Medical therapy of AKI complications

Refik Gökmen

AKI Academy

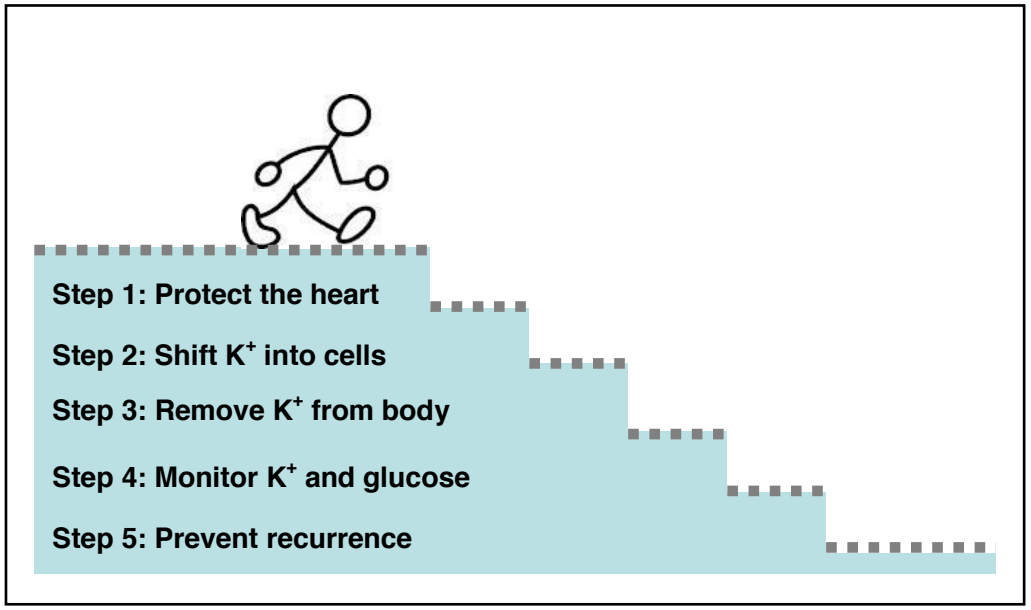
18 October 2014

Medical therapy of AKI complications

- Hyperkalaemia
- Volume status, fluid therapy
- Acidosis
- Calcium & phosphate
- Bleeding risk
- Sepsis
- Nutrition
- Follow up

Hyperkalaemia

- Serious, potentially life-threatening
- Particular danger if:
  - Acute rise
  - Oligo/anuria
  - Elderly
  - Cardiac arrhythmias



THE RENAL ASSOCIATION founded 1950

Resuscitation Council (UK)

Emergency Management of Hyperkalaemia in Adults

NAME:
ADDRESS:
D.O.B.:
CHI:

Hyperkalaemia ($K^+ \geq 5.5$ mmol/L)
Consider initiating treatment if Hyperkalaemia suspected and K^+ unknown

Assess Patient

Airway Breathing Circulation Disability Exposure (ABCDE) Approach
Seek expert help if airway, breathing or circulation compromised

Perform 12-lead ECG

MILD	MODERATE	SEVERE
K^+ 5.5 - 5.9 mmol/L	K^+ 6.0 - 6.4 mmol/L	$K^+ \geq 6.5$ mmol/L
Consider cause and if treatment indicated	*Treatment guided by clinical scenario, ECG and rate of rise*	*Emergency treatment indicated*

Seek expert help!

Monitor ECG in high dependency area
Sick patient; $K^+ \geq 6.5$ mmol/L; Acute ECG changes present

Acute ECG changes present (*tick if present*)?
NO
- ☐ Peaked T waves
- ☐ Broad QRS
- ☐ Bradycardia
- ☐ Absent or flattened P waves
- ☐ Sine wave
- ☐ VT

YES

Protect the Heart

Calcium Chloride OR Calcium Gluconate IV
Repeat ECG and consider further dose after 5 min if ECG changes persists

Insulin–Glucose IV Infusion
Give in severe hyperkalaemia
Consider in moderate hyperkalaemia (*assess ECG and rate of rise*)

Shift K^+ into cells

Salbutamol 10-20 mg Nebulised
Give in severe hyperkalaemia
Consider in moderate hyperkalaemia (*assess ECG and rate of rise*)

Remove K^+ from body

Consider Calcium Resonium
15 g x4/day oral or 30 g x2/day PR

Consider Dialysis
Seek advice from Renal or ICU team; patient transfer may be required

$K \geq 6.5$ mmol/L despite medical therapy

Monitor K^+ and Blood Glucose

Monitor serum K^+ and blood glucose

Prevention

Consider cause of hyperkalaemia, prevent further rise and recurrence
Stop all nephrotoxic medication including ace-inhibitors, angiotensin II receptor blockers, potassium-sparing diuretics, NSAIDS and assess diet

K^+: potassium; Na^+: sodium; Creat: creatinine; IV: intravenous; min: minutes; PR: per rectum; EWS: early warning score; IHD: Ischaemic Heart Disease; NSAIDS: non-steroidal anti-inflammatory drugs

Date: ___/___/___ Time: ___:___

First 15-30 min

Na^+: _____	0_2 Sat: _____%
K^+: ___.__	RR: _____
Urea: ___.__	BP: ___/___
Creat: _____	Pulse: _____
Time: ___:___	EWS: _____

Check K^+
Send lithium-heparin sample to lab
Use blood gas analyser if available
Exclude pseudo-hyperkalaemia

Dialysis patient: Contact Renal Unit
Cardiac monitoring: YES/ NO
Call for senior help: YES/ NO
Renal or ICU referral: YES/ NO

IV Calcium (6.8 mmol)
10 ml 10% Calcium Chloride IV OR
30 ml 10% Calcium Gluconate IV
Use large vein
Give over 5-10 min

Next 30-60 min

Glucose (25 g) over 15 min
50 ml 50% Glucose OR
125 ml 20% Glucose,
WITH **Soluble Insulin – 10 units**

Salbutamol
Give 10 mg if history of IHD
Avoid if tachyarrhythmia present

Blood Monitoring:
Baseline Glucose __.__ K^+ ___.__
15 min Glucose __.__
30 min Glucose __.__
60 min Glucose __.__ K^+ ___.__

After 1st hour

Blood Monitoring:
90 min Glucose __.__
120 min Glucose __.__ K^+ ___.__
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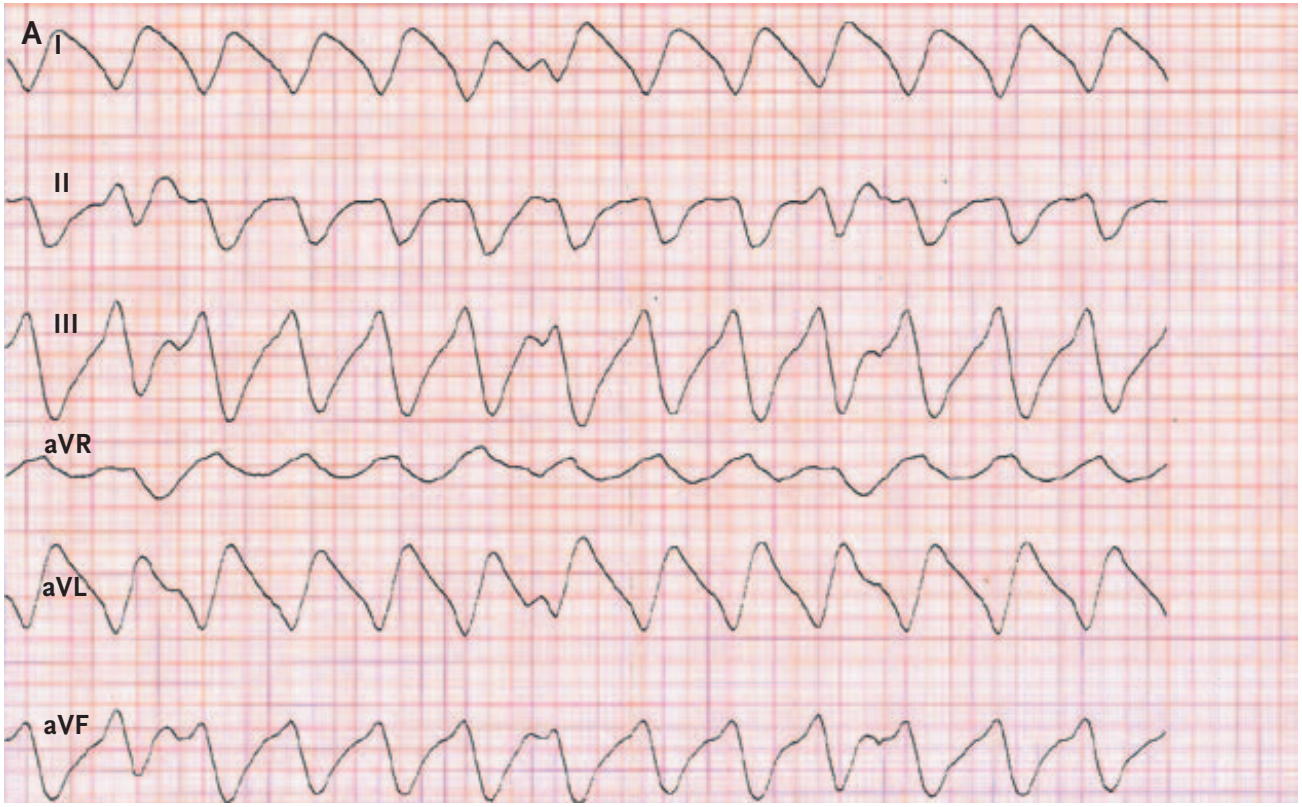
360 min Glucose __.__ K^+ ___.__
24 hours K^+ ___.__

Publication date: 1.03.14 Review date: 1.03.16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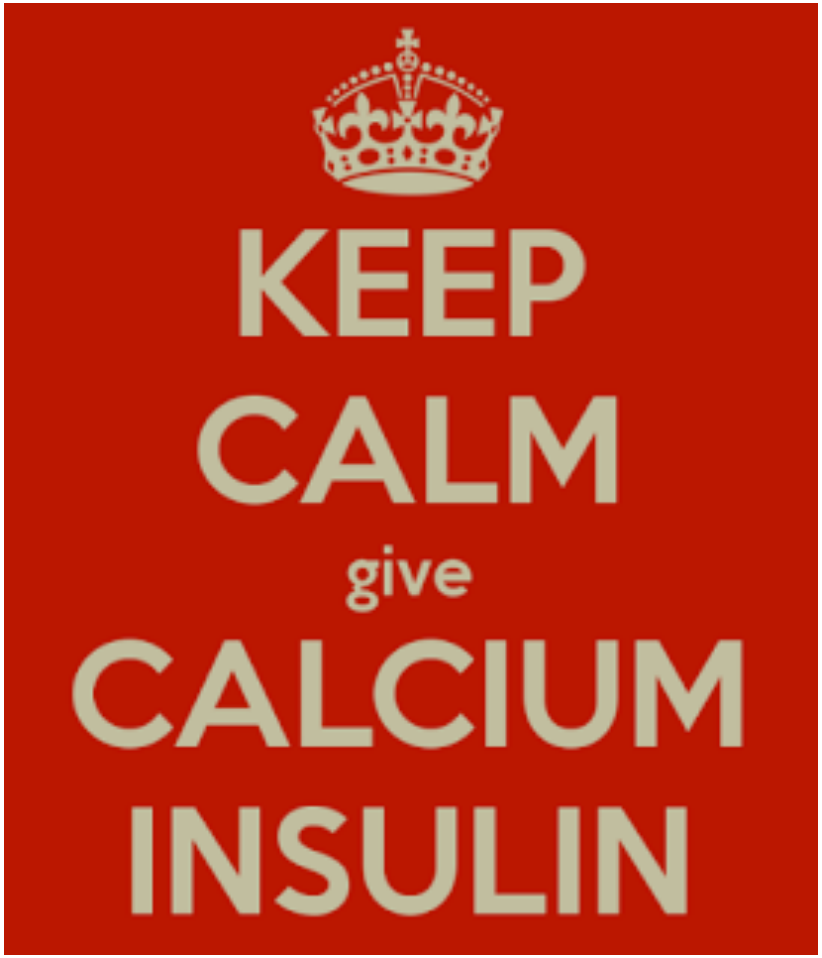
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ECG abnormalities in hyperkalaemia

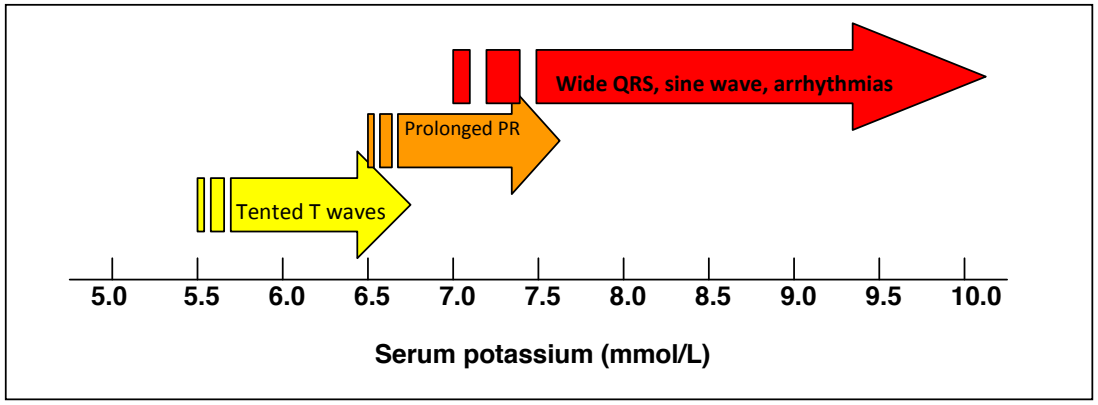


Figure 2: Progressive changes in ECG with increasing severity of hyperkalaemia.

ECG abnormalities in hyperkalaemia

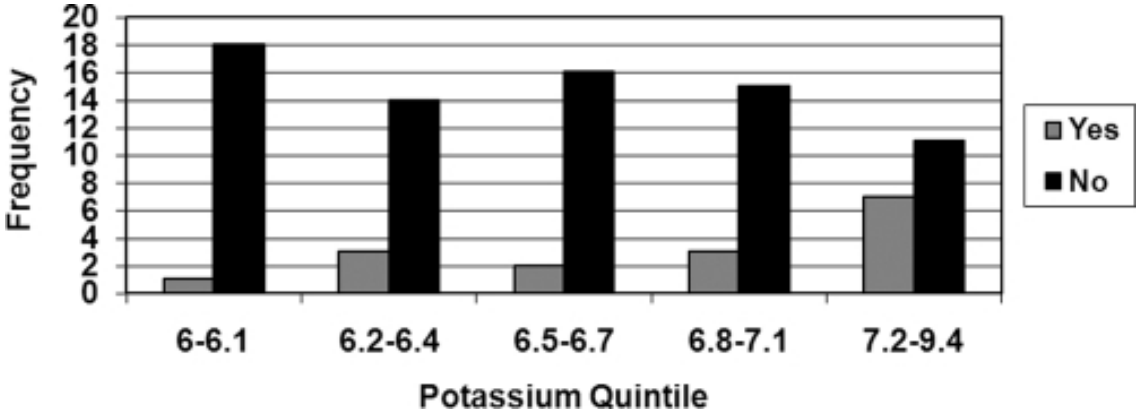
Montague BT, Ouellette JR, Buller GK. Retrospective review of the frequency of ECG changes. Clin J Am Soc Nephrol 2008;3:324-30

Table 1.

Criteria for assessment of ECG changes on the basis of reviewer assessment[a]

Criteria Level	Details
Strict	Baseline and follow-up available. New peaked and symmetric T waves noted, which completely resolved on follow-up.
Any	Peaked or symmetric T waves noted, which were new or either partially or completely resolved on follow-up
Peaked	Peaked T waves noted, which were new or either partially or completely resolved on follow-up
Symmetric	Symmetric T waves noted, which were new or either partially or completely resolved on follow-up

[a]ECG, electrocardiogram.



Calcium in hyperkalaemia

10 ml 10% Calcium Chloride = 6.8 mmol Ca^{2+}

10 ml 10% Calcium Gluconate = 2.26 mmol Ca^{2+}

- A single dose is often not enough
- Repeat ECG to assess response
- Can cause bradycardia
- Short duration of action: repeat until K treated

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24 hours K^+ ___.__

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Insulin - dextrose

STUDY	N	Dose of Soluble Insulin	Dose of Glucose	Mean initial K^+ (mmol/L)	Peak reduction in K^+ (mmol/L)	Time of max action	Duration of Effect (min)	Hypoglycaemia (%)
Lens[13] 1989	10	10 units	40g	6.7	1.0	60	>360	20
Allon[7] 1990	12	10 units	25g	5.48	0.65	45	>60	75
Ljutic[11] 1993	9	10 units	25g	6.33	0.76	60	>60	11
Allon[8] 1996	5	5 mU/kg/min	60g	4.28	0.85	60	>60	0
Duranay[12] 1996	20	10 units	30g	>6.0	0.98	180	>360	0
Kim[14] 1996	8	5 mU/kg/min	40g	6.3	0.7	60	>60	0
Ngugi[10] 1997	70	10 units	25g	6.9	0.9	60-120	>360	20
Mahajan[9] 2001	30	12 units	25g	6.59	0.83	180	>360	3.3

Table 4: Efficacy of insulin-glucose monotherapy.

Sodium bicarbonate

- Useful (necessary) if hyperkalaemia is accompanied by acidosis +/- volume depletion
- 1.26% $NaHCO_3$
- Beware sodium load, drop in ionised calcium

Removing K^+ from the body

- Cation exchange resins: calcium resonium
  - Probably overused
  - Risk of intestinal necrosis
- Furosemide + iv saline
- Fludrocortisone?
- Dialysis

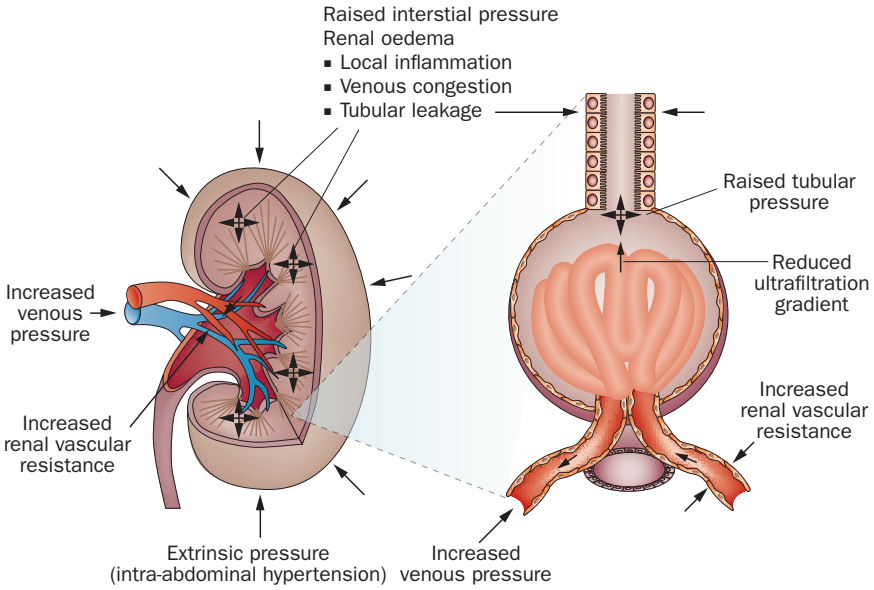
- Review medications…

Fluids & volume status

- Volume resuscitation in pre-renal AKI

  … which fluid, how much, how quickly?

- Importance of monitoring, reassessment
- Beware of causing volume overload



Prowle, J. R. *et al.* (2013) Fluid management for the prevention and attenuation of acute kidney injury
Nat. Rev. Nephrol. doi:10.1038/nrneph.2013.232

Fluid Balance, Diuretic Use, and Mortality in Acute Kidney Injury

Morgan E. Grams,[*†] *Michelle M. Estrella,*[*] *Josef Coresh,*[*†‡], *Roy G. Brower,*[*] *and Kathleen D. Liu*[§] *for the National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome Network*

Summary

Background and objectives Management of volume status in patients with acute kidney injury (AKI) is complex, and the role of diuretics is controversial. The primary objective was to elucidate the association between fluid balance, diuretic use, and short-term mortality after AKI in critically ill patients.

Design, setting, participants, & measurements Using data from the Fluid and Catheter Treatment Trial (FACTT), a multicenter, randomized controlled trial evaluating a conservative *versus* liberal fluid-management strategy in 1000 patients with acute lung injury (ALI), we evaluated the association of post-renal injury fluid balance and diuretic use with 60-day mortality in patients who developed AKI, as defined by the AKI Network criteria.

Results 306 patients developed AKI in the first 2 study days and were included in our analysis. There were 137 in the fluid-liberal arm and 169 in the fluid-conservative arm ($P = 0.04$). Baseline characteristics were similar between groups. Post-AKI fluid balance was significantly associated with mortality in both crude and adjusted analysis. Higher post-AKI furosemide doses had a protective effect on mortality but no significant effect after adjustment for post-AKI fluid balance. There was no threshold dose of furosemide above which mortality increased.

Conclusions A positive fluid balance after AKI was strongly associated with mortality. Post-AKI diuretic therapy was associated with 60-day patient survival in FACTT patients with ALI; this effect may be mediated by fluid balance.

Clin J Am Soc Nephrol 6: 966–973, 2011. doi: 10.2215/CJN.08781010

Managing fluid overload in AKI

- Nitrates
- Loop diuretic
- CPAP
- Dialysis

Bicarbonate replacement for metabolic acidosis

- Particularly useful in the context of acidosis due to diarrhoeal loss
- Recommended in rhabdomyolysis
- Discuss with nephrology or critical care
- Beware sodium load, hypocalcaemia, respiratory disease

Other complications

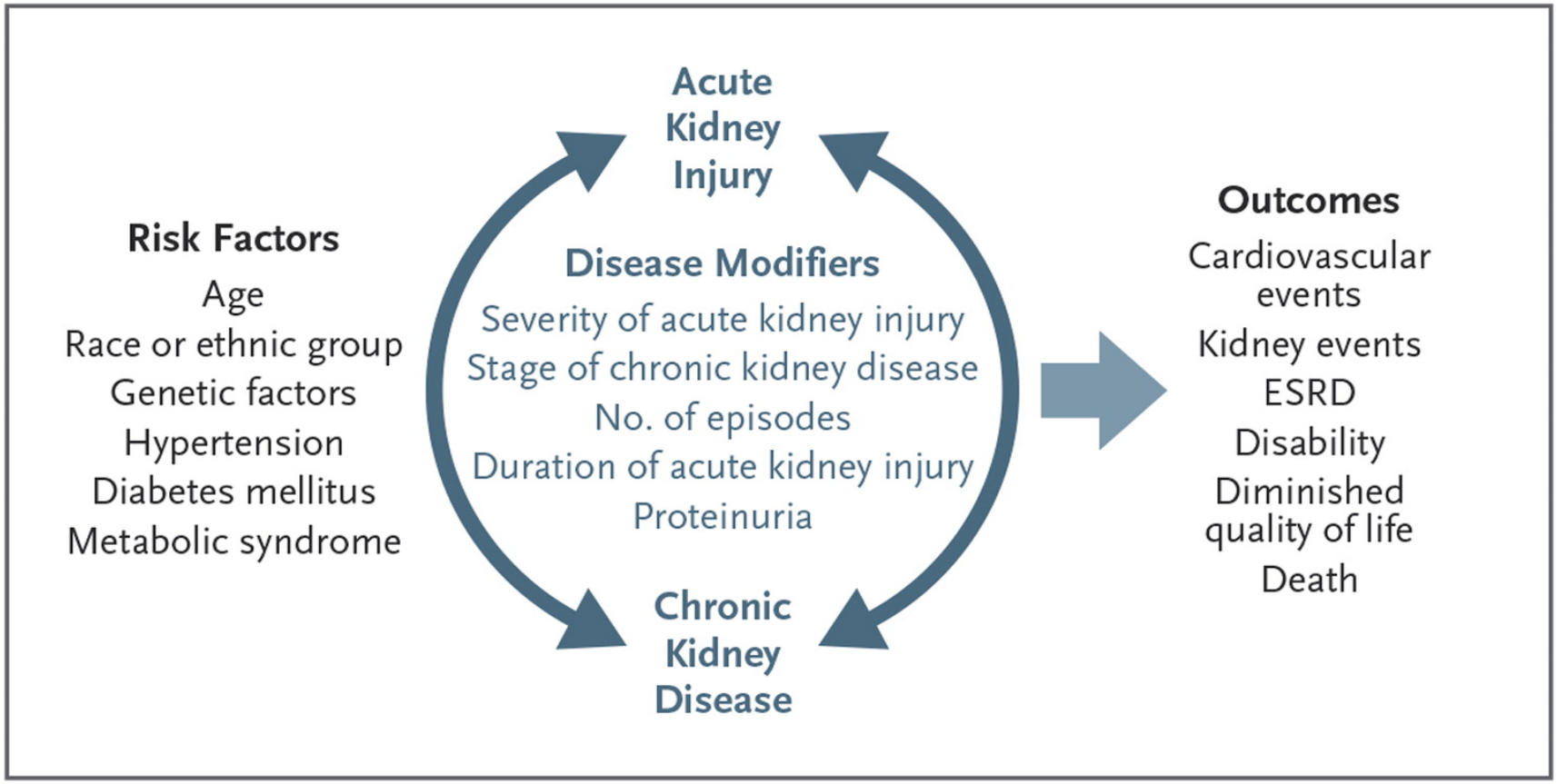
- Calcium & phosphate
  - Correct hypocalcaemia before correcting acidosis
  - Phosphate binders, alfacalcidol may be necessary
  - NB care with correcting hypocalcaemia in rhabdomyolysis or if phosphate very high
- Bleeding risk
  - Consider stopping anti-platelet agents
  - Gastroprotection: ranitidine / PPI
  - Care with thromboprophylaxis & dosing of LMWH
  - DDAVP if overt bleeding / invasive procedures – but beware of causing hyponatraemia

Supportive management

- Think about nutrition early
  - Specialist dietitian input early
  - Help with potassium control
- Identify & treat sepsis early
- Identify & stop nephrotoxins
  - NSAIDs, ACEi/ARB, metformin, radiological contrast.
  - Consider witholding anti-hypertensives

- Make arrangements to recheck kidney function, review medications, consider cardiovascular risk

Acute Kidney Injury and Chronic Kidney Disease as an Interconnected Syndrome.



Chawla LS et al. N Engl J Med 2014;371:58-66.

Questions