PRODUCTIVITY IN THE DELIVERY OF U.S. DIALYSIS TREATMENTS ACCELERATED AFTER 2010 WITHOUT COMPROMISING QUALITY OF CARE

J. Mark Stephens[1], David Barrus[2], Dennis Cotter[3], Martin Ma[2], Mae Thamer[3], Jay Wish[4]

[1]Prima Health Analytics, Weymouth MA [2]Brigham Young University-Idaho, Rexburg ID [3]Medical Technology & Practice Patterns Institute, Bethesda, MD [4]Indiana University, Indianapolis, IN

INTRODUCTION

BACKGROUND

- Implementation of the End-Stage Renal Disease (ESRD) Prospective Payment System (PPS) in 2011 created strong economic incentives for Medicare dialysis providers to improve efficiency in the delivery of dialysis treatments, while incentives to maintain or improve quality of care were more limited.

OBJECTIVES

- To evaluate whether trade-offs were made between economic efficiency and quality in the delivery of dialysis care in the pre vs post-PPS era.

METHODS

Study Setting

- A stratified random sample of 935 Medicare-certified free-standing dialysis facilities in the U.S. that offered in-center hemodialysis from 2007 through 2014 and that had clean and complete cost report data was selected from the full set of 6,187 dialysis providers (**Table 1**).

Data Sources

- Treatment data and cost and labor inputs of dialysis treatments were obtained from 2007-2014 Medicare Renal Cost Reports.[1] Quality of care measures for each facility were sourced from the annual Dialysis Facility Reports.[2] Dialysis facility characteristics were obtained from the Cost Reports. All cost data were adjusted to 2010 dollars and compensation costs were adjusted for geographic wage differences.

Definitions

- **Efficiency**: Dialysis facilities are faced with relatively fixed demand for patients for whom they produce a fixed number of dialysis treatments. Due to fixed demand, this is a variable-returns-to-scale market; that is, outputs cannot be increased proportionally to any increase in inputs. Efficiency in dialysis is best viewed from the perspective of technical efficiency (i.e., improvement in some inputs or outputs without worsening any other inputs or outputs). Efficiencies are realized through minimizing inputs while maintaining a fixed level of output. In such an input-oriented model, the minimum inputs that a facility should require to produce its outputs is estimated from the best-practice frontier, as defined through appropriate benchmarking for technical efficiency.[3]
- **Productivity**: Changes in productivity are the result of the combination of changes in the relative efficiency of a unit and changes in the best practices frontier. As the best practices frontier changes, e.g. – through technological or management innovation, there is a change in the minimum input requirements to produce a given level of outputs.[4] A previously efficient unit may fall behind if the industry-leading innovations are not adopted, resulting in a decline in relative productivity.

Analysis Technique

- This was a facility-level retrospective study using **Data Envelopment Analysis** (DEA) to model the technical efficiency of free-standing dialysis centers for each year between 2007-2014. DEA uses linear programming to convert multiple inputs (e.g., costs, staffing levels) that a dialysis facility uses to produce an output (e.g., dialysis treatments) to a relative efficiency score between 0 and 1, where scores are proportional to the efficiency frontier (score of 1.0.) The DEA-based **Malmquist Productivity Index** was used to compare DEA-based efficiency scores across years.

Outputs Modeled

- Models measured changes in efficiency in the production of dialysis treatments as well as in the maximization of select proxies for quality of care:
  - dialysis dose adequacy – *Percent of Patients with Urea Reduction Ratio ≥ 65%*
  - anemia management - *Percent of Patients with Hemoglobin ≥ 10 g/dl*
  - avoidance of access-related infections - *Non-Infection Rate (1 – infection rate)*
  - avoidance of days hospitalized - *Average Days Not Hospitalized (365 – average days hospitalized)*
- Models were run for each output variable independently, as well as for all outputs combined – the "5-Output Model" (**Table 2**).

Statistical Analysis.

- Statistics from each model included the relative efficiency (DEA) score for each unit for each year 2007-2014, and the Malmquist Productivity Index for each unit for each year-over-year time period. Results were stratified by time period and by industry segment. All the iterations of the DEA and Malmquist models were performed using R statistical software.

RESULTS

DESCRIPTIVE STATISTICS ON STUDY SAMPLE

Table 1: Comparison of Study Sample to Full Industry Data Set

	Industry	Study Sample
N Facilities (Facility-Years)	6,187 (40,781)	935 (7,324)
% Large Dialysis Organization	71.9%	80.8%
% Medium Dialysis Organization	13.4%	13.6%
% Small/Independent Organization	14.8%	5.6%
% For Profit	93.8%	98.6%
% Midwest Region	22.2%	23.0%
% Northeast Region	12.4%	13.6%
% South Region	46.6%	50.2%
% West Region	18.0%	13.0%
% Puerto Rico	0.7%	0.3%
Average Cost per Treatment	$248.82	$247.03
Average Number of Stations	18.2	19.4
Average Number of Treatments	10,792	11,221

Table 2: Model Input and Output Variables

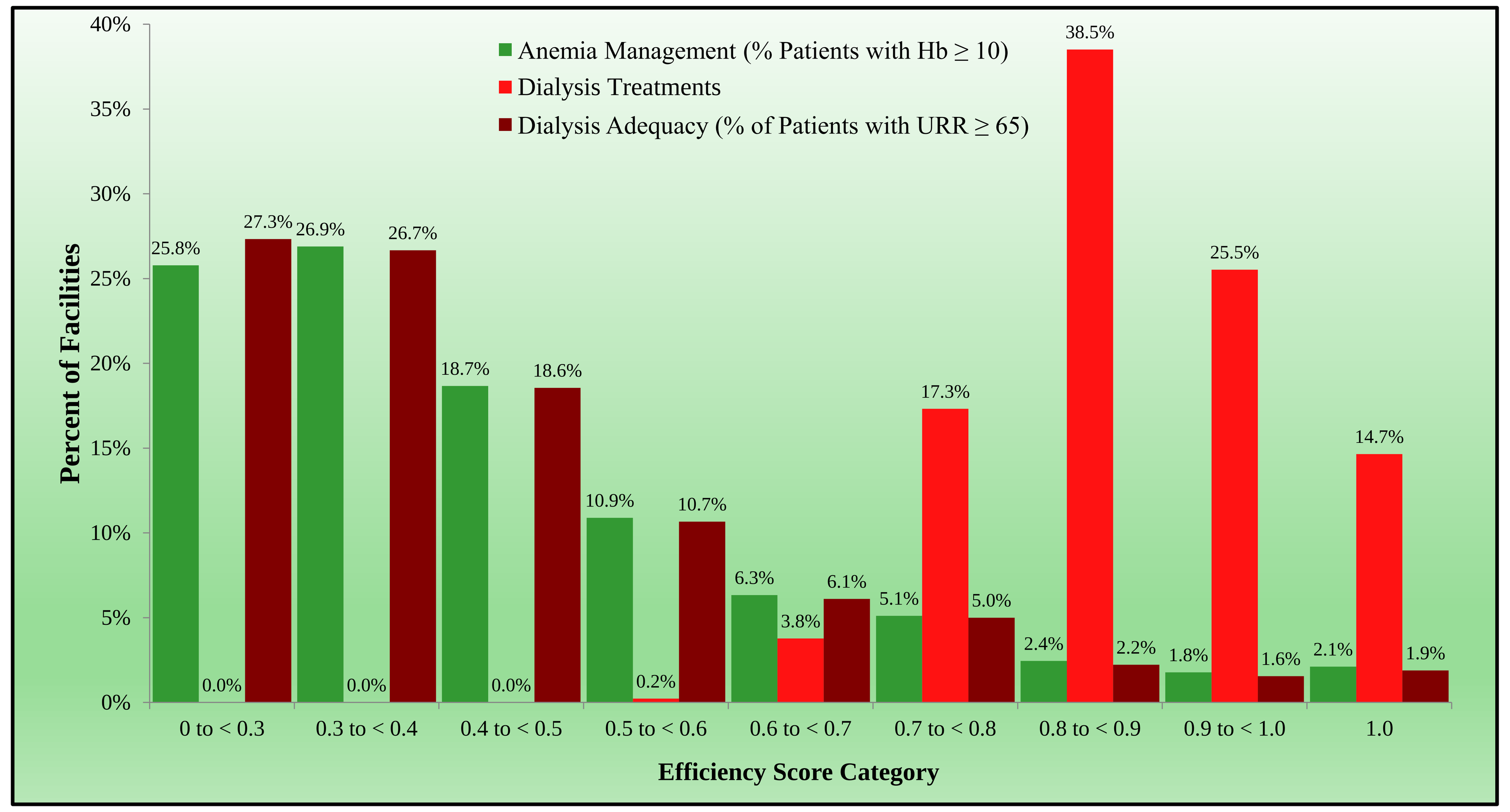
Variable *Observations (n=7324)**	*Mean*	*Median*	*SD*
Outputs			
Annual Dialysis Treatments	11,221	9,976	6,154
% Patients with URR >=65	97.9%	100.0%	3.4%
% of Patients with Hb >= 10	93.9%	96.4%	7.9%
Access-Related Non-Infection Rate	97.7%	98.1%	2.1%
Average Annual Non-Hospitalized Days	351.7	352.3	4.7
Cost Inputs			
Capital Costs (Buildings & Fixtures)	$ 217,778	$193,779	$124,005
Dialysis Machine Costs	$ 111,260	$ 98,464	$ 56,115
Operations & Maintenance	$ 117,068	$101,394	$ 66,595
Compensation for Direct Patient Care	$ 797,511	$687,424	$519,596
Ancillary Costs (Drugs & Supplies)	$ 849,661	$727,230	$518,280
Administrative and General and Other Costs	$ 633,053	$558,541	$325,845

**5-Output Model. SD=Standard Deviation; URR=Urea Reduction Ratio; Hb=Hemoglobin.*

DATA ENVELOPMENT ANALYSIS

- Technical efficiency in the production of dialysis center outputs varied widely by the output modeled. By 2014, providers were technically efficient in production of dialysis treatments but were generally inefficient in delivery of quality care **(Figure 1)**.
- When modeling efficiency in the production of dialysis treatments, nearly 80% of facilities were near the efficiency frontier (DEA score of 0.8 or higher) and 15% were technically efficient (score of 1.0).
- In contrast, when modeling anemia management or adequacy of dialysis dose, only 2% of units were efficient and over 70% of units scored 0.5 or lower.
- DEA scores are proportional, i.e. – a score of 0.5 is twice the distance from the efficiency frontier as a score of 0.75.

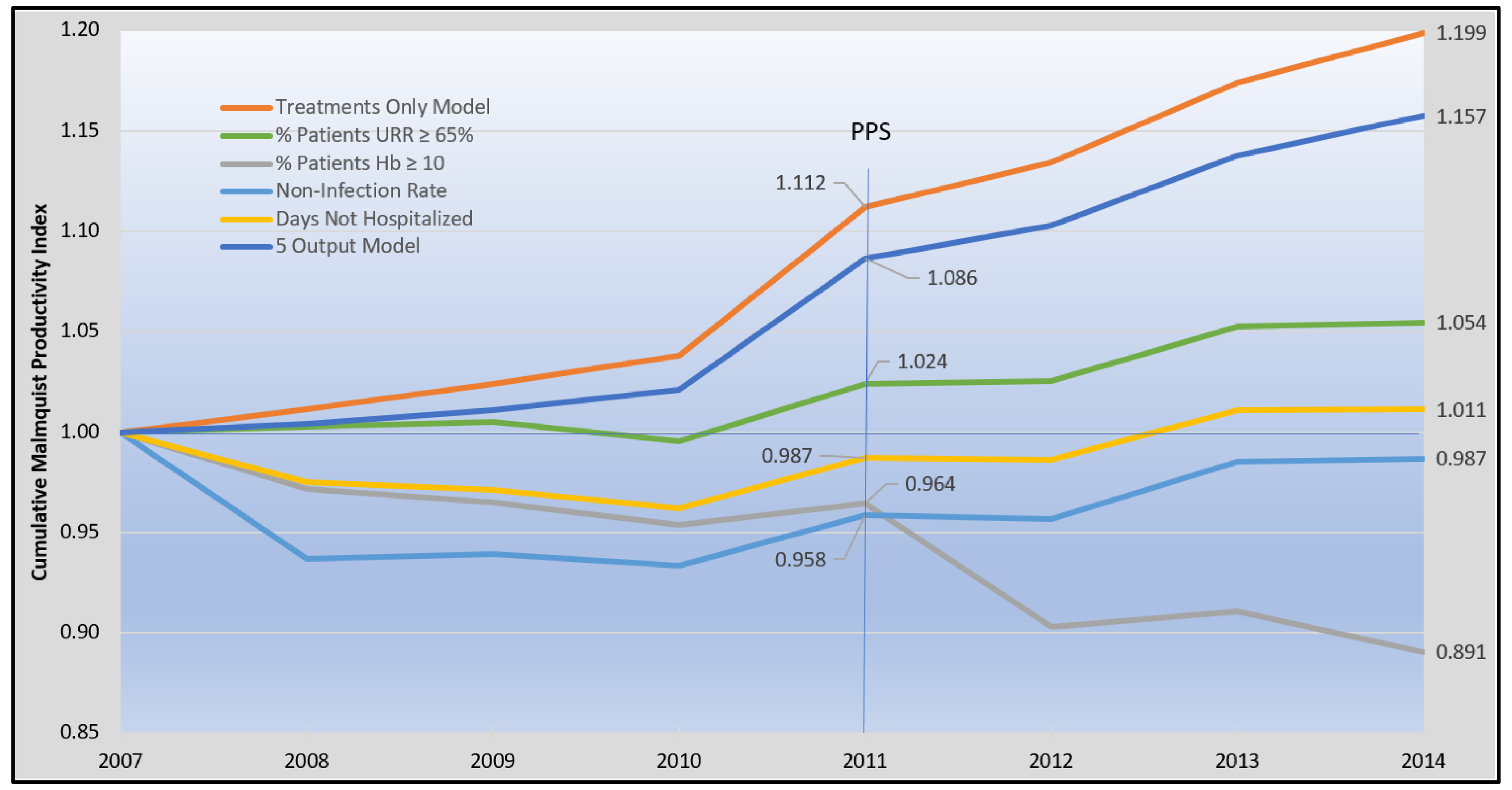
Figure 1: 2014 DEA Score Distributions by Select Output Measures



PRODUCTIVITY CHANGE 2007 TO 2014

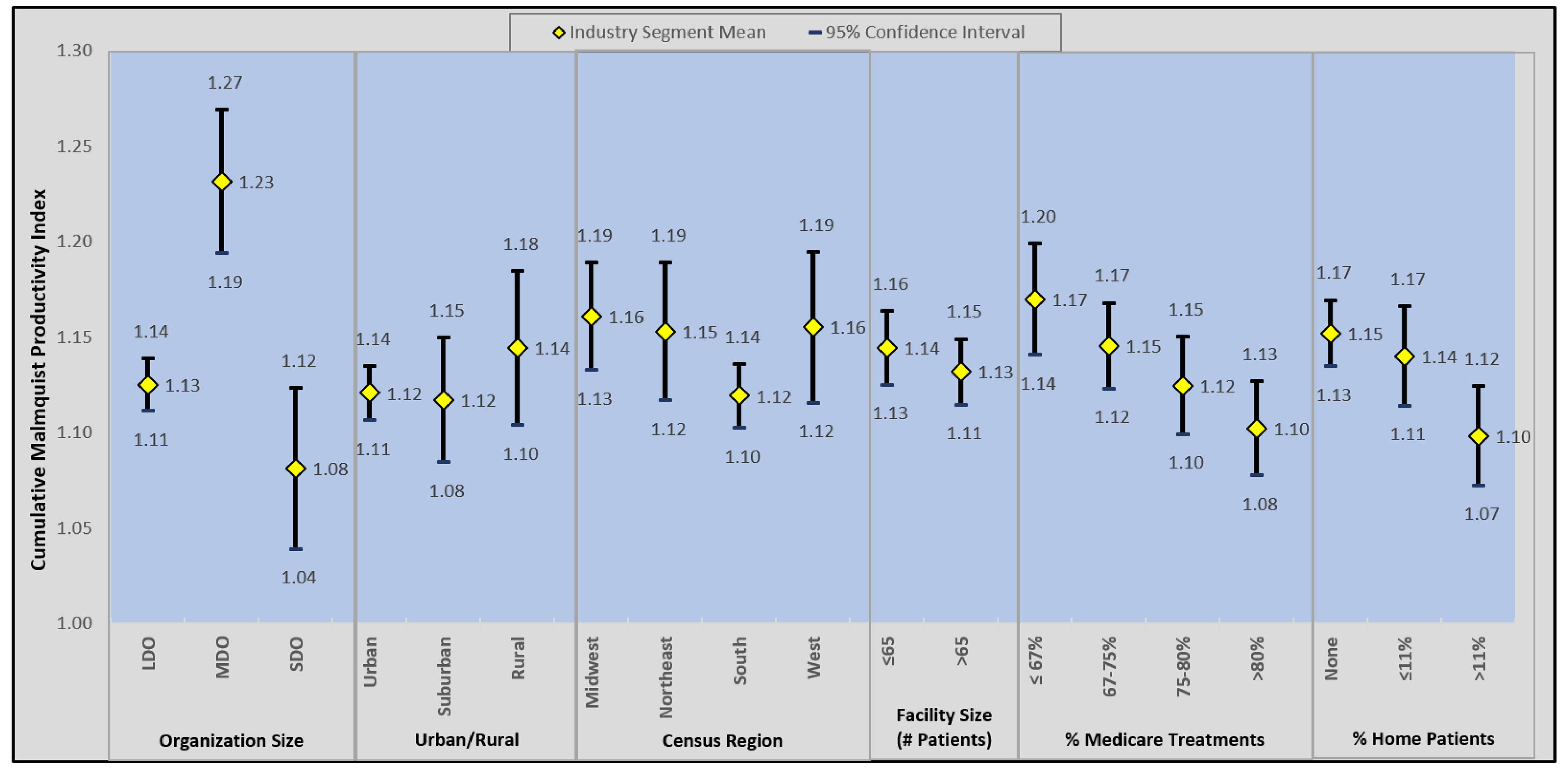
- Productivity change was flat to negative for most dialysis facility outputs from 2007-2010, but productivity gains were observed on all outputs going into the PPS in 2011 (**Figure 2**). After implementation of the PPS in 2011 productivity continued to improve in all measures except anemia management.
- Modeling treatments as the only output, productivity improved by 19.9% from 2007 to 2014, with 78% of this improvement occurring after 2010. When including quality measures as outputs, productivity gains were 15.7%.
- 3 of the 4 quality measures showed productivity gains after 2010, whereas productivity declined for all four from 2007-2010. Productivity in anemia management declined by 11% from 2007-2014, with equal declines in the pre vs post-PPS timeframe.

Figure 2: Cumulative Malmquist Productivity Index by Dialysis Output Measure 2007-2014



- By industry segment, the biggest productivity gains on average were observed in medium-sized firms, and facilities with lower proportions of Medicare treatments (**Figure 3**). The poorest performers were small and independent dialysis organizations and facilities with the highest percent of home patients. (Data shown for the 5-Output Model – all outputs combined).

Figure 3: Means and 95% Confidence Intervals of Cumulative Malmquist Productivity Index 2007-2014, by Industry Segment (5-Output Model)



LDO=Large Dialysis Organization; MDO=Medium Dialysis Organization; SDO=Small and Independent Dialysis Organization.

DISCUSSION

- The US dialysis industry's response to the 2011 Medicare payment reforms was to improve productivity and efficiency not only in the production of dialysis treatments but also in quality of care metrics.
- The one exception that was found in this study was that firms were found to be less efficient in the maintenance of patient hemoglobin above 10 g/dl. Optimal anemia management strategies remain controversial and the post-2011 results may also have been influenced by the mid-2011 FDA label change to reduce use of erythropoiesis-stimulating agents.
- When combining all outputs into a single efficiency model, the longitudinal productivity gains over the study period were almost 16% on average. This, when compared to a 20% productivity improvement in production of dialysis treatments alone, suggests that quality of care generally was not sacrificed for economic expediency in the new era of tightening reimbursements for Medicare dialysis patients.

LIMITATIONS

- DEA is very sensitive to errors and outliers in the study data set and requires careful specification of model inputs and outputs. It is important that the potential combinations of inputs and outputs are realistic.
- Our models did not include input measures to adjust for variability in patient case mix (i.e. – input requirements) across facilities, and there is possibility of selection bias in the sample facilities with clean non-missing data.
- Finally, the proxy measures for quality of care that were available for this study were limited to what was reported across the full study period. Better quality measures are needed to validate our findings.

CONCLUSIONS

- Enactment of the PPS appears to have achieved the objective of improved dialysis center efficiency generally without compromising quality of care.
- This novel approach to the measurement of performance on both the efficient delivery of dialysis treatments as well as maintenance of quality of care will provide insights for design of the next generation of integrated care models for Medicare's dialysis patients.

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