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Journal

Kidney Medicine, 4(8)

Authors

Khakharia, Anjali
Hoge, Courtney
Vandenberg, Ann
et al.

Publication Date

2022-08-01

DOI

10.1016/j.xkme.2022.100511

Peer reviewed

Effectiveness of a Web-Based Provider Communications Platform in Reducing Hospital Readmissions Among Patients Receiving Dialysis: A Pilot Pre-Post Study

Laura C. Plantinga, Anjali Khakharia, Courtney Hoge, Ann E. Vandenberg, Janice P. Lea, Tahsin Masud, Carol Gray, Christopher M. O'Donnell, Kyle James, Rich Mutell, and Bernard G. Jaar

Rationale & Objective: Suboptimal care coordination between dialysis facilities and hospitals is an important driver of 30-day hospital readmissions among patients receiving dialysis. We examined whether the introduction of web-based communications platform ("DialysisConnect") was associated with reduced hospital readmissions.

Study Design: Pilot pre-post study.

Setting & Participants: A total of 4,994 index admissions at a single hospital (representing 2,419 patients receiving dialysis) during the study period (January 1, 2019-May 31, 2021).

Intervention: DialysisConnect was available to providers at the hospital and 4 affiliated dialysis facilities (=intervention facilities) during the pilot period (November 1, 2020-May 31, 2021).

Outcomes: The primary outcome was 30-day readmission; secondary outcomes included 30-day emergency department visits and observation stays. Interrupted time series and linear models with generalized estimating equations were used to assess pilot versus prepilot differences in outcomes; difference-in-difference analyses were performed to compare these differences between intervention versus control facilities. Sensitivity analyses included a third, prepilot/COVID-19 period (March 1, 2020-October 31, 2020).

Results: There was no statistically significant difference in the monthly trends in the 30-day readmissions pilot versus prepilot periods (−0.60 vs -0.13, P = 0.85) for intervention facility admissions; the difference-in-difference estimate was also not statistically significant (0.54 percentage points, P = 0.83). Similar analyses including the prepilot/COVID-19 period showed that, despite a substantial drop in admissions at the start of the pandemic, there were no statistically significant differences across the 3 periods. The age-, sex-, race-, and comorbid condition-adjusted, absolute pilot versus prepilot difference in readmissions rate was 1.8% (−3.7% to 7.3%); similar results were found for other outcomes.

Limitations: Potential loss to follow-up and pandemic effects.

Conclusions: In this pilot, the introduction of DialysisConnect was not associated with reduced hospital readmissions. Tailored care coordination solutions should be further explored in future, multisite studies to improve the communications gap between dialysis facilities and hospitals.

Visual Abstract included

Complete author and article information provided before references.

Correspondence to L.C. Plantinga (laura.plantinga@emory.edu)

Kidney Med. 4(8):100511. Published online 26 June 2022.

doi: 10.1016/j.xkme.2022.100511

INTRODUCTION

The more than half a million US patients receiving dialysis treatment average 1.6 hospital admissions per year, resulting in annual Medicare costs of nearly $12 billion.[1] About one-third of hospitalizations in dialysis patients are followed by a readmission within 30 days[1]; with the exception of previous readmission, kidney failure is the strongest risk factor for readmission among Medicare beneficiaries.[2] Furthermore, such readmissions are most likely among those for whom patient-driven care coordination is most challenged,[3-6] and readmissions in this population are associated with poor subsequent outcomes, including mortality.[7,8]

With the primary goals of improving patient outcomes and reducing costs, the Centers for Medicare & Medicaid Services prioritized reduction of hospital readmissions in dialysis patients via payment incentives for both hospitals and outpatient dialysis facilities.[9-11] Despite this national emphasis on readmission reduction among dialysis patients, there is a substantial lack of interoperability between US dialysis facilities and hospitals [which generally use different electronic health records (EHRs)].[12] Without the EHR as a direct avenue for communication between providers, essential components of successful care transitions (eg, discharge summaries, updated problem/medication lists, weight changes)[13-16] are frequently not transmitted in a timely manner to the outpatient dialysis facility, increasing risk of hospital readmission[17] and other poor outcomes. Similarly, hospitals may not receive adequate, timely patient information from dialysis facilities that is needed to provide high-quality, appropriate care during hospitalization (eg, continuation of antibiotics, current medications, and laboratory test results).[18]

To address this gap, we introduced "DialysisConnect," a secure, web-based, 2-way communications platform that allowed direct communication between providers, automated messages at admission and discharge, and timely

PLAIN-LANGUAGE SUMMARY

Patients receiving dialysis spend a lot of time in the hospital, and they are often hospitalized again within 30 days of discharge ("30-day readmission"). Improving communication between providers at dialysis facilities and hospitals could help improve coordination of care of dialysis patients who are hospitalized, ultimately improving outcomes. Here we examined whether the introduction of web-based communications platform ("DialysisConnect") to providers at a single hospital and 4 dialysis facilities was associated with reduced 30-day readmissions, comparing hospitalizations before (January 1, 2019-October 31, 2020) versus after (November 1, 2020-May 31, 2021) its introduction. We found that DialysisConnect was not associated with reduced 30-day readmissions. Given the importance of improving care coordination and reducing hospital readmissions in this population, additional studies are needed.

exchange of critical discharge information (Fig S1).[19] The system was available to physicians, advanced practice providers, nurses, social workers, and other individuals as identified by the site champions.[19] We piloted DialysisConnect at Emory University Hospital Midtown (EUHM) and 4 affiliated Emory Dialysis facilities. Despite the shared affiliation, EUHM and Emory Dialysis do not share health care management or an EHR, reflecting the typical situation at most US hospitals and dialysis facilities. Our primary aim was to assess the effectiveness of DialysisConnect in reducing 30-day hospital readmissions among Emory Dialysis patients who were admitted to EUHM before and after implementation. Secondarily, we examined other outcomes pre- and postimplementation, including postdischarge observation stays, emergency department (ED) visits, length of stay, and mortality.

METHODS

Study Design and Data Sources

Our pilot was designed as a pre-post study of outcomes of admissions among patients who were treated at all 4 Emory Dialysis facilities and admitted to EUHM on or after January 1, 2019 and discharged before or on May 31, 2021 (end of pilot). Emory Dialysis offers in-center hemodialysis, peritoneal dialysis, and home hemodialysis to ∼750 patients at any given time; only its physicians and advanced practice providers have academic affiliations. EUHM is a 531-bed tertiary care teaching hospital with a 16-bed hemodialysis inpatient unit and ongoing quality improvement efforts to improve dialysis care.[20] Admissions among EUHM patients receiving dialysis at locations other than Emory Dialysis who were hospitalized during the same period were included as a control. EUHM EHR data were used to identify all admissions and outcomes, except for postdischarge mortality, which was identified using Emory Dialysis EHR data. Patients receiving dialysis were identified in the EUHM EHR using *International Classification of Diseases, Tenth Revision* (ICD-10) diagnosis codes related to dialysis (any of: N18.6, Z99.2, Z91.1, V45.11, V45.12); in a preliminary sensitivity analysis using prepilot data, this method was shown to capture 99% of admissions of Emory Dialysis patients. We identified 5,368 inpatient admissions among 2,584 individuals in the period January 1, 2019-May 31, 2021; excluding those events with a discharge status of expired (n = 232 events), left against medical advice (n = 139), and planned readmissions (n = 3), there were 4,994 remaining index admissions among 2,419 individuals. No providers or patients were enrolled in the study; the study protocol and waiver of patient consent for the use of EHR data were approved by the Emory University Institutional Review Board (IRB00102971).

Variables

Study Period

The system was initially rolled out October 12, 2020 and its first use was on October 28, 2020; the pilot ran for 7 months. The pilot period was defined as November 1, 2020-May 31, 2021, and the prepilot period was defined as January 1, 2019-October 31, 2020. Because of the potentially substantial effect of the COVID-19 pandemic on hospitalization patterns, we additionally examined 3 periods to determine appropriate comparison group(s): prepilot/pre-COVID (January 1, 2019-February 29, 2020), prepilot/COVID (March 1, 2020-October 31, 2020), and pilot (November 1, 2020-May 31, 2021).

Intervention

DialysisConnect was available to providers for hospitalized patients who were being treated by Emory Dialysis (=intervention facilities). Thus, the intervention index admissions were defined as admissions among patients treated at Emory Dialysis at the time of admission; control index admissions were defined as admissions among patients treated at any other dialysis facility at admission. To identify intervention versus control index admissions, we linked the Emory Dialysis census to the EUHM EHR data using medical record numbers and other identifiers (names, dates of birth, Social Security numbers) as necessary.

Outcomes

All inpatient events among patients receiving dialysis at hospital admission during the study period were considered index admissions. The primary outcome of hospital readmission was defined for each index admission by whether the patient was admitted at EUHM within 30 days of the discharge date (yes vs no). In addition to hospital readmissions, observation stays, and ED visits within 30 days of discharge from the index admission were examined, alone and combined with hospital readmissions. Length of stay in days was calculated as discharge date–admission date. Mortality within 30 days of discharge was assessed for index admissions associated with Emory Dialysis patients only.

Other Variables

Age at time of admission, sex, and race were obtained from the EHR data. Comorbid conditions were estimated using the Charlson comorbidity index, based on inpatient ICD-10 codes per Quan et al,[21,22] using all available codes in the year prior to the first admission in our sample; all patients were coded to have kidney disease regardless of whether the codes were present. Cardiovascular, infectious (excluding COVID-19), and vascular access-related causes of index admission were defined using primary ICD-9 codes, based on classifications historically used by the US Renal Data System.[1] COVID-19-related admissions were defined by the presence of the ICD-10 code U07.1 in either primary or secondary discharge diagnoses. For each index admission, high utilizer status was defined by whether the patient had had at least 3 admissions or observation stays in the year before the admission date.

Statistical Analysis

Characteristics of hospital admissions during the study period were summarized overall and compared by intervention status and by period (within intervention status). For interrupted time series analysis,[23] index admissions were collapsed by month and readmission rates were calculated as (number of index admissions in the month followed by a 30-day readmission)/(number of index admissions in the month); interruptions were defined as the start of the pilot. Single-group pre-post analyses within intervention facilities and multiple-group difference-in-difference analyses including the control group were performed, using Newey-West standard errors for ordinary least-squares regression coefficients. To additionally account for the correlations introduced by the same individuals having multiple admissions during the study period, we also performed admission-level linear regression for readmissions as well as secondary outcomes using generalized estimating equations and terms for period (prepilot, pilot); for difference-in-difference analyses, terms for intervention (Emory Dialysis vs other) and intervention × period were added. Adjustment for age, race, sex, and Charlson comorbidity index was also performed. Sensitivity analyses included the following: including 2 interruptions, start of the pilot and start of the COVID-19 period; ignoring within-person correlation (ordinary least-squares regression); excluding index admissions that were COVID-19- or vascular access-related or that were followed by a death within 30 days (Emory Dialysis/pre-post analysis only); stratifying by high utilizer status; and using "captured in DialysisConnect" rather than Emory Dialysis affiliation as the treatment group in the pilot period to account for not all hospital admissions being captured in the system (in percentage points). Data management and analyses were performed using SAS v. 9.4 and Stata v. 17.0.

RESULTS

Characteristics of Index Admissions

Intervention facilities accounted for 1,046 (20.9%) of the 4,994 total index admissions examined over the study period (Table 1). Among intervention index admissions, 251 (24.0%) were during the pilot period; among control index admissions, 883 (22.4%) were during the pilot period. Index admissions for intervention versus control were more likely to be among women (54.2% vs 49.5%) and Black (95.6% vs 90.8%) patients, as well as among patients with more comorbid conditions ($P < 0.001$ for all). Index admissions from intervention facilities were less likely to be related to cardiovascular causes (61.3% vs 67.2%) and more likely to be among high utilizers (44.6% vs 28.4%; $P < 0.001$ for both; Table 1). Within intervention facilities, fewer index admissions involved Black and female patients and cardiovascular causes in the pilot versus prepilot period; among patients receiving dialysis at other dialysis facilities, more index admissions involved female patients and patients with few comorbid conditions in the pilot versus prepilot period (Table S1).

Readmissions Pre- and Post-DialysisConnect Rollout in Intervention Facilities

The readmission rate among all admissions in intervention facilities in the baseline (prepilot) period was 23.1%. Fig 1 shows the interrupted time series of monthly readmission rates in intervention facilities. The pilot and prepilot trends were both negative, but neither was statistically significant, and the pilot versus prepilot difference in trends was also not statistically significant. In admission-level analyses (Table 2), the absolute difference in readmission rates for the pilot versus prepilot was 1.9%; after adjustment for age, sex, race, and comorbid conditions, this difference was 1.8%; neither difference was statistically significant. Results were similar for secondary outcomes: the largest pilot versus prepilot difference (−3.2%) was for the combined outcome of 30-day observation stay or ED visit, and the difference was not statistically significant (Table 2).

An interrupted time series including a third prepilot/COVID-19 period (Fig S2) showed that this period had lower readmission rates ($P = 0.12$) than the pre-COVID-19 period (during which readmissions were increasing); however, no differences in trends across all 3 periods were statistically significant. Additionally, admission-level analysis showed that the absolute adjusted difference in readmissions (−6.5%) for the prepilot/COVID-19 versus

Table 1. Characteristics of Index Inpatient Admissions to Emory University Hospital Midtown Among Patients Receiving Dialysis, Overall and by Intervention Status at Index Admission, From January 1, 2019 to May 31, 2021

Characteristic	Overall	Intervention (Emory Dialysis Facilities)	Control (Other Dialysis Facilities)	*P*[a]
No. of admissions	4,994	1,046	3,948	—
No. of patients	2,419	396[b]	2,099[b]	—
Period				
Prepilot	3,860 (77.3)	795 (76.0)	3,065 (77.6)	0.26
Pilot	1,134 (22.7)	251 (24.0)	883 (22.4)	—
Patient age, y, mean (SD)	59.2 (14.7)	59.1 (15.0)	59.2 (14.7)	0.84
Sex, *n* (%)				0.007[a]
Female	2,521 (50.5)	567 (54.2)	1,954 (49.5)	—
Male	2,473 (49.5)	479 (45.8)	1,994 (50.5)	—
Race,[c] *n* (%)				<0.001[a]
Black	4,524 (91.9)	990 (95.6)	3,534 (90.8)	
Other	401 (8.1)	45 (4.4)	356 (9.2)	—
Charlson comorbidity index,[d] median (IQR)	3 (2-5)	4 (2-5)	3 (2-5)	<0.001[a]
Diabetes,[d] *n* (%)				<0.001[a]
Yes	2,652 (53.2)	623 (59.6)	2,029 (51.5)	—
No	2,338 (46.8)	423 (40.4)	1,915 (48.5)	—
Congestive heart failure,[d] *n* (%)				<0.001[a]
Yes	2,416 (48.4)	565 (54.0)	1,851 (46.9)	—
No	2,574 (51.6)	481 (46.0)	2,093 (53.1)	—
COPD,[d] *n* (%)				<0.001[a]
Yes	1,200 (24.1)	308 (29.5)	892 (22.6)	—
No	3,790 (76.0)	738 (70.5)	3,052 (77.4)	—
Cardiovascular admission,[e] *n* (%)				<0.001[a]
Yes	3,293 (66.0)	641 (61.3)	2,652 (67.2)	—
No	1,699 (34.0)	405 (38.7)	1,294 (32.8)	—
Infectious admission,[e] *n* (%)				0.51
Yes	1,651 (33.1)	337 (32.2)	1,314 (33.3)	—
No	3,341 (66.9)	709 (67.8)	2,632 (66.7)	—
Vascular access-related admission,[e] *n* (%)				0.34
Yes	704 (14.1)	157 (15.0)	547 (13.9)	—
No	4,288 (85.9)	889 (85.0)	3,399 (86.1)	—
COVID-19-related admission,[e] *n* (%)				0.96
Yes	288 (5.8)	60 (5.7)	228 (5.8)	—
No	4,704 (94.2)	986 (94.3)	3,718 (94.2)	—
High utilizer,[f] *n* (%)				<0.001[a]
Yes	1,589 (31.8)	466 (44.6)	1,123 (28.4)	—
No	3,405 (68.2)	580 (55.5)	2,825 (71.6)	—

Abbreviations: COPD, chronic obstructive pulmonary disease; IQR, interquartile range; SD, standard deviation.
[a]Statistically significant for Emory Dialysis versus all other dialysis, by *t*, Wilcoxon rank sum, or χ^2 test, as appropriate.
[b]Number of patients adds up to more than the total, due to $n = 76$ patients who were dialyzing at Emory Dialysis at the start of some index admissions but dialyzing elsewhere (or initiating emergent dialysis) at the start of other index admissions during the pilot period.
[c]$N = 4{,}925$. Other race is primarily White (6.8% overall) but also includes Asian (1.1%), American Indian/Alaskan Native (<0.1%), Hawaiian/Pacific Islander (<0.1%), and multiple races (0.1%).
[d]$N = 4{,}990$.
[e]$N = 4{,}992$. Diagnostic codes for cardiovascular, infectious, vascular access-related, and COVID-19-related causes can occur in the same admission.
[f]Defined as having ≥3 inpatient admissions or observation stays in the year before index admission.

prepilot/pre-COVID-19 period was statistically significant, but there were no differences in readmissions or other secondary outcomes in the pilot versus prepilot/pre-COVID-19 period (Table S2). Additional sensitivity analyses not accounting for within-person clustering, excluding COVID-19-related ($n = 60$) and vascular access-related ($n = 157$) index admissions, and excluding those index admissions followed by a death within 30 days ($n = 47$) gave results that were similar to the primary results (Table S3). Finally, results stratified by high utilizer status at admission (Table S4) showed statistically significant difference-in-differences of 14.2% for readmissions and −13.3% for observation stays (−19.8% for the combined outcome), among high utilizer status versus other status; no other comparisons were statistically significant.

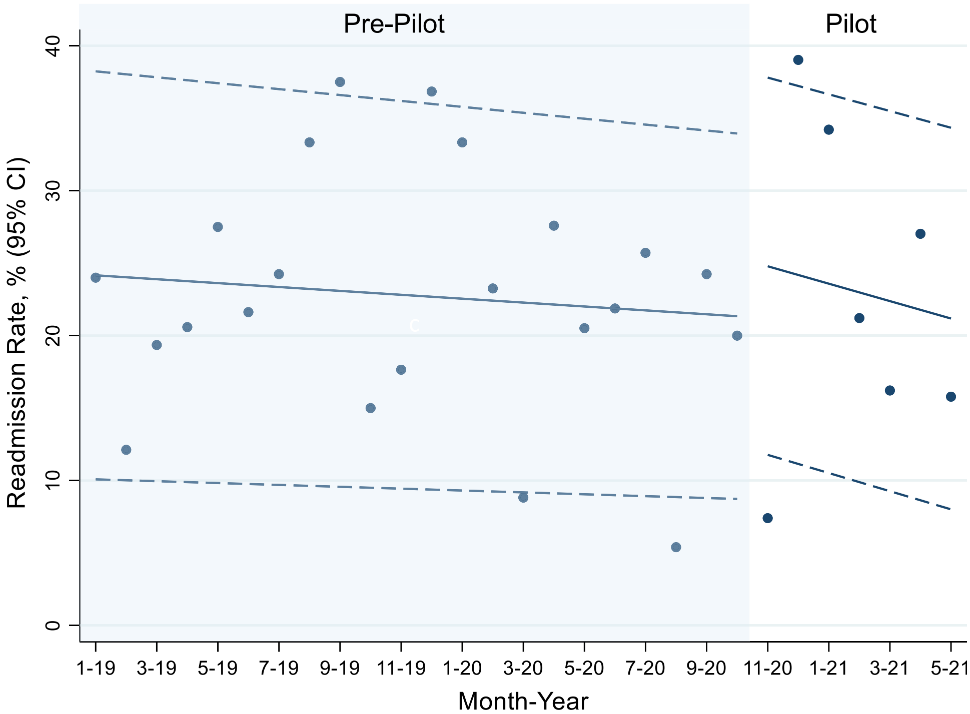


Figure 1. Interrupted time series of crude monthly readmission rates for index admissions at intervention facilities from January 1, 2019 to May 31, 2021, with introduction of the DialysisConnect pilot on November 1, 2021. Solid lines, fitted slopes for the prepilot and pilot periods; dashed lines, upper and lower bounds of the 95% confidence interval. Slopes were −0.13 ($P = 0.60$) and −0.60 ($P = 0.81$) for the prepilot and pilot periods, respectively; $P = 0.76$ for the change (β = 3.58) at the start of the pilot and $P = 0.85$ for the difference in slopes between the prepilot and pilot periods. CI, confidence interval.

Readmissions Pre- and Post-DialysisConnect Rollout, Comparing Intervention and Control Facilities

An interrupted time series including a comparison of admissions among intervention versus control facilities (baseline unadjusted readmission rate, 17.6%; Fig 2) showed similar monthly trends in both the pilot and prepilot periods, although readmission rates were generally higher in intervention facilities. The overall difference-in-difference (= 0.5%) was not statistically significant. Adjusted, admission-level analysis showed similarly null results for readmissions and for secondary outcomes; the strongest effect was again among the combined observation stay or ED visit outcome (difference-in-difference = −3.5%), but this estimate was not statistically significant (Table 3).

Sensitivity analyses including a third COVID-19 period showed diverging trends in the prepilot/pre-COVID-19 period; however, none of the difference or difference-in-difference estimates were statistically significant across the 3 periods (Fig S3). Adjusted, admission-level analysis showed that the prepilot/COVID-19 versus prepilot/pre-COVID-19 difference-in-difference estimate (=−6.4%) for readmissions was statistically significant, but there were no differences for the other period comparisons, or for any other outcome, with the exception of prepilot/COVID-19 versus prepilot/pre-COVID-19 30-day observation stays (= 5.7%) (Table S5). Additional sensitivity analysis comparing the pilot versus prepilot periods showed similarly null results, including: using ordinary least-squares regression without generalized estimating equations to account for within-person clustering (Table S6); using "captured in DialysisConnect" rather than treatment at Emory Dialysis as the intervention, to account for not all hospital admissions in the pilot period being captured in the system (Table S7); and excluding discharges that were associated with COVID-19 ($n = 288$; Table S8).

DISCUSSION

In this pilot, we found that the introduction of our web-based provider communications platform, DialysisConnect, was not associated with a reduction in 30-day readmissions to EUHM among intervention (Emory Dialysis) facilities during the 7-month pilot period, relative to the prepilot period. While 30-day observation stays and ED visits were lower (by ∼3% combined) in the pilot versus. prepilot period, these associations were not statistically significant. There was no pilot versus prepilot difference in hospital length of stay or 30-day mortality among these patients exposed to the intervention. Further, these associations were similar after comparison with a control group (all other dialysis patients seen at EUHM), to account for potential seasonal or secular trends.

Table 2. Difference in Admission-Level Outcomes Between the DialysisConnect Pilot Period (November 1, 2020-May 31, 2021) and the Prepilot Period (January 1, 2019-October 31, 2020): Intervention Facilities

Index Admission Outcome	Absolute Difference (Pilot–Prepilot) in Outcome Between Pilot Period and Prepilot Period (95% CI)	
	Unadjusted	Adjusted[a]
Primary:		
% followed by 30-d readmission	1.9 (−3.6 to 7.4)	1.8 (−3.7 to 7.3)
Secondary:		
% followed by 30-d readmission, observation stay, or ED visit	−1.2 (−7.6 to 5.2)	−0.6 (−6.9 to 5.8)
% followed by 30-d readmission or observation stay	0.8 (−5.0 to 6.6)	1.3 (−4.5 to 7.1)
% followed by 30-d observation stay or ED visit	−4.0 (−9.6 to 1.5)	−3.2 (−8.8 to 2.3)
% followed by 30-d observation stay	−2.2 (−6.4 to 2.0)	−1.8 (−6.0 to 2.4)
% followed by 30-d ED visit	−1.6 (−5.8 to 2.5)	−1.1 (−5.3 to 3.1)
Hospital length of stay, d	0.6 (−0.6 to 1.7)	0.4 (−0.8 to 1.6)
% followed by 30-d mortality	1.5 (−1.5 to 4.5)	1.0 (−2.0 to 4.0)

Abbreviations: CI, confidence interval; ED, emergency department.
Note: All estimates are population-averaged estimates from models using generalized estimating equations to account for within-patient correlation.
[a]Adjusted for age, sex, race (Black vs other), and Charlson comorbidity index.

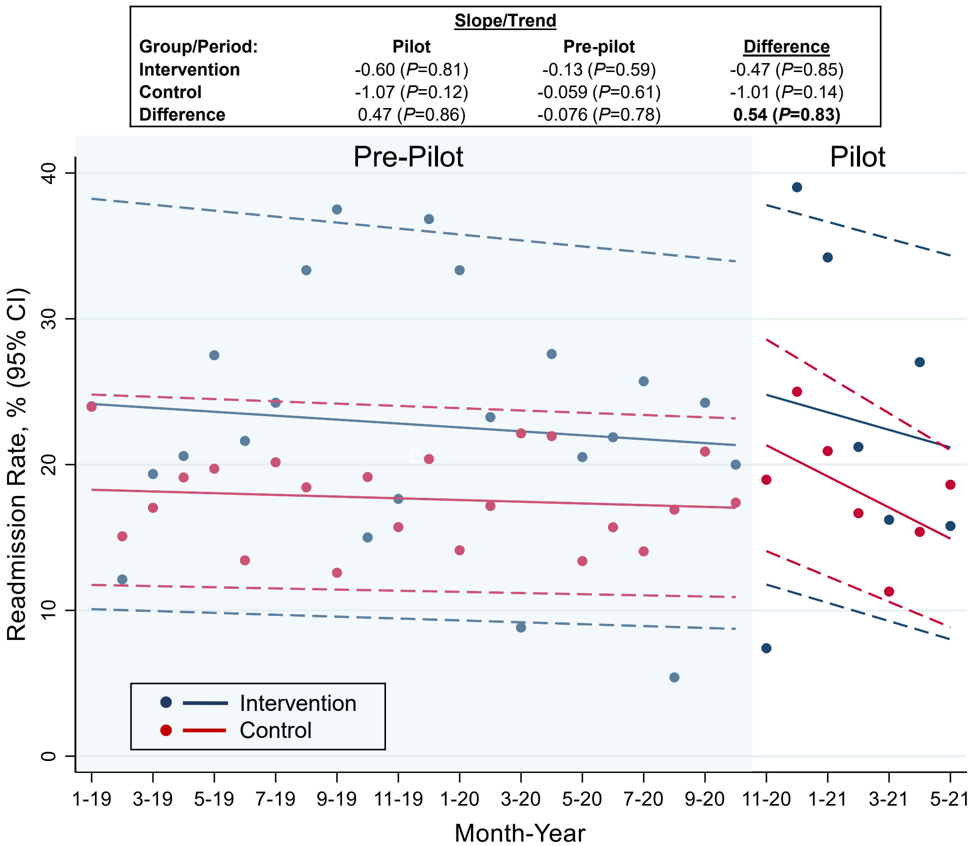


Figure 2. Interrupted time series of crude monthly readmission rates for index admissions occurring January 1, 2019 to May 31, 2021, comparing intervention and control facilities, with introduction of the DialysisConnect pilot on November 1, 2021. Solid lines, fitted slopes for the prepilot and pilot periods; dashed lines, upper and lower bounds of the 95% confidence interval. For admissions among intervention versus control patients, slopes in the prepilot period were −0.13 (P = 0.59) versus −0.059 (P = 0.61); the difference in slopes in the prepilot period was −0.076 (P = 0.78). The "jump" at the start of the pilot was 5.88 (P = 0.09). Slopes were −0.60 (P = 0.81) and −1.07 (P = 0.12) for intervention versus control in the pilot period; the difference in slopes in the pilot period was 0.47 (P = 0.86). For other dialysis patients the pilot versus prepilot difference in slopes was −1.01 (P = 0.14); for intervention admissions, this difference was −0.47 (P = 0.85). The difference-in-difference estimate for intervention versus control, pilot versus prepilot was 0.54 (P = 0.83). CI, confidence interval.

Table 3. Adjusted Difference-in-Difference Results Comparing Differences Between Prepilot and Pilot Outcomes: Intervention versus Control Facilities

	Mean[a] (95% CI)		
Outcome	Pilot Period	Prepilot Period	Difference
Primary:			
% followed by 30-d readmission			
Intervention	13.8 (8.9-18.7)	12.3 (8.8-15.9)	1.4 (−3.5 to 6.4)
Control	12.8 (10.1-15.4)	10.9 (9.2-2.7)	1.8 (−0.9 to 4.6)
Difference	1.0 (−4.5 to 6.5)	1.4 (−2.4 to 5.2)	−0.4 (−6.0 to 5.3)
Secondary:			
% followed by 30-d readmission, observation stay, or ED visit			
Intervention	24.8 (19.0-30.6)	25.8 (21.8-30.0)	−1.1 (−7.0 to 4.9)
Control	22.8 (19.7-25.9)	20.7 (18.7-22.7)	2.0 (−1.2 to 5.3)
Difference	2.0 (−4.5 to 8.5)	5.1 (0.7-9.6)	−3.1 (−9.9 to 3.6)
% followed by 30-d readmission or observation stay			
Intervention	19.4 (14.0-24.8)	18.7 (14.8-22.6)	0.7 (−4.8 to 6.1)
Control	17.0 (14.1-19.9)	16.2 (14.3-18.1)	0.8 (−2.2 to 3.8)
Difference	2.4 (−3.6 to 8.4)	2.5 (−1.7 to 6.7)	−0.1 (−6.3 to 6.1)
% followed by 30-d observation stay or ED visit			
Intervention	13.8 (9.3-18.3)	17.1 (14.3-19.9)	−3.4 (−8.4 to 1.6)
Control	12.0 (9.6-14.4)	11.9 (10.6-13.3)	0.1 (−2.5 to 2.7)
Difference	1.7 (−3.4 to 6.8)	5.2 (2.1-8.3)	−3.5 (−9.1 to 2.2)
% followed by 30-d observation stay			
Intervention	6.6 (3.3-10.1)	8.5 (6.5-10.6)	−1.9 (−5.6 to 1.9)
Control	5.4 (3.7-7.2)	6.5 (5.6-7.6)	−1.1 (−3.1 to 0.9)
Difference	1.2 (−2.6 to 5.1)	2.0 (−0.3 to 4.3)	−0.7 (−5.0 to 3.5)
% followed by 30-d ED visit			
Intervention	7.7 (4.5-10.9)	9.0 (7.1-10.8)	−1.2 (−4.9 to 2.4)
Control	6.9 (5.2-8.6)	5.8 (4.8-6.7)	1.2 (−0.7 to 3.1)
Difference	0.8 (−2.8 to 4.4)	3.2 (1.1-5.3)	−2.4 (−6.5 to 1.7)
Hospital length of stay, d			
Intervention	6.8 (5.6-7.9)	6.4 (5.7-7.1)	0.4 (−0.9 to 1.7)
Control	8.9 (8.3-9.5)	7.7 (7.3-8.0)	1.2 (0.6-1.9)
Difference	−2.1 (−3.4 to −0.8)	−1.3 (−2.1 to −0.5)	−0.8 (−2.3 to 0.6)

Abbreviation: CI, confidence interval; ED, emergency department.
[a]Adjusted for age, sex, race (Black vs other), and Charlson comorbidity index. In some cases, difference estimates do not reflect the difference of the estimated means displayed, due to rounding error.

The results of our pilot study of DialysisConnect may simply reflect that it is not effective as a stand-alone intervention in reducing readmissions or improving other hospital outcomes. However, we believe that there are several other possible explanations for our results. Although the ability to communicate and receive timely, critical information is a necessary component to successful care transitions across hospital and dialysis facility settings,[12] it may not be sufficient to improve outcomes to an extent that is detectable within the limitations of our pilot. For example, Hoyer et al[17] found that every additional 3 days to complete the discharge summary was associated with only 1% higher odds of all-payer readmissions in Maryland. However, even small changes, if real, could be significant in terms of better reimbursement and less system strain.

Furthermore, most care transitions programs are multicomponent, including elements of patient activation and care transition coaching in addition to communications tools.[24,25] Specifically in the setting of dialysis, Wingard et al,[26] in a nonrandomized trial of 26 intervention and 18 control dialysis facilities in the Ohio River Valley, delivered a multicomponent, phased intervention (Right TraC) that included not only information exchange (via reports and discharge summaries, using a call center) but also care transition coaches (registered nurses) who reviewed discharge instructions individually with discharged patients. The readmissions rate using this method was reduced over 2 years at the intervention clinics (from 0.88-0.66 per patient-year; although the difference-in-difference was not statistically significant, given that readmissions also declined in the control facilities [0.73-0.61 per patient-year]). Thus, DialysisConnect may be more effective as a single component of an intervention that includes dedicated care transition coaches, as has been shown for the general population.[27] However, fewer than half of the patients receiving dialysis in the Right TraC study were successfully contacted within 30 days of discharge,[26] suggesting this approach will be uniquely challenging for this population.

Potential effect modification may have partially driven the overall null results as well. We found an increase in readmissions and decrease in observation stays among index admissions associated with high utilizer status versus other admissions (which showed the opposite pattern) for the pilot versus prepilot period, suggesting that interventions like DialysisConnect may need to be tailored to address the specific needs of high utilizers to reduce hospital readmissions. Explorations of other potential effect modifiers by other variables, such as race or socioeconomic status, were limited by the smaller sample sizes and lack of variation in our pilot, or by lack of reliable data in our available sources.

There are other factors related to study design and timing that may have resulted in our nonstatistically significant results. The pre-post study design used here is quasi-experimental. Even with control of secular trends via difference-in-difference analyses and control of potential confounding by patient characteristics across time periods and settings, it is possible that there are unmeasured confounding factors, such as dialysis facility policies and practices, that drive our results. Although our study period included a large number of index admissions, particularly in the prepilot comparison period, the length of the pilot, which was limited by the funding period, was only 7 months. Although the changes in practice and workflow required to use DialysisConnect were minimal, it is likely that changing provider behavior—and seeing subsequent changes in outcomes related to changes in provider behavior—require more time to overcome barriers to behavioral change, such as organizational culture, leadership commitment, and motivation.[28] A longer pilot period would have provided a greater opportunity to improve provider uptake of the system, potentially reducing readmissions further as well as providing more statistical power to detect smaller changes.

Additionally, the timing of the pilot, which was necessary because of funding period limitations, coincided with the COVID-19 pandemic. As a tertiary referral care center with COVID-19 expertise, EUHM has intermittently experienced high overall patient volumes during the pandemic, which likely had substantial effects on hospitalization patterns among patients receiving dialysis. Our sensitivity analyses including a "prepilot/COVID-19 period" showed that readmissions were substantially lower among Emory Dialysis patients at the start of the pandemic but had returned to prepandemic levels by the start of our pilot, complicating our comparison period. These temporal patterns may also be driven seasonally, irrespective of the pandemic. Additionally, regional COVID-19 transmission, and associated hospitalizations among patients receiving dialysis, peaked at the start of 2021[29] in the middle of our pilot. However, similar results in sensitivity analyses excluding COVID-19-related hospitalizations, as well as excluding vascular access-related hospitalizations (which may have been avoided during peak transmission), suggest that this effect may have been minimal.

Finally, there are site-specific factors that may have contributed to our results. Emory Dialysis facilities operate under different management and use a different EHR than EUHM, mirroring the situation of most community dialysis facility–hospital dyads. However, many of the nephrologists who treat patients at Emory Dialysis also attend at EUHM, contributing to continuity of care that might be lacking elsewhere. Additionally, some Emory Dialysis personnel (eg, advanced practice providers) also have access to the EUHM EHR, providing a means to exchange information, albeit in a far less timely manner than via DialysisConnect. These advantages may result in lower baseline readmission rates (and improved postdischarge outcomes generally), which would be harder to improve with an intervention.

In fact, we found that baseline readmission rates at EUHM, though higher among Emory Dialysis versus other dialysis patients (23% vs 18%), were quite low, compared with the national average of 31%.[1] These low rates are likely at least partially because of ongoing quality improvement initiatives aimed at patients receiving dialysis, including "Fast Track Dialysis," a triage pathway for lower-risk patients presenting to the ED requiring urgent hemodialysis.[20] Thus, the extent to which any intervention, including DialysisConnect, could improve readmissions at our site may be minimal. Because of this issue, our conclusions in this single-institution study are quite limited in their generalizability to other settings. A multisite rollout of DialysisConnect, or similar interventions aimed at improving care coordination between hospitals and dialysis facilities, could provide quite different results. Particularly, sites where baseline readmissions rates were, on average, closer to the national rate and there was sufficient variation in baseline rates across sites would allow greater room for improvement and provide a better estimate of the intervention's effect.

Other limitations not noted above deserve mention. Fidelity to the intervention was suboptimal; although most hospital admissions were captured in the system, the number of users engaged with DialysisConnect was low, even among some of the most critical roles for care transitions (eg, dialysis nurses and social workers).[19] Most, but not all, inpatient care for Emory Dialysis patients occurs at EUHM; we were not able to track inpatient admissions or other hospital utilization outside of EUHM, and this potential loss to follow-up may have been greater among other dialysis patients admitted to EUHM. Although, loss to follow-up because of mortality could lead to selection bias, sensitivity analyses showed that results were not substantially changed with the exclusion of discharges followed by mortality within 30 days. However, postdischarge mortality could only be captured among Emory Dialysis patients, and there may be differential postdischarge mortality rates among other dialysis patients. Similarly, we were limited to patient characteristic data available at the hospital level, given that we did not have access to the EHRs of other regional dialysis facilities, adding to the potential for residual confounding. Misclassification of some of the study variables, particularly related to hospital billing codes, is also possible. Finally, as mentioned above, our power to detect small changes was limited, leading to wide confidence intervals for our difference and difference-in-difference estimates and reduced ability to draw conclusions about estimates.

In this pilot, the introduction of a web-based provider communications platform, DialysisConnect, was generally not statistically significantly associated with reduced readmissions or improved hospital outcomes. However, the development of new approaches to close gaps in the fragmented US health care system remains critical to improving care coordination and, ultimately, outcomes, for this vulnerable population. Future multisite studies examining such solutions in larger, community-based dialysis populations, perhaps in concert with efforts to improve patient activation and with one-on-one transitional coaching, are needed to determine the utility of DialysisConnect and similar care coordination platforms.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Major features of the DialysisConnect platform.

Figure S2: Interrupted time series of crude monthly readmission rates for admissions intervention facilities from January 1, 2019 to May 31, 2021, with introduction of COVID pandemic on March 1, 2021 and the DialysisConnect pilot on November 1, 2021.

Figure S3: Interrupted time series of crude monthly readmission rates for admissions from January 1, 2019 to May 31, 2021, comparing intervention to control, with introduction of the COVID pandemic on March 1, 2021 and the DialysisConnect pilot on November 1, 2021.

Table S1: Characteristics of Index Inpatient Admissions to Emory University Hospital Midtown Among Patients Receiving Dialysis, by Intervention Status and Period, From January 1, 2019 to May 31, 2021.

Table S2: Difference in Admission-Level Outcomes Between the DialysisConnect Pre-Pilot/COVID (March 1, 2020-October 31, 2020) and Pilot (November 1, 2020-May 31, 2021) Periods and the Pre-Pilot/Pre-COVID Period (January 1, 2019-February 29, 2020): Intervention Facilities.

Table S3: Difference in Admission-Level Outcomes Between the DialysisConnect Pilot Period (November 1, 2020-May 31, 2021) and the Pre-Pilot Period (January 1, 2019-October 31, 2020): Intervention Facilities, Not Accounting for Within-Person Correlation and Excluding COVID-19- and Vascular Access-Related Admissions and Admissions Followed by Death Within 30 Days.

Table S4: Difference-in-Difference in Admission-Level Outcomes Between the DialysisConnect Pilot Period (November 1, 2020-May 31, 2021) and the Pre-Pilot Period (January 1, 2019-October 31, 2020): Intervention Facilities, by High Utilizer Status.

Table S5: Adjusted Difference-in-Difference Results Comparing Differences in Outcomes Between Pilot Period (November 1, 2020-May 31, 2021), Pre-Pilot/COVID (March 1, 2020-October 31, 2020), and Pre-Pilot/Pre-COVID (January 1, 2019-February 29, 2020): Intervention vs Control Facilities.

Table S6: Adjusted Difference-in-Difference Results Comparing Differences Between Pilot and Pre-Pilot Outcomes: Intervention vs Control Facilities, Ignoring Within-Person Correlation.

Table S7: Adjusted Difference-in-Difference Results Comparing Differences Between Pilot and Pre-Pilot Outcomes: Intervention Facilities, by Whether Index Admission Was Captured in DialysisConnect.

Table S8: Adjusted Difference-in-Difference Results Comparing Differences Between Pilot and Pre-Pilot Outcomes: Intervention vs Control Facilities, Excluding COVID-19-Related Hospitalizations.

ARTICLE INFORMATION

Authors' Full Names and Academic Degrees: Laura C. Plantinga, PhD, ScM, Anjali Khakharia, MS, Courtney Hoge, MSPH, Ann E. Vandenberg, PhD, MPH, Janice P. Lea, MD, MSCR, Tahsin Masud, MD, Carol Gray, DNP, MSN, Christopher M. O'Donnell, MD, Kyle James, MD, Rich Mutell, MBA, MA, and Bernard G. Jaar, MD, MPH.

Authors' Affiliations: Department of Medicine, Emory University School of Medicine, Atlanta, GA (LCP, AK, CH, AEV, JPL, TM, COD, KJ); Emory Healthcare, Atlanta, GA (CG); Apex Health Innovations, Williamsburg, VA (RM); Department of Medicine, Johns Hopkins School of Medicine, Baltimore, MD (BGJ); Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD (BGJ); Nephrology Center of Maryland, Baltimore, MD (BGJ); and Welch Center for Prevention, Epidemiology, and Clinical Research, Baltimore, MD (BGJ).

Address for Correspondence: Laura Plantinga, PhD, Wesley Wood Health Center, 1841 Clifton Road NE, Room 552, Atlanta, GA 30329. Email: laura.plantinga@emory.edu

Authors' Contributions: DialysisConnect idea conception: LCP, BGJ, CMO, RM; funding acquisition: LCP; DialysisConnect development and maintenance: RM; mentorship and supervision: BGJ; project management: CH; advisor: AEV; site champion: JPL, TM, CMO, KJ, CG; data analysis and interpretation: LCP, AK. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

Support: Research reported in this publication was supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health under Award Number R18DK118467. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The funder had no role in the study design; collection, analysis, or interpretation of data; or the decision to submit the report for publication.

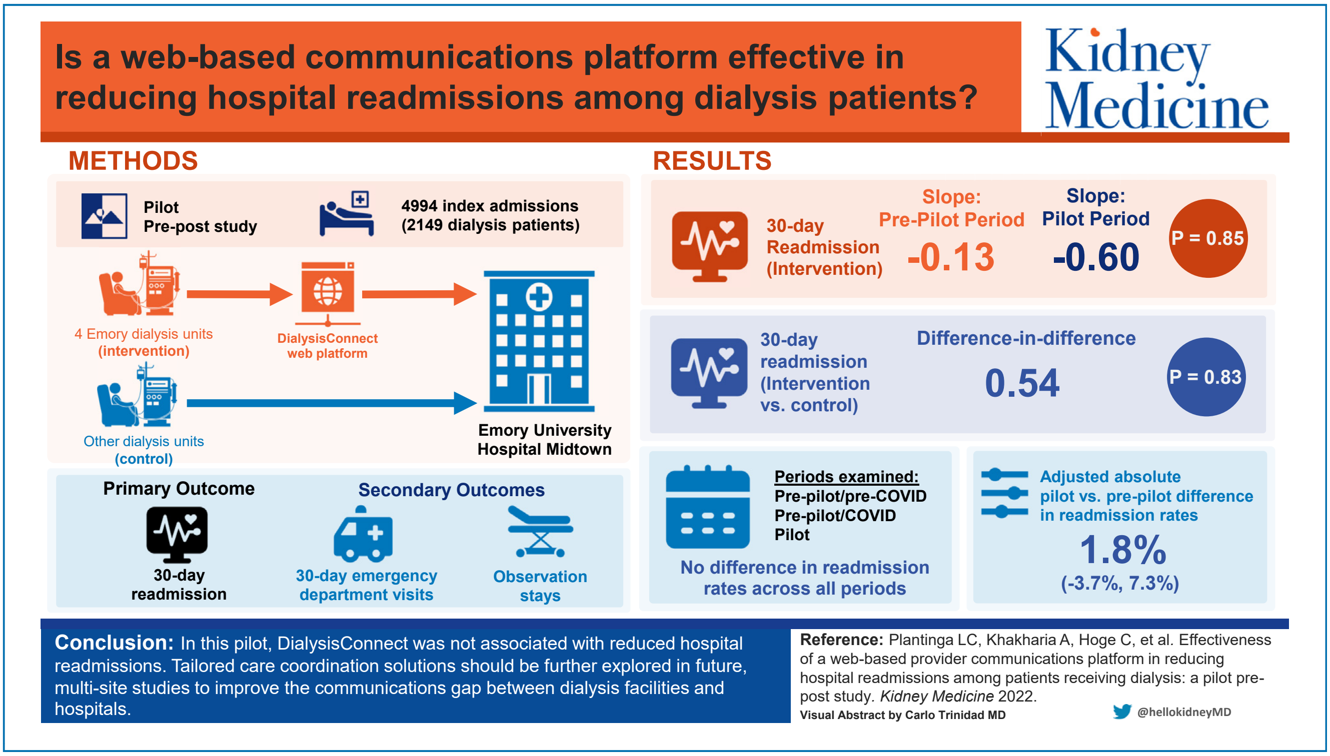
Financial Disclosure: Author Mutell is the Chief Executive Officer of Apex Health Innovations, which provided the technical expertise to build DialysisConnect. DialysisConnect was not, and is not currently, a commercially available product. The remaining authors declare that they have no relevant financial interests.

Acknowledgements: We thank the providers and staff at Emory Dialysis and Emory University Hospital Midtown (EUHM) who facilitated this pilot, especially Carol Gray, Linda Turberville-Trujillo, Michelle Young, Kathy Oliver, Ifeoma Imonugo, and Kristy Hamilton; and the staff at Apex Health Innovations for developing DialysisConnect (Richard Dacre, Amber Webster, Alice Jordan, Alex Turnbull, John Scott) and facilitating information technology compliance (Charlie Bonar). We also thank José Navarrete for providing mortality data from the Emory EHR and Christian Park for performing the stratified high utilizer analyses.

Peer Review: Received February 2, 2022. Evaluated by 2 external peer reviewers, with direct editorial input by the Statistical Editor and the Editor-in-Chief. Accepted in revised form May 22, 2022.

REFERENCES

1. US Renal Data System. *USRDS 2021 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda, MA: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2021. Accessed January 15, 2022. https://adr.usrds.org/2021
2. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360(14):1418-1428.
3. Adisa O, Jaar BG, Masud T, et al. Association of social worker-assessed psychosocial factors with 30-day hospital readmissions among hemodialysis patients. *BMC Nephrol*. 2018;19(1):360.
4. Plantinga LC, Masud T, Lea JP, Burkart JM, O'Donnell CM, Jaar BG. Post-hospitalization dialysis facility processes of care and hospital readmissions among hemodialysis patients: a retrospective cohort study. *BMC Nephrol*. 2018;19(1):186.
5. Hickson LJ, Thorsteinsdottir B, Ramar P, et al. Hospital readmission among new dialysis patients associated with young age and poor functional status. *Nephron*. 2018;139(1):1-12.
6. Chan L, Chauhan K, Poojary P, et al. National estimates of 30-day unplanned readmissions of patients on maintenance hemodialysis. *Clin J Am Soc Nephrol*. 2017;12(10):1652-1662.
7. Ross KH, Jaar BG, Lea JP, Masud T, Patzer RE, Plantinga LC. Long-term outcomes among Medicare patients readmitted in the first year of hemodialysis: a retrospective cohort study. *BMC Nephrol*. 2019;20(1):285.
8. Plantinga LC, King L, Patzer RE, et al. Early hospital readmission among hemodialysis patients in the United States is associated with subsequent mortality. *Kidney Int*. 2017;92(4):934-941.
9. Centers for Medicare & Medicaid Services. Hospital readmissions reduction program. 42 CFR Part 412 (§412.150 through §412.154); 2012. Accessed December 15, 2021. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program
10. Centers for Medicare & Medicaid Services (CMS). HHS. Medicare program; end-stage renal disease prospective payment system, quality incentive program, and durable medical equipment, prosthetics, orthotics, and supplies: final rule. *Fed Regist*. 2014;79(215):66119-66265.
11. Patient Protection and Affordable Care Act of 2010, 42 USC §18001. Accessed January 12, 2022. https://www.govinfo.gov/content/pkg/PLAW-111publ148/pdf/PLAW-111publ148.pdf
12. Kelly YP, Kuperman GJ, Steele DJR, Mendu ML. Interoperability and patient electronic health record accessibility: opportunities to improve care delivery for dialysis patients. *Am J Kidney Dis*. 2020;76(3):427-430.
13. Plantinga LC, Jaar BG. Preventing repeat hospitalizations in dialysis patients: a call for action. *Kidney Int*. 2009;76(3):249-251.
14. Hakim RM, Collins AJ. Reducing avoidable rehospitalization in ESRD: a shared accountability. *J Am Soc Nephrol*. 2014;25(9):1891-1893.
15. Wish JB. The role of 30-day readmission as a measure of quality. *Clin J Am Soc Nephrol*. 2014;9(3):440-442.
16. Flythe JE, Katsanos SL, Hu Y, Kshirsagar AV, Falk RJ, Moore CR. Predictors of 30-day hospital readmission among maintenance hemodialysis patients: a hospital's perspective. *Clin J Am Soc Nephrol*. 2016;11(6):1005-1014.
17. Hoyer EH, Odonkor CA, Bhatia SN, Leung C, Deutschendorf A, Brotman DJ. Association between days to complete inpatient discharge summaries with all-payer hospital readmissions in Maryland. *J Hosp Med*. 2016;11(6):393-400.
18. McPherson L, Mutell R, Broughton P, et al. Enhancing coordination across healthcare settings through a web-based Transplant Referral Exchange (T-REX) platform [Abstract]. *Am J Transplant*. 2017;17(suppl 3). Accessed November 15, 2021. https://atcmeetingabstracts.com/abstract/enhancing-coordination-across-healthcare-settings-through-a-web-based-transplant-referral-exchange-t-rex-platform/
19. Plantinga LC, Hoge C, Vandenberg AE, et al. A web-based, provider-driven mobile app to enhance patient care coordination between dialysis facilities and hospitals: development and pilot implementation study. *JMIR Form Res*. 2022;6(6):e36052.
20. O'Donnell C, Molitch-Hou E, James K, et al. Fast track dialysis: improving emergency department and hospital throughput for patients requiring hemodialysis. *Am J Emerg Med*. 2021;45:92-99.
21. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005;43(11):1130-1139.
22. Sundararajan V, Quan H, Halfon P, et al. Cross-national comparative performance of three versions of the ICD-10 Charlson index. *Med Care*. 2007;45(12):1210-1215.
23. Linden A, Adams JL. Applying a propensity score-based weighting model to interrupted time series data: improving causal inference in programme evaluation. *J Eval Clin Pract*. 2011;17(6):1231-1238.
24. Coleman EA, Parry C, Chalmers S, Min SJ. The care transitions intervention: results of a randomized controlled trial. *Arch Intern Med*. 2006;166(17):1822-1828.
25. Enderlin CA, McLeskey N, Rooker JL, et al. Review of current conceptual models and frameworks to guide transitions of care in older adults. *Geriatr Nurs*. 2013;34(1):47-52.
26. Wingard RL, McDougall K, Axley B, et al. Right TraC™ post-hospitalization care transitions program to reduce readmissions for hemodialysis patients. *Am J Nephrol*. 2017;45(6):532-539.
27. Branowicki PM, Vessey JA, Graham DA, et al. Meta-analysis of clinical trials that evaluate the effectiveness of hospital-initiated postdischarge interventions on hospital readmission. *J Healthc Qual*. 2017;39(6):354-366.
28. Cretin S, Farley DO, Dolter KJ, Nicholas W. Evaluating an integrated approach to clinical quality improvement: clinical guidelines, quality measurement, and supportive system design. *Med Care*. 2001;39(8)(suppl 2):II70-II84.
29. Georgia Department of Public Health. Daily status report: Georgia COVID-19 daily status of cases and hospitalizations with interactive charts and graphs. Atlanta, GA. 2022. Accessed January 15, 2022. https://dph.georgia.gov/covid-19-daily-status-report


Is a web-based communications platform effective in reducing hospital readmissions among dialysis patients?
Kidney Medicine
METHODS
Pilot
Pre-post study
4994 index admissions
(2149 dialysis patients)
4 Emory dialysis units
(intervention)
DialysisConnect
web platform
Other dialysis units
(control)
Emory University
Hospital Midtown
Primary Outcome
30-day
readmission
Secondary Outcomes
30-day emergency
department visits
Observation
stays
RESULTS
30-day
Readmission
(Intervention)
Slope:
Pre-Pilot Period
-0.13
Slope:
Pilot Period
-0.60
P = 0.85
30-day
readmission
(Intervention
vs. control)
Difference-in-difference
0.54
P = 0.83
Periods examined:
Pre-pilot/pre-COVID
Pre-pilot/COVID
Pilot
No difference in readmission
rates across all periods
Adjusted absolute
pilot vs. pre-pilot difference
in readmission rates
1.8%
(-3.7%, 7.3%)
Conclusion: In this pilot, DialysisConnect was not associated with reduced hospital readmissions. Tailored care coordination solutions should be further explored in future, multi-site studies to improve the communications gap between dialysis facilities and hospitals.
Reference: Plantinga LC, Khakharia A, Hoge C, et al. Effectiveness of a web-based provider communications platform in reducing hospital readmissions among patients receiving dialysis: a pilot pre-post study. Kidney Medicine 2022.
Visual Abstract by Carlo Trinidad MD
@hellokidneyMD