Hemodialysis Quality Metrics in the First Year Following a Failed Kidney Transplant

Anne M. Huml^{a–c} Ashwini R. Sehgal^{a, b, d}

^aCenter for Reducing Health Disparities, Case Western Reserve University, Cleveland, OH, USA; ^bDivision of Nephrology, Department of Medicine, Metro Health Medical Center, Cleveland, OH, USA; ^cGlickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, OH, USA; ^dDepartment of Epidemiology and Biostatistics, Case Western Reserve University Cleveland, Cleveland, OH, USA

Keywords

Transplant failure · Quality metrics · Hemodialysis

Abstract

Background: Failure of a previously transplanted kidney is a common cause of end-stage renal disease (ESRD) and represents 5% of incident dialysis patients in the United States. Patients with native kidney failure ESRD (Nat-ESRD) who receive predialysis care from a nephrologist have better outcomes in the first 12 months on dialysis than those who don't. Because many patients with a failed kidney transplant ESRD (Tx-ESRD) receive care from nephrologists, they would also be expected to have good dialysis outcomes. We sought to compare the quality metrics of Tx-ESRD patients and Nat-ESRD patients during the first 12 months of hemodialysis. **Methods:** We used data from the United States Renal Data System to identify hemodialysis patients who began treatment between May 2012 and December 2013 and who received nephrology care prior to starting hemodialysis. Quality metrics by quarter for the first 12 months of treatment were dichotomized according to practice guidelines to determine the percentage of patients in each quarter who met quality of care goals. **Results:** Compared to Nat-ESRD ($n = 96,063$) patients, Tx-ESRD ($n = 5,528$) patients had 10–19%

lower rates of at goal hemoglobin levels, 6–12% lower rates of at goal serum phosphorus, and 3–11% lower rates of at goal albumin levels. Compared to Nat-ESRD patients, Tx-ESRD patients had a 6% higher rate of fistula use in the first quarter but a 3–7% lower rate in subsequent quarters.

Conclusions: Tx-ESRD patients have worse quality metrics related to anemia, phosphorus, albumin, and vascular access compared to Nat-ESRD patients. Nephrology care for patients with Tx-ESRD should be improved to address these quality metrics gaps.

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Introduction

Failure of a previously transplanted kidney is a common cause of end-stage renal disease (ESRD) and is associated with high health care costs and mortality rates. In the United States, nearly 30,000 patients currently receive chronic dialysis after failure of a previously functioning transplant (Tx-ESRD) and, as a group, this number continues to increase [1–3]. The overall cost of care for patients within the first year of a failed transplant is estimated to be USD 130,000, which is higher than the USD 85,000 and USD 70,000 annual cost of hemodialysis

and peritoneal dialysis [2, 4, 5]. In addition, mortality rates for patients with Tx-ESRD are 3 times higher than those with a functioning transplant [6–8]. For these reasons, patients with Tx-ESRD are an important population to study.

Receiving predialysis care in a timely fashion and for a longer duration is associated with a slower progression of chronic kidney disease to ESRD, higher survival after initiation of dialysis, and better quality of dialysis care [9–13]. Patients who do not receive predialysis care have a 50% higher mortality in the first year after starting dialysis than those who do [10, 14]. After transplant, patients are seen frequently within the first year, and at least annually thereafter by transplant or general nephrologists [15]. Therefore, it might be expected that patients with Tx-ESRD would also have better quality metrics during the transition back to and after starting dialysis. Multiple studies have examined patient survival on hemodialysis following Tx-ESRD with mixed results; however, evidence of decreased quality of life and increased infectious complications have been reported [6, 16, 17]. We sought to determine the quality metrics that patients with Tx-ESRD have as compared to patients with native kidney failure (Nat-ESRD) during the first 12 months on dialysis.

Materials and Methods

Data Sources

We obtained standard analytic files from the United States Renal Data System (USRDS). We queried the core patient profile dataset to determine patients whose first date of dialysis following Nat-ESRD or Tx-ESRD was between May 1, 2012, and December 31, 2013. We used the Medicare Medical Evidence Report form 2,728 to determine whether they received predialysis nephrology care and to determine cause of ESRD. This study was approved by the Institutional Review Board of MetroHealth Medical Center, Cleveland, OH, USA.

Patients

Eligible patients were those ≥ 18 years old at the time of Nat-ESRD or Tx-ESRD. We included only patients who received any duration of predialysis nephrology care. Patients with Tx-ESRD were included after the failure of their first kidney transplant only. We limited the analysis to patients who were treated with hemodialysis as their first modality of renal replacement therapy following onset of Nat-ESRD or Tx-ESRD.

Variables

The CROWNWeb Clinical data standard analytic files contain patient level clinical data that are reported on a monthly basis from each Medicare certified dialysis facility in the United States. We obtained quality metrics for each patient in our cohort from the CROWNWeb Clinical data system over the first 12 months of dialysis. Anemia management, bone mineral parameters, hemodi-

alysis adequacy, and vascular access were the variables of interest. Specific anemia parameters included hemoglobin, ferritin, transferrin saturation, and use of intravenous iron or erythropoiesis-stimulating agent. For bone mineral disease, we evaluated serum calcium, phosphorus, and albumin levels. Adequacy was based on hemodialysis Kt/V. Vascular access was categorized as catheter, graft, or fistula.

Statistical Analysis

Patient characteristics are reported as means with SDs for continuous outcomes and numbers with percentages for categorical variables. We averaged all quality of care parameters available per quarter for each patient. The average for each patient by quarter was determined to be “at goal” according to the National Kidney Foundation’s Kidney Disease Outcomes Quality Initiative practice-based guidelines [18]. We calculated the proportion of patients in each quarter with a goal value and also the difference in at goal values among Nat-ESRD versus Tx-ESRD patients and report these with accompanying 95% CIs. Patients were censored at the time of death, transplant, discontinuation of dialysis, and loss to follow-up. Statistical analyses were conducted using JMP Pro version 14.0.0 (SAS Institute, Cary, NC, USA).

Results

We identified 96,063 incident hemodialysis patients with Nat-ESRD and 5,528 patients with Tx-ESRD who began hemodialysis. The mean age of patients with Nat-ESRD was 65 years, and the mean age of patients with Tx-ESRD was 53 years (Table 1). A majority of patients in both groups were male, white, and non-Hispanic. About 46% of patients with Nat-ESRD and 78% of Tx-ESRD patients had >12 months of predialysis care. The causes of kidney failure among Nat-ESRD patients were 50% diabetes mellitus, 28% hypertension, 6% glomerulonephritis, and 12% other causes.

Compared to patients with Nat-ESRD, patients with Tx-ESRD had poorer anemia-related parameters. During the first year on hemodialysis, patients with Tx-ESRD had 9.8–18.5% lower rates of at goal hemoglobin and received iron supplementation 7.7–9.8% less frequently compared to patients with Nat-ESRD (Table 2). The lower rates of at goal hemoglobin persisted over the first year on hemodialysis (Fig. 1).

Patients with Tx-ESRD had 2.6–4.3% lower rates of at goal serum calcium, 6.3–12.2% lower rates of at goal phosphorus, and 3.6–10.9% lower rates of at goal albumin as compared to patients with Nat-ESRD (Table 3). The lower rates of mineral- and nutrition-related parameters persisted over the entire first year of hemodialysis (Fig. 2, 3).

Table 1. Characteristics of patients with Nat-ESRD and Tx-ESRD

	Nat-ESRD (<i>n</i> = 96,063)	Tx-ESRD (<i>n</i> = 5,528)
Age, years, mean (SD)	65 (14)	53 (15)
Gender, male, <i>n</i> (%)	55,251 (58)	3,324 (60)
Race, <i>n</i> (%)		
White	66,074 (69)	3,494 (63)
Black	24,484 (25)	1,672 (30)
Asian	4,410 (5)	300 (5)
Other	1,095 (1)	62 (1)
Hispanic, <i>n</i> (%)	12,825 (13)	783 (14)
Duration of Pre-ESRD nephrology care, <i>n</i> (%)		
<6 months	21,654 (23)	499 (9)
6–12 months	29,833 (31)	731 (13)
>12 months	44,548 (46)	4,298 (78)

ESRD, end-stage renal disease; Nat-ESRD, native ESRD; Tx-ESRD, transplant failure ESRD.

Table 2. Anemia related parameters among patients with Nat-ESRD and Tx-ESRD

	Hemoglobin ≥10 g/dL	Ferritin >200 ng/mL	Transferrin saturation >20%	Received iron	Received erythropoiesis- stimulating agent
Nat-ESRD, % (<i>n</i> / <i>N</i>)					
Q1	70.9 (61,510/86,747)	77.0 (63,570/82,579)	65.5 (55,204/84,218)	78.4 (69,714/88,945)	77.4 (68,877/88,945)
Q2	83.2 (62,400/74,960)	89.6 (61,579/68,707)	83.2 (59,958/72,030)	74.6 (57,128/76,632)	75.7 (58,015/76,624)
Q3	84.1 (58,475/69,498)	93.2 (60,073/64,490)	86.6 (58,128/67,200)	72.5 (55,006/75,870)	75.5 (57,333/75,965)
Q4	85.3 (56,388/66,095)	95.3 (59,978/62,969)	89.5 (57,761/64,525)	78.2 (52,014/66,509)	79.1 (52,756/66,673)
Tx-ESRD, % (<i>n</i> / <i>N</i>)					
Q1	52.4 (2,181/4,162)	83.0 (3,178/3,827)	66.4 (2,629/3,961)	68.5 (3,056/4,459)	78.4 (3,497/4,459)
Q2	68.6 (2,869/4,181)	89.7 (3,285/3,663)	77.2 (3,059/3,962)	66.0 (2,886/4,375)	74.7 (3,270/4,376)
Q3	71.0 (2,964/4,178)	92.4 (3,559/3,849)	81.9 (3,298/4,025)	64.8 (2,780/4,288)	75.0 (3,221/4,295)
Q4	75.5 (3,157/4,180)	94.4 (3,766/3,991)	87.3 (3,567/4,088)	69.7 (2,935/4,212)	77.3 (3,274/4,234)
Difference, % (95% CI)					
Q1	18.5 (17.0 to 20.1)	−6.1 (−7.3 to −4.8)	−0.8 (−0.7 to 2.3)	9.8 (8.5 to 11.3)	−1.0 (−0.3 to 2.2)
Q2	14.6 (13.2 to 16.1)	−0.1 (−1.0 to 1.0)	6.0 (4.7 to 7.4)	8.6 (7.2 to 10.0)	1.0 (−0.3 to 2.3)
Q3	13.2 (11.8 to 14.6)	0.7 (−0.1 to 1.6)	4.6 (3.4 to 5.8)	7.7 (6.2 to 9.1)	0.5 (−0.8 to 1.8)
Q4	9.8 (8.5 to 11.1)	0.9 (0.2 to 1.7)	2.3 (1.3 to 3.3)	8.5 (7.1 to 10.0)	1.8 (0.5 to 3.1)

ESRD, end-stage renal disease; Nat-ESRD, native ESRD; Tx-ESRD, transplant failure ESRD.

There was no difference in dialysis dose between patients with Tx-ESRD and Nat-ESRD (Table 4). There was a 6.2% higher rate of fistula use and an 8.3% lower rate of catheter use among patients with Tx-ESRD as compared to Nat-ESRD during the first quarter. However, the fistula rate among Nat-ESRD patients increased over time. As a result, Tx-ESRD patients had a 3.0–7.2% lower rate of fistula use in subsequent quarters (Fig. 4). Because of the large sample sizes, the 95% CIs were all less than $\pm 2\%$ and are not shown in the figures.

Discussion

We found that the quality metrics for American patients with Tx-ESRD over the first 12 months on hemodialysis was worse in terms of anemia, bone mineral, and nutrition-related parameters compared to patients with Nat-ESRD. Biological differences including longer ESRD vintage, exposure to immunosuppression medications, or chronic inflammation because of an in situ failed kidney allograft may be the sources of worse anemia, bone mineral, and nutrition-related parameters [19]. Our

Fig. 1. Percentage of at goal hemoglobin values by quarter. Nat-ESRD, native ESRD; Tx-ESRD, transplant ESRD.

Table 3. Mineral and nutrition related parameters among patients with Nat-ESRD and Tx-ESRD

	Calcium 8.2–10.1 g/dL	Phosphorus 3.5–6 g/dL	Albumin ≥ 3.5 g/dL
Nat-ESRD, % (n/N)			
Q1	92.5 (74,276/80,304)	77.4 (66,421/85,799)	61.9 (52,624/85,006)
Q2	92.9 (63,809/68,659)	76.5 (56,759/74,228)	76.4 (56,251/73,596)
Q3	93.1 (59,217/63,607)	76.7 (52,955/69,024)	80.8 (54,252/67,097)
Q4	93.4 (56,767/60,789)	77.6 (50,995/65,747)	82.8 (53,928/65,138)
Tx-ESRD, % (n/N)			
Q1	89.9 (3,394/3,776)	71.1 (2,897/4,074)	58.3 (2,343/4,021)
Q2	89.5 (3,419/3,822)	66.7 (2,753/4,130)	65.5 (2,679/4,087)
Q3	89.1 (3,429/3,847)	64.7 (2,674/4,136)	70.3 (2,877/4,090)
Q4	89.1 (3,448/3,872)	65.4 (2,718/4,157)	73.4 (3,029/4,124)
Difference, % (95% CI)			
Q1	2.6 (1.7–3.6)	6.3 (4.9–7.7)	3.6 (2.1–5.2)
Q2	3.5 (2.5–4.5)	9.8 (8.4–11.3)	10.9 (9.4–12.4)
Q3	4.0 (3.0–5.0)	12.1 (10.6–13.6)	10.5 (9.1–12.0)
Q4	4.3 (3.4–5.4)	12.2 (10.7–13.7)	9.3 (8.0–10.7)

ESRD, end-stage renal disease; Nat-ESRD, native ESRD; Tx-ESRD, transplant failure ESRD.

findings also suggest that Tx-ESRD patients were less likely to receive iron and had lower iron stores than Nat-ESRD patients. Rates of fistula use in patients with Tx-ESRD were higher within the first quarter, but lower throughout the remaining quarters compared to patients with Nat-ESRD. Strengths of this study include use of a large national sample of dialysis patients with both Tx-ESRD and Nat-ESRD, analysis of well-defined quality parameters known to impact outcomes, and 12 months of longitudinal follow-up. By examining a 12-month time period, we likely captured the impact of predialysis care (first several months) as well as the impact of care while undergoing chronic dialysis (later months of the study timeline).

A previous study that examined quality of care for patients with Tx-ESRD also showed that anemia and nutri-

tion parameters were no different between patients with Tx-ESRD and Nat-ESRD [20]. That study was limited to quality of care markers at the initiation of dialysis examined using a cross-sectional design. Another study of Tx-ESRD patients also found higher rates of anemia along with higher doses of erythropoietin-stimulating agents compared to Nat-ESRD patients [21]. That study's findings about erythropoietin-stimulating agent use contrasted with our findings, perhaps because it was conducted prior to the transition of ESRD reimbursement to a bundled payment model as well as prior to trials that redefined hemoglobin targets in patients with kidney disease [22, 23]. A cross-sectional study examining nutrition and bone mineral parameters in patients with Tx-ESRD found that patients with Tx-ESRD were less likely to have albumin levels greater than 4 g/dL, and more likely to

Fig. 2. Percentage of at goal albumin values by quarter. Nat-ESRD, native ESRD; Tx-ESRD, transplant ESRD.

Fig. 3. Percentage of at goal phosphorus values by quarter. Nat-ESRD, native ESRD; Tx-ESRD, transplant ESRD.

have parathyroid hormone levels above 500 pg/mL [16]. To our knowledge, no previous studies have reported serum calcium or phosphorus levels in patients with Tx-ESRD. Finally, 2 prior studies looked at vascular access use at the start of hemodialysis following Tx-ESRD. Both examined vascular access used at the initiation of hemodialysis and did not limit the populations to patients receiving nephrology care prior to dialysis start. They found that more patients with Tx-ESRD started dialysis with a fistula as compared to patients with Nat-ESRD. However, most patients with Tx-ESRD and Nat-ESRD started dialysis with a catheter [16, 24]. Whereas these 2 studies reported type of vascular access at dialysis initiation, we reported the access used at the end of each quarter on dialysis throughout the 12 month study period. Since patients with Tx-ESRD had longer duration of nephrology care prior to dialysis than patients with Nat-ESRD, the high catheter rates in patients with

Tx-ESRD in the first quarter actually may indicate poor quality of care. The trend of higher fistula rates in patients with Tx-ESRD compared to Nat-ESRD at the start of dialysis, did not persist over time.

Our work has implications for patients, providers, policy makers, and researchers. Patients with failing transplants should be better informed about the possibility of needing to start dialysis. Patients with anemia, hyperphosphatemia, and catheters as vascular access may be at higher risk for adverse outcomes. They should be educated and vigilant about these modifiable parameters to mitigate this risk. Providers should focus not only on efforts to prolong the function of a failing kidney transplant but also on preparations for a possible transition to dialysis. Some providers may assume that patients with Tx-ESRD who were previously on hemodialysis recall important information including dietary restrictions and vascular access planning and therefore fail to re-educate or refer for such services. At a system level, the quality of care provided to patients during this transition back to hemodialysis may be complicated by lack of care coordination between transplant centers and dialysis facilities. Training for providers may be necessary to help them meet the specific needs of patients with Tx-ESRD such as individualized care plans for medication management, dialysis options and preparation, transplant re-listing candidacy, and psychosocial support. Policies for public reporting of additional transplant-specific data (e.g., immunosuppression medications) may allow for better understanding of mechanisms that contribute to quality of care parameters. Support for researchers to determine evidence-based best practices to care for patients with Tx-ESRD is also important.

Several limitations must be considered in interpreting our findings. We analyzed quality metrics that are reported to the USRDS by dialysis facilities. Although many of these quality metrics may serve as surrogate markers for dialysis outcomes, they may not reflect patient-centered quality measures such as quality of life, survival, hospitalization, time spent on dialysis, or dialysis-related symptoms or complications [25, 26]. We did not account for immunosuppression regimens that may influence quality of care parameters such as anemia. We did not have data on doses of erythropoietin-stimulating agents and could not determine if anemia management reflected resistance to these medications versus differences in dosing. As far as vascular access is concerned, we could not differentiate between existing vascular access that predated transplantation and placement of a new vascular access for patients once Tx-ESRD developed. We were unable to determine

Table 4. Dialysis dose and vascular access-related parameters among patients with Nat-ESRD and Tx-ESRD

	Kt/V ≥1.4	Vascular access type		
		catheter	graft	fistula
Nat-ESRD, % (n/N)				
Q1	63.8 (52,990/83,101)	61.5 (53,778/87,506)	7.2 (6,257/87,506)	31.2 (27,300/87,506)
Q2	75.7 (54,993/72,666)	38.1 (28,844/75,802)	11.2 (8,467/75,802)	50.6 (38,365/75,802)
Q3	79.4 (53,787/67,715)	23.9 (17,284/72,036)	13.3 (9,596/72,036)	62.6 (45,128/72,036)
Q4	82.2 (53,235/64,788)	15.3 (10,176/66,613)	14.9 (9,919/66,613)	69.8 (46,496/66,613)
Tx-ESRD, % (n/N)				
Q1	68.3 (2,516/3,683)	53.1 (2,212/4,159)	9.3 (386/4,159)	37.4 (1,556/4,159)
Q2	77.2 (2,707/3,507)	39.3 (1,509/3,834)	12.9 (494/3,834)	47.7 (1,827/3,834)
Q3	79.0 (2,698/3,416)	27.7 (1,012/3,653)	15.6 (570/3,653)	56.7 (2,071/3,653)
Q4	81.7 (2,814/3,446)	19.8 (707/3,576)	17.6 (629/3,576)	62.6 (2,238/3,576)
Difference, % (95% CI)				
Q1	−4.6 (−6.1 to −3.0)	8.3 (6.7 to 9.8)	−2.1 (−3.1 to −1.3)	−6.2 (−7.7 to −4.7)
Q2	−1.5 (−2.9 to 0.1)	−1.3 (−2.9 to 0.3)	−1.7 (−2.8 to −0.7)	3.0 (1.3 to 4.6)
Q3	0.5 (−0.9 to 1.9)	−3.7 (−5.1 to −2.3)	−2.3 (−3.5 to −1.1)	5.9 (4.3 to 7.6)
Q4	0.5 (−0.8 to 1.9)	−4.5 (−5.9 to −3.2)	−2.7 (−4.0 to −1.5)	7.2 (5.6 to 8.9)

ESRD, end-stage renal disease; Nat-ESRD, native ESRD; Tx-ESRD, transplant failure ESRD.

Fig. 4. Percentage of fistulas by quarter. Nat-ESRD, native ESRD; Tx-ESRD, transplant ESRD.

specific recommendations made to patients with failing transplants by their providers to determine if there were issues with nonadherence or delayed referrals that may have impacted dialysis planning. Our data are limited to the United States, and the findings may not apply to other countries.

In conclusion, there is a gap between the quality metrics for patients with Tx-ESRD as compared to patients with Nat-ESRD, which may increase their risk for adverse outcomes. We recommend that further work be done to determine the causes of these differences and to develop interventions and guidelines to address the needs of this population.

Acknowledgments

The data reported here have been supplied by the USRDS. The interpretation and reporting of these data are the responsibility of the author(s) and in no way should be seen as an official policy or interpretation of the U.S. government.

Statement of Ethics

The study protocol has been approved by the MetroHealth Institutional Review Board.

Disclosure Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Anne M. Huml, MD, MS: contributed with the conception, design, analysis, and interpretation of the data, drafting and editing the manuscript, and providing intellectual content of critical importance to the work. Ashwini R. Sehgal, MD: contributed with the analysis and interpretation of the data, editing the manuscript, and giving final approval to the submitted version.

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