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Association of Scheduled vs Emergency-Only Dialysis With Health Outcomes and Costs in Undocumented Immigrants With End-stage Renal Disease

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IMPORTANCE In 40 of 50 US states, scheduled dialysis is withheld from undocumented immigrants with end-stage renal disease (ESRD); instead, they receive intermittent emergency-only dialysis to treat life-threatening manifestations of ESRD. However, the comparative effectiveness of scheduled dialysis vs emergency-only dialysis and the influence of treatment on health outcomes, utilization, and costs is uncertain.

OBJECTIVE To compare the effectiveness of scheduled vs emergency-only dialysis with regard to health outcomes, utilization, and costs in undocumented immigrants with ESRD.

DESIGN, SETTING, AND PARTICIPANTS Observational cohort study of 181 eligible adults with ESRD receiving emergency-only dialysis in Dallas, Texas, who became newly eligible and applied for private commercial health insurance in February 2015; 105 received coverage and were enrolled in scheduled dialysis; 76 were not enrolled in insurance for nonclinical reasons (eg, lack of capacity at a participating outpatient dialysis center) and remained uninsured, receiving emergency-only dialysis. We examined data on eligible persons during a 6-month period prior to enrollment (baseline period, August 1, 2014-January 31, 2015) until 12 months after enrollment (follow-up period, March 1, 2015-February 29, 2016), with an intervening 1-month washout period (February 2015). All participants were undocumented immigrants; self-reported data on immigration status was collected from Parkland Hospital electronic health records.

EXPOSURES Enrollment in private health insurance coverage and scheduled dialysis.

MAIN OUTCOMES AND MEASURES We used enrollment in health insurance and scheduled dialysis to estimate the influence of scheduled dialysis on 1-year mortality, utilization, and health care costs, using a propensity score–adjusted, intention-to-treat approach, including time-to-event analyses for mortality, difference-in-differences (DiD) negative binomial regression analyses for utilization, and DiD gamma generalized linear regression for health care costs.

RESULTS Of 181 eligible adults with ESRD, 105 (65 men, 40 women; mean age, 45 years) received scheduled dialysis and 76 (38 men, 38 women; mean age, 52 years) received emergency-only dialysis. Compared with emergency-only dialysis, scheduled dialysis was significantly associated with reduced mortality (3% vs 17%, $P = .001$; absolute risk reduction, 14%; number needed to treat, 7; adjusted hazard ratio, 4.6; 95% CI, 1.2-18.2; $P = .03$), adjusted emergency department visits (−5.2 vs +1.1 visits/mo; DiD, −6.2; $P < .001$), adjusted hospitalizations (−2.1 vs −0.5 hospitalizations/6 months; DiD, −1.6; $P < .001$), adjusted hospital days (−9.2 vs +0.8 days/6 months; DiD, −9.9; $P = .007$), and adjusted costs (−$4316 vs +$1452 per person per month; DiD, −$5768; $P < .001$).

CONCLUSIONS AND RELEVANCE In this study, scheduled dialysis was significantly associated with reduced 1-year mortality, health care utilization, and costs compared with emergency-only dialysis. Scheduled dialysis should be the universal standard of care for all individuals with ESRD in the United States.

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Invited Commentary
Supplemental content

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Scheduled, thrice-weekly hemodialysis is an effective, evidence-based treatment for prolonging and improving quality of life and is the standard of care for end-stage renal disease (ESRD).[1,2] However, despite nearly universal coverage for scheduled dialysis in the United States via Medicare and Medicaid, not all individuals with ESRD in the United States receive this care.[3,4] In 40 of 50 US states, uninsured individuals with ESRD who are ineligible for federal assistance, namely undocumented immigrants, receive emergency-only dialysis—that is, dialysis that is intermittent and given in the emergency department (ED) only when imminently life-threatening indications are present as a result of withholding needed scheduled dialysis (severe metabolic acidosis; hyperkalemia with impending fatal arrhythmia; uremia with altered sensorium; or severe volume overload with hypoxia).[4,5] Individuals receive enough dialysis such that they are no longer on the precipice of death, as mandated under the 1986 Emergency Medical Treatment and Labor Act, and are instructed to return to the ED when symptoms indicating the need for dialysis again arise.[6-9]

Though often called compassionate dialysis, emergency-only dialysis is associated with lower quality of life and physical stress for patients, as well as substantial psychosocial stress for both patients and clinicians compared with scheduled hemodialysis.[1,8,10-13] Limited data from small, nonrandomized studies suggest correspondingly worse health outcomes, increased health care use, and higher costs associated with emergency-only dialysis.[10,14] Nonetheless, this treatment persists in part because providing scheduled dialysis to undocumented immigrants is perceived to be more expensive. However, robust data on the comparative effectiveness and costs of scheduled vs emergency-only dialysis are lacking.[4,5] A recent observational study found a higher hazard of mortality that only became evident after 3 years of follow-up among undocumented immigrants receiving emergency-only dialysis compared with scheduled dialysis.[15] Additionally, this study was limited by a lack of randomization; considerable heterogeneity in populations and care strategies, with the emergency-only and scheduled dialysis groups from different states; and a lack of data on health care costs. A randomized clinical trial on this topic would be unlikely because withholding scheduled dialysis from experimental participants with ESRD would be unethical under federal and international scientific standards for human subject research.[16,17]

To address these limitations, we took advantage of a unique opportunity. In 2014, uninsured individuals with ESRD receiving emergency-only dialysis in Dallas, Texas became eligible to purchase off-exchange, private, commercial health insurance plans owing in part to the universal ban on preexisting condition exclusions under the Affordable Care Act.[18] Charitable premium assistance for dialysis-related care through nonprofit organizations, with direct reimbursement to insurance companies from nonprofits for plan premiums and copayments, made it financially feasible for individuals to enroll in off-exchange, private, health insurance coverage and transition to scheduled dialysis.[19,20] Over half of those who applied were enrolled, received insurance coverage (which was contingent on simultaneously being accepted for placement at a participating outpatient dialysis center), and initiated scheduled dialysis. The remaining patients who did not receive insurance coverage as a result of limited capacity or lack of proximity to a participating dialysis center (rather than for clinical or patient-related reasons) continued to receive emergency-only dialysis. This differential enrollment allowed us to assess the comparative effectiveness of scheduled vs emergency-only dialysis with regard to mortality, health care utilization, and costs among undocumented immigrants with ESRD.

Key Points

Question What is the association of scheduled vs emergency-only hemodialysis with health care outcomes and costs in undocumented immigrants with end-stage renal disease?

Findings In this cohort study of 181 adults, individuals receiving scheduled vs emergency-only dialysis had a 1-year mortality rate of 3% vs 17%, 6 fewer emergency department visits per month, 1.5 fewer hospitalizations, 10 fewer hospital days per 6 months, and incurred $5768 less in health care costs per month.

Meaning Compared with emergency-only dialysis, scheduled dialysis was associated with reduced mortality, health care utilization, and costs during a 1-year follow-up period and should be the universal standard of care for all individuals with end-stage renal disease in the United States.

Methods

Study Setting

Parkland Hospital (hereafter referred to as Parkland) is among the 5 largest safety-net hospitals in the United States, and Texas has the second-largest state population of undocumented immigrants in the country.[21,22] As the only safety-net hospital in Dallas County, Parkland is the de facto medical home for individuals in Dallas with ESRD who lack access to scheduled dialysis. Care for uninsured individuals with ESRD at Parkland is restricted to emergency-only dialysis; individuals typically receive 1 hemodialysis session via a tunneled central venous catheter on presentation to the ED with imminently life-threatening manifestations of untreated ESRD.[15,23] The institutional review board at University of Texas Southwestern approved this study. Because this is a retrospective observational study of existing data, patient written informed consent was not required.

Intervention

We included uninsured adults 18 years old or older with ESRD who were receiving emergency-only dialysis at Parkland in February 2015. They consecutively applied (with social worker assistance) for an off-exchange, private health insurance plan with coverage for scheduled dialysis during a 2-week enrollment period from February 1 to February 15, 2015 (the end of 2014-2015 open enrollment). Receipt of charitable premium assistance (and therefore receipt of insurance and enrollment in scheduled dialysis) was contingent on being accepted for placement at an outpatient dialysis center. The individuals who were denied placement were denied owing to

the lack of availability at an individual's center of choice or the selected center's uncertainty about likelihood of insurance coverage rather than individual characteristics such as comorbidities or incomplete paperwork. Dialysis center placement occurred on a first-come-first-served basis. Consequently, individuals who presented more frequently for emergency-only dialysis (because they were more likely to be first in line in the referral process) and those who selected dialysis centers with immediate availability may have been more likely to be accepted for placement, though individuals were unaware the program existed until approached by a Parkland social worker, and dialysis center availability was unknown at the time of application.

Individuals who were accepted for dialysis center placement received charitable premium assistance and private health insurance coverage, and started scheduled dialysis by March 2015. Those declined by a dialysis center remained uninsured and continued to receive emergency-only dialysis because they were unable to afford premiums and copayments for the insurance plans without charitable premium assistance. We used these initial group assignments for our intention-to-treat analyses for outcomes at 12 months of follow-up.

Notably, most individuals remaining in the emergency-only group subsequently enrolled into scheduled dialysis during a second enrollment period from November 1, 2015, to January 31, 2016 (55 of 60 individuals).

Data Sources, Timeline, and Outcomes

We used multiple data sources, including Parkland electronic health records (EHR), ED and hospital claims from 80 hospitals within 100 miles of Dallas from a comprehensive regional all-payer claims database (North Texas Health Information and Quality Collaborative), and data manually abstracted from medical records from 30 participating dialysis centers. Self-reported data on undocumented status was obtained from the Parkland EHR. Although being an undocumented immigrant was not specifically a criterion for inclusion or exclusion in the study, permanent residents and citizens of the United States with ESRD typically qualify for coverage for dialysis services through eligibility for Medicare or Medicaid and rarely would be recipients of emergency-only dialysis.

We examined data on all eligible individuals during a 6-month period prior to enrollment (baseline period, August 1, 2014-January 31, 2015) until 12 months after enrollment (follow-up period, March 1, 2015-February 29, 2016), with an intervening 1-month washout period (February 2015).

We ascertained demographics, comorbidities, laboratory data, dialysis vintage (defined as the time since starting emergency-only dialysis), and vascular access on enrollment and at the end of follow-up obtained from dialysis center records and the EHR.

The primary outcomes were death and health care utilization (ED visits, hospitalizations, and hospital days). We ascertained death from the EHR, regional claims database, dialysis center records, and the Texas Vital Statistics database. We ascertained ED visits and hospitalizations from the EHR and regional claims database.

The secondary outcome was the total cost of care per person per month (PPPM) across 4 major expense categories, which was calculated using average Medicare reimbursement rates for the following billed services: (1) ED visits; (2) hospitalizations[24] and observation visits[25]; (3) scheduled hemodialysis,[26,27] assuming 3 visits per week in the scheduled group; and (4) vascular access placement and complications. An imputed range of potential complication rates was based on data from previous studies[28,29] because complications are frequently treated in outpatient settings and were not captured in our data. Our approach to cost analyses is detailed in the eMethods and eTable 1 in the Supplement.

Statistical Analysis

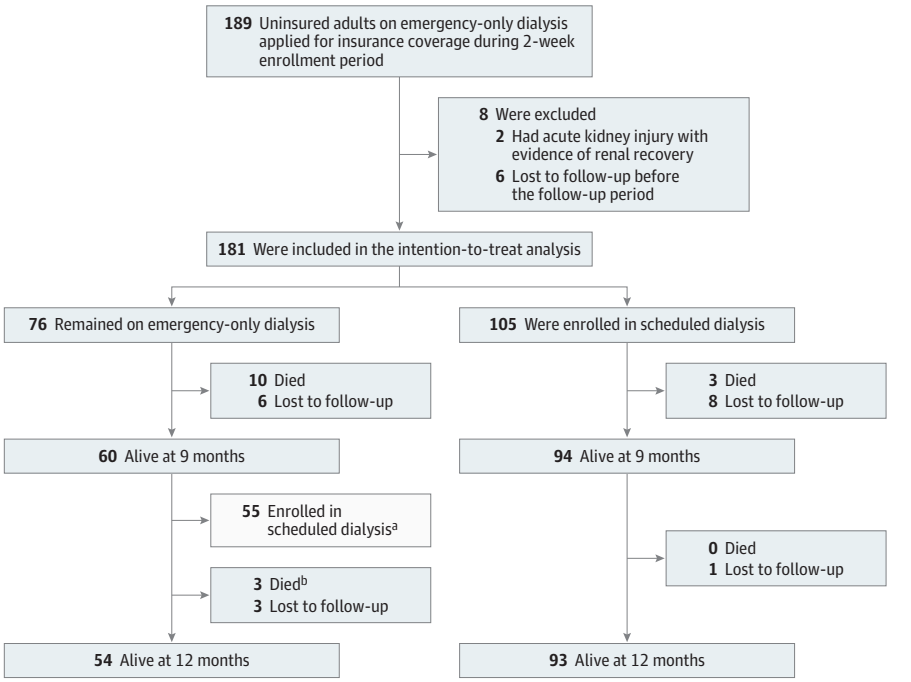
We compared outcomes between groups using an intention-to-treat analytic approach. We compared mortality using Kaplan-Meier survival curves and Cox proportional hazards regression, adjusting for the propensity of enrollment in scheduled dialysis. Propensity scores were estimated using a logistic regression model adjusted for age, sex, dialysis vintage, baseline ED visits, baseline hospital days, vascular access type, and serum albumin at enrollment (C statistic, 0.79). We assessed the functional form of all continuous predictors and the propensity score and found no departures from linearity (eTable 2 and eFigure in the Supplement).

To determine health care utilization, we conducted difference-in-differences (DiD) analyses using negative binomial regression to compare ED visits, hospitalizations, and hospital days of the scheduled and emergency-only dialysis groups during the 6-month baseline and 12-month follow-up periods. In our models, we included time period (baseline vs follow-up), group (scheduled vs emergency-only dialysis), and the interaction between them as predictors, where the interaction term is the DiD term and the primary predictor of interest, adjusted for the propensity score. From the models, we estimated average incidence rates for ED visits per month, and hospitalizations and hospital days per 6 months.

To compare health care costs, we conducted DiD analyses using gamma generalized linear regression models with a log link function. To assess the temporal effect of receiving scheduled dialysis, we examined monthly ED visits, hospitalizations, and health care costs by group.

We conducted sensitivity analyses repeating comparisons for a truncated 9-month follow-up period because most noncensored individuals in the emergency-only group enrolled in scheduled dialysis during a second open enrollment period (55 of 60 individuals). Of the 5 patients who did not cross over, 1 declined placement owing to advanced dementia, 2 delayed placement until subsequent enrollment periods owing to dialysis center-related factors (distance and lack of availability), and 2 patients died during the second open enrollment before being assessed for eligibility (**Figure 1**). We also conducted a number of sensitivity analyses to assess the robustness of our propensity score adjustment, including modeling the propensity score as a restricted cubic spline, as inverse probability treatment weights (both natively and trimming large weights to the 99% value), and limiting analyses to propensity scores where there was overlap to avoid po-

Figure 1. Study Flow Diagram



Adults receiving emergency-only dialysis were consecutively referred to apply for private health insurance with coverage for scheduled dialysis services during a 2-week enrollment period.

[a] Individuals in the emergency-only group had the potential to enroll in scheduled dialysis during the second open enrollment from November 2015 to February 2016. For all analyses, these individuals were considered to be in the emergency-only group for the entirety of the follow-up period.

[b] Of the 3 individuals who died between 9 and 12 months of follow-up, 1 was enrolled in scheduled dialysis and died shortly after enrollment.

tential positivity violations. Our findings were materially the same (data not reported, available on request).

Results

Study Population

Of 181 individuals with ESRD receiving emergency-only dialysis, 105 enrolled in scheduled dialysis (65 men, 40 women; mean age, 45 years) and 76 (38 men, 38 women; mean age, 52 years) continued to receive emergency-only dialysis (Figure 1). Prior to enrollment, individuals in the scheduled group were slightly younger, presented more frequently for dialysis, and had a longer dialysis vintage compared with the emergency-only dialysis group (**Table 1**). Additionally, those in the scheduled group had biochemical abnormalities suggestive of more advanced kidney disease at baseline. Both groups had similarly low rates of long-term vascular access (15%-17%) and high rates of diabetes (70%), hypertension (92%), and ESRD-related complications. Most individuals had a medical record established at Parkland for 6 or more years prior to the study period, suggesting that they were long-standing Dallas residents. Median follow-up time for patients in both groups was 12 months. At the end of follow-up, three-quarters (73%) of the scheduled group and one-third of the emergency-only group (32%) received an arteriovenous fistula or graft.

Mortality

At 12 months, the overall unadjusted mortality rate was lower in the scheduled dialysis group than in the emergency-only dialysis group (3% vs 17%; $P = .001$), corresponding to an absolute risk reduction of 14% and a number needed to treat (NNT) of 7 (**Figure 2**). The adjusted hazard ratio (aHR) of death at 12 months was almost 5-fold higher among individuals remaining on emergency-only dialysis, with the 2 groups beginning to diverge at 3 months and continuing to separate at 1 year of follow-up (aHR, 4.6; 95% CI, 1.2-18.2).

Health Care Utilization

At baseline, individuals in the scheduled group had a slightly higher adjusted rate of ED visits per month, and a similar number of hospitalizations but fewer hospital days per 6 months than those in the emergency-only group (**Table 2**).

After enrollment, adjusted rates of ED visits, hospitalizations, and hospital days remained the same or slightly increased in the emergency-only dialysis group but were markedly reduced in the scheduled dialysis group, with 5.2 fewer ED visits per month ($P < .001$), 1.6 fewer hospitalizations per 6 months ($P < .001$), and 9.9 fewer hospital days per 6 months ($P = .007$) compared with the emergency-only group (Table 2). Principal diagnoses for hospitalizations are shown in eTable 3 in the Supplement.

Costs

At baseline, individuals in the scheduled group had adjusted worst-case scenario PPPM costs of $10 806 vs $8686 in the emergency-only group. After enrollment, costs in the scheduled group dropped by an average of $4316 PPPM while costs in the emergency-only group increased by an average of $1452 PPPM, for a net savings of $5768 PPPM for those enrolled in scheduled dialysis (95% CI, $3204 to $8332, Table 2). Cost savings from reductions in health care utilization exceeded increases from vascular access and scheduled dialysis (eTable 4 in the Supplement).

Table 1. Baseline Characteristics of the Study Population

Characteristic	Emergency-Only Dialysis (n = 76)	Scheduled Dialysis (n = 105)
Age, mean (SD), y	51.9 (15.7)	45.3 (12.0)
Female sex, %	50.0	40.0
Race or ethnic group, %		
White	0.0	1.0
Black	2.6	0.0
Hispanic	97.4	97.1
Months in health system prior to baseline period, median (IQR)	73 (19-172)	78 (29-160)
Dialysis characteristics		
Dialysis vintage, median (IQR), mo[a]	17 (6-29)	24 (11-38)
Frequency of dialysis per wk, median (IQR)	1.1 (0.8-1.5)	1.6 (1.1-2.0)
Vascular access type prior to enrollment, %		
Central venous catheter	85.5	82.9
Arteriovenous fistula or graft[b]	14.5	17.1
Charlson comorbidity index, median (IQR)	4 (3-4)	4 (3-4)
Key comorbidities, %		
Diabetes	69.7	69.5
Hypertension	92.1	92.4
Autoimmune illness	31.6	30.5
ESRD and emergency dialysis-related complications, %		
Central catheter-associated bloodstream infection	31.6	24.8
Endocarditis	11.8	10.5
Sepsis	18.4	21.9
Ascites requiring paracentesis	10.5	11.4
Laboratory measurements, median (IQR)		
Potassium, mEq/L	5.4 (4.8-6.1)	5.7 (5.0-6.2)
Bicarbonate, mEq/L	21 (18-25)	21 (19-24)
Blood urea nitrogen, mg/dL	91 (71-106)	84 (67-100)
Creatinine, mg/dL	10.6 (7.5-13.1)	11.9 (9.8-14.9)
eGFR, mL/min/1.73 m^2[c]	6 (4-9)	4 (3-6)
Calcium, mg/dL	8.5 (7.7-9.2)	8.6 (8.1-9.2)
Phosphorus, mg/dL	6.5 (5.1-7.8)	6.7 (5.5-8.2)
Hemoglobin, g/dL	9.5 (8.8-10.1)	9.3 (8.7-10.0)
Albumin, g/dL	3.5 (3.2-3.8)	3.8 (3.5-4.0)
Parathyroid hormone, pg/mL	446 (258-742)	575 (329-1002)

Abbreviations: eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; IQR, interquartile range.

SI conversion factors: To convert albumin g/dL to g/L, multiply by 10; to convert blood urea nitrogen mg/dL to mmol/L, multiply by 0.357; to convert calcium mg/dL to mmol/L, multiply by 0.25; to convert creatinine mg/dL to μmol/L, multiply by 88.4; to convert hemoglobin g/dL to g/L, multiply by 10; to convert parathyroid hormone pg/mL to ng/L, multiply by 0.1053; to convert phosphorus mg/dL to mmol/L, multiply by 0.323.

[a] Dialysis vintage refers to the total time since initiation of emergency-only dialysis prior to the start of baseline.

[b] In the emergency group, 4 individuals had an arteriovenous graft and 7 had an arteriovenous fistula prior to enrollment. In the scheduled group, 0 had a graft and 18 had a fistula prior to enrollment.

[c] Per values reported in electronic health record, estimated from the isotope dilution mass spectrometry traceable Modification of Diet in Renal Disease study equation.

Figure 2. Survival Rates in Scheduled vs Emergency-Only Dialysis

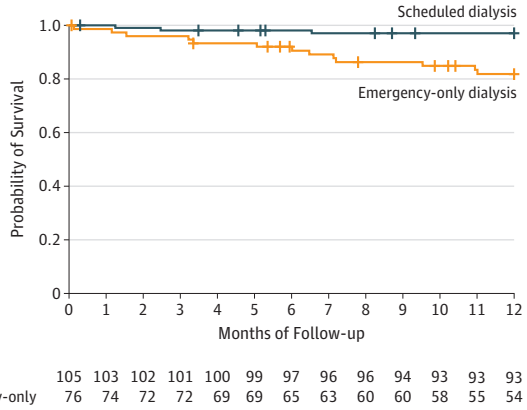


Figure shows the Kaplan-Meier estimates of overall survival during the 12-month follow-up period. Individuals were censored at death (n = 16) or loss to follow-up (n = 20). The overall unadjusted mortality rate was 3% in the scheduled dialysis group (n = 3) compared with 17% in the emergency-only dialysis group (n = 13; *P* = .001), corresponding to an estimated absolute risk reduction of 14% and number needed to treat of 7 at 12 months. The adjusted hazard ratio for death for emergency-only vs scheduled dialysis was 4.6 (95% CI, 1.2-18.2; *P* = .03) by log-rank test.

Sensitivity Analyses

With truncating follow-up at 9 months, we found a 5% to 10% greater magnitude of benefit for ED visits and costs in favor of scheduled dialysis (eTable 5 in the Supplement).

Monthly Trends in Utilization and Costs

Monthly health care utilization and costs precipitously declined in the scheduled dialysis group immediately following initial enrollment and in the emergency-only group after the second open enrollment period, during which 92% of remaining individuals enrolled in scheduled dialysis (**Figure 3**).

Discussion

In this study of scheduled vs emergency-only hemodialysis among individuals with ESRD, we found that scheduled dialysis was associated with improvement in survival, decreased acute care utilization, and decreased costs over 1 year. Few interventions in health care have as large an influence on meaningful patient health outcomes while simultaneously reducing costs. Our study provides compelling evidence to support the case for universal dialysis coverage for all individuals with ESRD.

We found that scheduled dialysis for individuals with ESRD was associated with survival. To put the magnitude of benefit into context (NNT of 7 to prevent 1 death at 1 year), the NNT for the mortality benefit of aspirin after an ST-segment elevation myocardial infarction—one of the most effective therapies in medicine—is 42.[30] Nonetheless, it is withheld from certain vulnerable populations, namely undocumented immigrants.

In 40 of 50 US states, the perceived but unsubstantiated financial costs of providing scheduled hemodialysis to un-

Table 2. Influence of Scheduled Dialysis on Health Care Utilization and Costs[a]

Outcome	Emergency-Only Dialysis (n = 76)			Scheduled Dialysis (n = 105)			Difference-in-Differences (95% CI)[c]	*P* Value
	Baseline	Follow-up	Net Change[b]	Baseline	Follow-up	Net Change[b]		
Unadjusted Average Utilization Rates								
ED visits per mo	4.0	4.5	+0.6	6.3	0.2	−6.1	−6.7 (−7.3 to −6.0)	<.001
Dialysis ED visits per mo	3.5	4.3	+0.8	5.6	0.0	−5.5	−6.3 (−7.0 to −5.7)	<.001
Non-dialysis ED visits per mo	0.5	0.3	−0.2	0.8	0.2	−0.6	−0.4 (−0.6 to −0.2)	<.001
Hospitalizations per 6 mo	3.0	2.4	−0.5	3.0	1.0	−2.0	−1.5 (−2.3 to −0.8)	<.001
Hospital d per 6 mo	22.4	24.1	+1.7	14.8	6.4	−8.4	−10.1 (−17.7 to −2.5)	.009
Adjusted Average Utilization Rates[d]								
ED visits per mo	5.0	6.1	+1.1	5.3	0.2	−5.2	−6.2 (−7.0 to −5.4)	<.001
Dialysis ED visits per mo	4.4	5.6	+1.2	4.8	0.0	−4.7	−6.0 (−6.7 to −5.2)	<.001
Non-dialysis ED visits per mo	0.6	0.4	−0.2	0.6	0.1	−0.5	−0.2 (−0.4 to −0.04)	.02
Hospitalizations per 6 mo	2.9	2.3	−0.5	3.1	1.0	−2.1	−1.6 (−2.3 to −0.8)	<.001
Hospital d per 6 mo	19.2[e]	20.0	+0.8	16.7[e]	7.6	−9.2	−9.9 (−17.1 to −2.7)	.007
Costs: Best-Case Scenario[f]								
Unadjusted costs PPPM, $	8317	9581	+1264	11 223	6288	−4935	−6199 (−8677 to −3721)	<.001
Adjusted costs PPPM, $[d]	8691	10 146	+1455	10 802	6090	−4711	−6166 (−8753 to −3579)	<.001
Costs: Worst-Case Scenario[g]								
Unadjusted costs PPPM, $	8317	9581	+1264	11 223	6697	−4525	−5790 (−8246 to −3333)	<.001
Adjusted costs PPPM, $[d]	8686	10 138	+1452	10 806	6490	−4316	−5768 (−8332 to −3204)	<.001

Abbreviations: ED, emergency department; PPPM, per person per month.

[a] All utilization and costs were estimated per individual. We estimated costs per person per month by applying average national Medicare reimbursement rates for the following billed services to monthly event rates estimated for each individual: (1) emergency care and observation visits, (2) hospitalizations, (3) outpatient hemodialysis, (4) vascular access placement and/or complications. For further details, refer to the eMethods in the Supplement.

[b] Values may not equal the exact difference in baseline and follow-up values due to rounding.

[c] Difference-in-differences were estimated as the difference in net change in scheduled dialysis group minus net change in emergency-only group.

[d] Adjusted for propensity score (age, sex, dialysis vintage, baseline ED visits, baseline hospital days, baseline serum albumin, baseline vascular access type).

[e] In a sensitivity analysis, we omitted extreme outliers defined as individuals in the highest 99th percentile (n = 2). At baseline, the emergency-only group had an adjusted rate of 16.9 vs 15.9 hospital days per 6 mo in the scheduled group. At follow-up, the emergency-only group had an adjusted rate of 18.9 vs 7.1 hospital days per 6 mo in the scheduled group. The adjusted difference-in-differences estimate was −10.7 hospital days per 6 mo (95% CI −17.9 to −3.5, *P* = .003).

[f] To estimate average health care costs PPPM in a best-case scenario with low vascular access complication rates, we applied vascular access complication rates observed in the late dialysis initiation arm of a previously published randomized controlled trial of early vs late dialysis initiation.[28] For further details, refer to the eMethods in the Supplement.

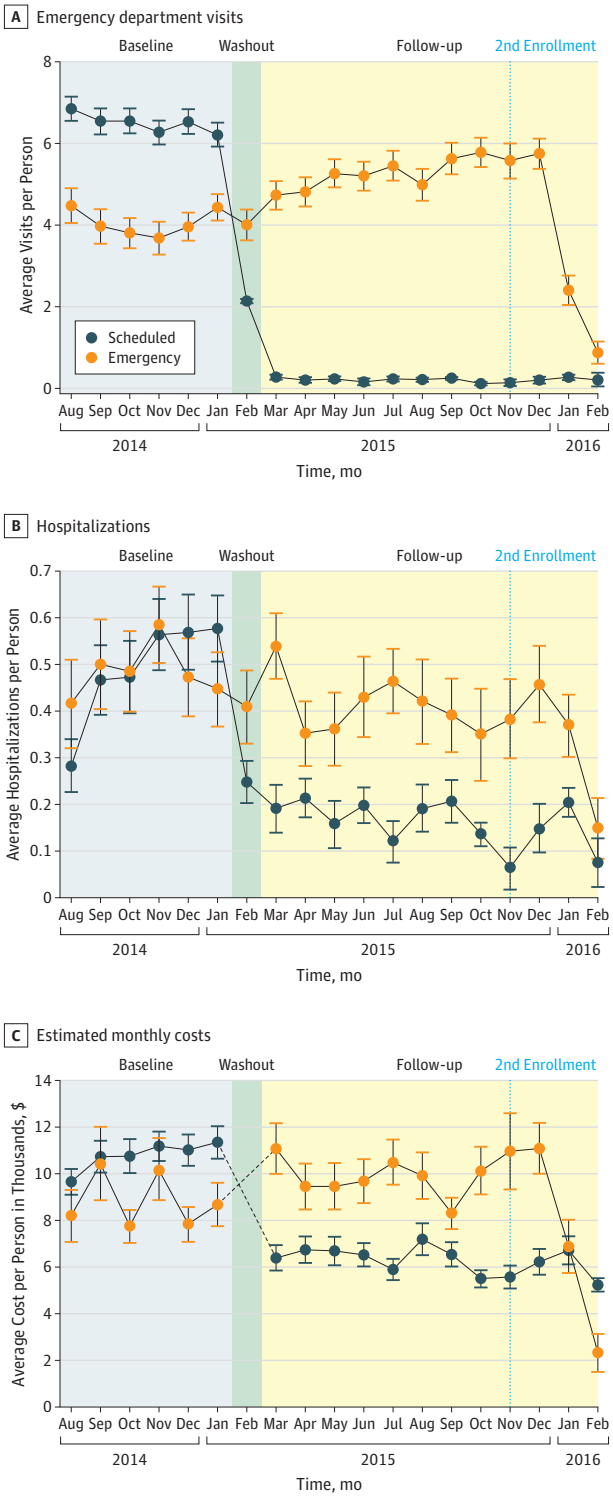
[g] To estimate average health care costs PPPM in a worst-case scenario with high vascular access complication rates, we applied vascular access complication rates observed during the first year after initial arteriovenous fistula placement in an observational study of older Medicare beneficiaries.[29] For further details, refer to the eMethods in the Supplement.

documented immigrants with ESRD currently outweigh the humanistic and ethical concerns of withholding needed care. Contrary to current policy assumptions, our findings demonstrate that scheduled dialysis results in substantial cost savings compared with emergency-only dialysis, with an estimated net savings of nearly $6000 PPPM or $72 000 per person per year. In our health system alone, providing scheduled dialysis to all 181 individuals in this study would have yielded a 1-year cost savings approaching $13 million.

Policymakers considering expanding access to dialysis for all individuals with ESRD should be aware of several additional factors that support this policy. First, of the estimated 6500 undocumented immigrants with ESRD in the United States, most are employed, are unaware of their disease before their diagnosis, and already contribute to the Medicare Trust Fund despite being unable to receive benefits.[4,14,23,31-33] Second, states that provide ESRD-related care to undocumented immigrants, most notably California, have had no increase in the number of undocumented immigrants for nearly a decade, which should obviate concerns that universal dialysis access would promote migration because of increased access to care.[22,34-38] Third, individuals in our study all received in-center hemodialysis, the most costly dialysis modality. Expanding coverage to allow for use of less costly renal replacement therapies such as home hemodialysis and peritoneal dialysis, which are preferred by patients, would result in equivalent or better health outcomes, improved patient satisfaction and an even greater magnitude of cost savings.[39-43]

Our study has several strengths. First, nearly random enrollment of individuals previously on emergency-only dialysis to scheduled dialysis allowed for a concurrent control group with similar baseline health and health system contextual effects compared with past studies, which have largely focused on individuals newly initiating scheduled dialysis (and therefore likely to have better baseline health) and/or patients from different health systems for comparison.[10,14,15] Second, the abrupt decline in health care utilization and costs observed among individuals in the emergency-only group crossing over into scheduled dialysis group during subsequent open enrollment further supports

Figure 3. Monthly Trends in Utilization and Costs



Average monthly emergency department visits (A), hospitalizations (B), and costs (C). Bars indicate standard error. Enrollment was in February 2015 (washout). Grey dotted line marks the start of the second open enrollment (November 2015-February 2016), when 92% of those remaining on emergency-only dialysis enrolled.

our inference of the benefits of scheduled dialysis since the benefits are reproducible, consistent, and not unique to the group of individuals who were enrolled initially. Third, we had one of the largest groups of individuals receiving scheduled dialysis among several studies[10,14,15] on undocumented immigrants with ESRD. This is particularly noteworthy given the challenges of both conducting research and obtaining health care services for this highly vulnerable population. Fourth, we had near-complete ascertainment of deaths across the entire state of Texas, and all ED visits and hospitalizations within a 100-mile radius of Dallas.

Limitations

Our study has certain limitations. Despite nearly random enrollment, there were some differences in baseline characteristics that we accounted for in our analyses, though residual confounding may persist. However, our findings that scheduled dialysis saves lives and reduces health care utilization are consistent with prior studies. Additionally, patients in the scheduled dialysis group more frequently met clinical criteria to receive emergent dialysis at baseline, suggesting more severe renal impairment; thus, our findings potentially underestimate the potential benefits of scheduled dialysis. Furthermore, our DiD approach accounts for between-group differences, assuming that patients in the scheduled dialysis group would have had utilization and cost trends parallel to those of patients in the emergency-only group had they not received coverage. Second, in our cost analyses, we were unable to account for expenditures on professional fees, outpatient medications, and ambulatory care other than those related to hemodialysis. However, acute health care use and hemodialysis are the biggest drivers of cost in ESRD patients.[44] Last, we likely underestimated several potential downstream health system and societal benefits of scheduled dialysis. We were unable to assess changes in ED and inpatient dialysis unit wait times and crowding, which likely declined since patients on scheduled dialysis used the ED far less frequently. Dialysis sessions for individuals remaining on emergency-only dialysis were also anecdotally longer and higher quality because of decreased crowding. Quality of life and return to employment for both individuals and caregivers in the scheduled dialysis group also likely improved.

Conclusions

Our study provides robust evidence of the clear health and societal benefits of providing scheduled dialysis to undocumented immigrants with ESRD, leveraging a unique opportunity for assessing the comparative effectiveness of the 2 strategies where an randomized clinical trial would be unethical and unfeasible. Given the quadruple win in terms of saving lives, saving money, improving quality of life, and reducing disparities with a more humane and evidence-based dialysis strategy for a highly vulnerable population, scheduled dialysis should be the universal standard of care for all individuals with ESRD in the United States.

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