Examining Facility-Level Data for the USRDS

Yi Li, PhD

Professor of Biostatistics, University of Michigan, Ann Arbor
Director, Kidney Epidemiology and Cost Center (KECC)

Co-Deputy Director, United States Renal Data System Coordinating Center
Disclosures

• Federal funding sources
  – National Institutes of Health – NIDDK and NCI
  – Centers for Medicare & Medicaid Services
  – Centers for Disease Control and Prevention
  – Veterans Health Administration

• Non-federal funding sources
  – Joint Institute (University of Michigan and Beijing University)
Initial Modality
Peritoneal Dialysis (PD) and Hemodialysis (HD)

• About 90% of ESRD patients started with HD, while 10% started with PD

• However, some argue that the predominance of HD as initial therapy has “little to do with clinical outcomes,” but is “driven by ease of HD initiation” (Ghaffari et al., 2013)

• There is an increasing trend of PD usage (ADR, 2014) and more interest in starting dialysis with PD
Should We Start with PD?

• PD preserves residual renal function and vascular access sites, lowers cost of therapy, and offers better patient autonomy compared with HD (Dalal et al., 2011)

• PD is not associated with myocardial stunning, as opposed to HD (Selby and McIntyre, 2011)
Some Studies Comparing PD versus HD

<table>
<thead>
<tr>
<th>Publication</th>
<th>No. of Patients (duration of study)</th>
<th>Hazard Ratio (PD vs HD)</th>
<th>Follow-up Time</th>
<th>Statistical Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lukowsky et. al (2013)</td>
<td>23,718 (2001–2006)</td>
<td>0.52</td>
<td>2 years</td>
<td>Marginal structural model</td>
</tr>
<tr>
<td>Weinhandl et. al (2010)</td>
<td>98,875 (2003)</td>
<td>0.92</td>
<td>4 years</td>
<td>Propensity score</td>
</tr>
<tr>
<td>Mehrotra et. al (2010)</td>
<td>684,426 (1996–2004)</td>
<td>1.03~1.08</td>
<td>5 years</td>
<td>Propensity score</td>
</tr>
</tbody>
</table>
Our Goals and Methods

• Utilize the most recent USRDS data to study the effect of initial dialysis modality on patients’ early mortality

• Explore various statistical approaches to compare early survival outcomes in an observational setting
  – descriptive analysis
  – covariate adjustment
  – propensity score
  – instrumental variable

• All analyses are conducted under “intent-to-treat”
Study Population
2010-2012 Incident Patients

310,496 adult dialysis patients
- 296,531 patients w/ complete information
- 294,346 patients at facilities with 10+ patients
- 270,342 patients survived 90 days

6,109 dialysis facilities
- 5,771 facilities
- 5,292 facilities
Weekly Mortality Rate
2010-2012 incident patients

Number of Patients
HD  271623
PD  22723
Comparisons of Patient Characteristics by Initial Modality

<table>
<thead>
<tr>
<th>Patient characteristic</th>
<th>Hemodialysis</th>
<th>Peritoneal Dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (M)</td>
<td>64.3</td>
<td>59.0</td>
</tr>
<tr>
<td>Black (%)</td>
<td>28.4</td>
<td>22.7</td>
</tr>
<tr>
<td>Nephrology care &gt;6 months (%)</td>
<td>42.1</td>
<td>67.2</td>
</tr>
<tr>
<td>eGFR (M)</td>
<td>11.7</td>
<td>11.2</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>60.4</td>
<td>53.0</td>
</tr>
<tr>
<td>CAD (%)</td>
<td>20.2</td>
<td>13.4</td>
</tr>
<tr>
<td>PAD (%)</td>
<td>13.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Number of comorbidities* (M)</td>
<td>1.9</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*Excluding CAD, PAD and diabetes.
Distribution of Facility-Level PD Usage (2012)

Among facilities with any PD patients (51% of all facilities)
Weekly Mortality Rate

Patient Age

Age <65

Age 65+

Number of Patients
HD 132701
PD 14427

Number of Patients
HD 138922
PD 8296

Mortality rate, per 100 pt-years
Weekly Mortality Rate
Race

**White**
- Number of Patients
  - HD: 178885
  - PD: 15874

**Black**
- Number of Patients
  - HD: 77064
  - PD: 5150

**Other**
- Number of Patients
  - HD: 15674
  - PD: 1699
**Weekly Mortality Rate**

**Patient Health Status**

**Healthier**
- < 65 years old, no diabetes, no coronary artery disease (CAD) or peripheral artery disease (PAD)

**Less Healthy**
- > 65, diabetes, either CAD or PAD

---

**USRDS**

**UNITED STATES RENAL DATA SYSTEM**
Weekly Mortality Rate
Pre-ESRD Nephrologist Care

<6 Months

6-12 Months

>12 Months

Number of Patients
HD  157161
PD  7444

Number of Patients
HD  47144
PD  5560

Number of Patients
HD  67318
PD  9719

Mortality rate, per 100 pt-years

Week
Crude Comparison of PD vs HD in Early Mortality

<table>
<thead>
<tr>
<th></th>
<th>Day 0–90 (n = 294,346)</th>
<th>Day 91–365 (n = 270,342)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Ratio</td>
<td>0.23</td>
<td>0.41</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>0.21–0.26</td>
<td>0.39–0.44</td>
</tr>
</tbody>
</table>
Potential Issues

• Differences in patient-level and facility-level characteristics among the treatment groups

• Unobserved confounders could also render bias
Statistical Approach
Propensity Score

• Aims to create a pseudo-randomized trial setting by accounting for the covariates that predict treatment assignment
• Balances comparison groups on a large number of covariates without losing many observations
• One main disadvantage is that it only accounts for observed (and observable) covariates
Statistical Approach
Instrumental Variable (IV)

• Accounts for unobserved confounders
• Selection of instrumental variables depends on subject-matter knowledge, and “weak” instruments cause instability
Average PD Usage of Other Patients in Facilities as IV

• Represents the facility preference of PD usage
• Possibly independent of unmeasured patient-related confounders (conditional on measured covariates)
• Fairly strong instrument (i.e., the large variation of PD usage across facilities)
## Comparisons of PD and HD in Early Mortality Estimates from Competing Methods

<table>
<thead>
<tr>
<th></th>
<th>Day 0–90 (n = 294,346)</th>
<th>Hazard Ratio (95% CI)</th>
<th>Day 91–365 (n = 270,342)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude</td>
<td>0.23 (0.21, 0.26)</td>
<td></td>
<td>0.41 (0.39, 0.44)</td>
<td></td>
</tr>
<tr>
<td>Covariate adjusted</td>
<td>0.40 (0.37, 0.44)</td>
<td></td>
<td>0.62 (0.59, 0.65)</td>
<td></td>
</tr>
<tr>
<td>Propensity score</td>
<td>0.38 (0.34, 0.42)</td>
<td></td>
<td>0.63 (0.59, 0.66)</td>
<td></td>
</tr>
<tr>
<td>Instrumental variable</td>
<td>0.39 (0.34, 0.45)</td>
<td></td>
<td>0.62 (0.57, 0.67)</td>
<td></td>
</tr>
</tbody>
</table>
## Comparisons of PD and HD in Early Mortality Subgroup Analysis

### Healthier (Age 65, no diabetes, CAD or PAD)

<table>
<thead>
<tr>
<th></th>
<th>Day 0–90 (n = 44,792)</th>
<th>Day 91–365 (n = 42,601)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude</td>
<td>0.09 (0.06, 0.14)</td>
<td>0.21 (0.17, 0.44)</td>
</tr>
<tr>
<td>Covariate adjusted</td>
<td>0.19 (0.13, 0.27)</td>
<td>0.34 (0.28, 0.42)</td>
</tr>
<tr>
<td>Propensity score (stratified)</td>
<td>0.21 (0.12, 0.36)</td>
<td>0.32 (0.24, 0.44)</td>
</tr>
<tr>
<td>Instrumental variable</td>
<td>0.18 (0.11, 0.30)</td>
<td>0.29 (0.21, 0.40)</td>
</tr>
</tbody>
</table>

### Less Healthy (Age 65, diabetes and either CAD or PAD)

<table>
<thead>
<tr>
<th></th>
<th>(n = 53,424)</th>
<th>(n = 46,879)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude</td>
<td>0.41 (0.34, 0.49)</td>
<td>0.68 (0.61, 0.76)</td>
</tr>
<tr>
<td>Covariate adjusted</td>
<td>0.56 (0.47, 0.66)</td>
<td>0.83 (0.75, 0.91)</td>
</tr>
<tr>
<td>Propensity score (stratified)</td>
<td>0.53 (0.44, 0.63)</td>
<td>0.83 (0.75, 0.91)</td>
</tr>
<tr>
<td>Instrumental variable</td>
<td>0.51 (0.38, 0.70)</td>
<td>0.89 (0.74, 1.08)</td>
</tr>
</tbody>
</table>
Summary

• There is an increasing trend of PD usage recently
• There is a mortality peak around 6 weeks among the initial HD group, while no obvious peaks are found among the initial PD group
• Different approaches hint at early survival advantages of initial PD, and these advantages differ by subgroups
• Statistical approaches are useful for the analysis of observational data, although more effort is needed to verify certain assumptions
• Accounting for duration of PD usage and modality switch is an ongoing project
Should Peritoneal Dialysis as Initial Modality Become a Standard of Care?

- Patient education
- Bundled payment
- Technique failure
- Patient satisfaction
Acknowledgments

• Hui Liu
• Rajiv Saran
• Doug Lehmann
• Yun Li
• Deanna Chyn
• Amy Jiao
• Tempie Shearon
• Anca Tilea
• Valarie Ashby
Distribution of Propensity Scores, by Modality
Facility-Level PD Usage, by Facility Characteristics

* Median for each facility’s ZIP code. *Education* represents the median percentage of bachelor’s degrees in the ZIP code.