The Kidney—The organ of the year 2014

Marcello Malpighi 1628-1694
De Viscerum Structura 1666,
«De renibus»
The Kidney-The organ of the year
The Kidney-The organ of the year
Examples of good urine
e.g. “A thick grumous scanty urine associated with fever when turned into a copious and thin urine is beneficial.”

On bad urines portending death
e.g. Diluted urine of long duration, in a disease with a nonfavorable course, is destructive since indicates crudeness of humors
The importance of urine: “Urine has the same colour of meat and drinks and may be considered a melting of internal humours.” Urine must be distinguished according to consistency, qualities, quantity and contents. The color may be whitish, pale, yellow, golden, red, green, livid or black.

Hippocrates c. 460- c. 370 BC
The Kidney - The organ of the year

Kontrastmittelinduziertes akutes Nierenversagen
PD Dr. Micha Mäder, Kantonsspital St. Gallen

De Medicina Aegyptiorum by Prospero Alpini 1591

“Ad vitae conservationen aquae Nili fluminis usu, num vino sit utilior necne” (Book I, Chap. XII)

Prospero Alpini 1553-1616
Doctor in philosophy and medicine, University of Padua, physician of Giorgio Emo, the consul of Venice in Cairo
The Kidney—The organ of the year

Rhabdomyolysis
Dr. Roger Lussmann,
Kantonsspital St. Gallen

On bad urines portending death
“Black urine with a black sediment is the worst.”
In fact, Galen pointed out (De crisibus) that he did “never see a patients recover after voiding this kind of urine.”
The Kidney-The organ of the year

Zugang für CRRT  (Die Achillesferse der Nierenersatztherapie)
PD Dr. Stefan Blumenthal, Stadtspital Triemli, Zürich

In Memoriam

In 1960\textsuperscript{1)}, Dr. Scribner, working with Wayne Quinton and David Dillard, perfected the Scribner shunt, a Teflon device that allowed patients for the first time to be connected repeatedly to hemodialysis machines thereby launching the era of modern renal replacement therapy as well as the clinical discipline of nephrology as we now know it.

\textsuperscript{1)} Quinton W, Dillard D, Scribner BH Cannulation of blood vessels for prolonged hemodialysis. Trans. Amer. Soc. Artificial Internal Organs 6, 104-109 1960
The Kidney-The organ of the year

CRRT, welche Filter bei welcher Indikation
Alchemie oder Evidenz
Prof. Dr. Christoph Haberthür, Klinik Hirslanden Zürich
The Kidney-The organ of the year

Pharmakologie bei akutem Nierenversagen
Opening Pandoras Box
Prof. Dr. Dominik Uehlinger, Inselspital Bern
The Kidney-The organ of the year

Nierentransplantation: primäre Nicht-Funktion und verzögerte Transplantatfunktion

Wenn die «Neue» nicht funktioniert
Dr. Isabelle Binet, Kantonsspital St.Gallen
1. Galen of Pergamum (131-201 AD), *On the Natural Faculties and the Usefulness of the Parts of the Body*, 150-200 AD
2. William Harvey (1578-1657), *An Anatomical Disquisition on the Motion of the Heart and the Blood in Animals*, 1628
3. Marcello Malpighi (1628-1694), *De Viscerum Structura*, 1666
4. Richard Bright (1789-1858), *Reports of Medical Cases: Selected With a View of Illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy*, 1827

*Fine LG. J Nephrol 2013; 26S: 6*
The Kidney-
The organ of the year 2014

Acute Kidney Failure (AKF) in the Intensive Care Unit
Dr. G.R. Kleger, St.Gallen
What is acute kidney failure?

-before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
Bellomo R. Crit Care 2004

-2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality

-AKIN proposed to replace the term ARF by AKI
traditional classification prerenal, postrenal, "intrinsic" renal AKI maintained
Mehta RL. Crit Care 2007

-RIFLE classification: based on the parameters SCr and Urine output
Bellomo R. Crit Care 2004

-AKIN classification to overcome some limitations of RIFLE
Mehta RL. Crit Care 2007

-KDIGO classification
KDIGO. Kidney Int 2012
What is acute kidney failure?

-before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
Bellomo R. Crit Care 2004

-2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality

-AKIN proposed to replace the term ARF by AKI
traditional classification prerenal, postrenal, «intrinsic» renal AKI maintained
Mehta RL. Crit Care 2007

-RIFLE classification: based on the parameters SCr and Urine output
Bellomo R. Crit Care 2004

-AKIN classification to overcome some limitations of RIFLE
Mehta RL. Crit Care 2007

-KDIGO classification
KDIGO. Kidney Int 2012
What is acute kidney injury (failure)?

- Before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
  *Bellomo R. Crit Care 2004*

- 2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality

- AKIN proposed to replace the term ARF by AKI
  Traditional classification prerenal, postrenal, «intrinsic» renal AKI maintained
  *Mehta RL. Crit Care 2007*

- RIFLE classification: based on the parameters SCr and Urine output
  *Bellomo R. Crit Care 2004*

- AKIN classification to overcome some limitations of RIFLE
  *Mehta RL. Crit Care 2007*

- KDIGO classification
  *KDIGO. Kidney Int 2012*
What is acute kidney injury (failure)?

-before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
Bellomo R. Crit Care 2004

-2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality

-AKIN proposed to replace the term ARF by AKI
traditional classification prerenal, postrenal, «intrinsic» renal AKI maintained
Mehta RL. Crit Care 2007

-RIFLE classification: based on the parameters SCr and Urine output
Bellomo R. Crit Care 2004

-AKIN classification to overcome some limitations of RIFLE
Mehta RL. Crit Care 2007

-KDIGO classification
KDIGO. Kidney Int 2012
RIFLE  Bellomo R. Crit Care 2004

Mortality in ICU-patients with IFLE is ↑↑↑

What is acute kidney injury (failure)?

- Before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
  *Bellomo R. Crit Care 2004*

- 2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality

- AKIN proposed to replace the term ARF by AKI
  traditional classification prerenal, postrenal, «intrinsic» renal AKI maintained
  *Mehta RL. Crit Care 2007*

- RIFLE classification: based on the parameters SCr and Urine output
  *Bellomo R. Crit Care 2004*

- AKIN classification to overcome some limitations of RIFLE
  *Mehta RL. Crit Care 2007*

- KDIGO classification
  *KDIGO. Kidney Int 2012*
-addition of an absolute change in SCr of $\geq 0.3$ mg/dl (26.4 µmol/L). 80%↑ mortality with this small change in SCr. (*Chertow GM JASN 2005, Lassnigg A. JASN 2004*)
-GFR criteria omitted
-endstage criteria omitted
-indication for RRT indicates automatically stage 3, regardless of severity
-after volume replacement and exclusion of urinary tract obstruction

---

Ravindra L Mehta, John A Kellum, Sudhir V Shah, Bruce A Molitoris, Claudio Ronco, David G Warnock, Adeera Levin and the Acute Kidney Injury Network
What is acute kidney injury (failure)?

- before 2004: Lack of precise biochemical definitions of ARF: At least 35 variations
  
  Bellomo R. Crit Care 2004

- 2004-2006 accumulating evidence, that even minimal increase in SCr is associated with a dramatic impact on the risk for mortality
  

- AKIN proposed to replace the term ARF by AKI
  traditional classification prerenal, postrenal, «intrinsic» renal AKI maintained
  Mehta RL. Crit Care 2007

- RIFLE classification: based on the parameters SCr and Urine output
  Bellomo R. Crit Care 2004

- AKIN classification to overcome some limitations of RIFLE
  Mehta RL. Crit Care 2007

- KDIGO classification 2012
  KDIGO. Kidney Int 2012
AKI is defined as any of the following:
- An increase in SCr by ≥0.3 mg/dl (≥26.5 µmol/l) within 48 hours; or
- An increase in SCr to ≥1.5 times baseline, which is known/presumed to have occurred in the prior 7 days; or
- Urine volume <0.5 ml/kg/h for 6 hours.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Serum creatinine</th>
<th>Urine output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5-1.9 times baseline OR ≥0.3 mg/dl (≥26.5 µmol/l) increase</td>
<td>&lt;0.5 ml/kg/h for 6-12 hours</td>
</tr>
<tr>
<td>2</td>
<td>2.0-2.9 times baseline</td>
<td>&lt;0.5 ml/kg/h for ≥12 hours</td>
</tr>
<tr>
<td>3</td>
<td>3.0 times baseline OR Increase in serum creatinine to ≥4.0 mg/dl (≥353.6 µmol/l) OR Initiation of renal replacement therapy OR In patients &lt;18 years, decrease in eGFR to &lt;35 ml/min per 1.73 m²</td>
<td>&lt;0.3 ml/kg/h for ≥24 hours OR Anuria for ≥12 hours</td>
</tr>
</tbody>
</table>
FINNAKKI (90 d mortality)

Cohort study on 1’141 AKI vs. 1760 non AKI patients in 17 Finnish ICU’s.

*Nisula S. Incidence, risk-factors and 90 d mortality of patients with acute kidney failure in Finnish intensive care units: the FINNAKI study. Intens Care Med 2013*
Cohort study in 16’784 patients of the SAPS 3 cohort. (303 ICU’s, staging AKI within 48 h)
AKIN & RIFLE

Cohort study in 16,784 patients of the SAPS 3 cohort. (303 ICU’s, staging AKI within 48 h)

- Incidence of AKI between 28.5 and 35.5%
- Excess overall mortality (adjusted for illness severity)
- Excess mortality within each AKI stratum (adjusted for illness severity)

Joannidis M. Intens Care Med 2009
the duration of AKI and mortality

Cohort study on 35’302 diabetic patients with heart surgery. Short AKI≤2d, medium 3-6d, long≥7d

*Coca SG. The duration of postoperative acute kidney injury is an additional parameter predicting long-term survival in diabetic veterans. Kidney Int 2010; 78: 926*
AKI and mortality

Cohort study, 3’769 AKI patients requiring RRT vs. 13’598 matched controls without AKI.

*Wald R.* Chronic dialysis and death among survivors of acute kidney injury requiring dialysis. *JAMA* 2009; 302: 1179

HR = 0.95, (CI 95% = 0.89-1.02)
Costs:
Costs:
**Costs:**

Retrospective matched cohort study (258 patients with AKI and RRT vs. 258 matched controls)

<table>
<thead>
<tr>
<th></th>
<th>Total post operative costs</th>
<th>ICU costs</th>
<th>Total postoperative LOS (days)</th>
<th>ICU LOS (days)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases with RRT (n = 27)</td>
<td>74 040 (38 155–124 425)</td>
<td>71 511 (26 508–122 980)</td>
<td>21.0 (13–35)</td>
<td>6.7 (3.2–20.8)</td>
<td>37.0%</td>
</tr>
<tr>
<td>Cases without RRT (n = 231)</td>
<td>34 953 (22 275–61 495)</td>
<td>23 880 (14 509–49 489)</td>
<td>10.0 (7–17)</td>
<td>2.7 (1.4–6.1)</td>
<td>8.2%</td>
</tr>
<tr>
<td>Controls (N = 258)</td>
<td>18 463 (14 704–23 822)</td>
<td>13 836 (11 165–19 923)</td>
<td>5.0 (4–7)</td>
<td>1.4 (1.1–2.0)</td>
<td>2.3</td>
</tr>
</tbody>
</table>

*Dasta JF. Costs and outcomes of acute kidney injury (AKI) following cardiac surgery. Neprol Dial Transplant 2008*
Costs:

Retrospective matched cohort study (258 patients with AKI and RRT vs. 258 matched controls)

Table 2. Costs and outcomes of patients with and without AKI after coronary artery bypass graft surgery*

<table>
<thead>
<tr>
<th></th>
<th>Total postoperative costs</th>
<th>ICU costs</th>
<th>Total postoperative LOS (days)</th>
<th>ICU LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AKI patients (n = 258)</td>
<td>37 674 (23 654–68 433)</td>
<td>25 949 (15 547–59 175)</td>
<td>11.0 (7–18)</td>
<td>3.2 (1.5–6.5)</td>
</tr>
<tr>
<td>Controls (n = 258)</td>
<td>18 463 (14 704–23 822)</td>
<td>13 836 (11 165–19 923)</td>
<td>5.0 (4–7)</td>
<td>1.4 (1.1–2.0)</td>
</tr>
</tbody>
</table>

*All are statistically different (P < 0.001), medians (interquartile ranges)
AKI, acute kidney injury; ICU, intensive care unit; LOS, length of stay; RRT, renal replacement therapy.

Dasta JF. Costs and outcomes of acute kidney injury (AKI) following cardiac surgery. Neprol Dial Transplant 2008
How to get the money?
Fallpauschalen: SwissDRG-Grouper

- **MDC**
  - major diagnostic category

- **Hauptdiagnose**
  - (ICD-10GM)

- **DRG**
AKIN vs. RIFLE  Joannidis M. Intens Care Med 2009

<table>
<thead>
<tr>
<th>AKIN</th>
<th>RIFLE</th>
<th>Total (AKIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>non-AKI</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>8759 (12.9%)</td>
<td>10263 (15.9%)</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>457 (25.2%)</td>
<td>1077 (34.5%)</td>
</tr>
<tr>
<td>*</td>
<td>282 (33.0%)</td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>36 (30.6%)</td>
<td>1033 (29.0%)</td>
</tr>
<tr>
<td>*</td>
<td>21 (47.6%)</td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>11 (18.2%)</td>
<td>1983 (41.2%)</td>
</tr>
<tr>
<td>*</td>
<td>8 (12.5%)</td>
<td></td>
</tr>
<tr>
<td>Total (RIFLE)</td>
<td>9263 (13.6%)</td>
<td>14356 (21.7%)</td>
</tr>
<tr>
<td></td>
<td>1092 (29.2%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1596 (32.3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2405 (42.6%)</td>
<td></td>
</tr>
</tbody>
</table>

AKIN misclassified 1,504 patients as non-AKI compared to RIFLE which misclassified 504 patients.
## AKIN vs. RIFLE

Joannidis M. Intens Care Med 2009

<table>
<thead>
<tr>
<th>AKIN</th>
<th>RIFLE</th>
<th></th>
<th></th>
<th></th>
<th>Total (AKIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>non-AKI</td>
<td>Risk</td>
<td>Injury</td>
<td>Failure</td>
<td></td>
</tr>
<tr>
<td>non-AKI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>8759</td>
<td>781</td>
<td>452</td>
<td>271</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>(12.9%)</td>
<td>(27.7%)</td>
<td>(37.4%)</td>
<td>(41.3%)</td>
</tr>
<tr>
<td>Stage 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>457</td>
<td>282</td>
<td>243</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>(25.2%)</td>
<td>(33.0%)</td>
<td>(44.0%)</td>
<td>(60.0%)</td>
</tr>
<tr>
<td>Stage 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>36</td>
<td>21</td>
<td>885</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>(30.6%)</td>
<td>(47.6%)</td>
<td>(25.9%)</td>
<td>(54.9%)</td>
</tr>
<tr>
<td>Stage 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>11</td>
<td>8</td>
<td>16</td>
<td>1948</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>(18.2%)</td>
<td>(12.5%)</td>
<td>(62.5%)</td>
<td>(41.3%)</td>
</tr>
<tr>
<td>Total (RIFLE)</td>
<td>n</td>
<td>9263</td>
<td>1092</td>
<td>1596</td>
<td>2405</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>(13.6%)</td>
<td>(29.2%)</td>
<td>(32.3%)</td>
<td>(42.6%)</td>
</tr>
</tbody>
</table>

AKIN misclassified 1,504 patients as non-AKI compared to RIFLE which misclassified 504 patients.
Das akute Nierenversagen ist eine rasche (in der Regel innerhalb von 7 Tagen) eintretende Verschlechterung der Nierenfunktion. Es unterscheidet sich von der chronischen Niereninsuffizienz dadurch, dass das akute Nierenversagen grundsätzlich reversibel ist.

<table>
<thead>
<tr>
<th>Stadieneinteilung der akuten Nierenschädigung</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RIFLE</strong></td>
</tr>
<tr>
<td>Risk</td>
</tr>
<tr>
<td>Injury</td>
</tr>
<tr>
<td>Failure</td>
</tr>
<tr>
<td>Loss</td>
</tr>
<tr>
<td>ESRD</td>
</tr>
</tbody>
</table>

Fallpauschalen: SwissDRG-Grouper

- **MDC**
  - *major diagnostic category*

- **Hauptdiagnose**
  - (ICD-10GM)

- **Nebendiagnosen**
  - *CCL (complication and/or comorbidity level)*

- **DRG**
Fallpauschalen: SwissDRG-Grouper

MDC
*major diagnostic category*

Hauptdiagnose
*(ICD-10GM)*

Nebendiagnosen
*CCL (complication and/or comorbidity level)*

CHOP
*(Prozeduren)*
Komplizierende Prozeduren:
Gerinnungsstörungen od. SIRS mit
Reanimation, ECMO, *Nierenersatz*, IABP,
cardiac Assist, Pleuradrainage, Plasmapherese,
ICP-Monitoring, cerebrale Mikrodialyse

**MDC**
*major diagnostic category*

**IM Komplexbehandlung**

**Beatmung 24 - 96 – 250 h**

**Prä-MDC**

**Hauptdiagnose**
*(ICD-10GM)*

**Nebendiagnosen**
*CCL (complication and/or comorbidity level)*

**CHOP**
*(Prozeduren)*
Komplizierende Proz. in Prä-MDC

Komplizierende Prozeduren Prä-MDC

Mindestens zwei unterschiedliche Prozeduren aus Tabelle KPP-2 oder Prozedur in Tabelle KPP-2 und mindestens eine Prozedur in Tabelle KPP-3 oder Diagnose in Tabelle KPP-1 und mindestens eine Prozedur in Tabelle KPP-4

Diagnose KPP-1

D65.0 Erworb Afishinogenämie
D65.1 Disseminierte intravas Gerinn [DIG, DIC]
D65.2 Erworb Fibrinolyseblutung
D65.9 DefibrinatSynd, nnbez

D69.53 Heparin-induzierte Thrombozytopenie Typ II

R65.1 Syst inflam Response-Synd [SIRS] infekt m Organkomp
R65.3 Syst inflam Response-Synd [SIRS] ni-infekt m Organkomp

KPP2, 3, 4: Pleuradrainage, ECMO, IABP, cardiac Assist, Nierenersatz, Plasmapherese, ICP-Messung, cerebrale Mikrodialyse, Reanimation
Komplizierende Prozeduren:
Gerinnungsstörungen od. SIRS mit
Reanimation, ECMO, Nierenersatz, IABP,
cardiac Assist, Pleuradrainage, Plasmapherese,
ICP-Monitoring, cerebrale Mikrodialyse

MDC
*major diagnostic category*

DRG

Pra-MDC

Hauptdiagnose
*(ICD-10GM)*

CHOP
*(Prozeduren)*

Nebendiagnosen
*CCL (complication and/or comorbidity level)*

Zusatzentgelte
*Nierenersatzverfahren*
„Kunstherz“
Gerinnungsfaktoren für Bluter

Beatmung 24 - 96 – 250 h

IM Komplexbehandlung
Isuffisance renale aiguë: Une épidémie mondiale

14 March 2013

Int. Soc. of Nephrology & Int. Fed. of Kidney Foundations
Incidence of AKI

-AKI is 30-70% in ICU patients

-about 5% of these patients had ARF requiring RRT

-mortality is increased 50-80%

*Uchino S. JAMA 2005,*  
*Cerda J. CJASN 2008,*  
*Cerda J. Nat Clin Pract Nephrol 2008*
Hsu RK. Temporal changes in incidence of dialysis-requiring AKI. *J Am Soc Nephrol* 2013
Incidence of AKI (requiring RRT)

Hsu RK. Temporal changes in incidence of dialysis-requiring AKI. *J Am Soc Nephrol* 2013
## Causes of AKI (requiring RRT)

Contributing factors (n=1726)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic shock</td>
<td>820</td>
<td>47.5</td>
</tr>
<tr>
<td>Major surgery</td>
<td>592</td>
<td>34.3</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>465</td>
<td>26.9</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>442</td>
<td>25.6</td>
</tr>
<tr>
<td>Drug-induced</td>
<td>328</td>
<td>19.0</td>
</tr>
<tr>
<td>Hepatorenal syndrome</td>
<td>99</td>
<td>5.7</td>
</tr>
<tr>
<td>Obstructive uropathy</td>
<td>45</td>
<td>2.6</td>
</tr>
<tr>
<td>Other</td>
<td>211</td>
<td>12.2</td>
</tr>
</tbody>
</table>

*Uchino S. Acute renal failure in critically ill patients. JAMA 2005; 294: 813*
Chronic kidney disease after AKI

AKI has long been thought of as completely reversible syndrome.
Chronic kidney disease after AKI

n=39’805 with preexisting GFR < 45 ml/min

- GFR 30-44 ARF (n=294)
- GFR 30-44 No-ARF (n=28’434)
- GFR 15-29 ARF (n=476)
- GFR 15-29 No-ARF (n=7’763)
- GFR <15 ARF (n=291)
- GFR <15 No-ARF (n=2’547)

Cohort study on 39’850 hospitalized patients with previously reduced GFR.

Chronic kidney disease after AKI

Cohort study, 3’769 AKI patients requiring RRT vs. 13’598 matched controls without AKI.

Wald R. Chronic dialysis and death among survivors of acute kidney injury requiring dialysis. JAMA 2009; 302: 1179
Chronic kidney disease after AKI

Coca S. Chronic kidney disease after acute kidney injury: A systematic review and meta-analysis. *Kidney Intern* 2012; 81: 442
The Lingering Consequences of Sepsis
A Hidden Public Health Disaster?

Derek C. Angus, MD, MPH
The epidemiology of sepsis (USA)

- National Hospital Discharge Survey (NHDS) 1979-2000
  350,000 Discharges/y from 500 non-governemental hospitals

*Figure 1. Population-Adjusted Incidence of Sepsis, According to Sex, 1979–2000.* Points represent the annual incidence rate, and I bars the standard error.
Heublein S. Epidemiologie der Sepsis in deutschen Krankenhäusern-eine Analyse administrativer Daten. *Intensiv-News* 2013
Bolton, C.F. Intens Care Med 1993
Two-Year Cognitive, Emotional, and Quality-of-Life Outcomes in Acute Respiratory Distress Syndrome

Ramona O. Hopkins, Lindell K. Weaver, Dave Collingridge, R. Bruce Parkinson, Karen J. Chan, and James F. Orme, Jr.

Department of Medicine, Pulmonary and Critical Care Divisions, and Statistical Data Center, LDS Hospital; University of Utah School of Medicine, Salt Lake City; and Psychology Department and Neuroscience Center, Brigham Young University, Provo, Utah; and Department of Clinical and Health Psychology, University of Florida, Gainesville, Florida

Long-term Cognitive Impairment and Functional Disability Among Survivors of Severe Sepsis

• prospective cohort study
• patienten in der health and retirement study (n=16‘772)
• minimal one interview before severe sepsis
• n= 1194, 1520 hospitalizations with severe sepsis
• 516 survivors to the follow-up interview
• 2 validated questionaires

Iwashina TJ, Ely WE Smith MD, Langa KM. JAMA 2010; 304 1787-1794
Long-term Cognitive Impairment and Functional Disability Among Survivors of Severe Sepsis

Iwashina TJ, Ely WE Smith MD, Langa KM. *JAMA* 2010; 304:1787-1794

Error bars indicate 95% confidence intervals (CIs); IQR, interquartile range.

*Interpretive Example:* Compared with stable rates before severe sepsis, the prevalence of moderate to severe cognitive impairment increased from 6.1% (95% CI, 4.2%-8.0%) before severe sepsis to 16.7% (95% CI, 13.8%-19.7%) at the first survey after severe sepsis ($P < .001$ by $\chi^2$ test; Table 2).
Management guidelines

1. Early screening and detection of AKI (“Kidney attack”)
2. The cause of AKI should be determined whenever possible. (Not Graded)
3. Patients be stratified for risk of AKI according to their susceptibilities and exposures. (1B)
4. Manage patients according to their susceptibilities and exposures to reduce the risk of AKI

5. Individualize frequency and duration of monitoring based on risk and clinical course. (Not Graded)

6. Manage patients with AKI according to the stage and cause. (Not Graded)

7. Evaluate patients 3 months after AKI for resolution, new onset, or worsening of pre-existing CKD. (Not Graded)
   - If patients have CKD, manage these patients as detailed in KDOQI CKD (Not Graded)
   - If patients do not have CKD, consider them to be at increased risk for CKD and care for them as detailed in KDOQI (Not Graded)

adapted from KDIGO. Kidney Int 2012
Management guidelines

1. Early screening and detection of AKI (“Kidney attack”)
2. The cause of AKI should be determined whenever possible. (Not Graded)
3. Patients be stratified for risk of AKI according to their susceptibilities and exposures. (1B)
4. Manage patients according to their susceptibilities and exposures to reduce the risk of AKI
5. Individualize frequency and duration of monitoring based on risk and clinical course. (Not Graded)
6. Manage patients with AKI according to the stage and cause. (Not Graded)
7. Evaluate patients 3 months after AKI for resolution, new onset, or worsening of pre-existing CKD. (Not Graded)
   - If patients have CKD, manage these patients as detailed in KDOQI CKD (Not Graded)
   - If patients do not have CKD, consider them to be at increased risk for CKD and care for them as detailed in KDOQI (Not Graded)

adapted from KDIGO. Kidney Int 2012
Management guidelines (stage-based)

<table>
<thead>
<tr>
<th>High Risk</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discontinue all nephrotoxic agents when possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure volume status and perfusion pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider functional hemodynamic monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor Serum creatinine and urine output</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avoid hyperglycemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider alternatives to radiocontrast procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-invasive diagnostic workup</td>
<td>Consider invasive diagnostic workup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check for changes in drug dosing</td>
<td>Consider Renal Replacement Therapy</td>
<td>Consider ICU admission</td>
</tr>
<tr>
<td></td>
<td>Avoid subclavian catheters if possible</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Management guidelines

1. Early screening and detection of AKI ("Kidney attack")

2. The cause of AKI should be determined whenever possible. (Not Graded)

3. Patients be stratified for risk of AKI according to their susceptibilities and exposures. (1B)

4. Manage patients according to their susceptibilities and exposures to reduce the risk of AKI

5. Individualize frequency and duration of monitoring based on risk and clinical course. (Not Graded)

6. Manage patients with AKI according to the stage and cause. (Not Graded)

7. Evaluate patients 3 months after AKI for resolution, new onset, or worsening of pre-existing CKD. (Not Graded)
   - If patients have CKD, manage these patients as detailed in KDOQI CKD (Not Graded)
   - If patients do not have CKD, consider them to be at increased risk for CKD and care for them as detailed in KDOQI (Not Graded)

adapted from KDIGO. Kidney Int 2012
Nephrologist consultation

Prospective, controlled, non-randomized intervention study

### Table 4. Primary and Secondary Outcomes of Patients in the EARLI and Control Groups

<table>
<thead>
<tr>
<th></th>
<th>EARLI</th>
<th>Control</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Renal outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary outcome(^a)</td>
<td>3 (3.3)</td>
<td>11 (12.9)</td>
<td>0.02</td>
</tr>
<tr>
<td>Peak SCr (mg/dL)</td>
<td>1.8 ± 0.1</td>
<td>2.1 ± 0.2</td>
<td>0.01</td>
</tr>
<tr>
<td>Dialysis</td>
<td>1 (1.1)</td>
<td>1 (1.2)</td>
<td>—</td>
</tr>
<tr>
<td><strong>Secondary outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>4 (4.4)</td>
<td>7 (8.2)</td>
<td>0.4</td>
</tr>
<tr>
<td>Cardiovascular events</td>
<td>1 (1.1)</td>
<td>1 (1.2)</td>
<td>—</td>
</tr>
</tbody>
</table>

The take home messages I

-AKI (any degree) ↑ mortality of hospitalized patients independent of illness severity

-mortality ↑ is proportional to the severity of AKI

-longer duration of AKI ↑ mortality

-AKI consumes a lot of resources (LOS, personnel, consumables)

-only ARF (RIFLE F or AKIN 3) is a cost factor in the DRG system
The take home messages II

- there is a real epidemiology in AKI and ARF

- severe sepsis and severe systemic inflammatory response are the main causes of (hospital acquired) AKI (and ARF)

- AKI is often not fully reversible and is a step towards CKI, even years after the primary AKI

- CKI progresses by intercurrent AKI
The take home messages III

- suspect AKI early in the context of severe inflammatory diseases and monitor kidney function regularly

- perform «good intensive care» and stop nephrotoxic drugs

- evaluate kidney function of previous AKI patients some months later and consult a nephrologist
Biomarkers

Stages defined by creatinine and urine output are surrogates

Markers such as NGAL, KIM-1, and IL-18 are surrogates

KDIGO. Kidney Int 2012; 2: 19