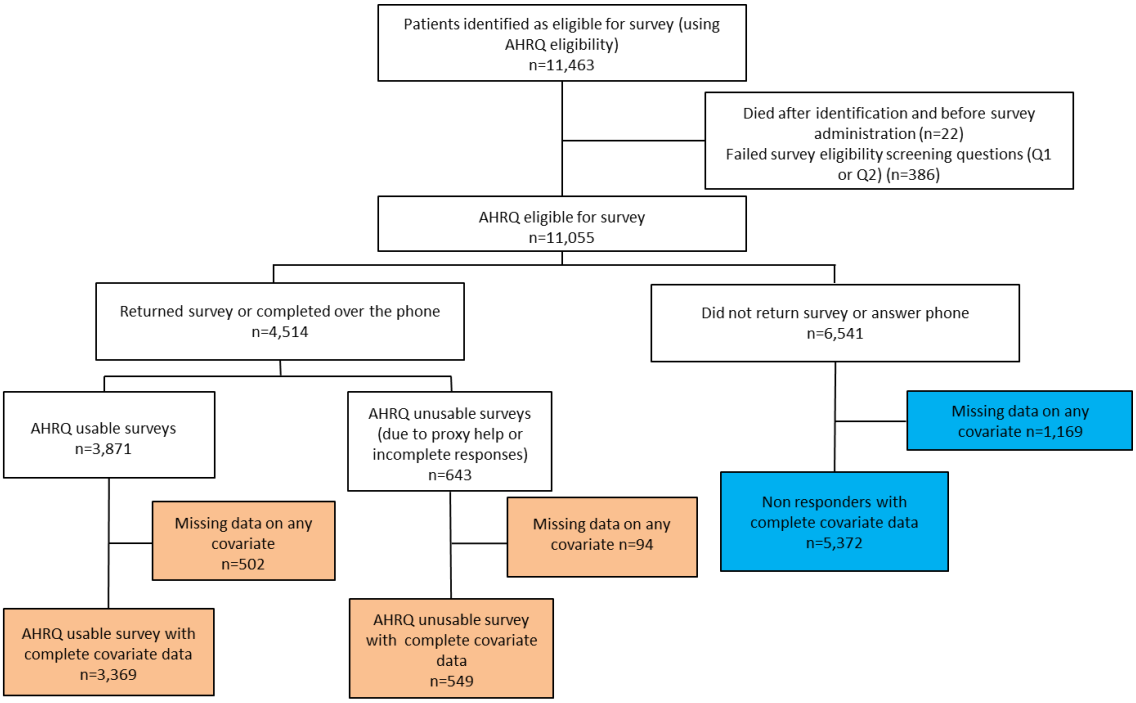
*Patients in the orange boxes are combined ("Expanded usable") and compared to patients in the blue box above

Figure 6.2: Flow diagram for first sensitivity analysis



*After multiple imputation for missing non-functional covariate data, patients from the orange boxes are compared to patients from the blue boxes above

Figure 6.3: Flow diagram for second sensitivity analysis



*After multiple imputation for missing non-functional covariate data, patients from the orange boxes are compared to patients from the blue

Figure 6.4: Responses gained using the expanded usable criteria

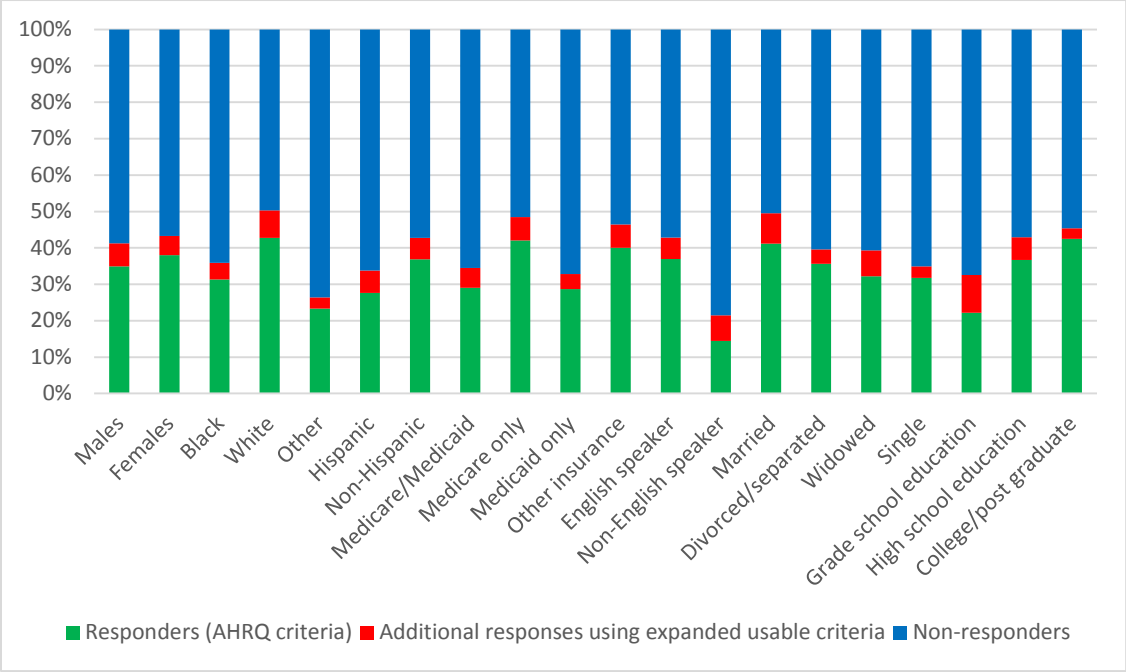


Table 6.2: Multivariable logistic regression models predicting non-response using "expanded usable" criteria

	Model 1	Model 2	Model 3
ICC	0.012	0.013	0.014
Age, per 5 years	**0.95 (0.93, 0.97)**	**0.93 (0.91, 0.95)**	**0.89 (0.87, 0.91)**
Female sex	**0.81 (0.74, 0.88)**	**0.79 (0.72, 0.88)**	**0.77 (0.70, 0.86)**
Race, white vs. black	**0.61 (0.55, 0.67)**	**0.62 (0.55, 0.68)**	**0.58 (0.52, 0.65)**
Race, other vs. black	**1.33 (1.08, 1.63)**	**1.37 (1.11, 1.69)**	**1.34 (1.08, 1.66)**
Ethnicity, Hispanic vs non-Hispanic	1.17 (0.95, 1.43)	1.17 (0.95, 1.45)	1.21 (0.98, 1.49)
Insurance, Medicare/Medicaid vs. other	**1.27 (1.12, 1.45)**	**1.20 (1.05, 1.37)**	1.04 (0.91, 1.20)
Insurance, Medicare only vs. other	0.97 (0.87, 1.10)	0.99 (0.88, 1.12)	0.99 (0.87, 1.12)
Insurance, Medicaid only vs. other	1.16 (0.93, 1.45)	1.05 (0.84, 1.31)	0.89 (0.71, 1.13)
Marital status, married vs. single	**0.75 (0.66, 0.85)**	**0.77 (0.68, 0.88)**	**0.78 (0.69, 0.89)**
Marital status, divorced/separated vs. single	1.00 (0.88, 1.14)	0.98 (0.86, 1.12)	1.03 (0.90, 1.19)
Marital status, widowed vs. single	**1.31 (1.11, 1.54)**	**1.33 (1.12, 1.57)**	**1.34 (1.13, 1.59)**
Education level, grade school vs. college or more	**1.36 (1.16, 1.60)**	**1.33 (1.13, 1.57)**	**1.29 (1.10, 1.53)**
Education level, high school vs. college or more	1.00 (0.91, 1.11)	0.98 (0.88, 1.09)	0.99 (0.89, 1.10)
English speaker	**0.52 (0.38, 0.72)**	**0.48 (0.35, 0.66)**	**0.49 (0.35, 0.68)**
Hospitalizations		**1.49 (1.30, 1.71)**	**1.45 (1.26, 1.67)**
Active on transplant waitlist		**0.82 (0.71, 0.95)**	0.90 (0.77, 1.04)
BMI, per 2 kg/m^2		**0.96 (0.95, 0.97)**	**0.96 (0.95, 0.97)**
Cause ESRD, diabetes vs. other		**1.17 (1.05, 1.31)**	1.07 (0.95, 1.20)
Cause ESRD, hypertension vs. other		1.07 (0.95, 1.21)	1.07 (0.95, 1.21)
Vascular access, catheter vs. fistula		1.34 (1.18, 1.53)	**1.16 (1.02, 1.32)**
Vascular access, graft vs.		0.98 (0.88,	0.96 (0.85,

fistula		1.10)	1.08)
Hemoglobin, per 0.5 g/dL		0.99 (0.97, 1.01)	0.99 (0.97, 1.01)
Albumin, per 0.2 g/dL		**0.92 (0.89, 0.94)**	**0.95 (0.93, 0.98)**
Kt/V, per 0.2		0.98 (0.95, 1.02)	0.97 (0.94, 1.01)
ESRD vintage, per 12 months		1.01 (1.00, 1.03)	1.01 (1.00, 1.03)
ESRD vintage > 12 months before current facility		0.97 (0.86, 1.10)	0.95 (0.84, 1.07)
Unexcused absences		**1.30 (1.15, 1.47)**	**1.35 (1.19, 1.53)**
Treatments shortened		**1.33 (1.21, 1.45)**	**1.32 (1.20, 1.45)**
Ability to ambulate			**0.84 (0.71, 1.00)**
Ability to transfer			1.16 (0.95, 1.41)
Falls			0.88 (0.76, 1.03)
Nursing home resident			**2.11 (1.68, 2.64)**
ADL score, per 1 increase			**0.88 (0.86, 0.91)**

Data shown as odds ratio (OR) (95% CI). OR above 1.00 is associated with non-response. Associations with $p<0.05$ are in bold. BMI: Body mass index; ESRD: End stage renal disease; ADL: Activities of daily living

Table 6.3: Proportion of missing data for each covariate

	Eligible (N=11055)
Race	149 (1.4%)
Ethnicity	194 (1.8%)
ESRD cause	14 (0.1%)
Insurance	287 (2.6%)
Vascular access	16 (0.1%)
English speaker	597 (5.4%)
Nursing Home Residence	631 (5.7%)
Ability to ambulate	597 (5.4%)
Ability to transfer	597 (5.4%)
Falls	597 (5.4%)
Marital status	478 (4.3%)
Education Level	478 (4.3%)
Transplant waitlist status	529 (4.8%)
Albumin	23 (0.2%)
Hemoglobin	19 (0.2%)
Kt/V	74 (0.7%)
ADL score	597 (5.4%)
BMI	148 (1.3%)

Data shown as n (%). BMI: Body mass index; ESRD: End stage renal disease; ADL: Activities of daily living

Table 6.4: Baseline characteristics of participants with complete vs missing data

	Eligible (N=11055)	Any missing data (n=1765, 16%)	Complete data (n=9290, 84%)
Age	61.0 ± 14.8	60.4 ± 14.7	61.1 ± 14.8
Female sex	4893 (44.3%)	825 (46.7%)	4068 (43.8%)
Race			
Black	5054 (46.3%)	928 (57.4%)	4126 (44.4%)
White	5071 (46.5%)	585 (36.2%)	4486 (48.3%)
Other	781 (7.2%)	103 (6.4%)	678 (7.3%)
Hispanic Ethnicity	748 (6.9%)	111 (7.1%)	637 (6.9%)
Cause of ESRD			
Diabetes	4719 (42.7%)	704 (40.2%)	4015 (43.2%)
Hypertension	3223 (29.2%)	593 (33.9%)	2630 (28.3%)
Other	3099 (28.1%)	454 (25.9%)	2645 (28.5%)
Marital status			
Married	3988 (37.7%)	433 (33.6%)	3555 (38.3%)
Divorced/Separated	2209 (20.9%)	262 (20.4%)	1947 (21.0%)
Widowed	1693 (16.0%)	217 (16.9%)	1476 (15.9%)
Single	2687 (25.4%)	375 (29.1%)	2312 (24.9%)
Education Level			
Grade School	1397 (13.2%)	176 (13.7%)	1221 (13.1%)
High School	6463 (61.1%)	784 (60.9%)	5679 (61.1%)
College/Post Graduate	2717 (25.7%)	327 (25.4%)	2390 (25.7%)
English speaker	10130 (96.9%)	1138 (97.4%)	8992 (96.8%)
Nursing home resident	769 (7.4%)	87 (7.7%)	682 (7.3%)
Insurance			
Medicare/Medicaid	3812 (35.4%)	509 (34.4%)	3303 (35.6%)
Medicare only	4272 (39.7%)	626 (42.4%)	3646 (39.3%)
Medicaid only	627 (5.8%)	94 (6.4%)	533 (5.7%)
Other	2057 (19.1%)	249 (16.9%)	1808 (19.5%)
Active on transplant waitlist	1199 (11.4%)	151 (12.2%)	1048 (11.3%)
Vascular access			
Fistula	6773 (61.4%)	1008 (57.6%)	5765 (62.1%)
Catheter	1922 (17.4%)	371 (21.2%)	1551 (16.7%)
Graft	2344 (21.2%)	370 (21.2%)	1974 (21.3%)
Albumin (g/dL)	3.8 ± 0.4	3.8 ± 0.5	3.8 ± 0.4
Hemoglobin (g/dL)	11.1 ± 1.2	11.1 ± 1.3	11.1 ± 1.2
Kt/V	1.61 ± 0.28	1.57 ± 0.28	1.62 ± 0.28
BMI (kg/m^2)	28.4 ± 7.6	28.5 ± 7.6	28.4 ± 7.6

Unexcused absences	1964 (17.8%)	326 (18.5%)	1638 (17.6%)
Treatments shortened	5485 (49.6%)	853 (48.3%)	4632 (49.9%)
Hospitalizations	1541 (13.9%)	238 (13.5%)	1303 (14.0%)
ESRD vintage (months)	39.4 (18.8, 75.3)	34.3 (14.9, 69.4)	40.4 (19.5, 76.4)
ESRD vintage > 12 months before current facility	2413 (21.8%)	356 (20.2%)	2057 (22.1%)
Ability to ambulate	7970 (76.2%)	865 (74.1%)	7105 (76.5%)
Ability to transfer	8769 (83.9%)	949 (81.3%)	7820 (84.2%)
Falls	1017 (9.7%)	123 (10.5%)	894 (9.6%)
ADL score	5.7 ± 2.6	5.7 ± 2.6	5.7 ± 2.6

Data shown as mean ± SD or median (25^{th}, 75^{th} percentiles) or n (%). BMI: Body mass index; ESRD: End stage renal disease; ADL: Activities of daily living

Table 6.5: Multivariable logistic regression models predicting non-response using multiple imputation using AHRQ method

	Model 1	Model 2
Age, per 5 years	0.99 (0.97, 1.00)	**0.96 (0.94, 0.98)**
Female sex	**0.77 (0.71, 0.84)**	**0.72 (0.65, 0.79)**
Race, white vs. black	**0.63 (0.58, 0.70)**	**0.64 (0.58, 0.71)**
Race, other vs. black	1.16 (0.96, 1.42)	1.18 (0.97, 1.44)
Ethnicity, Hispanic vs non-Hispanic	1.17 (0.95, 1.44)	1.18 (0.95, 1.46)
Insurance, Medicare/Medicaid vs. other	**1.37 (1.21, 1.55)**	**1.28 (1.12, 1.45)**
Insurance, Medicare only vs. other	0.96 (0.86, 1.07)	0.96 (0.86, 1.08)
Insurance, Medicaid only vs. other	**1.32 (1.07, 1.63)**	1.20 (0.96, 1.49)
Marital status, married vs. single	**0.83 (0.73, 0.93)**	**0.86 (0.76, 0.97)**
Marital status, divorced/separated vs. single	0.95 (0.84, 1.08)	0.94 (0.82, 1.07)
Marital status, widowed vs. single	**1.24 (1.05, 1.45)**	**1.25 (1.06, 1.47)**
Education level, grade school vs. college or more	**2.08 (1.76, 2.46)**	**2.04 (1.72, 2.42)**
Education level, high school vs. college or more	**1.22 (1.11, 1.35)**	**1.19 (1.08, 1.32)**
English speaker	**0.53 (0.40, 0.70)**	**0.51 (0.38, 0.67)**
Hospitalizations		**1.46 (1.28, 1.67)**
Active on transplant waitlist		**0.82 (0.72, 0.94)**
BMI, per 2 kg/m^2		**0.96 (0.95, 0.97)**
Cause ESRD, diabetes vs. other		**1.32 (1.19, 1.47)**
Cause ESRD, hypertension vs. other		**1.13 (1.01, 1.27)**
Vascular access, catheter vs. fistula		**1.33 (1.18, 1.50)**
Vascular access, graft vs. fistula		1.02 (0.92, 1.14)
Hemoglobin, per 0.5 g/dL		0.99 (0.97, 1.01)
Albumin, per 0.2 g/dL		**0.89 (0.87, 0.91)**
Kt/V, per 0.2		1.02 (0.97, 1.08)
ESRD vintage, per 12 months		**1.02 (1.00, 1.04)**
ESRD vintage > 12 months before current facility		0.96 (0.86, 1.08)
Unexcused absences		**1.26 (1.12, 1.41)**
Treatments shortened		**1.24 (1.13, 1.35)**

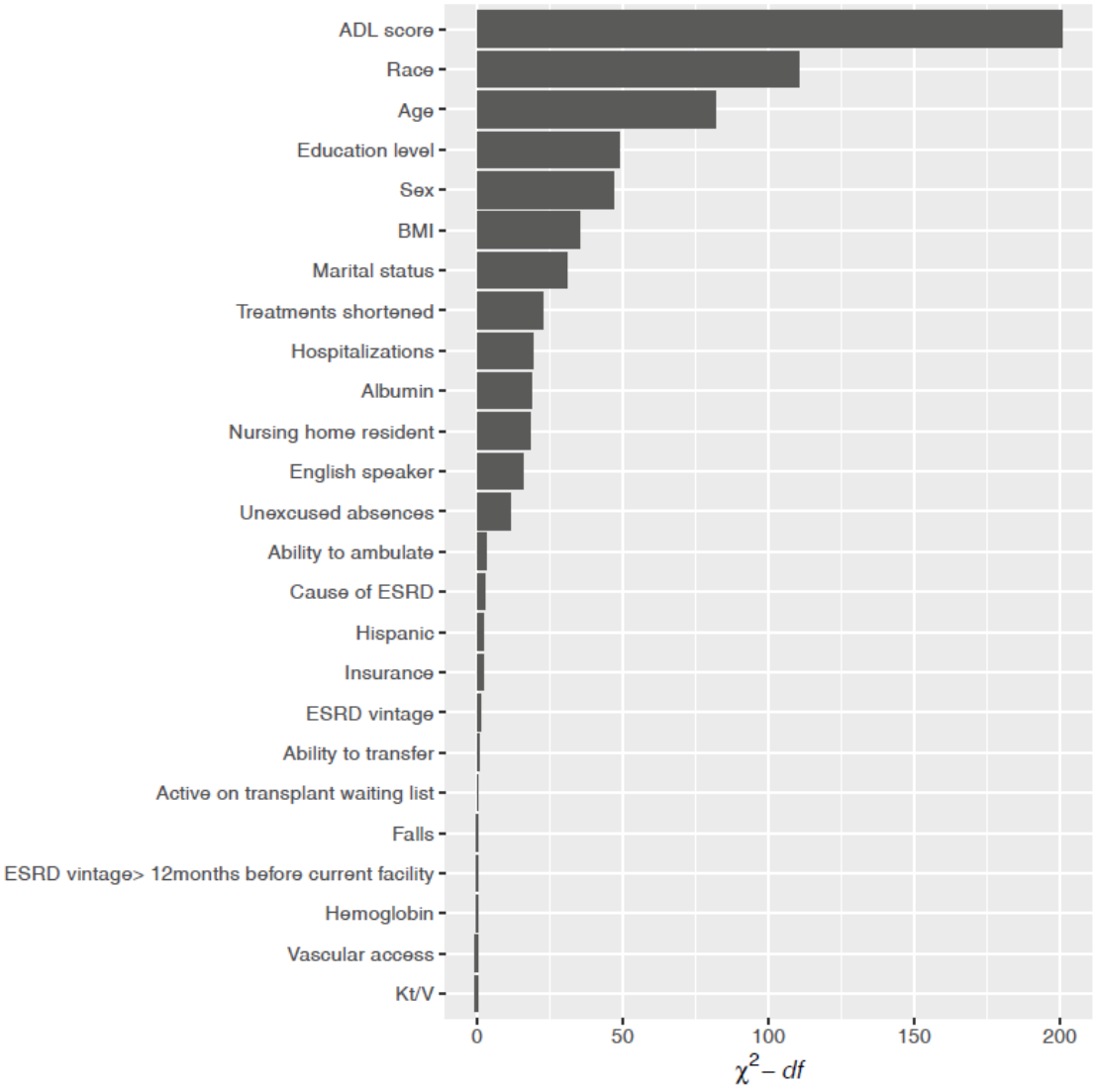
Data shown as odds ratio (OR) (95% CI). OR above 1.00 is associated with non-response. Associations with $p<0.05$ are in bold. Only 2 models are show since we did not impute functional covariate data. BMI: Body mass index; ESRD: End stage renal disease; ADL: Activities of daily living

Table 6.6: Multivariable logistic regression models predicting non-response using multiple imputation using "expanded usable criteria"

	Model 1	Model 2
Age, per 5 years	**0.95 (0.94, 0.97)**	**0.93 (0.91, 0.95)**
Female sex	**0.82 (0.76, 0.89)**	**0.78 (0.71, 0.86)**
Race, white vs. black	**0.61 (0.56, 0.67)**	**0.61 (0.56, 0.68)**
Race, other vs. black	**1.26 (1.04, 1.53)**	**1.30 (1.06, 1.59)**
Ethnicity, Hispanic vs non-Hispanic	1.18 (0.98, 1.42)	1.20 (1.00, 1.45)
Insurance, Medicare/Medicaid vs. other	**1.29 (1.15, 1.46)**	**1.23 (1.08, 1.39)**
Insurance, Medicare only vs. other	0.96 (0.86, 1.08)	0.98 (0.87, 1.10)
Insurance, Medicaid only vs. other	**1.26 (1.03, 1.55)**	1.15 (0.93, 1.42)
Marital status, married vs. single	**0.76 (0.67, 0.85)**	**0.78 (0.69, 0.88)**
Marital status, divorced/separated vs. single	1.00 (0.88, 1.14)	0.99 (0.87, 1.13)
Marital status, widowed vs. single	**1.22 (1.05, 1.43)**	**1.24 (1.06, 1.45)**
Education level, grade school vs. college or more	**1.40 (1.21, 1.63)**	**1.37 (1.17, 1.60)**
Education level, high school vs. college or more	1.04 (0.95, 1.14)	1.01 (0.92, 1.12)
English speaker	**0.51 (0.40, 0.65)**	**0.49 (0.38, 0.62)**
Hospitalizations		**1.54 (1.35, 1.75)**
Active on transplant waitlist		**0.82 (0.71, 0.94)**
BMI, per 2 kg/m^2		**0.96 (0.95, 0.97)**
Cause ESRD, diabetes vs. other		**1.19 (1.07, 1.32)**
Cause ESRD, hypertension vs. other		1.11 (0.99, 1.24)
Vascular access, catheter vs. fistula		**1.41 (1.25, 1.59)**
Vascular access, graft vs. fistula		0.98 (0.88, 1.09)
Hemoglobin, per 0.5 g/dL		0.98 (0.95, 1.01)
Albumin, per 0.2 g/dL		**0.92 (0.88, 0.96)**
Kt/V, per 0.2		1.02 (0.96, 1.08)
ESRD vintage, per 12 months		1.01 (0.99, 1.03)
ESRD vintage > 12 months before current facility		0.98 (0.88, 1.10)
Unexcused absences		**1.34 (1.19, 1.50)**
Treatments shortened		**1.27 (1.17, 1.38)**

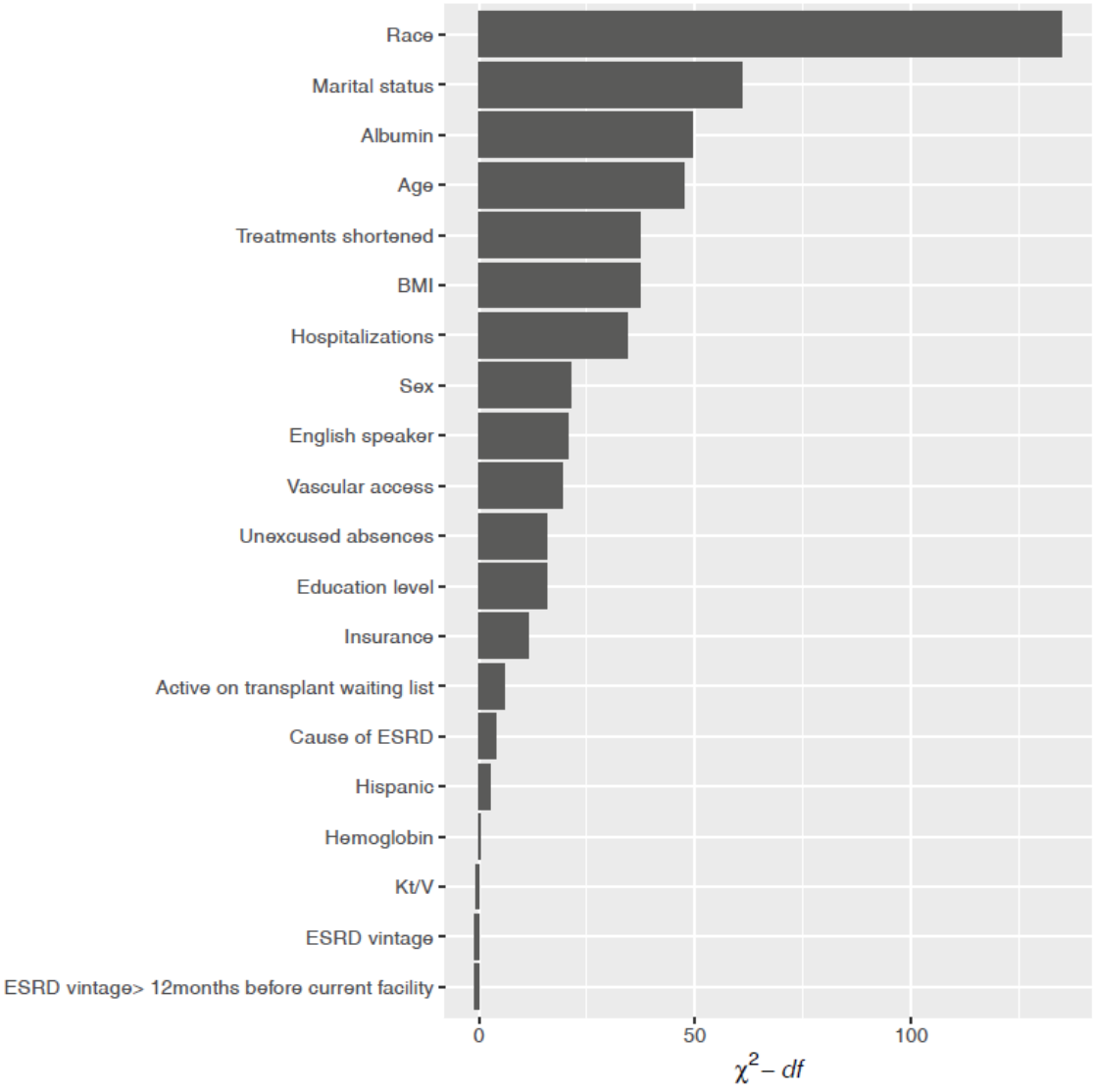
Data shown as odds ratio (OR) (95% CI). OR above 1.00 is associated with non-response. Associations with $p<0.05$ are in bold. BMI: Body mass index; ESRD: End stage renal disease; ADL: Activities of daily living

Figure 6.5: Ranking of variable contribution for determining non-response using AHRQ method and full model (Model 3)



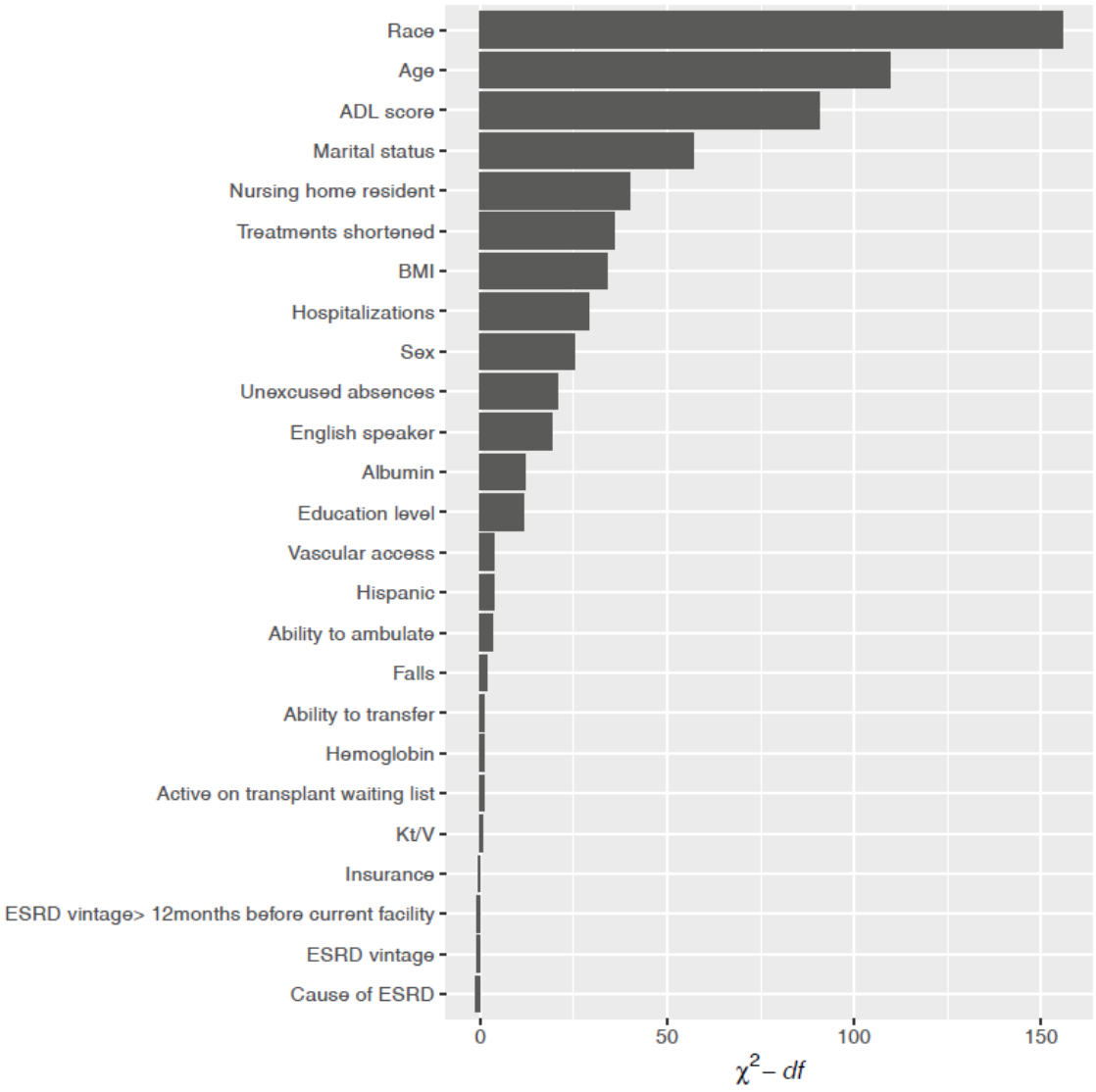
ESRD: End stage renal disease; ADL: Activities of daily living; BMI: Body mass index

Figure 6.6: Ranking of variable contribution for determining non-response using "expanded usable" criteria and model 2 (without functional covariates)



ESRD: End stage renal disease; BMI: Body mass index

Figure 6.7: Ranking of variable contribution for determining non-response using "expanded usable" criteria and full model (Model 3)



ESRD: End stage renal disease; ADL: Activities of daily living; BMI: Body mass index

6.2 Supplementary material for chapter 3

Figure 6.8: Geographic distribution of DCI clinics

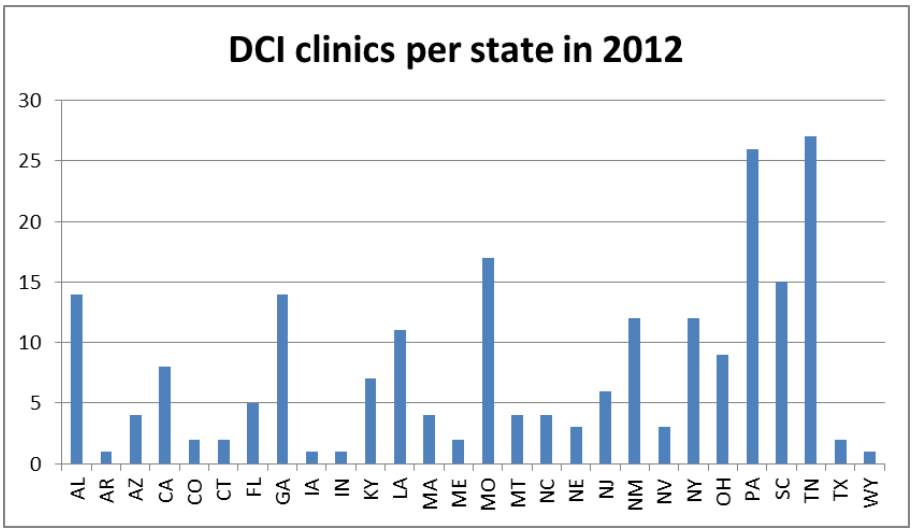


Table 6.7: Reasons for patient loss during survey administration by response status

	No Response (n=584)	Response (n=76)
Death=434	408 (69.9%)	26 (34.2%)
Transplant=74	48 (8.2%)	26 (34.2%)
Transfer out of DCI=128	108 (18.5%)	20 (26.3%)
Recovered kidney function=17	13 (2.2%)	4 (5.3%)
Lost to follow up/unknown follow up=7	7 (1.2%)	0

Figure 6.9: Kaplan-Meier plot of hospitalization or death

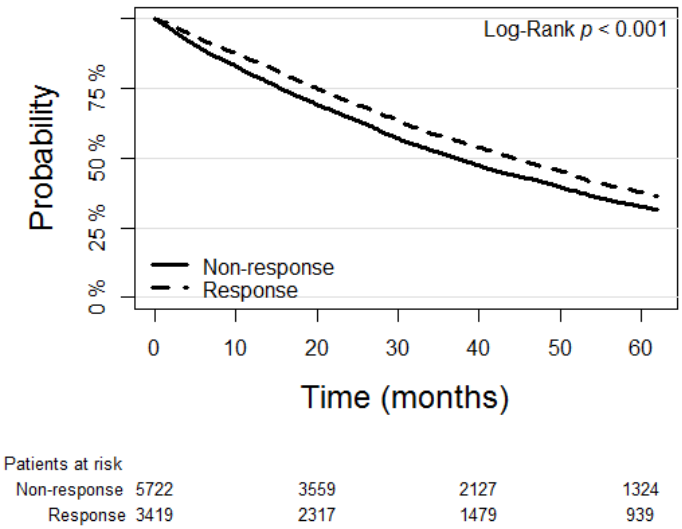


Table 6.8: Missing data and response status

Total=10395	Response	No response
Complete data=9141 (87.9%)	3419 (90.1%)	5722 (86.7%)
Missing covariate data=1254 (12.1%)	375 (9.9%)	879 (13.3%)

Table 6.9: Distribution of missing covariate data

Covariates	Missing
Race	132
Insurance	259
Marital status	337
Education	337
Active on transplant waitlist	516
BMI	68
Cause ESRD	10
Vascular access	8
Albumin	12
Kt/V	58

Variables used for adjustment that are not listed had no missing values

Table 6.10: Comparison of baseline covariates in patients with and without missing data

	Complete data (n=9,141)	**Missing data (n=1,254)**
Age (years)	61.0 ± 14.7	59.3 ± 14.7
Female Sex	4022 (44.0)	592 (47.2)
Race: Black	4090 (44.7)	738 (65.8)
White	4386 (48.0)	314 (28.0)
Other	665 (7.3)	70 (6.2)
Insurance: Medicare/Medicaid	3258 (35.6)	352 (35.4)
Medicare only	3581 (39.2)	425 (42.7)
Medicaid only	533 (5.8)	63 (6.3)
Other	1769 (19.4)	155 (15.6)
Marital status: Married	3499 (38.3)	305 (33.3)
Divorced/separated	1920 (21.0)	185 (20.2)
Widowed	1426 (15.6)	141 (15.4)
Single	2296 (25.1)	286 (31.2)
Education: Grade school	1193 (13.1)	128 (14.0)
High school	5570 (60.9)	574 (62.6)
College or more	2378 (26.0)	215 (23.4)
Hospitalized during survey administration	2090 (22.9)	233 (18.6)
Active on transplant waitlist	1030 (11.3)	83 (11.2)
BMI (per 2 kg/m^2)	28.5 ± 7.5	28.6 ± 7.6
Cause ESRD: Diabetes	3950 (43.2)	477 (38.3)
Hypertension	2585 (28.3)	456 (36.7)
Other	2606 (28.5)	311 (25.0)
Vascular access: Catheter	1462 (16.0)	253 (20.3)
Graft	1955 (21.4)	280 (22.5)
Fistula	5724 (62.6)	713 (57.2)
Albumin (per 0.2 g/dL)	3.8 ± 0.4	3.8 ± 0.4
Kt/V (per 0.2)	1.62 ± 0.28	1.57 ± 0.28
ESRD vintage (months)	40.3 (19.5, 76.3)	36.3 (16.3, 72.1)
Treatment shortened in last month	4537 (49.6)	642 (51.2)
Unexcused absences in last month	1575 (17.2)	225 (17.9)

Data shown as mean ± SD or median (25th, 75th percentiles) or n (%). BMI: Body mass index; ESRD: End-stage renal disease.

Table 6.11: Outcomes in patients with or without missing covariate data

	Death	Transplant	Hospitalization
Complete data (n=9141)	4588 (50.2%)	789 (8.6%)	7638 (83.6%)
Missing data (n=1254)	557 (44.4%)	83 (6.6%)	953 (76.0%)

6.3 Supplementary material for chapter 4

Table 6.12: Analyses performed

	Primary analysis	**Sensitivity analysis 1**	**Sensitivity analysis 2**	**Sensitivity analysis 3**
Top box definition for global ratings	9-10	9-10	8-10	8-10
Top box definition for composite scores	Average equal to 4 for NCC and DCO and 1 for PIP	Average equal to 4 for NCC and DCO and 1 for PIP	Average equal to 4 for NCC and DCO and 1 for PIP	Average equal to 4 for NCC and DCO and 1 for PIP
Missing covariate data	Not included	Multiple imputation performed	Not included	Multiple imputation performed
Incomplete composite responses	Decreased denominator to obtain average*	Decreased denominator to obtain average*	Decreased denominator to obtain average*	Decreased denominator to obtain average*
<50% key questions answered	Not included	Not included	Not included	Not included
Proxy help indicated	Not included	Not included	Not included	Not included

*As long as at least 50% of the questions within a composite were answered otherwise individual was not included. 9-10 is the current CMS top box definition and 8-10 was the older AHRQ top box definition. NCC: Nephrologists' Communication and Caring; DCO: Quality of Dialysis Center Care and Operations; PIP: Providing Information to Patients

Table 6.13: Patient Characteristics stratified by higher or lower nephrologist rating

	Total (n=3,294)	Top Box (n=2,045, 62%)	Below Top Box (n=1249, 38%)
Age (years)	61.9 ± 13.9	63.0 ± 13.7	60.2 ± 13.9
Female	1498 (45.5)	978 (47.8)	520 (41.6)
Race			
Black	1269 (38.5)	800 (39.1)	469 (37.6)
White	1870 (56.8)	1161 (56.8)	709 (56.8)
Other	155 (4.7)	84 (4.1)	71 (5.7)
Hispanic Ethnicity	171 (5.2)	103 (5.0)	68 (5.4)
Cause of ESRD			
Diabetes	1322 (40.1)	795 (38.9)	527 (42.2)
Hypertension	939 (28.5)	603 (29.5)	336 (26.9)
Other	1033 (31.4)	647 (31.6)	386 (30.9)
Marital status			
Married	1437 (43.6)	909 (44.5)	528 (42.3)
Divorced/Separated	676 (20.5)	409 (20.0)	267 (21.4)
Widowed	455 (13.8)	315 (15.4)	140 (11.2)
Single	726 (22.0)	412 (20.2)	314 (25.1)
Education Level			
Grade School	258 (7.8)	173 (8.5)	85 (6.8)
High School	2039 (61.9)	1285 (62.8)	754 (60.4)
College/Post Graduate	997 (30.3)	587 (28.7)	410 (32.8)
English speaker	3254 (98.8)	2014 (98.5)	1240 (99.3)
Insurance			
Medicare/Medicaid	930 (28.2)	561 (27.4)	369 (29.5)
Medicare only	1507 (45.8)	953 (46.6)	554 (44.4)
Medicaid only	148 (4.5)	83 (4.1)	65 (5.2)
Other	709 (21.5)	448 (21.9)	261 (20.9)
Active on transplant waitlist	454 (13.8)	294 (14.4)	160 (12.8)
Vascular access			
Fistula	2152 (65.3)	1336 (65.3)	816 (65.3)
Graft	456 (13.8)	440 (21.5)	246 (19.7)
Catheter	686 (20.8)	269 (13.2)	187 (15.0)
Albumin (g/dL)	3.9 ± 0.4	3.88 ± 0.4	3.89 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.1	11.2 ± 1.1	11.3 ± 1.2
Kt/V	1.62 ± 0.27	1.64 ± 0.27	1.60 ± 0.27
BMI (kg/m^2)	29.2 ± 7.7	29.1 ± 7.5	29.3 ± 7.8
Unexcused absences	463 (14.1)	250 (12.2)	213 (17.1)

Treatments shortened	1445 (43.9)	811 (39.7)	634 (50.8)
Hospitalization	331 (10.1)	197 (9.6)	134 (10.7)
ESRD vintage (months)	37.8 (18.2, 72.3)	37.1 (17.7, 71.1)	39.1 (19.2, 73.7)
ESRD vintage > 12 months before current facility	695 (21.1)	414 (20.2)	281 (22.5)
Ability to ambulate	2800 (85.0)	1734 (84.8)	1066 (85.4)
Ability to transfer	2981 (90.5)	1843 (90.1)	1138 (91.1)
Falls	301 (9.1)	176 (8.6)	125 (10.0)
ADL score	8 (5, 8)	8 (5, 8)	8 (5, 8)
Response mode			
Mail	2739 (83.2)	1690 (82.6)	1049 (84.0)
Telephone	555 (16.9)	355 (17.4)	200 (16.0)

Top box score defined as 9-10 on the global rating scale. Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.14: Patient Characteristics stratified by higher or lower dialysis staff rating

	Total (n=3,145)	Top Box (n=2,071, 66%)	Below Top Box (n=1,074, 34%)
Age (years)	61.8 ± 13.9	62.8 ± 13.6	59.8 ± 14.2
Female	1433 (45.6)	949 (45.8)	484 (45.1)
Race			
Black	1201 (38.2)	751 (36.3)	450 (41.9)
White	1795 (57.1)	1226 (59.2)	569 (53.0)
Other	149 (4.7)	94 (4.5)	55 (5.1)
Hispanic Ethnicity	173 (5.5)	108 (5.2)	65 (6.1)
Cause of ESRD			
Diabetes	1253 (39.8)	838 (40.5)	415 (38.6)
Hypertension	891 (28.3)	589 (28.4)	302 (28.1)
Other	1001 (31.8)	644 (31.1)	357 (33.2)
Marital status			
Married	1370 (43.6)	921 (44.5)	449 (41.8)
Divorced/Separated	641 (20.4)	409 (19.8)	232 (21.6)
Widowed	427 (13.6)	311 (15.0)	116 (10.8)
Single	707 (22.5)	430 (20.8)	277 (25.8)
Education Level			
Grade School	256 (8.1)	187 (9.0)	69 (6.4)
High School	1946 (61.9)	1315 (63.5)	631 (58.8)
College/Post Graduate	943 (30.0)	569 (27.5)	374 (34.8)
English speaker	3103 (98.7)	2043 (98.7)	1060 (98.7)
Insurance			
Medicare/Medicaid	903 (28.7)	568 (27.4)	335 (31.2)
Medicare only	1424 (45.3)	958 (46.3)	466 (43.4)
Medicaid only	143 (4.6)	99 (4.8)	44 (4.1)
Other	675 (21.5)	446 (21.5)	229 (21.3)
Active on transplant waitlist	434 (13.8)	277 (13.4)	157 (14.6)
Vascular access			
Fistula	2064 (65.6)	1352 (65.3)	712 (66.3)
Graft	436 (13.9)	449 (21.7)	196 (18.3)
Catheter	645 (20.5)	270 (13.0)	166 (15.5)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.4	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.1	11.2 ± 1.1	11.2 ± 1.2
Kt/V	1.62 ± 0.27	1.63 ± 0.26	1.61 ± 0.29
BMI (kg/m^2)	29.2 ± 7.7	29.2 ± 7.6	29.1 ± 7.7

Unexcused absences	454 (14.4)	282 (13.6)	172 (16.0)
Treatments shortened	1381 (43.9)	853 (41.2)	528 (49.2)
Hospitalization	313 (10.0)	205 (9.9)	108 (10.1)
ESRD vintage (months)	38.1 (18.4, 72.5)	36.9 (17.9, 68.5)	40.3 (19.3, 77.5)
ESRD vintage > 12 months before current facility	670 (21.3)	411 (19.9)	259 (24.1)
Ability to ambulate	2681 (85.3)	1760 (85.0)	921 (85.8)
Ability to transfer	2853 (90.7)	1882 (90.9)	971 (90.4)
Falls	284 (9.0)	187 (9.0)	97 (9.0)
ADL score	8 (5, 8)	6.5 ± 2.1	6.5 ± 2.1
Response mode			
Mail	2589 (82.3)	1686 (81.4)	903 (84.1)
Telephone	556 (17.7)	385 (18.6)	171 (15.9)

Top box score defined as 9-10 on the global rating scale. Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.15: Patient Characteristics stratified by higher or lower dialysis facility rating

	Total (n=3,153)	Top Box (n=2,157, 68%)	Below Top Box (n=996, 32%)
Age (years)	61.8 ± 13.9	62.9 ± 13.5	59.4 ± 14.2
Female	1432 (45.4)	983 (45.6)	449 (45.1)
Race			
Black	1200 (38.1)	787 (36.5)	413 (41.5)
White	1804 (57.2)	1268 (58.8)	536 (53.8)
Other	149 (4.7)	102 (4.7)	47 (4.7)
Hispanic Ethnicity	174 (5.5)	121 (5.6)	53 (5.3)
Cause of ESRD			
Diabetes	1252 (39.7)	875 (40.6)	377 (37.9)
Hypertension	897 (28.5)	613 (28.4)	284 (28.5)
Other	1004 (31.8)	669 (31.0)	335 (33.6)
Marital status			
Married	1376 (43.6)	968 (44.9)	408 (41.0)
Divorced/Separated	644 (20.4)	432 (20.0)	212 (21.3)
Widowed	428 (13.6)	322 (14.9)	106 (10.6)
Single	705 (22.4)	435 (20.2)	270 (27.1)
Education Level			
Grade School	258 (8.2)	203 (9.4)	55 (5.5)
High School	1949 (61.8)	1360 (63.1)	589 (59.1)
College/Post Graduate	946 (30.0)	594 (27.5)	352 (35.3)
English speaker	3110 (98.6)	2119 (98.2)	991 (99.5)
Insurance			
Medicare/Medicaid	907 (28.8)	596 (27.6)	311 (31.2)
Medicare only	1426 (45.2)	1002 (46.5)	424 (42.6)
Medicaid only	142 (4.5)	94 (4.4)	48 (4.8)
Other	678 (21.5)	465 (21.6)	213 (21.4)
Active on transplant waitlist	435 (13.8)	282 (13.1)	153 (15.4)
Vascular access			
Fistula	2070 (65.7)	1396 (64.7)	674 (67.7)
Graft	434 (13.8)	460 (21.3)	189 (19.0)
Catheter	649 (20.6)	301 (14.0)	133 (13.4)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.4	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.2	11.2 ± 1.1	11.2 ± 1.2
Kt/V	1.62 ± 0.27	1.63 ± 0.26	1.62 ± 0.29
BMI (kg/m^2)	29.2 ± 7.7	29.2 ± 7.7	29.1 ± 7.6
Unexcused absences	455 (14.4)	288 (13.4)	167 (16.8)

Treatments shortened	1383 (43.9)	891 (41.3)	492 (49.4)
Hospitalization	315 (10.0)	209 (9.7)	106 (10.6)
ESRD vintage (months)	38.0 (18.3, 72.4)	36.4 (17.5, 68.5)	41.4 (21.8, 77.4)
ESRD vintage > 12 months before current facility	671 (21.3)	424 (19.7)	247 (24.8)
Ability to ambulate	2690 (85.3)	1831 (84.9)	859 (86.2)
Ability to transfer	2862 (90.8)	1954 (90.6)	908 (91.2)
Falls	287 (9.1)	203 (9.4)	84 (8.4)
ADL score	8 (5, 8)	6.4 ± 2.1	6.6 ± 2.0
Response mode			
Mail	2592 (82.2)	1742 (80.8)	850 (85.3)
Telephone	561 (17.8)	415 (19.2)	146 (14.7)

Top box score defined as 9-10 on the global rating scale. Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.16: Patient Characteristics stratified by higher or lower Nephrologists' Communication and Caring (NCC) score

	Total (n=3,357)	Top Box (n=1,255, 37%)	Below Top Box (n=2,102, 63%)
Age (years)	62.1 ± 13.9	62.6 ± 13.3	61.8 ± 14.2
Female	1543 (46.0)	616 (49.1)	927 (44.1)
Race			
Black	1292 (38.5)	498 (39.7)	794 (37.8)
White	1909 (56.9)	707 (56.3)	1202 (57.2)
Other	156 (4.7)	50 (4.0)	106 (5.0)
Hispanic Ethnicity	176 (5.2)	59 (4.7)	117 (5.6)
Cause of ESRD			
Diabetes	1349 (40.2)	492 (39.2)	857 (40.8)
Hypertension	958 (28.5)	356 (28.4)	602 (28.6)
Other	1050 (31.3)	407 (32.4)	643 (30.6)
Marital status			
Married	1463 (43.6)	565 (45.0)	898 (42.7)
Divorced/Separated	691 (20.6)	259 (20.6)	432 (20.6)
Widowed	472 (14.1)	182 (14.5)	290 (13.8)
Single	731 (21.8)	249 (19.8)	482 (22.9)
Education Level			
Grade School	269 (8.0)	103 (8.2)	166 (7.9)
High School	2077 (61.9)	790 (63.0)	1287 (61.2)
College/Post Graduate	1011 (30.1)	362 (28.8)	649 (30.9)
English speaker	3314 (98.7)	1242 (99.0)	2072 (98.6)
Insurance			
Medicare/Medicaid	955 (28.5)	357 (28.5)	598 (28.5)
Medicare only	1527 (45.5)	574 (45.7)	953 (45.3)
Medicaid only	152 (4.5)	50 (4.0)	102 (4.9)
Other	723 (21.5)	274 (21.8)	449 (21.4)
Active on transplant waitlist	456 (13.6)	192 (15.3)	264 (12.6)
Vascular access			
Fistula	2190 (65.2)	825 (65.7)	1365 (64.9)
Graft	465 (13.9)	161 (12.8)	304 (14.5)
Catheter	702 (20.9)	269 (21.4)	433 (20.6)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.3	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.1	11.2 ± 1.1	11.2 ± 1.1
Kt/V	1.63 ± 0.27	1.65 ± 0.27	1.61 ± 0.27

BMI (kg/m^2)	29.2 ± 7.7	29.0 ± 7.3	29.3 ± 7.8
Unexcused absences	475 (14.2)	163 (13.0)	312 (14.8)
Treatments shortened	1473 (43.9)	489 (39.0)	984 (46.8)
Hospitalization	335 (10.0)	124 (9.9)	211 (10.0)
ESRD vintage (months)	37.6 (18.2, 72.1)	39.2 (18.0, 73.9)	37.3 (18.3, 70.7)
ESRD vintage > 12 months before current facility	709 (21.1)	282 (22.5)	427 (20.3)
Ability to ambulate	2848 (84.8)	1064 (84.8)	1784 (84.9)
Ability to transfer	3037 (90.5)	1147 (91.4)	1890 (89.9)
Falls	310 (9.2)	96 (7.7)	214 (10.2)
ADL score	8 (5, 8)	8 (5, 8)	8 (5, 8)
Response mode			
Mail	2795 (83.3)	1762 (83.8)	1033 (82.3)
Telephone	562 (16.7)	340 (16.2)	222 (17.7)

Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.17: Patient Characteristics stratified by higher or lower Quality of Dialysis Center Care and Operations (DCO) score

	Total (n=3,238)	Top Box (n=508, 16%)	Below Top Box (n=2,730, 84%)
Age (years)	61.9 ± 13.9	64.4 ± 13.5	61.4 ± 13.9
Female	1480 (45.7)	221 (43.5)	1259 (46.1)
Race			
Black	1237 (38.2)	169 (33.3)	1068 (39.1)
White	1847 (57.0)	322 (63.4)	1525 (55.9)
Other	154 (4.8)	17 (3.4)	137 (5.0)
Hispanic Ethnicity	175 (5.4)	31 (6.1)	144 (5.3)
Cause of ESRD			
Diabetes	1295 (40.0)	199 (39.2)	1096 (40.2)
Hypertension	919 (28.4)	152 (29.9)	767 (28.1)
Other	1024 (31.6)	157 (30.9)	867 (31.8)
Marital status			
Married	1407 (43.5)	242 (47.6)	1165 (42.7)
Divorced/Separated	662 (20.4)	93 (18.3)	569 (20.8)
Widowed	448 (13.8)	80 (15.8)	368 (13.5)
Single	721 (22.3)	93 (18.3)	628 (23.0)
Education Level			
Grade School	265 (8.2)	55 (10.8)	210 (7.7)
High School	2001 (61.8)	330 (65.0)	1671 (61.2)
College/Post Graduate	972 (30.0)	123 (24.2)	849 (31.1)
English speaker	3195 (98.7)	501 (98.6)	2694 (98.7)
Insurance			
Medicare/Medicaid	931 (28.8)	134 (26.4)	797 (29.2)
Medicare only	1465 (45.2)	231 (45.5)	1234 (45.2)
Medicaid only	148 (4.6)	23 (4.5)	125 (4.6)
Other	694 (21.4)	120 (23.6)	574 (21.0)
Active on transplant waitlist	446 (13.8)	49 (9.7)	397 (14.5)
Vascular access			
Fistula	2117 (65.4)	325 (64.0)	1792 (65.6)
Graft	451 (13.9)	86 (16.9)	365 (13.4)
Catheter	670 (20.7)	97 (19.1)	573 (21.0)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.3	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.2	11.2 ± 1.0	11.2 ± 1.2
Kt/V	1.62 ± 0.27	1.64 ± 0.27	1.62 ± 0.27

BMI (kg/m^2)	29.2 ± 7.7	28.4 ± 6.8	29.3 ± 7.8
Unexcused absences	464 (14.3)	54 (10.6)	410 (15.0)
Treatments shortened	1425 (44.0)	199 (39.2)	1226 (44.9)
Hospitalization	320 (9.9)	42 (8.3)	278 (10.2)
ESRD vintage (months)	38.1 (18.4, 72.4)	31.0 (15.1, 61.7)	39.5 (19.1, 74.3)
ESRD vintage > 12 months before current facility	689 (21.3)	78 (15.4)	611 (22.4)
Ability to ambulate	2756 (85.1)	427 (84.1)	2329 (85.3)
Ability to transfer	2933 (90.6)	463 (91.1)	2470 (90.5)
Falls	293 (9.1)	47 (9.3)	246 (9.0)
ADL score	8 (5, 8)	8 (5, 8)	8 (5, 8)
Response mode			
Mail	2669 (82.4)	2290 (83.9)	379 (74.6)
Telephone	569 (17.6)	440 (16.1)	129 (25.4)

Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.18: Patient Characteristics stratified by higher or lower Providing Information to Patients (PIP) score

	Total (n=3,185)	Top Box (n=1,098, 34%)	Below Top Box (n=2,087, 66%)
Age (years)	61.8 ± 13.8	59.1 ± 13.5	63.3 ± 13.8
Female	1454 (45.7)	491 (44.7)	963 (46.1)
Race			
Black	1215 (38.2)	420 (38.3)	795 (38.1)
White	1818 (57.1)	619 (56.4)	1199 (57.5)
Other	152 (4.8)	59 (5.4)	93 (4.5)
Hispanic Ethnicity	173 (5.4)	59 (5.4)	114 (5.5)
Cause of ESRD			
Diabetes	1270 (39.9)	439 (40.0)	831 (39.8)
Hypertension	902 (28.3)	313 (28.5)	589 (28.2)
Other	1013 (31.8)	346 (31.5)	667 (32.0)
Marital status			
Married	1382 (43.4)	481 (43.8)	901 (43.2)
Divorced/Separated	650 (20.4)	214 (19.5)	436 (20.9)
Widowed	443 (13.9)	134 (12.2)	309 (14.8)
Single	710 (22.3)	269 (24.5)	441 (21.1)
Education Level			
Grade School	261 (8.2)	91 (8.3)	170 (8.2)
High School	1965 (61.7)	695 (63.3)	1270 (60.9)
College/Post Graduate	959 (30.1)	312 (28.4)	647 (31.0)
English speaker	3142 (98.7)	1085 (98.8)	2057 (98.6)
Insurance			
Medicare/Medicaid	921 (28.9)	583 (27.9)	338 (30.8)
Medicare only	1436 (45.1)	953 (45.7)	483 (44.0)
Medicaid only	148 (4.7)	95 (4.6)	53 (4.8)
Other	680 (21.4)	456 (21.9)	224 (20.4)
Active on transplant waitlist	439 (13.8)	191 (17.4)	248 (11.9)
Vascular access			
Fistula	2084 (65.4)	712 (64.9)	1372 (65.7)
Graft	444 (13.9)	144 (13.1)	300 (14.4)
Catheter	657 (20.6)	242 (22.0)	415 (19.9)
Albumin (g/dL)	3.9 ± 0.4	3.9 ± 0.4	3.9 ± 0.4
Hemoglobin (g/dL)	11.2 ± 1.2	11.2 ± 1.1	11.2 ± 1.2
Kt/V	1.62 ± 0.27	1.61 ± 0.27	1.63 ± 0.27

BMI (kg/m^2)	29.2 ± 7.7	29.7 ± 7.7	28.9 ± 7.6
Unexcused absences	463 (14.5)	155 (14.1)	308 (14.8)
Treatments shortened	1397 (43.9)	472 (43.0)	925 (44.3)
Hospitalization	315 (9.9)	108 (9.8)	207 (9.9)
ESRD vintage (months)	38.1 (18.4, 72.5)	37.8 (18.1, 71.3)	38.2 (18.5, 73.2)
ESRD vintage > 12 months before current facility	682 (21.4)	225 (20.5)	457 (21.9)
Ability to ambulate	2711 (85.1)	970 (88.3)	1741 (83.4)
Ability to transfer	2888 (90.7)	1029 (93.7)	1859 (89.1)
Falls	290 (9.1)	94 (8.6)	196 (9.4)
ADL score	8 (5, 8)	8 (5, 8)	8 (5, 8)
Response mode			
Mail	2618 (82.2)	1752 (84.0)	866 (78.9)
Telephone	567 (17.8)	335 (16.1)	232 (21.1)

Data presented as n (%), mean $\pm$ standard deviation, or median (25^{th}, 75^{th} percentiles). ESRD: End stage renal disease; BMI: Body mass index; ADL: Activities of daily living. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.19: Multivariable association of characteristics with higher nephrologist rating with multiple imputation

	Model 1	Model 2
Age, per 5 years	**1.07 (1.03, 1.11)**	**1.07 (1.03, 1.11)**
Female	1.03 (0.88, 1.21)	0.98 (0.82, 1.17)
Race, black vs white	1.07 (0.89, 1.30)	1.05 (0.86, 1.29)
Race, other vs white	0.71 (0.48, 1.05)	0.71 (0.48, 1.05)
Ethnicity, Hispanic vs non-Hispanic	1.51 (1.00, 2.29)	1.42 (0.94, 2.16)
Insurance, Medicare/Medicaid vs Medicare only	1.06 (0.85, 1.31)	1.07 (0.86, 1.33)
Insurance, Medicaid only vs Medicare only	1.03 (0.68, 1.56)	1.11 (0.73, 1.69)
Insurance, Other vs Medicare only	1.00 (0.81, 1.24)	1.02 (0.82, 1.27)
Marital status, married vs single	0.94 (0.74, 1.19)	0.94 (0.74, 1.19)
Marital status, divorced/separated vs single	0.90 (0.70, 1.15)	0.94 (0.73, 1.20)
Marital status, widowed vs single	1.16 (0.83, 1.62)	1.18 (0.85, 1.65)
Education level, grade school vs college or more	1.17 (0.83, 1.65)	1.11 (0.78, 1.57)
Education level, high school vs college or more	1.03 (0.87, 1.24)	1.02 (0.85, 1.22)
English speaker	0.81 (0.38, 1.71)	0.87 (0.41, 1.85)
Hospitalization		0.90 (0.69, 1.19)
Active on transplant waitlist		1.19 (0.93, 1.52)
BMI, per 2 kg/m^2		1.02 (1.00, 1.04)
Cause ESRD, diabetes vs. other		0.90 (0.74, 1.10)
Cause ESRD, hypertension vs. other		0.95 (0.77, 1.19)
Vascular access, catheter vs. fistula		0.95 (0.75, 1.21)
Vascular access, graft vs. fistula		1.05 (0.85, 1.30)
Hemoglobin, per 0.5 g/dL		**0.95 (0.92, 0.98)**
Albumin, per 0.2 g/dL		1.00 (0.96, 1.05)
Kt/V, per 0.2		1.02 (0.95, 1.09)
ESRD vintage, per 12 months		1.02 (0.99, 1.05)
ESRD vintage > 12 months before current facility		0.88 (0.70, 1.11)
Unexcused absences		0.83 (0.66, 1.04)
Treatments shortened		**0.70 (0.59, 0.83)**
Telephone administration vs mail		**1.56 (1.24, 1.98)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.20: Multivariable association of characteristics with higher dialysis staff rating with multiple imputation

	Model 1	Model 2
Age, per 5 years	**1.10 (1.06, 1.15)**	**1.09 (1.04, 1.13)**
Female	0.87 (0.72, 1.04)	0.82 (0.67, 1.00)
Race, black vs white	0.88 (0.71, 1.08)	0.87 (0.70, 1.09)
Race, other vs white	0.74 (0.47, 1.14)	0.73 (0.47, 1.14)
Ethnicity, Hispanic vs non-Hispanic	1.21 (0.77, 1.90)	1.11 (0.70, 1.74)
Insurance, Medicare/Medicaid vs Medicare only	0.93 (0.73, 1.17)	0.92 (0.72, 1.17)
Insurance, Medicaid only vs Medicare only	1.51 (0.94, 2.44)	1.56 (0.96, 2.53)
Insurance, Other vs Medicare only	1.01 (0.79, 1.29)	0.96 (0.74, 1.23)
Marital status, married vs single	1.07 (0.83, 1.39)	1.07 (0.82, 1.39)
Marital status, divorced/separated vs single	0.94 (0.72, 1.23)	0.97 (0.74, 1.27)
Marital status, widowed vs single	1.41 (0.97, 2.04)	1.42 (0.97, 2.06)
Education level, grade school vs college or more	1.22 (0.83, 1.79)	1.10 (0.75, 1.63)
Education level, high school vs college or more	1.16 (0.95, 1.42)	1.13 (0.92, 1.39)
English speaker	0.96 (0.46, 2.02)	1.02 (0.49, 2.14)
Hospitalization		1.06 (0.76, 1.46)
Active on transplant waitlist		1.09 (0.83, 1.44)
BMI, per 2 kg/m^2		1.01 (0.98, 1.03)
Cause ESRD, diabetes vs. other		1.02 (0.81, 1.28)
Cause ESRD, hypertension vs. other		1.06 (0.83, 1.35)
Vascular access, catheter vs. fistula		0.90 (0.68, 1.18)
Vascular access, graft vs. fistula		1.13 (0.89, 1.43)
Hemoglobin, per 0.5 g/dL		0.98 (0.94, 1.02)
Albumin, per 0.2 g/dL		0.96 (0.91, 1.01)
Kt/V, per 0.2		1.05 (0.97, 1.13)
ESRD vintage, per 12 months		0.98 (0.94, 1.01)
ESRD vintage > 12 months before current facility		0.92 (0.72, 1.19)
Unexcused absences		0.87 (0.68, 1.12)
Treatments shortened		**0.76 (0.63, 0.92)**
Telephone administration vs mail		**1.72 (1.32, 2.23)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.21: Multivariable association of characteristics with higher dialysis facility rating with multiple imputation

	Model 1	Model 2
Age, per 5 years	**1.12 (1.08, 1.16)**	**1.10 (1.05, 1.15)**
Female	0.91 (0.76, 1.09)	0.82 (0.67, 1.00)
Race, black vs white	0.85 (0.69, 1.05)	0.84 (0.67, 1.05)
Race, other vs white	0.81 (0.52, 1.27)	0.79 (0.50, 1.25)
Ethnicity, Hispanic vs non-Hispanic	1.47 (0.90, 2.40)	1.31 (0.80, 2.15)
Insurance, Medicare/Medicaid vs Medicare only	1.09 (0.86, 1.38)	1.05 (0.82, 1.34)
Insurance, Medicaid only vs Medicare only	1.06 (0.68, 1.65)	1.06 (0.68, 1.67)
Insurance, Other vs Medicare only	1.07 (0.83, 1.37)	1.02 (0.79, 1.32)
Marital status, married vs single	1.02 (0.78, 1.33)	1.02 (0.78, 1.33)
Marital status, divorced/separated vs single	0.91 (0.70, 1.19)	0.95 (0.72, 1.25)
Marital status, widowed vs single	1.39 (0.95, 2.04)	1.39 (0.94, 2.05)
Education level, grade school vs college or more	1.26 (0.85, 1.88)	1.13 (0.75, 1.70)
Education level, high school vs college or more	1.13 (0.92, 1.38)	1.10 (0.89, 1.35)
English speaker	0.90 (0.38, 2.10)	0.96 (0.42, 2.20)
Hospitalization		0.92 (0.67, 1.27)
Active on transplant waitlist		0.95 (0.72, 1.25)
BMI, per 2 kg/m^2		1.01 (0.99, 1.04)
Cause ESRD, diabetes vs. other		0.99 (0.79, 1.25)
Cause ESRD, hypertension vs. other		1.00 (0.78, 1.28)
Vascular access, catheter vs. fistula		0.93 (0.71, 1.23)
Vascular access, graft vs. fistula		1.15 (0.90, 1.46)
Hemoglobin, per 0.5 g/dL		0.96 (0.93, 1.00)
Albumin, per 0.2 g/dL		**0.94 (0.90, 1.00)**
Kt/V, per 0.2		**1.09 (1.01, 1.17)**
ESRD vintage, per 12 months		0.97 (0.94, 1.01)
ESRD vintage > 12 months before current facility		1.08 (0.84, 1.40)
Unexcused absences		0.89 (0.69, 1.14)
Treatments shortened		**0.74 (0.62, 0.90)**
Telephone administration vs mail		**2.00 (1.51, 2.64)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.22: Multivariable association of characteristics with higher Nephrologists' Communication and Caring (NCC) score with multiple imputation

	Model 1	Model 2
Age, per 5 years	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)
Female	**1.18 (1.03, 1.36)**	1.13 (0.97, 1.31)
Race, black vs white	1.09 (0.93, 1.28)	1.13 (0.96, 1.33)
Race, other vs white	0.82 (0.58, 1.16)	0.79 (0.56, 1.14)
Ethnicity, Hispanic vs non-Hispanic	1.07 (0.76, 1.51)	1.01 (0.71, 1.44)
Insurance, Medicare/Medicaid vs Medicare only	1.06 (0.89, 1.27)	1.10 (0.91, 1.32)
Insurance, Medicaid only vs Medicare only	0.95 (0.66, 1.36)	1.00 (0.69, 1.44)
Insurance, Other vs Medicare only	1.04 (0.87, 1.24)	1.05 (0.88, 1.26)
Marital status, married vs single	1.18 (0.96, 1.45)	1.18 (0.96, 1.45)
Marital status, divorced/separated vs single	1.08 (0.87, 1.34)	1.11 (0.89, 1.37)
Marital status, widowed vs single	1.06 (0.81, 1.38)	1.05 (0.80, 1.38)
Education level, grade school vs college or more	1.12 (0.85, 1.47)	1.12 (0.85, 1.49)
Education level, high school vs college or more	1.06 (0.91, 1.23)	1.07 (0.92, 1.25)
English speaker	1.35 (0.76, 2.38)	1.39 (0.78, 2.49)
Hospitalization		1.06 (0.84, 1.34)
Active on transplant waitlist		**1.29 (1.05, 1.58)**
BMI, per 2 kg/m^2		1.00 (0.98, 1.02)
Cause ESRD, diabetes vs. other		0.92 (0.77, 1.09)
Cause ESRD, hypertension vs. other		0.95 (0.79, 1.14)
Vascular access, catheter vs. fistula		0.93 (0.76, 1.14)
Vascular access, graft vs. fistula		0.90 (0.76, 1.08)
Hemoglobin, per 0.5 g/dL		0.99 (0.96, 1.02)
Albumin, per 0.2 g/dL		1.01 (0.97, 1.05)
Kt/V, per 0.2		**1.08 (1.02, 1.14)**
ESRD vintage, per 12 months		1.00 (0.97, 1.03)
ESRD vintage > 12 months before current facility		1.10 (0.91, 1.33)
Unexcused absences		0.90 (0.73, 1.10)
Treatments shortened		**0.77 (0.67, 0.89)**
Telephone administration vs mail		1.16 (0.97, 1.40)

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.23: Multivariable association of characteristics with higher Quality of Dialysis Center Care and Operations (DCO) score with multiple imputation

	Model 1	Model 2
Age, per 5 years	**1.08 (1.03, 1.12)**	1.04 (0.99, 1.09)
Female	0.86 (0.71, 1.04)	0.86 (0.70, 1.06)
Race, black vs white	0.88 (0.71, 1.09)	0.90 (0.71, 1.13)
Race, other vs white	0.66 (0.40, 1.11)	0.70 (0.42, 1.18)
Ethnicity, Hispanic vs non-Hispanic	1.33 (0.86, 2.05)	1.10 (0.70, 1.73)
Insurance, Medicare/Medicaid vs Medicare only	1.13 (0.88, 1.45)	1.10 (0.85, 1.42)
Insurance, Medicaid only vs Medicare only	1.17 (0.71, 1.91)	1.13 (0.68, 1.88)
Insurance, Other vs Medicare only	1.20 (0.95, 1.52)	1.12 (0.88, 1.43)
Marital status, married vs single	1.12 (0.84, 1.49)	1.22 (0.91, 1.64)
Marital status, divorced/separated vs single	1.02 (0.75, 1.38)	1.12 (0.82, 1.52)
Marital status, widowed vs single	1.08 (0.75, 1.56)	1.13 (0.78, 1.63)
Education level, grade school vs college or more	**1.81 (1.26, 2.59)**	**1.64 (1.13, 2.38)**
Education level, high school vs college or more	**1.50 (1.20, 1.86)**	**1.46 (1.17, 1.82)**
English speaker	1.34 (0.60, 2.97)	1.50 (0.65, 3.48)
Hospitalization		0.78 (0.56, 1.09)
Active on transplant waitlist		0.74 (0.54, 1.00)
BMI, per 2 kg/m^2		0.97 (0.95, 1.00)
Cause ESRD, diabetes vs. other		0.97 (0.77, 1.22)
Cause ESRD, hypertension vs. other		1.01 (0.78, 1.29)
Vascular access, catheter vs. fistula		**1.43 (1.10, 1.85)**
Vascular access, graft vs. fistula		0.96 (0.75, 1.22)
Hemoglobin, per 0.5 g/dL		0.99 (0.94, 1.03)
Albumin, per 0.2 g/dL		1.02 (0.97, 1.08)
Kt/V, per 0.2		1.05 (0.97, 1.13)
ESRD vintage, per 12 months		**0.96 (0.92, 0.99)**
ESRD vintage > 12 months before current facility		0.76 (0.57, 1.01)
Unexcused absences		**0.67 (0.50, 0.91)**
Treatments shortened		0.86 (0.71, 1.05)
Telephone administration vs mail		**1.93 (1.53, 2.43)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.24: Multivariable association of characteristics with higher Providing Information to Patients (PIP) score with multiple imputation

	Model 1	Model 2
Age, per 5 years	**0.86 (0.84, 0.89)**	**0.87 (0.84, 0.90)**
Female	0.96 (0.83, 1.11)	1.00 (0.85, 1.17)
Race, black vs white	0.90 (0.76, 1.06)	0.85 (0.72, 1.02)
Race, other vs white	1.20 (0.84, 1.70)	1.23 (0.86, 1.76)
Ethnicity, Hispanic vs non-Hispanic	0.85 (0.60, 1.22)	0.79 (0.55, 1.14)
Insurance, Medicare/Medicaid vs Medicare only	0.95 (0.79, 1.15)	0.97 (0.80, 1.18)
Insurance, Medicaid only vs Medicare only	0.80 (0.55, 1.17)	0.85 (0.58, 1.24)
Insurance, Other vs Medicare only	0.92 (0.76, 1.12)	0.89 (0.73, 1.08)
Marital status, married vs single	**1.30 (1.05, 1.60)**	**1.29 (1.04, 1.60)**
Marital status, divorced/separated vs single	1.03 (0.82, 1.29)	1.04 (0.83, 1.31)
Marital status, widowed vs single	1.33 (1.00, 1.77)	1.33 (1.00, 1.78)
Education level, grade school vs college or more	1.14 (0.85, 1.53)	1.09 (0.81, 1.47)
Education level, high school vs college or more	1.08 (0.92, 1.26)	1.07 (0.91, 1.25)
English speaker	1.20 (0.71, 2.02)	1.25 (0.74, 2.11)
Hospitalization		1.02 (0.80, 1.31)
Active on transplant waitlist		**1.38 (1.10, 1.72)**
BMI, per 2 kg/m^2		1.01 (0.99, 1.03)
Cause ESRD, diabetes vs. other		1.09 (0.91, 1.31)
Cause ESRD, hypertension vs. other		1.13 (0.93, 1.38)
Vascular access, catheter vs. fistula		1.03 (0.83, 1.28)
Vascular access, graft vs. fistula		1.16 (0.96, 1.39)
Hemoglobin, per 0.5 g/dL		1.00 (0.96, 1.03)
Albumin, per 0.2 g/dL		1.04 (1.00, 1.09)
Kt/V, per 0.2		0.96 (0.90, 1.01)
ESRD vintage, per 12 months		0.99 (0.96, 1.02)
ESRD vintage > 12 months before current facility		0.87 (0.71, 1.07)
Unexcused absences		0.84 (0.68, 1.04)
Treatments shortened		**0.84 (0.72, 0.98)**
Telephone administration vs mail		**1.36 (1.13, 1.65)**

Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.25: Multivariable association of characteristics with higher nephrologist rating using older top box definition*

	Model 1	Model 2
ICC	0.06	0.06
Age, per 5 years	**1.07 (1.03, 1.10)**	**1.06 (1.02, 1.10)**
Female	**1.26 (1.08, 1.46)**	**1.21 (1.02, 1.43)**
Race, black vs white	1.18 (0.99, 1.41)	**1.21 (1.01, 1.46)**
Race, other vs white	0.80 (0.54, 1.16)	0.79 (0.54, 1.16)
Ethnicity, Hispanic vs non-Hispanic	1.05 (0.71, 1.55)	1.03 (0.69, 1.54)
Insurance, Medicare/Medicaid vs Medicare only	1.03 (0.85, 1.26)	1.09 (0.89, 1.33)
Insurance, Medicaid only vs Medicare only	0.91 (0.62, 1.34)	0.99 (0.67, 1.46)
Insurance, Other vs Medicare only	1.06 (0.87, 1.28)	1.07 (0.88, 1.31)
Marital status, married vs single	1.10 (0.88, 1.37)	1.11 (0.89, 1.38)
Marital status, divorced/separated vs single	1.00 (0.80, 1.26)	1.06 (0.84, 1.33)
Marital status, widowed vs single	1.14 (0.85, 1.54)	1.17 (0.87, 1.58)
Education level, grade school vs college or more	1.35 (0.99, 1.85)	1.35 (0.98, 1.86)
Education level, high school vs college or more	**1.19 (1.01, 1.40)**	**1.19 (1.01, 1.41)**
English speaker	**0.43 (0.18, 0.98)**	0.48 (0.21, 1.11)
Hospitalization		0.93 (0.73, 1.20)
Active on transplant waitlist		1.25 (0.99, 1.57)
BMI, per 2 kg/m^2		1.01 (0.99, 1.03)
Cause ESRD, diabetes vs. other		0.85 (0.71, 1.03)
Cause ESRD, hypertension vs. other		1.02 (0.83, 1.25)
Vascular access, catheter vs. fistula		0.88 (0.70, 1.10)
Vascular access, graft vs. fistula		0.97 (0.80, 1.18)
Hemoglobin, per 0.5 g/dL		0.98 (0.95, 1.01)
Albumin, per 0.2 g/dL		0.99 (0.95, 1.04)
Kt/V, per 0.2		1.06 (0.99, 1.13)
ESRD vintage, per 12 months		0.99 (0.97, 1.02)
ESRD vintage > 12 months before current facility		0.95 (0.77, 1.18)
Unexcused absences		**0.77 (0.62, 0.96)**
Treatments shortened		**0.71 (0.61, 0.83)**
Telephone administration vs mail		1.20 (0.97, 1.47)

*Prior to 2014 top box referred to 8-10 rating instead of 9-10. Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.26: Multivariable association of characteristics with higher dialysis staff rating using older top box definition*

	Model 1	Model 2
ICC	0.08	0.08
Age, per 5 years	**1.07 (1.04, 1.11)**	**1.06 (1.03, 1.10)**
Female	0.99 (0.84, 1.16)	0.95 (0.80, 1.13)
Race, black vs white	0.95 (0.79, 1.14)	0.92 (0.76, 1.12)
Race, other vs white	0.92 (0.62, 1.37)	0.92 (0.61, 1.37)
Ethnicity, Hispanic vs non-Hispanic	0.87 (0.58, 1.30)	0.82 (0.54, 1.23)
Insurance, Medicare/Medicaid vs Medicare only	0.96 (0.78, 1.19)	0.96 (0.78, 1.18)
Insurance, Medicaid only vs Medicare only	1.50 (0.99, 2.27)	**1.54 (1.02, 2.34)**
Insurance, Other vs Medicare only	1.02 (0.83, 1.25)	1.00 (0.81, 1.23)
Marital status, married vs single	1.07 (0.85, 1.34)	1.06 (0.84, 1.33)
Marital status, divorced/separated vs single	1.00 (0.79, 1.27)	1.02 (0.80, 1.30)
Marital status, widowed vs single	1.21 (0.88, 1.65)	1.21 (0.88, 1.66)
Education level, grade school vs college or more	**1.72 (1.23, 2.41)**	**1.61 (1.15, 2.27)**
Education level, high school vs college or more	**1.45 (1.22, 1.72)**	**1.42 (1.19, 1.70)**
English speaker	1.02 (0.48, 2.15)	1.14 (0.54, 2.41)
Hospitalization		1.03 (0.79, 1.35)
Active on transplant waitlist		1.03 (0.81, 1.31)
BMI, per 2 kg/m^2		1.01 (0.99, 1.04)
Cause ESRD, diabetes vs. other		1.05 (0.86, 1.27)
Cause ESRD, hypertension vs. other		1.05 (0.85, 1.29)
Vascular access, catheter vs. fistula		0.84 (0.66, 1.06)
Vascular access, graft vs. fistula		**1.24 (1.01, 1.53)**
Hemoglobin, per 0.5 g/dL		1.00 (0.97, 1.04)
Albumin, per 0.2 g/dL		1.01 (0.96, 1.06)
Kt/V, per 0.2		1.05 (0.98, 1.12)
ESRD vintage, per 12 months		0.98 (0.95, 1.01)
ESRD vintage > 12 months before current facility		0.90 (0.72, 1.13)
Unexcused absences		0.96 (0.76, 1.20)
Treatments shortened		**0.81 (0.69, 0.96)**
Telephone administration vs mail		**1.33 (1.07, 1.65)**

*Prior to 2014 top box referred to 8-10 rating instead of 9-10. Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.27: Multivariable association of characteristics with higher dialysis facility rating using older top box definition*

	Model 1	Model 2
ICC	0.09	0.08
Age, per 5 years	**1.08 (1.04, 1.12)**	**1.07 (1.03, 1.11)**
Female	0.97 (0.82, 1.14)	0.93 (0.78, 1.11)
Race, black vs white	1.04 (0.86, 1.27)	1.05 (0.86, 1.29)
Race, other vs white	1.03 (0.68, 1.57)	1.07 (0.70, 1.63)
Ethnicity, Hispanic vs non-Hispanic	0.95 (0.63, 1.45)	0.88 (0.58, 1.35)
Insurance, Medicare/Medicaid vs Medicare only	0.98 (0.79, 1.21)	0.97 (0.78, 1.21)
Insurance, Medicaid only vs Medicare only	1.07 (0.71, 1.62)	1.09 (0.72, 1.66)
Insurance, Other vs Medicare only	0.99 (0.80, 1.23)	0.94 (0.76, 1.16)
Marital status, married vs single	1.15 (0.91, 1.44)	1.17 (0.92, 1.48)
Marital status, divorced/separated vs single	1.10 (0.87, 1.41)	1.15 (0.90, 1.47)
Marital status, widowed vs single	1.26 (0.92, 1.74)	1.30 (0.94, 1.80)
Education level, grade school vs college or more	**1.99 (1.40, 2.83)**	**1.88 (1.31, 2.70)**
Education level, high school vs college or more	**1.45 (1.21, 1.73)**	**1.43 (1.20, 1.71)**
English speaker	**0.31 (0.11, 0.86)**	**0.35 (0.13, 0.98)**
Hospitalization		0.90 (0.69, 1.19)
Active on transplant waitlist		1.00 (0.79, 1.27)
BMI, per 2 kg/m^2		1.02 (0.99, 1.04)
Cause ESRD, diabetes vs. other		0.99 (0.81, 1.21)
Cause ESRD, hypertension vs. other		0.97 (0.78, 1.20)
Vascular access, catheter vs. fistula		1.11 (0.87, 1.43)
Vascular access, graft vs. fistula		1.20 (0.97, 1.49)
Hemoglobin, per 0.5 g/dL		1.00 (0.97, 1.04)
Albumin, per 0.2 g/dL		1.00 (0.95, 1.05)
Kt/V, per 0.2		1.03 (0.96, 1.10)
ESRD vintage, per 12 months		0.97 (0.94, 1.00)
ESRD vintage > 12 months before current facility		0.91 (0.73, 1.14)
Unexcused absences		0.88 (0.70, 1.11)
Treatments shortened		**0.81 (0.69, 0.96)**
Telephone administration vs mail		**1.45 (1.16, 1.81)**

*Prior to 2014 top box referred to 8-10 rating instead of 9-10. Data shown as odds ratio (OR) (95% CI). Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Table 6.28: Multivariable association of characteristics with higher scores after excluding patients who responded by phone

	Nephrologist Rating (N=2739)	Staff Rating (N=2589)	Dialysis Facility Rating (N=2592)	NCC Score (N=2795)	DCO Score (N=2669)	PIP Score (N=2618)
ICC	0.06	0.09	0.08	0.03	0.06	0.04
Age, per 5 years	**1.08 (1.03, 1.13)**	**1.10 (1.04, 1.15)**	**1.11 (1.05, 1.17)**	1.03 (0.99, 1.07)	1.05 (0.99, 1.11)	**0.86 (0.82, 0.89)**
Female	1.07 (0.87, 1.32)	0.84 (0.66, 1.06)	0.81 (0.64, 1.02)	**1.24 (1.04, 1.48)**	0.88 (0.68, 1.14)	1.06 (0.87, 1.28)
Race, black vs white	1.04 (0.83, 1.30)	0.91 (0.70, 1.17)	0.87 (0.68, 1.13)	1.10 (0.91, 1.34)	0.79 (0.59, 1.05)	**0.78 (0.64, 0.97)**
Race, other vs white	0.73 (0.46, 1.16)	0.95 (0.55, 1.64)	0.96 (0.55, 1.67)	0.80 (0.52, 1.24)	**0.45 (0.21, 0.94)**	1.39 (0.89, 2.17)
Ethnicity, Hispanic vs non-Hispanic	1.32 (0.77, 2.24)	0.80 (0.45, 1.42)	1.03 (0.57, 1.87)	0.88 (0.55, 1.41)	1.46 (0.79, 2.71)	**0.53 (0.31, 0.89)**
Insurance, Medicare/Medicaid vs Medicare only	0.96 (0.74, 1.24)	0.90 (0.68, 1.19)	1.02 (0.77, 1.35)	1.04 (0.84, 1.29)	1.18 (0.85, 1.64)	0.83 (0.65, 1.04)
Insurance, Medicaid only vs Medicare only	0.95 (0.59, 1.54)	1.49 (0.84, 2.62)	1.04 (0.61, 1.75)	0.83 (0.53, 1.29)	1.18 (0.62, 2.25)	0.66 (0.42, 1.06)
Insurance, Other vs Medicare only	0.90 (0.70, 1.15)	0.93 (0.69, 1.24)	0.92 (0.69, 1.22)	0.99 (0.80, 1.22)	1.05 (0.79, 1.40)	0.86 (0.68, 1.08)
Marital status, married vs single	0.93 (0.70, 1.23)	1.09 (0.80, 1.48)	1.06 (0.78, 1.44)	1.12 (0.87, 1.43)	1.22 (0.85, 1.76)	1.12 (0.87, 1.45)
Marital status, divorced/separated vs single	0.87 (0.65, 1.16)	0.87 (0.63, 1.18)	0.87 (0.63, 1.18)	1.06 (0.82, 1.37)	1.03 (0.70, 1.53)	0.83 (0.63, 1.09)
Marital status, widowed vs single	1.04 (0.71, 1.52)	1.34 (0.86, 2.07)	1.41 (0.90, 2.20)	0.89 (0.64, 1.22)	1.05 (0.66, 1.68)	1.22 (0.87, 1.73)
Education level, grade school vs college or more	1.32 (0.84, 2.08)	1.45 (0.85, 2.48)	1.32 (0.79, 2.23)	1.21 (0.84, 1.74)	**1.79 (1.10, 2.91)**	1.21 (0.82, 1.80)
Education level, high school vs college or more	1.05 (0.85, 1.29)	1.10 (0.87, 1.39)	1.09 (0.86, 1.38)	1.09 (0.92, 1.30)	**1.41 (1.09, 1.84)**	1.05 (0.87, 1.28)

Hospitalization	0.89 (0.64, 1.23)	1.06 (0.72, 1.55)	1.00 (0.68, 1.47)	0.95 (0.71, 1.27)	0.67 (0.42, 1.06)	0.97 (0.71, 1.33)
Active on transplant waitlist	1.25 (0.94, 1.66)	1.03 (0.76, 1.40)	0.92 (0.68, 1.24)	1.21 (0.95, 1.53)	**0.67 (0.45, 0.99)**	**1.39 (1.08, 1.77)**
BMI, per 2 kg/m^2	1.02 (0.99, 1.04)	1.02 (0.99, 1.05)	1.02 (0.99, 1.05)	1.00 (0.98, 1.03)	0.98 (0.94, 1.01)	1.01 (0.99, 1.04)
Cause ESRD, diabetes vs. other	0.85 (0.67, 1.08)	1.00 (0.77, 1.31)	0.97 (0.74, 1.27)	0.91 (0.75, 1.11)	0.96 (0.72, 1.28)	1.09 (0.88, 1.35)
Cause ESRD, hypertension vs. other	0.88 (0.68, 1.13)	0.98 (0.74, 1.30)	0.88 (0.66, 1.16)	0.93 (0.75, 1.15)	1.12 (0.83, 1.51)	1.23 (0.98, 1.55)
Vascular access, catheter vs. fistula	0.97 (0.73, 1.29)	0.82 (0.59, 1.13)	0.87 (0.63, 1.21)	0.92 (0.72, 1.17)	1.36 (0.98, 1.88)	1.03 (0.79, 1.35)
Vascular access, graft vs. fistula	1.02 (0.80, 1.30)	1.13 (0.85, 1.50)	1.27 (0.95, 1.68)	0.96 (0.78, 1.18)	1.00 (0.74, 1.35)	1.24 (1.00, 1.55)
Hemoglobin, per 0.5 g/dL	**0.95 (0.91, 0.99)**	1.00 (0.95, 1.04)	0.99 (0.94, 1.04)	1.01 (0.97, 1.04)	0.98 (0.93, 1.04)	1.01 (0.97, 1.05)
Albumin, per 0.2 g/dL	1.00 (0.94, 1.05)	0.96 (0.90, 1.02)	0.95 (0.89, 1.01)	1.02 (0.97, 1.07)	1.05 (0.98, 1.13)	1.03 (0.98, 1.08)
Kt/V, per 0.2	1.02 (0.94, 1.10)	1.04 (0.95, 1.13)	1.07 (0.98, 1.17)	**1.09 (1.02, 1.16)**	1.07 (0.97, 1.17)	0.94 (0.87, 1.01)
ESRD vintage, per 12 months	1.01 (0.98, 1.05)	0.96 (0.92, 1.00)	**0.96 (0.92, 1.00)**	1.00 (0.97, 1.03)	**0.94 (0.90, 0.99)**	0.99 (0.95, 1.02)
ESRD vintage > 12 months before current facility	0.87 (0.67, 1.13)	0.91 (0.68, 1.21)	1.00 (0.75, 1.34)	1.14 (0.91, 1.43)	**0.68 (0.47, 0.99)**	0.84 (0.66, 1.08)
Unexcused absences	0.80 (0.62, 1.05)	0.95 (0.70, 1.28)	0.87 (0.65, 1.17)	0.99 (0.77, 1.27)	0.74 (0.50, 1.08)	0.90 (0.69, 1.16)
Treatments shortened	**0.70 (0.58, 0.85)**	**0.75 (0.60, 0.94)**	**0.72 (0.58, 0.90)**	**0.71 (0.60, 0.84)**	0.99 (0.78, 1.27)	0.85 (0.71, 1.02)

Data shown as odds ratio (OR) (95% CI) adjusted for all other variables in the table. Odds ratio above 1.00 is associated with top box response. Associations with $p<0.05$ are in bold. NCC: Nephrologists' Communication and Caring; DCO: Quality of Dialysis Center Care and Operations; PIP: Providing Information to Patients; ESRD: End stage renal disease; BMI: Body mass index. Unexcused absence was defined as missing an entire HD treatment without rescheduling, shortened treatment was defined as treatments that were at least 15 minutes shorter than prescribed, hospitalization included hospital stays for any reason.

Figure 6.10: Geographic distribution of DCI clinics

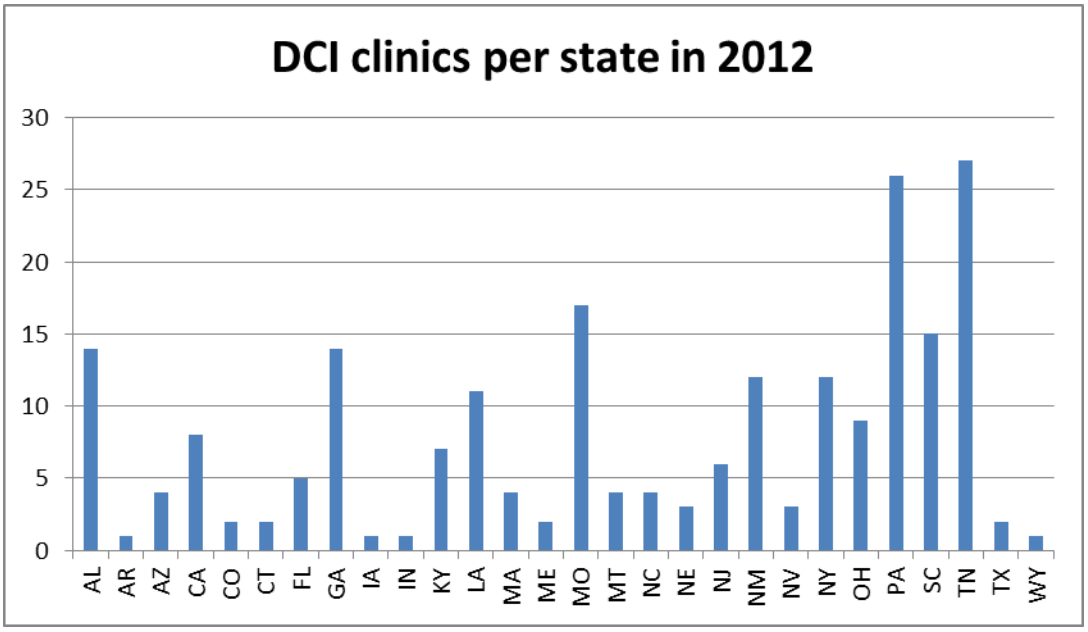


Figure 6.11: Geographic distribution of responders

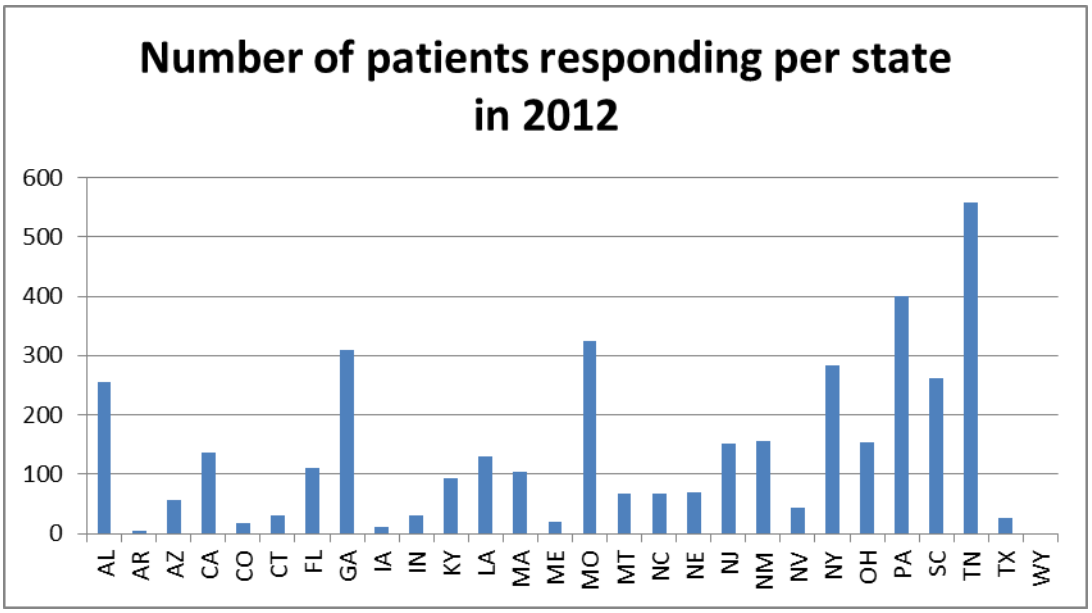
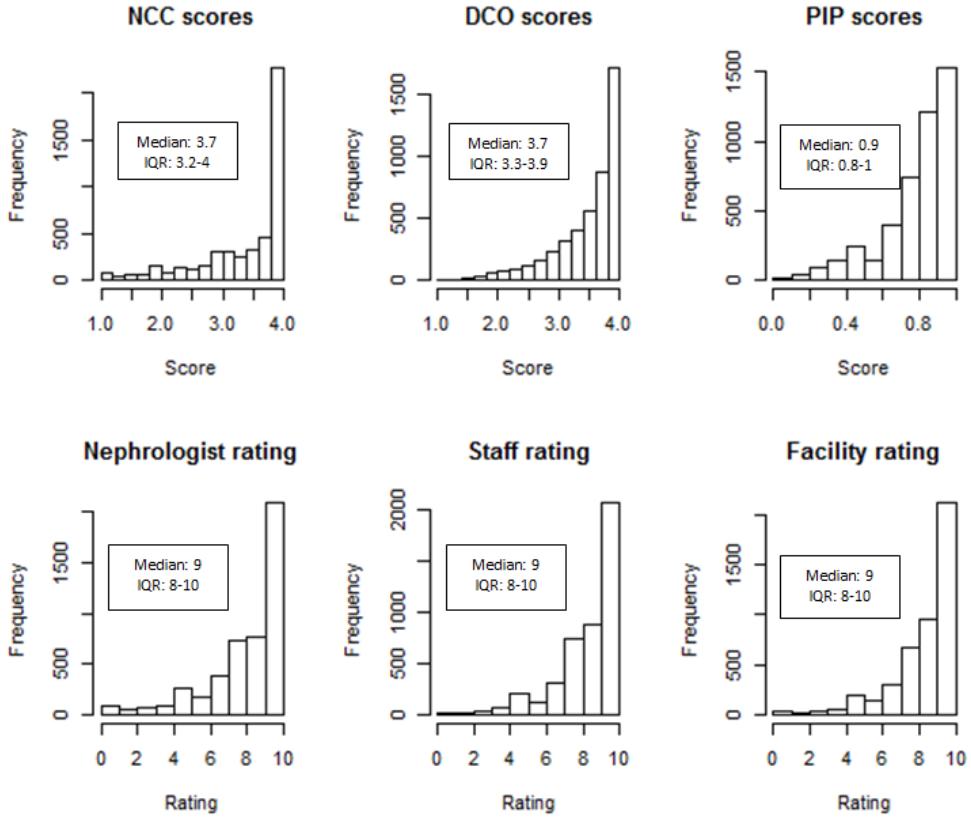


Figure 6.12: Distribution of scores



NCC: Nephrologists' Communication and Caring (NCC); DCO: Quality of Dialysis Center Care and Operations; PIP: Providing Information to Patients

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