Acute Kidney Injury (AKI)

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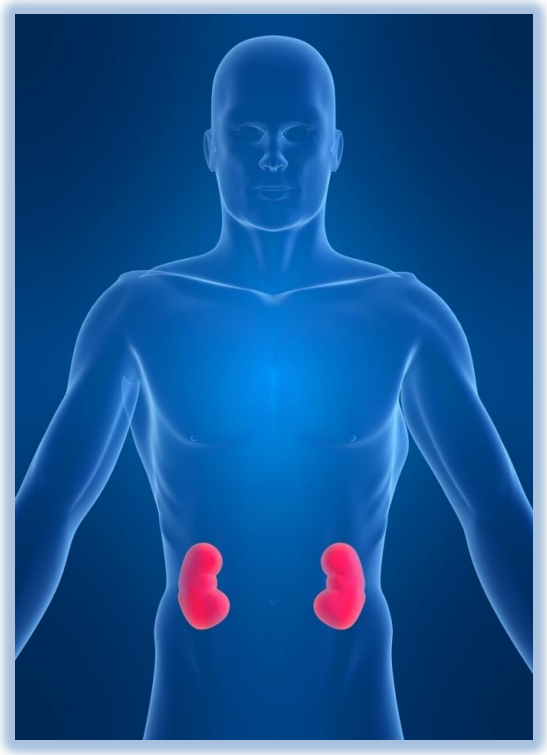
September 12th 2018

Consultant in Anaesthetics and Intensive Care Medicine

Fluid and AKI Lead

Barnsley Hospital NHS Foundation Trust

Overview:



- AKI key messages in adults
- Local stats
- Role of Pharmacy
- AKI initiatives

Introduction

- Acute Kidney Injury (AKI) is extremely common
  - **Prevention, supportive therapy & renal replacement therapy (RRT)** are the only management options

What is AKI?

Historically:

- **Acute renal failure** = considered final stage of a single-organ reversible problem in previously healthy persons that can be supported by RRT.

Termed no longer used

AKI has evolved from a single-organ problem to a systemic disease which is associated with short and long-term patient and kidney outcomes

What is AKI?

- An abrupt decline in renal function over hours or days

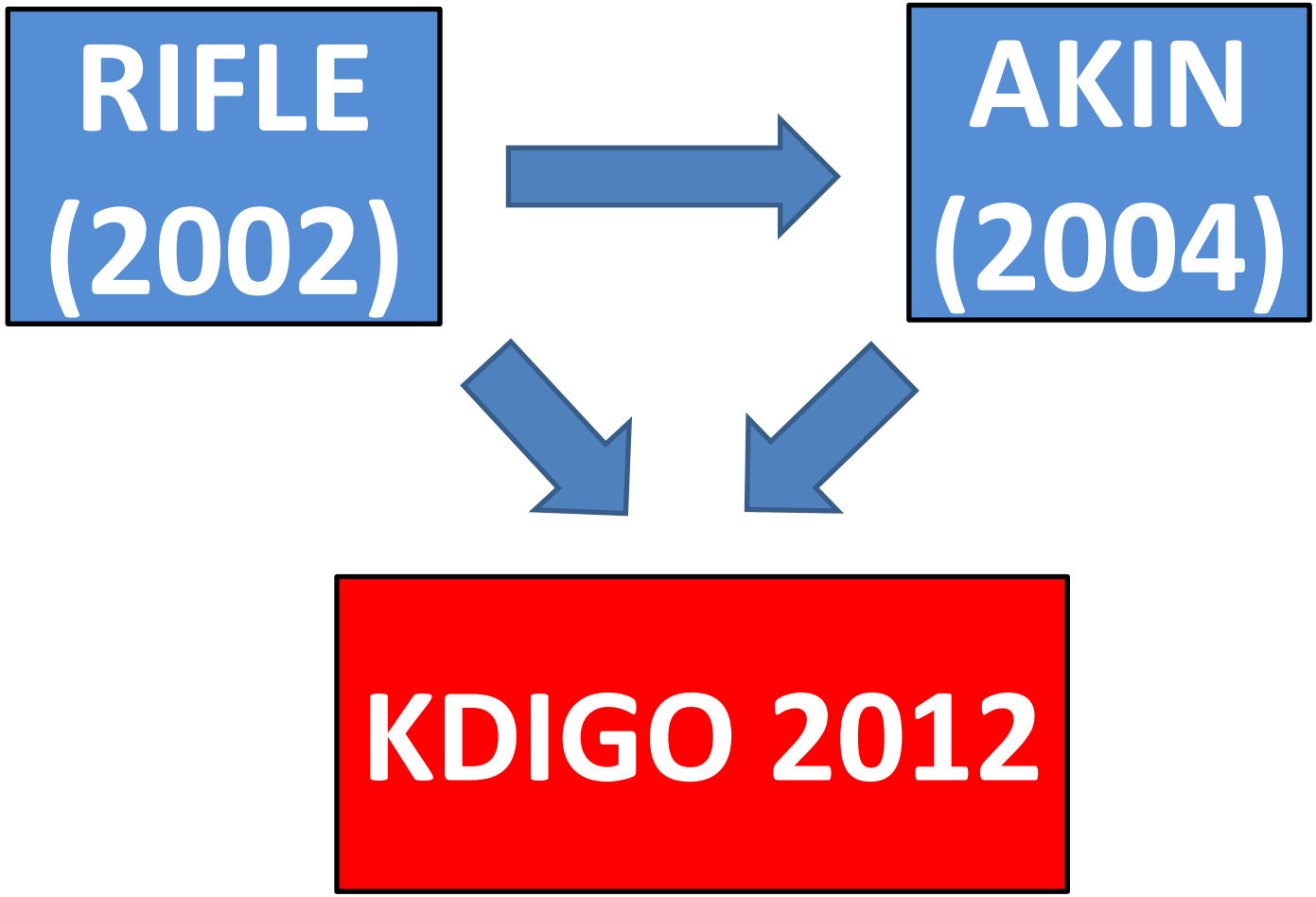
- Defined by:

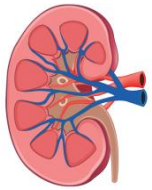
an acute rise in serum **creatinine**

AND / OR

a reduction in **urine output**

How is AKI Classified?





AKI: KDIGO 2012

Stage	Serum Creatinine (Cr) <u>Increase</u>	Urine Output (UO)
1	**1.5-1.9x** baseline OR **≥26.5µmol/L**	**<0.5ml/kg/hr** for 6-12hrs
2	**2.0-2.9x** baseline	**<0.5ml/kg/hr** for ≥12hrs
3	**3.0x** baseline OR Rise **≥353.6µmol/L** OR Initiation of Renal Replacement Therapy OR, in patients <18yrs old, decrease in eGFR to <35ml/min per 1.73m^3	**<0.3ml/kg/hr** for >12hrs OR **Anuria** for ≥12hrs

NHS choices Your health, your choices

Health A-Z | Live Well | Care and support

Kidney damage 'killing thousands,' study claims

Share: Save: Subscribe: Print:

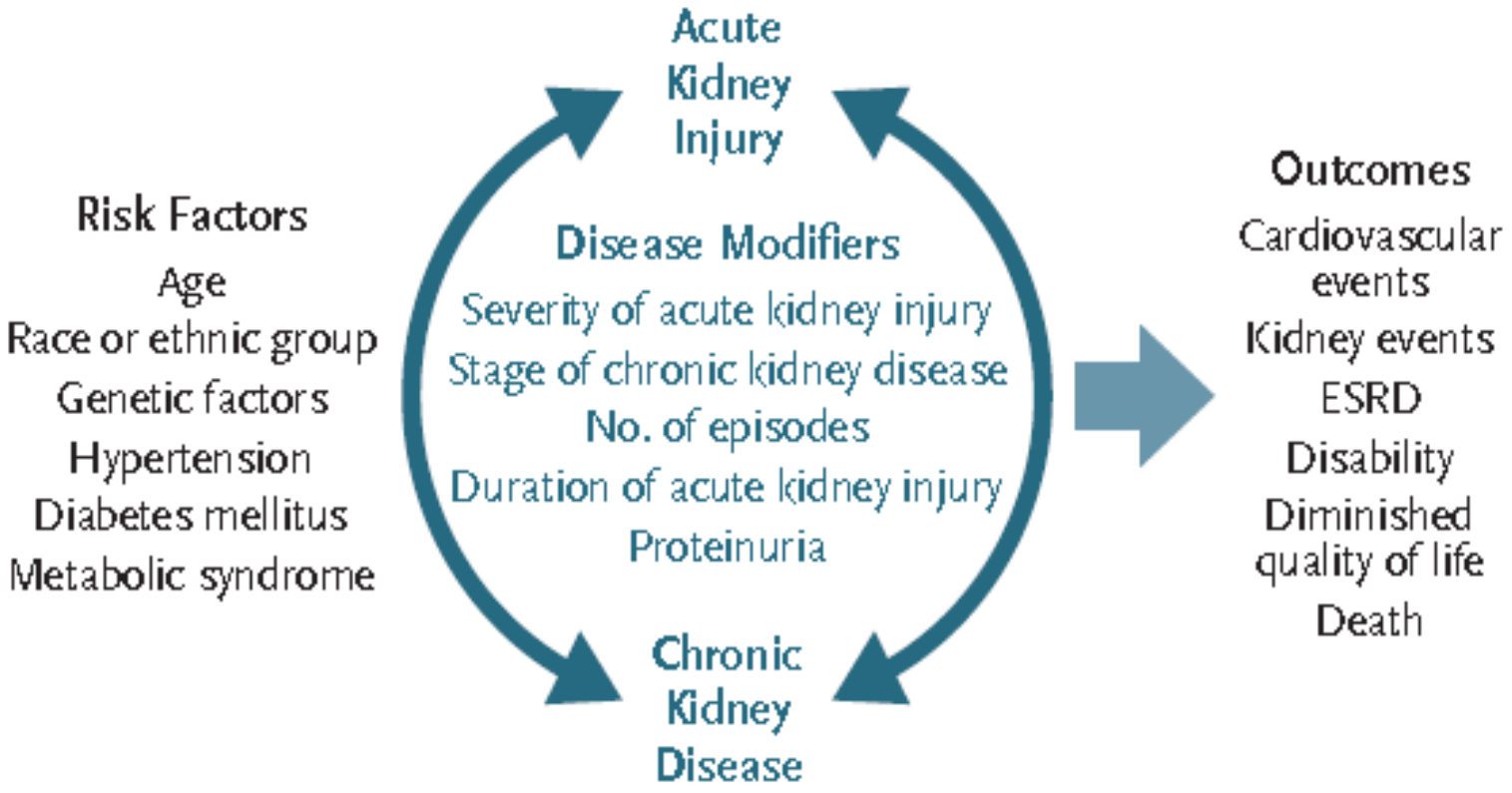
Wednesday April 23 2014

"Failures in basic hospital care are resulting in more than 1,000 deaths a month from … acute kidney injury," The Independent reports. A study commissioned by the NHS estimates

So what's the big deal with AKI?…

- Associated 100,000 deaths per year
- One in five emergency admissions to hospital
- 60% start in the community
- 30% AKI cases are PREVENTABLE
- Cost: £1.01 Billion per year!

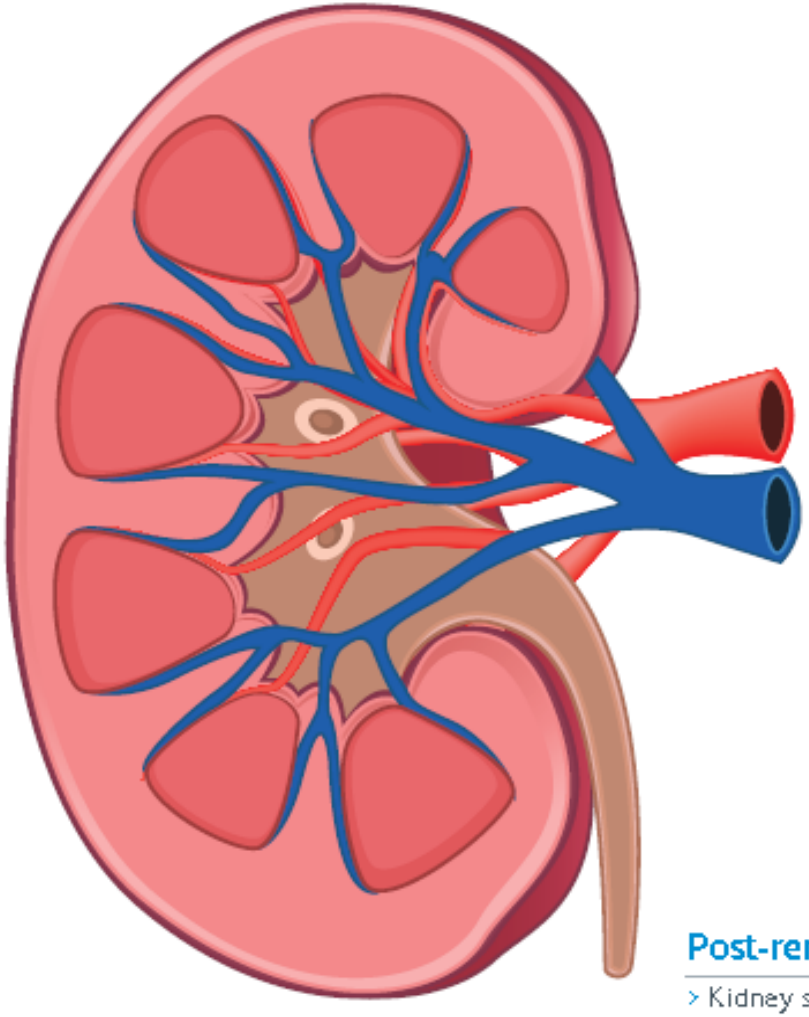
AKI and Chronic Kidney Disease (CKD): 'Inter-connected Syndrome'



Causes of AKI

Intrinsic AKI

- Acute tubular injury
  - Prolonged pre-renal AKI
  - Rhabdomyolysis
  - Haemoglobinuria
  - Nephrotoxins
    - Iodinated contrast
    - NSAIDs
    - Gentamicin
- Tubulointerstitial injury
- Glomerulonephritis
- Myeloma
- Vasculitis
  - Lupus
  - ANCA associated



Pre-renal AKI

- Sepsis
- Hypovolaemia
  - Haemorrhage
  - Burns
  - Vomiting/diarrhoea
  - Diuretics
- Hepatorenal syndrome
- Cardiac failure
- Hypotension
  - Medications

Post-renal AKI

- Kidney stones
- Prostatic hypertrophy
- Tumours
- Retroperitoneal fibrosis

30% of AKI cases are preventable!

AKI presence is often a **marker of organ failure** rather than primary kidney problem

Prevention and treatment is difficult as many patient, healthcare factors cause AKI

Sepsis & Dehydration are the most common Trust **causes** of AKI

Intensive Care Med (2015) 41:1411–1423
DOI 10.1007/s00134-015-3934-7

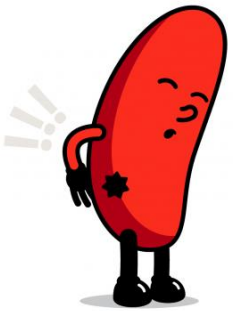
SEVEN-DAY PROFILE PUBLICATION

Eric A. J. Hoste
Sean M. Bagshaw
Rinaldo Bellomo
Cynthia M. Cely

Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study

Causes of AKI in Critically Ill

Etiology of AKI	
Sepsis	271 (40.7 %)
Hypovolemia	227 (34.1 %)
Drug related	96 (14.4 %)
Cardiogenic shock	88 (13.2 %)
Hepatorenal syndrome	21 (3.2 %)
Obstruction of the urine outflow tract	9 (1.4 %)
Predisposing factors for AKI	
Diuretic treatment	216 (32.4 %)
NSAID administration	79 (11.9 %)
Aminoglycoside administration	45 (6.8 %)
Glycopeptide administration	9 (1.4 %)
Amphotericin administration	0 (0 %)
Radiocontrast media administration	14 (2.1 %)



Barnsley AKI Stats

24% of emergency patients in the Trust will be affected by AKI

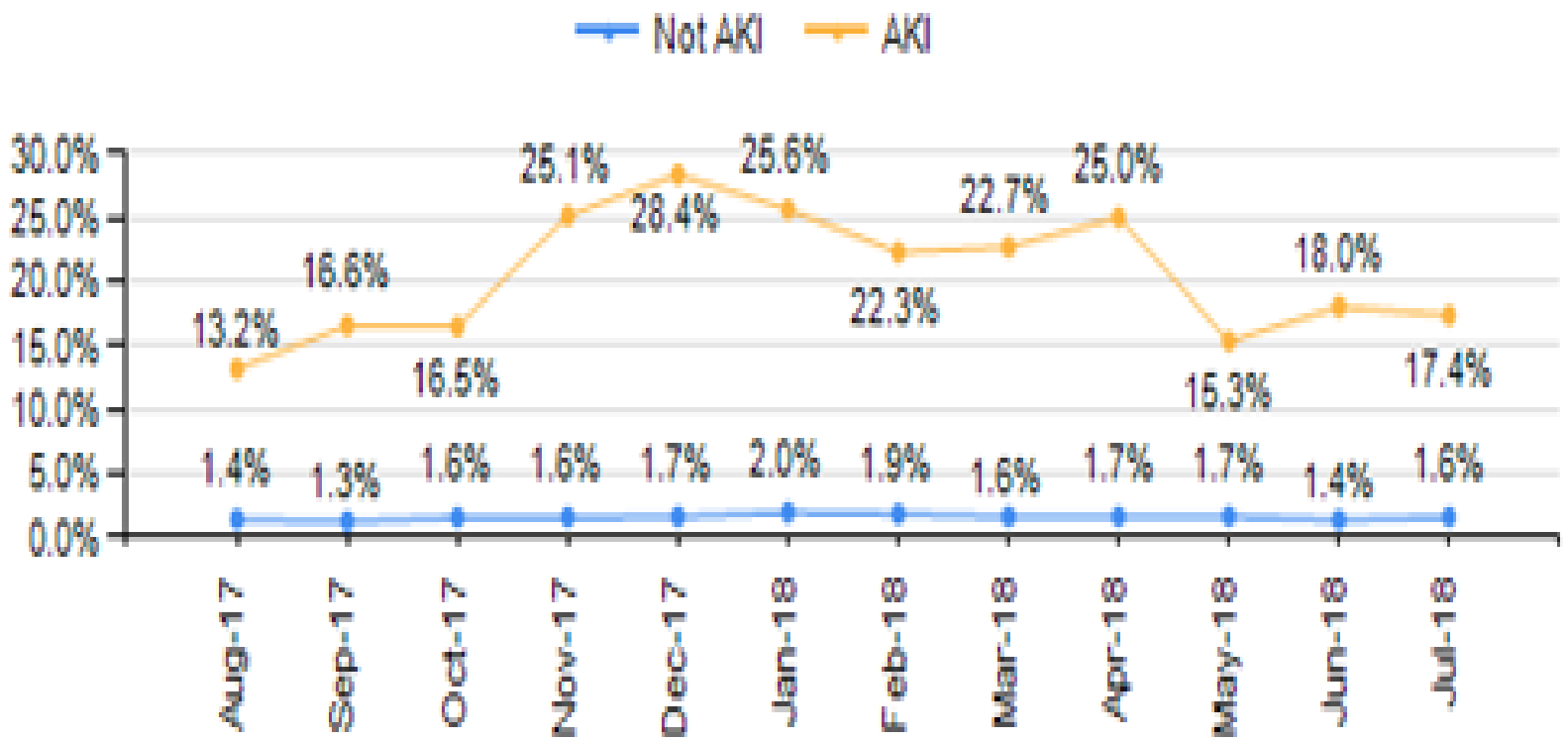
60% have AKI on admission 

AKI is more common in **older** (>65yrs), **medical** patients

It is **4x** more common in emergency patients compared to elective admissions

Barnsley AKI Stats

NEL Inpatient Mortality Over Time

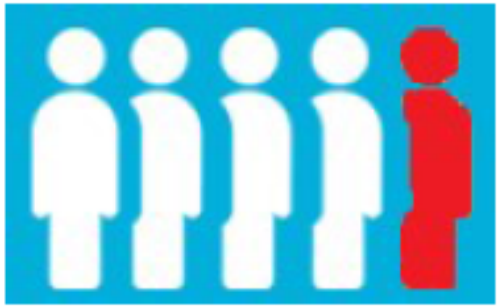


The presence of AKI is a

medical emergency

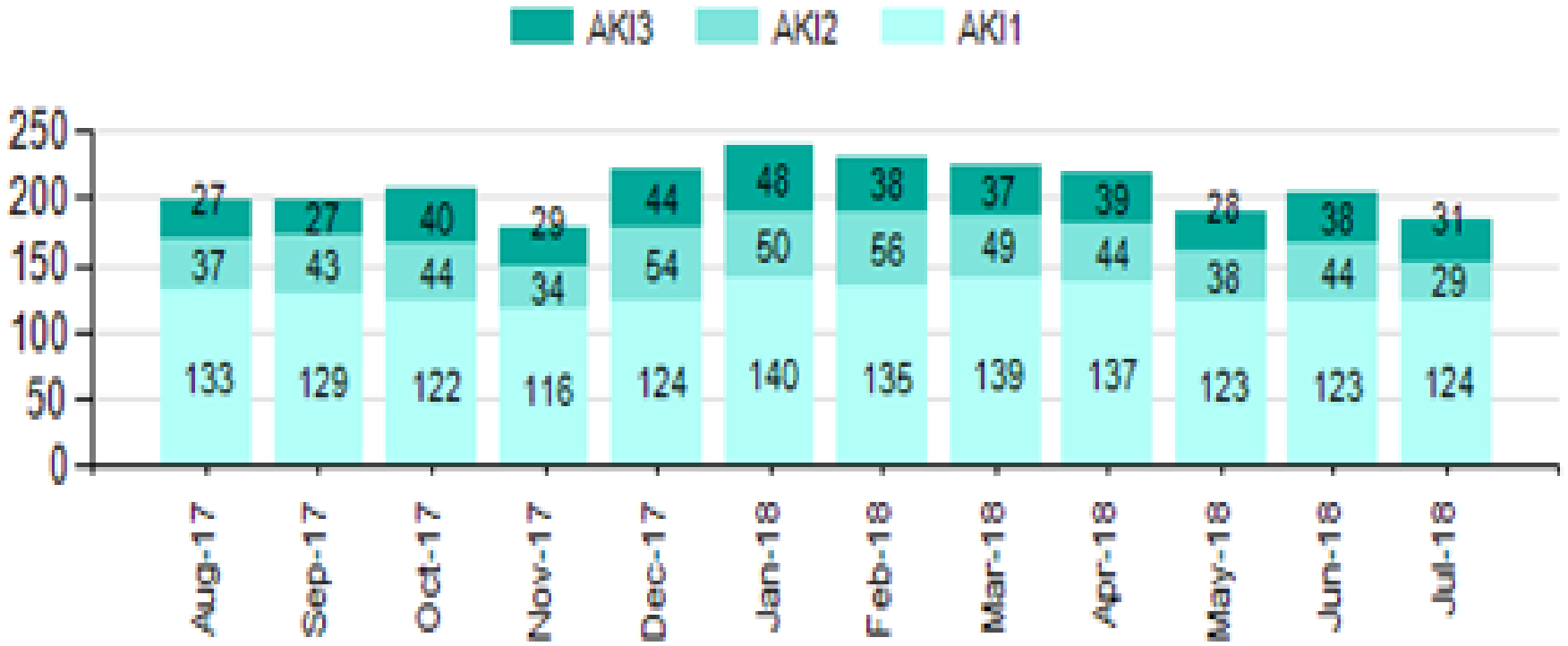
In emergency patients, the average inpatient mortality is **1.5%** without AKI vs. **19.6%** if AKI is present!

1 in 5 patients with AKI will die during their hospital stay!



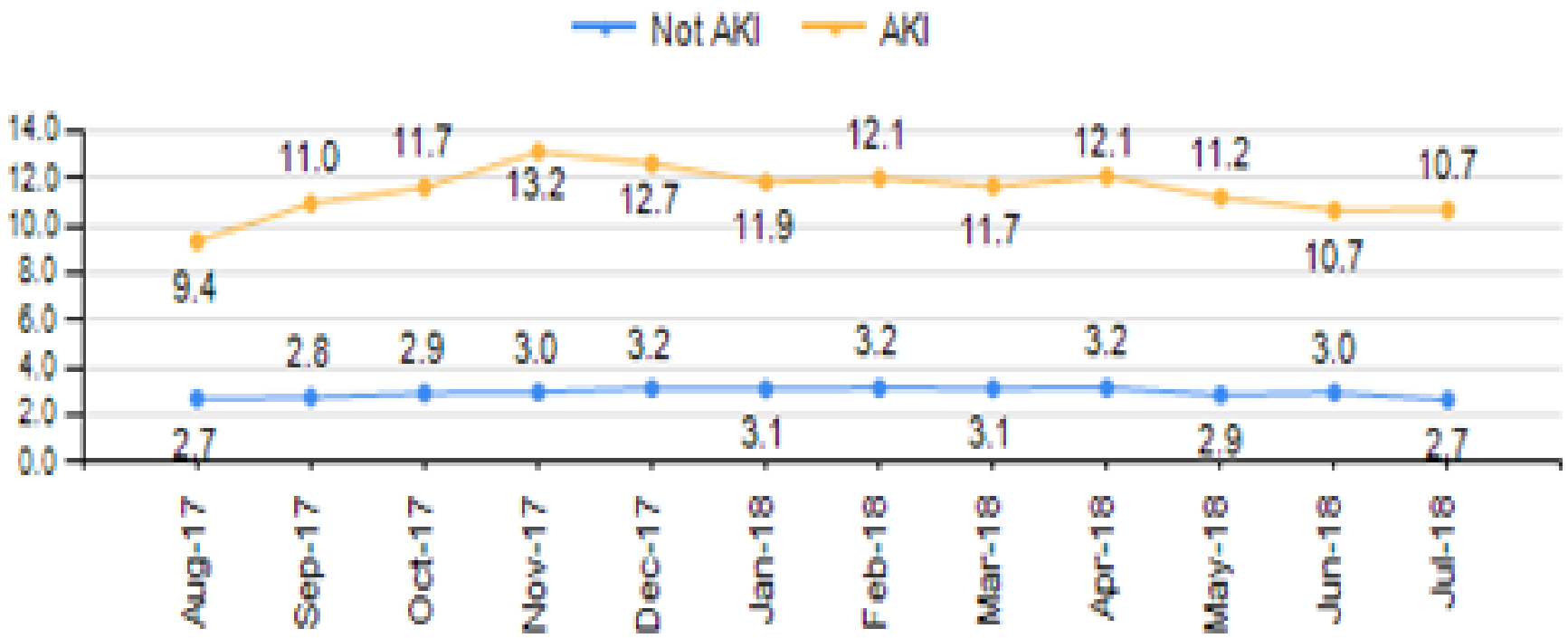
Barnsley AKI Stats

NEL AKI Severity Over Time



Barnsley AKI Stats

NEL Average Length of Stay Over Time



In emergency patients, **length of hospital stay (LOS)** on average is **3 days without AKI**, rising to **11 days with AKI**!

Small changes in practice by **EVERYONE**, with greater attention to fluid balance monitoring and early AKI bundle use, could save many lives and reduce hospital stay!

Case

- 82yr old man presented acute confusion and lethargic 7 day history of diarrhoea
- PMHx: Type II DM, HTN, COPD
- DHx: Furosemide, Co-Codamol, Amlodipine, Clopidogrel, Doxazosin, Metformin, Pioglitazone, Ramipril, Ranitidine, Simvastatin

What AKI Risk Factors does this patient have?

AKI Prevention: Risk Assessment

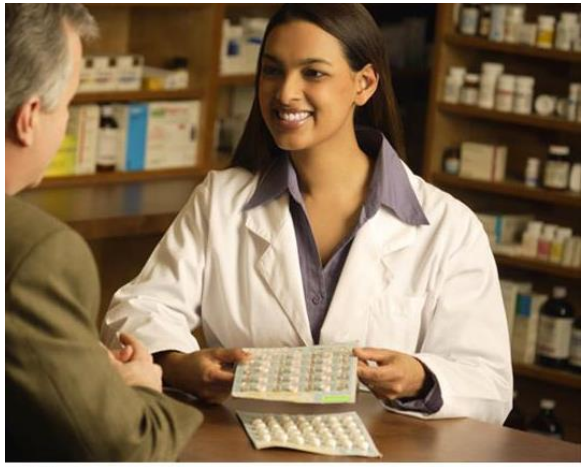
- Age >75 years
- Pre-existing CKD (eGFR <60 mL/kg/1.73 m^2)
- Previous episode of AKI
- Debility and dementia
- Heart failure
- Liver disease
- Diabetes mellitus
- Hypotension (mean arterial pressure <65 mmHg, systolic pressure <90 mmHg)
- Sepsis
- Hypovolaemia
- Nephrotoxins, eg gentamicin, NSAIDs, iodinated contrast
- Antihypertensives in setting of hypotension, eg ACE inhibitors, loop diuretics

ACE = angiotensin-converting enzyme; eGFR = estimated glomerular filtration rate; NSAIDs = non-steroidal anti-inflammatory drugs

Case:
Patient here would be deemed high risk for fluid and AKI issues

How to recognise those at risk in Primary Care?

Individual consultation



Systemic search of GP practice IT systems

Identify repeat prescriptions for target medications

Case

- <u>Barnsley ED: (28/7/16)</u>
  - Creatinine 437µmol/L
  - Baseline 109µmol/L
  - Admitted to AMU for IV fluid and antibiotics

AKI-3

What else could be done?

AKI Prevention

- Fluid Therapy
- Medicines Review
- Contrast-prophylaxis

Remember: up to 30% AKI cases preventable!

Fluid Therapy

Too Little = Harm

(dehydration, falls, increase VTE, poor healing, pressure ulcers, AKI, increased LOS and deaths)

Too Much = Harm

(overload: worsen cardiorespiratory failure & oedema, poor mobility, falls, poor healing, pressure ulcers, ileus, increase LOS & death, AKI with high Cl- fluids e.g. 0.9% saline)

Fluid Therapy effects every aspect of patient care and Must Be <u>JUST RIGHT!</u>

Crystalloids

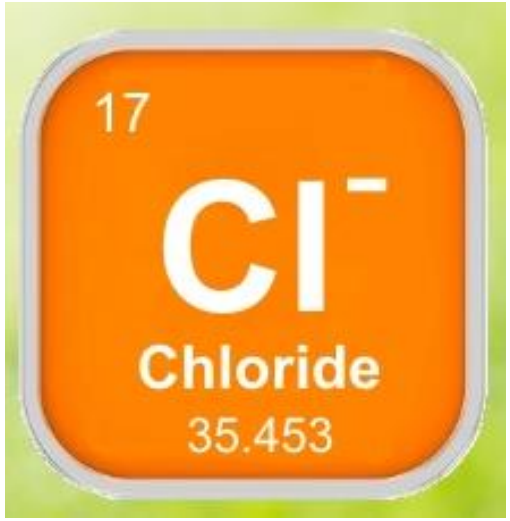
Crystalloids	Na+	K+	HCO3-	Cl-	Ca+	Other	Osmolality
0.9% Saline	154	0	0	154	0	0	310
5% Dextrose	0	0	0	0	0	50g/L dextrose	250
Plasmalyte-148	140	5	Acetate Gluconate	98	0	27mmol/L acetate 23 mmol/L gluconate Mg2+ 1.5	295
Hartmans	131	5	Lactate	111	2	29mmol/L Lactate	280
0.45% Saline	77	0	0	77	0	0	154
4% Dextrose / 0.18% Saline	30	0	0	30	0	40g/L dextrose	262

Values: mmol/L

Chloride (Cl-)

- Chloride termed the ‘Cinderella’ electrolyte
- Major strong anion in plasma
- Normal range 97-107 mmol/L, Daily requirement 150mmol/day

- <u>Hyperchloraemia</u> results in:
  - Metabolic acidosis
  - Renal dysfunction (AKI)
  - Increased mortality
  - Coagulation disturbances
  - Splanchnic ischaemia
  - Pro-inflammatory state



- Choice of IV fluids greatly influences development of hyperchloraemia

SALT-EM. NEJM 2018

- **Non-critically ill adult patients** compared balanced solution (mainly hartmans) to normal saline
- Single-centre randomised cross-over trial, USA. 13,347 patients

- **Balanced-crystalloids significantly lower incidence** of **Major Adverse Kidney Events** within 30 days (MAKE 30)
- (4.7% vs. 5.6%; adjusted odds ratio, 0.82; 95% CI, 0.70 to 0.95; P = 0.01). Number needed to treat 111

SMART 2018. NEJM 2018

Trial:

- RCT. USA. 5 ICU's. 15,802 critically ill patients randomised
- **MAKE 30 – significantly greater in saline group**
- **Large and strong methodological study adds further doubt to the safety of normal saline use in critically ill patients.**
- **Plasmalyte / Hartmans 1st choice!**

Evidence: Colloids

- **Starches:**
  - **CHEST 2012** – compare 6% HES vs 0.9% Saline for fluid resuscitation. Starch-based fluids **NO mortality benefit** and lead to **increased renal dysfunction** requiring renal replacement therapy.

  - **6S trial 2012**– patients with severe sepsis assigned to fluid resuscitation with HES 130/0.42 had an **increased risk of death** at day 90 and were more likely to require renal-replacement therapy, as compared with those receiving Ringer's acetate

- **Gelatins:** no major studies done. More expensive / anaphylactic than crystalloid. Unclear future roles?

Medicines REVIEW

- Any drug that can affect kidney directly or alter perfusion needs review
- Simply adjusting, stopping certain drugs may prevent AKI!
- Only 60% of patients have their medicines review within 24h of AKI alert on audit!

‘Sick Day Rules’

Barnsley Hospital Quality in Care

Barnsley Hospital NHS
NHS Foundation Trust

Medicine sick day guidance

When you are unwell with any of the following:

- Vomiting or diarrhoea (unless only minor)
- Fevers, sweats and shaking

Then **STOP** taking the medicines listed overleaf

Restart when you are well (after 24-48 hours of eating and drinking normally)

If you are in any doubt, contact your pharmacist, GP or nurse

‘Sick Day Rules’

Medicines to stop on sick days

ACE inhibitors:	medicine names ending in “pril” eg. *lisinopril, perindopril, ramipril*
ARBs:	medicine names ending in “sartan” eg. *losartan, candesartan, valsartan*
NSAIDs:	anti-inflammatory pain killers eg. *ibuprofen, diclofenac, naproxen*
Diuretics:	sometimes called “water pills” *eg. furosemide, spironolactone, indapamide, bendroflumethiazide*
Metformin:	a medicine for diabetes

Originally developed by NHS Highland

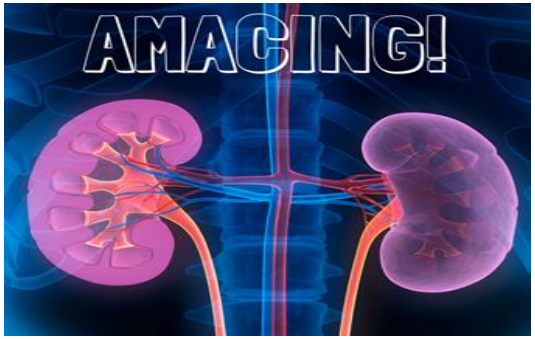
Community

- People who are at risk of AKI - **made aware** of causes
- **Educate** patients regarding hydration and advice on sick day rules during acute episodes of illness
- Consider **temporarily stopping** ACEI , ARBs, metformin, diuretics or NSAIDs when patients have diarrhoea, vomiting or sepsis
- **Communicate** effectively about changes in medicines (or not)

GP-based team role & AKI

- **Monitor the use of medicines** (and combinations) that are potentially nephrotoxic eg, ACEi/ARB with an NSAID and spironolactone
- **Monitor GFR** at least annually in people prescribed drugs known to be nephrotoxic for example calcineurin inhibitors (eg, ciclosporin, tacrolimus), lithium and NSAIDs
- **Monitor renal function** one week after introducing ACEI, ARB and spironolactone and in patients with CKD: trimethoprim and loop diuretics
- **Post AKI Reviews:** no consensus on follow-up -> 1month compromise

Contrast-Induced AKI Prophylaxis:



Nijssen Lancet 2017

- Compared no CI-AKI prophylaxis to intravenous 0.9% saline in high risk AKI patients

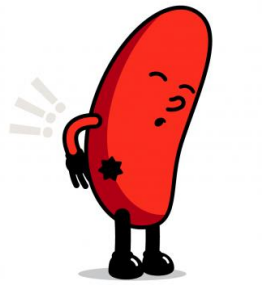
5.5% had complications in IV hydration group, such as symptomatic heart failure (4.0%), hyponatraemia (0.3%) and arrhythmias (1.2%)

Not receiving prophylaxis was non-inferior and cost saving in preventing CI-AKI compared with IV hydration

- NICE – **not** recommend IV prophylaxis in everyone!

AKI Diagnosis

- Fluid Balance Monitoring
  - Urine output parameters
  - Why accurate fluid balance monitoring is so important!
- AKI e-Alerts
  - Response to NHS England 2014 alert
  - Rise in serum creatinine relative to baseline



Identifying AKI from Urine Output

Low Urine output per AKI criteria **<u>requires medical escalation</u>**

- Stage 1: <0.5ml/kg/hr for 6hr
- Stage 2: <0.5ml/kg/hr for 12hr
- Stage 3: <0.3ml/kg/hr for 24hr or anuria 12hr

- Urine output may be an early indicator of a problem, therefore **<u>always</u>** ensure that it is monitored as accurately as feasible

Patient Safety Alert

Stage Three: Directive

Standardising the early indentification of Acute Kidney Injury

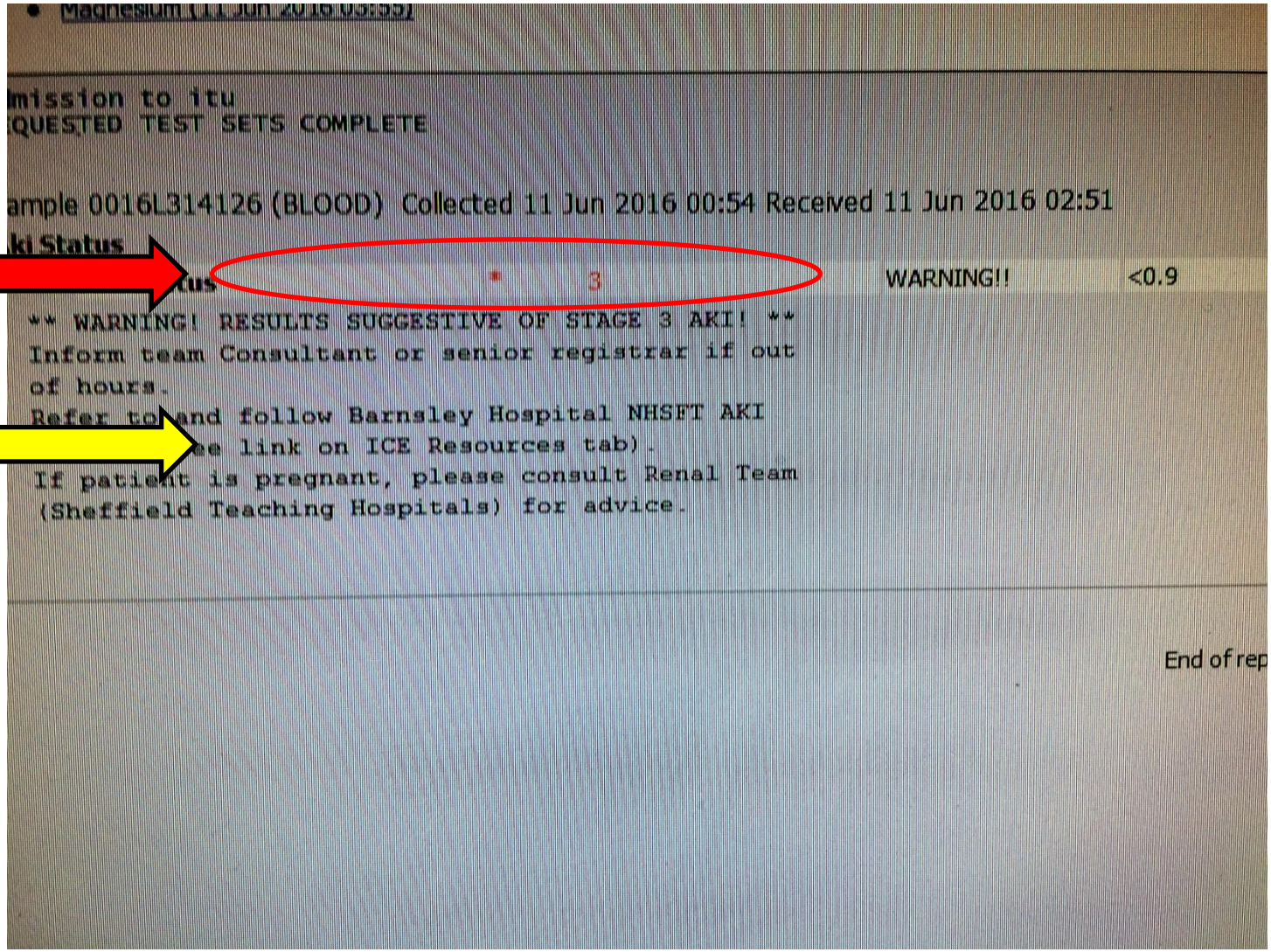
9 June 2014

Alert reference number:	NHS/PSA/D/2014/010
Alert stage:	Three - Directive

ICE: AKI e-alert

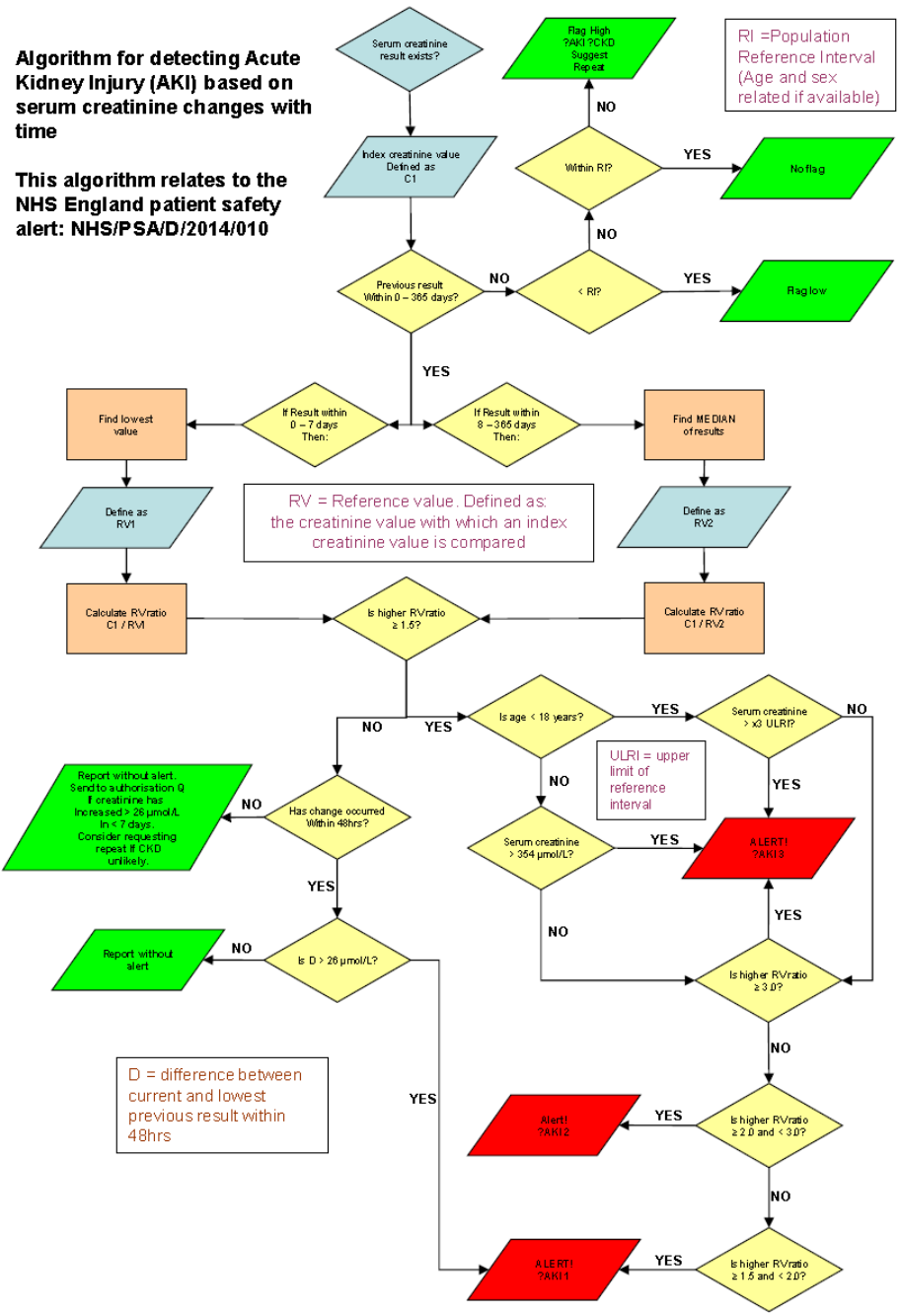
AKI Stage 1, 2 or 3

Action Message



Algorithm for detecting Acute Kidney Injury (AKI) based on serum creatinine changes with time

This algorithm relates to the NHS England patient safety alert: NHS/PSA/D/2014/010



Algorithm Key Points

Creatinine Measured **(C1)**

C1 compared to previous results on ICE to determine baseline change

If **previous result** within 0-365 days

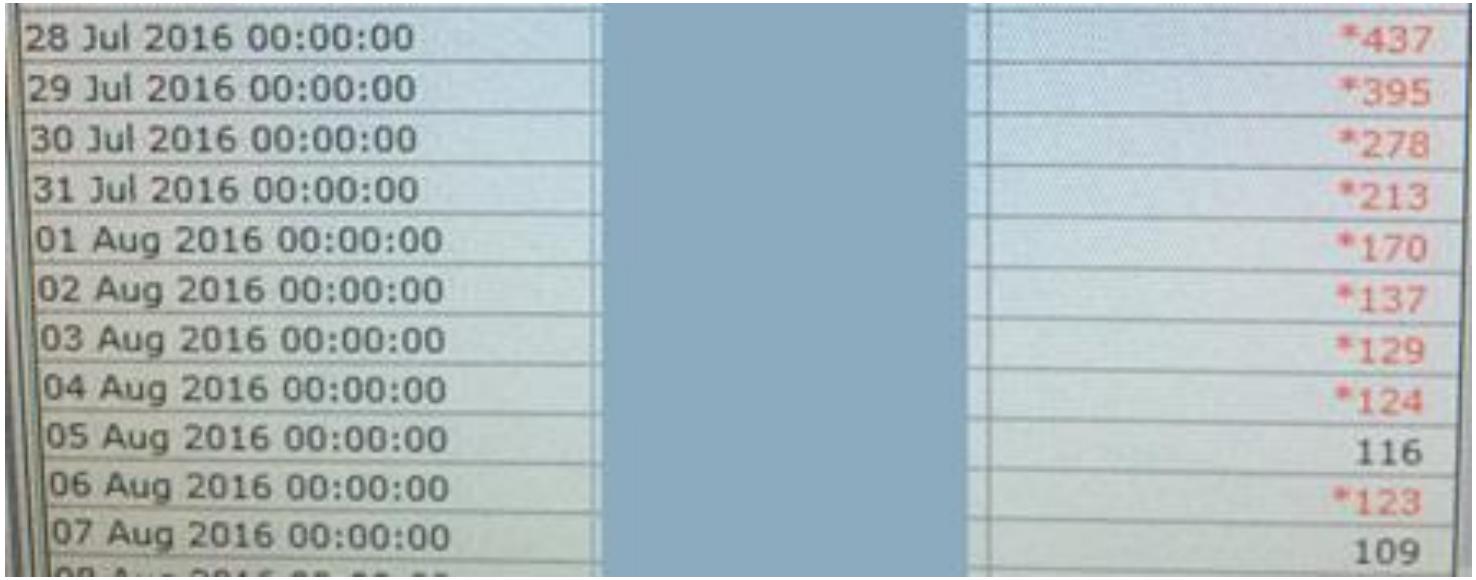
- **Within 0-7days** = Lowest creatinine value used for baseline
- **Within 8-365days** = Median creatinine used for baseline

Ratio of creatinine (C1:reference) rise then assessed for AKI Stage

If NO previous result within 365 days but C1 is greater than reference index for population then flagged ?AKI or CKD. Repeat sample suggested

https://www.england.nhs.uk/wp-content/uploads/2014/06/psa-aki-alg.pdf

Case: AKI Recognition / Monitoring



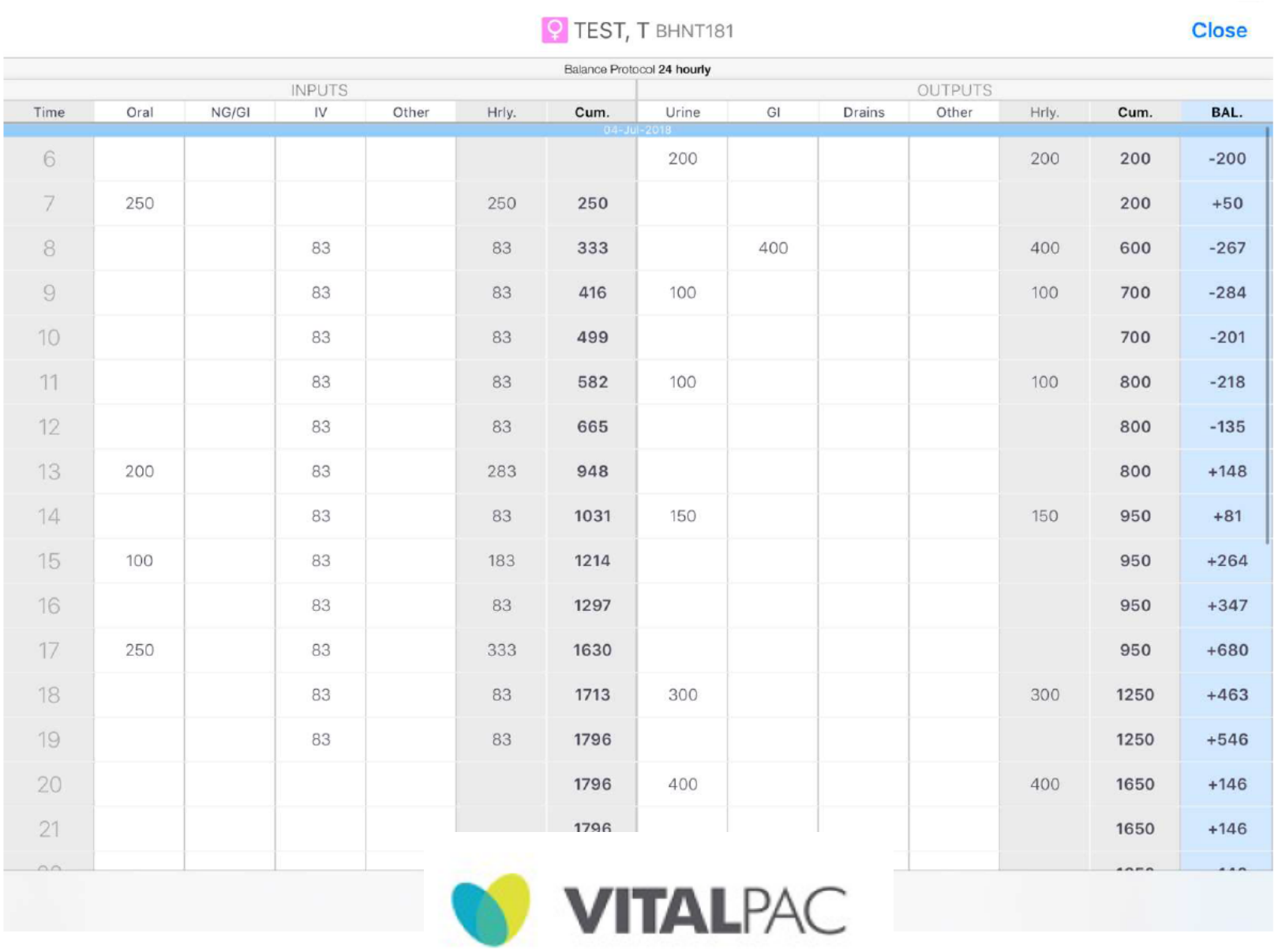
28 Jul 2016 00:00:00	*437
29 Jul 2016 00:00:00	*395
30 Jul 2016 00:00:00	*278
31 Jul 2016 00:00:00	*213
01 Aug 2016 00:00:00	*170
02 Aug 2016 00:00:00	*137
03 Aug 2016 00:00:00	*129
04 Aug 2016 00:00:00	*124
05 Aug 2016 00:00:00	116
06 Aug 2016 00:00:00	*123
07 Aug 2016 00:00:00	109

Cr

28 Jul 2016 00:00:00	*3
29 Jul 2016 00:00:00	*3
30 Jul 2016 00:00:00	*2
31 Jul 2016 00:00:00	*2
01 Aug 2016 00:00:00	*1

AKI

Fluid Balance Charts



♀ TEST, T BHNT181

Close

Balance Protocol **24 hourly**

	INPUTS						OUTPUTS						
Time	Oral	NG/GI	IV	Other	Hrly.	Cum.	Urine	GI	Drains	Other	Hrly.	Cum.	BAL.
04-Jul-2018													
6							200				200	200	-200
7	250				250	250						200	+50
8			83		83	333		400			400	600	-267
9			83		83	416	100				100	700	-284
10			83		83	499						700	-201
11			83		83	582	100				100	800	-218
12			83		83	665						800	-135
13	200		83		283	948						800	+148
14			83		83	1031	150				150	950	+81
15	100		83		183	1214						950	+264
16			83		83	1297						950	+347
17	250		83		333	1630						950	+680
18			83		83	1713	300				300	1250	+463
19			83		83	1796						1250	+546
20						1796	400				400	1650	+146
21						1796						1650	+146

VITALPAC

AKI Management

- STOP-AKI
- AKI Bundles
- AKI Complications
- Renal Replacement Therapy (RRT)

IMMEDIATE MANAGEMENT

STOP-AKI

S - Sepsis

T - Toxins

O - Optimise BP

P - Prevent Harm

AKI Bundles:

- Growing evidence of benefit when used with e-alerts
- Traditional designs associated with poor uptake in UK (only 22% uptake in one study at best)
- Need to design ways to improve / adapt how bundles are used everyday -> change behaviour

Patient Details Affix Sticker
Name:

Hosp Nos:

Date of Birth:

Acute Kidney Injury (AKI) Care Bundle

Barnsley Hospital NHS
NHS Foundation Trust

For AKI & Electrolyte (e.g. high K+) Emergency Guidance
See Trust Intranet -> click A-Z -> AKI, Fluid & Electrolytes Folder

Initial AKI e-Alert = **1 / 2 / 3** (Please circle)

Assess

- ABCDE
- NEWS / Fluid Balance / Kardex
- True AKI? ***Could this be sepsis?***
- Review bloods (U&Es, FBC).
- Venous blood gas (Lactate/Bicarbonate)

Y	N	Date & Time Done **Assess**

Act

- If Sepsis -> Start SEPSIS 6 Bundle
- Urinalysis -> if Blood+ & Protein+ on dipstick ?Intrinsic cause)
- Correct Low BP / ? **Fluid Challenge**
- Bladder Scan / ? Urinary Catheter
- Treat AKI Complications **NOW!**

Y	N	Date & Time Done **Act**

Analyse

- Stop / Adjust Medication: 'Sick-Day' Rules -> (e.g. ACEi/ NSAIDS / ARBs/ Diuretics / Gentamicin / avoid Contrast)
- If Obstruction suspected or unclear cause: Ultrasound or non-contrast CT KUB
- Intrinsic Renal Screen (Seek **Senior approval.** ICE request: see immunology)

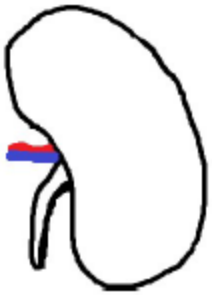
Y	N	Date & Time Done **Analyse**

Kidney Cause

(Please Circle likely cause if known)

PRE (60%)

Sepsis
Hypovolaemia
Heart Failure
Hepatorenal
Low BP (2º Drugs)



INTRINSIC (10%)

Acute Tubular
Tubulointerstitial
Glomerulonephritis
Myeloma
Vasculitis

POST (30%)

Kidney Stones
Prostatic Hypertrophy
Tumour / Retroperitoneal Fibrosis

AKI Complication: (Please Circle):
Encephalopathy
Acute Pulmonary Oedema
High Potassium (K+)
pH <7.2 or HCO3 <15mmol/L

Intervention

- New AKI?
- Inform Acute Response Team (ring 717 or 718)

Do you need to escalate?

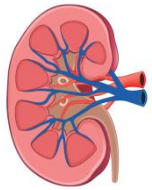
Parent team: Consultant / ST3+
Renal (Sheffield)
Critical Care (2nd call 462)
Urology
(Please Circle who contacted)

Date & Time Done	

RE-ASSESSMENT PLAN:

ART Seen?: Y / N

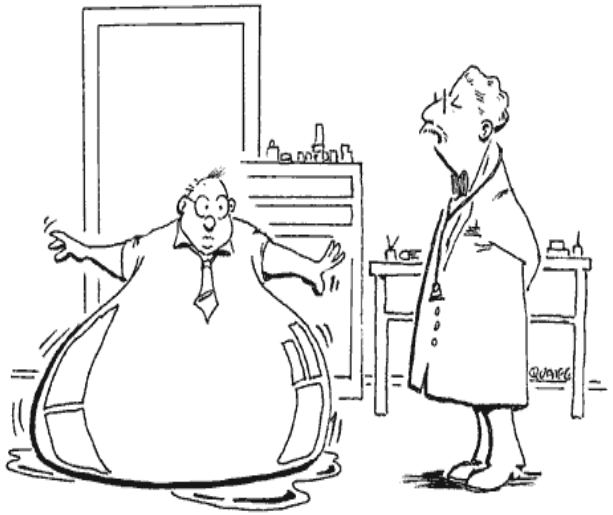
AKI Bundle Version 1.
August 2018
Lobaz / George



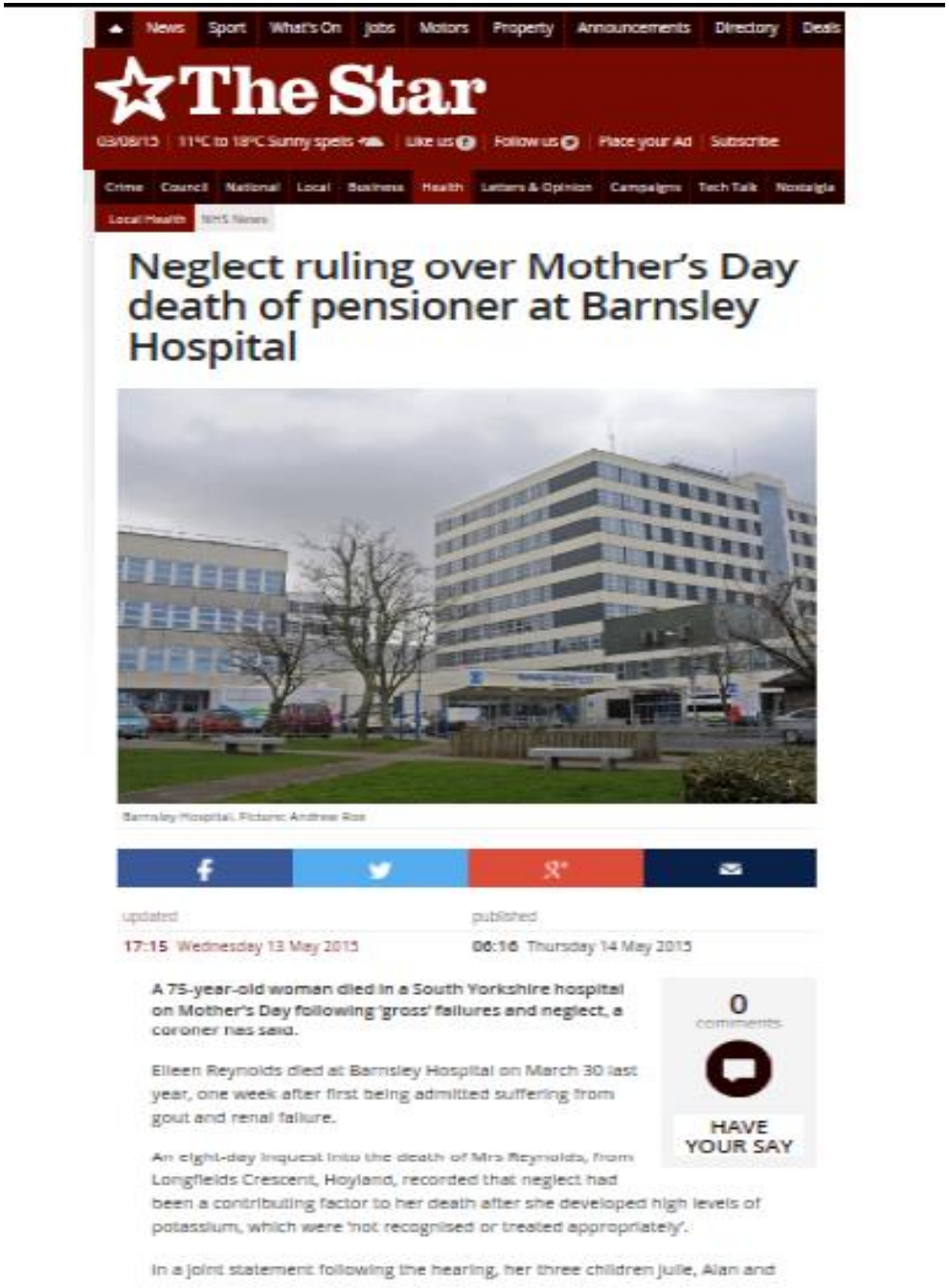
AKI: Complications

- Severe Hyperkalaemia (K+>6.5mmol/L)
- Acidosis (pH <7.2, HCO3 <15mmol/L)
- Uraemic complications (encephalopathy, pericarditis)
- Pulmonary Oedema / Overload

- Other Electrolyte Issues
- RRT may be needed to resolve!



Your tests reveal that you are retaining fluids!



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Local Health NHS News

Neglect ruling over Mother's Day death of pensioner at Barnsley Hospital

Barnsley Hospital. Picture: Andrew Roe

updated 17:15 Wednesday 13 May 2015

published 06:16 Thursday 14 May 2015

A 75-year-old woman died in a South Yorkshire hospital on Mother's Day following 'gross' failures and neglect, a coroner has said.

Eileen Reynolds died at Barnsley Hospital on March 30 last year, one week after first being admitted suffering from gout and renal failure.

An eight-day inquest into the death of Mrs Reynolds, from Longfields Crescent, Hoyland, recorded that neglect had been a contributing factor to her death after she developed high levels of potassium, which were 'not recognised or treated appropriately'.

In a joint statement following the hearing, her three children Julie, Alan and

0 comments

HAVE YOUR SAY

Potassium Maintenance / Replacement

- Assess current fluid balance booklet. What previously had? What are the patients most recent U&Es?
- Always check concurrent drug kardex (?concurrent oral replacement e.g. SandoK)
- NO FASTER than 10mmol/hr
- E.g. 20mmol/L over 2hrs, 40mmol/L over 4hrs MAX
- ALWAYS DELIVER via a FLUID PUMP
- If in maintenance fluid (0.18% saline / 4% glucose): GIVE NO FASTER THAN 100ml/hr
- Seek help early if problems or if you are unsure!
- If hyperkalaemia identified intervene quickly

Severe Hyperkalaemia (K^+ >6.5mmol/L)

- **ABCDE Approach** / Resuscitate / Senior Support / Critical Care
- **Confirm** Hyperkalaemia (repeat Lab bloods / ABG)

- **Cardiac Protection:**
  - Identify any Acute ECG Changes
  - 10% Calcium Gluconate iv 30ml or 10% Calcium Chloride iv 10ml over 5 min
- **Shift K+ INTO cells:**
  - 10 units Actrapid iv / 50ml 50% Glucose (large vein) (125ml 20% Glucose or 250ml 10% Glucose) over 15min
  - Salbutamol 5mg Neb back to back (up to 10-20mg)
  - Sodium Bicarbonate 1.26% or 1.4% 500ml over 2-4hr if pH <7.2 (discuss with senior first)
- **Remove K+ from the body:**
  - Calcium Resonium (30g PO, 15g QDS and Laxative or Rectal Enema 30g to retain >6hr)

- **Escalation:** Dialysis / Renal and Critical Care / AKI bundle

Renal Replacement Therapy

GAMBRO

Medication Dosing whilst on CRRT

- Pharmacokinetics of drugs in critically ill requiring CRRT complex
- Disease state: increase Vd, extend drug half-life, alter protein binding capacity
- Difficult to make generalised dosing recommendations
- Mechanical process may affect drug clearance
- Modern CRRT result in Creatinine clearance 25-50ml/min
- Fluconazole (high clearance on CRRT), Vancomycin (narrow therapeutic window) closer monitoring

Case: Discharge & Follow-up

STAGES OF ACUTE KIDNEY INJURY (AKI) (D) - 3

HAS MEDICATIONS BEEN REVIEWED (AKI) (D) - yes

FOLLOW UP BLOODS REQUIRED (AKI) (D)
Yes
Please continue to monitor U&E

FREQUENCY OF BLOOD TESTS (AKI) (D) - 7-14 Days

FOLLOW UP PLANS – HOSPITAL & ACTIONED (D) - TWOC Clinic

FOLLOW UP PLANS – GP AND COMMUNITY (D)
Yes
Please continue to monitor renal function. UEs in 1 week please

MEDICATION ON ADMISSION (D)
furosemide
cocoadamol
amlodipine
clopidogrel
doxazosib
metformin
pioglitazone
ramipril
ranitidine
simvastatin

Perfect Discharge D1!

Local Initiatives

- Hospital:
  - e-alerts, AKI Bundle -> real-time review
  - Fluid Management Vital Pac
  - Dashboards
  - Education / Training
  - Special: Obstetrics / Paediatrics
  - Renal Registry reporting

- Community:
  - e-Alerts
  - Education
  - AKI Working Group (target high risk populations)
  - GP Guidance Pathway / Post-AKI Care

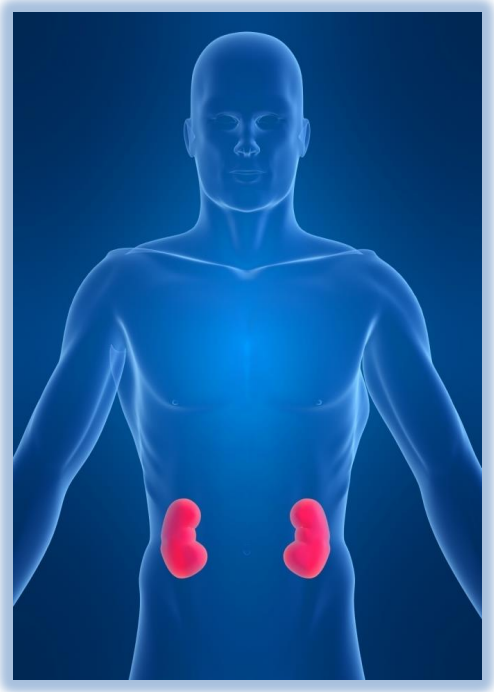
CCG Pharmacy AKI workstream

- Targeted Patient Reviews:
  - CKD4 or CKD3 & proteinuria
  - History of AKI
  - Episode of AKI as an inpatient

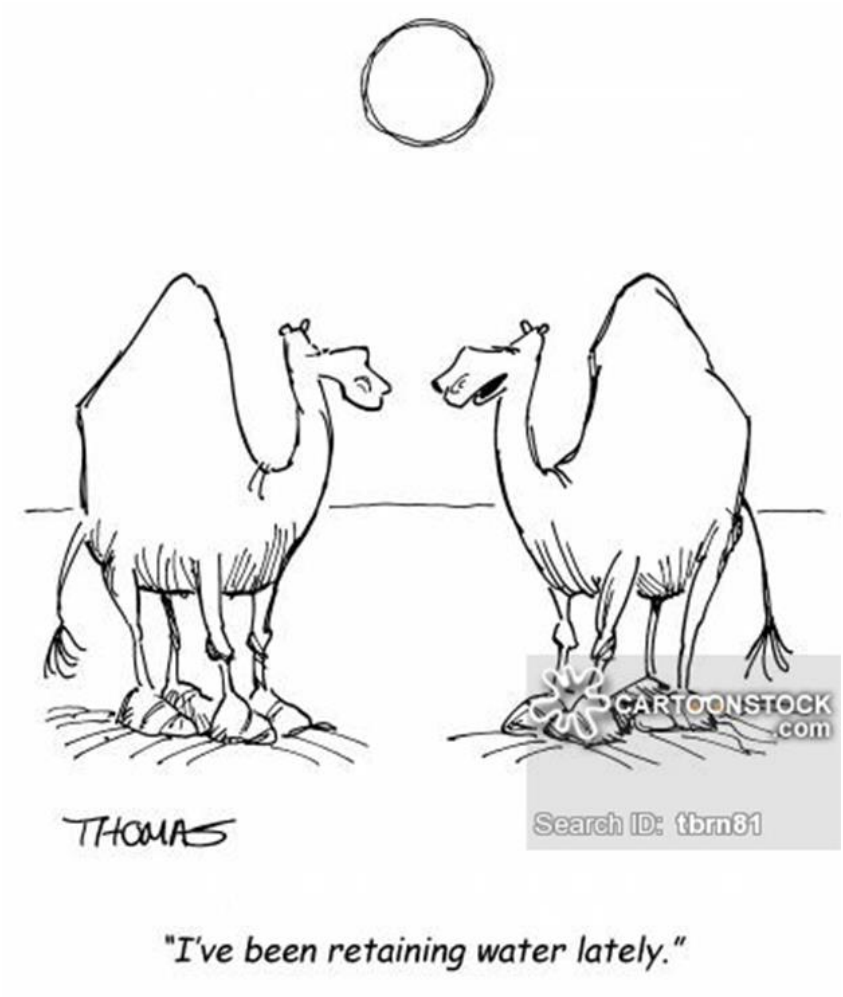
- Prompt Medicines review / follow-up
- Sick-Day Rules advice

Summary: AKI

- **Primary Care**
  - **Simple advice = prevent significant harm!**
  - Medication review
  - Targeting high risk patients
- **Secondary Care**
  - **Prevention, early recognition, escalation and intervention will save lives!**
  - AKI Bundle, AKI e-alerts
  - Sick-Day Rules
  - Fluid Management



Any Questions?



Think Kidneys is a national programme led by NHS England in partnership with UK Renal Registry

https://www.thinkkidneys.nhs.uk/aki/

iSpyAKI