

# Perioperative Medicine Summit

Using Evidence to Improve Quality, Safety and Patient Outcomes



*Rapid Fire*

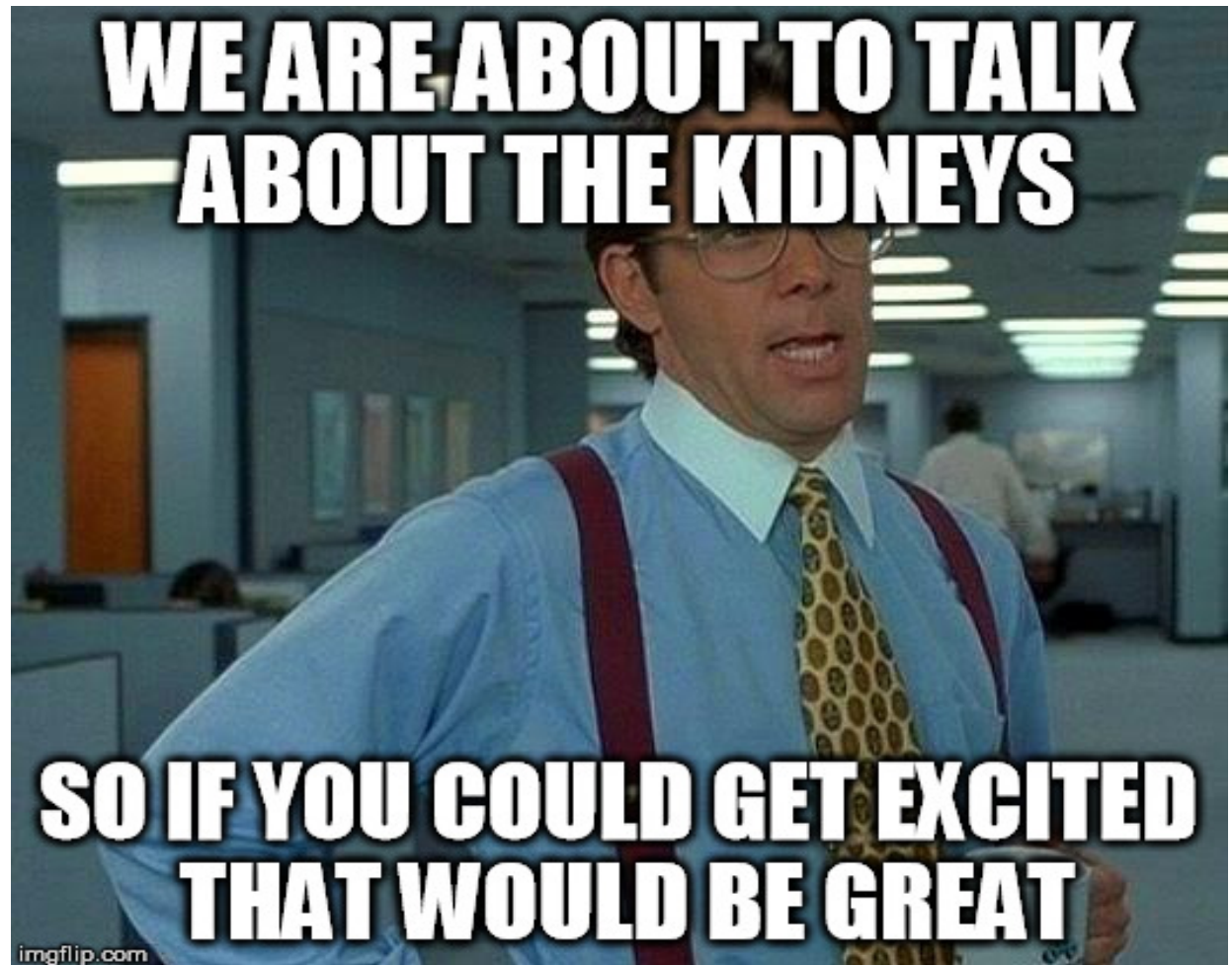
Answering challenging,  
common clinical questions

## Renal Risk in the Surgical Patient

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# Disclosures

*None*



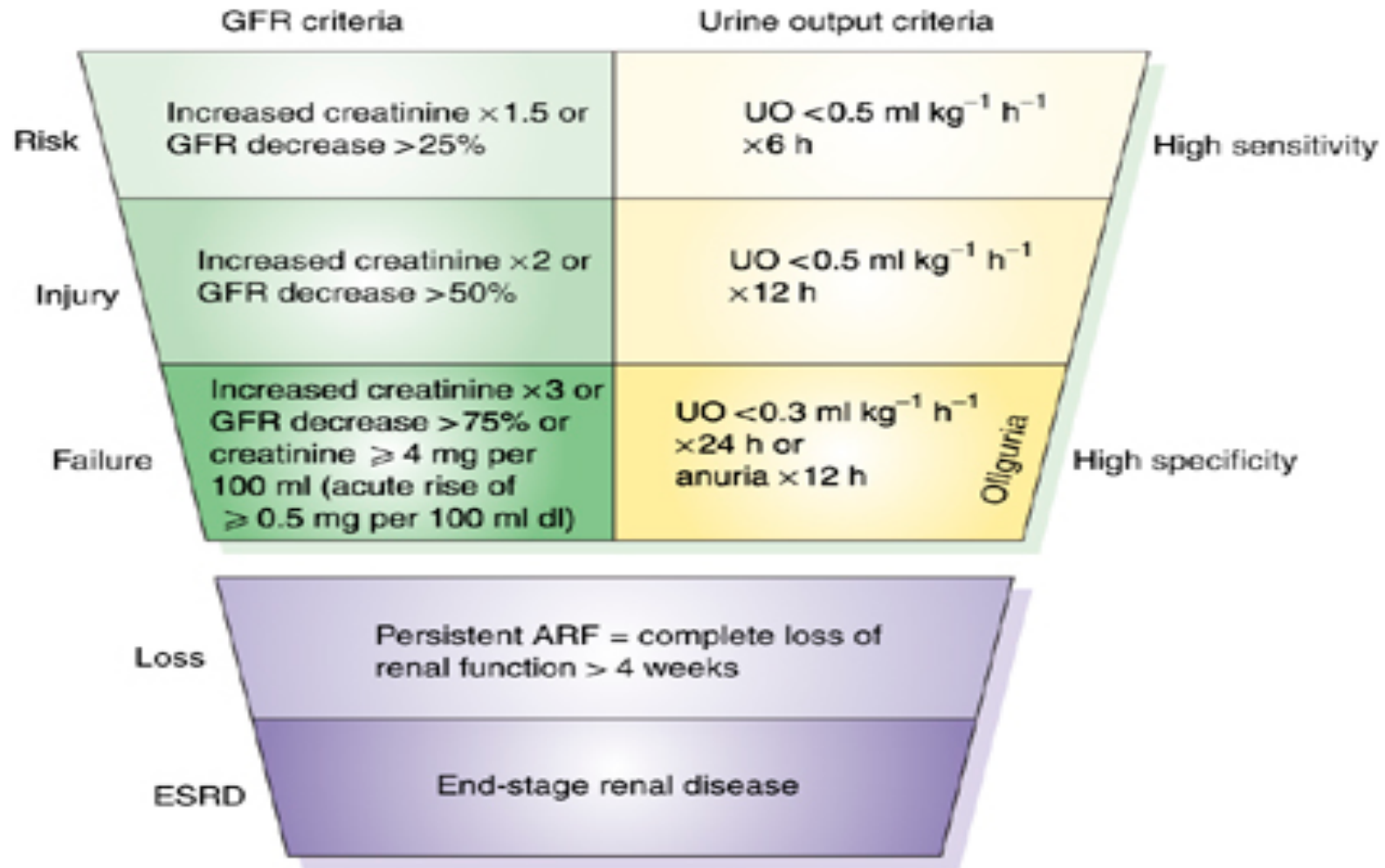
# Learning Objectives

- **By the end of this session, you will be able to:**
- **Define AKI**
- **Identify risks for development of perioperative AKI**
- **Be aware of how to prevent and manage perioperative AKI**

# ARS Question

- Which of the following patients are at lowest risk for developing postoperative AKI?
- A) 50 M, PMH ESLD, going for liver transplant
- B) 50 F, PMH gastric cancer, going for hernia repair
- C) 60 M, no significant PMH, going for emergency trauma surgery after MVA
- D) 60 F, PMH DM, CAD, going for CABG

# Acute Kidney Injury: What is it?



# Creatinine is imperfect..

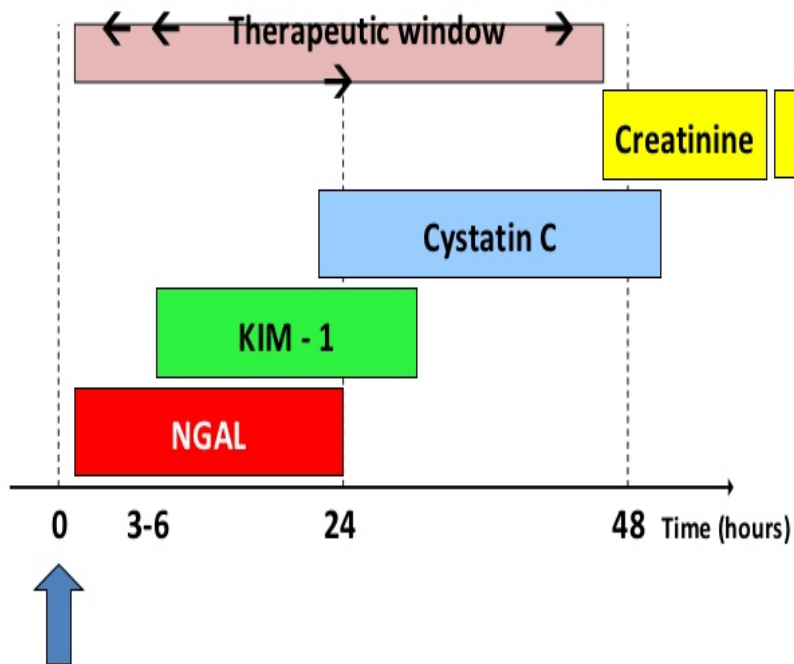
- Similar creatinine concentrations do not necessarily have the same renal function
- 50% nephron function must be lost before changes in creatinine are apparent
- eGFR more sensitive
- New biomarkers in the pipeline...
  - Plasma appears more specific than urine

	4h AUC	24h AUC
NGAL, plasma	0.83	0.84
Cystatin C, plasma	0.76	0.8
Cr, plasma	0.72	0.83

Schley et al. Comparison of plasma and urine biomarker performance in acute kidney injury. PLoS ONE 10(12):e0145042

# Creatinine is imperfect...

## Biomarker time-course



## Lee Revised Cardiac Risk Index

### Derivation and Prospective Validation of a Simple Index for Prediction of Cardiac Risk of Major Noncardiac Surgery

Thomas H. Lee, MD, SM; Edward R. Mazantoni, MD, SM; Carol M. Mangione, MD, SM; Eric J. Thomas, MD, SM; Carol A. Polanczyk, MD; E. Francis Cook, ScD; David J. Sagarbaker, MD; Magruder C. Donaldson, MD; Robert Doss, MD; Kalan K.L. Ho, MD, SM; Lynn E. Loebig, MS, RN  
*Circulation* September 7, 1999

- High risk surgical procedure
- History of ischemic heart disease
- History of congestive heart failure
- History of TIA or stroke
- Preoperative insulin therapy
- Preoperative serum creatinine >2.0 mg/dL

McIlroy DR, Wagener G, Lee HT. *Anesthesiology* 2010; **112**: 998-1004

# Acute Kidney Injury

## The grim reality of real world AKI

In 222 non-ICU AKI patients requiring RRT...

**29%** of patients died within 30 days

**37.6%** died within 90 days

**51.4%** died within one year

**34.9%** of survivors RRT dependent at 1 year

**55%** of survivors off RRT by 90d had eGFR < 60

Ng KP, et al. Q J Med 2011, advance access August 22 2011

## Outcomes after perioperative AKI

	CV events	Mortality	Non CV complic > 2 weeks postop
OR	3.56 95% CI 1.13-8.52 P < 0.001	3.83 95% CI 1.09-13.4 P = 0.016	1.83 95% CI 1.09-3.46 P = 0.036

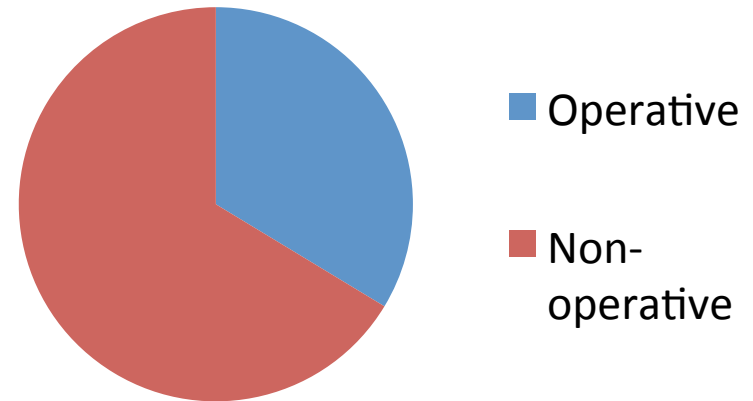
Bitekera, M. et al. Incidence, risk factors, and outcomes of perioperative acute kidney injury in noncardiac and nonvascular surgery. Am J Surg 2014; 207: 53.



# Acute Kidney Injury

- AKI incidence in acute care setting: 5-7.5%
  - 30-40% in operative settings
  - Surgical incidence varies depending on type
    - Most of our data from cardiac and vascular surgery
  - Surgery is the **MOST COMMON CAUSE** of AKI....after sepsis

National VA ICU Cohort  
% AKI in ICU

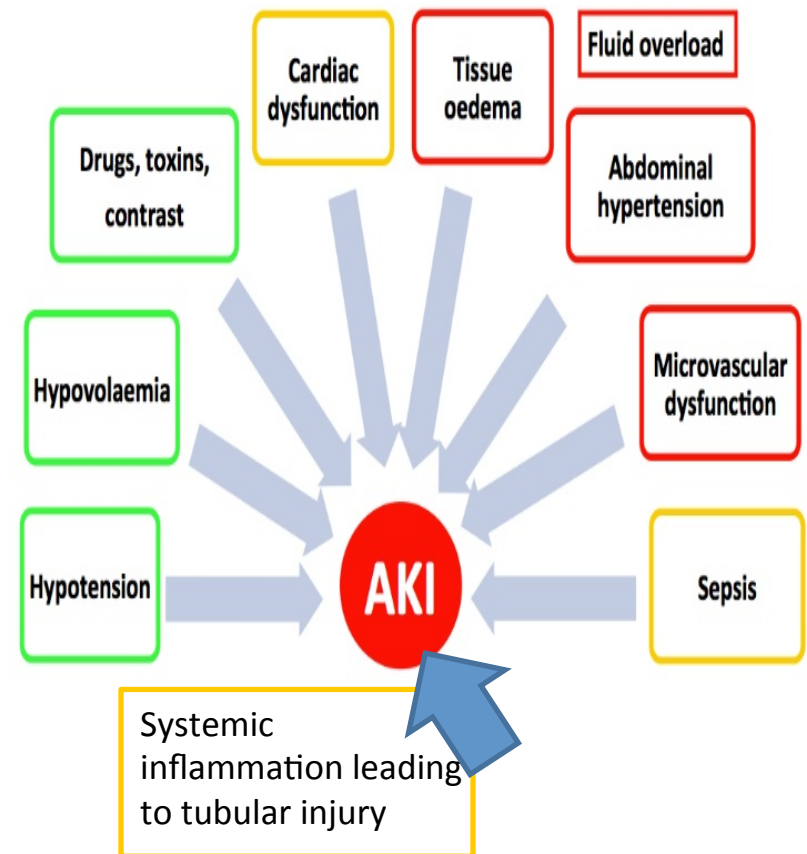


Thakar et al. Perioperative acute kidney injury. Adv in Chr Kid Dis 2013;20:67-75.

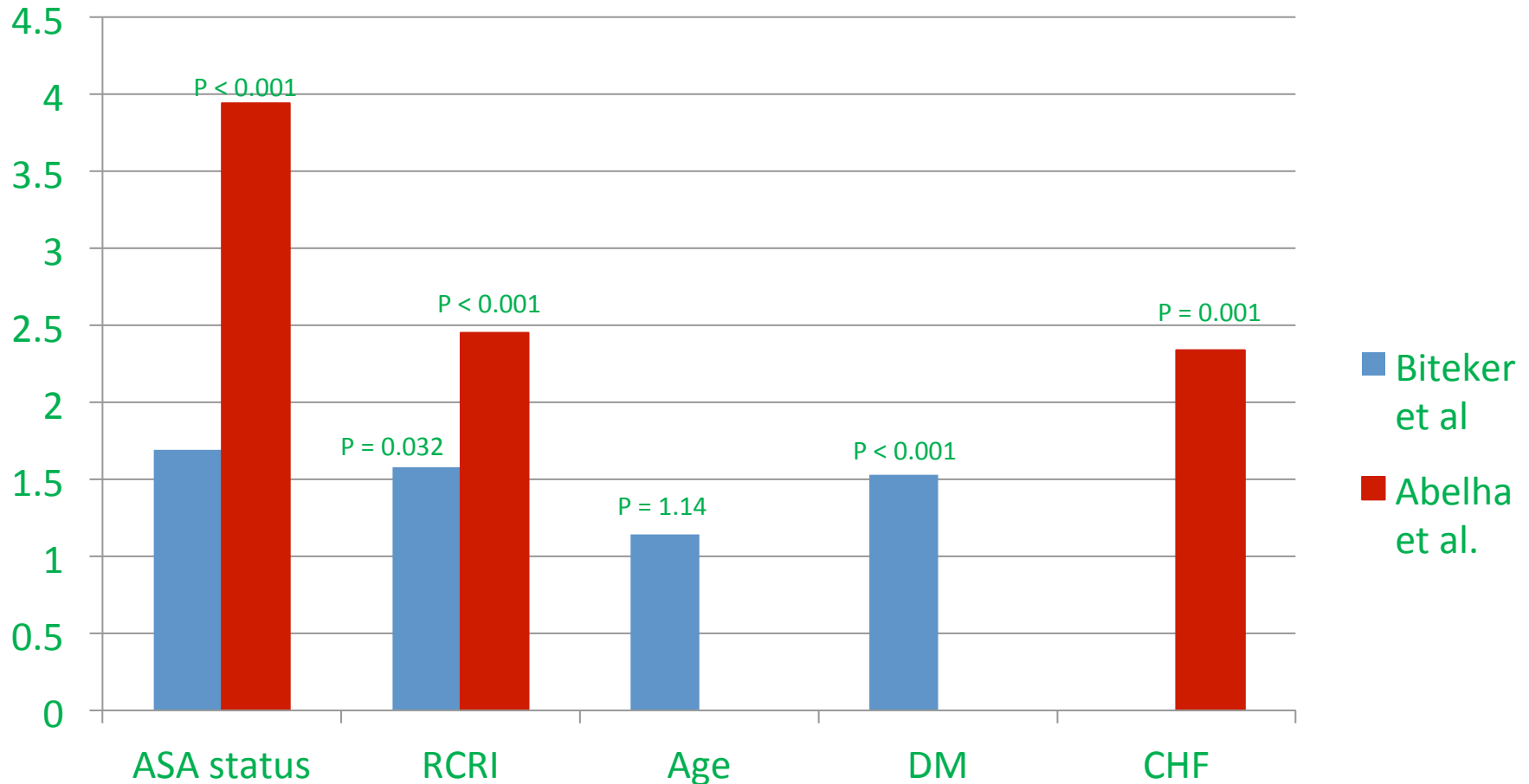
# Risk Factors for Postoperative AKI

- Depends on:
  - Patient factors
    - Different between cardiac and noncardiac surgery
  - Type of surgery
    - Cardiac studied much more extensively than noncardiac
  - Exposure to nephrotoxic drugs
  - Perioperative hemodynamics

## AKI Triggers & Perpetuators



# Patient Risk Factors for AKI



Abelha, F. et al. Determinants of postoperative acute kidney injury. Crit Care 2009;13:R79.  
Biteker, M. et al. Incidence, risk factors, and outcomes of perioperative acute kidney injury in noncardiac and nonvascular surgery. Am J Surg 2014;207: 53.

# Models of Risk Stratification

- Scoring systems in cardiac surgery
  - Three externally validated
- *Cleveland Clinic Foundation*
- *Society of Thoracic Surgeons*
- *Simplified Renal Index*
- Accuracy of prediction (AUC) to predict stage II/III AKI: 0.81, 0.76, 0.75 respectively

Risk Factor	Score	Score Group	AKI Dialysis
Female	1	0 - 2	0.4%
CHF	1	3 - 5	2%
LVEF < 35%	1	6 - 8	8%
Pre-op IABP	2	9 - 13	21%
COPD	1		
IDDM	1		
Prior Surgery	1		
Emergency surgery	2		
Surgery Type:			
Valve only	1		
CABG + Valve	2		
Other	2		
Pre-op Creatinine:			
1.2 to < 2.1 mg/dl	2		
2.1 mg/dl or greater	5		

Outcome	ROC value
<b>CCF Score</b>	
AKI - Dialysis	0.82
<b>External Validation of CCF Score</b>	
AKI Dialysis	0.86
Stage II or III AKI	0.81

ROC - receiver operating characteristics  
CCF - Cleveland Clinic Foundation score

**Figure 2.** Clinical Score to Predict AKI requiring Dialysis (AKI-D) after Cardiac Surgery.<sup>36,38</sup>

Mehta et al. Bedside tool for predicting the risk of postoperative dialysis in patients undergoing cardiac surgery. *Circulation*. 2006;114:2208-2216.

# Models of Risk Stratification

**Table 4. General Surgery Acute Kidney Injury Risk Index**

Risk factor
Age $\geq$ 56 yr
Male sex
Active congestive heart failure
Ascites
Hypertension
Emergency surgery
Intraperitoneal surgery
Renal insufficiency—mild or moderate*
Diabetes mellitus—oral or insulin therapy

Five General Surgery Acute Kidney Injury Risk Index classes are based on the number of risk factors the patient possesses: class I (zero, one, or two risk factors), class II (three risk factors), class III (four risk factors), class IV (five risk factors), and class V (six or more risk factors).

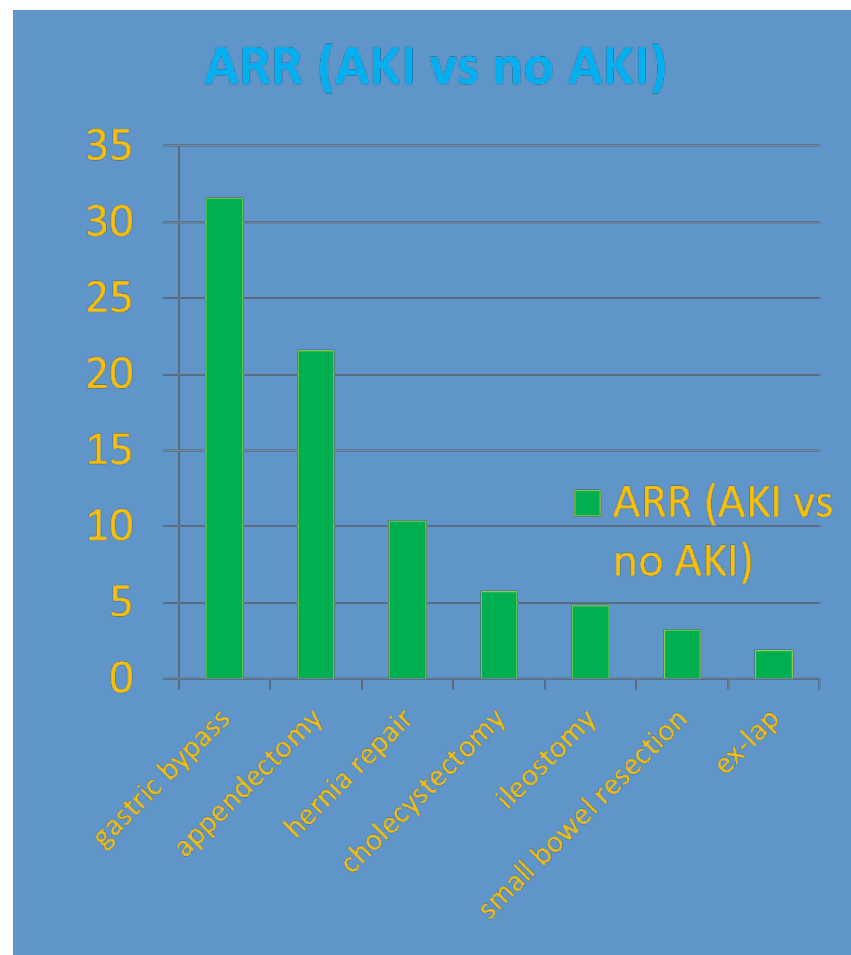
\* Preoperative serum creatinine value  $>$  1.2 mg/dl.

#Risk Factors	Hazard Ratio
0-2	1
3	3.1
4	8.5
5	15.4
6	46.2

Kheterpal et al. Anesthesiology 2009;110:505-515.

# Surgical Risk Factors

- Risk of developing AKI:
  - On pump cardiothoracic surgery 10-30%
    - Risk increases with increased duration
  - Liver transplantation 17-90%
    - immunosuppressants
  - Abdominal aortic aneurysm surgery 50%
  - General surgery 1%
  - Laparoscopy (Uop)



Kim et al. Variations in the risk of acute kidney injury across intraabdominal surgery procedures. Anesth Analg. 2014 Nov.

# Hemodynamic/Intraoperative Factors

- Duration of surgery
- Transfusion needs
- Hypovolemia (MAP < 75)
- Relative hypotension
- Development of sepsis
- Increased intra-abdominal pressure
- In vascular surgery:
  - Clamp time (AAA repair)
- In cardiac surgery:
  - Use of IABP
  - Use of cardiopulmonary bypass circuit (?inflammation)

	Risk difference (on vs off pump CABG)
GFR > 90	
Death	0.04
RRT	0.07
GFR < 30	
death	1.73
RRT	2.76

Chawla et al. Off pump vs on pump coronary artery bypass grafting outcomes stratified by preoperative renal function. J Am Soc Nephrol. 2012;23:1389-1397.

# Medication Risk Factors

- NSAIDs
- ACE/ARBs
  - No protective benefit continuing ACE in perioperative period
- Antibiotics
  - Aminoglycosides
  - PCN, cephalosporins: AIN
- IV contrast
- #medications

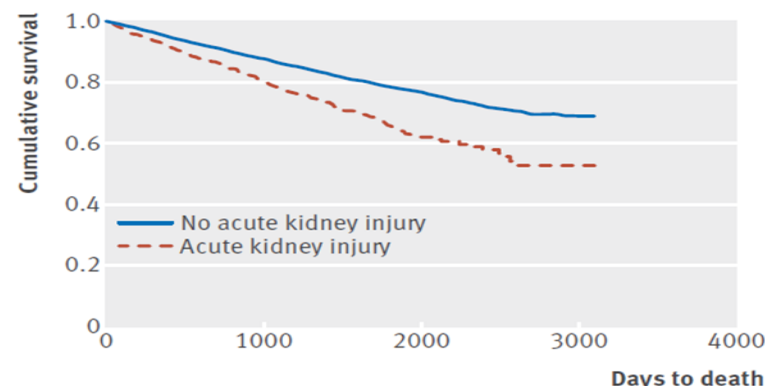


Fig 3 | Kaplan Meier plot of overall survival in patients with acute kidney injury compared with no acute kidney injury

Older age  
Male sex  
DM  
# prescribed drugs  
Lower eGFR  
ACE/ARB use  
ASA class

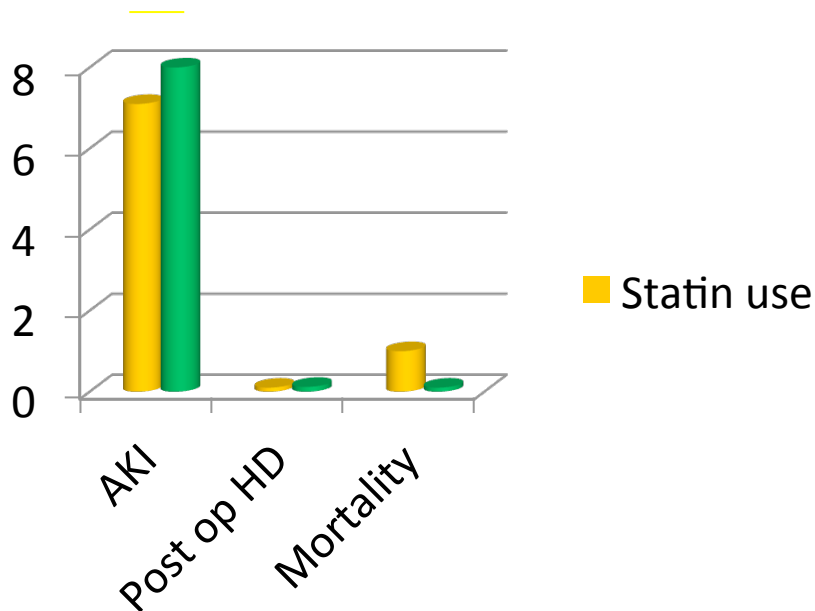
Bell et al. Risk of postoperative acute kidney injury in patients undergoing orthopaedic surgery. *BMJ* 2015;351:h5639



# Prevention: what doesn't work?

No benefit from:

- NAC
- Perioperative statins (noncardiac) dopamine
- Aspirin or clonidine (noncardiac) fenoldopam
- Theophylline
- ANP
- Tight glucose control
- nesiritde
- Prophylactic RRT (??)
- diuretics (furosemide/mannitol)



Argalious et al. Association of preoperative statin use and acute kidney injury after noncardiac surgery. *Anesth Analg* 2013;117:916-923.

	Asa vs placebo (RR)	P-value	Clonidine vs placebo (RR)	P-value
AKI	1.1	0.17	1.03	0.68
AKI or death	1.1	0.17	1.03	0.67

Garg et al. Perioperative aspirin and clonidine and risk of AKI. *JAMA* 2014;312:2254-2264.

# Prevention: what does work?

In cardiac surgery,  
evidence for EPO  
perioperatively in anemia,  
early RRT postoperatively.  
Anemia, blood transfusion  
deleterious

Type of anesthesia  
important

SEPSISAM trial: MAP  
65-70 with  
increased need RRT  
(for just 10-20min)  
Fluid overload also  
detrimental

>2 nephrotoxic medications increase  
risk AKI  
Avoid prograf postop liver transplant

## Preoperative:

### Identify patients at risk:

Patient related factors- co-morbidities (obesity, CKD, DM, cardiovascular and hepatobiliary diseases, male sex, obesity, pulmonary disease, steroid use, cancer, ASA score, ICU patients, increased intraabdominal pressure, sepsis, older age and neonates)

Procedure related factors- a. Major surgery (extensive laparotomy lung resections, transplantations)  
b. Emergency surgery  
c. Cardiac surgery  
d. Use of contrast dye

Anaemia- Correct anaemia before to surgery when possible according to the patient's management protocol.† 139 140 141 142 143 145

## Intraoperative:

Choice of fluid solution- a. Avoid HES solutions when possible.† 22 91 108 112 113 117 118 119  
b. Balanced crystalloid solutions may prove superior to chloride rich solutions in preventing AKI.† 103 104 105

Fluid management- a. The use of intraoperative urinary output as a guide to fluid administration may not be beneficial.† 127 128 129 130  
b. Avoid the use of diuretics unless a need to treat volume overload arises.22 98 135 136 137  
c. Use measures during surgery to avoid blood loss and unnecessary PRBC transfusion.† 139 140 141 142 143 145

Haemodynamic goals- a. Avoid a low MAP even for relatively short periods of time.† 55 56  
b. Evidence so far do not recommend the use of one vasopressor over the other.22  
c. Low dose dopamine is no longer considered "renoprotective" and is not recommended.22 98 148

General considerations- a. Avoid the use of aminoglycosides unless no suitable less nephrotoxic alternative exists.22

Some evidence  
0.9 NS increases  
hyperchloremia  
and decreases  
renal blood flow

Goren et al. Perioperative acute kidney injury. Br J Anaesthesia 2015;115.