Acute Kidney Injury

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Objectives

- Causes and etiologies of Acute Kidney Injury (AKI)
- Care of patients with AKI in ESRD facilities

Acute Dialysis Quality Initiative

Second International Consensus Conference

Conference Topic: ARF

May 11-13, 2002

Vicenza

Acute Kidney Injury (AKI)

- High mortality rate. Most deaths are not due to AKI but rather underlying disease or complication.
- Rapid deterioration of kidney function
- Usually reversible with majority of patients recovering completely
- HOWEVER can lead to residual impairment of kidney function and lead to ESRD

Causes of Acute Kidney Injury

- Sepsis
- Hypoperfusion, hypovolemia (Kidneys require 20% of resting cardiac output)
- Nephrotoxic injury (drugs, contrast media)

Treatment for Acute Kidney Injury

- Know the cause – treat accordingly – volume replacement, resumption of perfusion, remove causative agent
- Renal Replacement Therapy
- Usually Intermittent Hemodialysis or Continuous Renal Replacement Therapy (CRRT)
- Usually in the Critical Care Area

Indications for Dialysis

- Uremia
- Acidosis
- Electrolyte derangement
- Intoxication
- Volume overload

Factors Affecting Recovery

- Age
- Multiple co-morbidities – usually cardiovascular
- Pre existing Chronic Kidney Disease
- Prolonged exposure to nephrotoxins
- Low serum albumin

Acute Kidney Injury/CKD

Acute Kidney Injury and Chronic Kidney Disease: A Work in Progress

Jason R. Bydash[§] *and Areef Ishani*[§¶]

Clin J Am Soc Nephrol 6: 2555–2557, 2011. doi: 10.2215/CJN.09560911

Criteria for acute kidney injury

	Serum creatinine criteria			Urine output criteria
	RIFLE	**AKIN**	**KDIGO**	
Definition	Increase in serum creatinine of >50% developing over <7 days	Increase in serum creatinine of 0.3 mg/dL or >50% developing over <48 hours	Increase in serum creatinine of 0.3 mg/dL developing over 48 hours or >50% developing over 7 days	Urine output of <0.5 mL/kg/hour for >6 hours
Staging				
RIFLE-Risk AKIN/KDIGO stage 1	Increase in serum creatinine of >50%	Increase in serum creatinine of 0.3 mg/dL or >50%	Increase in serum creatinine of 0.3 mg/dL or >50%	Urine output of <0.5 mL/kg/hour for >6 hours
RIFLE-Injury AKIN/KDIGO stage 2	Increase in serum creatinine of >100%	Increase in serum creatinine of >100%	Increase in serum creatinine of >100%	Urine output of <0.5 mL/kg/hour for >12 hours
RIFLE-Failure AKIN/KDIGO stage 3	Increase in serum creatinine of >200%	Increase in serum creatinine of >200%	Increase in serum creatinine of >200%	Urine output of <0.3 mL/kg/hour for ≥24 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*

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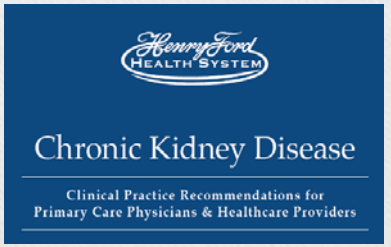
Stages of Chronic Kidney Disease (CKD)

TABLE 2. CHRONIC KIDNEY DISEASE (CKD) STAGES

NKF CKD Stage (USA)	KDIGO GFR Category (International)	Glomerular Filtration Rate (mL/min/1.73 m²)	Terms
Stage 1	G1	≥90	Normal or high In the absence of evidence of kidney damage and abnormal urinalysis, neither GFR category G1 nor G2 fulfill the criteria for CKD
Stage 2	G2	60–89	Mildly decreased relative to a young adult level In the absence of kidney damage and abnormal urinalysis, neither GFR category G1 nor G2 fulfill the criteria for CKD
Stage 3A	G3a	45–59	Mildly to moderately decreased
Stage 3B	G3b	30–44	Moderately to severely decreased
Stage 4	G4	15–29	Severely decreased
Stage 5	G5	<15	Kidney failure
Stage 5D	G5	<15	Dialysis
Stage 5T	G5	<15	Kidney transplant



Recovery of Kidney Function

- Recovered = sustained independence from Renal Replacement therapy
- Gradual recovery = varied time frame – may take months or even years
- Will start seeing increase in urine output if oliguric

Transitioning from Acute to the Chronic Unit

- Goal is recovery of kidney function
- Communication is key
- Know how patient tolerated hemodialysis
- Recent lab results and start trending
- Access = usually tunneled hemodialysis catheter
- Medications
- Patient and family support = answer questions, allay anxiety and fears

Managing Care of the Post AKI Patient in the Chronic Unit

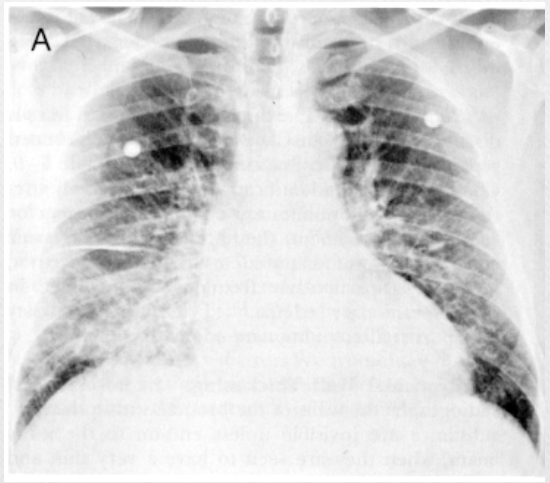
- 2728 not signed immediately
- MD orders are specific to AKI
- Established protocols for anemia and mineral bone disease management may not apply
- Weekly assessment of Basic metabolic panel (trending creatinine)
- Assessment of residual kidney function = 24 hour urine for volume, urea and creatinine clearance

Managing Care of the Post AKI Patient in the Chronic Unit

- Requires close monitoring = labs, urine output, medication – avoidance of nephrotoxic agents.
- More frequent care planning among members of the interdisciplinary team
- Dialysis prescription is adjusted more frequent to accommodate return of kidney function

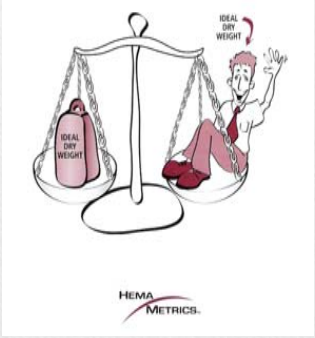
Fluid Management is Critical

- **GOAL – <u>Renal Function Recovery</u>**
- **<u>Avoid Intradialytic hypotension</u>**



Assessment of Fluid status

- **Know urine output**
- **Salt restriction**
- **Ostomies ?**
- **Increasing appetite during recovery?**
- **May need more frequent treatment for safe fluid removal**
- **Accurate pre and post dialysis weights (may need to be witnessed if in doubt)**
- **Volume monitoring during HD**



Vascular Access

- Non tunneled dialysis catheter
- Tunneled dialysis catheter
- Maturing AV Fistula

- Educate patient in access care = dressing at all times, dry at all times, to be accessed by dialysis personnel only
- Educate patient on vein preservation

Other Aspects of Care

- Patient and family education

1. Medication – know why it is given, avoid nephrotoxic agents
2. Fluid volume prescription
3. Dietary modifications
4. Urine output monitoring
5. Progress to previous level of activity
6. Coordinated multiple health provider care

Other Aspects of Care

- Patient and family support

1. Allow to express fears, concerns
2. Recovery of kidney function varies and may take months
3. Encourage patient and family to be engaged in all aspect of care

Recovering from AKI

- Decreasing serum creatinine trends
- Increasing urine volume, creatinine and urea clearance
- Improving overall chemistries and other blood tests
- Improving sense of well being
- May take weeks to months

Recovering from AKI = Dialysis on Hold

- Weekly if not more frequent lab draw
- Usually done in the dialysis unit = if a difficult "stick", specimen drawn from tunneled dialysis catheter
- Dialysis catheter care done at the same time
- On going education and supportive care done at this time
- Consider removal of dialysis catheter vs line sepsis at some point

The patient states that he was diagnosed with type 2 diabetes mellitus about 3 years ago. He was also diagnosed with borderline high blood pressure. He is unaware of any history of kidney disease. He denies any history of any proteinuria or any gross or microscopic hematuria. He denies any chronic nonsteroidal anti-inflammatory medication use. He has no family history of any renal disease.

He has not been followed on any regular basis by any physician. He states that his last labs were more than a year ago, but does not recall being told of any kidney issues at that time. He checks his blood sugar at home off and on and has fluctuating readings.

Over the past few days, he was having symptoms of nausea and vomiting. He denies any chest pain or shortness of breath, no change in urine output. No headache, no fevers or chills, no diarrhea, no dysuria, and no lower extremity edema. He has been on metformin and has been taking it regularly.

He presented to the emergency department late last night where he was noted to have a BUN of 89 with a creatinine of 13.2. His potassium was 4.5 and his carbon dioxide was 20. His lipase was 484. He was therefore admitted. Overnight, he had received some IV fluids. He feels slightly better. However, his labs remain the same with a BUN of 90 and a creatinine of 13.4. Of note is that his lactic acid is 16.9. His lipase is again elevated to 772.

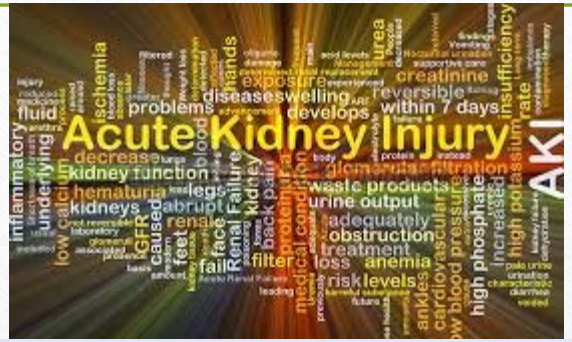
He had a renal ultrasound done yesterday which showed normal size kidneys, but with increased cortical echogenicity compatible with medical renal disease.

IMPRESSION

1. Renal failure. Patient with evidence of echogenic kidneys on ultrasound. This most likely represents chronic kidney disease stage 5, and end-stage renal disease at this point. He is symptomatic with nausea and vomiting. He will need to start dialysis. A few serologies have been checked. I will also check an antineutrophil cytoplasmic antibody, and anti-glomerular basement membrane antibody. However, given his advanced disease, biopsy is unlikely to change current therapy.
2. Metabolic acidosis, mostly lactic acidosis. This may be associated with metformin as well as with his renal disease. He will need dialysis today.
3. Type 2 diabetes mellitus with an elevated hemoglobin A1C of 8.1, consistent with uncontrolled diabetes.
4. Hypertension.
5. Possible pancreatitis based on elevated lipase.

Treatment Parameters									
		15-Mar-17		8-Feb-17		11-Jan-17		15-Dec-16	
Dialyses per wk		3x week		3x week		3x week		3x week	
Dialysis Schedule		3rd Shift MWF A		3rd Shift MWF A		3rd Shift MWF A		3rd Shift TThS A	
Day of week		Wed		Wed		Wed		Thu	
Location		A4		A8		A7		A6	
Tx Time	min	182		180		183		183	
Dialyzer Name		Optiflux F160NR		Optiflux F160NR		Optiflux F160NR		Optiflux F160NR	
KoA	mL/min	1064		1064		1064		1064	
DFR	mL/min	504		510		476		486	
BFR	mL/min	301		301		301		292	
Pre Weight		65.0		65.0		64.5		64.3	
Post Weight		64.0		63.5		62.9		63.0	
Wt Loss		1		2		2		1	
Pre-BUN	mg/dL	38		40		42		43	
Post-BUN	mg/dL	13		13		15		14	
Creatinine	mg/dL	1.8		1.9		2.2		2.2	
Hct	vol%	35.1		33.7		35.7		38.4	
BUN for KrU	mg/dL	Jan 11	42	Jan 11	42	Jan 11	42	Nov 10	39
Urine Volume	mL	Jan 11	785	Jan 11	785	Jan 11	785	Nov 10	850
Urine Urea	mg/dL	Jan 11	523	Jan 11	523	Jan 11	523	Nov 10	342
KrU	mL/min	6.79		6.79		6.79		5.18	
Single-Pool Modeling Outputs									
URR	%	66		68		64		67	
Kt/V		1.21		1.30		1.19		1.28	
Kt/V with KrU		2.00		2.10		1.99		1.89	
Estimated Kd	Qf, ml/min	212.20		213.10		210.80		207.70	
TAC urea	mg/dL	28.4		29.8		31.6		31.7	

Treatment Parameters									
		15-Dec-16		10-Nov-16		6-Oct-16			
Dialyses per wk		3x week		3x week		3x week			
Dialysis Schedule		3rd Shift TThS A		3rd Shift TThS A		3rd Shift TThS A			
Day of week		Thu		Thu		Thu			
Location		A6		A3		A7			
Tx Time	min	183		187		180			
Dialyzer Name		Optiflux F160NR		Optiflux F160NR		Optiflux F160NR			
KoA	mL/min	1064		1064		1064			
DFR	mL/min	486		477		425			
BFR	mL/min	292		291		222			
Pre Weight		64.3		64.0		63.9			
Post Weight		63.0		62.3		63.5			
Wt Loss		1		2		0			
Pre-BUN	mg/dL	43		39		43			
Post-BUN	mg/dL	14		13		15			
Creatinine	mg/dL	2.2		2.4		5.2			
Hct	vol%	38.4		36.3		26.2			
BUN for KrU	mg/dL	Nov 10	39	Nov 10	39	Oct 06	43		
Urine Volume	mL	Nov 10	850	Nov 10	850		0		
Urine Urea	mg/dL	Nov 10	342	Nov 10	342		0		
KrU	mL/min	5.18		5.18		0.00			
Single-Pool Modeling Outputs									
URR	%	67		67		65			
Kt/V		1.28		1.28		1.15			
Kt/V with KrU		1.89		1.89		1.15			
Estimated Kd	Qf, ml/min	207.70		206.90		171.20			
TAC urea	mg/dL	31.7		28.8		30.7			



Laboratory - Urines

Selected Visits | Lifetime Summary

Hematology | Coagulation | Urines | Other Body Source | Miscellaneous

Blood Gas | Chemistry | Toxicology | Immunology | Serology

	10/2/16 19:20	10/2/16 23:00	11/10/16 14:00	1/11/17 17:00	3/20/17 17:00
Urine Color	Straw				
Urine Clarity	Clear				
Urine pH	7.0				
Ur Specific Gravity	1.008				
Urine Protein	100 H				
Urine Glucose (UA)	150 H				
Urine Ketones	20 H				
Urine Blood	Small H				
Urine Nitrite	Negative				
Urine Bilirubin	Negative				
Urine Urobilinogen	<2.0				
Ur Leukocyte Esterase	Negative				
Urine WBC (Auto)	🗨				
Urine RBC (Auto)	16 H				
Ur Squamous Epith Cells	7 H				
Urine Bacteria	Rare H				
Hyaline Casts	1				
Ur Random Creatinine		27.9			
U Random Total Protein		205 🗨			
Ur Random Sodium		113			
Urine Total Volume			850	785	1220
Urine Creatinine		27.9			
Urine Urea Nitrogen			342	523 Δ	445 Δ
Ur Urea Nitrogen 24 Hr			2.9 L	4.1 L	5.4 L

Creatinine - History

Date	Time	Result	Units	Reference	
3/31/17	09:40	1.68 H	MG/DL	0.70-1.30	ℹ
3/27/17	15:55	1.80 H	MG/DL	0.70-1.30	ℹ
3/24/17	16:55	1.65 H	MG/DL	0.70-1.30	ℹ
3/15/17	17:08	1.82 H	MG/DL	0.70-1.30	ℹ
2/8/17	17:00	1.85 H	MG/DL	0.70-1.30	ℹ
1/11/17	17:10	2.16 H	MG/DL	0.70-1.30	ℹ
12/15/16	13:37	2.20 H	MG/DL	0.70-1.30	ℹ
11/10/16	13:50	2.39 H	MG/DL	0.70-1.30	ℹ
10/14/16	19:30	3.65 H	MG/DL	0.70-1.30	ℹ
10/6/16	14:00	5.22 H	MG/DL	0.70-1.30	ℹ
10/5/16	04:52	6.86 H Δ	MG/DL	0.70-1.30	ℹ
10/4/16	05:20	9.38 H Δ	MG/DL	0.70-1.30	ℹ
10/3/16	07:16	13.40 H	MG/DL	0.70-1.30	ℹ
10/2/16	17:54	13.20 H	MG/DL	0.70-1.30	ℹ

Creatinine - History

Date	Time	Result	Units	Reference	
3/22/17	11:23	2.83 H	MG/DL	0.70-1.30	
10/26/16	14:50	2.56 H	MG/DL	0.70-1.30	
7/23/16	17:55	2.72 H	MG/DL	0.70-1.30	
4/28/16	10:25	2.23 H	MG/DL	0.70-1.30	
9/24/15	10:02	2.24 H	MG/DL	0.70-1.30	
2/9/15	09:25	2.23 H	MG/DL	0.70-1.30	

Dialyzed 5.5 yrs
Last Dialysis Aug 2012

Coverage and Payment

- Trade Protection Extension Act of 2015 (TPEA)
- Included coverage and provided payment for dialysis furnished by an End Stage Renal Disease (ESRD) facility to an individual with Acute Kidney Injury (AKI)
- Effective date: January 1, 2017

Next 2 slides taken from presentation done with Mary Schira and Glenda Payne at the 2017 ADC meeting

Are you ready for these questions your patient might ask?

- How long before you'll know if my kidneys will recover?
- What happens if some but not all of my function comes back?
- What's the longest time you've seen for kidneys to recover?
- I've noticed that I pee less on the days I come here for treatment. Does that mean this treatment helps or hurts my chances of getting better?

MORE questions…..

- I peed 4 times yesterday! Does that mean I don't have to go on the machine today?
- I feel like I'm getting weaker instead of stronger, especially on days I come here. How can I be sure I'm getting better?
- I'm afraid my insurance is going to run out. What do I do?
- I have to go to rehab for strengthening 3 days a week. Between that and this I'm so tired I just want to sleep. What am I doing wrong?
- Why can't I do this at my local hospital instead of here?

Thank you for the opportunity