Trends in the ESRD Program and Escalation of Infectious Events in the First Three Months of Dialysis: A Public Health Concern?

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Director, United States Renal Data System
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Patient counts, by modality
Figure p.3 (Volume 2)

Incident & December 31 point prevalent patients.
Adjusted incident rates & annual percent change

Figure 2.3 (Volume 2)

Incident ESRD patients; rates adjusted for age, gender, & race.
Projected counts of incident & prevalent ESRD patients through 2020
Figure 2.1 (Volume 2)

Incident counts & adjusted rates, by age

Figure 2.5 (Volume 2)

Incident ESRD patients; rates adjusted for gender & race.
Incident counts & adjusted rates, by primary diagnosis

Figure 2.8 (Volume 2)

Incident ESRD patients; rates adjusted for age, gender, & race.
Adjusted incident rates of ESRD due to diabetes, by age, race, & ethnicity

Figure 1.21 (Volume 2)
Adjusted incident rates of ESRD due to diabetes, by age, race, & ethnicity

Figure 1.21 (Volume 2)
Growth of the ESRD program

- Incident counts and rates have been stable for 7 years
- The projected incident population to 2020 is now 143,000, for 2015 130,000 and 2010 117,000
- The projected prevalent population continues to grow at the same rate and may reach 581,000 by 2010, 676,000 by 2015 and 774,000 by 2020
- Most incidence rates have peaked except for younger non-White populations
- ESRD incidence rates for African Americans, Native Americans and Hispanics age 30-39 years old are increasing in contrast to the declining rates for White!
Total ESRD expenditures
Figure p.22 (Volume 2)

Period prevalent ESRD patients. Includes payments for MSP patients, but no estimate for HMO costs or organ acquisition.
Per person per month costs for clinical services

Figure 10.22 (Volume 2)
Total Medicare spending on injectables
Figure p.26 (Volume 2)

Period prevalent dialysis patients. Same methods as those used in Table K.2.
Cost of the ESRD Program

- Total Medicare ESRD expenditures has reached $23.9 Billion
- Injectable medications cost have been stable since the introduction of Average Sale Price (ASP) plus 6%.
Adjusted mortality rates, by vintage: Prevalent Population on dialysis

Figure 6.7 (Volume 2)

Period prevalent dialysis patients; adjusted for age, gender, race, & primary diagnosis. Dialysis patients, 2005, used as reference cohort.
Adjusted mortality rates, by modality & year of treatment
Figure 6.1 (Volume 2)

Incident ESRD patients; adjusted for age, gender, race, & primary diagnosis. Incident ESRD patients, 2005, used as reference cohort.
Adjusted mortality rates, by modality & year of treatment

Figure 6.1 (Volume 2)

Incident ESRD patients; adjusted for age, gender, race, & primary diagnosis. Incident ESRD patients, 2005, used as reference cohort.
Mortality patterns among incident and prevalent dialysis populations

- Prevalent based death rates show a continued decline since 2000 across all vintage populations.
- Incident based death rates show continued declines except those in the first year of hemodialysis.
- The most recent data show even first year death have started to decline but it may be too early to be confident of the trend.
Access procedures in prevalent hemodialysis patients, by diabetic status

Figure hp.13 (Volume 2)

Period prevalent hemodialysis patients with or without simple fistulas. Data from physician/supplier claims. Some patients may have more than one access at a given point in time.
Arteriovenous fistula use in incident hemodialysis patients

Figure hp.11 (Volume 2)

Incident patients initiating dialysis between January 1 & August 31 of the year of data collection; 1999–2007 ESRD CPM data. Access represents the current access used as of the latest data collection for that year. Includes only patients for whom an access is known.
Vascular access use at initiation, by gender, 2007

Figure p.10 (Volume 2)
Catheter utilization is a major concern

- Placement rates for catheter have declined. However, the type of catheter being placed has changed significantly (Temporary Catheters without cuffs to cuffed catheters).
- It is unclear if the use of different catheters has changed the infectious risk over time.
- Hospitalizations patterns may provide important trend information on infectious morbidity.
- A detailed assessment of outpatient cultures and the use of antibiotics may provide a clearer picture infectious complications.
Change in all-cause & cause-specific hospitalization rates, by modality

Figure p.17 (Volume 2)

Period prevalent ESRD patients; adjusted for age, gender, race, & primary diagnosis. ESRD patients, 2005, used as reference cohort. Vascular access hospitalizations are “pure” inpatient vascular access events. New vascular access codes for peritoneal dialysis patients appeared in late 1998; therefore, peritoneal dialysis vascular access values are shown as changing since 1999 rather than 1993.
Adjusted admissions for principal diagnoses, by modality
Figure 6.4 (Volume 2)

Period prevalent ESRD patients; adjusted for age, gender, race, & primary diagnosis. ESRD patients, 2005, used as reference cohort.
Adjusted admissions for infection in the first year of hemodialysis, by month & age

Figure 1.8 (Volume 2) incident patients by cohort year

Incident hemodialysis patients age 20 and older; followed from the day of onset of ESRD; adjusted for gender, race, & primary diagnosis. Incident hemodialysis patients alive at day 90 after initiation, 2005, used as reference.
Infections are a major concern in the hemodialysis population

- Hospitalizations for infection in the prevalent population have increased 40% over the last 10 years!
- The most recent two years show a decline but this needs to be confirmed with additional surveillance data
- Infectious hospitalization associated with the incident population has increased across all age groups particularly in those 65+!

- What about outpatient infectious complications?
Figure 5: Adjusted rates of outpatient IV antibiotic use, blood cultures, and bacterial cultures in the first year after initiation of incident hemodialysis patients, age 65+.
Patients with at least one outpatient antibiotic claim during the year

Figure 1.10 (Volume 2)

Point prevalent hemodialysis patients who survive the entire year.
Infectious complications in the dialysis population need to be addressed

• Infections in the first months of dialysis now approach that of cardiovascular disease a finding that did not exist 10 years ago
• Although the type of catheter placed has changed, it does not appear this has reduced the risk of infectious complications and the use of IV antibiotics
• The Fistula First Program should direct greater attention to avoidance of catheters and timely removal to reduce infectious morbidity.
Mortality Implications of Proteinuria and eGFR in the General U.S. Population: Do We Have the Correct Classification System?

Robert N Foley, MB, MS
United States Renal Data System
Major Topics for Today

  - Implications of intermittently abnormal kidney function
  - GFR/urinary ACR and absolute mortality risk
    - Which?
    - How much?
    - In whom?
Intermittently Abnormal Kidney Function
Background

• The short-term variability of abnormal kidney function not been quantified among community-dwelling adults.

• Not known whether the mortality associations of intermittently abnormal kidney function are more like the associations of persistently normal or persistently abnormal function.

• This information could help when designing screening programs.
Methods

- NHANES III (1988-1994) was a multistage, cross-sectional, stratified, clustered probability.
- For repeat laboratory testing, a nonrandom 5% sample was obtained by selecting ~ 20 participants from the ~ 400 examined at each location, using general guidelines stipulating selection of equal proportions aged 20-39 and ≥ 40 years and equal proportions of men and women.
- For our study, we selected 1162 adults aged ≥ 20 years in whom serum creatinine and urinary ACR were tested on both occasions, a median of 17 days apart.
- The CKD-EPI formula was used to calculate GFR.
- Vital status tracked through December 31, 2000, linked via National Death Index.
GFR < 60

Intermittently Abnormal Kidney Function

Persistence
4.2/4.2 + 1.6 + 1.4 = 58%
ACR >= 30

Intermittently Abnormal Kidney Function

Persistence

\[ \frac{8.4}{8.4} + 4.9 + 3.2 = 63\% \]
GFR < 60 or ACR >=30

-/- 79.8%
-/+ 5.1%
+/- 4.0%
+/+ 11.2%

Persistence
11.2/11.2 + 5.1 + 4.0 = 55%

Intermittently Abnormal Kidney Function
<table>
<thead>
<tr>
<th></th>
<th>GFR &lt; 60</th>
<th>-/+ or +/-</th>
<th>+/-</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead</td>
<td>10.0%</td>
<td>40.0%</td>
<td>49.0</td>
<td>&lt;0.01</td>
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<tr>
<td>AHR</td>
<td>1 (ref)</td>
<td>5.1</td>
<td>7.0</td>
<td>&lt;0.01</td>
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<tr>
<td>ACR &gt;= 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead</td>
<td>10.0%</td>
<td>23.4%</td>
<td>39.8</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>AHR</td>
<td>1 (ref)</td>
<td>2.5</td>
<td>2.2</td>
<td>&lt;0.01</td>
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<tr>
<td>GFR &lt; 60 or ACR &gt;= 30</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead</td>
<td>10.0%</td>
<td>22.9%</td>
<td>39.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>AHR</td>
<td>1 (ref)</td>
<td>2.9</td>
<td>2.4</td>
<td>&lt;0.01</td>
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</tbody>
</table>

Intermittently Abnormal Kidney Function
Conclusions

• When GFR thresholds of 60 mL/min/1.73 m² and ACR thresholds of 30 mg/g are used to define CKD, positivity is variable for a substantial proportion of people.
• The problem of non-persistence of positive tests is as evident for GFR < 60 as ACR >=30.
• As individuals with intermittent and persistent abnormal kidney function have similar mortality risks, they may need to be managed similarly.
• A two-test approach may be needed for screening, even if the first test is negative.
GFR or ACR and Mortality
Which? How much? In whom?
Background

• It has been suggested that there should be screening for kidney function tests in community-dwelling adults.
• It is often useful to define threshold levels for risk factors to define subgroups requiring enhanced follow-up and treatment.
• It is unknown whether GFR thresholds, ACR thresholds or both should be used.
• It is unknown whether kidney function thresholds are equally applicable across all segments of the community.

GFR or ACR-Which? How much? In whom?
Methods.

- CKD-EPI was used to calculate GFR.
- GFR values of maximum sensitivity and specificity for death were identified.
- Similar strategies were used to rank GFR and ACR when other risk factors were considered and to identify major subgroups where GFR and ACR is useful (CART Analysis).

GFR or ACR-Which? How much? In whom?
GFR thresholds for death

- **GFR 60:**
  - Sensitivity (Sn) = 0.25
  - Specificity (Sp) = 0.98
  - Sn + Sp = 1.23

- **GFR 95:**
  - Sensitivity (Sn) = 0.82
  - Specificity (Sp) = 0.65
  - Sn + Sp = 1.47

Maximum Sensitivity and Specificity

GFR or ACR-Which? How much? In whom?
ACR thresholds for death

GFR or ACR-Which? How much? In whom?

ACR 30:
Sn = 0.26
Sp = 0.94
Sn + Sp = 1.19

ACR 8:
Sn = 0.67
Sp = 0.70
Sn + Sp = 1.37
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 58</td>
<td>1.60</td>
<td>0.78</td>
<td>0.82</td>
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<tr>
<td>GFR ≤ 95</td>
<td>1.47</td>
<td>0.82</td>
<td>0.65</td>
</tr>
<tr>
<td>Sys BP &gt; 130</td>
<td>1.41</td>
<td>0.62</td>
<td>0.79</td>
</tr>
<tr>
<td>ACR &gt; 8</td>
<td>1.37</td>
<td>0.67</td>
<td>0.70</td>
</tr>
<tr>
<td>Glucose &gt; 98</td>
<td>1.22</td>
<td>0.53</td>
<td>0.69</td>
</tr>
<tr>
<td>LDL &gt; 144</td>
<td>1.13</td>
<td>0.42</td>
<td>0.71</td>
</tr>
</tbody>
</table>

GFR or ACR-Which? How much? In whom?
Classification and Regression Tree

GROUP UNDER EXAMINATION

Risk factor with maximum sensitivity + specificity

Percentage of population being examined

ALL: Age > 58
100%

AGE ≤ 58:
Systolic > 119
76.6%

AGE > 58:
ACR > 12
23.4%

AGE > 58 and ACR ≤ 12:
GFR ≤ 63
14.0%

AGE > 58, ACR ≤ 12
and GFR > 63
Male
11.7%

AGE > 58, ACR > 12
and GFR > 66:
CVD
6.4%

AGE > 58, ACR > 12
and GFR > 66
and LDL ≤ 129:
CVD
3.9%

AGE > 58, ACR > 12
and GFR > 66
and LDL > 129:
CVD
2.5%

AGE > 58, ACR > 12
and GFR > 66
and no CVD:
CVD
2.0%

AGE > 58, ACR ≤ 12
and GFR > 63
and FEMALE:
BMI ≤ 23
5.3%

AGE > 58, ACR > 12,
GFR > 66
and LDL ≤ 129:
HDL ≤ 51
2.0%
Conclusions

• GFR and ACR thresholds demonstrate prognostic discrimination close to optimal age thresholds, and with the exception of systolic blood pressure, higher than those of commonly-advocated public health screening measures.

• ACR and GFR both carry prognostic discrimination in older adults.

• Optimum ACR thresholds are substantially less than 30 mg/g.
Awareness, Treatment, and Control of Hypertension, Dyslipidemia, and Diabetic Risk Factors: Are We Doing Enough for the CKD Population?

Jon J. Snyder, PhD, MS
Yi Peng, MS
United States Renal Data System
Incident ESRD patients; adjusted for age, gender, & race.
Increased Risk

Normal Renal Function

Increased Risk

Kidney Damage

Decreased Function

Kidney Failure

CKD Death

Complications

Chronic Kidney Disease Progression

Note: adapted from KDOQI CKD Classification Guidelines, Figure 1.
KDOQI: To Date

• Guidelines specifically addressing the CKD population (pre-ESRD):
  ▪ Bone Metabolism and Disease in Chronic Kidney Disease (2003)
  ▪ Hypertension and Antihypertensive Agents in Chronic Kidney Disease (2004)
CKD and Cardiovascular Disease

• Risk of death in the CKD population is 16 times greater than that of advancing to ESRD (CKD Stage 5).*

• The vast majority of CKD Patients die of cardiovascular complications prior to making it to ESRD.*

• Cardiovascular disease in patients with chronic kidney disease is treatable and potentially preventable.**

**NKF KDOQI CKD Classification Guidelines, p. S43
Association of eGFR and Cardiovascular Event Rates

Adapted from Go et al. NEJM 2004;351:1296-1305
Prevalence of cardiovascular disease in the NHANES 1999-2006 population, by age & CKD stage

Figure 1.5 (Volume 1)

Awareness of Chronic Kidney Disease

Figure 2. Percentage of subjects with chronic kidney disease (CKD) who were aware of their disease by CKD stage (National Health and Nutrition Examination Survey 1999-2004). P value for trend across stage, adjusted for age, sex, and race. *Stages 1 and 2 defined by single measurement of albuminuria only; persistent albuminuria data not available. †No standard error estimates because of small sample size. Error bars indicate 95% confidence interval.

Awareness of CKD:
NHANES 2005-2006

- Stage 1-2: 4.6%
- Stage 3-4: 7.2%
Awareness, Treatment, and Control of Hypertension in CKD
Measured Hypertensive Status by CKD Stage

Data: NHANES 1999-2004
Awareness, Treatment, and Control of Hypertension

Table 1.f (Volume 1)

- Unaware
- Aware, Not Treated
- Aware, Treated, Not Controlled
- Aware, Treated, Controlled

Non-CKD
Stage 1-2
Stage 3-4
Odds of Awareness, Treatment, & Control of Hypertension

Figure 1.12 (Volume 1)

NHANES participants age 20 & older with Stage 5 (eGFR <15) are excluded

Odds ratio (log scale: reference = non-CKD)
Blood Pressure and Decline in Kidney Function in Patients With Atherosclerotic Vascular Disease: A Cohort Study

Anne L.M. Vlek, MD, Yolanda van der Graaf, MD, PhD, Branko Braam, MD, PhD, Frans L. Moll, MD, PhD, Hendrik M. Nathoe, MD, PhD, and Frank L.J. Visseren, MD, PhD on behalf of the SMART Study Group

Adjusted mean decline in eGFR per year

Data adapted from Table 2.
Blood Pressure and Decline in Kidney Function in Patients With Atherosclerotic Vascular Disease: A Cohort Study

Anne L.M. Vlek, MD,1 Yolanda van der Graaf, MD, PhD,1 Branko Braam, MD, PhD,2 Frans L. Moll, MD, PhD,3 Hendrik M. Nathoe, MD, PhD,4 and Frank L.J. Visseren, MD, PhD,5 on behalf of the SMART Study Group

Figure 2.

No Albuminuria (ACR ≤ 27)  Albuminuria (ACR > 27)
Main Conclusion: “Intensified blood-pressure control, with target 24-hour blood pressure levels in the low range of normal, confers a substantial benefit with respect to renal function among children with chronic kidney disease.”
Blood Pressure Control Among Persons Without and With Chronic Kidney Disease

Laura C. Plantinga, Edgar R. Miller, III, Lesley A. Stevens, Rajiv Saran, Kassandra Messer, Nicole Flowers, Linda Geiss, Neil R. Powe; for the Centers for Disease Control and Prevention Chronic Kidney Disease Surveillance Team
Awareness, Treatment, and Control of Elevated LDL-Cholesterol in CKD
Prevalence of Elevated LDL-Cholesterol
Table 1.f (Volume 1)

Above ATP-III Target or Treated

- Non-CKD: 33.7%
- Stage 1-2: 47.9%
- Stage 3-4: 79.8%
Awareness, Treatment, and Control of Elevated LDL Cholesterol

Table 1.f (Volume 1)
Odds of Awareness, Treatment, & Control of Elevated LDL Cholesterol

Figure 1.13 (Volume 1)

NHANES participants age 20 & older with Stage 5 (eGFR <15) are excluded

Odds ratio (log scale: reference = non-CKD)
Patients with a prior history of cardiovascular disease.
HDL and Total Cholesterol

Table 1.f (Volume 1)

<table>
<thead>
<tr>
<th>HDL</th>
<th>Total Cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40 (desirable)</td>
<td>Non-CKD: 20%, Stage 1-2: 30%, Stage 3-4: 20%</td>
</tr>
<tr>
<td>200-239 (borderline high)</td>
<td>Non-CKD: 50%, Stage 1-2: 60%, Stage 3-4: 50%</td>
</tr>
<tr>
<td>240+ (high)</td>
<td>Non-CKD: 20%, Stage 1-2: 10%, Stage 3-4: 20%</td>
</tr>
</tbody>
</table>
Odds of meeting target HDL & total cholesterol levels, by CKD stage

Figure 1.14 (Volume 1)

NHANES participants age 20 & older with Stage 5 (eGFR <15) are excluded
Diabetic Control in CKD
Control of Diabetes

Table 1.f (Volume 1)

A1c < 7%

- Non-CKD: 51.3%
- Stage 1-2: 36.1%
- Stage 3-4: 53.5%
Odds of Diabetes Control

Figure 1.15 (Volume 1)

Glycohemoglobin <7%

Stages 1-2

Stages 3-4

Odds ratio (log scale: reference = non-CKD)

0.37
1.00
2.72
Does Awareness of CKD Matter?
Control of CVD Risk Factors by Awareness of CKD (Stage 3-4 patients only)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Aware of CKD</th>
<th>Unaware of CKD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN (ATC)</td>
<td>21%</td>
<td>20%</td>
</tr>
<tr>
<td>LDL-C (ATC)</td>
<td>44%</td>
<td>46%</td>
</tr>
<tr>
<td>HDL (in target)</td>
<td>78%</td>
<td>82%</td>
</tr>
<tr>
<td>Total Chol. (&lt;200)</td>
<td>55%</td>
<td>47%</td>
</tr>
<tr>
<td>A1c (&lt;7%)</td>
<td>36%</td>
<td>58%</td>
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</tbody>
</table>

* p<0.01
In Summary…

• Less than 10% of patients with markers of chronic kidney disease are aware of the condition.

• Among patients with markers of CKD Stages 3-4:
  - 81% are hypertensive; only 20% are aware, treated, and controlled.
  - 80% are above ATP-III LDL-C target; only 18% are aware, treated, and controlled.
  - 47% of diabetic patients have A1c levels above target.

• Patients with CKD markers in the Stage 1-2 range are even less likely to have hypertension controlled or to have A1c in target range.
Strategies for Comparing Outcomes at Transplant Centers in the United States

Bertram L. Kasiske, MD FACP
Jon J. Snyder, PhD, MS
United States Renal Data System
SRTR & CMS Oversight

- SRTR Center-Specific Reports and CMS Conditions of Participation aim to identify underperforming transplant centers using 1-year patient & graft survival rates.
To flag a center as underperforming, three 1-year patient/graft outcomes must be met:

- Observed (O) – Expected (E) Graft Failures > 3.0
- O / E > 1.5
- O / E greater than 1 (one-sided \( p < 0.05 \))
Challenges to SRTR & CMS Methodology

- Limited statistical power.
- Limited outcomes.
- Limited risk adjustment.
- Unintended consequences: *risk aversion* among centers, possibly limiting access to transplantation for high-risk patients.
Current Risk Adjustment: Adult Deceased Donor Kidney Model

- **Recipient Factors**
  - Recipient Age
  - Race
  - Sex
  - Functional Status
  - Previous Solid Organ Transplant
  - Body Mass Index
  - Primary Cause of Renal Failure
  - Hepatitis C Serostatus
  - Panel-Reactive Antibody
  - Time on Renal Replacement Therapy
  - Insurance

- **Donor Factors**
  - Cold Ischemia Time
  - Pumped Kidney
  - Donor History of Diabetes
  - Donor History of Hypertension
  - Donation after Cardiac Death
  - Donor Age
  - Shipped Kidney
  - Expanded Criteria Donor
  - Donor Race
  - Donor Terminal Serum Creatinine
  - Donor-Recipient Weight Ratio
  - Donor Cause of Death: CVA
  - HLA Mismatches
Current Risk Adjustment: Adult Living Donor Kidney Model

- **Recipient Factors**
  - Age
  - Race
  - Sex
  - Body Mass Index
  - Primary Cause of Renal Failure
  - Functional Status
  - Previous Solid Organ Transplant
  - Hepatitis C Serostatus
  - Panel-Reactive Antibody
  - Time on Renal Replacement Therapy
  - Insurance

- **Donor Factors**
  - Donor Age
  - Donor Race
  - HLA Mismatches
  - Unrelated/Related Donor

ASN 2009
We hypothesized that adjusting for comorbidity would substantially alter the identification of underperforming centers under existing CMS rules.
Methods

- Identified CMS underperforming centers for kidney transplants in 1992 - 2004
- 88,954 Medicare kidney-only transplants
- 22 rolling 30-month cohorts

Comparison:
- Adjusted for SRTR variables
- Adjusted for SRTR variables + comorbidity¹

¹16 comorbid conditions (Charlson and Elixhauser)

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>DD Prev. (%)</th>
<th>DD HR (# Models)</th>
<th>LD Prev. (%)</th>
<th>LD HR (# Models)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestive Heart Failure</td>
<td>11.2</td>
<td>1.15 (18)</td>
<td>8.6</td>
<td>1.37 (14)</td>
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<tr>
<td>Cardiac Arrhythmias</td>
<td>9.0</td>
<td>1.34 (22)</td>
<td>7.1</td>
<td>1.56 (17)</td>
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<td>Valvular Heart Disease</td>
<td>5.2</td>
<td>1.19 (18)</td>
<td>4.3</td>
<td>0.99 (8)</td>
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<td>Peripheral Vascular Disease</td>
<td>11.7</td>
<td>1.29 (22)</td>
<td>8.3</td>
<td>1.44 (22)</td>
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<td>Neurological Disorders</td>
<td>3.8</td>
<td>1.46 (22)</td>
<td>3.0</td>
<td>1.74 (21)</td>
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<td>Chronic Pulmonary Disease</td>
<td>5.0</td>
<td>1.06 (10)</td>
<td>4.1</td>
<td>1.53 (17)</td>
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<td>Diabetes</td>
<td>26.2</td>
<td>1.14 (11)</td>
<td>17.8</td>
<td>1.01 (12)</td>
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<td>Hypothyroidism</td>
<td>4.8</td>
<td>1.06 (11)</td>
<td>3.4</td>
<td>1.15 (13)</td>
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<td>Liver Disease</td>
<td>18.0</td>
<td>1.05 (15)</td>
<td>9.6</td>
<td>0.98 (11)</td>
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<td>Cancer</td>
<td>1.5</td>
<td>1.21 (9)</td>
<td>1.3</td>
<td>1.74 (9)</td>
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<td>Collagen Vascular Diseases</td>
<td>4.0</td>
<td>0.93 (9)</td>
<td>4.2</td>
<td>0.70 (16)</td>
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<td>Coagulopathy</td>
<td>5.6</td>
<td>1.18 (9)</td>
<td>3.9</td>
<td>1.66 (17)</td>
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<td>Fluid/Electrolyte Disorders</td>
<td>27.1</td>
<td>1.05 (16)</td>
<td>20.0</td>
<td>1.24 (14)</td>
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<td>Ischemic Heart Disease</td>
<td>14.8</td>
<td>1.09 (15)</td>
<td>11.4</td>
<td>1.17 (18)</td>
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<tr>
<td>Cerebrovascular Disease</td>
<td>3.3</td>
<td>0.96 (6)</td>
<td>2.4</td>
<td>0.72 (10)</td>
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<tr>
<td>Gastrointestinal Bleeding</td>
<td>3.6</td>
<td>1.17 (17)</td>
<td>2.4</td>
<td>1.28 (14)</td>
</tr>
</tbody>
</table>

Summary/Conclusions

- There is substantial between-center variability in comorbidity.
- Comorbidity has a strong effect on CMS identification of underperforming centers, with a 14.6% misclassification rate.
- Failure to adjust for comorbidity could encourage centers to inappropriately deny access to candidates with a high burden of comorbidity.

Do Waiting List Mortality Rates Predict Posttransplant Outcomes & Center Performance?

- Mortality rates for patients on the waiting list at different centers varied 2.2 – 16.9 per 100 patient years.
- Centers were categorized into quartiles based on waiting list mortality.

Schold, JD, et al. *Transplantation* 2008; 85:1
Mortality on the Waiting List and Deceased Donor Transplant Deaths

Schold, JD, et al. *Transplantation* 2008; 85:1
Mortality on the Waiting List and Living Donor Transplant Deaths

Schold, JD, et al. *Transplantation* 2008; 85:1
Distribution of Low Performance Centers (N=43/224)*

*Centers meeting all 3 SRTR criteria for low performance for either deceased or living donor transplants.

Schold, JD, et al. *Transplantation* 2008; 85:1
Waiting List Mortality Rates and Rates of Removal Due to Illness/Death

Includes top 90% of centers by volume, year 2003.
2003 Waiting List Mortality and Relative Rate of Graft Failure through 3 Years for Transplants in 2004-2005

p = 0.02 for inclusion in full survival model.

Hazard Ratio

Quintile of Waiting List Mortality Rate

Graft Failure
Death
DCGF
Examples of Center Variation in High Risk Transplants Performed 2003-2007

- Living Donor: 35.5%
- Medicare: 55%
Examples of Center Variation in High Risk Transplants Performed 2003-2007
Is there a better approach (using current data and resources)?
Use All Available Data Resources

- Link OPTN data to other data, e.g.
  - Postal codes

- Assess *centers* rather than *patients* to allow the broadest use of other data sets, e.g.
  - Medicare claims
Assess Additional Outcomes

- Long-term outcomes
- Acute rejection rates
- Readmission rates
- Complication rates
- Quality care parameters
Conclusions

- Current methods to assess center performance may have unintended adverse consequences.
- Accounting for risk is important to avoid potentially harmful risk aversion by centers.
- Additional data and analyses are both possible and necessary to better compare center performance.
Acute Kidney Injury: Trends in Hospitalization, Use of Dialytic Therapy and Long-term Predictors of Death Versus ESRD

Areef Ishani, MD MS

USRDS 2009
Annual Data Report
Outline

- Trends in AKI
- Risk factors for AKI
- Short and Long-Term Outcomes after an AKI episode
- Care provided to individuals after an AKI episode
Hospitalizations for acute kidney injury, with or without dialysis

Figure 8.1 (Volume 1)

General Medicare patients age 66 & older on Dec. 31 of the cohort year, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving and without ESRD in the cohort year.
Characteristics of patients with acute kidney injury, by age, gender, & race, 2007

Figure 8.2 (Volume 1)

Medicare: general Medicare patients age 66 & older on 12/31/2007, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving & without ESRD in 2007. MarketScan: MarketScan patients age 20-64 on 12/31/2007, enrolled in a fee-for-service plan. Ingenix: Ingenix i3 patients age 20-64 on 12/31/2007, enrolled in a fee-for-service plan. Excludes any patients whose ESRD date is on or before the AKI discharge date. Includes only patients with AKI identified through the 584 ICD-9-CM code appearing on inpatient claims in 2007.
### Descriptive demographics of patients with AKI, by dataset, by age, gender, race, dialysis & contrast use, medication use, & primary diagnosis code

**Table 8.a (Volume 1)**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Medicare</th>
<th>MarketScan</th>
<th>Ingenix i3</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-44</td>
<td>23.1 21.7 21.0</td>
<td>9.2 13.6 15.2</td>
<td>4.4 3.1 2.3</td>
</tr>
<tr>
<td>45-54</td>
<td>31.4 31.1 29.9</td>
<td>26.4 26.5 26.3</td>
<td>12.7 14.9 15.4</td>
</tr>
<tr>
<td>55-64</td>
<td>45.5 47.2 49.1</td>
<td>64.4 59.9 58.5</td>
<td>17.2 22.7 27.0</td>
</tr>
<tr>
<td>66-69</td>
<td>12.3 11.9 12.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70-74</td>
<td>19.8 17.9 17.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75-79</td>
<td>23.3 22.8 21.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-84</td>
<td>21.8 22.7 22.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85+</td>
<td>22.8 24.8 26.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47.9 47.3 47.2</td>
<td>61.4 60.5 59.7</td>
<td>44.5 39.9 28.9</td>
</tr>
<tr>
<td>Female</td>
<td>52.1 52.7 52.8</td>
<td>38.6 39.5 40.3</td>
<td>44.2 41.7 42.0</td>
</tr>
<tr>
<td>White</td>
<td>82.1 81.3 82.8</td>
<td></td>
<td></td>
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<tr>
<td>African American</td>
<td>13.5 14.1 12.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4.4 4.6 4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% requiring dialysis</td>
<td>4.4 3.1 2.3</td>
<td>7.0 5.9 3.0</td>
<td>44.5 39.9 28.9</td>
</tr>
<tr>
<td>% receiving contrast</td>
<td>4.3 5.9 6.2</td>
<td>12.7 14.9 15.4</td>
<td>44.5 39.9 28.9</td>
</tr>
<tr>
<td>% on ACEs/ARBs</td>
<td>24.4 23.7 18.9</td>
<td>21.3 25.4 24.8</td>
<td></td>
</tr>
<tr>
<td>% on statins</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Primary diagnosis codes (%):**

<table>
<thead>
<tr>
<th>Diagnosis Code</th>
<th>Medicare</th>
<th>MarketScan</th>
<th>Ingenix i3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute renal failure, unspecified</td>
<td>18.3 23.5 23.2</td>
<td>20.5 22.1 19.7</td>
<td>19.2 21.8 20.4</td>
</tr>
<tr>
<td>Congestive heart failure, unspecified</td>
<td>7.3 5.6 4.4</td>
<td>4.0 3.0 2.4</td>
<td>3.2 2.6 2.0</td>
</tr>
<tr>
<td>Pneumonia, organism unspecified</td>
<td>3.8 4.1 3.5</td>
<td>2.6 2.1 2.0</td>
<td>1.9 1.8 2.2</td>
</tr>
<tr>
<td>Subendocardial infarction-initial episode of care</td>
<td>3.7 3.1 2.8</td>
<td>2.1 1.6 1.7</td>
<td>1.9 1.5 1.4</td>
</tr>
<tr>
<td>Coronary atherosclerosis of native coronary artery</td>
<td>3.1 2.7 2.0</td>
<td>2.7 2.6 2.5</td>
<td>2.4 2.1 1.5</td>
</tr>
</tbody>
</table>

---

Medicare: general Medicare patients age 66 & older on 12/31 of the year, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving & without ESRD in the year.

MarketScan: MarketScan patients age 20-64 on 12/31, enrolled in a fee-for-service plan. Ingenix: Ingenix i3 patients age 20-64 on 12/31, enrolled in a fee-for-service plan. Excludes any patients whose ESRD date is on or before the AKI discharge date. Includes only patients with AKI identified through the 584 ICD-9-CM code appearing on inpatient claims in the year. Dialysis occurs during AKI hospitalization period. Contrast is received in the 2 weeks before AKI hospitalization. ACE-Is/ARBs and statins are taken in the 3 months before AKI hospitalization.
## Descriptive demographics of patients with AKI, by dataset, by age, gender, race, dialysis & contrast use, medication use, & primary diagnosis code

Table 8.a (Volume 1)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Total N</td>
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<td>14,863</td>
<td>19,369</td>
<td>1,490</td>
<td>5,407</td>
<td>14,433</td>
<td>1,757</td>
<td>3,557</td>
<td>5,474</td>
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<td>23.5</td>
<td>23.2</td>
<td>20.5</td>
<td>22.1</td>
<td>19.7</td>
<td>19.2</td>
<td>21.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Congestive heart failure, unspecified</td>
<td>7.3</td>
<td>5.6</td>
<td>4.4</td>
<td>4.0</td>
<td>3.0</td>
<td>2.4</td>
<td>3.2</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Pneumonia, organism unspecified</td>
<td>3.8</td>
<td>4.1</td>
<td>3.5</td>
<td>2.6</td>
<td>2.1</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Subendocardial infarction-initial episode of c</td>
<td>3.7</td>
<td>3.1</td>
<td>2.8</td>
<td>2.1</td>
<td>1.6</td>
<td>1.7</td>
<td>1.9</td>
<td>1.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Patients with acute kidney injury using ACE-Is, ARBs, or statins

Figure 8.6 (Volume 1)
Percent of hospitalized AKI patients requiring dialysis, by type of dialysis

Figure 8.3 (Volume 1)

Medicare: general Medicare patients age 66 & older on 12/31/2007, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving & without ESRD in 2007. MarketScan: MarketScan patients age 20-64 on 12/31/2007, enrolled in a fee-for-service plan. Ingenix: Ingenix i3 patients age 20-64 on 12/31/2007, enrolled in a fee-for-service plan. Excludes any patients whose ESRD date is on or before the AKI discharge date. Includes only patients with AKI identified through the 584 ICD-9-CM code appearing on inpatient claims in 2007.
Rates of acute kidney injury in 2007: no entry period, by age, gender, & race, 2007 patients

Figure 8.7 (Volume 1)

Rates of acute kidney injury in 2007, by age, gender, & race: entry period, 2006 patients

Geographic variations in unadjusted rates (per 1,000 patient years) of AKI, by HSA: no entry period, 2007

Figure 8.10 (Volume 1)

Geographic variations in unadjusted rates of AKI requiring dialysis (per 1,000 patient years, by state: no entry period, 2007

Figure 8.11 (Volume 1)

### Percentage & adjusted OR of in-hospital death during AKI hospitalization

**Table 8.d (Volume 1)**

<table>
<thead>
<tr>
<th></th>
<th>Medicare</th>
<th></th>
<th>MarketScan</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>OR</td>
<td>%</td>
<td>OR</td>
</tr>
<tr>
<td>20-44</td>
<td>5.5</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>6.1</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>6.8</td>
<td>1.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66-70</td>
<td>11.7</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-75</td>
<td>13.0</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>13.3</td>
<td>1.15</td>
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<td></td>
</tr>
<tr>
<td>80+</td>
<td>16.1</td>
<td>1.41</td>
<td></td>
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</tr>
<tr>
<td>Male</td>
<td>14.8</td>
<td>1.05</td>
<td>6.6</td>
<td>1.03</td>
</tr>
<tr>
<td>Female</td>
<td>14.1</td>
<td>1.00</td>
<td>6.3</td>
<td>1.00</td>
</tr>
<tr>
<td>White</td>
<td>14.7</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>12.5</td>
<td>0.90</td>
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<tr>
<td>Other race</td>
<td>15.8</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12.3</td>
<td>0.86</td>
<td>4.8</td>
<td>0.68</td>
</tr>
<tr>
<td>No</td>
<td>15.9</td>
<td>1.00</td>
<td>7.4</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline hypertension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13.2</td>
<td>0.75</td>
<td>4.8</td>
<td>0.68</td>
</tr>
<tr>
<td>No</td>
<td>18.4</td>
<td>1.00</td>
<td>7.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline CKD</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11.4</td>
<td>0.78</td>
<td>4.1</td>
<td>0.70</td>
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<tr>
<td>No</td>
<td>15.5</td>
<td>1.00</td>
<td>6.9</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Medicare: patients with hospitalized AKI events in 2006 or 2007, age 66 and older; CKD, DM, and hypertension defined from claims. MarketScan data constructed in a similar fashion, but restricted to ages 20-64, enrolled in a fee-for-service plan.
# Percentage & adj. OR of in-hospital death during AKI/dialysis hospitalization

**Table 8.h (Volume 1)**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Medicare %</th>
<th>Medicare OR</th>
<th>MarketScan %</th>
<th>MarketScan OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-44</td>
<td>9.3</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>6.3</td>
<td>0.61 (0.21-1.71)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>4.9</td>
<td>0.48 (0.18-1.28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66-70</td>
<td>36.0</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-75</td>
<td>40.3</td>
<td>1.20 (0.95-1.52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>40.3</td>
<td>1.18 (0.93-1.50)</td>
<td></td>
<td></td>
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<tr>
<td>&gt;80</td>
<td>41.8</td>
<td>1.26 (1.01-1.58)</td>
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<tr>
<td>Male</td>
<td>40.8</td>
<td>1.06 (0.91-1.25)</td>
<td>7.2</td>
<td>1.79 (0.80-4.00)</td>
</tr>
<tr>
<td>Female</td>
<td>38.7</td>
<td>1.00</td>
<td>4.3</td>
<td>1.00</td>
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<tr>
<td>White</td>
<td>40.1</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>36.7</td>
<td>0.91 (0.72-1.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>44.6</td>
<td>1.25 (0.90-1.74)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline diabetes</th>
<th>Medicare %</th>
<th>Medicare OR</th>
<th>MarketScan %</th>
<th>MarketScan OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>35.5</td>
<td>0.79 (0.67-0.94)</td>
<td>6.3</td>
<td>1.26 (0.53-3.01)</td>
</tr>
<tr>
<td>No</td>
<td>43.5</td>
<td>1.00</td>
<td>5.9</td>
<td>1.00</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline hypertension</th>
<th>Medicare %</th>
<th>Medicare OR</th>
<th>MarketScan %</th>
<th>MarketScan OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>38.3</td>
<td>0.89 (0.74-1.08)</td>
<td>4.4</td>
<td>0.60 (0.24-1.47)</td>
</tr>
<tr>
<td>No</td>
<td>44.6</td>
<td>1.00</td>
<td>6.9</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline CKD</th>
<th>Medicare %</th>
<th>Medicare OR</th>
<th>MarketScan %</th>
<th>MarketScan OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>33.9</td>
<td>0.76 (0.63-0.91)</td>
<td>9.1</td>
<td>2.18 (0.75-6.35)</td>
</tr>
<tr>
<td>No</td>
<td>42.5</td>
<td>1.00</td>
<td>5.7</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Medicare: patients with hospitalized AKI with dialysis in 2006 or 2007, age 66 and older; CKD, DM, and hypertension defined from claims. MarketScan data constructed in a similar fashion, but restricted to ages 20-64, enrolled in a fee-for-service plan.
Probability of ESRD & death after live hospital discharge, by AKI status
Figure 8.19 (Volume 1)

General Medicare patients age 66 & older on 12/31/2006, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving in 2006. AKI defined in 2006. Excludes patients whose ESRD date is on or before the AKI discharge date. Patients followed to a maximum of one year after AKI discharge date for those with AKI or Jan.1, 2007 for those without AKI. A one-year entry period before follow-up is used to define CKD status and comorbid conditions.
Probability of ESRD & death after live hospital discharge, by AKI & CKD status

Figure 8.20 (Volume 1)

General Medicare patients age 66 & older on 12/31/2006, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving in 2006. AKI defined in 2006. Excludes patients whose ESRD date is on or before the AKI discharge date. Patients followed to a maximum of one year after AKI discharge date for those with AKI or Jan.1, 2007 for those without AKI. A one-year entry period before follow-up is used to define CKD status and comorbid conditions.
Hazard ratios of ESRD & death, by AKI & CKD status

Figure 8.22 (Volume 1)

General Medicare patients age 66 & older on 12/31/2006, continuously enrolled in Medicare inpatient/outpatient & physician/supplier coverage, & with no HMO coverage, surviving in 2006. AKI defined in 2006. Excludes patients whose ESRD date is on or before the AKI discharge date.
## Rate per 1,000 patient years & hazard ratio of ESRD after discharge for AKI

**Table 8.f (Volume 1)**

<table>
<thead>
<tr>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-44</td>
<td>37.4</td>
<td>1.00</td>
<td>46.3</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>48.9</td>
<td>0.99 (0.67-1.47)</td>
<td>46.9</td>
<td>0.84 (0.58-1.23)</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>51.2</td>
<td>0.95 (0.66-1.36)</td>
<td>44.3</td>
<td>0.70 (0.49-1.00)</td>
<td></td>
</tr>
<tr>
<td>66-70</td>
<td>57.9</td>
<td>1.00</td>
<td>51.9</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>71-75</td>
<td>50.7</td>
<td>0.87 (0.73-1.04)</td>
<td>44.3</td>
<td>0.69 (0.58-0.82)</td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>39.3</td>
<td>0.69 (0.58-0.82)</td>
<td>25.2</td>
<td>0.45 (0.38-0.54)</td>
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</tr>
<tr>
<td>80+</td>
<td>25.2</td>
<td>0.45 (0.38-0.54)</td>
<td></td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

### Male
- Rate: 41.5, HR: 1.13 (1.01-1.28), 46.9, HR: 0.91 (0.75-1.12), 41.0, HR: 0.81 (0.62-1.05)
- Female: Rate: 34.7, HR: 1.00, 51.9, HR: 1.00, 52.1, HR: 1.00

### Female
- Rate: 34.7, HR: 1.00, 51.9, HR: 1.00, 52.1, HR: 1.00

### White
- Rate: 36.1, HR: 1.00

### African American
- Rate: 46.8, HR: 1.10 (0.94-1.30)

### Other race
- Rate: 44.3, HR: 1.08 (0.82-1.42)

### Baseline diabetes
- Yes: Rate: 51.8, HR: 1.24 (1.09-1.41), 86.0, HR: 1.97 (1.58-2.45), 75.3, HR: 1.65 (1.24-2.19)
- No: Rate: 28.2, HR: 1.00, 29.0, HR: 1.00, 30.1, HR: 1.00

### Baseline hypertension
- Yes: Rate: 41.6, HR: 1.02 (0.85-1.22), 74.4, HR: 1.43 (1.15-1.77), 63.8, HR: 1.33 (0.96-1.85)
- No: Rate: 25.4, HR: 1.00, 32.8, HR: 1.00, 26.1, HR: 1.00

### Baseline CKD
- Yes: Rate: 92.0, HR: 3.85 (3.38-4.38), 159.7, HR: 4.19 (3.38-5.19), 140.8, HR: 4.55 (3.43-6.04)
- No: Rate: 21.4, HR: 1.00, 28.3, HR: 1.00, 24.7, HR: 1.00

---

*Medicare: patients with hospitalized AKI events in 2005 or 2006, age 66 and older; CKD, DM, and hypertension defined from claims. Patients are followed from discharge date until the earliest of one year, ESRD, death, December 31, 2007, or loss of insurance coverage.*

*MarketScan and Ingenix i3 data constructed in a similar fashion, but restricted to patients age 20-64, enrolled in a fee-for-service plan.*
Rate per 1,000 patient years & hazard ratio of ESRD after discharge for AKI & dialysis

Table 8.j (Volume 1)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Medicare Rate</th>
<th>MarketScan Rate</th>
<th>Ingenix i3 Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-44</td>
<td>20.7</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>45-54</td>
<td>13.7</td>
<td>0.43 (0.02-7.87)</td>
<td>0.43 (0.02-7.87)</td>
</tr>
<tr>
<td>55-64</td>
<td>9.8</td>
<td>0.25 (0.01-5.03)</td>
<td>0.25 (0.01-5.03)</td>
</tr>
<tr>
<td>66-70</td>
<td>300.9</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>71-75</td>
<td>269.9</td>
<td>0.86 (0.58-1.26)</td>
<td>0.86 (0.58-1.26)</td>
</tr>
<tr>
<td>76-80</td>
<td>203.5</td>
<td>0.66 (0.43-1.00)</td>
<td>0.66 (0.43-1.00)</td>
</tr>
<tr>
<td>80+</td>
<td>355.0</td>
<td>0.95 (0.65-1.38)</td>
<td>0.95 (0.65-1.38)</td>
</tr>
<tr>
<td>Male</td>
<td>288.9</td>
<td>1.14 (0.87-1.50)</td>
<td>7.4  1.29 (0.11-15.72)</td>
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<tr>
<td>Female</td>
<td>271.3</td>
<td>1.00</td>
<td>5.1  1.00</td>
</tr>
<tr>
<td>White</td>
<td>278.3</td>
<td>1.00</td>
<td>5.1  1.00</td>
</tr>
<tr>
<td>African American</td>
<td>331.9</td>
<td>1.08 (0.75-1.57)</td>
<td>0.66 (0.31-1.41)</td>
</tr>
<tr>
<td>Other race</td>
<td>182.3</td>
<td>0.66 (0.31-1.41)</td>
<td>0.66 (0.31-1.41)</td>
</tr>
<tr>
<td>Baseline diabetes</td>
<td>Yes</td>
<td>315.6</td>
<td>1.01 (0.76-1.35)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>248.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline hypertension</td>
<td>Yes</td>
<td>310.7</td>
<td>1.21 (0.83-1.79)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>190.3</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline CKD</td>
<td>Yes</td>
<td>566.0</td>
<td>2.49 (1.87-3.31)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>184.9</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Medicare: patients with hospitalized AKI with dialysis in 2005 or 2006, age 66 and older; CKD, DM, and hypertension defined from claims. Patients are followed from discharge date until the earliest of one year, ESRD, death, December 31, 2007, or loss of insurance coverage. MarketScan and Ingenix i3 data constructed in a similar fashion, but restricted to patients age 20-64, enrolled in a fee-for-service plan.
## Rate per 1,000 patient years & hazard ratio of recurrent AKI hospitalization after discharge for AKI

**Table 8.g (Volume 1)**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-44</td>
<td>95.5</td>
<td>1.00</td>
<td>126.0</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>124.2</td>
<td>1.13 (0.88-1.45)</td>
<td>131.1</td>
<td>0.95 (0.76-1.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>147.3</td>
<td>1.28 (1.02-1.61)</td>
<td>132.9</td>
<td>0.90 (0.72-1.13)</td>
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<tr>
<td>66-70</td>
<td>252.0</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-75</td>
<td>256.4</td>
<td>1.02 (0.94-1.11)</td>
<td>131.1</td>
<td>0.95 (0.76-1.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>262.5</td>
<td>1.07 (0.99-1.16)</td>
<td>132.9</td>
<td>0.90 (0.72-1.13)</td>
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</tr>
<tr>
<td>80+</td>
<td>268.3</td>
<td>1.15 (1.07-1.24)</td>
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<table>
<thead>
<tr>
<th>Gender</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>260.3</td>
<td>1.01 (0.96-1.06)</td>
<td>133.6</td>
<td>0.97 (0.86-1.10)</td>
<td>121.8</td>
<td>0.85 (0.73-1.00)</td>
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<tr>
<td>Female</td>
<td>264.3</td>
<td>1.00</td>
<td>137.6</td>
<td>1.00</td>
<td>145.0</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Race</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>248.5</td>
<td>1.00</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>343.1</td>
<td>1.32 (1.24-1.41)</td>
<td>137.6</td>
<td>1.00</td>
<td>145.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Other race</td>
<td>283.4</td>
<td>1.06 (0.95-1.19)</td>
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<td></td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Baseline diabetes</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>319.0</td>
<td>1.25 (1.19-1.31)</td>
<td>195.1</td>
<td>1.51 (1.33-1.73)</td>
<td>183.8</td>
<td>1.50 (1.26-1.79)</td>
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<tr>
<td>No</td>
<td>224.5</td>
<td>1.00</td>
<td>103.9</td>
<td>1.00</td>
<td>104.6</td>
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<table>
<thead>
<tr>
<th>Baseline hypertension</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>280.9</td>
<td>1.11 (1.04-1.18)</td>
<td>168.3</td>
<td>1.14 (1.00-1.30)</td>
<td>153.1</td>
<td>1.00 (0.84-1.21)</td>
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<tr>
<td>No</td>
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<td>1.00</td>
<td>114.8</td>
<td>1.00</td>
<td>108.2</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline CKD</th>
<th>Medicare Rate</th>
<th>Medicare HR</th>
<th>MarketScan Rate</th>
<th>MarketScan HR</th>
<th>Ingenix i3 Rate</th>
<th>Ingenix i3 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>425.0</td>
<td>1.80 (1.71-1.90)</td>
<td>284.1</td>
<td>2.18 (1.89-2.51)</td>
<td>255.6</td>
<td>2.16 (1.80-2.58)</td>
</tr>
<tr>
<td>No</td>
<td>216.0</td>
<td>1.00</td>
<td>109.3</td>
<td>1.00</td>
<td>105.3</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Medicare: patients with hospitalized AKI events in 2005 or 2006, age 66 and older; CKD, DM, and hypertension defined from claims. Patients are followed from discharge date until the earliest of one year, ESRD, death, December 31, 2007, or loss of insurance coverage. MarketScan and Ingenix i3 data constructed in a similar fashion, but restricted to patients age 20-64, enrolled in a fee-for-service plan.
Rate per 1,000 patient years & hazard ratio of recurrent AKI hospitalization after discharge for AKI & dialysis

Table 8.k (Volume 1)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Medicare Rate</th>
<th>MarketScan Rate</th>
<th>Ingenix i3 Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR</td>
<td>Rate HR</td>
<td>Rate HR</td>
</tr>
<tr>
<td>20-44</td>
<td>80.9</td>
<td>1.00</td>
<td>158.7</td>
</tr>
<tr>
<td>45-54</td>
<td>90.8</td>
<td>1.10 (0.40-2.97)</td>
<td>119.4</td>
</tr>
<tr>
<td>55-64</td>
<td>150.4</td>
<td>1.80 (0.75-4.34)</td>
<td>163.1</td>
</tr>
<tr>
<td>66-70</td>
<td>331.1</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>71-75</td>
<td>338.0</td>
<td>1.00 (0.68-1.47)</td>
<td></td>
</tr>
<tr>
<td>76-80</td>
<td>319.0</td>
<td>0.96 (0.65-1.41)</td>
<td></td>
</tr>
<tr>
<td>80+</td>
<td>334.4</td>
<td>1.05 (0.71-1.54)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>312.0</td>
<td>0.98 (0.75-1.29)</td>
<td>120.5</td>
</tr>
<tr>
<td>Female</td>
<td>352.2</td>
<td>1.00</td>
<td>124.9</td>
</tr>
<tr>
<td>White</td>
<td>308.3</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>511.6</td>
<td>1.56 (1.11-2.18)</td>
<td></td>
</tr>
<tr>
<td>Other race</td>
<td>235.7</td>
<td>0.70 (0.35-1.44)</td>
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</tr>
<tr>
<td>Baseline diabetes</td>
<td>Yes</td>
<td>376.2</td>
<td>1.12 (0.85-1.48)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>290.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline hypertension</td>
<td>Yes</td>
<td>358.9</td>
<td>1.20 (0.84-1.71)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>247.9</td>
<td>1.00</td>
</tr>
<tr>
<td>Baseline CKD</td>
<td>Yes</td>
<td>522.7</td>
<td>1.75 (1.32-2.33)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>270.8</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Medicare: patients with hospitalized AKI with dialysis in 2005 or 2006, age 66 and older; CKD, DM, and hypertension defined from claims. Patients are followed from discharge date until the earliest of one year, ESRD, death, December 31, 2007, or loss of insurance coverage. MarketScan and Ingenix i3 data constructed in a similar fashion, but restricted to patients age 20-64, enrolled in a fee-for-service plan.
Type of physician seen after hospitalization for acute kidney injury

Figure 8.12 (Volume 1)

Prevalent Medicare patients age 65 & older, 2006. For each follow-up period, only patients who survive without starting ESRD and without another AKI hospitalization are included.
Visits to a nephrologist after hospitalization for acute kidney injury, 2006
Figure 8.13 (Volume 1)

Prevalent Medicare patients age 65 & older, 2006. For each follow-up period, only patients who survive without starting ESRD and without another AKI hospitalization are included.
Probability of serum creatinine testing after hospitalization for AKI, year

Figure 8.14 (Volume 1)

Prevalent Medicare patients age 65 & older, 2006. Follow-up time censored at death, ESRD, & subsequent hospitalization.
Probability of microalbumin testing after hospitalization for AKI

Figure 8.15 (Volume 1)

Prevalent Medicare patients age 65 & older, 2006. Follow-up time censored at death, ESRD, & subsequent hospitalization
Statin treatment prior to & after AKI hospitalization, 2007
Figure 8.17 (Volume 1)

December 31 point prevalent Ingenix i3 patients age 20-64 with AKI in 2007. Medication in three months before & after AKI.
ACE-I/ARB treatment prior to & after AKI hospitalization, 2007
Figure 8.16 (Volume 1)

December 31 point prevalent Ingenix i3 patients age 20-64 with AKI in 2007. Medication in three months before & after AKI.
Conclusion

• Billed AKI episodes are increasing, but the incidence of AKI requiring dialysis has been constant

• AKI episodes are associated with both short and long term adverse outcomes (recurrent AKI, ESKD, and death)
  • This association is modified by the presence of CKD at baseline
Conclusion

• Care after an AKI episode is poor
  • Most individuals do not see a nephrologist – even those with AKI requiring dialysis
  • Most individuals have at least one creatinine following an AKI episode
  • Few individuals have proteinuria assessed after an AKI episode
  • An AKI episode results in decreased use of both Statins and ACEI/ARBs
• Future Studies should:
  • Better define the long-term complications of AKI
  • Identify therapies to decrease these complications
  • Determine the optimal renal care post AKI