Acute Kidney Injury cases

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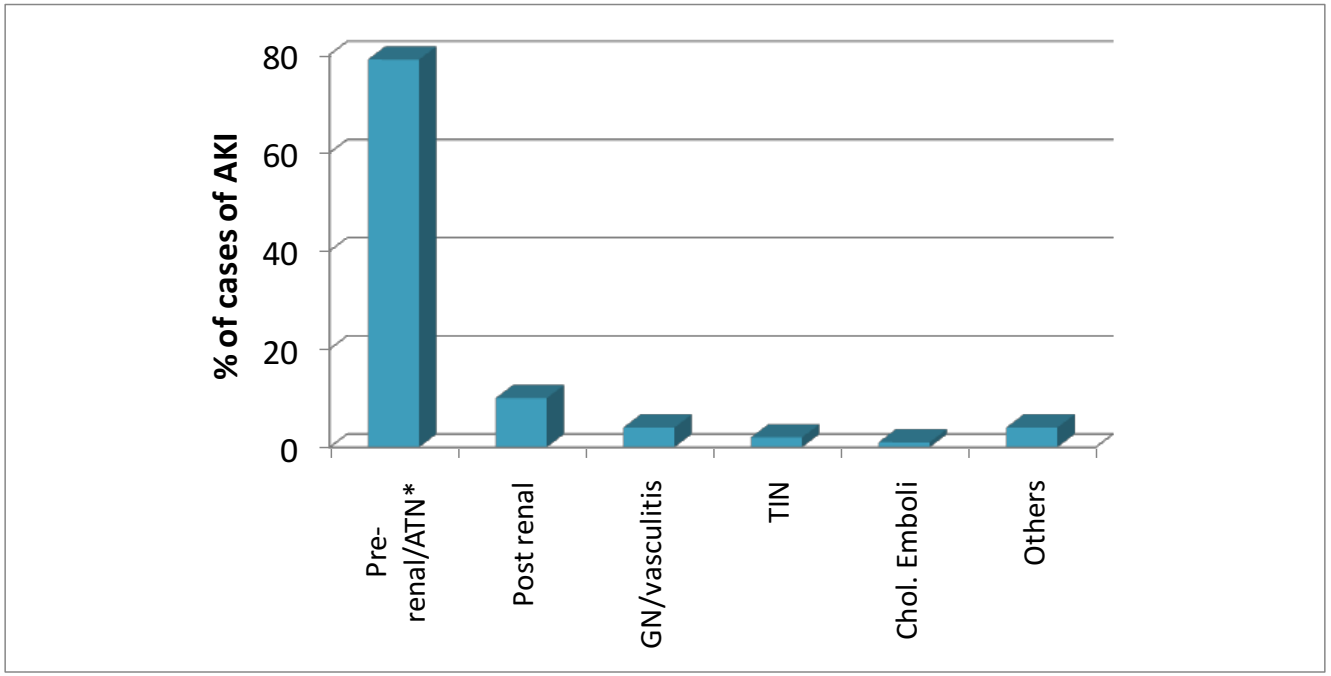
NHS Foundation Trust

Causes of in-hospital AKI



Pre-renal/ATN
(80% of cases)

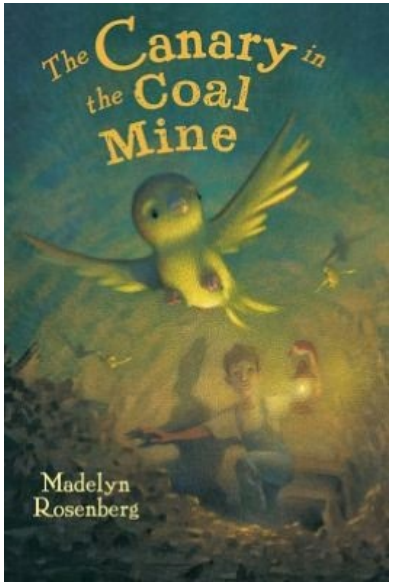
Post-renal obstruction
(5-10% of cases)

*ATN (ischaemic and toxic)

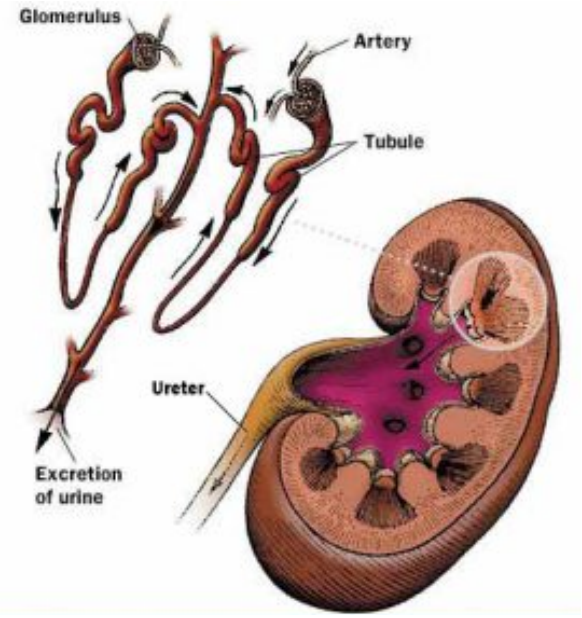
Liano F; Pascual J. Kidney Int 1996 Sep;50(3):811-8.

Two sides of AKI

- Secondary to acute illness
- Force multiplier



- Specific kidney disease



Causes of AKI

Pre-renal/ATN

(80% of cases)

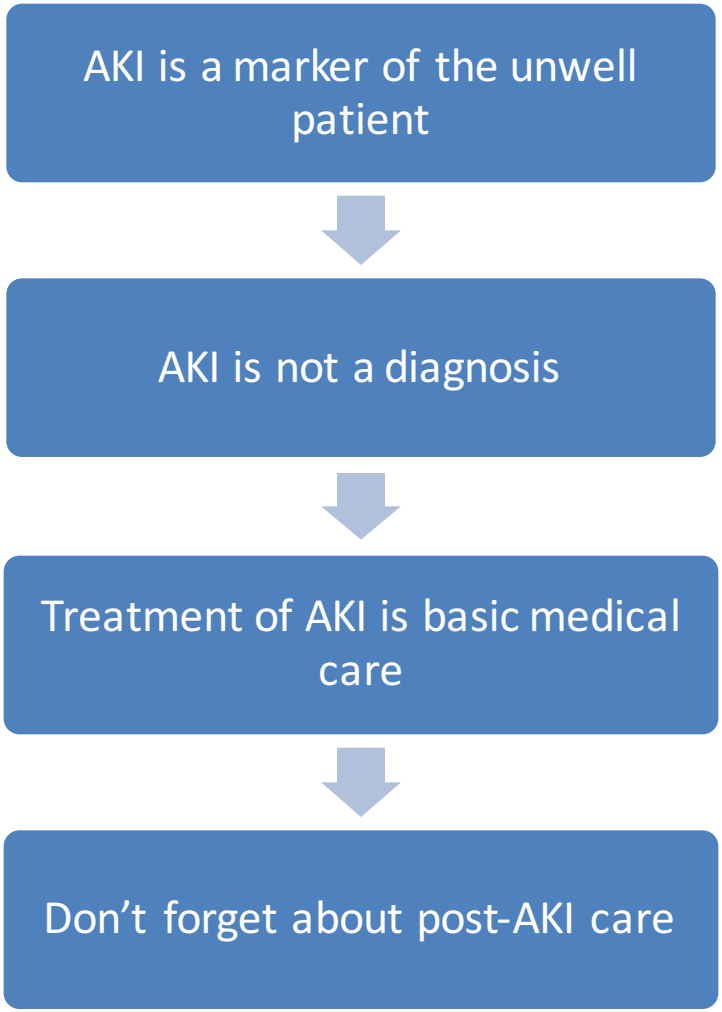
Drug induced TIN

Inflammatory renal disease

Myeloma

Post-renal obstruction (*10% of cases)*

Approach to AKI



- Spot unusual features
- Dip the urine
- Rule out intrinsic dis and obstruction

- Go back and reassess
- Don't ignore the deteriorating patient

GD, 87M

- PMH
  - ‘Early dementia’ – recent-onset cognitive impairment & hallucinations
- DH
  - Furosemide 40mg OD, vitamin B injection every 3/12
- SH
  - Carers TDS, no ETOH, walks ½ mile 3x/week for shopping (independently mobile)

GD, 87M

- Presented to ED with confusion
  - Seen by son 20:30 previous night, left with water to drink
  - Carers attended and found drowsy/confused

- GCS 14/15 on arrival
- Then 11/15…

GD, 87M

- Presented to ED with confusion
  - Seen by son 20:30 previous night, left with water to drink
  - Carers attended and found drowsy/confused
  - 2/7 previously carers had found glass of blue fluid at table (thought to be washing up liquid)
  - Subsequently antifreeze found with 150ml missing
  - Son also found fertiliser and screen-wash in cabinet

- GCS 14/15 on arrival
- Then 11/15
- Then 5/15…

GD, 87M

- O/E:
  - RR 22, Kussmaul resps
  - Chest clear on auscultation, sats 98% (on air)
  - Abdomen soft, non-tender
  - BP 155 systolic
  - Diminished reflexes, no focal neurology
  - Clinically dry but peripheries well perfused
  - BM 4.8

- ECG: sinus tachycardia CXR: unremarkable

- ABG:
  - pH 7.11, HCO 8.3mmol/l, pC02 3.1kPa, pO2 14.5kPa
  - BE -21.2, Lactate >20mmol/l

Anion gap

$= Na^{+} – Cl^{-} – HC03^{-}$

(normal range 8-14)

→ Anion gap 39

Lactate >20

Raised anion gap	
G	Glycols (ethylene glycol) and toluene
O	Oxoproline (pyroglutamic acid)
L	L-lactate
D	D-lactate
M	Methanol
A	Aspirin
R	Renal failure
R	Rhabdomyolysis (rare)
K	Ketoacidosis (diabetes, starvation, alcohol)

Lactic acidosis

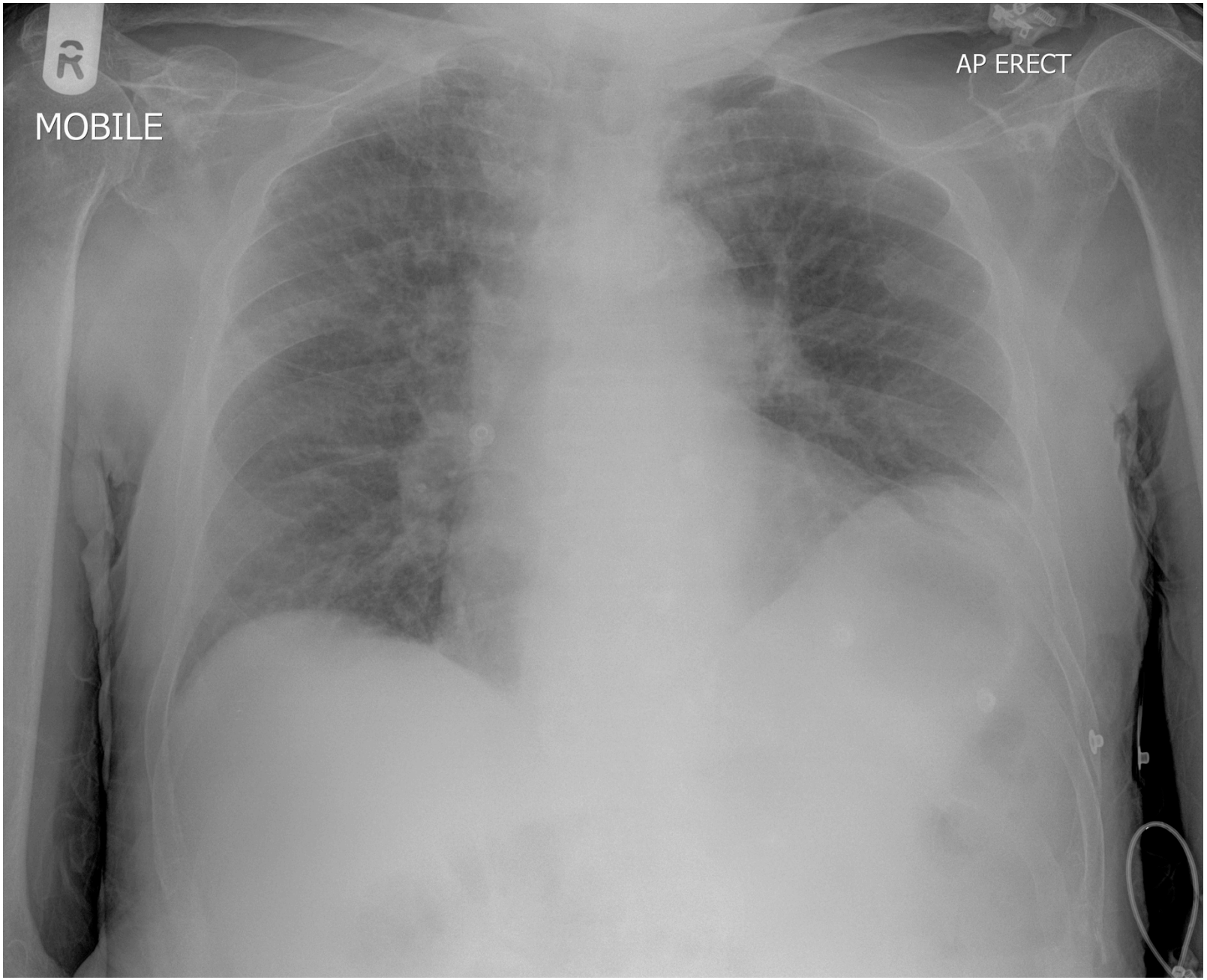
Type A

Tissue hypoperfusion

Type B

Absence of systemic hypoperfusion

- Metformin
- Chronic alcoholism
- Malignancy (mechanism not clear)
- HIV
- Mitochondrial dysfunction (including linezolid and HAART)


R
MOBILE
AP ERECT

GD, 87M

- Bloods:
  - Na 137, K 5.5, Urea 8.8, Creatinine 193, glucose 4.4

    (22/05/14 – Creatinine 90, eGFR >60)

  - Measured osmolality 311 (calculated 283.2)
  - Osmolar gap = 27.8 (expected <10)

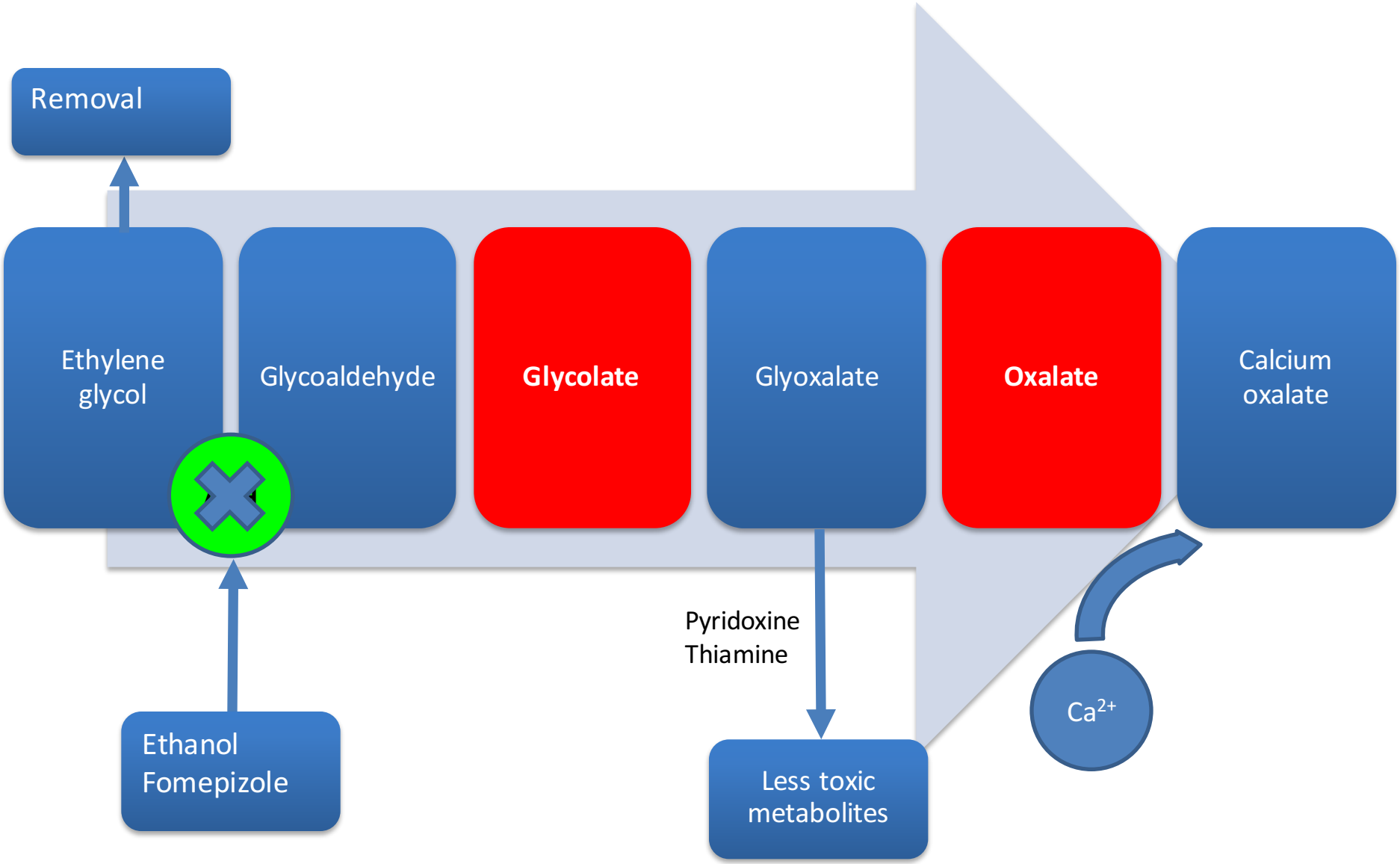
- Ethylene glycol level = 393mg/dl
  - Salicylate/paracetamol normal
  - INR 1.3

- Reason for raised lactate?

Initial management of ethylene glycol poisoning

1. Don’t wait for drug level before commencing Rx
2. Correct acidosis with IV sodium bicarb (Jacobsen Med Toxicol 1986)
3. ADH inhibition
4. Consider dialysis
5. Give co-factors

Metabolism of ethylene glycol



GD, 87M

- Fomepizole commenced (15mg/kg loading dose)
- Immediate transfer for HD via femoral line

- Dose: 1mg/kg/hr during dialysis & change to 10mg/kg every 12hrs off dialysis

- *If no fomepizole: give Ethanol*

  IV – difficult to dose, aim 1/3 of ethylene glycol levels or >100mg/dl

  NG or oral as last resort

Day 2

- BP 85/39, HR 76
- Further fluid resuscitation

- 12:30pm
- On ivi. BP 96/52 on HD, AF to SVT rate 150, given Mg^{2+} & 1L saline
- BP drops to 60 systolic, SVT/flutter. 50J DCCU performed – SR. Further 100J as reverted, responded. Subsequently loaded with amiodarone.
- Rpt VBG: pH 7.23, Lac 10.5, HCO 14. CVC R IJV inserted.
- BP 130/80, HR 80. Put back on HD, no fluid off, low bicarb.

GD, 87M

- 16:25
- Rpt level = 60

- VBG: pH 7.29, Lac 5.1, HCO 18.7, BE -7.3

- Further dialysis:
- Post VBG – pH 7.34, Lac 1.2, HCO 24.2, BE 0.1

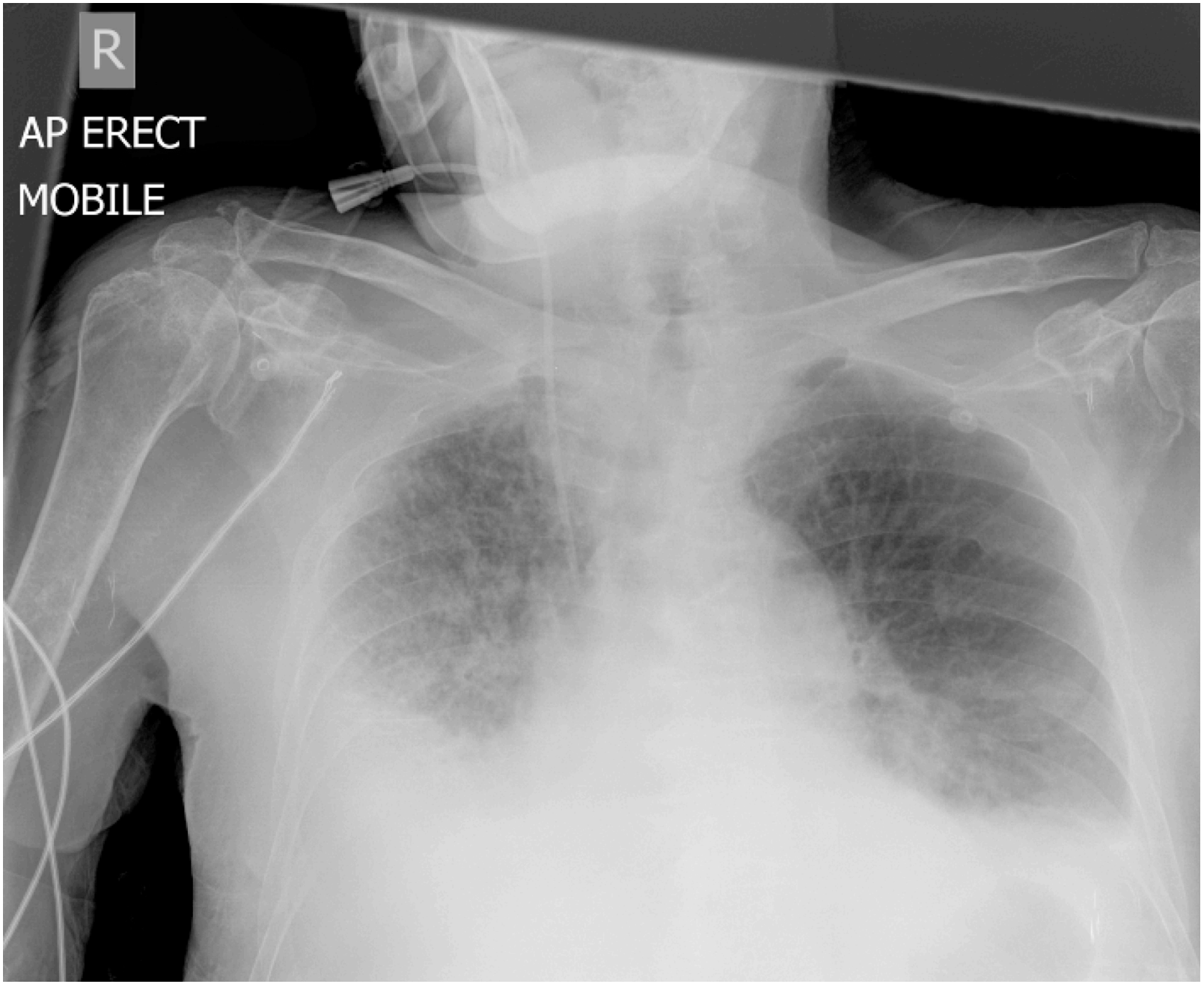
GD, 87M

Day 3

- Fluctuating GCS continued, fomepizole stopped

- Remained oligoanuric

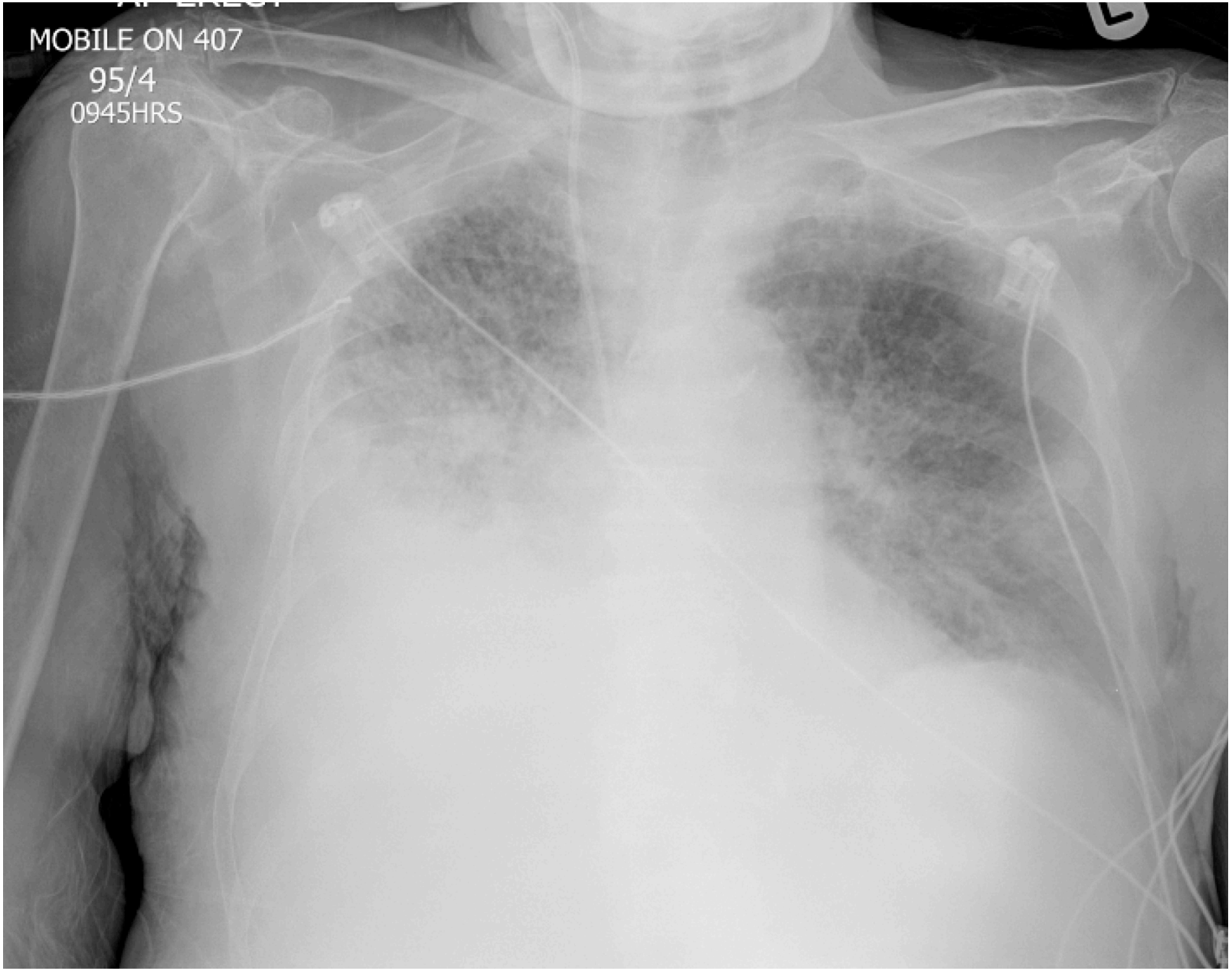
- Acute desaturation to 65%, to 91% on 15L
- ABG: pH 7.35, pO2 4.5, Lac 1.7, HCO 22.0, BE -2.9
- CXR: fluid/infection, started on taz & furosemide (had 200mg iv)


R
AP ERECT
MOBILE

GD, 87M

- Seen overnight – new acidosis pH 7.26, pCO2 6.8, pO2 7.6, lac 0.9, started on CPAP

- Significant respiratory distress next day…

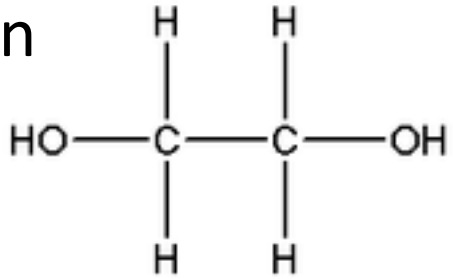

MOBILE ON 407
95/4
0945HRS

GD, 87M

- Further HD but no response
- Kept comfortable on ward with family input

Ethylene glycol

- (1,2-Ethanediol)
- Molecular weight 62.07 (cf. methanol 32.04, ethanol 46.7)
- 0.5-0.8L/kg distribution
- 80% hepatic, 20% renal excretion
- Half-life 3 to 8 hours



- Found in:
  - Car antifreeze, brake fluid, de-icer
- Rapidly absorbed from gut
- Inhalation/skin absorption not so concerning

Ethylene glycol poisoning

- No data on UK episodes but 5300 cases reported to American Association of Poison Control Centres in US in 2012

- >0.1g/kg pure ethylene glycol = medical assessment
- >0.15g/kg (0.13ml/kg) = likely antidote required
- Fatal dose: 90ml pure ethylene glycol

- 75kg male = 9.75ml
- GD potentially drank 150ml
- Serious toxicity reported from as little as 8g

Ethylene glycol poisoning

- Initial high osmolar gap >20 mOsm/L
  - Low molecular weight serum substance
  - Higher than ketoacidosis or lactic acidosis (<20)
- Followed by falling osmolar gap & rising anion gap
  - Glycolic acid metabolite produced
- Important factors
  - Dose ingested & time to antidote

Ethylene glycol poisoning

- ***Stage 1 (30 mins – 12 hrs) = neurological***
  - *Apparent intoxication (but no ethanol breath)*
  - *N&V, coma and convulsions (often focal)*
  - *CNS effects: nystagmus, ataxia, ophthalmoplegia, papilloedema, hypotonia, hyporeflexia, myoclonic jerks, tetanic contractions, CN palsies (II, V, VII, VIII, IX, X, XII)*

- ***Stage 2 (12-24 hrs) = cardiopulmonary***
  - *Tachypnoea, sinus tachycardia, hypertension*
  - *Arrhythmias*
  - *Pulmonary oedema and CCF develop*

Ethylene glycol poisoning

- ***Stage 3 (24-72 hrs) = renal dysfunction***
  - *Flank pain, renal angle tenderness, ATN, hypocalcaemia*
  - *Calcium oxalate monohydrate crystalluria, hyperkalaemia and hypomagnesaemia develop*
  - *Severe metabolic acidosis, hyperkalaemia, seizures and coma carry poorest prognosis*

Treatment – HD

- Indications:
  - Metabolic acidosis
  - Renal impairment
  - Ethylene glycol level >50

- HD versus CVVH

Treatment – Monitoring

- To continue fomepizole until level <50 mg/L
  AND acidosis/toxicity signs resolved

- OR ethylene glycol level undetectable

EG poisoning clues

- If similar presentation to alcohol but no smell
- Severe metabolic acidosis with raised anion gap
- Abnormally high lactate with lab discrepancy
- Abnormally high osmolar gap

Case

In-Patient

Out-Patient

DATE & TIME

CONTINUATION NOTES

PRINT NAME DESIGNATION & BLEEP NO. ALONGSIDE SIGNATURE

5/7/12

2005

PC

— ABNORMAL BLOODS

HPC

— SAW GP TODAY WHO CHECKED

ROUTINE BLOODS — AKI +

FEELS WELL

NO RECENT ILLNESSES

NO DYSURIA / HAEMATURIA

E+D ✓

PMHx

— INVESTIGATED FOR WEIGHT LOSS 6/12 AGO — NAD

TLIPIDS

TBP

DHx

— AMLODIPINE 5mg

SIMVASTATIN 40mg

NKDA

Please refer all smokers to the local smoking cessation service
dchst.freshstart@nhs.net, 01332 861174, 0800 7076870

WPH 0028

Siemens Diagnostics
Clinitek Status

Patient Name:
Case 1

Multistix 10 SG

Test date	Not Entered
Time	10:00AM
Operator	_____
Test Number	0001
Color	Not Entered
Clarity	Not Entered

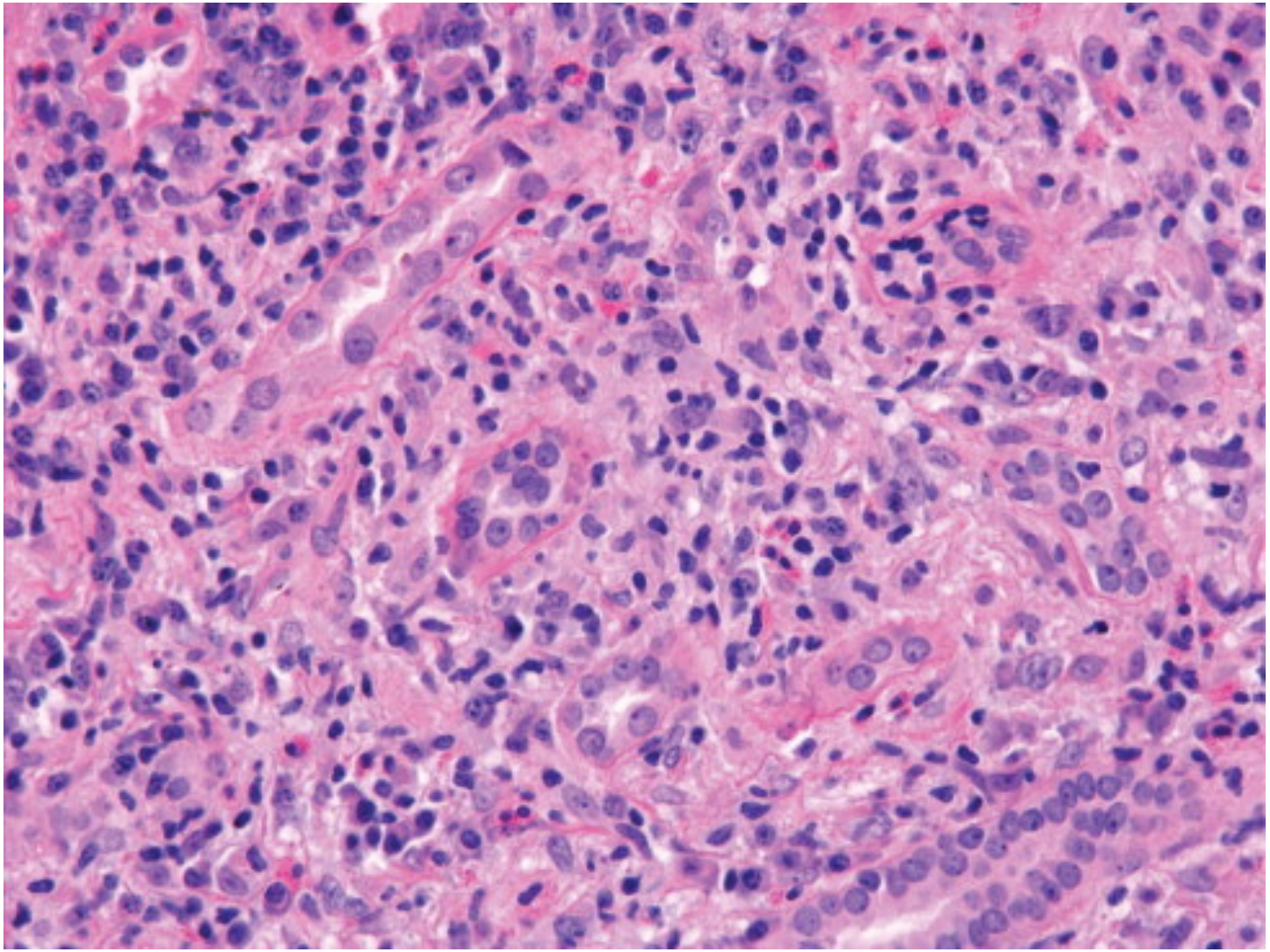
GLU	Negative
BIL	Negative
KET	Negative
BLO	Negative
PROT	30mg/dL
URO	0.2 E.U./dL
NIT	Negative
LEU	Negative

	Feb 2008	Mar 2010	Oct 2010	Nov 2011	4/7/12
Creatinine	82	87	97	93	246

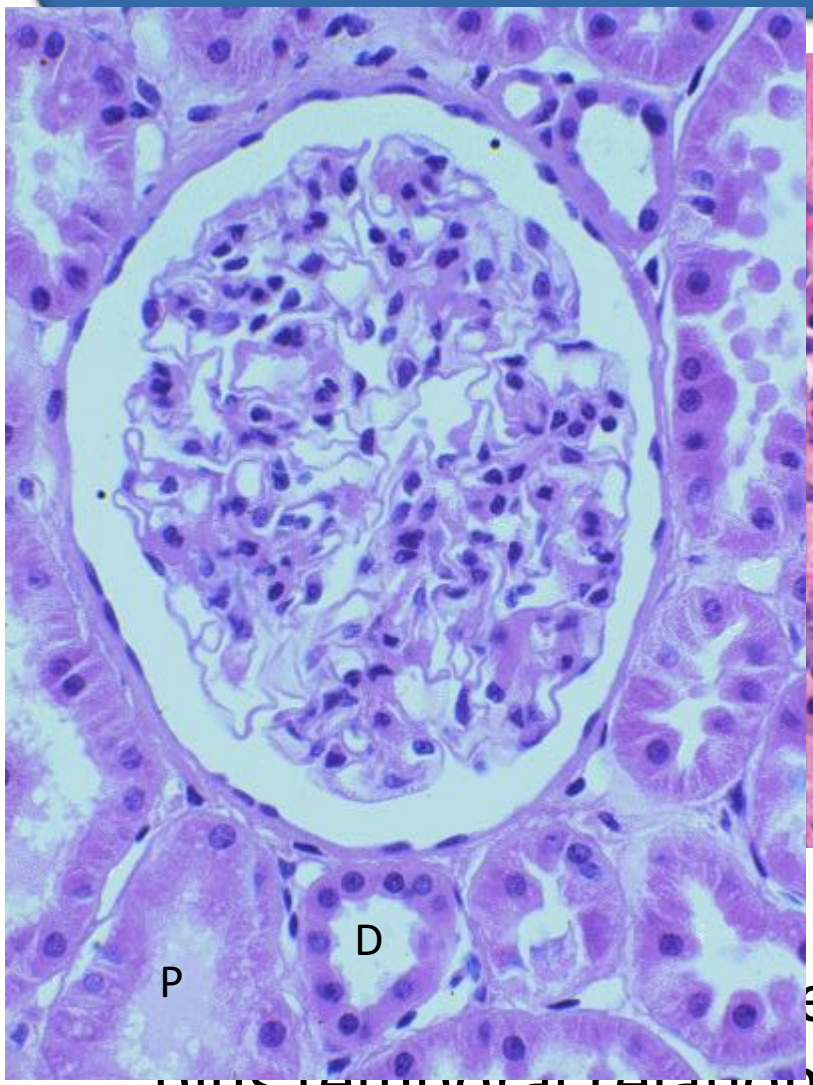
Subsequent investigations

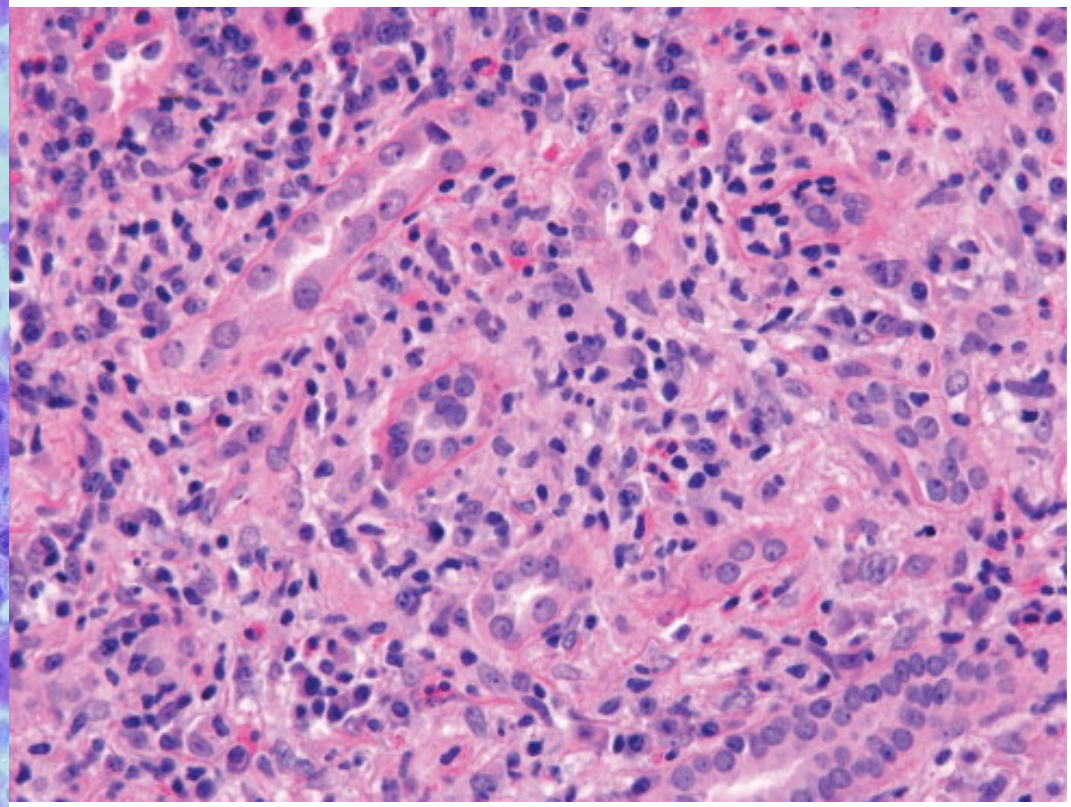
- Examination: normal
- U/S – normal appearance of kidneys with no evidence of hydronephrosis
- Myeloma screen –ve
- ANA and ANCA –ve

Renal biopsy: interstitial nephritis



Drug induced TIN

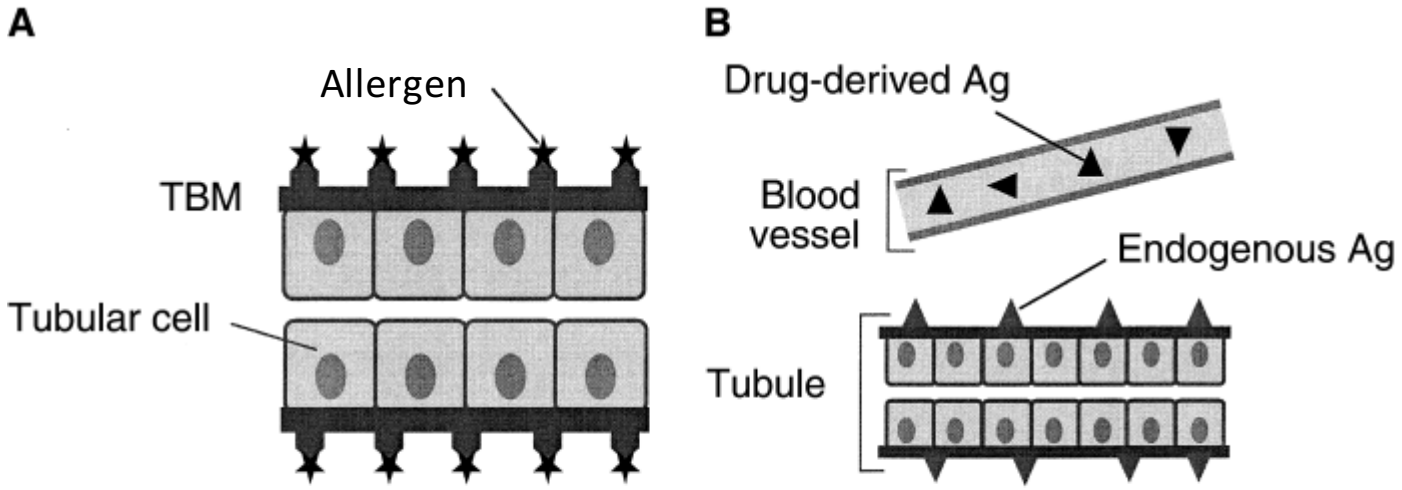




e is lack of other causes of AKI

plus temporal relationship with drug

Mechanisms whereby a drug (or one of its metabolites) can induce acute interstitial nephritis



(A) The drug can bind to a normal component of the tubular basement membrane (TBM) and act as an allergen.

(B) The drug can mimic an antigen normally present within the TBM or the interstitium and induce an immune response that will also be directed against this antigen.

Management of TIN

- Stop drug!
  - And make sure no re-exposure
- Steroids?
  - Lack of evidence
  - If severe
  - Without early improvement
  - Starting late associated with worse response

Drugs and AKI

- Very common and important cause/contributor to AKI
- Variety of mechanisms:
  - Pre-renal
    - *Diuretics, ACE inhibitors, NSAIDs*
  - Direct tubular toxicity
    - *Aminoglycosides, contrast media*
  - 'Allergic' – tubulo-interstitial nephritis
    - *Antibiotics, NSAIDs, PPIs, + many more*

  (Can also cause GN but rarer)

Case

- 43 male, referred from Burton CCU with AKI, shortness of breath and weight loss

- Unwell for 2-3 weeks with increasing SOB
- Ankle oedema
- Cough with dark brown sputum
- Weight loss

- PMH
  - Asthma
  - Nasal polyps

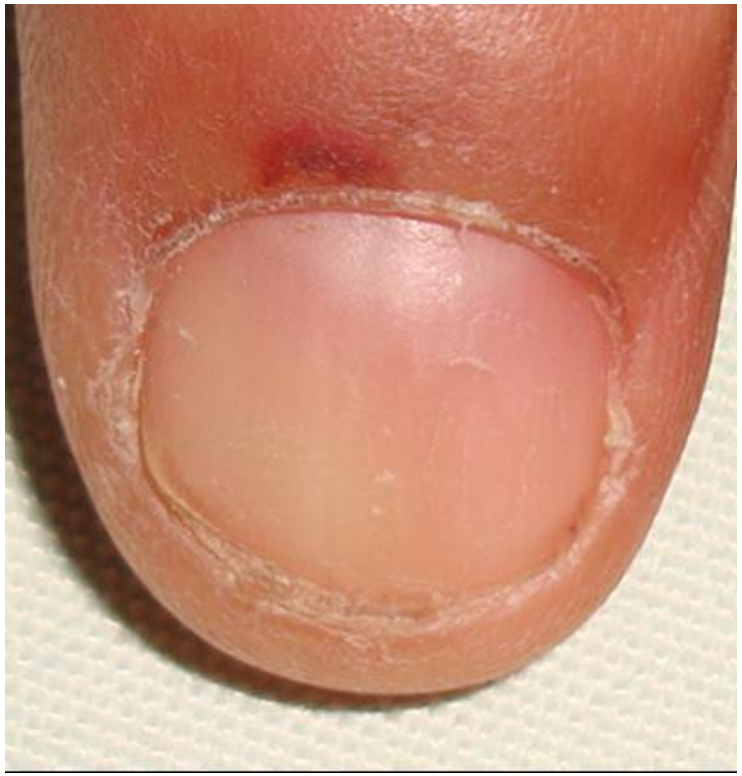
- DH
  - Symbicort

Examination

- BP 110/70
- HR 110
- Ankle oedema
- Gallop rhythm
- Expiratory wheeze
- Nail fold infarct

- Urine dip
  - Blood 4+
  - Prot 3+

- Blood tests from Burton:
  - Creatinine 178
    (was 91 two weeks ago)
  - Trop T 4915



ug-12 06:50	D Dimers.			
D Dimers		445	↑↑	[0-230 ug/
ug-12 19:15	**Full Blood Count.**			
Specimen Comment	⊞			
White Cells		10.32		[4.5-11.0 1
Red Cells		3.72	↓	[4.5-6.5 10
Haemoglobin		11.7	↓	[13.5-18.0
Haematocrit		0.333	↓	[0.42-0.52]
Mean Cell Volume		89.5		[80-100 fL]
Mean Cell Haemoglobin		31.5		[27-32 pg]
Mean Cell Haemoglobin Concentration		35.1	↑	[30-35 g/d
Platelets		538	↑	[150-450 1
Neutrophils AB		7.71	↑	[2.5-7.5 10
Lymphocytes AB		1.43	↓	[1.5-3.5 10
Eosinophils AB		0.43	↑	[0.04-0.4 1
Monocytes AB		0.72		[0.2-0.8 10
Basophils AB		0.03		[0.01-0.1 1

Aug-12 19:15	Routine Chemistry.		
Specimen Comment			
Liver Function Comment			
PROTEINS :			
Serum Calcium comment			
PROTEINS :			
Sodium	126	↓↓	[133-146 mm
Potassium	4.9		[3.5-5.3 mmo
Urea	19.8	↑↑	[2.5-7.8 mmo
Creatinine	169	↑	[70-120 umol
eGFR	39		[ml/min (cor)]
This eGFR = CKD stage 3.			
Bicarbonate	15	↓	[22-29 mmol/
Calcium	2.28		[2.20-2.60 m
Albumin Adjusted Calcium	2.47		[2.20-2.60 m
Phosphate	1.84	↑	[0.80-1.5 mm
Total Bilirubin	13		[0-21 umol/L
ALT	79	↑	[0-40 iu/L]
GGT	111	↑	[11-51 iu/L]
Total Protein	76		[60-80 g/L]
Albumin	30	↓	[35-50 g/L]
Globulins	46	↑	[25-41 g/L]
Alkaline Phosphatase	90		[40-129 iu/L]

[redacted]

ID:H01071051

19-AUG-2012 14:24:57

SDAH NHS TRUST

28-MAY-1969 (43 yr)
Caucasian

Loc:15

Vent. rate	114	BPM
PR interval	162	ms
QRS duration	106	ms
QT/QTc	338/465	ms
P-R-T axes	61 111 146	

[redacted]

Med:

Referred by:

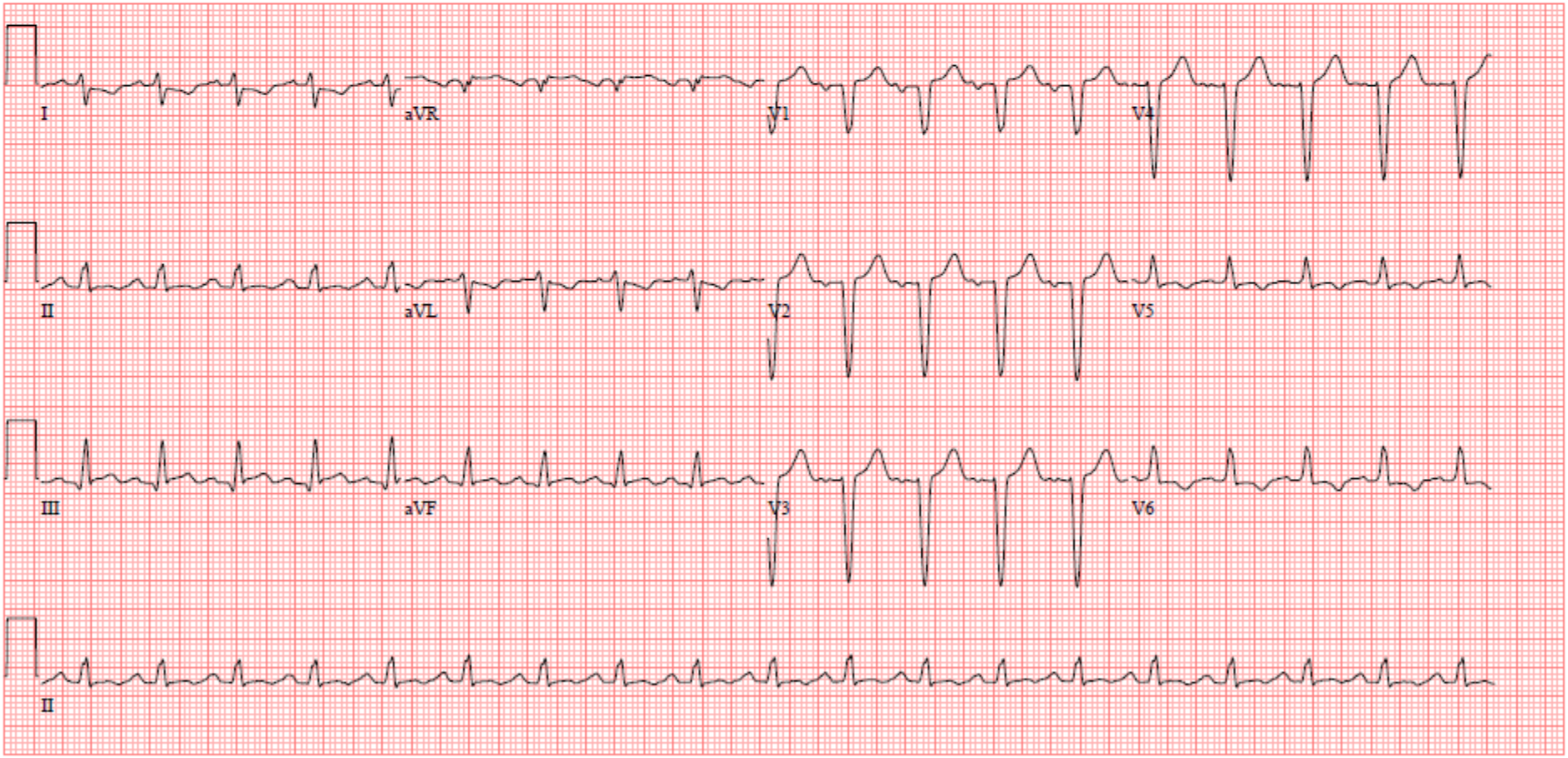
Confirmed By: REPORT PROVISIONAL

NURSE NAME:PAUL REED

WARD:407

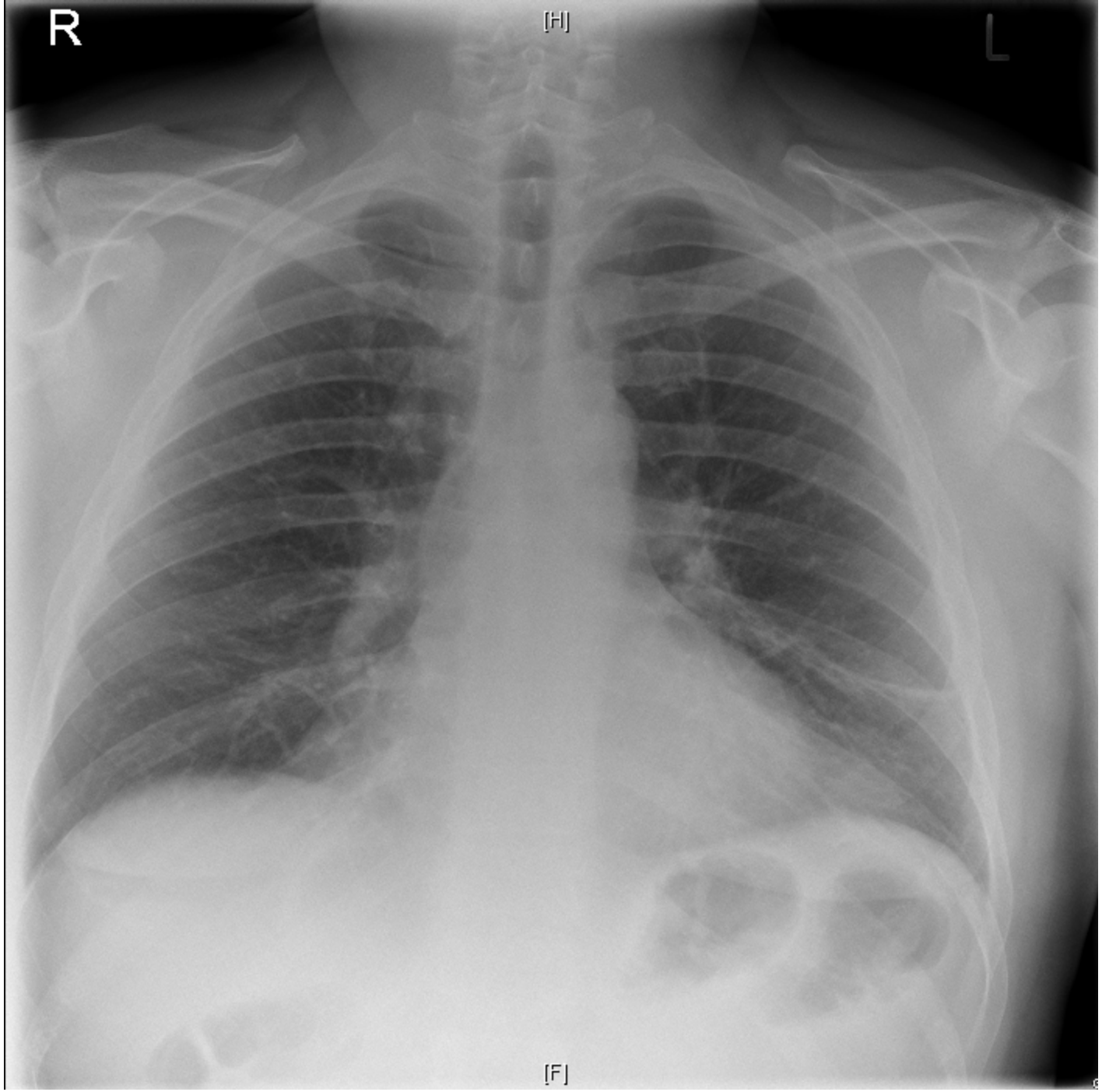
CONSULTANT:FLUCK

:



25mm/s 10mm/mV 40Hz 005E 12SL 231 CID: 68

EID:100 EDT: 13:48 23-AUG-2012 ORDER:


R
[H]
L
[F]

Summary and differential?

- AKI
  - Active urine dip
- Systemic symptoms
  - Cardiac involvement
  - Haemoptysis?
- Nail fold infarct
  - Small vessel inflammation
    - » Vessel lumen: Embolic, DIC, TTP, CAPS
    - » Vessel wall: primary vasculitis (incl. infection related and cryo)
- Abnormal bloods including eosinophilia

Primary vasculitis: Churg-Strauss Syndrome

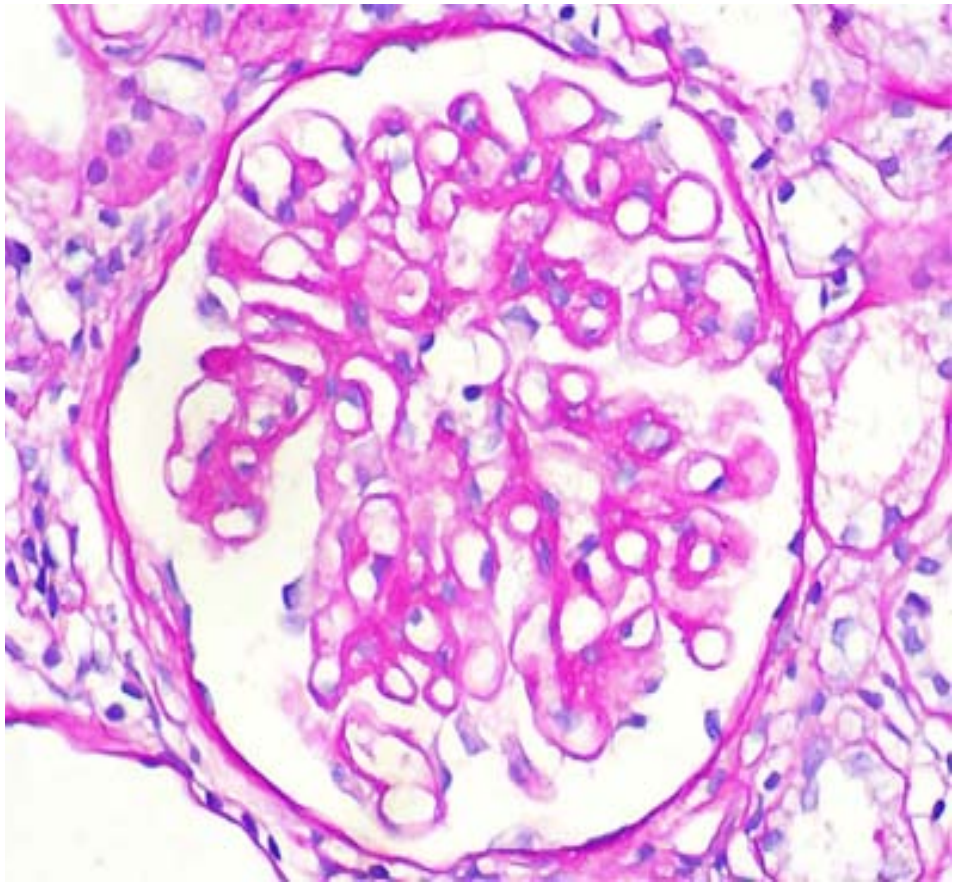
ANCA +ve

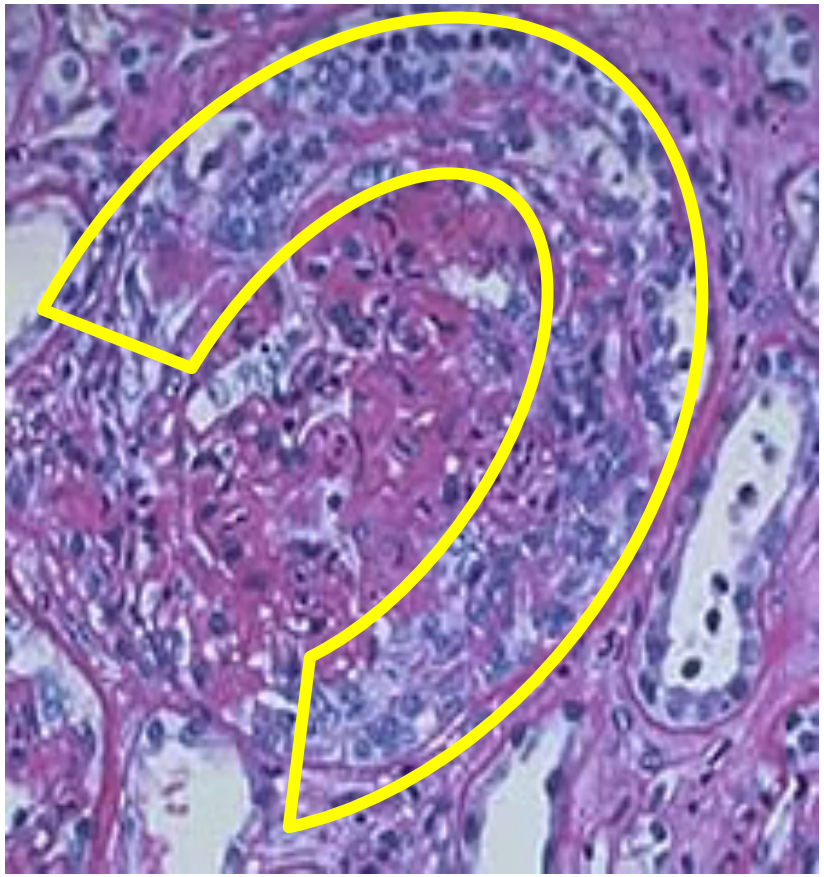
AKI and eosinophilia

- Acute TIN
- Cholesterol emboli
- Churg-Strauss syndrome

- DRESS syndrome
- Lymphoma
- Hypereosinophilic syndrome
- Schistosomiasis

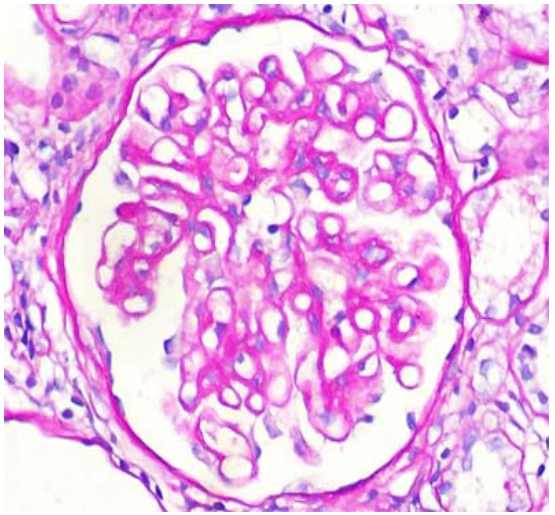
Crescentic glomerulonephritis

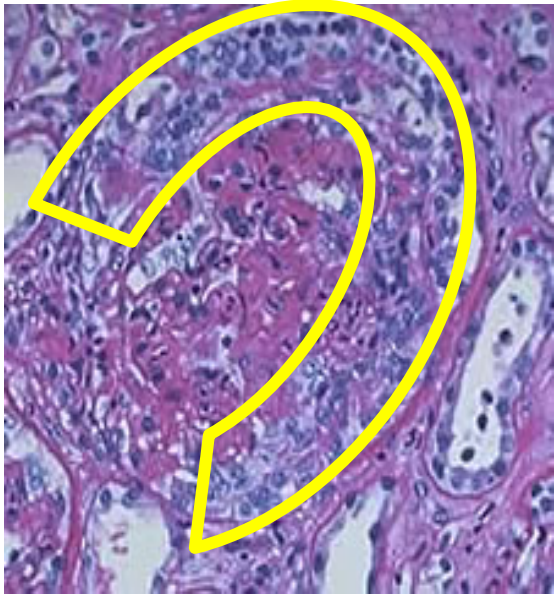




Subsequent progress

- Echo – severely impaired LV function with LV thrombus
- High dose steroids and cyclophosphamide
- Anticoagulated
- Good renal and cardiac recovery over following 6/12





‘Inflammatory’ renal disease

ACTIVE URINE

More than 2+ of blood and protein

VASCULITIC RASH

SYSTEMIC SYMPTOMS

Often present for months – myalgias, arthralgias, malaise

EPISTAXIS, SINUSITIS, HAEMOPTYSIS

Low platelets

ALWAYS DIP THE URINE

*Urine dip is **not** to look for infection, it's to help with diagnosis*

NAD

Pre-renal
Post-renal
Myeloma
Drug-induced TIN
(Renovascular)

Blood and protein

Still can be ATN, but raises the possibility of inflammatory renal disease
e.g. vasculitis

Proteinuria (PCR>3)

(=Protein loss>3g per day)

Definitely glomerular

Case

- 62yr male
- Admitted to MAU
- General decline over 2 months
- Loss of appetite, weight loss,
- PMH
  - Hypertension
- Meds
  - Bendrofluazide
  - Antacids

O/E

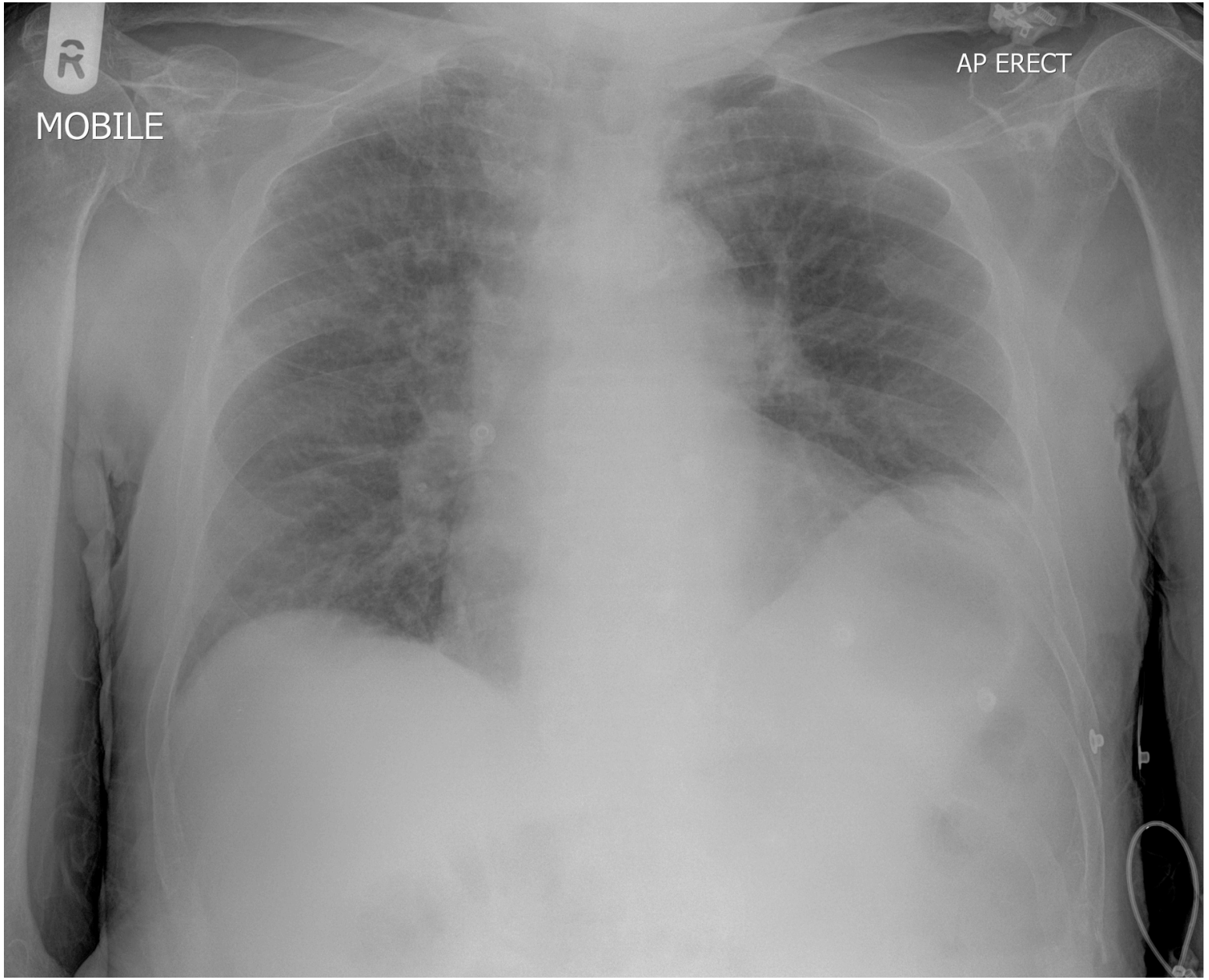
- Clinically dry
- BP 118/67
- HS normal
- Chest clear
- Abdo soft
- No abnormal neurological findings

Urine dip	
Blood	NEG
Alb	NEG
WBC	1+
Nitrites	NEG

Initial workup

Hb	11.1
WBC	11.2
Plt	268
MCV	89

Na	145
K	3.9
Urea	39
Creatinine	426 (previously 89)
Corrected Ca^{2+}	3.45
P04	1.9
Bil	5
AlP	180
ALT	55
Alb	32



→ Summary and differential diagnosis?

AKI and hypercalcaemia

- Hypercalcaemia itself can cause reduced GFR
  - 90% of hypercalcaemia is malignancy or primary hyperpara
  - Medications
- Specific conditions that involve the kidney and cause increased Ca^{2+}
  - Myeloma
  - Sarcoidosis
  - Lymphoma
  - TB

Initial Management

- Correct volume depletion
  - Normal saline
- Reduce plasma calcium levels
  - Bisphosphonates
  - Frusemide
  - Calcitonin
  - Steroids
  - Dialysis
  - Cinacalcet
- Stop relevant medications
  - Thiazide, antacids
- Initiate investigations

Further investigations?

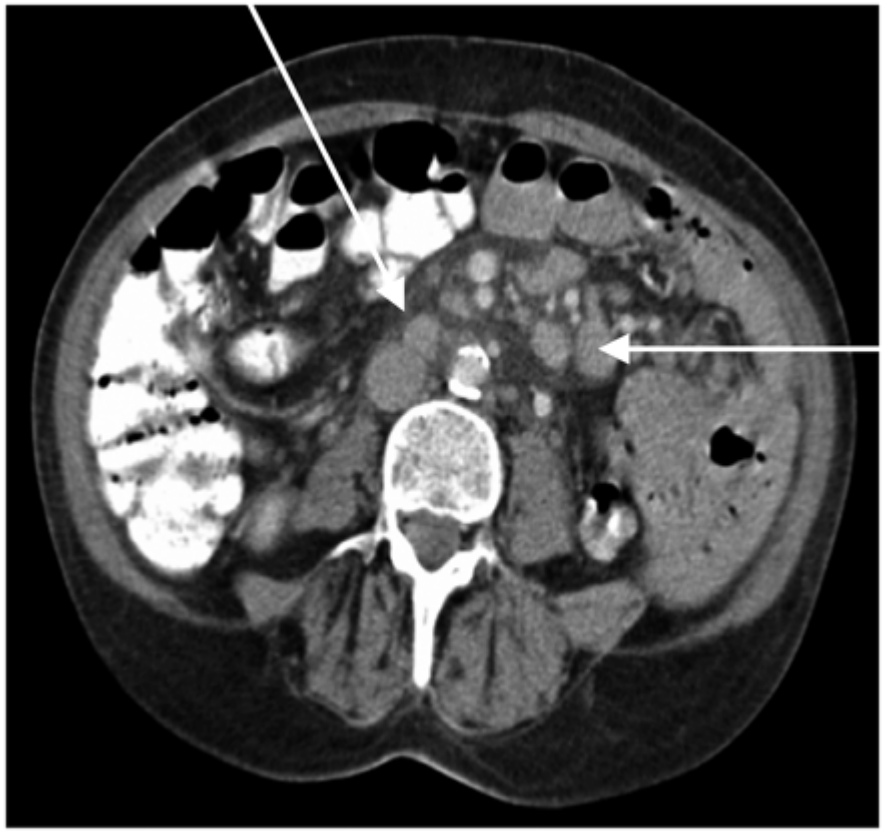
- PTH → 2pg/ml
- Myeloma screen → negative
- Imaging

Progress

- Calcium improved over 3-4 days with rehydration alone, 2.72mmol/l on day 4

- Creatinine also improved but stuck at around ~200

- Multiple enlarged lymph nodes
- Enlarged spleen
- Suspicious of lymphoma



- Haematology, surgical, radiology review

- Lymph node excision biopsy:

  Non-caseating granulomata consistent with sarcoid, no evidence of lymphoma

→ Prednisolone 50mg od, tapering course

Resolution of renal impairment over 8 weeks

Case

- 76yr old male
- PMH
  - CKD stage 3A
  - CCF (LVEF <35%)
  - Previous AKI episodes x2
- DH
  - Aspirin 75mg od
  - Frusemide 80mg bd
  - Ramipril 10mg od
  - Spironolactone 25mg od
  - Allopurinol 300mg od
  - Atorvastatin 40mg od
  - Omeprazole 20mg od

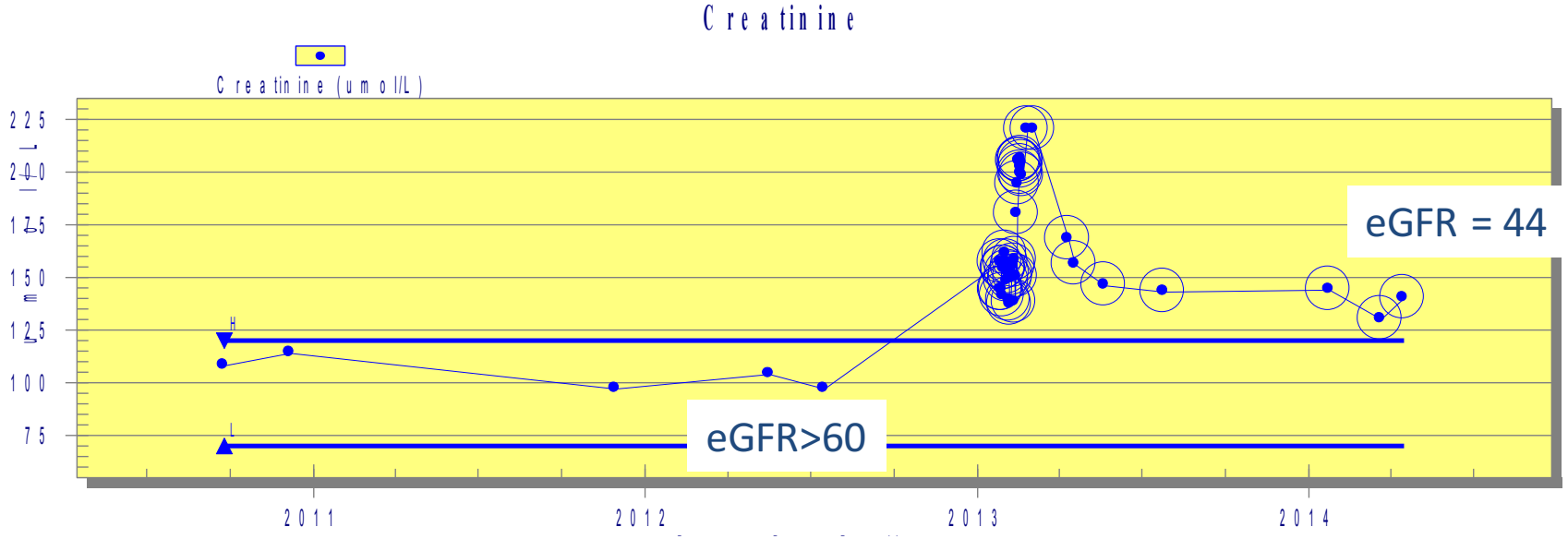
- Admitted with high temperature, vomiting and SOB
- BP 132/82
- Sats 93% air
- Crepitations R base
- CXR – right basal consolidation
- Creatinine 3 weeks ago 144
- Creatinine now 322

- All drugs stopped
- IV fluids
- IV ABs for community acquired pneumonia

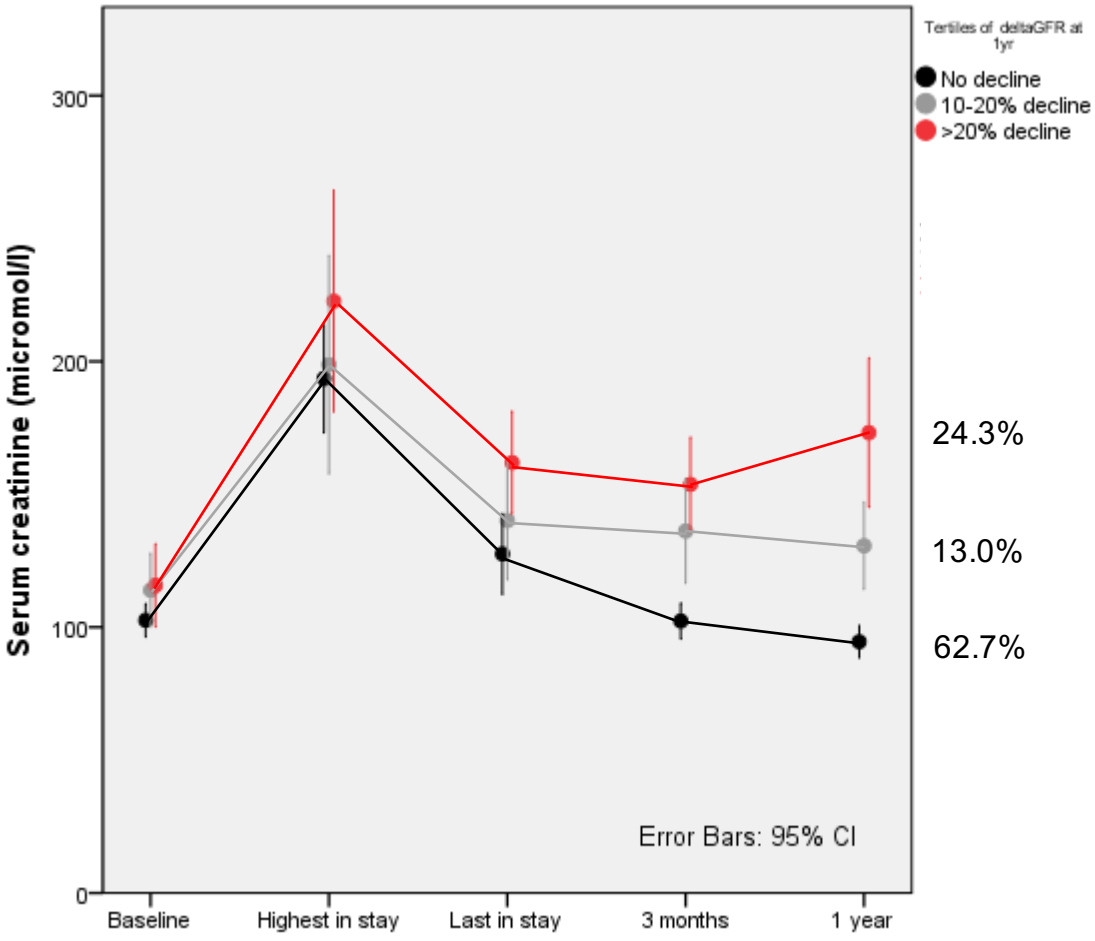
→ does well. Creatinine improves but settles at 201 after 5 days, K^+ 5.2mmol/l

patient ready for discharge

Serial creatinine plot



AKI leads to CKD *(in some people)*



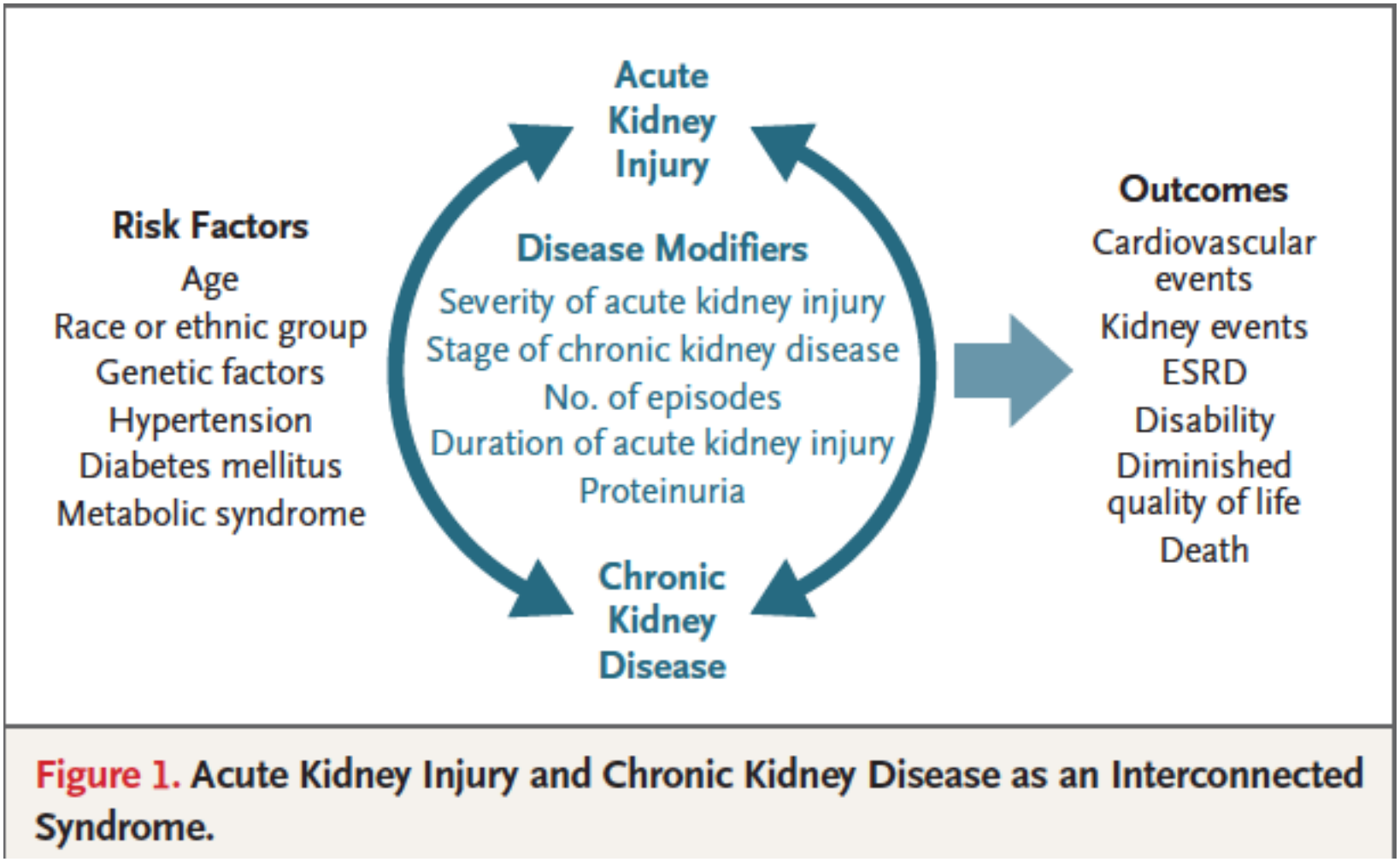


Figure 1. Acute Kidney Injury and Chronic Kidney Disease as an Interconnected Syndrome.

N Engl J Med 2014;371:58-66.

What is your post discharge plan?

- 76yr old male
- PMH
  - CKD stage 3A
  - CCF (LVEF <35%)
  - Previous AKI episodes x2
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  - Aspirin 75mg od
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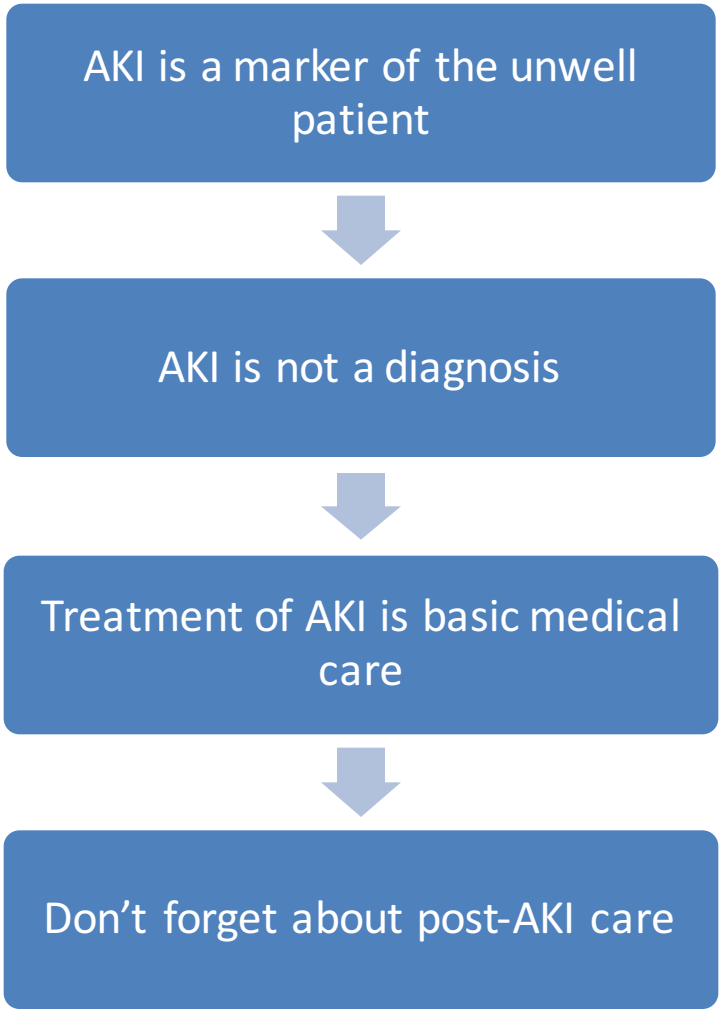
- Repeat U/Es – specify when?
- Restart meds – which ones and when?
- AKI avoidance advice
- Refer nephrology if non-recovery

Approach to AKI



- Spot unusual features
- Dip the urine
- Rule out intrinsic dis and obstruction

- Go back and reassess
- Don't ignore the deteriorating patient

Acute kidney injury cases

Dr Nick Selby
Consultant Nephrologist