In-patient Permanent Access is associated with Reduced Catheter Time for Emergent Start Hemodialysis Patients

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Abstract

Introduction: Hemodialysis initiation with a tunneled catheter carries an increased risk of morbidity and mortality. Conversion from a hemodialysis catheter to an AV fistula or an AV graft at any time is associated with improved outcomes. As such, there is a strong motivation to place permanent dialysis access and remove the dialysis catheter as soon as possible. This study investigates whether a strategy of placing permanent dialysis access in incident HD patients without permanent access while still hospitalized is associated with reduced exposure to hemodialysis catheters.

Methods: We conducted a retrospective cohort study of newly diagnosed ESRD patients initiating Hemodialysis with a catheter while hospitalized at a single University Hospital Medical Center from October 2010 through June 2013. Patients were divided into two groups: those with permanent access placed during the hospitalization (N = 22) vs. those discharged without permanent access (N = 67). Our primary endpoint was removal of the hemodialysis catheter. Secondary outcomes included early access failure rate and length of hospital stay.

Results: Subjects who underwent permanent access placement while still hospitalized had a median catheter exposure time of 114 days compared with 241 days for those who did not. The median time with HD catheter in place was shorter by 127 days in the Inpatient Access group. There was no significant difference in length of hospital stay or early access loss.

Conclusion: The practice of placing permanent access while the patient is still admitted to the hospital is associated with greater likelihood of hemodialysis catheter removal.

Introduction

Hemodialysis vascular access dysfunction is a major cause of morbidity in patients with End Stage Renal Disease (ESRD), accounting for 25-50% of hospitalizations with an estimated cost to Medicare of nearly \$1 billion per year [1]. Central venous catheters are associated with the highest risk of mortality as compared to permanent arteriovenous access with a fistula or graft [2,3]. In addition, permanent arteriovenous access offers superior blood flow rates, and lower rates of infection, thrombosis, septicemia, and central venous stenosis [2,4-8].

Hemodialysis initiation with a central venous catheter carries a 50-60% increased 2 year mortality risk [3]. Unfortunately, approximately 80% of patients initiate hemodialysis with a central venous catheter as their means of dialysis access [9]. Conversion to permanent access, with a fistula or a graft, at any time is associated with significantly improved survival and decreased number of hospitalizations [10,11]. As such, decreasing the length of time a hemodialysis catheter is in place by expediting permanent access placement is a potential strategy to reduce risk in this population. In an effort to reduce catheter time, some new hemodialysis starts receive permanent dialysis access while still hospitalized. This study assesses whether this practice is associated with reduced catheter exposure time. Our secondary aims include assessing the risks of primary access failure, post-operative bleeding or infection, bacteremia, and length of hospital stay in patients with expedited permanent access.

Subjects and Methods

Study Design and Participant Selection

We conducted a retrospective cohort study of adult (age 18 and older) incident ESRD patients initiating hemodialysis therapy while hospitalized at our institution from October 1, 2010 through June 30, 2013. All individuals with presumed ESRD were included. Participants were identified by hospital billing query of all patients who had newly started hemodialysis at one of

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the area dialysis units, and further evaluated by chart review. Patients were excluded from the study for the following reasons: functioning permanent access at the time of dialysis initiation, temporary hemodialysis due to short-term complication with Peritoneal Dialysis, temporary dialysis due to acute renal failure, or relocation from the area precluding data collection. Patients were identified as having ESRD based on attending nephrologist documentation of such at the time of discharge. Participants were divided into two groups: those with permanent access placed during that same hospitalization (AV fistula, graft, or PD catheter) versus those discharged without permanent access.

Data Collection

The study dataset was derived from patients' medical records. Demographic data included sex, age, and race. Baseline health data included diabetes, coronary artery disease, peripheral artery disease and history of previous failed permanent dialysis access. Hospital course data included length of hospital stay. The primary outcome was the number of days from dialysis initiation to catheter removal. The type and location of access, as well as the operating surgeon were recorded. The presence or absence of a referral for permanent access placement while hospitalized was also noted. Diabetes, peripheral artery disease, coronary artery disease, and previously failed access were recorded and used to calculate the Failure to Mature (FTM-1) score, a validated tool used to predict risk of access maturation failure [12]. Additional outcome data collected included the length of time between dialysis initiation and permanent access placement. An episode of bacteremia in the first year after dialysis initiation was defined by positive blood cultures requiring either antibiotic treatment and/or hemodialysis catheter replacement. An episode of bacteremia was concluded at the documentation of completed treatment course and/or negative blood cultures. Early access loss was defined as a fistula or a graft that was abandoned within three months of creation. Procedures on permanent access were identified by review of interventional radiology and surgical records of included patients. Patients' outcomes including death, recovery, and receipt of a functioning kidney transplant were recorded. The Research Subject Review Board approved this study as exempt (RSRB#048453).

Data Analysis

All analyses were conducted using SAS 9.3 (SAS Institute Inc., Cary, NC). Continuous variables were assessed for having a normal distribution using the Shapiro-Wilk test and visually using Q-Q plots. Continuous variables with normal distributions were reported as mean $\pm$ SD. Comparisons across groups were made by t-test or ANOVA. Continuous variables with non-normal distributions were reported as mean $\pm$ interquartile range. Comparisons across these groups were made by the Kruskal-Wallis test. Categorical variables were expressed by N (%), and comparisons across these groups were made using the chi-square test. Bivariate analyses for survival analysis used the log rank test. Cox step wise regression analyses were used to create multivariate models for the hazard rate censoring for death, transplant, recovery, or loss to follow-up. Only covariates with a log-rank test p-value < 0.2 were considered for inclusion in multivariate models. Model selection was limited to those that included only parameters with $p < 0.05$, but maximized the log likelihood ratio and minimized data exclusion. Collinearity was assessed using Proc Reg with the VIF option for all parameters with log-rank p values < 0.05 with no parameters found to have VIFs > 2.0 .

Figure 1: Flow chart describing included participants.

Results

Participants

Initial query of new hemodialysis patients yielded 340 patients for review. Of these, 109 were identified as patients with incident ESRD, initiating maintenance hemodialysis as an inpatient without a functioning permanent dialysis access. Thirty one included patients received permanent access (either AV Fistula, Graft, or PD catheter) as inpatients, and 78 were discharged without permanent access being placed. Of these 109 subjects, 20 were excluded upon further review. Of these exclusions, 11 were from the No Access group and 9 from the Inpatient Access group. Twelve were excluded due to insufficient records to assess outcomes and 8 due to unclear diagnosis of ESRD in the initial hospitalization. All patients excluded due to the latter criteria were discharged without permanent access. A total of 89 patients were included in the final analysis, 22 in the Inpatient Access group and 67 in the No Access group. A summary of included and excluded participants is outlined in Figure 1.

Figure 2: Probability of Hemodialysis Catheter Removal as a function of Inpatient Access Placement. Survival curves depicting probability of catheter remaining in place in the group who received inpatient permanent access placement compared to the group discharged without permanent access being placed. Patients who received inpatient permanent access placement were more likely to experience hemodialysis catheter removal during the study period. Censoring was performed in the event of death, transplant, recovery, or loss to follow-up.

Table 1: Baseline Characteristics of Study Participants.

Demographic	Access Inpatient (N =22)	No Access Inpatient (N= 67)	p value
Age (y)	60 (22-87)	60 (21-93)	0.99
Male (N)	13(59.1)	37 (55.2)	0.196
Caucasian (N)	8 (36.4)	45 (67.2)	0.011
Diabetes (N)	14 (63.6)	32 (47.8)	0.75
Coronary Artery Disease (N)	4 (18.2)	25 (37.3)	0.097
Peripheral Vascular Disease (N)	4 (18.2)	17 (25.4)	0.553
Previous Failed Access (N)	2 (9.1)	4 (6.0)	0.724
FTM-1 Score (N)			
Low	1 (4.5)	15 (22.4)	0.059
Moderate	12 (54.5)	21 (31.3)	0.051
High	8 (36.4)	19 (28.4)	0.479
Very High	1 (4.5)	12 (17.9)	0.124
FTM-1 Score Median	3	3	0.634
Access Type (N)			
No Access	0.0 (0)	24.0 (35.8)	0.001
AVF**	14.0 (63.6)	33.0 (49.2)	0.264
AVG***	7.0 (31.8)	6.0 (9.0)	0.088
Peritoneal Dialysis Catheter	1.0 (4.5)	4.0 (6.0)	0.496
AV Access Location (N)			
Forearm	4.0 (19)	8.0 (20.5)	0.588
Upper Arm	17.0 (81)	31.0 (79.5)	0.892
Transposed AVF (N)	0.0 (0)	7 (21.2)	0.062
Length of Stay (d)	13 (10.75-17)	13 (6-26)	0.466

Unless otherwise specified, data are expressed as N (%) or median days (IQR).

*FTM- Failure to Mature.

**AVF- Arteriovenous Fistula.

*** AVG- Arteriovenous Graft.

Table 2: Outcomes Data.

	Access Inpatient (N = 22)	Access Outpatient (N=43)	p value
Received inpatient surgical consult (N)	22 (100)	15 (24.6)	<0.0001
Time to Permanent Access Placement (d)	7.5 (5.75-11)	188 (73-523)	<0.0001
HD Catheter Time (d)	114 (93-145.5)	241 (130-401)	<0.0001
By Access Type(d)			
AVF	112.5	301	<0.0001
AVG	116	272.5	0.0223
By Access Location (d)			
Forearm	104.5	186.5	0.0066
Upper Arm	117	303	<0.0001
Post-Operative Bleeding or Infection (N)	3 (13.6)	4 (9.3)	0.503
Requiring Procedure for Primary Access Use (N)	8 (36.4)	14 (32.6)	0.866
Access Loss < 3 months (N)	5 (22.7)	7 (16.2)	0.588
1 or more Bacteremia episodes in first year (N)	4 (18.2)	23 (34.3)	0.295
Death Prior to AVF Use (N)	5 (22.7)	4 (9.3)	0.138
Transplant Prior to AVF (N)	0	0	

Unless otherwise specified, data are expressed as N (%) or median days (IQR).

The demographic and disease characteristics of patients are summarized in Table 1. There was no significant difference between groups excepting in race, with a higher proportion of Caucasians in the group that did not receive inpatient permanent access. Median FTM-1 scores were no different between groups. All 22 patients who underwent permanent access placement as an inpatient received surgical consults as an inpatient as well. Of the 43 patients who eventually received permanent access as an outpatient, 15 (24.6%) received surgical consults for access as an inpatient.

Outcomes

The primary and secondary outcomes are summarized in Table 2. Median time to dialysis access creation was 7.5 days in the Inpatient Access group and 188 days in the group discharged without access. Dialysis catheters were in place for a significantly shorter time in the Inpatient Access group with a median of 114 days as compared to 241 days in the No Inpatient Access group (Figure 2). There was no difference in median length of hospital stay between the groups.

Multivariate survival analysis was performed (Table 3) to determine independent parameters which predicted propensity for catheter removal. For the entire cohort, creation of access while still an inpatient was the dominant factor predicting catheter removal. Hospital stay of 14 days or less and inpatient surgical referral also independently predicted reduced exposure to a hemodialysis catheter. When analysis was limited to individuals who actually underwent surgery, inpatient surgical referral was no longer a significant predictive factor. When analysis was limited to individuals who underwent AVF placement, only inpatient access creation was a significant predictor of dialysis catheter removal.

There was a higher proportion of AVGs placed in the Inpatient Access group but this difference was not significant. No transposed AV fistulas were created in the Inpatient Access group.

In the group of patients discharged without permanent access, 36% never received permanent access. Moreover, 55% remained catheter dependent compared to 22% catheter dependence in the inpatient access group by the end of the study period. For those discharged without placement of permanent access, inpatient surgical consult was not a robust independent predictor for catheter removal. The strongest predictor for catheter removal was hospital stay of 14 days or less. A model (Table 3: model 1) consisting of inpatient surgical consult and length of stay of 14 days or less was not better than a model consisting of length of stay of 14 days or less and patient sex (Table 3: model 2). Both vascular and transplant surgery consultations were available for our study population. These were chosen at the discretion of care providers at the time of hospitalization. The majority of patients receiving inpatient access received transplant surgery consultation (77%). In comparison, of those patients who received permanent access in the No Inpatient Access group, 48% were performed by Vascular Surgeons.

Access loss and complications are listed in Table 2. There was no significant difference in post-operative complications or access abandonment in the first 3 months following placement between the groups. Access complications were not associated with access location or type.

The number of patients with episodes of bacteremia in the first

Table 3: Multivariate Survival Analysis.

	Total Population		89 Observations Read; 82 Observations Used	
	Parameter	Parameter Estimate (± SEM)	p	Hazard Ratio
	Inpatient Placement of Access	1.37 (± 0.42)	0.001	3.953
	Length of Stay 14 Days or Less	1.21 (± 0.40)	0.0022	3.378
	Inpatient Surgical Consult	0.86 (± 0.40)	0.035	2.361
	Only Patients who received surgery		65 Observations Read; 65 Observations Used	
	Parameter	Parameter Estimate (± SEM)	p	Hazard Ratio
	Inpatient Placement of Access	1.72 (± 0.37)	<.0001	5.58
	Length of Stay 14 Days or Less	1.15 (± 0.37)	0.0022	3.145
	Only Patients who received an AVF		47 Observations Read; 47 Observations Used	
	Parameter	Parameter Estimate (± SEM)	p	Hazard Ratio
	Inpatient Placement of Access	2.47 (± 0.45)	<.0001	11.818
Model 1	Patients who did not receive inpatient access		67 Observations Read; 60 Observations Used	
	Parameter	Parameter Estimate (± SEM)	p	Hazard Ratio
	Length of Stay 14 Days or Less	1.12 (± 0.51)	0.0271	3.058
	Inpatient Surgical Consult	0.84 (± 0.41)	0.0395	2.322
Model 2	Patients who did not receive inpatient access		67 Observations Read; 67 Observations Used	
	Parameter	Parameter Estimate (± SEM)	p	Hazard Ratio
	Length of Stay 14 Days or Less	1.56 (± 0.47)	0.001	4.762
	Male Sex	-1.12 (± 0.40)	0.0053	0.328

year after dialysis initiation was not significantly different between the treatment groups. There were a total of 15 deaths in the group of patients who did not receive expedited access during the study period. Of these, five patients had received permanent access that had not yet matured. Five patients in the Inpatient Access group died prior to permanent access maturation. Two patients in the No Inpatient Access group underwent transplantation. Neither of these two patients had undergone permanent access placement.

Discussion

Patients who received expedited permanent access placement experienced significantly shorter time that their hemodialysis catheter was in place. This effect size was significant, with median decrease in time of 127 days. Those patients who did not receive inpatient permanent access were more likely to be catheter dependent by the end of the study period. Additionally, there were fewer episodes of bacteremia in the Inpatient Access group. This suggests that early referral for permanent access, a parameter within the control of treating physicians, can significantly impact the risk profile of chronic dialysis patients. The hospitalization during which dialysis is initiated should be viewed as an opportune time for intervention.

In our study, the time to access placement was significantly longer in those patients discharged without permanent access, with median time to insertion of 188 days compared to 7.5 days in the expedited access group. Inpatient permanent access placement was the most robust predictor of dialysis catheter removal. In our study, failure to secure follow-up appointments prior to discharge, failure of patient to attend appointments, and intercurrent hospitalizations were the most commonly listed barriers to outpatient access placement.

This highlights the importance of intervening early in this high risk population. Effect size is therefore expected to vary depending on the availability of local outpatient resources.

An additional parameter which predicted catheter removal was length of stay less than 14 days. We interpret this parameter as a broad marker for both acute and chronic illness. Acute illness would temporarily delay placement of access while a chronically ill individual may well be a poor permanent access candidate.

In the total population, inpatient surgical referral also predicted removal of HDTC. There was significant collinearity between this predictor and inpatient access creation. For those patients who did not receive inpatient access, surgical referral was not the dominant predictor of HD catheter removal. As such, inpatient referral does not appear to be as important a predictor for catheter removal as inpatient access creation.

The practice of creating permanent access prior to hospital discharge was not associated with a significant increase in length of hospital stay. Notably, length of stay > 14 days was associated with delayed catheter removal in both groups, likely serving as a surrogate marker for severity of illness. Given the concern that expedited access strategies may lead to permanent access that is never used, we evaluated the number of deaths or transplants prior to access use as a measure of premature access creation. There was no difference in either parameter between the groups, although it should be noted that expected transplant was a cited reason to defer inpatient access referral. Access failure rates were similar between the groups, as were immediate post-operative complications.

This study has several limitations. The study period and sample size were insufficient to assess the impact of expedited access on mortality. Data were collected from a single center utilizing services from a limited group of vascular and transplant surgeons. The majority (77%) of inpatient access referrals were provided by a transplant surgical group, whereas 48% of those patients discharged without permanent access were evaluated by a vascular surgery group. Although surgical outcomes were similar between the groups, we were not able to control for provider factors that may have influenced timing of appointments. Selection of patients for expedited access was not randomized, and patients deemed inappropriate for permanent access creation due to unclear diagnosis of ESRD, poor prognosis, or imminent transplant were excluded from inpatient access referral. Patient characteristics were similar between the two groups, notably variables contributing to the FTM-1 score. This score does not include many significant co-morbidities including advanced cardiomyopathy or hepatic failure which may have influenced patient selection and outcomes. Several parameters, including type of permanent access, would be expected to influence likelihood of HD catheter removal. There was no effect seen likely due to the study's low power. While collinearity was not severe, there was significant collinearity in predictive factors, most notably between inpatient consult and inpatient access placement. As such, and given small sample size, parameter estimates should be interpreted with caution.

In conclusion, our data indicate that inpatient permanent access placement is associated with increased likelihood of dialysis catheter removal. Of the parameters studied, inpatient access placement was the most potent and robust predictor of 'loss' of the dialysis catheter state. As all patients who undergo inpatient access creation by necessity also receive a surgical evaluation, we found that overall, these patient are up to 13 times more likely to experience catheter removal at any given time compared with those who did not undergo access placement as an inpatient and over five times more likely to experience catheter removal at any given time compared with those who underwent access creation as an outpatient. These findings support the strategy of placing permanent access in patients with incident ESRD while still inpatient.

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