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No difference in meeting hemoglobin and albumin targets for dialyzed children with urologic disorders

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Abstract

Urologic disorders are the most common cause of chronic kidney disease in children. To determine whether children with urologic etiology of end-stage renal disease (ESRD) fare better than children with ESRD from other causes while on dialysis, we conducted a cross-sectional study of children <18 years receiving peritoneal and hemodialysis in the United States using data from the Centers for Medicare & Medicaid Services 2005 ESRD CPM Project. We compared baseline demographics and the study groups. In multivariate logistic regression analysis of 1,286 subjects, we assessed whether children with urologic disorders had a higher odds of meeting adult KDOQI targets for hemoglobin levels ≥ 11 g/dl and albumin ≥ 3.5 BCG/3.2 BCP g/dl. We conducted a subset analysis of 1,136 patients to examine the impact of erythropoietin on hemoglobin targets. Our results did not reveal differences in achievement of adult hemoglobin targets (adjusted OR: 1.27; p value 0.09; CI: 0.97–1.66) or in the subset analysis with erythropoietin (adjusted OR: 1.32; p value 0.06; CI: 0.98–1.78) or albumin targets (adjusted OR: 1.22; p value 0.21; CI: 0.90–1.65) in adjusted analyses. Due to our study's limitations, it is difficult to determine whether this may result from treatment prior to dialysis initiation or treatment effect of dialysis rather than underlying diagnosis.

Keywords

Pediatrics; Dialysis; Outcomes; Urologic disorders; ESRD

Introduction

Congenital abnormalities of the kidney and urinary tract (CAKUT) represent a wide variety of disorders with a broad range of severity. With an incidence rate between 0.3 and 1.6 per 1,000 births [1], the pathology of these malformations includes, but is not limited to, abnormalities of the renal parenchyma, embryonic migration, and the developing urinary collecting system. Data from the North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS), a voluntary registry of children with kidney disease, reveals that almost one-half of chronic kidney disease (CKD) patients have urologic disease as the etiology of their CKD [2, 3]. In addition, children with urologic disorders of any cause have been shown to have improved renal transplant outcomes including better 7-year graft survival when compared to those with kidney disease from other causes [2]. It is also often assumed that children with urologic disorders at all stages of chronic kidney disease have better treatment outcomes and an apparent slower progression to end-stage renal disease [4]. Recently, the ESCAPE trial has also shown that patients with urologic disorders had lower odds of progression of CKD with intensified blood pressure management [5]. However, the current literature detailing outcomes by diagnosis in children maintained on dialysis continues to be limited.

The purpose of this analysis was to determine whether children with end-stage renal disease (ESRD) as a result of urologic disorders who are maintained on chronic dialysis experienced improved clinical outcomes compared to those with other underlying diagnoses. In order to isolate the impact that primary urologic disease has on clinical outcomes, we controlled for variables that can influence the success of dialysis treatment. As mortality as an outcome is rare in children, we examined intermediate outcomes of dialytic care, specifically achievement of adult target hemoglobin and albumin levels. Previous studies have shown that meeting adult hemoglobin and serum albumin target levels in children maintained on hemodialysis has been associated with decreased mortality and less frequent hospitalizations [6–8].

Methods

We performed a cross-sectional analysis of data from the Centers for Medicare & Medicaid Services (CMS) 2005 ESRD CPM Project. Details of the methods of CPM data collection have been reported elsewhere [9, 10]. Briefly, the data collection for the ESRD CPM project occurs in the spring of each study year, and the dialysis facilities provide clinical information abstracted from the patient's medical records during October, November, and December for patients maintained on hemodialysis (HD) and in October through March for patients receiving peritoneal dialysis (PD). Therefore, for the 2005 CPM study year, data were obtained on patients receiving HD from October through December of 2004 and from October of 2004 through March of 2005 for those maintained on PD. A four-page detailed questionnaire (one for HD and one for PD) was completed and the data was then abstracted from these questionnaires. Data for children aged <18 years receiving hemodialysis (HD) or peritoneal dialysis (PD) are presented in the 2005 report. This was the first year that data was collected on pediatric patients receiving peritoneal dialysis.

Inclusion of a pediatric HD patient in this cohort required that data were available for at least one of the 3 months in the designated 3-month collection period with at least one paired pre- and post-dialysis BUN, at least one hemoglobin value, at least one serum albumin value and one ferritin value. Inclusion of a PD patient in the cohort required that the patient received peritoneal dialysis at least 1 month during the annual collection period, and that at least one hemoglobin value, at least one serum albumin value, and one ferritin value were reported during the 6-month study period.

ICD-9 codes for primary diagnosis of cause of ESRD were reviewed and transformed into a dichotomous variable in which all children with urologic disorders were placed in a single category and children with non-urologic causes of their ESRD as the reference category. The following ICD-9 codes were included as urologic diagnoses: 59389A (urologic-ureter problems), 5996A (urinary obstruction), 7530B (renal agenesis/dysgenesis), 7532A (obstructive defects of renal pelvis and ureter), 7533A (congenital anomalies of kidney), 7567A (anomalies of the abdominal wall). All other ICD-9 diagnosis codes were classified as non-urologic. Mean serum albumin levels were calculated for each subject based upon the available albumin levels (with the associated laboratory method-Bromocresol Green (BCG) or Bromocresol Purple (BCP) as these two methods have been shown to yield systematically different results). The mean serum albumin level was then transformed into a dichotomous variable representing target albumin (target ≥ 3.5 g/dl for BCG; ≥ 3.2 g/dl for BCP). Mean hemoglobin level was calculated for each subject and then dichotomized to represent those subjects reaching adult target levels (≥ 11 g/dL) in comparison with those who did not. As ferritin is an acute-phase reactant that is increased in inflammation, we treated serum ferritin as a surrogate marker of inflammatory status. Current Kidney Disease Outcomes Quality Initiatives (KDOQI) guidelines recommend holding iron supplementation for serum ferritin levels greater than 500 ng/dl [11]. However, ferritin levels greater than 800 ng/dl have been shown to correlate with other markers of inflammation such as CRP and have been associated with a worse malnutrition complex score in hemodialysis patients. Thus the higher threshold of 800 ng/dl was selected as a marker of increased inflammation rather than iron sufficiency [12]. Mean ferritin level was calculated for each subject and then dichotomized into those with ferritin levels ≥ 800 vs. <800 as the reference group.

In order to control for the effects treatment with erythropoiesis stimulating agents (ESAs) on achievement of hemoglobin targets, we assessed whether patients were exposed to erythropoietin (EPO) and/or darbepoetin. Furthermore, we calculated the mean weekly EPO dosage in units per kilogram per week in the patients with available data (1,136 of 1,286). For patients maintained on HD, this was calculated using the weekly EPO dose recorded divided by the post dialysis weight for that week. A mean was then calculated for each patient. In patients receiving PD, the monthly EPO dose was first divided by four to generate an estimated weekly EPO dose. This was then divided by the patient's weight and a mean was calculated for each patient.

Kt/V was calculated for HD patients using the Daugirdas II formula $Kt/V = -\ln(R - 0.008 * t) + (4 - 3.5 * R) * UF/W$ [13]. For PD patients, total Kt/V was calculated as the sum of renal Kt/V and dialysis Kt/V $-\text{total (renal+dialysis)kt/V}$ [14]. Total body water (V) was

calculated using the sex-specific formulas created by Morgenstern et al. specifically for patients who are on peritoneal dialysis [15].

Renal Kt/V was calculated for patients who had urine samples available as: $(\text{renal urea clearance} \times 1,440 \text{ min/day} \times 7) / (1,000 \text{ ml} \times V)$. Renal urea clearance was then calculated as: $(\text{volume of 24-h urine in ml} \times \text{urine urea} / (1,440 \text{ min/day} \times \text{serum BUN}))$. We then calculated weekly dialysis Kt/V as: $(24\text{-h dialysis urea/serum urea}) \times (24\text{-h drain volume of PD fluid} / 1,000) \times 7/V$. For patients who did not have urine available or who no longer produce urine only their dialysis Kt/V was used. Patients on HD had up to three possible Kt/V values if Kt/V was measured at all time points. For PD patients, there were two opportunities for collection of Kt/V. A mean Kt/V was generated based upon the Kt/V values that were available. It was then transformed into a dichotomous variable for dialysis adequacy. Patients receiving HD were categorized as having adequate dialysis if their mean calculated Kt/V was ≥ 1.2 . Patients in the PD group were deemed to have met targets if their mean calculated Kt/V ≥ 1.8 per KDOQI guidelines [16].

The adult hemoglobin target of 11 g/dl was selected based upon the KDOQI Clinical Practice Guidelines and Clinical Practice Recommendations for Anemia in Chronic Kidney Disease in the pediatric patient [11]. The albumin target of albumin ≥ 3.5 (BCG)/3.2 (BCP) g/dl was selected based upon prior literature that documented albumin at this threshold was associated with decreased morbidity and mortality in pediatric patients [6, 17].

Statistical analyses

All data management and analysis were conducted using Stata 10.0 software (StataCorp, College Station, TX). Associations of clinical data with patient characteristics were tested with Chi-square, hierarchical analysis of variance, and two-tailed Student's *t* test. A *p* value less than 0.05 was considered significant. Summary statistics were also generated for each variable. Logistic regression was used to assess the effect of urologic diagnosis on the odds of meeting hemoglobin and albumin targets.

Variables included in the logistic regression models for both hemoglobin and albumin targets were race, sex, age, mean Kt/V, dialysis modality/access, time on dialysis, ferritin level categorized as $\geq$ vs. less than 800 ng/ml and EPO dose. Hosmer–Lemeshow's goodness-of-fit test was used to assess the respective models goodness of fit as there were many unique patterns as a result of linear variables included in the model [18].

Results

Of the 781 HD patients identified, complete data were available for 628 (80%). Of 761 PD identified, 658 (86%) had data available and were included for a total of 1,286 dialysis patients in this analysis. A subset analysis was conducted on the 1,136 patients with data available to calculate a mean weekly EPO dose (units/kg).

Hemoglobin target levels by urologic diagnosis

Demographic characteristics of study subjects are presented in Table 1 by underlying cause of ESRD. Bivariate analyses were conducted comparing the patient groups. As shown in

Table 2, patients with urologic disease have 27% increased odds of meeting adult hemoglobin targets compared to patients with a non-urologic etiology of ESRD (adjusted odds ratio [Adj. OR]) 1.27, $p=0.09$, 95% confidence interval [CI]: 0.97–1.66), but this trend did not reach statistical significance. Dialysis modality and access type did affect the odds of patients meeting adult hemoglobin targets. Patients maintained on HD with an AV graft or fistula were more likely to reach adult hemoglobin targets compared to those patients maintained on PD (Adj. OR 1.68, $p=0.004$, CI: 1.18–2.40). Patients on HD with catheters were 26% less likely to meet hemoglobin targets than those maintained on PD (Adj. OR 0.74, $p=0.03$, CI: 0.56–0.97). Increasing age was noted to improve odds of meeting the hemoglobin targets.

Hemoglobin targets and ESAs by urologic diagnosis

Of the 1,286 patients included in the study, 48 did not have documented exposure to any ESA. As shown in Table 1, bivariate analysis revealed no difference in likelihood of ESA exposure between patients with urologic versus no urologic disease (p value 0.25). Of the remaining 1,238 patients, 103 had exposure to darbepoetin and 1,163 had exposure to erythropoietin. Bivariate analysis did not reveal differences by urologic disease among these groups (darbo p value 0.89)(EPO p value 0.21). Thus, 28 patients had exposure to both EPO and darbepoetin and 75 patients were exposed only to darbepoetin. Of the 1,163 patients prescribed EPO, 1,136 had data available to calculate a mean weekly EPO dose. As there did not appear to be a difference in the populations by diagnosis in terms of ESA use or type of ESA exposure, we did perform a multivariate analysis on this subset of subjects (patients with exposure to only darbepoetin were not included in this analysis, as a standard conversion to EPO could not be considered reliable). As shown in Table 3, for subjects receiving EPO, the presence of a urologic disorder did not result in a statistically significant advantage for achievement of the hemoglobin target (Adj. OR 1.32; p value 0.06; CI 0.98–1.78). As a linear variable, each unit increase EPO dose did not result in increased odds of meeting hemoglobin targets.

Albumin target by urologic vs. non-urologic diagnosis

As shown in Table 4, a non-significant trend was noted for subjects with urologic causes of ESRD with them having 22% higher odds of meeting albumin targets compared to those with a non-urologic diagnosis. (Adj. OR 1.22, $p=0.21$, 95% CI: 0.90–1.65). Gender appears to have a major effect as males have 1.3 times higher odds (Adj. OR 1.3, $p=0.04$, 95% CI: 1.01–1.75) compared with females of achieving serum albumins 3.5(BCG)/3.2 (BCP)g/dl. Increase in age also had a positive association. Black race (Adj. OR 0.72, $p=0.04$ 95% CI 0.53–0.98) also appeared to negatively impact patient achievement of targets. Peritoneal dialysis was negatively associated with achievement of albumin targets; patients maintained on HD with an AV graft or fistula (Adj. OR 2.75, $p<0.001$, CI: 1.77–4.27) and those with a catheter (Adj. OR 1.57 $p=0.006$, CI: 1.14–2.17) had a higher odds of achieving albumin targets than patients maintained on PD. Inflammation also played a role in achievement of albumin targets. With an elevated level of serum ferritin as a proxy for inflammation, subjects with a serum level greater than 800 had 53% lower odds of meeting albumin targets (Adj. OR 1.48, $p=0.04$, CI: 1.01–2.15)

Discussion

Urologic disorders are the leading cause of end-stage renal disease in children, particularly in younger children [2]. Based upon clinical observation and extrapolation from the adult population, it has often been assumed that children with urologic disease fare better at all stages of disease [4, 19] [20]. However, there is limited outcome data in the literature regarding the effects of underlying urologic disease in the dialysis population. We found that patients with underlying urologic disorders who are maintained on dialysis appear to be different in some baseline characteristics from their non-urologic counterparts. In our study, they are more likely to be male, younger, maintained on peritoneal dialysis, have higher dialysis adequacy, and have lower ferritin levels. However, having a urologic cause of ESRD may not significantly alter a dialysis patient's odds of achieving hemoglobin and albumin targets. While the point estimates in this study indicate that patients with urologic disease may be more likely to meet albumin and hemoglobin targets than patients with non-urologic disease, the results are not statistically significant. Reasons for this are likely multifactorial.

Firstly, patients with underlying urologic disorders often present earlier in life with progressive kidney disease. Although younger, in our cross-sectional analysis, patients with urologic disorders had equal dialysis duration to those without urologic disorders. Selection bias may have influenced these findings given that children with urologic disease may have a slower progression to end-stage renal disease. Early care and intervention allows patients to prepare for pre-emptive renal transplantation. Many patients with underlying urologic disease may be preemptively transplanted prior to requiring dialysis and not captured in this study. Therefore, urologic patients in this study remaining on dialysis may be "sicker" than patients with urologic disorders that were transplanted. As a previous study has shown, pediatric patients who are kidney transplant recipients have been shown to have a survival benefit compared with those on the waiting list [21].

In this analysis, we observed an advantage in hemodialysis patients with an AV graft or fistula as their access, in comparison to peritoneal dialysis in achieving higher serum hemoglobin and albumin targets. The benefit an AV graft/fistula confers in terms of higher hemoglobin levels over hemodialysis performed with a catheter has been previously reported and discussed by Fadrowski et al. Compared to the PD population, the benefit may be related to patients receiving erythropoietin doses intravenously during hemodialysis treatments, while patients on peritoneal dialysis undergo subcutaneous injections at home, which may result in differences in adherence [22]. It is notable that patients with urologic disease did not appear to differ in terms of ESA prescription or doses compared to the non-urologic patients. However, as summarized by Port and Mehls, over the past several years, the dosing of ESA's based upon weight has been called into question as studies have revealed inadequate responses to the standard starting dose of 150 units/kg/week [23]. This is a particular problem for the youngest and smallest patients. As demonstrated by Chavers et al., in a study of the prevalence of anemia in pediatric and adult dialysis patients treated with EPO, the youngest children have the highest prevalence of anemia even while receiving EPO treatment [24]. As stated previously, patients in our study with urologic disorders tended to be younger, therefore, it is possible that inadequate EPO dosing in these patients may be responsible for the lack of difference in achievement of hemoglobin targets

compared to their non-urologic counterparts. Dosing based upon hemoglobin deficit or standard dosing have been proposed as alternatives to weight-based prescriptions and our results may be further evidence for this approach to anemia management [23, 25].

In terms of serum albumin levels, patients on peritoneal dialysis may have albumin losses through the peritoneal membrane often as a result of inflammation secondary to episodes of peritonitis resulting in the findings seen in our study. One interesting observation was that males had 38% increased odds of meeting albumin targets than females. This may be related to underlying diagnosis and residual confounding. Patients with SLE for example are more likely to be female, have increased inflammation, and have lower albumin levels.

There are several limitations of this study. As the study is cross-sectional, causal inference is limited. Also, most importantly, the premise of this study relies on the fact that patients were correctly assigned diagnoses by ICD-9 codes, which were used to classify patients for the purpose of this analysis. If patients were coded incorrectly, this may have resulted in misclassification error with patients placed in an incorrect category for the analysis. Patients with urologic disease in this study account for 33% of the total. This closely approximates prevalence in the average pediatric ESRD population as seen in the NAPRTCS report of 2008 in which patients with urologic disease comprise 32.4% of the dialysis study population [2]. Additionally, we do not have information about the subjects' albumin and hemoglobin levels at the time of dialysis initiation. Therefore, it remains unclear as to whether some of the effect on achievement of these targets is one of dialysis therapy rather than underlying diagnosis. Though we attempted to control for treatment factors such as Kt/V, time on dialysis and type of access, residual confounding may be present. Furthermore, as this is a registry, we are limited to the data available. Data representing important nutritional makers such as dietary intake, nPCR, and changes in height SDS are not available as part of the CPM. The ability to control for nutritional status with these direct markers may have permitted further isolation of the effect of underlying diagnosis on albumin as well as hemoglobin targets. We also recognize that the inability to measure and report to residual renal function is a limitation of our study. Patients with urologic disease often will have residual renal function. In fact, studies of adult patients on peritoneal dialysis have demonstrated that renal clearance, independent of peritoneal clearance, is associated with a decreased risk of death [26, 27]. The CPM data collection does not make it possible to assess whether patients with urologic disease had higher residual renal function than their counterparts and if those with higher residual kidney function had improved outcomes. Urine samples were provided by some patients and for those patients, it was included in part of their Kt/V. However, the data does not distinguish between absence of urine sample because it was not provided or absence because the patients did not have urine output. Selection bias is another possible limitation of this analysis. As complete data was available on only 1,286 (83%) of the 1,542 patients listed in the CPM report, their lack of inclusion could lead to bias [10].

Given these limitations, based on the results of this analysis, it remains unclear as to whether children with underlying urologic disorders who are maintained on dialysis may have an advantage in achievement of hemoglobin or albumin targets. Further prospective studies, which follow children with chronic kidney disease through initiation of renal replacement

therapy with either with dialysis or transplantation, are needed to assess the impact of underlying diagnosis on achievement of hemoglobin and albumin levels. These studies would allow for the assessment of baseline hemoglobin levels as well as for the collection of important growth and nutrition makers such as changes in height SDS, growth hormone supplementation, nPCR, dietary intake, iron supplementation, changes in ESA dosing, and residual renal function. Additionally, and more importantly, these prospective studies could evaluate the impact of underlying diagnosis on hospitalization and mortality. Longitudinal follow-up of children from the time of diagnosis and dialysis initiation would allow for further separation of underlying disease process from the influences of chronicity and dialysis. Based on the trends seen in our study, further evaluation of the impact of underlying disease on long-term outcomes is warranted.

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Table 1

Baseline demographic and descriptive clinical characteristics

	Urologic Total N(%) / mean (SD) n=420 (33%)	Non-urologic Total N(%) / mean (SD) n=866 (67%)	p value
Male	283 (67)	433 (50)	0.00
Female	137 (33)	433 (50)	
Race:			
White	258 (62)	513 (59)	0.62
Black	120 (29)	252 (29)	
Other	42 (16)	101 (12)	
Dialysis modality:			
Hemodialysis with AV graft/fistula	67 (16)	204 (24)	0.00
Hemodialysis with Catheter	114 (27)	243 (28)	
Peritoneal dialysis	239 (57)	419 (48)	
ESA prescribed	408 (97)	830 (96)	0.25
Darbepoetin prescribed	33 (8)	70 (8)	0.89
Erythropoietin prescribed	386 (92)	777 (90)	0.21
Mean EPO dose (units/kg/week)	304 (344)	295 (299)	0.67 [∞]
Age (years) *	10.4 (5.6)	12.9 (4.5)	0.00 [∞]
Hemoglobin (g/dl) *	11.53 (1.44)	11.56 (1.54)	0.71 [∞]
Albumin (g/dl) *	3.74 (0.52)	3.73 (0.60)	0.91 [∞]
Kt/v *	2.6 (3.2)	2.2 (1.6)	0.02 [∞]
Ferritin (ng/ml) *	336 (378)	463 (641)	0.00 [∞]
Time on dialysis (years) *	2.9 (3.2)	2.5 (3.3)	0.09 [∞]

* Calculated mean variables

per Chi-square analysis [∞] per Student's *t* test HD data collected from October 2004 to December 2004 PD data collected from October 2004 to March 2005 subset of 1,136 patients with erythropoietin dose calculated

Table 2

Adjusted $\blacklozenge$ odds ratios for participants meeting hemoglobin target ≥ 11 g/dl with urologic vs. non-urologic diagnosis ($n = 1,286$)

Variable	Adj. odds ratio	95% CI	p value
Urologic/non-urologic:	1.27	0.97–1.66	0.09
Sex:			
Male vs. female	1.04	0.81–1.33	0.76
Age (year) [*] :	1.04	1.01–1.06	0.01
Race:			
Black vs. white:	0.78	0.59–1.02	0.08
Other vs. white:	0.91	0.62–1.34	0.62
Dialysis access type:			
HD with AV graft or fistula vs. PD	1.68	1.18–2.39	0.004
HD with catheter vs. PD	0.74	0.56–0.97	0.03
Meet Kt/V dialysis target:	1.23	0.82–1.85	0.31
≥ 1.2 on HD or ≥ 1.8 on PD vs. < 1.2 on HD or < 1.8 on PD			
Ferritin level:	1.13	0.80–1.60	0.49
≤ 800 vs. > 800 (ng/ml)			
Duration of dialysis:	0.84	0.65–1.08	0.18
≥ 1 year on dialysis vs. < 1 year			

* Continuous variable by year

$\blacklozenge$ Analysis was adjusted for all characteristics listed: sex, age, race, dialysis access type, meeting Kt/V target, ferritin level, and duration of dialysis

Table 3

Adjusted $\blacklozenge$ odds ratios for participants meeting hemoglobin target ≥ 11 g/dl with urologic vs. non-urologic diagnosis for patients prescribed erythropoietin ($n=1,136$)

Variable	Adj. odds ratio	95% CI	p value
Urologic/non-urologic:	1.32	0.98–1.78	0.06
Sex:			
Male vs. female	1.03	0.78–1.33	0.91
Age (year) [*] :	1.03	1.00–1.06	0.04
Race:			
Black vs. White:	0.84	0.62–1.14	0.27
Other vs. White:	0.95	0.62–1.46	0.82
Dialysis access type:			
HD with AV graft or fistula vs. PD	1.98	1.33–2.95	0.001
HD with catheter vs. PD	0.99	0.72–1.36	0.96
Meet Kt/V dialysis target:	1.37	0.89–2.13	0.15
≥ 1.2 on HD or ≥ 1.8 on PD vs. < 1.2 on HD or < 1.8 on PD			
Ferritin level:	1.13	0.77–1.65	0.54
≤ 800 vs. > 800 (ng/ml)			
Duration of dialysis:	0.92	0.70–1.21	0.56
≥ 1 year on dialysis vs. < 1 year			
Erythropoietin dose:	1.00	1.00–1.00	< 0.001
(units per week/kg) [*]			

^{*} Continuous variable by year

$\blacklozenge$ Analysis was adjusted for all characteristics listed: sex, age, race, dialysis access type, meeting Kt/V target, ferritin level and duration of dialysis

Table 4

Adjusted $\blacklozenge$ odds ratios for participants meeting albumin target $\geq 3.5(\text{BCG})/3.2(\text{BCP})\text{g/dl}^*$ with urologic vs. non-urologic diagnosis ($n=1,286$)

Variable	Adj. odds ratio	95% CI	p value
Urologic/non-urologic:	1.22	0.90–1.65	0.21
Sex:			
Male vs. female	1.33	1.01–1.75	0.04
Age (year) ^{**} :	1.07	1.04–1.10	<0.001
Race:			
Black vs. White:	0.72	0.53–0.98	0.04
Other vs. White:	0.94	0.60–1.45	0.77
Dialysis modality:			
HD with AV graft or fistula vs. PD	2.75	1.77–4.27	<0.001
HD with catheter vs. PD	1.57	1.14–2.17	0.01
Met Kt/V dialysis target:			
≥ 1.2 on HD or ≥ 1.8 on PD vs. < 1.2 on HD or < 1.8 on PD	1.22	0.78–1.93	0.38
Ferritin level:	1.48	1.01–2.15	0.04
≤ 800 vs. > 800 (ng/ml)			
Duration of dialysis:	1.22	0.92–1.60	0.17
≥ 1 year on dialysis vs. < 1 year			

* Calculated using Green/Purple method

** Continuous variable by year

$\blacklozenge$ Analysis was adjusted for all listed variables: sex, age, race dialysis modality, Kt/V, ferritin, duration of dialysis