Acute Kidney Injury: Ending learned helplessness

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CRITICAL CARE MEDICINE CRISMA

Disclosures

- Consulting:
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Updated Jan 2018

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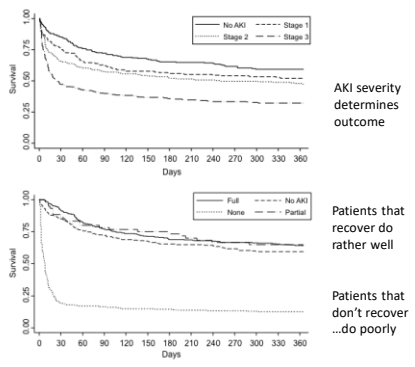

AKI severity determines outcome

Patients that recover do rather well

Patients that don't recover ...do poorly

Kellum et al. Am J Respir Crit Care Med. 2016 Feb 1;193(3):281-7.

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Protocol-Based Care for Early Septic Shock

The ProCESS Investigators

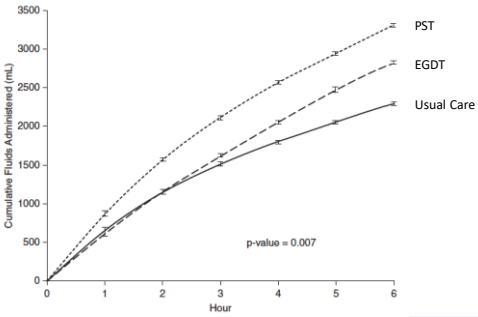
ABSTRACT

BACKGROUND

In a single-center study published more than a decade ago involving patients presenting to the emergency department with severe sepsis and septic shock, mortality was markedly lower among those who were treated according to a 6-hour protocol of early goal-directed therapy (EGDT), in which intravenous fluids, vasopressors, inotropes, and blood transfusions were adjusted to reach central hemodynamic targets, than among those receiving usual care. We conducted a trial to determine whether these findings were generalizable and whether all aspects of the protocol were necessary.

The members of the writing committee (Donald M. Yealy, M.D., John A. Kellum, M.D., David T. Huang, M.D., Amber E. Barnato, M.D., Lisa A. Weissfeld, Ph.D., and Francis Pike, Ph.D., University of Pittsburgh, Pittsburgh; Thomas Terndrup, M.D., Ohio State University, Columbus; Henry E. Wang, M.D., University of Alabama at Birmingham, Birmingham; Peter C. Hou, M.D., Brigham and Women's Hospital, Boston; Frank LoVecchio, D.O., Maricopa

Differences in Fluid Administered



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Renal Outcomes

Table 2. Outcomes.*

Outcome	Protocol-based EGDT (N = 439)	Protocol-based Standard Therapy (N = 446)	Usual Care (N = 456)	P Value†
Death — no./total no. (%)				
In-hospital death by 60 days: primary outcome	92/439 (21.0)	81/446 (18.2)	86/456 (18.9)	0.83‡
Death by 90 days	129/405 (31.9)	128/415 (30.8)	139/412 (33.7)	0.66
New organ failure in the first week — no./total no. (%)				
Cardiovascular	269/439 (61.3)	284/446 (63.7)	256/456 (56.1)	0.06
Respiratory	165/434 (38.0)	161/441 (36.5)	146/451 (32.4)	0.19
Renal	12/382 (3.1)	24/399 (6.0)	11/397 (2.8)	0.04
Duration of organ support — days§				
Cardiovascular	2.6±1.6	2.4±1.5	2.5±1.6	0.52
Respiratory	6.4±8.4	7.7±10.4	6.9±8.2	0.41
Renal	7.1±10.8	8.5±12	8.8±13.7	0.92

No treatment effect on...

N Engl J Med 2014;370:1683-93.

- RRT at any other time point or overall
- New AKI or AKI progression (by KDIGO or Biomarkers)
- AKI Recovery

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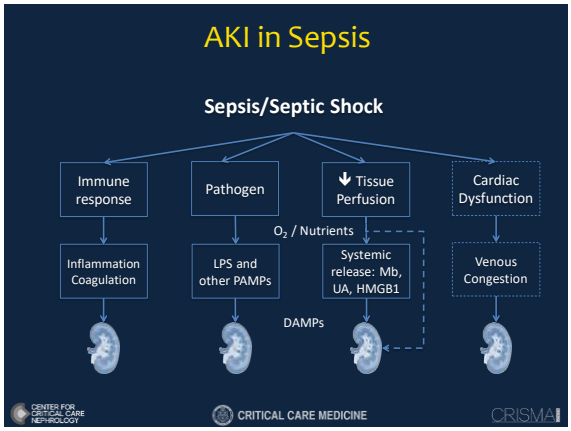
Kellum et al. Am J Respir Crit Care Med. 2016 Feb 1;193(3):281-7.

AKI in Sepsis



PEDIATRICS
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Electronic Health Record Identification of Nephrotoxin Exposure and Associated Acute Kidney Injury

Stuart L. Goldstein, Eric Kirkendall, Hovi Nguyen, Joshua K. Schaffzin, John Bucuvalas, Tracey Bracke, Michael Seid, Marshall Ashby, Natalie Foertmeyer, Lori Brunner, Anne Lesko, Cynthia Barclay, Carole Lannon and Stephen Muething

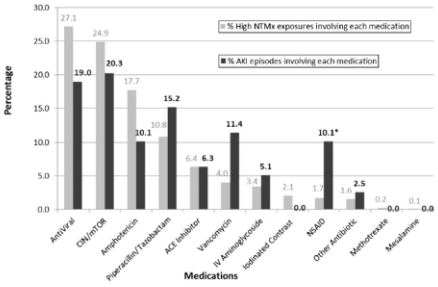
Pediatrics 2013;132;e756; originally published online August 12, 2013;
DOI: 10.1542/peds.2013-0794

TABLE 1 List of Nephrotoxic Medications

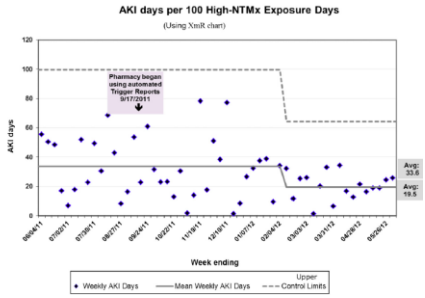
Acyclovir	Enalaprilat	Mesalamine
Ambisome[a]	Foscarnet	Methotrexate
Amikacin	Gadopentetate dimeglumine[a]	Nafcillin
Amphotericin B	Gadoxetate disodium[a]	Piperacillin/tazobactam
Captopril	Ganciclovir	Piperacillin
Carboplatin	Gentamicin	Sirolimus
Cefotaxime	Ibuprofen	Sulfasalazine
Ceftazidime	Ifosfamide	Tacrolimus
Cefuroxime	Iodixanol[a]	Ticarcillin/clavulanic acid
Cidofovir[a]	Iohexol[a]	Tobramycin
Cisplatin	Iopamidol[a]	Topiramate
Colistimethate	Ioversol[a]	Valacyclovir
Cyclosporine	Ketorolac	Valganciclovir
Dapsone	Lisinopril	Vancomycin
Enalapril	Lithium	Zonisamide

[a] Medications counted for 7 days after administration toward exposure.

NINJA



NINJA



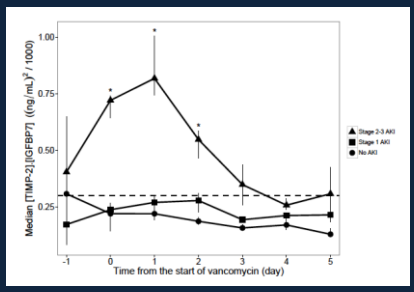
UPMC

Characteristics	AKI Day 3to8 from ICU admission		
	No AKI (14,290)	AKI (Any) (3,387)	P-Value
Age, median (Q1-Q3)	56 (43-70)	62(48-75)	0.00001
Age			
18-44	3471 (85)	611(15)	
45-64	5042(82)	1073(18)	
65-74	1836(77)	553(23)	
≥75	2608(75)	850(25)	0.0001
Males N(%)	8013(80)	1963(20)	0.047
Race N(%)			
White	11461(81)%	2691(19)%	
Black	1130(82)%	251(18)%	
Other			
Weight, me			
Comorbid c			
Hypertens			
Diabetes			
Cardiac dis			
Liver transplant	219(77)	65(23)	0.108
Chronic liver disease (CLD)	638(77)	189(23)	0.006
Sequele of CLD	521 (79)	136(21)	0.307
Neoplasms	1996 (82)	433 (18)	0.072
Malignant neoplasms	690 (84)	130(16)	0.014
Chronic airway obstruction	1147 (75)	389 (25)	0.0001
Chronic renal disease (includes CKD)	397 (71)	164 (29)	0.0001
Multiple comorbidities	5313 (79)	1437(21)	0.0001

Characteristics	AKI Day 3to8 from ICU admission		
	No AKI (14,290)	AKI (Any) (3,387)	P-Value
Surgical admission	7992 (79)	2081 (21)	0.0001
Baseline Creatinine, mg/dl, mean (SD)	0.91 (0.382)	1.08 (0.55)	0.0001
Baseline Creatinine, mg/dl, median (Q1-Q3)	0.8 (0.7-1)	0.9 (0.7-1.3)	
Creatinine at Hospital admission	0.9(0.7-1)	0.9(0.7-1.2)	0.00001
APS-III Score at ICU, median (Q1-Q3), (n=39,986)	40 (29-55)	52 (38-70)	0.00001
Severity of Hypotension at ICU, median (Q1-Q3), (n=39,321)	0 (0-0)	0(0-1.3)	0.00001
Suspected sepsis at ICU[#]	2031 (61)	1291 (39)	0.0001

	N (Med24*AKI 2to7)	Odds ratio Meds24*AK i2to7	P value Meds24*AK i2to7	N (Med48*AKI 3to8)	Odds ratio Meds48*AK i3to8	P value Meds48*AK i3to8	N (Med72*AKI 4to9)	Odds ratio Meds72*AK i4to9	P value Meds72*AK i4to9
Tobramycin	12242	1.61	0.147	14817	3.62	0.0001	15391	4.41	0.0001
Vancomycin	12617	1.2	0.008	14817	2.07	0.0001	15391	2.33	0.0001

Following First Dose of Vancomycin



Ostermann et al. Crit Care Med. 2017 Nov 20.

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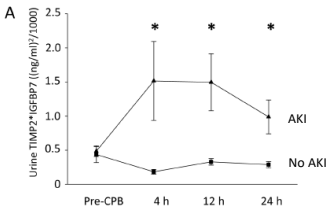
OPEN ACCESS Freely available online

PLOS ONE

Urinary TIMP-2 and IGFBP7 as Early Biomarkers of Acute Kidney Injury and Renal Recovery following Cardiac Surgery

Melanie Meersch[1,9], Christoph Schmidt[1,9], Hugo Van Aken[1], Sven Martens[2], Jan Rossaint[1], Kai Singbartl[3], Dennis Görlich[4], John A. Kellum[5], Alexander Zarbock[1]*



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Intensive Care Med
DOI 10.1007/s00134-016-4670-3

SEVEN-DAY PROFILE PUBLICATION

Prevention of cardiac surgery-associated AKI by implementing the KDIGO guidelines in high risk patients identified by biomarkers: the PrevAKI randomized controlled trial

Melanie Meersch[1], Christoph Schmidt[1], Andreas Hoffmeier[2], Hugo Van Aken[1], Carola Wiesmann[1], Joachim Gerss[3] and Alexander Zarbock[1]*

Take home message: An implementation of the KDIGO guidelines compared with standard care reduced the frequency and severity of cardiac surgery-associated AKI (CSA-AKI) in high risk patients identified by biomarkers. Future studies will be needed to address whether this approach has an impact on long-term outcomes.

- Avoid nephrotoxins (NSAIDs, ACEi/ARBs)
- Avoid hyperglycemia
- Optimize volume status and hemodynamics

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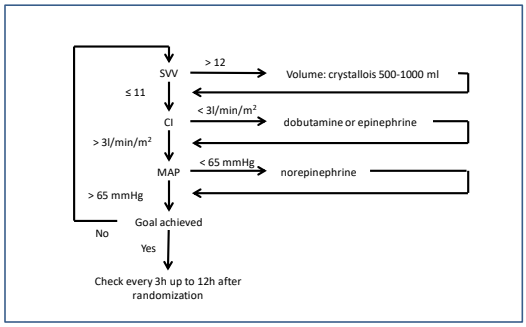


Meersch et al. ICM 2017

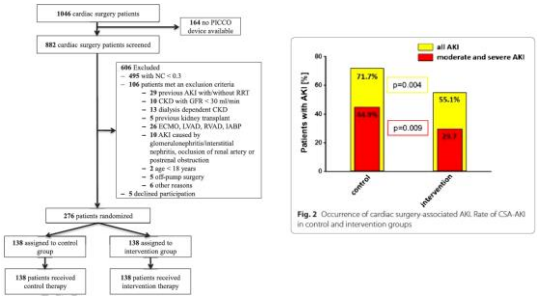


Fig. 2 Occurrence of cardiac surgery-associated AKI. Rate of CSA-AKI in control and intervention groups

Meersch et al. ICM 2017

NEWS & VIEWS

ACUTE KIDNEY INJURY

AKI: the myth of inevitability is finally shattered

John A. Kellum

Acute kidney injury continues to challenge physicians, researchers and patients. To date, there is no efficient treatment for acute kidney injury and its occurrence in many critically ill patients seems inevitable. However, a new study might just change the way we approach this seemingly intractable problem.

haemodynamic monitoring), avoidance of nephrotoxic drugs, and prevention of hyperglycaemia — in patients at high risk of AKI who had undergone cardiac surgery[3] (FIG. 1). Patients at high risk were identified by assessing urine levels of IGFBP7 and TIMP-2. The investigators found that rates of AKI were significantly lower in patients who received the bundled intervention than in patients who received standard care, including the specification to keep mean arterial pressure >65 mmHg and central venous pressure 8–10 mmHg (55.1% versus 71.7%; absolute risk reduction (ARR) 16.6%; 95% CI 5.5%–27.9%; $P = 0.004$). Furthermore, implementation of the bundle resulted in

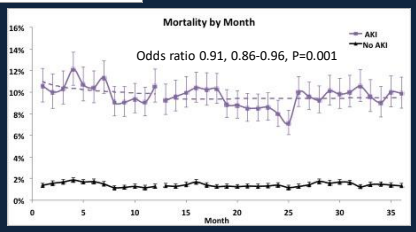
> Now that evidence demonstrates that AKI can be prevented, it is our duty to find more ways to do it

Using biomarker enrichment the authors were able to achieve an effect with a number needed to treat of only 6. Without biomarkers it would have been >33.

UPMC AKI Alert

Result Comment by SYSTEM on April 15, 2014 4:45 AM
Warning Possible Acute Kidney Injury: This result indicates an increase of 0.3 or more (in the past 52 hours). Based on a reference creatinine of 0.60 (04/1/2014) this result indicates a change of 166.67%. This change in kidney function is consistent with KDIGO Stage 2. Note, that Acute Kidney Injury is a clinical diagnosis and clinical evaluation is recommended before management is altered. Consider consultation with renal medicine or, if patient may be critically ill, the consult intensivist.

Al-Jaghbeer M, et al.
JASN 2017; Nov 2



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Clinical Decision Support for Acute Kidney Injury and Hospital Survival

METHODS

Outcomes were measured pre- and post-implementation of a Clinical Decision Support System (CDSS) for AKI

Pre-CDSS (12 months):

181k patients
11.0% clinically diagnosed AKI

Implemented the CDSS

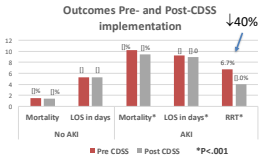
Clinical Decision Support System
- Derives reference serum creatinine from historical values in EMR
- Flags creatinine changes and KDIGO stage

Post-CDSS (24 months):

346k patients
12.8% clinically diagnosed AKI

doi: 10.1681/ASN.

OUTCOMES



CONCLUSION

Implementation of a CDSS for AKI resulted in a small but sustained decrease in hospital mortality, length of stay and use of dialysis.

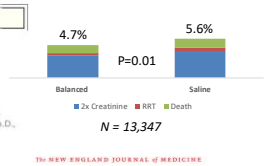
JASN

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Noncritically Ill Adults

Wesley H. Self, M.D., M.P.H., Matthew W. Semler, M.D., Jonathan P. Wanderer, M.D., Li Wang, M.S., Daniel W. Byrne, M.S., Sean P. Collins, M.D., Corey M. Slovis, M.D., Christopher J. Lindsell, Ph.D., Jesse M. Ehrenfeld, M.D., M.P.H., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SALT-ED Investigators*



N = 13,347

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ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults

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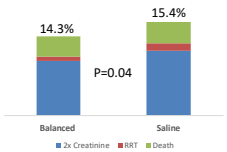

N = 15,802

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abc NEWS

What's in the IV bag? Studies show safer option than saline

•BY MARILYNN MARCHIONE, AP CHIEF MEDICAL WRITER

Feb 27, 2018, 5:10 PM ET

The difference could mean 50,000 to 70,000 fewer deaths and 100,000 fewer cases of kidney failure each year in the U.S., researchers estimate. Some doctors are hoping the results will persuade more hospitals to switch.

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Conclusions

- Markers of cell-cycle arrest appear to be robust measures of risk for AKI (manifesting in the next 12-24h)
- Underlying biology suggestive of an "alarm-phase" marker before actual damage has a occurred.
- A "KDIGO Bundle" can reduce AKI when applied to biomarker positive patients after cardiac surgery.
- Nephrotoxic drug exposure accounts for as much as 30% of AKI and may contribute to more than half.
- Improved risk assessment and early detection can prevent Acute Renal Failure.
- Stop using saline!

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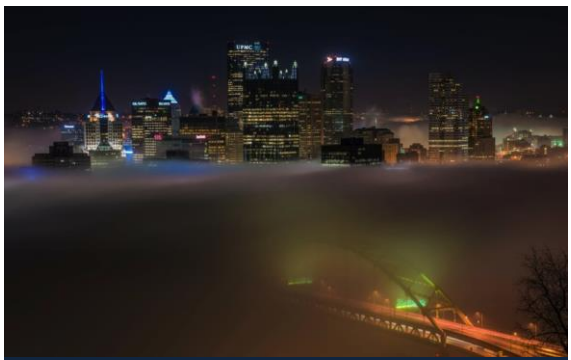

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ACUTE KIDNEY INJURY (AKI) TREATMENT AND MANAGEMENT

PREVENTING AKI INDUCED ADVERSE DRUG EVENTS

SANDRA KANE-GILL, PHARMD, MSC, FCCM, FCCP
ASSOCIATE PROFESSOR, UNIVERSITY OF PITTSBURGH
CRITICAL CARE MEDICATION SAFETY PHARMACIST, UPMC
FACULTY, CENTER FOR CRITICAL NEPHROLOGY, UPMC AND UNIVERSITY OF PITTSBURGH

CONFLICT OF INTEREST

- NO DISCLOSURES

PREVALENCE OF DRUG ASSOCIATED ACUTE KIDNEY INJURY (D-AKI) IN THE ICU

- 5,143 PATIENTS IN 20 ICUS
  - 20% (74/355) ASS H DRUGS
- ICUS AT 5 HOSPI
  - 25% (157/6 UGS
- 26,269 CRITICALLY ILL PATIENTS IN 54 HOSPITALS IN 23 COUNTRIES
  - 19% (328/1726) ASSOCIATED WITH DRUGS

3rd_5th

Brivet FG et al. Crit Care Med 1996;24:192; Mehta RL et al. Kid International 2004;66:1613-1621; Uchino S et al. JAMA 2005;294:813-818.

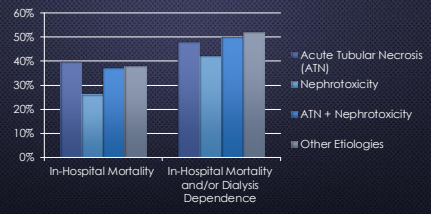
D-AKI CONSEQUENCES PEDIATRIC, NON-ICU PATIENTS

Variable	AKI due to Nephrotoxin (n=77)	No AKI	P Value
Baseline eGFR (mL/min/1.73m2)	118	120	0.48
eGFR at 6 months (mL/min/1.73m2)	113.8	123.4	0.04
Up/C ratio at 6 months, mg/mg	0.9	.0.27	0.04
Hypertension	37.7%	19.3%	0.01
≥ 1 sign of CKD	33.7%	8.8%	<0.01

- 70% of patients with drug associated AKI have evidence (reduced eGFR, hyperfiltration, proteinuria, or hypertension) of residual kidney damage

Menon S et al. J Pediatr 2014;165:522

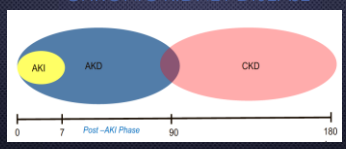
D-AKI CONSEQUENCES



Similar, slightly better, mortality rates and/or dialysis dependence compare to AKI of other etiologies

Mehta RL et al. Kid Int 2004;66:1613

TRANSITIONING FROM ACUTE KIDNEY INJURY TO CHRONIC KIDNEY DISEASE



- PATIENTS WITH AKI HAVE A SUBSTANTIAL RISK OF PROGRESSING TO CKD
  - ABOUT 30% OF PATIENTS WHO HAVE AKI PROGRESS TO CKD
  - DIALYSIS DEPENDENCE FOR AKI SURVIVORS IS 40%

Chawla LS et al. Nat Rev Nephrol 2017;13:241.

AKI- acute kidney injury
AKD- acute kidney disease
CKD- chronic kidney disease

RISK FACTORS FOR AKI/D-AKI

Description	Risk Factors for Critically Ill
Susceptibilities	Age, black race, female, history of diabetes, history of hypertension, previous AKI episode, elevated baseline serum creatinine
Exposures	Nephtoroxin administration, trauma, burn, circulatory shock, sepsis, high risk surgery, hypotension, fluid overload
Drug-specific Exposure	Nephrotoxin treatment duration, cumulative dose, total daily dose, pharmacokinetic and pharmacodynamic drug interactions, nephrotoxic burden

- Concomitant nephrotoxin administration was an independent predictor of AKI
- 53% greater odds of developing AKI for every nephrotoxic drug received (OR 1.53; CI 1.09-2.14)
- Significant association between cumulative number of exposures and risk of AKI (p = 0.02) but no association between the each type of exposure and AKI (p = 0.22)

Kane-Gill SL, Goldstein SL. Crit Care Clin 2015;31:675
Cotner SE et al. AAC 2017;61:e00871
Cartin-Ceba R et al. Crit Care Res Pract 2012; article ID 691013
Ostermann M et al. Crit Care Med 2018: ahead of print

ADVANCE OUR THINKING BEYOND SINGLE NEPHROTOXINS: DRUG COMBINATIONS

- EVIDENCE FOR DRUG CLASS COMBINATIONS ASSOCIATED WITH AKI
- COMPLETED A FORMAL GRADE PROCESS FOR QUALITY OF EVIDENCE ASSESSMENT
- 76 UNIQUE DRUG COMBINATIONS
  - 74% VERY LOW QUALITY OF EVIDENCE (D)
  - 16% LOW QUALITY OF EVIDENCE (C)
  - 10% MODERATE QUALITY OF EVIDENCE (B)
  - 0% HIGH QUALITY OF EVIDENCE (A)

Rivosecchi RM et al. Ann Pharmacother 2016;50:953-972.

DRUG COMBINATIONS: MODERATE QUALITY OF EVIDENCE

Drug Class 1	Drug Class II	Mechanism
NSAIDs	Diuretic	pharmacodynamic effect with a decrease in prostaglandin synthesis by NSAIDs causing afferent vasoconstriction and a decrease in effective blood volume by diuretics
NSAIDs	Diuretic plus renin-angiotensin aldosterone system "triple whammy"	cumulative pharmacodynamic effect of each drug - exacerbated by the efferent arteriolar vasodilation caused by the RAAS
Statins	Macrolide	increased serum statin concentrations as a result of inhibition of the cytochrome 450 (CYP450) enzyme system by macrolides
Calcium channel blockers	Clarithromycin	CYP3A4 inhibition of clarithromycin, leading to elevated concentrations of calcium channel blockers leads to global hypotension, affecting the kidney results in ischemic renal injury resulting in AKI
Statins	Calcium channel blockers	drug-drug interaction between certain calcium channel blockers inhibiting CYP3A4 metabolism of statins metabolized through this pathway
Piperacillin/tazo-bactam	Vancomycin	decreased vancomycin clearance caused by piperacillin/tazobactam potentially leading to a greater degree of vancomycin exposure

Rivosecchi RM et al. Ann Pharmacother 2016;50:953-972.

PREVENTING AKI INDUCED ADVERSE DRUG EVENTS EARLY WARNING AND HYPERVIGILANCE

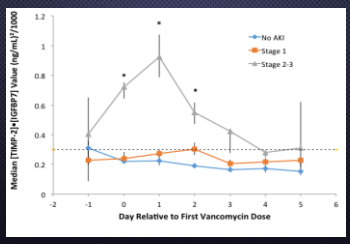
KINETICS OF URINARY BIOMARKERS(KIM-1, NGAL) AND VANCOMYCIN EXPOSURE

Biomarker	AUC-ROC	95% CI
SCr Day 0	0.447	0.222-0.673
SCr Day 1	0.676	0.461-0.892
SCr Day 2	0.782	0.582-0.981
SCr Day 3	0.799	0.617-0.981
uKIM-1 Day 0	0.769	0.629-0.910
uKIM-1 Day 1	0.724	0.556-0.892
uKIM-1 Day 2	0.849	0.75-0.948
uKIM-1 Day3	0.781	0.658-0.904
uNGAL Day 0	0.703	0.575-0.831
uNGAL Day 1	0.733	0.59-0.877
uNGAL Day 2	0.824	0.7260.922
uNGAL Day 3	0.812	0.698-0.927
uKIM-1 and uNGAL	0.852	0.754-0.996

NGAL = Neutrophil gelatinase-associated lipocalin; KIM-1 = kidney injury molecule-; AUC-ROC= area under thereceiver operating characteristic curve

Pang HM et al. Eur Rev Med Pharmaocol SCI 2017;21:4203

BIOMARKER(TIMP2-IGFBP7)KINETICS AND VANCOMYCIN EXPOSURE



Ostermann M et al. Crit Care Med 2018; epub ahead of print

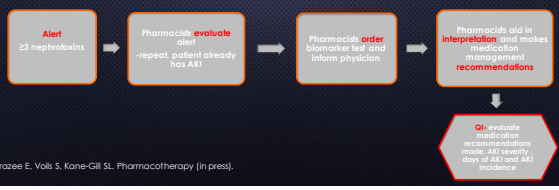
HYPERVIGILANCE/SURVEILLANCE PREVENTION IN PEDIATRIC, NON-ICU PATIENTS

- Development and refinement of a predictive AKI trigger with the goal of reducing AKI severity
- Knowledge for alert
  - ≥3 nephrotoxins on the same day
  - IV aminoglycoside for ≥ 3 days
  - Recent: vancomycin for ≥ 3 days
- Pharmacist managed alert -outside of workflow and advice provided to practitioner
- Evidence of AKI
  - Pediatric RIFLE criteria; no urine evaluation
    - Risk: eCrCl decrease by 25%
    - Injury: eCrCl decrease by 50%
    - Failure: eCrCl decrease by 75%
- 1-yr: 42% decrease in AKI intensity with a reduction in days in AKI per 100 exposure days
- 3-yr: Results sustained with a 31% AKI intensity decrease and a 64% AKI rate decrease

Goldstein SL et al. *Pediatrics* 2013;132:e756
Kirkendall ES et al. *Appl Clin Inform* 2014;5:313
Goldstein SL Kidney Int 2016;90:212

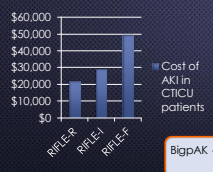
CHANGE SERUM CREATININE TO BIOMARKER MONITORING

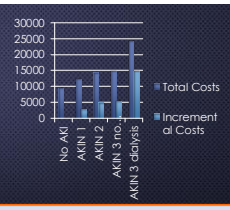
- Adults? ICU patients?
- We already monitor serum creatinine regularly



Frazee E, Vols S, Kane-Gill SL. Pharmacotherapy (in press).

COST OF AKI





BigpAK - One ICU day LOS reduction in intervention about a $2400 (US) savings

Averting or reducing AKI severity in one patient could result in cost savings. Budget impact models and economic evaluations are needed

Dasta JF et al. *Nephrol Dial Transplant* 2008;23:1970-4
Collister D et al. *Clin J Am Soc Nephrol* 2017; 12:1733
Gocze I et al. Annals of Surgery 2017; epub ahead of print

ACUTE KIDNEY INJURY (AKI) TREATMENT AND MANAGEMENT

PREVENTING AKI INDUCED ADVERSE DRUG EVENTS

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Disclosures: None

Case of Acute Kidney Injury

- John Videen, M.D.
- Nephrologist with Balboa Nephrology Medical Group
- Sharp Chula Vista Medical Center

BNMG
Balboa Nephrology Medical Group

Disclosures

- Speaker for Astute Medical
- Speaker for Merck Pharmaceuticals

Case of Acute Kidney Injury

- 60 year old male, with massive obesity, chronic obstructive pulmonary disease and worsening bilateral lower extremity edema admitted with cellulitis of the legs.
- He had recurrent cellulitis and previous skin grafts of this region.
- Comorbidities of obstructive sleep apnea, atrial fibrillation and schizophrenia.
- Frequently admitted with respiratory issues, poorly compliant.

Case of Acute Kidney Injury
Initial Evaluation

- HR 120, irregular, 119/60, T 38.5
- Weight estimated at 500 lb. Edema noted from feet to abdomen several mm in depth, large pannus, chronic hyperkeratotic lesions of legs, with lipodermatosclerosis. Draining open wounds. Awake and alert.
- MRSA nasal screen +, wbc 16k, Crn 0.9. Bicarbonate 34.
- CXR showed layering effusions.

Case of Acute Kidney Injury
Initial Therapy

- Treated with vancomycin, receiving 7 gm over the first 48 hr and piperacillin-tazobactam.
- Diuretics started: bumetanide 1 mg IV bid plus spironolactone 25 mg bid.
- Urine output was about 200 ml over 8 hr.
- Complained of pain, demanding treatment with narcotics.

Case of Acute Kidney Injury
Deterioration

- Late on day 2 he became drowsy, not responding to naloxone or bipap.
- Episodes of bradycardia noted.
- Transferred to the ICU.
- ABG: 7.09/pCO_2 118/pO_2 124
- Intubated with bronchoscopy showing clear airways. Hemodynamics stabilized with pressors. HR 110s.
- Crn rose to 1.4 on day 3.
- Foley placed with urine output <10 ml/hr
- Biomarker TIMP2*IGFB7 measured >10

Case of Acute Kidney Injury
ICU Treatment

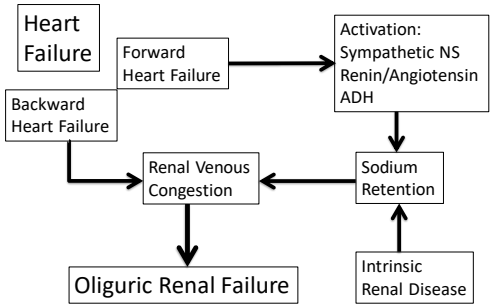
- Blood cultures remained negative. Streptococcus grew from wound and vancomycin was stopped. Cephalosporin given.
- Bumetanide increased to an intravenous infusion at 1 mg/hr.
- Urine output improved to 150 ml/hr over 12 hr.
- Metolazone 10 mg given PO.

Case of Acute Kidney Injury
Resolution

- UO increased to 800 ml/hr and diuretics stopped and a spontaneous diuresis continued.
- Creatinine peaked at 2.1, returned to baseline over next 2 weeks.
- Tracheostomy performed.
- Transferred to lower level of care.

Case of Acute Kidney Injury
Teaching Points

- Not a single insult to the kidney
- Despite co-morbidities, his renal function was normal before admission.
- Period of hemodynamic instability.
- Exposed to nephrotoxic agents: Vancomycin and Piperacillin-Tazobactam.
- Elevated renal vein pressure.



That's all folks,
Any Questions?