Dialysis Facility Ownership and Epoetin Dosing in Patients Receiving Hemodialysis

Mae Thamer, PhD
Yi Zhang, MS
James Kaufman, MD
Dennis Cotter, MSE
Fan Dong, BS
Miguel A. Hernán, MD

A

EMIA IS A COMMON COM-
plication of chronic kidney
disease and end-stage renal
disease (ESRD). The
introduction of recombinant human
erthropoietin (rHuEPO; EPOGEN
[epoetin alfa]) in 1989 significantly
improved the clinical management of
anemia of ESRD. By 2005, 99% of
in-center hemodialysis patients
received epoetin treatment for their
anemia. Epoetin dosing has changed
dramatically in the past decade and a
half; between 1991 and 2005, the
mean dose of epoetin increased
about 4-fold in dialysis patients.
Today, epoetin therapy is the largest
single Medicare drug expenditure
totaling $1.8 billion in 2004 (an
increase of 17% from 2003) and epo-
etin comprised 11% of all Medicare
ESRD costs.

Since the introduction of epoetin, the
dialysis industry has experienced dra-
matic changes. For example, the num-
ber of facilities affiliated with dialysis
chains in the United States has in-
creased from fewer than 500 in 1993 to
2951 in 2004, and these facilities serve
3 of 4 dialysis patients. The growth of the
number of facilities affiliated with chains
has occurred mainly in the for-profit
arena and has occurred in all regions of
the country. The rapid growth of for-
profit freestanding facility ownership and
consolidation of large chain facilities has
raised concerns about the quality of care
delivered to ESRD patients. Compared
with chain-affiliated units, those that are
independently owned and/or hospital-based
have a greater proportion
of patients receiving peritoneal
dialysis, more patients receiving trans-
plants, lower ratios of patients to staff,
and higher average costs per dialysis ses-
tion. A study of epoetin treatment con-
ducted in 1990, when Medicare reim-
bursement policy capitated payment for

Context Epoetin therapy for dialysis-related anemia is the single largest Medicare
drug expenditure. The type of facility (profit, chain, and affiliation status) at which a
patient receives dialysis might affect epoetin dosing patterns and has implications for
future epoetin policies.

Objective To examine the association between dialysis facility ownership and the
doze of epoetin administered.

Design, Setting, and Participants Data from the US Renal Data System were used
to identify 159,522 adult Medicare-eligible, end-stage renal disease patients receiving
in-center hemodialysis during November and December 2004. Regression models were
used to estimate the mean epoetin dose and dose adjustment by profit, chain, and
affiliation status.

Main Outcome Measures Weekly mean epoetin dose administered in December
2004 and the adjustment in dose between November and December 2004.

Results Compared with patients in nonprofit dialysis facilities (n=28,199), patients
in large for-profit dialysis chain facilities (n=106,116) were consistently administered
the highest doses of epoetin regardless of anemia status. Compared with nonprofit
facilities, for-profit facilities administered, on average, an additional 3306 U/wk of epo-
etin. Among the 6 large chain facilities with a similar patient case-mix, the average
dose of epoetin ranged from 17,832 U/wk at chain 5 (nonprofit facilities with a mean
hematocrit level of 34.6%) to 24,986 U/wk at chain 2 (for-profit facilities with a mean
hematocrit level of 36.5%). Dosing adjustments also differed by type of facility. On
average, compared with nonprofit facilities, for-profit facilities increased epoetin doses
3-fold for patients with hematocrit levels of less than 33% and also increased the doses
among patients with hematocrit levels in the recommended target of 33% to 36%,
especially in the largest for-profit chain facilities. The greatest difference in dosing prac-
tice patterns between facilities was found among patients with hematocrit levels of
less than 33%.

Conclusions Dialysis facility organizational status and ownership are associated with
variation in epoetin dosing in the United States. Different epoetin dosing patterns sug-
gest that large for-profit chain facilities used larger dose adjustments and targeted higher
hematocrit levels.

www.jama.com

©2007 American Medical Association. All rights reserved.
Figure 1. Selection of Study Population Using 2004 Data From the US Renal Data System

- 236,912 Patients With ≥1 Dialysis Claim (Hemodialysis or Peritoneal Dialysis) in December 2004
- 198,815 Had Epoetin Treatment and Hematocrit Reported in November 2004
- 169,415 Used Hemodialysis and Did Not Change Dialysis Provider During Study Period
- 168,422 Had Dialysis Facility Data
- 161,906 Had Medicare as Primary Payer
- 159,522 Had Predialysis Comorbidity Data and Were Aged ≥18 y as of November 1, 2004

Epoetin and smaller doses resulted in greater profit margins, found that for-profit facilities administered smaller doses of epoetin compared with non-profit facilities. Since 1991, epoetin payment has been based on the amount of drug administered, creating a financial incentive for increased use of this therapy. In this analysis, we examine the relationship between organizational status and epoetin dosing.

METHODS

Data Source

The use of Medicare claims data to study practice variation is well established. The US Renal Data System (USRDS) is a national system that includes demographic and clinical data on patients with ESRD and on institutional dialysis providers. Medicare covers 93% of US dialysis patients and the USRDS Medicare claims database includes data on monthly hematocrit levels and epoetin doses for these patients. The Researcher’s Guide to the USRDS Database describes the variables, data source, collection methods, and validation studies, which is available on the USRDS Web site at http://www.usrds.org. We used the USRDS standard analytic files as of December 2004, which is the most recent available data for researchers (as of February 2007). Institutional claims including treatment information were used as the primary data set, and merged with variables from patient, medical evidence, and facility files from the USRDS core CD based on unique patient identifiers. The study was approved by the Essex Institutional Review Board (Lebanon, NJ) as part of a larger epoetin research study using administrative data.

Patient Selection and Variable Construction

Adult Medicare-eligible ESRD patients receiving in-center hemodialysis in November and December 2004 were eligible for inclusion in the study. All patients were required to have had a claim containing a valid hematocrit level (between 15%-60%) in November 2004 and an epoetin dose level (including zero) in December 2004. We identified 198,815 prevalent hemodialysis patients in December 2004 who had a hematocrit level in November 2004. The cascade of patients selected using the study selection criteria is depicted in Figure 1.

The primary end point for the study was the average weekly epoetin dose that each individual patient received in December 2004. Based on the distribution of epoetin doses in the study population, patient records containing epoetin dose outliers (cutoffs were based on 0.25th and 99.75th percentiles) were removed to avoid potential data anomalies, although inclusion of this group would not alter the main results. Hematocrit levels were taken from institutional claims from November 2004 and were categorized into 9 groups: less than 30%; 30% to less than 33%; 33% to less than 36%; 36% to less than 39%; and 39% or greater. A secondary analysis examined the relationship between dose adjustment from November to December 2004 and organizational status stratified on hematocrit level observed at the end of November.

Patient characteristics included age (years) at ESRD onset, race (reported by the physician as black, white, or other), sex, and proxies for health status such as underlying cause of ESRD (diabetes, glomerulonephritis, hypertension, cystic kidney, or other), duration of dialysis, and presence of cardiovascular and other comorbidities as defined elsewhere by using the Medical Evidence Record data. The Charlson Comorbidity Index was used to measure the severity and range of patient comorbid conditions based on the presence or absence of nonrenal disease during the study period.

Medicare-certified dialysis providers were identified using the USRDS facility file that contains information on each. Similar to the USRDS definitions, dialysis facility organizational status was defined by ownership (for-profit or non-profit) and chain membership (facilities in 1 of the 6 leading chains, small and/or non–chain-affiliated facilities subsequently referred to as nonchain [all freestanding facilities], and hospital-based facilities). Geographic region was included in the analysis based on ESRD network (1 to 18) (Northeast, Southeast, Midwest, or West).

Statistical Analysis

Regression models were fit to estimate the mean epoetin dose and dose adjustment by profit status and chain membership. All models were conditional on age, race, sex, cause of ESRD, duration of dialysis, geographic region, cardiovascular and other comorbidities, and predialysis hematocrit level (further adjustment for the Charlson Index, predialysis receipt of epoetin, and intravenous iron administration did not materially alter our results). The models also were adjusted for within-facility correlations using generalized estimating equations. An alternative 2-step modeling approach that accounts for the 3.3% of the patients who did not receive epoetin in December 2004 yielded similar results (data not shown). The estimated average epoetin dosing levels and epoetin dose adjustments were made by organizational status in the subpopulation of patients who were aged 65 years or older, white, male, reside in the Southeast, had diabetes, and had both cardiovascular and other comorbidities (the most common pattern of covariates). Under the models, the difference in the estimated doses and dose adjustment across facilities was con-
RESULTS

**Patient Characteristics by Organizational Status**

A total of 159,522 ESRD patients receiving hemodialysis services and epoetin therapy in 3982 dialysis facilities comprised the study population (Figure 1). The distribution of patients by organizational status is presented in Table 1. More than 80% of all patients received dialysis from for-profit facilities and more than two thirds from the 4 largest for-profit national chain facilities (chain facilities 1-4). Almost all patients in chain 5 facilities and in the hospital-based facilities received care from nonprofit dialysis centers. Nonprofit compared with for-

| Table 1. Patient Characteristics by Organizational Status (N = 159,522) |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                          | For Profit (n = 131,323) | Nonprofit (n = 28,199)  | Chain 1 (n = 45,919)  | Chain 2 (n = 23,052)  | Chain 3 (n = 24,175)  | Chain 4 (n = 14,787)  | Chain 5 (n = 6,989)  |
|                          |                          |                          |                          |                          |                          |                          |                          |
| Total patients, %*       | 82                       | 18                       | 29                       | 14                       | 15                       | 9                        | 4                        |
| Demographics, %          |                          |                          |                          |                          |                          |                          |                          |
| Age group, y             |                          |                          |                          |                          |                          |                          |                          |
| 18-44                    | 13                       | 12                       | 13                       | 12                       | 12                       | 11                       | 11                       |
| ≥65                      | 36                       | 36                       | 36                       | 36                       | 36                       | 36                       | 36                       |
| Race                     |                          |                          |                          |                          |                          |                          |                          |
| White                    | 54                       | 56                       | 54                       | 51                       | 51                       | 49                       | 57                       |
| Black                    | 41                       | 41                       | 41                       | 47                       | 47                       | 40                       | 47                       |
| Male sex                 | 52                       | 52                       | 52                       | 52                       | 52                       | 51                       | 51                       |
| Region†                  |                          |                          |                          |                          |                          |                          |                          |
| Northeast network 1-5    | 22                       | 34                       | 23                       | 24                       | 19                       | 7                        | 24                       |
| Southeast network 6-8, 13, 14 | 41           | 20                       | 49                       | 37                       | 35                       | 44                       | 48                       |
| Midwest network 9-12     | 20                       | 26                       | 18                       | 20                       | 20                       | 34                       | 17                       |
| West network 15-18       | 17                       | 19                       | 10                       | 19                       | 26                       | 15                       | 11                       |
| Clinical history         |                          |                          |                          |                          |                          |                          |                          |
| Cause of ESRD, %         |                          |                          |                          |                          |                          |                          |                          |
| Diabetes                 | 45                       | 43                       | 45                       | 43                       | 45                       | 44                       | 42                       |
| Hypertension             | 31                       | 27                       | 31                       | 32                       | 30                       | 31                       | 30                       |
| Glomerulonephritis       | 10                       | 12                       | 10                       | 10                       | 10                       | 11                       | 11                       |
| Cystic kidney            | 2                        | 2                        | 2                        | 2                        | 2                        | 2                        | 2                        |
| Other                    | 12                       | 15                       | 12                       | 12                       | 13                       | 14                       | 12                       |
| Mean duration of dialysis, y | 4.0                       | 4.3                       | 4.1                       | 4.1                       | 4.1                       | 4.0                       | 4.5                       |
| Charlson index score, mean‡ | 1.0                       | 1.1                       | 1.0                       | 0.9                       | 1.0                       | 0.9                       | 1.0                       |
| Comorbidities, %         |                          |                          |                          |                          |                          |                          |                          |
| Cardiovascular           | 43                       | 47                       | 43                       | 43                       | 41                       | 43                       | 44                       |
| Noncardiovascular        | 57                       | 56                       | 57                       | 56                       | 58                       | 58                       | 54                       |
| Anemia management, %     |                          |                          |                          |                          |                          |                          |                          |
| Predialysis              |                          |                          |                          |                          |                          |                          |                          |
| Receipt of epoetin       | 28                       | 32                       | 29                       | 27                       | 28                       | 28                       | 31                       |
| Mean hematocrit level    | 29                       | 29                       | 29                       | 29                       | 29                       | 29                       | 29                       |
| Hematocrit level         |                          |                          |                          |                          |                          |                          |                          |
| <30%                     | 6                        | 7                        | 6                        | 5                        | 5                        | 7                        | 8                        |
| 30%–<33%                 | 12                       | 14                       | 13                       | 9.2                      | 9.4                      | 13                       | 16                       |
| 33%–<36%                 | 28                       | 32                       | 28                       | 27                       | 24                       | 30                       | 38                       |
| 36%–<39%                 | 31                       | 30                       | 30                       | 35                       | 32                       | 31                       | 32                       |
| ≥39%                     | 23                       | 17                       | 22                       | 24                       | 30                       | 19                       | 5.9                      |
| Mean                     | 36.2                     | 35.6                     | 36.0                     | 36.5                     | 36.9                     | 35.7                     | 34.6                     |

Abbreviation: ESRD, end-stage renal disease.

*In this row, the percentages add to 100%.
†The Centers for Medicare & Medicaid Services contracts with the 18 end-stage renal disease network organizations covering all 50 states and US territories. The network organizations facilitate optimal care to all patients with ESRD and work in cooperation with individual facilities in their geographic areas.
‡Charlson index scores range from 0 to 16. This is a comorbidity scale that has been validated for use among the renal dialysis patient population. The higher the score, the more comorbidities are present. Due to the 2-month study period, many patients had a Charlson score of 0.
profit facilities, and hospital-based and nonchain facilities compared with large chain facilities had a larger proportion of patients who were older than 65 years, were white, resided in the Northeast, and had cardiovascular comorbidities. Epoetin use before initiation of continuous hemodialysis was more common in patients treated in non-profit facilities (32% of patients) than in for-profit facilities (28%). The average hematocrit level was 35.6% in non-profit facilities and 36.2% in for-profit facilities, and ranged from 34.6% in chain 5 facilities to 36.5% in chain 2 facilities and 36.9% in chain 3 facilities. The proportions of patients with hematocrit level below, within, and above the recommended target range of 33% to 36% were 21%, 32%, and 47%, respectively, in non-profit facilities and 18%, 28%, and 54% in for-profit facilities, respectively. The proportions of patients with hematocrit level below, within, and above the recommended target range of 33% to 36% were 14%, 27%, and 59% in chain 2 facilities, respectively, and 24%, 38%, and 38% in chain 3 facilities, respectively.

**Unadjusted Epoetin Dosing by Organizational Status**

For-profit facilities used an average epoetin dose of 20 838 U/wk (3306 U/wk more than nonprofit facilities). The average dose ranged from 16 188 U/wk in hospital-based facilities and 17 832 U/wk in chain 5 facilities to 24 986 U/wk in chain 2 facilities. A pattern of administration of higher doses of epoetin at for-profit compared with nonprofit facilities was found across all 5 hematocrit categories, although the absolute difference was greatest for patients with hematocrit levels less than 30%, for whom the average dose ranged from 45 697 to 75 822 U/wk at the largest for-profit chains and from 32 676 to 40 124 U/wk at chain 5 facilities, nonchain dialysis facilities, and hospital-based facilities (Table 2).

Patterns of epoetin dose adjustment between November and December 2004 are presented in Table 2. On average, compared with nonprofit facilities, for-profit facilities increased epoetin doses almost 3-fold (11 169 vs 4097 U/wk) for patients with hematocrit levels less than 30%, and 3-fold (6173 vs 1932 U/wk) for patients with hematocrit levels between 30% and less than 33%. The average dose adjustment for patients with hematocrit level less than 30% ranged from 26 093 U/wk at chain 2 facilities to 2023 U/wk at hospital-based facilities and 4841 U/wk at nonchain facilities. For patients with hematocrit levels in the recommended target of 33% to 36%, nonprofit facilities decreased the dose of epoetin by 634 U/wk, while

<table>
<thead>
<tr>
<th>Type of Facility</th>
<th>Overall</th>
<th>&lt;30</th>
<th>30-&lt;33</th>
<th>33-&lt;36</th>
<th>36-&lt;39</th>
<th>≥39</th>
</tr>
</thead>
<tbody>
<tr>
<td>For-profit</td>
<td>20 838</td>
<td>49 058</td>
<td>33 378</td>
<td>21 715</td>
<td>16 145</td>
<td>12 199</td>
</tr>
<tr>
<td>Nonprofit</td>
<td>17 532</td>
<td>37 144</td>
<td>25 066</td>
<td>16 810</td>
<td>13 626</td>
<td>11 484</td>
</tr>
<tr>
<td>Chain 1</td>
<td>20 283</td>
<td>46 552</td>
<td>30 750</td>
<td>20 002</td>
<td>16 052</td>
<td>12 546</td>
</tr>
<tr>
<td>Chain 2</td>
<td>24 886</td>
<td>75 822</td>
<td>52 799</td>
<td>29 565</td>
<td>17 359</td>
<td>10 529</td>
</tr>
<tr>
<td>Chain 3</td>
<td>20 659</td>
<td>49 831</td>
<td>35 694</td>
<td>23 219</td>
<td>16 931</td>
<td>12 988</td>
</tr>
<tr>
<td>Chain 4</td>
<td>20 504</td>
<td>45 697</td>
<td>30 037</td>
<td>20 224</td>
<td>16 054</td>
<td>11 964</td>
</tr>
<tr>
<td>Chain 5</td>
<td>17 832</td>
<td>40 124</td>
<td>25 793</td>
<td>16 426</td>
<td>11 834</td>
<td>7954</td>
</tr>
<tr>
<td>Chain 6</td>
<td>18 410</td>
<td>47 672</td>
<td>26 193</td>
<td>18 269</td>
<td>12 482</td>
<td>9545</td>
</tr>
<tr>
<td>Nonchain</td>
<td>18 601</td>
<td>38 021</td>
<td>27 027</td>
<td>18 059</td>
<td>14 596</td>
<td>12 288</td>
</tr>
<tr>
<td>Hospital-based</td>
<td>16 188</td>
<td>32 676</td>
<td>22 285</td>
<td>15 638</td>
<td>13 476</td>
<td>11 804</td>
</tr>
</tbody>
</table>

| Change in Epoetin Dose, U/wk From November to December 2004† |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| For-profit       | −431             | 11 169           | 6173             | 1214             | −2065            | −6694            |
| Nonprofit        | −945             | 4097             | 1932             | −634             | −2032            | −4066            |
| Chain 1          | −168             | 10 317           | 5251             | 1063             | −1752            | −5822            |
| Chain 2          | −259             | 26 093           | 16 593           | 3793             | −3676            | −11 336          |
| Chain 3          | −370             | 10 634           | 6523             | 1900             | −962             | −5004            |
| Chain 4          | −790             | 9 235            | 4 039            | −28              | −2259            | −6859            |
| Chain 5          | −612             | 5 069            | 2 723            | −850             | −2418            | −5762            |
| Chain 6          | −1273            | 7 698            | 3 094            | −970             | −2055            | −9350            |
| Nonchain         | −830             | 4 841            | 2 402            | −405             | −1848            | −4484            |
| Hospital-based   | −1 349           | 2 023            | 9 95             | −953             | −1 962           | −3495            |

*Hematocrit level was taken in November 2004.
†The minus signs indicate a reduction in epoetin dose.
for-profit facilities increased the dose of epoetin by 1214 U/wk. Chain facilities, 1, 2, and 3 increased the dose of epoetin for patients within the recommended hematocrit range of 33% to 36%. The largest increase in dose of epoetin was administered at chain 2 facilities (3793 U/wk).

**Adjusted Epoetin Dosing by Organizational Status**

The adjusted results were similar to the unadjusted ones. The adjusted average dose of epoetin was 3486 U/wk (95% confidence interval [CI], 3004–3968 U/wk) higher in for-profit than in nonprofit facilities (data not shown). The adjusted mean weekly epoetin doses by type of organization are presented in Figure 2. Among the 5 largest chain facilities, chain 2 facilities and chain 3 facilities had the highest average epoetin dose for patients with hematocrit levels above and below 33%, while chain 5 facilities had the lowest average doses and had dosing practice patterns similar to nonchain and hospital-based facilities. The difference in average dosing levels by organizational status was more marked for patients with hematocrit levels under 33%. In this group, chain 2 facilities administered 31,915 U/wk (95% CI, 29,281–34,548 U/wk) of epoetin more than chain 5 facilities and 36,646 U/wk (95% CI, 35,954–37,337 U/wk) of epoetin more than the hospital-based facilities (Table 3).

The findings were similar for any 2-month period in 2004, although the average epoetin dose decreased at chain 5 facilities in the second half of the year and...
the highest average dose was administered at chain 3 facilities (followed by chain 2 facilities) in the first quarter of the year. The analyses were repeated to examine epoetin dose concurrent with hematocrit levels (both averaged over the 2-month study period) and the results remained virtually unchanged. Inadequate iron stores are a known cause of epoetin hyporesponsiveness. Direct measures of iron indices are not available in this administrative database, but the amount of parenteral iron administered is available. After including the amount of intravenous iron administered during the 2-month study period in the multivariate model, the results were unchanged.

COMMENT

Our results indicate that facility ownership and chain status have a strong effect on epoetin dosing practice patterns. Compared with other facility types, we found that large for-profit chains administered higher epoetin doses, used higher dose increases, and had higher achieved hematocrit levels, as well as a larger proportion of patients above the upper limit of hematocrit level (target of 36% was recommended by the National Kidney Foundation and the US Food and Drug Administration during the time of our study). Our adjusted analyses suggest that the differences in epoetin dose levels among dialysis chains are not explained by differences in patient characteristics or responsiveness to epoetin therapy. In fact, previous data suggest that patients in for-profit facilities have characteristics that would make them more responsive to epoetin. Szczech et al19 examined dialysis facilities between 1995 and 2000 using data from the Centers for Medicare & Medicaid Services (CMS) ESRD Clinical Performance Measures project. The authors found that patients in for-profit facilities had higher adequacy of dialysis, mean albumin, mean transferrin saturation, and mean ferritin levels, suggesting that if patient-specific factors such as these had been included in our analysis, for-profit facilities would be expected to require lower not higher doses of epoetin.

The National Kidney Foundation–Kidney Disease Outcome Quality Initiative recommended a hemoglobin target of 11 to 12 g/dL (hematocrit level of 33%-36%) at the time of our study. The package insert for Epogen, the agent approved by the Food and Drug Administration for use in dialysis patients, recommended a target hemoglobin of 10 to 12 g/dL (hematocrit level of 30%-36%). However, factors other than the National Kidney Foundation–Kidney Disease Outcome Quality Initiative clinical practice guidelines and the Food and Drug Administration recommendations may have influenced 2004 epoetin administration practice patterns.

First, the CMS has required since 1994 the public reporting of the proportion of patients at a dialysis facility with a hematocrit level greater than or equal to 33% as a performance measure of the quality of care. The CMS has established a goal of having 70% or more of all patients in a given facility with a hematocrit level greater than 33%. At the time of our study, although the upper target of hematocrit level was 36%, the CMS would allow reimbursement for epoetin as long as the 3-month average hematocrit level was less than 37.5%. To show improved quality of care, therefore, the incentive is to use large doses of epoetin to achieve a high proportion of a facility’s patient population above a hematocrit level of 33%. In our study, the proportion of patients meeting this performance measure ranged from 79% at nonprofit facilities to 82% at for-profit facilities, and from 76% at chain 5 facilities to 86% at chain facilities 2 and 3, suggesting that despite large differences in epoetin doses, most facilities meet the CMS performance goals.

Second, financial incentives also might have contributed to the use of large epoetin doses based on facility type. Although the largest source of dialysis facility income is a predetermined payment (referred to as the ESRD composite rate that is exclusive of injectable drug costs) for each dialysis treatment, that rate has changed mally in the 2 decades preceding our study period and the real dollar value has actually declined by about 65%. Medicare epoetin payments are the second-largest source of facility income, comprising approximately 25%. Furthermore, dialysis providers belonging to large chains typically obtained volume discounts for supplies or drugs such as epoetin that are linked to usage. According to the 2005 annual report of DaVita Inc,23 which is one of the largest dialysis chains, epoetin accounts for about a quarter of its dialysis revenue and “our agreement with Amgen for the purchase of EPO [epoetin] includes volume discount and other thresholds which could negatively impact our earnings if we are unable to meet these thresholds.”

Different epoetin practice patterns across facilities may reflect different timing strategies regarding the target hematocrit range and how aggressively to raise the epoetin dose for hyporesponsive patients who do not achieve the target hematocrit level. In our study, for-profit facilities continued to increase epoetin doses in patients who had reached the recommended hematocrit target of 33%. In fact, the hematocrit target at which doses are no longer increased appears to exceed 36%. Similarly, Collins et al24 found that “overshooting” of the recommended hematocrit target was more prevalent in for-profit chain facilities than in nonprofit chain facilities.

We found that the largest differences in epoetin dosing by facility type are at hematocrit levels less than 33%. It is likely that aggressive dose increases in these patients may increase hematocrit level in some but hematocrit levels in many may be relatively unchanged.25-26 The lack of response to epoetin may reflect an underlying medical condition, which is not ameliorated by increasing the dose of epoetin.27-29 The National Kidney Foundation–Kidney Disease Outcome Quality Initiative guidelines recommend that patients who are poor responders to epoetin therapy be considered for other approaches that might be complemen-
Clinical practice guidelines have been the focus of considerable attention. However, both the coverage policy and the reimbursement for even higher epoetin dosing.

Changes might provide additional incentives for dialysis facilities to target hematocrit levels higher than 36%, and confirmation is provided by the finding that for-profit facilities increase epoetin doses for patients in the target hematocrit range of 33% to 36%. Furthermore, in our analysis, 23% of the hemodialysis population in for-profit facilities had a monthly hematocrit level of 39% or higher.

In May 2006, the National Kidney Foundation published revised guidelines changing the recommended target hematocrit from 33% to 36% to a target of 33% to less than 39%. In April 2006, the CMS enacted a new epoetin coverage policy that allowed for reimbursement up to hematocrit levels of 39%. Our results suggest that many facilities were already targeting hematocrit levels higher than 36% prior to these guideline and policy changes, and these changes might provide additional incentives for even higher epoetin dosing. However, both the coverage policy and clinical practice guidelines have been the subject of much recent controversy given the results from randomized controlled trials that have failed to show a cardiovascular or survival benefit of raising the hematocrit level above 36%. and 2 recently published trials suggest possible adverse consequences of higher hematocrit levels in patients with chronic kidney disease.

Our study has several limitations. First, factors that might be relevant to epoetin responsiveness such as iron levels and nutritional status are not available in administrative data. However, as discussed above, ours and previous studies suggest that factors associated with epoetin hyporesponsiveness may be less common in patients treated at for-profit facilities. Second, we did not have information on the route of epoetin administration. In an earlier study, we found that route of administration was associated with organizational status—nonprofit hospital-based small or nonchain units had higher rates of subcutaneous administration of epoetin. Third, since 2004 (the observation period for this study) the 6 largest dialysis chains have been consolidated into 3, possibly affecting the practice patterns observed in this study. Last, according to the USRDS, the use of the new darbepoetin drug for the treatment of dialysis-related anemia has increased since 2003; however, more than 99% of all claims submitted by chain-affiliated units in 2004 and 2005 were for the older epoetin product (alfa epoetin version of the drug).

In conclusion, these findings suggest that reimbursement policy and clinical performance measures may provide incentives for dialysis facilities, in particular for-profit facilities, to target hematocrit levels exceeding those recommended by the clinical guidelines. As existing guidelines are reevaluated, it will be important for policy makers to design an epoetin reimbursement policy that provides an incentive to achieve desired clinical outcomes while optimizing epoetin usage.

**Author Contributions:** Dr Thamer had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Dr Kaufman reported serving as a consultant and receiving grant support from Amgen and F. Hoffmann-La Röche. No other authors reported disclosures.

**Funding/Support:** The research for this article was supported in part by National Institutes of Health grant R01-DK066011-01-A2.

**Role of the Sponsor:** The National Institutes of Health was not involved in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

**Disclaimer:** The data were provided by the US Renal Data System but the interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as the official policy or interpretation of the US government.

**References**

15. Frankenfield DL, Roman SH, Rocco MV, Bederger MR, McClellan WM. Disparity in outcomes for adult Native American hemodialysis patients? find-

In law a man is guilty when he violates the rights of others. In ethics he is guilty if he only thinks of doing so.
—Immanuel Kant (1724-1804)