Chronic Renal Failure Followed by Acute Renal Failure

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Terminology

- Acute Kidney Injury
- Chronic Kidney Disease
- Acute Kidney Disease

- Acute kidney injury complicates >20% of hospital admision
- >50% of AKI patiens fail to recover baseline
- More than 5% of patients evolve to ESRD

Predicting progression to chronic kidney disease after recovery from acute kidney injury

Michael Heung[a] *and Lakhmir S. Chawla*[b,c]

Curr Opin Nephrol Hypertens 2012, 21:628–634

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Acute Renal Failure

- Severe acute kidney injury
- Usually need for renal replacement therapy

Chronic Renal Failure

- Severe chronic kidney disease
- Need for renal replacement therapy or transplant

Acute Kidney Injury (AKI)

- RIFLE (Risk, Injury, Fail, Loss,End stage)
- AKIN (Acute Kidney Injury Network)
- KDIGO (Kidney disease/Improving Global Outcomes)

Acute Kidney Injury (KDIGO)

- Increase in serum creatinine ≥0.3mg/dl within 48 hours
- Increase in serum creatinine ≥1.5 times baseline within 7 days
- Urine volume < 0.5mL/kg/hr for 6 hours

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Criteria for acute kidney injury

	Serum creatinine criteria			Urine output criteria
	RIFLE	AKIN	KDIGO	
Definition	Increase in serum creatinine of >50 percent developing over <7 days	Increase in serum creatinine of 0.3 mg/dL or >50 percent developing over <48 hours	Increase in serum creatinine of 0.3 mg/dL developing over 48 hours or >50 percent developing over 7 days	Urine output of <0.5 mL/kg/hr for >6 hours
Staging				
RIFLE-Risk AKIN/KDIGO stage 1	Increase in serum creatinine of >50 percent	Increase in serum creatinine of 0.3 mg/dL or >50 percent	Increase in serum creatinine of 0.3 mg/dL or >50 percent	Urine output of <0.5 mL/kg/hr for >6 hours
RIFLE-Injury AKIN/KDIGO stage 2	Increase in serum creatinine of >100 percent	Increase in serum creatinine of >100 percent	Increase in serum creatinine of >100 percent	Urine output of <0.5 mL/kg/hr for >12 hours
RIFLE-Failure AKIN/KDIGO stage 3	Increase in serum creatinine of >200 percent	Increase in serum creatinine of >200 percent	Increase in serum creatinine of >200 percent	Urine output of <0.3 mL/kg/hr for >12 hours or anuria for >12 hours
RIFLE-Loss	Need for renal replacement therapy for >4 weeks			
RIFLE-End-stage	Need for renal replacement therapy for >3 months			

AKIN: Acute Kidney Injury Network; KDIGO: Kidney Disease/Improving Global Outcomes.

References:

1. *Bellomo R, Ronco C, Kellum JA, et al. Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Crit Care 2004; 8:B204. Copyright © 2004 BioMed Central Ltd.*
2. *Mehta RL, Kellum JA, Shah SV, et al. Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. Crit Care 2007; 11:R31. Copyright © 2007 BioMed Central Ltd.*
3. *Kidney Disease: Improving Global Outcomes (KDIGO). Acute Kidney Injury Work Group. KDIGO clinical practice guidelines for acute kidney injury. Kidney Int Suppl 2012; 2:1.*

Acute Kidney Injury, Mortality, Length of Stay, and Costs in Hospitalized Patients

Table 2.

Mortality associated with selected changes in SCr[a]

Criterion	Unadjusted OR (95% CI)	Age- and Gender-Adjusted OR (95% CI)	Multivariable OR (95% CI)[b]	Area under ROC Curve
↑ SCr ≥ 0.3 mg/dl	6.9 (5.2 to 9.0)	6.6 (5.0 to 8.7)	4.1 (3.1 to 5.5)	0.84
↑ SCr ≥ 0.5 mg/dl	11.1 (8.7 to 14.2)	10.6 (8.3 to 13.6)	6.5 (5.0 to 8.5)	0.86
↑ SCr ≥ 1.0 mg/dl	19.9 (15.1 to 26.1)	19.0 (14.4 to 25.0)	9.7 (7.1 to 13.2)	0.84
↑ SCr ≥ 2.0 mg/dl	36.4 (24.3 to 54.6)	37.7 (25.0 to 56.9)	16.4 (10.3 to 26.0)	0.83
↑ SCr by 25%	4.0 (3.0 to 5.2)	3.9 (3.0 to 5.2)	2.0 (1.2 to 3.9)	0.83
↑ SCr by 50%	5.9 (4.6 to 7.5)	5.8 (4.6 to 7.5)	4.4 (3.4 to 5.7)	0.84
↑ SCr by 100%	8.9 (6.9 to 11.4)	9.2 (7.1 to 11.8)	6.5 (4.9 to 8.6)	0.84
↑ SCr by 50% to a minimum peak of 2.0 mg/dl	16.9 (12.8 to 22.3)	15.9 (12.0 to 21.0)	7.9 (5.8 to 10.9)	0.84
↑ SCr ≥ 0.5 mg/dl with baseline SCr < 2.0 mg/dl or ↑ SCr ≥ 1.0 mg/dl with baseline SCr ≥ 2.0 and < 5.0 mg/dl	11.0 (8.6 to 14.0)	10.5 (8.2 to 13.4)	6.5 (5.0 to 8.5)	0.86

- [a] n = 2892, 1236, 351, 105, 4060, 1967, 714, 352, and 1160 for respective acute kidney injury (AKI) criteria from denominator sample n = 9205. Results are relative to those without the change indicated. Multivariable analyses were adjusted for age, gender, DRG weight, chronic kidney disease status, and *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes for respiratory, gastrointestinal, malignant, and infectious diseases. Area under ROC curve for multivariable model. SCr, serum creatinine; OR, odds ratio; CI, confidence interval; ROC, receiver operating characteristic.

Chertow GM et al

J Am Soc Nephrol 16: 3365–3370, 2005

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Chronic Kidney Disease

GFR<60ml/min/1.73m2
Evidence of kidney damage
Abnormal radiologic findings

- For 3 months or more

Kidney Damage

- Albuminuria

  Albumin/Cr ratio (ACR) <30mg/gr
- Urinary sediment abnormalities

  Red or white blood cell casts
- Pathologic abnormalities

  Biopsy
- Kidney transplantation

Albuminuria

Categories for albuminuria and proteinuria

	Normal to mildly increased	Moderately increased	Severely increased
AER (mg/day)	<30	30 to 300	>300
PER (mg/day)	<150	150 to 500	>500
ACR (mg/g)	<30	30 to 300	>300
PCR (mg/g)	<150	150 to 500	>500
Protein dipstick	Negative to trace	Trace to 1+	>1+

AER: albumin excretion rate; PER: protein excretion rate; ACR: albumin/creatinine ratio; PCR: protein/creatinine ratio.

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Decresed GFR

- Best index of kidney functions
- GFR or eGFR (MDRD, CKD-EPI)

60ml/min/1.73m2	KD
15ml/min/1.73	KF

Revised chronic kidney disease classification based upon upon glomerular filtration rate and albuminuria

GFR stages	GFR (mL/min/1.73 m^2)	Terms
G1	>90	Normal or high
G2	60 to 89	Mildly decreased
G3a	45 to 59	Mildly to moderately decreased
G3b	30 to 44	Moderately to severely decreased
G4	15 to 29	Severely decreased
G5	<15	Kidney failure (add D if treated by dialysis)
Albuminuria stages	**AER (mg/day)**	**Terms**
A1	<30	Normal to mildly increased (may be subdivided for risk prediction)
A2	30 to 300	Moderately increased
A3	>300	Severely increased (may be subdivided into nephrotic and non-nephrotic for differential diagnosis, management, and risk prediction)

The cause of CKD is also included in the KDIGO revised classification but is not included in this table.

GFR: glomerular filtration rate; AER: albumin excretion rate; CKD: chronic kidney disease; KDIGO: Kidney Disease Improving Global Outcomes.

Data from:

1. *KDIGO. Summary of recommendation statements. Kidney Int 2013; 3 (Suppl):5.*
2. *National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis 2002; 39 (Suppl 1):S1.*

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Acute Kidney Disease

	Functional criteria	Structural criteria
AKI	Increase in SCr by 50% within 7 days, *OR* Increase in SCr by 0.3 mg/dl (26.5 μmol/l) within 2 days, *OR* Oliguria	No criteria
CKD	GFR <60 ml/min per 1.73 m^2 for >3 months	Kidney damage for >3 months
AKD	AKI, *OR* GFR <60 ml/min per 1.73 m^2 for <3 months, *OR* Decrease in GFR by $\geqslant 35\%$ or increase in SCr by $>50\%$ for <3 months	Kidney damage for <3 months
NKD	GFR $\geqslant 60$ ml/min per 1.73 m^2 Stable SCr	No damage

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Acute or Chronic ?

- Current Cr:4mg/dl 1 month ago 0.6 mg/dl Acute or rapidly progressive

- Current 4mg/dl 2 years ago 3.5 mg/dl Chronic kidney disease

When previous datas are unavailable…

Acute

- Recent onset of symptoms (sudden anasarca, discoloured urine)
- Oliguria
- Increase in Cr >0.3-0.5mg/dl

Chronic

- Small kidneys
- Hyperechogenity
- Multiple cysts

Diagnosing AKI

Case	Serum creatinine mg/dl (µmol/l)					Diagnosis AKI?	
	Baseline	Day 1	Day 2	Day 3	Day 7	Criterion 1 50% from baseline	Criterion 2 ⩾0.3 mg/dl (⩾26.5 µmol/l) rise in ⩽48 hours
A	1.0 (88)	1.3 (115)	1.5 (133)	2.0 (177)	1.0 (88)	Yes	Yes
B	1.0 (88)	1.1 (97)	1.2 (106)	1.4 (124)	1.0 (88)	No	Yes
C	0.4 (35)	0.5 (44)	0.6 (53)	0.7 (62)	0.4 (35)	Yes	No
D	1.0 (88)	1.1 (97)	1.2 (106)	1.3 (115)	1.5 (133)	Yes	No
E	1.0 (88)	1.3 (115)	1.5 (133)	1.8 (159)	2.2 (195)	Yes	Yes
F	?	3.0 (265)	2.6 (230)	2.2 (195)	1.0 (88)	Yes	No
G	?	1.8 (159)	2.0 (177)	2.2 (195)	1.6 (141)	?	Yes
H	?	3.0 (265)	3.1 (274)	3.0 (265)	2.9 (256)	?	No

Kidney International Supplements (2012) **2**, 19–36

. *Kidney inter., Suppl.* 2012; **2**: 1–138.

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Examples of AKI, CKD and AKD

Baseline GFR (ml/min per 1.73 m^2)	Increase in SCr during 7 consecutive days	GFR during next 3 months	Diagnosis
>60	>1.5 ×	NA	AKI
>60	<1.5 ×	<60	AKD without AKI
>60	<1.5 ×	>60	NKD

Baseline GFR (ml/min per 1.73 m^2)	Change in SCr during next 7 days	GFR during next 3 months	Diagnosis
<60	>1.5 ×	NA	AKI + CKD
<60	<1.5 ×	>35% decrease	AKD without AKI + CKD
<60	<1.5 ×	<35% decrease	CKD

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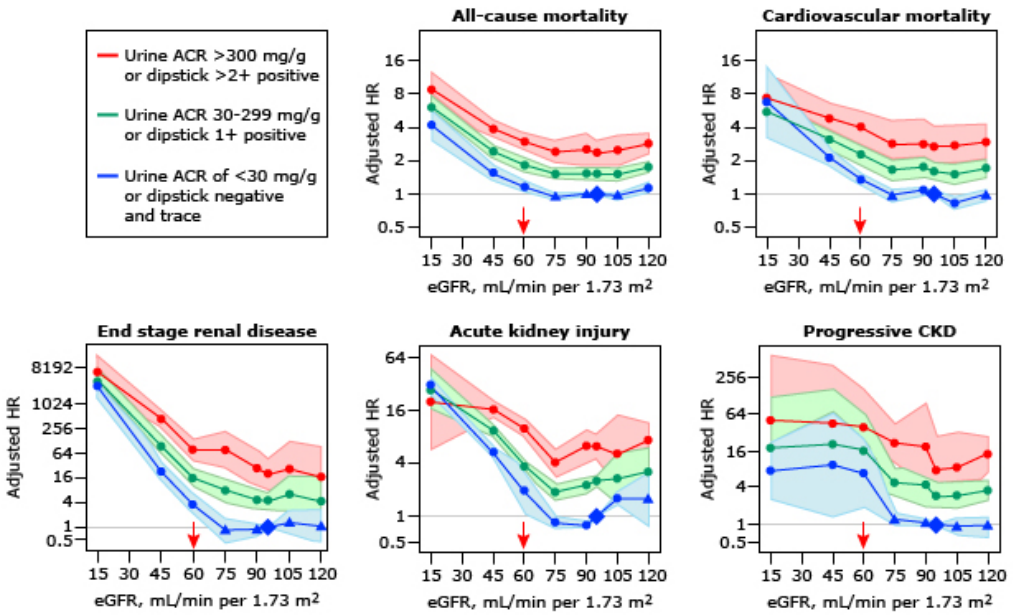
. *Kidney inter., Suppl.* 2012; **2**: 1–138.

Relative risks of major complications of chronic kidney disease based upon a continuous meta-analysis



Summary of continuous meta-analysis (adjusted RR) for general population cohorts with ACR. Mortality is reported for general population cohorts assessing albuminuria as urine ACR. Kidney outcomes are reported for general population cohorts assessing albuminuria as either urine ACR or dipstick. eGFR is expressed as a continuous variable. The three lines represent urine ACR of <30 mg/g or dipstick negative and trace (blue), urine ACR 30-299 mg/g or dipstick 1+ positive (green), and urine ACR >300 mg/g or dipstick >2+ positive (red). All results are adjusted for covariates and compared with reference point of eGFR of 95 mL/min per 1.73 m^2 and ACR of <30 mg/g or dipstick negative (diamond). Each point represents the pooled RR from a meta-analysis. Solid circles indicate statistical significance compared with the reference point ($p<0.05$); triangles indicate non-significance. Red arrows indicate eGFR of 60 mL/min per 1.73 m^2, threshold value of eGFR for the current definition of CKD.

CKD: chronic kidney disease; ACR: albumin creatinine ratio; HR: hazard ratio; eGFR: estimated glomerular filtration rate; RR: relative risk.

Reprinted by Permission from Macmillan Publishers Ltd: Levey AS, de Jong PE, Coresh J, et al. The definition, classification, and prognosis of chronic kidney disease: a KDIGO Controversies Conference report. Kidney Int 2010; 80:17. Copyright © 2010.

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UpToDate®

Acute on Chronic

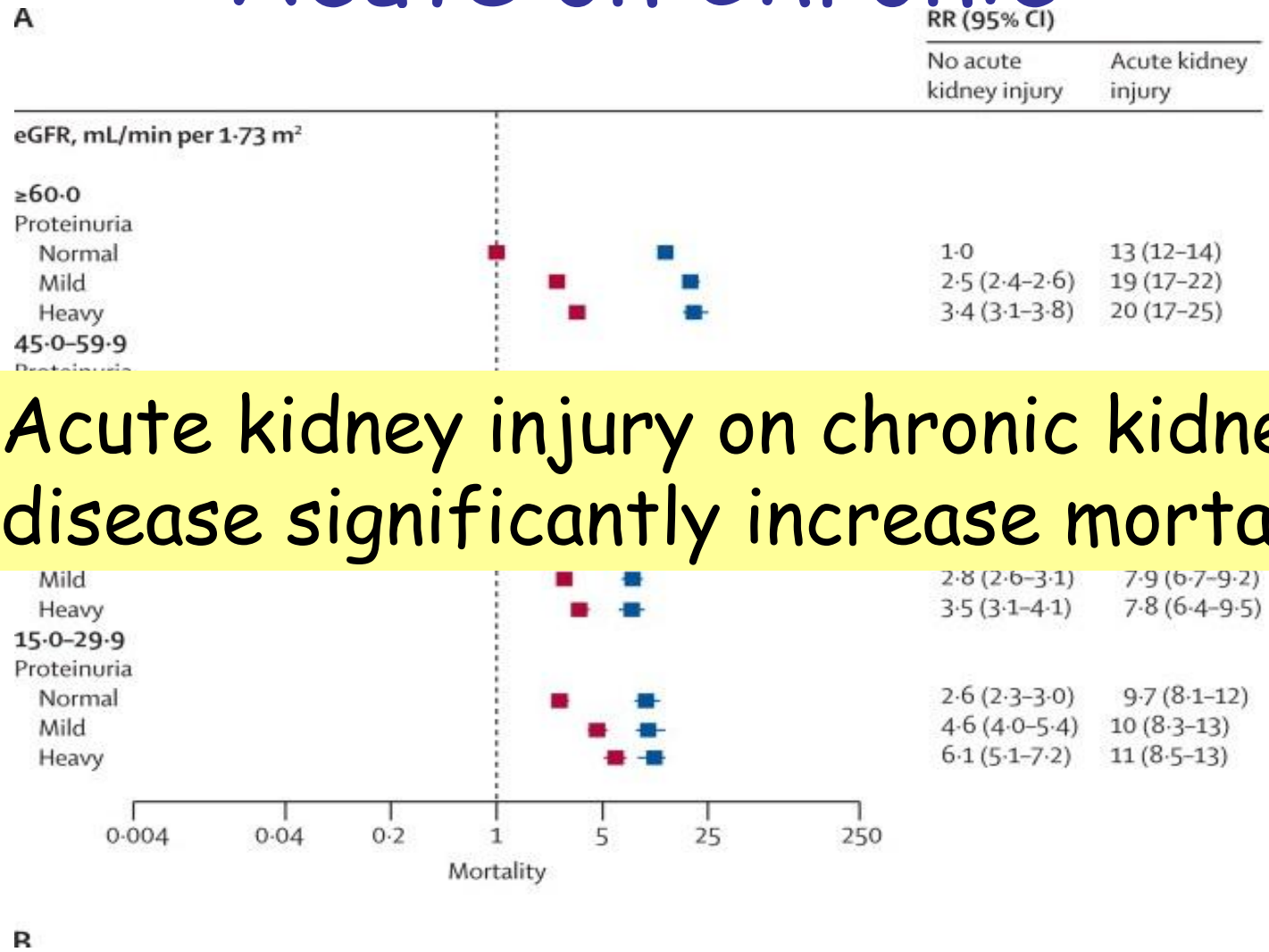
Chronic

- High mortality
- High risk of Cardiac events
- High risk of AKI
- ESRD

Acute

- High mortality
- CKD progression
- ESRD
- High risk of cardiac events

Acute on Chronic



Acute kidney injury on chronic kidney disease significantly increase mortality

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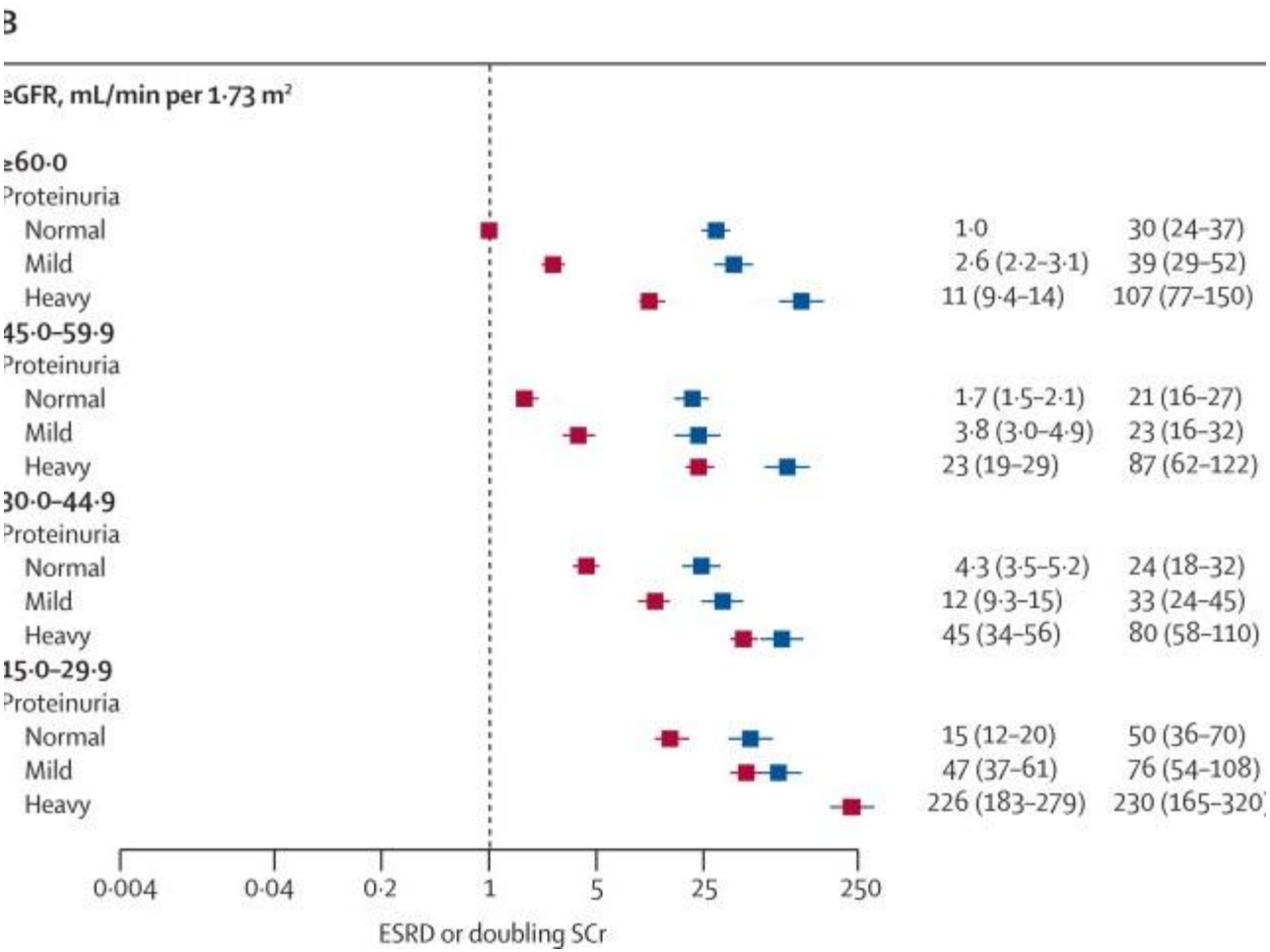
Glomerular filtration rate, proteinuria, and the incidence and consequences of acute kidney injury: a cohort study
Matthew T James, **MD**, Brenda R Hemmelgarn, **MD** et al
The Lancet Volume 376, Issue 9758, **2010**

Acute on Chronic



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Glomerular filtration rate, proteinuria, and the incidence and consequences of acute kidney injury: a cohort study
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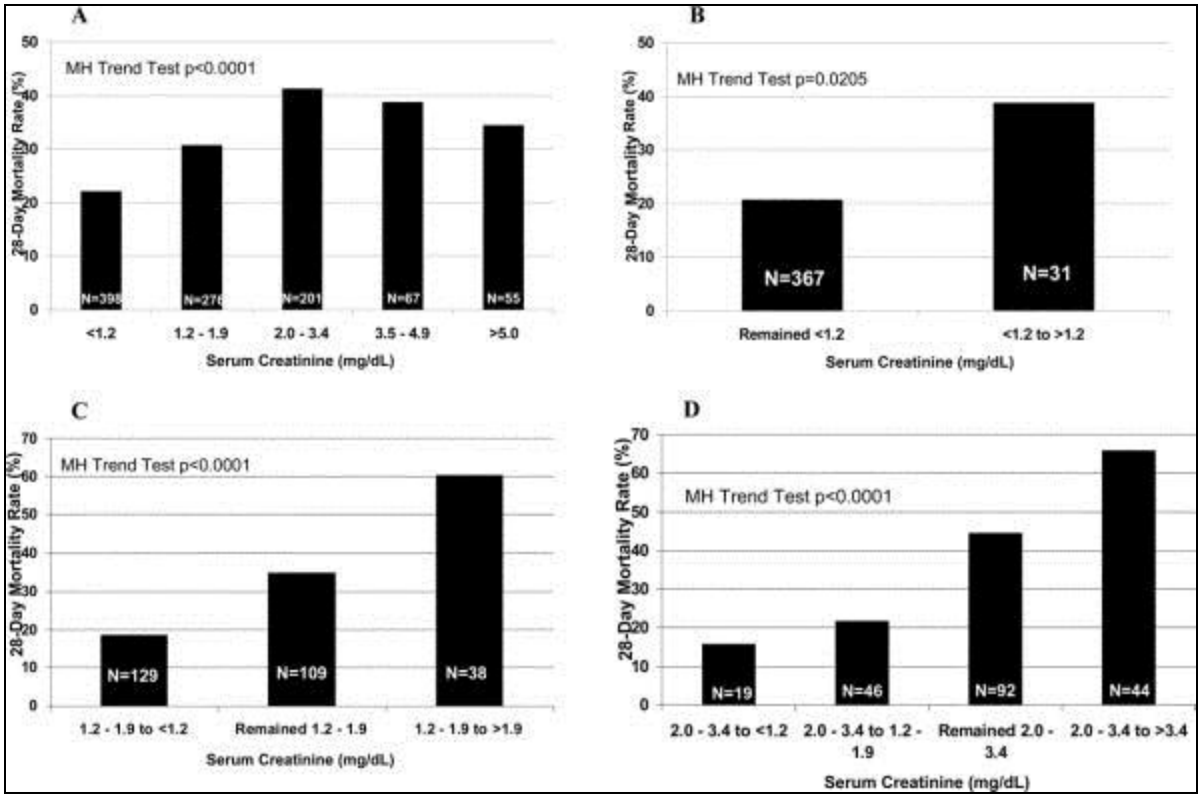
The Lancet Volume 376, Issue 9758, **2010**

Why It is Important?



Early changes in organ function predict eventual survival in severe sepsis *.
Levy, Mitchell; MD, FCCM; Macias, William; MD, PhD; Vincent, Jean-Louis; MD, PhD; Russell, James; Silva, Eliezer; MD, PhD; Trzaskoma, Benjamin; Williams, Mark

Critical Care Medicine. 33(10):2194-2201, October 2005.
DOI: 10.1097/01.CCM.0000182798.39709.84

Figure 3. Twenty-eight-day mortality rate by baseline and change from baseline to day 1 in creatinine levels. A, 28-day mortality rate by creatinine level at baseline (p B, mortality rate for patients who had normal creatinine levels at baseline whose level remained normal or increased the first postbaseline day (as defined in the Methods) of study (p = .021). C, mortality rates for patients who had moderately elevated creatinine levels at baseline whose levels decreased, remained stable, or increased during the first postbaseline day of study (p D, mortality rates for patients who had highly elevated creatinine levels at baseline whose levels returned to normal, decreased to moderately elevated, remained stable, or increased during the first postbaseline day of study (p MH, Mantel-Haenszel.

if the patient is not improving within the first postbaseline day of therapy, the patient's risk of death over the next 28 days is increased.

Wolters Kluwer Health | OvidSP

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Table 2. Risk factors for development of chronic kidney disease after acute kidney injury recovery

Variable	Definition	References
AKI severity	Repetitive episodes of AKI Degree of serum creatinine rise RRT vs. no RRT	[21▪,24▪▪] [22▪,25▪▪,32▪] [25▪▪,32▪]
Demographic	Increasing age	[25▪▪,28▪▪,29▪,33]
Causes of AKI	Mixed (multiple causes) vs. pure acute tubular necrosis	[34,35▪]
Biomarkers	Markers of renal recovery vs. ongoing inflammation Albumin	[36▪▪,37] [25▪▪,28▪▪]

Predicting progression to chronic kidney disease after recovery from acute kidney injury
Curr Opin Nephrol Hypertens 2012, 21:628–634

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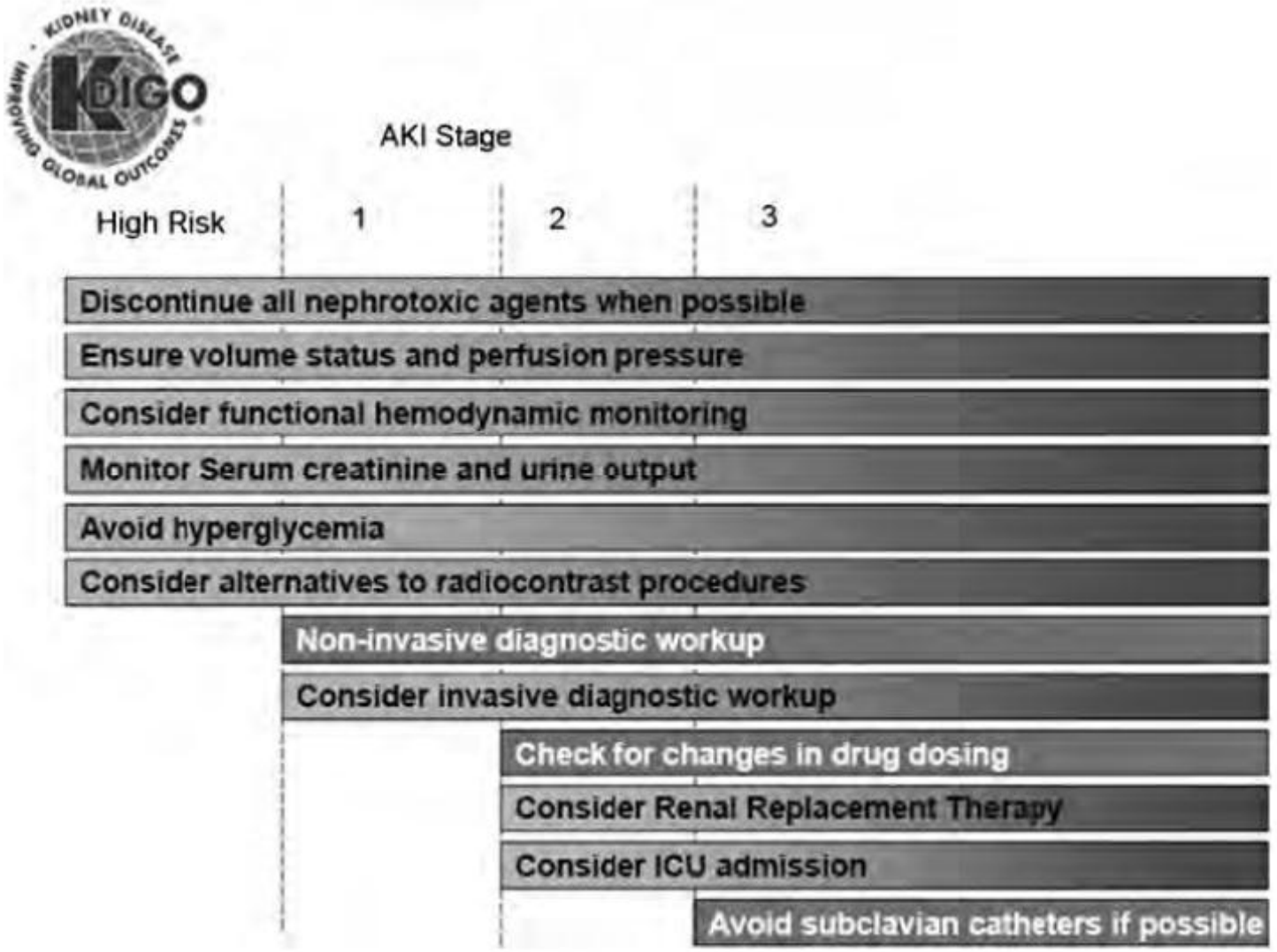
Management



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. *Kidney inter., Suppl.* 2012; **2**: 1–138.

Conclusion

- CKD is a risk factor for AKI
- Acute kidney injury on chronic kidney disease significantly increase morbidity and mortality
- Beware of the risk
- Restore hemodynamic instability
- Avoid nephrotoxins
- Avoid infections
- Treatment of underlying disease

THANK YOU

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3rd EURO-ASIAN CRITICAL CARE MEETING
10th INTERNATIONAL CONGRESS OF WORLD FEDERATION OF CRITICAL CARE NURSES
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