Association of the Comprehensive ESRD Care Model with Treatment Adherence

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Key Points

- Improving dialysis adherence was a strategic objective of many providers in the Comprehensive ESRD Care (CEC) Model.
- We assessed adherence using the percent of treatments received as-scheduled rate and likelihood a skipped treatment was rescheduled.
- Adherence was improved among patients aligned to the CEC Model relative to the matched comparison group, but the effect magnitudes were modest.

Abstract

Background Poor adherence to scheduled dialysis treatments is common and can cause adverse clinical and economic outcomes. In 2015, the Centers for Medicare and Medicaid Innovation launched the Comprehensive ESRD Care (CEC) Model, a novel modification of the Accountable Care Organization framework. Many model participants reported efforts to increase dialysis adherence and promptly reschedule missed treatments.

Methods With Medicare databases covering 2014–2019, we used difference-in-differences models to compare treatment adherence among patients aligned to 1037 CEC facilities relative to those aligned to matched comparison facilities, while accounting for their differences at baseline. Using dates of service, we identified patients who typically received three weekly treatments and the days when treatments typically occurred. Skipped treatments were defined as days when the patient was not hospitalized but did not receive an expected treatment, and rescheduled treatments as days when a patient who had skipped their previous treatment received an additional treatment before their next expected treatment date.

Results Patients in the CEC Model had higher odds of attending as-scheduled sessions relative to the comparison group, although the effect was only marginally significant (OR, 1.02; 95% CI, 1.00 to 1.04, P = 0.08). Effects were stronger among females (OR, 1.03; 95% CI, 1.00 to 1.06, P = 0.06) than males (OR, 1.01; 95% CI, 0.98 to 1.04, P = 0.49), and among those aged <70 years (OR, 1.02; 95% CI, 1.00 to 1.05, P = 0.04) than those aged ≥70 years (OR, 1.00; 95% CI, 0.96 to 1.04, P = 0.96). The CEC was associated with higher odds of rescheduled sessions (OR, 1.09; 95% CI, 1.05 to 1.14, P < 0.001). Effects were significant for both sexes, but were larger among males (OR, 1.11; 95% CI, 1.05 to 1.18, P < 0.001) than females (OR, 1.07; 95% CI, 1.02 to 1.13, P = 0.01), and effects were significant among those <70 years (OR, 1.12; 95% CI, 1.07 to 1.17, P < 0.001), but not those ≥70 years (OR, 0.99; 95% CI, 0.92 to 1.07, P = 0.80).

Conclusions The CEC Model is intended to incentivize strategies to prevent costly interventions. Because poor dialysis adherence may precipitate hospitalizations or other adverse events, many CEC Model participants encouraged adherence and promptly rescheduled missed treatments as strategic priorities. This study suggests these efforts were a success, although the absolute magnitudes of the effects were modest.

Introduction

The standard treatment schedule of three times a week in-center hemodialysis represents a significant burden for patients with chronic kidney failure. About 10% of scheduled treatments are missed by patients, with approximately 50% of them due to medical events, predominantly hospitalization, whereas the rest represent a form of treatment nonadherence (1,2).

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Missed treatments that are not related to medical events (referred to hereafter as skipped treatments) are associated with higher rates of health care utilization or adverse events, including hospitalization, emergency department visits, and mortality (2–8). Factors such as Black race, Hispanic ethnicity, current smoking, drug use, depression, and younger age are associated with higher skipped treatment rates (3,5–7,9). In addition, long travel time or other obstacles to transportation to the facility may result in more skipped treatments (3,10). Rescheduling a skipped treatment to the next day can decrease, although not fully mitigate, the risk of adverse events (11). Despite facilities’ efforts to make accommodations, only 10% of skipped treatment are rescheduled (4).

Virtually no systematic strategies have been implemented to encourage as-scheduled treatments, and attending rescheduled treatments when original treatments are skipped.

In response to the need for multisetting care, the Center for Medicare and Medicaid Innovation launched the Comprehensive ESRD Care (CEC) Model in 2015, representing a novel modification of the Accountable Care Organization framework aimed at patients on chronic dialysis (12). The overarching goal of the CEC Model was to promote collaboration across care settings (e.g., facilities, hospitals, primary care) to promote patient-centered care. On one hand, Accountable Care Organizations serving the general Medicare population have not been associated with increased patient adherence for medication use (13,14) and did not improve outcomes for beneficiaries with ESRD relative to traditional Medicare (15). On the other hand, there may be potential to improve dialysis adherence in the context of the CEC Model; the CEC’s targeted population management approach may improve coordination of dialysis therapy and the level of beneficiary engagement (16), which in turn may increase adherence.

ESRD Seamless Care Organizations (ESCOs), the participants of the CEC Model, consist of nephrologists, dialysis organizations, and dialysis facilities for improving treatment quality and efficiency across the spectrum of care for CEC beneficiaries. Improving coordination of care across settings was a key objective by the ESCOs, backed by new investments in areas such as care coordination staff and information technology to facilitate enhanced communication across providers. As examples, ESCOs reported efforts to improve dialysis treatment adherence through measures including improved communication with emergency departments to divert patients back to the outpatient setting for urgent dialysis, and coordination across participating facilities to make chairs available for urgent or rescheduled dialysis sessions away from the patient’s regular facility. Other efforts to improve adherence included enhanced communication with patients who were unexpectedly absent for a session, adding shifts to improve convenience, and facilitating transportation when regular sources were unavailable (17). Further, ESCOs’ sharing in the financial savings and/or losses associated with the total cost of care provides a clear incentive to improve adherence by educating and working with patients to adhere to scheduled treatments, or actively rescheduling skipped treatments. CEC was found to be associated with decreased hospitalizations and increased outpatient dialysis sessions, but it is unclear whether the increase in dialysis sessions is driven by better adherence or is because of reduced hospitalizations (15). In addition, site visits to ESCOs revealed that increasing adherence and facilitating treatment rescheduling were major strategic foci of many ESCOs (17).

This examination seeks to establish the extent to which ESCOs succeeded in improving dialysis adherence in the outpatient setting. Treatment adherence is operationalized by assessing whether patients are more likely to attend dialysis sessions as-scheduled, and more likely to attend rescheduled sessions than those patients receiving in-center hemodialysis in the comparison group. To obtain a more nuanced view of the CEC’s association with adherence, we also estimated subgroup analyses by age and sex to assess whether the associations were similar across groups.

Materials and Methods

Data Sources

Medicare Parts A and B enrollment and claims from January 1, 2014 to December 31, 2019 were used to determine beneficiary characteristics and service use and were linked to the ESRD Medicare Patient Registration (CMS Form 2728), containing dialysis start date, cause of ESRD, and other beneficiary characteristics. Medicare’s Master Beneficiary Summary File was the primary source used to determine beneficiary’s original reason for Medicare Entitlement, age, sex, race, and dual Medicare and Medicaid monthly enrollment. Nursing home stays were determined from the CMS Minimum Dataset. Medicare institutional claims identified hospice stays. Rural designation identifies that the dialysis facility is located in a nonmetropolitan area, on the basis of rural-urban-continuum codes from Medicare Dialysis Facility Compare data. This study was exempt from an Institutional Review Board review on the basis of the federal common rule (section 45 CFR 46.101(b) [5]), because it was to evaluate a public benefit program.

Study Population

The CEC population included Medicare Fee-for-Service beneficiaries aligned to a dialysis facility that joined an ESCO (referred to as CEC facilities) at any time during 2014–2019. To be aligned, beneficiaries must reside in the United States, be ≥18 years old before the first day of the month, not have received a kidney transplant within the previous 12 months, not be enrolled in a designated CMS shared-savings model and have Medicare as the primary payer. The comparison population included Medicare Fee-for-Service beneficiaries who were aligned to a matched comparison facility at any time during the same study period, and their eligibility, alignment, and dealignment were assessed the same as the CEC population (15). Beneficiaries identified as home dialysis recipients were excluded from these analyses.

There were two waves of ESCOs, designated by the date which they joined the CEC Model. Wave 1 included ESCOs that joined on October 1, 2015 and Wave 2 included ESCOs that joined the model on January 1, 2017. Both Wave 1 and Wave 2 ESCOs were able to drop or add facilities. There was no minimum duration an ESCO provider had to be in operation before participation in the study.
Facilities participating in CEC Model were matched to a pool of potential comparison facilities by implementing a one-to-one propensity score matching without replacement model. Means, standard deviations, and standardized mean differences of matching market and facility covariates are described in the Supplemental Appendix. After matching, standardized mean differences for the selected comparison group facilities relative to CEC participating facilities were generally small. In years 2014 through 2017, there were 1037 matched dialysis facilities in both CEC and comparison groups; in 2018, there were 1036 in CEC and 1037 in the comparison group; in 2019, there were 1020 in CEC and 1037 in the comparison group, after ESCOs dropped 16 facilities from the model. There was no minimum requirement for duration of facility.

**Outcome Variables for Treatment Adherence**

To avoid technicalities with the Medicare eligibility period and allow for the establishment of regular treatment, we excluded the first 90 days after a beneficiary’s first dialysis treatment. The weeks containing December 25 and January 1 were also excluded due to holiday disruptions. Outpatient claims were used to identify beneficiaries in the matched CEC and comparison facilities, and ultrafiltration sessions were counted as treatments. Outpatient claims were excluded for a beneficiary if treatment dates occurred after the verified death date, before the first dialysis treatment date, or outside of alignment. Beneficiaries were excluded from the study population at the first indication of a hospice stay between 2014 and 2019.

We developed a logic to identify thrice-weekly dialysis schedule patterns on the basis of claims data. Beneficiaries were included for a study year if they dialyzed thrice weekly for more than 1 out of 3 weeks during that year. For beneficiaries new to dialysis, once past the first 90 days after the first dialysis session, they were included in the analysis if they received dialysis thrice weekly in more than half of the subsequent 26 weeks. As such, the beneficiaries on thrice-weekly dialysis accounted for approximately 99% of the study beneficiaries, among which 338,334 patient-years were aligned to CEC dialysis facilities, and 277,342 patient-years were aligned to comparison group facilities.

The main end points that reflect treatment adherence are as-scheduled rates and rescheduled rates, defined in detail below. To calculate these rates, Medicare claims were used to identify dialysis session dates and day of the week treatment patterns, and classify dialysis sessions to be as-scheduled, skipped, or rescheduled.

**As-Scheduled, Skipped, and Expected Dialysis Sessions**

If a dialysis session claim was on an expected day, given prior treatment patterns, then that session was considered as-scheduled. If there was a gap between the expected day of a session and the next dialysis session, then a skipped treatment session was identified. For example, if claims indicate a beneficiary had dialysis sessions on Monday and Wednesday, the next expected dialysis session would be Friday. If the next dialysis claim service date indicated a Friday dialysis session, then there would be no gap between the expected day and received treatment; that Friday session would be classified as-scheduled. If, however, the patient did not receive dialysis on Friday, that treatment would be classified as skipped. There were additional considerations to validate the identification of a skipped treatment session. The date of a skipped treatment was crosschecked against inpatient hospitalization claims and emergency department claims for the beneficiary. If the treatment was missed due to hospitalization or an emergency department visit, that treatment was not considered skipped and was excluded in the calculation. Therefore, we only consider a session to be skipped if the patient was fully in the outpatient setting and did not receive dialysis on an expected date. This convention limits the measure of skipped treatments to those most clearly under the facility’s control or influence, recognizes that treatments may have been provided in the inpatient setting rather than being missed altogether, and is consistent with our desire to determine the extent to which the greater number of outpatient sessions observed in the CEC arises from fewer skipped treatments rather than simply from CEC patients spending less time in the inpatient setting.

At times, in-center hemodialysis beneficiaries receive additional treatment sessions, namely, those beyond the thrice expected sessions that were not identified to be a rescheduled treatment (as defined below). Additional sessions were identified through claims analyses and treatment pattern gaps whereby a received dialysis session date was sooner than expected. Additional sessions were not predictable and a dialysis facility would not be held accountable, as a missed session, beyond thrice sessions weekly. The total number of expected dialysis sessions in a given week was three plus any additional treatments received during the week.

**Rescheduled Dialysis Sessions**

If a session was received the next day after a validated skipped session, it was counted as a rescheduled session. For a Friday or Saturday skipped treatment, dialysis received on the first or second subsequent day after the skip was considered a rescheduled session. For a patient when a skip was rescheduled on a Sunday or Monday (defined here as part of the next week of treatment), the rescheduled session was counted in the week of the skipped session. This avoided double counting the rescheduled session as an as-scheduled or additional treatment in the next week.

**As-Scheduled and Rescheduled Dialysis Session Rates**

For each patient, the as-scheduled rate is defined as the total number of received as-scheduled and additional dialysis sessions per total number of expected dialysis sessions in a year, whereas the rescheduled rate is the number of rescheduled dialysis sessions per total number of skipped dialysis sessions in a year.

**Statistical Methods**

We used two binomial regression models, with the “trial size” being the total number of expected dialysis sessions in a year and the total number of skipped dialysis sessions in a year for each patient, to compare the as-scheduled and rescheduled rates, respectively, between the CEC beneficiaries and the comparison beneficiaries. The binomial regression, an extension of the logistic regression, is suitable for modeling rates on the basis of the aggregated data, as in our case (18). To account for intracluster correlations
among beneficiaries receiving services from the same facility and correlations among repeated observations from the same beneficiary over time, we used the generalized estimating equation approach to compute the robust standard errors of the coefficient estimates. We conducted our analysis using PROC GENMOD in SAS 9.4.

To adjust for the differences in the rates between CEC and comparison facilities in the baseline period, we used the difference-in-differences approach (19). Included in our models are a CEC group indicator, a time indicator to differentiate the pre- and postintervention periods, and an interaction term between the CEC and time indicators. The coefficient on the CEC Model indicator corresponds to the difference in outcomes between beneficiaries in the CEC group and those beneficiaries in the matched comparison group during the preintervention period. The coefficient on the time indicator corresponds to the difference in outcomes preintervention and postintervention for beneficiaries in the control group, characterizing the time effect even without CEC Model intervention. The coefficient on the interaction term is the differential change pre- and postintervention for the CEC population, relative to the comparison population (19). Therefore, the interaction term is the variable of interest to assess how the CEC Model intervention affects the rate of treatment adherence over time, relative to the comparison group.

We elaborate on how a time indicator is created to flag the preintervention and intervention periods, on the basis of the performance year when ESCO facilities joined the CEC Model. For example, for ESCO facilities that joined in performance year 1 (PY1), the preintervention period was in years 2014 through 2015 and the intervention period was in years 2016 through 2019. For beneficiaries receiving dialysis in a PY1 CEC facility or a PY1 comparison facility during the preintervention years 2014–2015, the time indicator is set to 0; otherwise, for beneficiaries receiving dialysis in a PY1 facility during the intervention years 2016 through 2019, the time indicator is set to 1.

Additional risk-adjustment covariates for the model included year indicators; beneficiary demographics, such as

### Table 1. Descriptive statistics for model variables

| Variable                           | Total (n=615,676) | Comprehensive ESRD Model (n=338,334; 55%) | Comparison (n=277,342; 45%) |
|------------------------------------|-------------------|-------------------------------------------|----------------------------|
| **Outcome variables**              |                   |                                           |                            |
| Annual count of total number of treatments, mean±SD | 122.2±51.8        | 122.8±51.5                                | 121.5±52.1                 |
| Annual count of as-scheduled treatments, mean±SD | 111.4±48.7        | 112.0±48.5                                | 110.7±49.0                 |
| Annual count of skipped treatments, mean±SD | 10.7±17.9         | 10.8±17.7                                 | 10.7±18.2                  |
| Annual count of rescheduled treatments*, mean±SD | 1.2±3.5           | 1.3±3.8                                   | 1.1±3.2                    |
| Rate: As-scheduled per expected sessions | 0.914±0.123       | 0.914±0.122                              | 0.914±0.124                |
| Rate: Rescheduled per skipped sessions | 0.123±0.181       | 0.126±0.183                               | 0.120±0.180                |
| **Control variables**              |                   |                                           |                            |
| Original reason for Medicare entitlement |                   |                                           |                            |
| Both disability and ESRD (reference group) | 133,885 (22%)     | 72,469 (21%)                              | 61,416 (22%)               |
| Old age and survivor’s insurance | 189,879 (31%)     | 103,616 (31%)                             | 86,263 (31%)               |
| Disability insurance benefits | 136,572 (22%)     | 75,628 (22%)                              | 60,944 (22%)               |
| ESRD | 155,340 (25%)     | 86,621 (26%)                              | 68,719 (25%)               |
| Cancer indicator | 44,561 (7%)       | 24,729 (7%)                               | 19,832 (7%)                |
| Months on dialysis, mean±SD | 59.0±61.4         | 59.4±60.9                                 | 58.6±61.9                  |
| Age, mean±SD | 63.6±14.3         | 63.5±14.3                                 | 63.7±14.4                  |
| **Cause of ESRD**                  |                   |                                           |                            |
| Diabetes | 279,733 (45%)    | 152,416 (45%)                             | 127,317 (46%)              |
| Hypertension | 198,632 (32%)    | 111,230 (33%)                             | 87,402 (32%)               |
| Other | 138,660 (22%)     | 74,688 (22%)                              | 62,623 (23%)               |
| Female | 274,338 (45%)    | 149,608 (44%)                             | 124,730 (45%)              |
| BMI, mean±SD | 30.3±8.4         | 30.3±8.4                                  | 30.3±8.4                   |
| **Race**                           |                   |                                           |                            |
| White | 259,676 (42%)    | 136,244 (40%)                             | 123,432 (45%)              |
| Black | 270,035 (44%)    | 153,399 (45%)                             | 116,676 (42%)              |
| Other non-White race | 85,965 (14%)    | 48,731 (14%)                              | 37,234 (13%)               |
| **Dual Medicare and Medicaid eligibility** |                   |                                           |                            |
| Percent months in year with full eligibility | 36.1±45.8        | 36.0±45.8                                 | 36.2±45.7                  |
| Percent months in year with partial eligibility | 11.8±30.4        | 11.3±29.9                                 | 12.4±31.1                  |
| Facility size (number of patients), mean±SD | 76.3±45.2        | 82.7±48.9                                 | 68.6±38.9                  |
| Percentage of dialysis sessions while in nursing home, mean±SD | 9.8±26.7         | 9.2±26.0                                  | 10.5±27.6                  |
| Rural | 74,149 (12%)    | 37,513 (11%)                              | 36,636 (13%)               |

Percentages are calculated on the basis of the denominator (n) shown in each column heading. BMI, body mass index.

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*Total n=507,066; CEC n=279,130; comparison n=227,936.
age, sex, race, percentage of months in year with full dual Medicare and Medicaid enrollment, percentage of months in year with partial dual Medicare and Medicaid enrollment; clinical risk factors, such as original reason for Medicare entitlement, annual cancer indicator, months on dialysis, cause of ESRD, body mass index at dialysis incidence; percentage of dialysis sessions in the year that occurred while the patient was in a nursing home; and annual patient count at the facility. Finally, subgroup analyses stratified by age and sex were performed to investigate whether the CEC’s effect differed by patient characteristics.

**Results**

**Descriptive Analyses**

Table 1 compares patient characteristics and outcomes for the CEC and comparison groups, averaged over 2014–2019. The average annual count of as-scheduled treatments is 112.0 and 110.7 for ESCO and comparison beneficiaries, respectively. The average annual count of skipped treatment is 10.8 for ESCO and 10.7 for comparison beneficiaries, whereas the average annual count of rescheduled treatment is 1.3 for ESCO and 1.1 for comparison. The CEC and comparison populations were similar on most measures, but the CEC beneficiaries had, on average, a slightly longer time on dialysis (59.4 versus 58.6 months) than the controls. The CEC beneficiaries were treated in facilities with more patients on average (83 versus 69 patients) in areas that were more urban than the comparison group. CEC facilities also had a smaller proportion of beneficiaries receiving dialysis sessions at nursing homes.

**As-Scheduled Treatments**

Table 2 shows that, after accounting for potential differences in the baseline rates and the time trend, participants in the CEC program on average had 2% higher odds of attending an as-scheduled session than those in the comparison group, although the effect was only marginally significant (odds ratio [OR], 1.02; 95% confidence interval [95% CI], 1.00 to 1.04, P=0.08). Table 3, which presents the subgroup analyses by sex or age, shows that CEC effects were stronger among females (OR, 1.03; 95% CI, 1.00 to 1.06, P=0.06) than males (OR, 1.01; 95% CI, 0.98 to 1.04, P=0.50), whereas CEC effects were stronger among those aged <70 years (OR, 1.02; 95% CI, 1.00 to 1.05, P=0.04) than those aged ≥70 (OR, 1.00; 95% CI, 0.96 to 1.04, P=0.97).

Dual Medicaid/Medicare eligibility was associated with substantially lower odds of as-scheduled treatment (OR, 0.82; 95% CI, 0.81 to 0.83, P<0.001 for full dual eligibility; OR, 0.87; 95% CI, 0.85 to 0.88, P<0.001 for partial dual eligibility). Nursing home residents were more likely to have as-scheduled treatments than those residing in the community (OR, 1.49; 95% CI, 1.46 to 1.53, P<0.001).

### Table 2. Model result for as-scheduled dialysis sessions as a proportion of expected number of sessions

| Variable | Estimate (95% Confidence Interval) | Standard Error | P Value |
|----------|-----------------------------------|----------------|---------|
| Intercept| 1.083 (2.979 to 3.117)            | 0.028          | <0.0001 |
| CEC Model| 0.010 (0.994 to 1.027)            | 0.009          | 0.2283  |
| Time (post-treatment period=1)| 0.046 (1.025 to 1.068)        | 0.011          | 0.0001  |
| CEC * time| 0.018 (0.998 to 1.039)            | 0.010          | 0.076   |
| 2015     | -0.018 (0.973 to 0.992)           | 0.005          | 0.0003  |
| 2016     | -0.035 (0.954 to 0.978)           | 0.006          | <0.0001 |
| 2017     | -0.094 (0.895 to 0.926)           | 0.009          | <0.0001 |
| 2018     | -0.164 (0.831 to 0.867)           | 0.011          | <0.0001 |
| 2019     | -0.197 (0.803 to 0.840)           | 0.012          | <0.0001 |

**Original Reason for Medicare Entitlement**

- Both disability and ESRD (reference group)
- Old age and survivor’s insurance: -0.001 (0.972 to 1.026)
- Disability insurance benefits: -0.098 (0.886 to 0.928)
- ESRD: -0.043 (0.938 to 0.979)
- Cancer indicator: -0.016 (0.960 to 1.009)
- Months on dialysis: 0.003 (1.003 to 1.003)
- Age: 0.018 (1.018 to 1.019)
- ESRD cause: diabetes: 0.108 (1.143 to 1.136)
- ESRD cause: hypertension: 0.005 (1.005 to 1.026)
- Female: -0.116 (0.878 to 0.904)
- BMI: 0.004 (1.003 to 1.005)
- Black: -0.010 (0.975 to 1.006)
- Other non-White race: 0.306 (1.326 to 1.390)

**Dual Medicare and Medicaid eligibility**

- Percent months in year with full eligibility: -0.199 (0.820 to 0.833)
- Percent months in year with partial eligibility: -0.145 (0.846 to 0.884)
- Annual facility patient count: -0.0004 (1.000 to 1.000)
- Percent of annual dialysis sessions while in nursing home: 0.399 (1.456 to 1.525)
- Rural: 0.056 (1.037 to 1.080)

CEC, Comprehensive ESRD Model; BMI, body mass index.
Table 3. As-scheduled dialysis rate subgroup results for key variables

| Demographic Group | Odds Ratio (95% Confidence Interval) | Standard Error | P Value |
|-------------------|-------------------------------------|----------------|---------|
| Female            | 0.027 (0.999 to 1.058)               | 0.015          | 0.62    |
| Male              | 0.010 (0.982 to 1.038)               | 0.014          | 0.485   |
| Age <70 yrs       | 0.024 (1.001 to 1.048)               | 0.012          | 0.040   |
| Age ≥70 yrs       | -0.001 (0.960 to 1.040)              | 0.020          | 0.963   |

Rescheduled Sessions

As shown in Table 4, in comparison with the control group, the CEC group was associated with 9% higher odds of rescheduled sessions (OR, 1.09; 95% CI, 1.05 to 1.14, P<0.001). The subgroup analyses (Table 5) further showed that CEC effects were significant for both sexes, but were larger among males (OR, 1.11; 95% CI, 1.05 to 1.17, P<0.001) than females (OR, 1.07; 95% CI, 1.02 to 1.13, P=0.01); when stratified by age, CEC effects were significant among those aged <70 (OR, 1.11; 95% CI, 1.07 to 1.17, P<0.001), but not aged ≥70 (OR, 0.99; 95% CI, 0.92 to 1.07, P=0.78).

Medicare and Medicaid dual eligibility was associated with lower rates of rescheduled treatments (OR, 0.65; 95% CI, 0.63 to 0.68, P<0.001 for full dual eligibility; OR, 0.77; 95% CI, 0.74 to 0.82, P<0.001 for partial dual eligibility). Black race was not significantly associated with rescheduled treatments in comparison with White race, unlike other studies (5,7,8). Other non-White race had slightly higher odds for rescheduled sessions (OR, 1.08; 95% CI, 1.02 to 1.12, P<0.001) when compared with White race. Nursing home residents had significantly higher odds of attending rescheduled sessions than those residing in the community (OR, 1.41; 95% CI, 1.35 to 1.48, P<0.001). Those beneficiaries receiving care in rural areas had lower odds of rescheduled treatments than those in urban areas (OR, 0.86; 95% CI, 0.83 to 0.90, P<0.001).

Table 4. Model result for rescheduled dialysis sessions as a proportion of total skipped sessions

| Variable, n=507,066 | Odds Ratio (95% Confidence Interval) | Standard Error | P Value |
|----------------------|-------------------------------------|----------------|---------|
| Intercept            | -2.258 (0.094 to 0.117)             | 0.057          | <0.0001 |
| CEC Model            | 0.086 (1.052 to 1.130)              | 0.018          | <0.0001 |
| Time (post-treatment period=1) | -0.026 (0.935 to 1.015) | 0.021          | 0.2179  |
| CEC * time           | 0.088 (1.092 to 1.136)              | 0.020          | <0.0001 |
| 2015                 | -0.040 (0.943 to 0.980)             | 0.010          | <0.0001 |
| 2016                 | -0.036 (0.940 to 0.990)             | 0.013          | 0.0062  |
| 2017                 | -0.079 (0.892 to 0.957)             | 0.018          | <0.0001 |
| 2018                 | -0.042 (0.919 to 1.001)             | 0.022          | 0.0569  |
| 2019                 | -0.122 (0.846 to 0.927)             | 0.023          | <0.0001 |

Original reason for Medicare entitlement

- Both disability and ESRD (reference group)
- Old age and survivor’s insurance
- Disability insurance benefits
- ESRD
- Cancer indicator
- Months on dialysis
- Age
- ESRD cause = diabetes
- ESRD cause = hypertension
- Female
- BMI
- Black
- Other non-White race

Dual Medicare and Medicaid eligibility

- Percent months in year with full eligibility
- Percent months in year with partial eligibility
- Annual facility patient count
- Percent of annual dialysis sessions while in nursing home
- Rural

Discussion

Our analysis showed that patients with ESRD enrolled in ESCos operating under the CEC Model were modestly more likely than patients in matched comparison facilities to receive dialysis treatments according to their prescribed schedule, and to promptly have missed treatments rescheduled. Our analysis of as-scheduled treatment sessions only used days in which the patient was not hospitalized or in an emergency department. Therefore, the finding that receipt of as-scheduled treatment was only modestly (and significantly at the P<0.10 level) improved for those in the CEC Model relative to the comparison group suggests
the improvement in total outpatient treatments observed in the evaluation of the program was driven primarily by the CEC’s reduction in hospitalization rates (15,17). That is, the extra treatments received by patients on CEC appear to arise primarily from more days in the outpatient setting due to the CEC Model lowering hospitalizations and only modestly from an increase in adherence conditional on being in the outpatient setting. Further, any association with the CEC was concentrated in younger and female patients. ESCOs did appear to have some association with rescheduling those outpatient treatments that were missed, again with the association arising among patients aged <70.

Although not specific to the CEC Model, two other factors stood out by having particularly strong associations with both as-scheduled and rescheduled treatments. First, patients with dual Medicaid/Medicare eligibility had much lower odds of as-scheduled treatments or rescheduling of missed treatments. This suggests the importance of addressing barriers to treatment compliance among patients with lower socioeconomic status. Second, patients residing in nursing homes had much higher odds of as-scheduled treatments or rescheduling of missed treatments. This likely reflects those patients having an institution (the nursing home) accountable for their receipt of treatment. Consequently, future studies of the compliance of patients on dialysis with care prescriptions should adjust for nursing home status. Finally, the study had important limitations. Despite using propensity-score matching to select the comparison group and using difference-in-differences methods, the study’s observational nature makes it difficult to draw causal inferences. The study also had to rely on claims data to identify treatment dates, requiring us to make inferences about skipped treatments on the basis of observed patterns. We could not confirm those inferences with medical records.

ESCs participating in the CEC Model have an incentive to better coordinate care and take other actions to reduce the need for high-cost interventions such as hospitalizations. Because poor treatment adherence may precipitate the need for high-cost interventions such as hospitalizations, many ESCs encouraged adherence and promptly rescheduled missed treatment as strategic priorities. This study suggests the success of these efforts, although the absolute magnitudes of improvement were modest.

Disclosures
A. Ackerman reports having an ownership interest in UnitedHealth Group. B. Negrusa reports having an ownership interest because Lewin employees are entitled to receive UnitedHealth Groups stock. C. Dahlerus reports being a scientific advisor or member through serving as a Guest Editor with the journal Medical Care for a 2019 supplement on patient-reported outcomes scoring methodologies. D. Strubler reports having an ownership interest in GlaxoSmithKline and Sanofi. D. Ullman reports having an ownership interest in UnitedHealth Group. J. Segal reports being a scientific advisor or member of the ESRD Network 11 Medical Review/Executive Committees. J. Wiens reports having an ownership interest in UnitedHealth Group. R. Braun reports having an ownership interest in UnitedHealth Group. R. Hirth reports being a scientific advisor or member on the Board of Directors of the Association of University Programs in Health Administration, Deputy Editor of Medical Care, and the Editorial Board of the American Journal of Managed Care. All remaining authors have nothing to disclose.

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Author Contributions
R. Hirth and T. Nahra conceptualized the study; K. Bacon, R. Braun, C. Dahlerus, J. Gunden, A. Jiao, T. Nahra, J. Segal, K. Sleeman, D. Strubler, and J. Wiens were responsible for the data curation; J. Gunden, A. Jiao, and T. Nahra were responsible for the formal analysis; G. Boyer, R. Hirth, G. Marrufo, B. Negrusa, and D. Ullman were responsible for the funding acquisition; R. Hirth was responsible for the investigation; C. Dahlerus, J. Gunden, R. Hirth, A. Jiao, Y. Li, G. Marrufo, T. Nahra, B. Negrusa, J. Segal, and K. Sleeman were responsible for the methodology; A. Ackerman was responsible for project administration; J. Gunden and A. Jiao were responsible for the software; R. Hirth was responsible for supervision and visualization; A. Ackerman, K. Bacon, G. Boyer, C. Dahlerus, and J. Segal were responsible for the resources; G. Marrufo and J. Segal were responsible for validation; J. Gunden, R. Hirth, A. Jiao, T. Nahra, B. Negrusa, and J. Segal wrote the original draft; and A. Ackerman, K. Bacon, G. Boyer, C. Dahlerus, J. Gunden, R. Hirth, Y. Li, G. Marrufo, K. Sleeman, T. Nahra, B. Negrusa, J. Segal, D. Ullman, and J. Wiens reviewed and edited the manuscript.

Table 5. Rescheduled dialysis rate subgroup results for key variables

| Demographic Group | Odds Ratio (95% Confidence Interval) | Standard Error | P Value |
|-------------------|-------------------------------------|----------------|---------|
| Female            | 0.068 (1.015 to 1.128)              | 0.027          | 0.012   |
| Male              | 0.103 (1.047 to 1.175)              | 0.030          | 0.0005  |
| Age <70 yrs       | 0.114 (1.071 to 1.174)              | 0.024          | <0.0001 |
| Age >70 yrs       | -0.010 (0.920 to 1.066)             | 0.037          | 0.796   |

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Data Sharing Statement

Anonymized data created for the study are or will be available in a persistent repository upon publication: Analyzable Data, Chronic Condition Warehouse.

Supplemental Material

This article contains the following supplemental material online at http://kidney360.asnjournals.org/lookup/suppl/doi:10.34067/KID.0006132021/-/DCSupplemental.

Supplemental Appendix. Facility matching for CEC model.

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