

AKI Care Bundles

AKI Academy 2014

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Guy's and St Thomas' Foundation NHS Trust



Case 1

- You are called to the ward on Sunday morning
- 85 year old female from nursing home is unwell
- Admitted with 'mechanical fall' on Friday
- Presenting complaint
 - Increased confusion
 - Drowsiness
 - Treated for UTI by GP 1 week ago
- PMH
 - Dementia
 - Hypertension



Case 1

- Blood results

Hb	104	Na	149
WCC	13.5	K	6.3
Ptl	136	Cr	170
CRP	330		



Case 1

- Comment on Renal Function?



Case 1

- Creatinine 100 on admission
- Creatinine at baseline 55



Case 1

- With regards to managing her AKI
 - Diagnose the cause
 - Treat the precipitant /prevent worsening of AKI
 - Manage complications
- What 8 things will you make sure is done in the first 12 – 24 hours?



Case 1

1. Volume assessment and signs of sepsis
 - HR 105, thready pulse
 - BP 95/60
 - T 34.3
 - Feels cold and shutdown
 - Dry mucus membranes

1. Volume resuscitation
 - HR, BP and UO unresponsive to first bolus
 - Responsive to 2nd bolus and is passing urine

1. Treat hyperkalaemia
 - Trust guidelines (workshop to follow!)



Case 1

4. Urine Dipstick

- Blood 1+
- Protein 1+
- Leucocytes 4+
- Nitrites +

5. Review medication

- 5 mg/kg gentamycin written up by another staff member
 - Trust Guidelines, Discuss with Micro, Dose Reduce, Levels or alternative
- Stop Ramipril

6. Repeat Creatinine the next day

- 130



Case 1

7. Renal USS

- Elect to wait

8. Strict input/output chart

- UO 30 mls/hr for 4 hours
- Clinically still dry so increase fluid resuscitation
- UO increases to 50 mls/hr for next 6 hours



NAME _____	DATE _____
HOSPITAL NUMBER _____	COMPLETED BY _____
DOB _____	SIGNATURE _____

AKI INITIAL MANAGEMENT BUNDLE
Serum Creatinine Rise of ≥ 1.5 fold from baseline

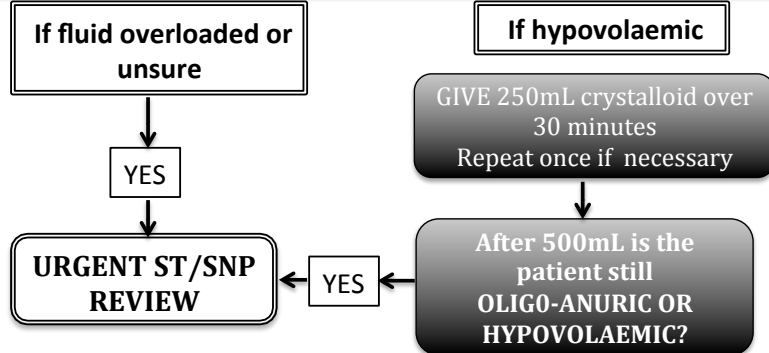
AKI is a Medical Emergency: Complete ALL 8 points

1 - ASSESSMENT 1

Full set of observations including PAR score
Full clinical assessment including:

- Signs of SIRS +/- shock
- Fluid Status / Presence of distended bladder

2 - FLUID THERAPY 2



- 3- If K > 6 , go to Trust Hyperkalaemia Protocol** 3
- 4 - URINE DIPSTICK** 4
Document in medical record
- 5 - REVIEW MEDICATION** 5
Stop NSAIDS / ACE / ARB / K⁺ Sparing diuretics
Review indication for aminoglycosides
Review anti-hypertensives (be aware of relative hypotension)
Pharmacy review within 24 hours
Only give contrast if necessary; follow Trust Prophylaxis Protocol
- 6 - REPEAT CREATININE THE NEXT DAY** 6
- 7 - RENAL TRACT USS WITHIN 24 HOURS** 7
- 8 - STRICT FLUID BALANCE CHART** 8
Including Urine Output and Daily Weights

If patient not responding seek Senior Review
See London Network AKI Guidelines for Continued Management
www.londonaki.net



Case 1b

- You are called to the ward on Sunday morning
- 85 year old female from nursing home is unwell
- Admitted with 'mechanical fall' on Friday
- Presenting complaint
 - Increased confusion
 - Abdominal pain
 - Drowsiness
 - Treated for UTI by GP 1 week ago
- PMH
 - Dementia
 - Hypertension
 - Right nephrectomy for RCC 5 years ago



Case 1b

- You are called to the ward on Sunday morning
- 85 year old female from nursing home is unwell
- Admitted with 'mechanical fall' on Friday
- Presenting complaint
 - Increased confusion
 - Abdominal pain
 - Drowsiness
 - Treated for UTI by GP 1 week ago
- PMH
 - Dementia
 - Hypertension
 - Right nephrectomy for RCC 5 years ago



Case 1b

7. Renal USS – **NEEDS URGENT USS (in 6 HOURS)**

- Single obstructed kidney
- Stone in ureter
- Nephrostomy placed that afternoon
- Pus and urine from nephrostomy tube
- Sepsis markers improving within in 24 hours
- Creatinine rises to 300 over next few days
- However, UO slowly improves
- Never requires dialysis



Case 1c

- You are called to the ward on Sunday morning
- 85 year old female from nursing home is unwell
- Admitted with 'mechanical fall' on Friday
- Presenting complaint
 - Increased confusion
 - Drowsiness
 - Treated for UTI by GP 1 week ago
- PMH
 - Dementia
 - Hypertension



Case 1c

7. Renal USS

- Elect to wait

8. Strict input/output chart

- UO 30 mls/hr for 4 hours
- Clinically still dry so increase fluid resuscitation
- **UO tails off over next 24hours**

Creatinine rises to 250 the next day.



Case 1c

7. Renal USS – **NEEDS URGENT USS**

- 8.5 cm kidneys bilaterally
- Bilateral hydronephrosis (? Pelvic mass on USS)
- Nephrostomies placed that afternoon
- Starts passing urine from nephrostomy tubes
- Sepsis markers improving within in 24 hours
- Creatinine plateaus and starts to improve over next few days
- Never requires dialysis



Case 2

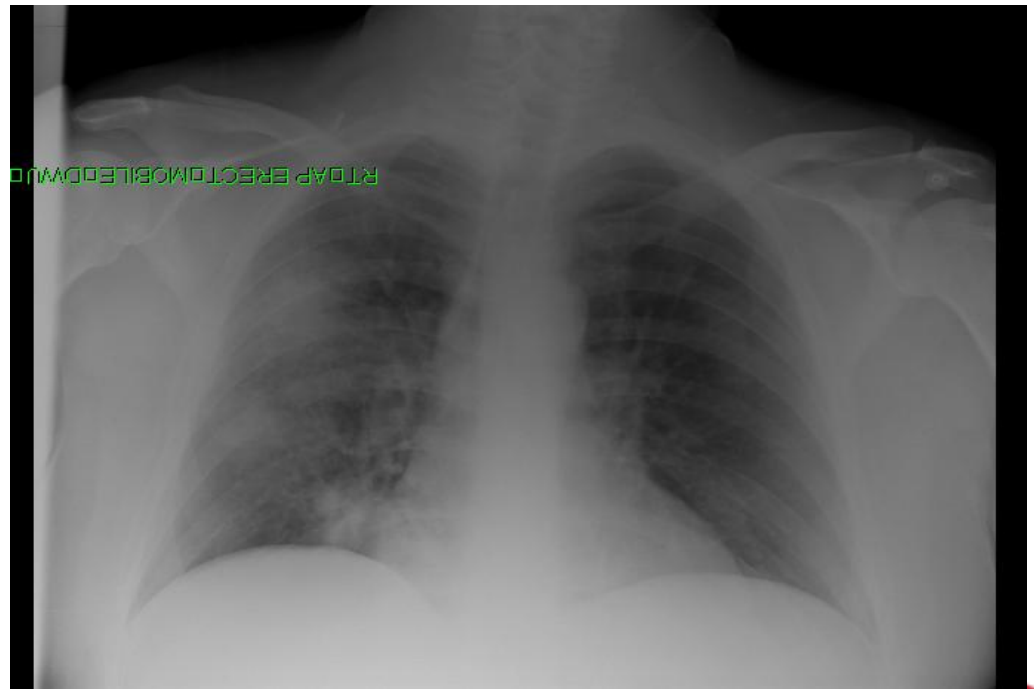
- Previously fit and well 55 year old
- Presenting complaint
 - Shortness of breath

No PMH



Case 2

- CXR
 - Suggestion of alveolar shadowing



- ABG
 - PaO₂ 8kPa



Case 2

- Bloods

Hb 119

Na 143

WCC 11.9

K 4.5

PtI 480

Cr 110



Case 2

- Comment on Renal Function?



Case 2

- Creatinine at baseline 60



Case 2

- With regards to managing his AKI
 - Diagnose the cause
 - Treat the precipitant /prevent worsening of AKI
 - Manage complications
- What 8 things will you make sure is done in the first 12 – 24 hours?



Case 2

1. Volume assessment and signs of sepsis

- Euvolaemic
- No evidence of sepsis

1. Volume resuscitation

- Given 1 x bolus and maintenance IV fluids

1. Potassium normal



Case 2

4. Urine Dipstick

- Blood 3+
- Protein 4+
- Leucocytes negative
- Nitrites Negative

5. No regular medication

6. Repeat Creatinine the next day

- 250



Case 2

7. Renal USS

- 2 normal size kidneys

8. Strict input/output chart

- UO 30 - 40 mls/hr for 10 hours
- Maintaining an even balance
- UO decreases to around 5 mls/hr the next day



- ‘AKI’ is not a ‘diagnosis’

- What is the cause?

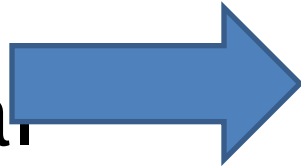


Causes of AKI

- Pre-renal
- Intrinsic
- Post-renal



- Pre-renal



- Intrinsic

- Post-renal

- **Intravascular Volume Depletion**

- Haemorrhage
- GI Losses
- Renal Losses
- Skin and Mucous Membranes
- Third space

- **Decreased Cardiac Output**

- Cardiac
- Pulm HTN, PE, PPV

- **Systemic Vasodilatation**

- Sepsis
- Liver Failures
- Anaphylaxis
- Drugs
 - Anti-hypertensives
 - Anaesthetic agents

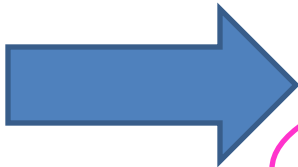
- **Renal Vasodilatation**

- Liver failure/Sepsis
- Noradrenaline/Ergotamine
- Hypercalcaemia

- **Agents which Impaired Autoregulation**

- ACE inh/ARB
- NSAIDs



- Pre-renal
- Intrinsic 
- Post-renal

DISEASES INVOLVING

• Large renal vessels

- Renal Artery Thrombosis
- Atheroembolism
- Renal Vein Thrombosis

• Renal Microvasculature & Glomerulus

- Vasculitis
- Glomerulonephritis
- Malignant HTN and Scleroderma Crisis
- TMA's

• Ischaemic & Nephrotoxic ATI

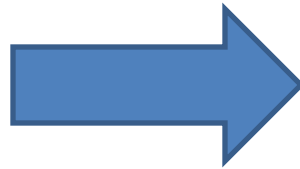
- Ischaemic
- Exogenous toxins
- Endogenous toxins

• Acute processed involving interstitium

- Interstitial nephritis
- Infection
- Rejection
- Malignant infiltrate



- Pre-renal
- Intrinsic
- Post-renal



DISEASES INVOLVING

• Large renal vessels

- Renal Artery Thrombosis
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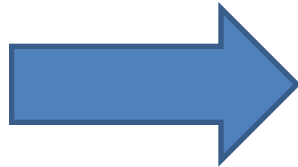
- Interstitial nephritis
- Infection
- Rejection
- Malignant infiltrate



- Pre-renal

- Intrinsic

- Post-renal



- Urinary Retention
 - Drugs
 - Mechanical Obstruction
- Papillary Necrosis
 - NSAIDs



'STOP' AKI and Checklist

The London AKI Network has Developed the 'STOP' Acronym to Improve Awareness of AKI Causes



Sepsis & hypoperfusion Toxicity Obstruction Parenchymal kidney disease

Patient Name:

No: DOB:

SEPSIS & HYOPERFUSION	YES	NO	N/A
Severe Sepsis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Haemorrhage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dehydration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cardiac Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Liver Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Renovascular Insult (E.G. Aortic Surgery)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

TOXICITY	YES	NO	N/A
Nephrotoxic Drugs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Iodinated Radiological Contrast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

OBSTRUCTION	YES	NO	N/A
Bladder Outflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stones	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tumour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Surgical Ligation Of Ureters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Extrinsic Compression (E.G. Lymph Nodes)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Retroperitoneal Fibrosis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

PARENCHYMAL KIDNEY DISEASE	YES	NO	N/A
Glomerulonephritis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tubulointerstitial Nephritis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rhabdomyolysis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Haemolytic Uraemic Syndrome	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Myeloma Kidney	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Malignant Hypertension	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Signed:

Date:

Position:

Fix patient sticker here

- Pre-renal
- Intrinsic
- Post-renal



website: www.londonaki.net
email: info@londonaki.net



'STOP' AKI and Checklist

The London AKI Network has Developed the 'STOP' Acronym to Improve Awareness of AKI Causes



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Patient Name:

No: DOB:

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Cardiac Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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TOXICITY

	YES	NO	N/A
Nephrotoxic Drugs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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OBSTRUCTION

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Bladder Outflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Signed:

Date:

Position:

Fix patient sticker here



website: www.londonaki.net
email: info@londonaki.net

NAME _____ DATE _____
HOSPITAL NUMBER _____ COMPLETED BY _____
DOB _____ SIGNATURE _____

AKI INITIAL MANAGEMENT BUNDLE

Serum Creatinine Rise of ≥ 1.5 fold from baseline

AKI is a Medical Emergency: Complete ALL 8 points

1 - ASSESSMENT

Full set of observations including PAR score
Full clinical assessment including:
• Signs of SIRS +/- shock
• Fluid Status / Presence of distended bladder

2 - FLUID THERAPY

If fluid overloaded or unsure

If hypovolaemic

GIVE 250mL crystalloid over 30 minutes
Repeat once if necessary

YES

URGENT ST/SNP REVIEW

YES

After 500mL is the patient still OLIGO-ANURIC OR HYPOVOLAEMIC?

3- If K > 6, go to Trust Hyperkalaemia Protocol

4 - URINE DIPSTICK

Document in medical record

5 - REVIEW MEDICATION

Stop NSAIDS / ACE / ARB / K⁺ Sparing diuretics

Review indication for aminoglycosides

Review anti-hypertensives (be aware of relative hypotension)

Pharmacy review within 24 hours

Only give contrast if necessary; follow Trust Prophylaxis Protocol

6 - REPEAT CREATININE THE NEXT DAY

7 - RENAL TRACT USS WITHIN 24 HOURS

8 - STRICT FLUID BALANCE CHART

Including Urine Output and Daily Weights

If patient not responding seek Senior Review

See London Network AKI Guidelines for Continued Management

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Diagnostic Methods



Diagnostic Methods

“Observe, record, tabulate, communicate. Use your five senses. Learn to see, learn to hear, learn to smell and know that by practice alone you can become an expert”



Sir William Osler (1849 – 1919)

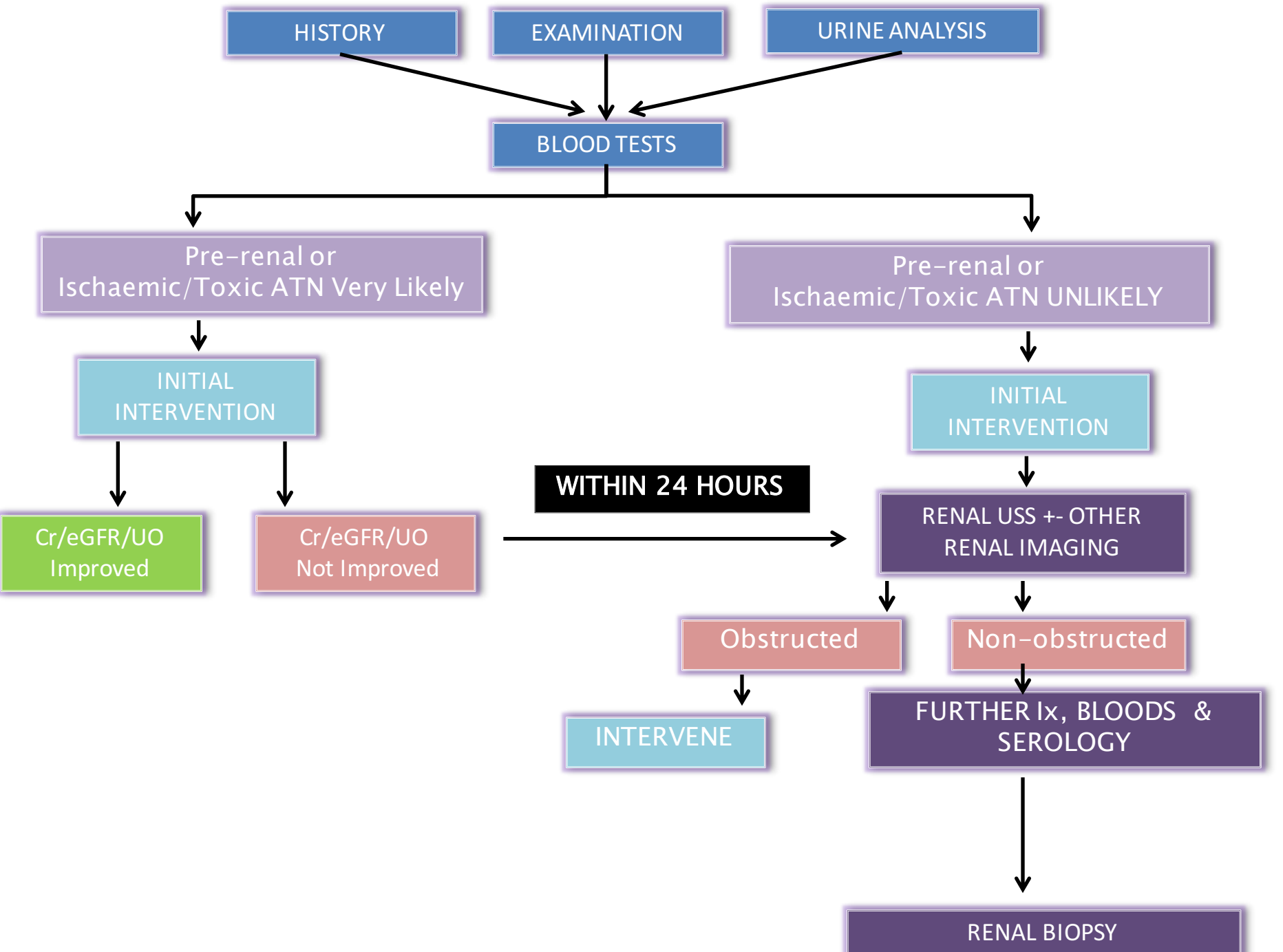


- From care bundle to diagnostic algorithm.....

HISTORY

EXAMINATION

URINE ANALYSIS



HISTORY

EXAMINATION

URINE ANALYSIS

BLOOD TESTS

Pre-renal or Ischaemic/Toxic ATN Very Likely

Pre-renal or Ischaemic/Toxic ATN UNLIKELY

INITIAL INTERVENTION

INITIAL INTERVENTION

Cr/eGFR/EO Improved

Cr/eGFR/EO Not Improved

WITHIN 24 HOURS

RENAL USS +- OTHER RENAL IMAGING

Obstructed

Non-obstructed

INTERVENE

FURTHER Ix, BLOODS & SEROLOGY

RENAL BIOPSY

HISTORY

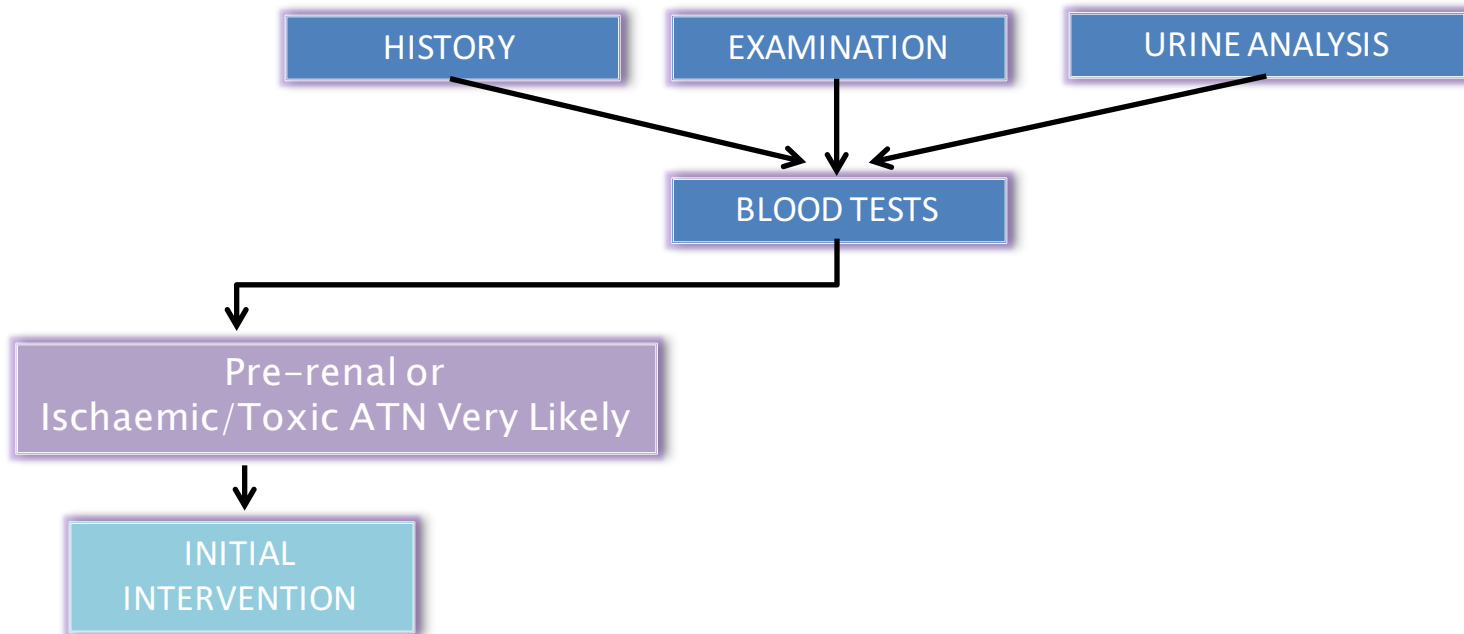
EXAMINATION

URINE ANALYSIS

BLOOD TESTS

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graph TD; HISTORY --> BLOOD_TESTS; EXAMINATION --> BLOOD_TESTS; URINE_ANALYSIS --> BLOOD_TESTS; BLOOD_TESTS --> DIAGNOSIS;
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HISTORY

EXAMINATION

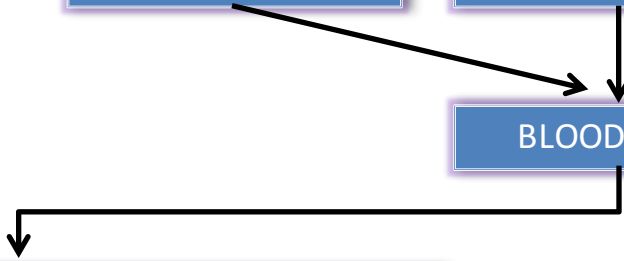
URINE ANALYSIS

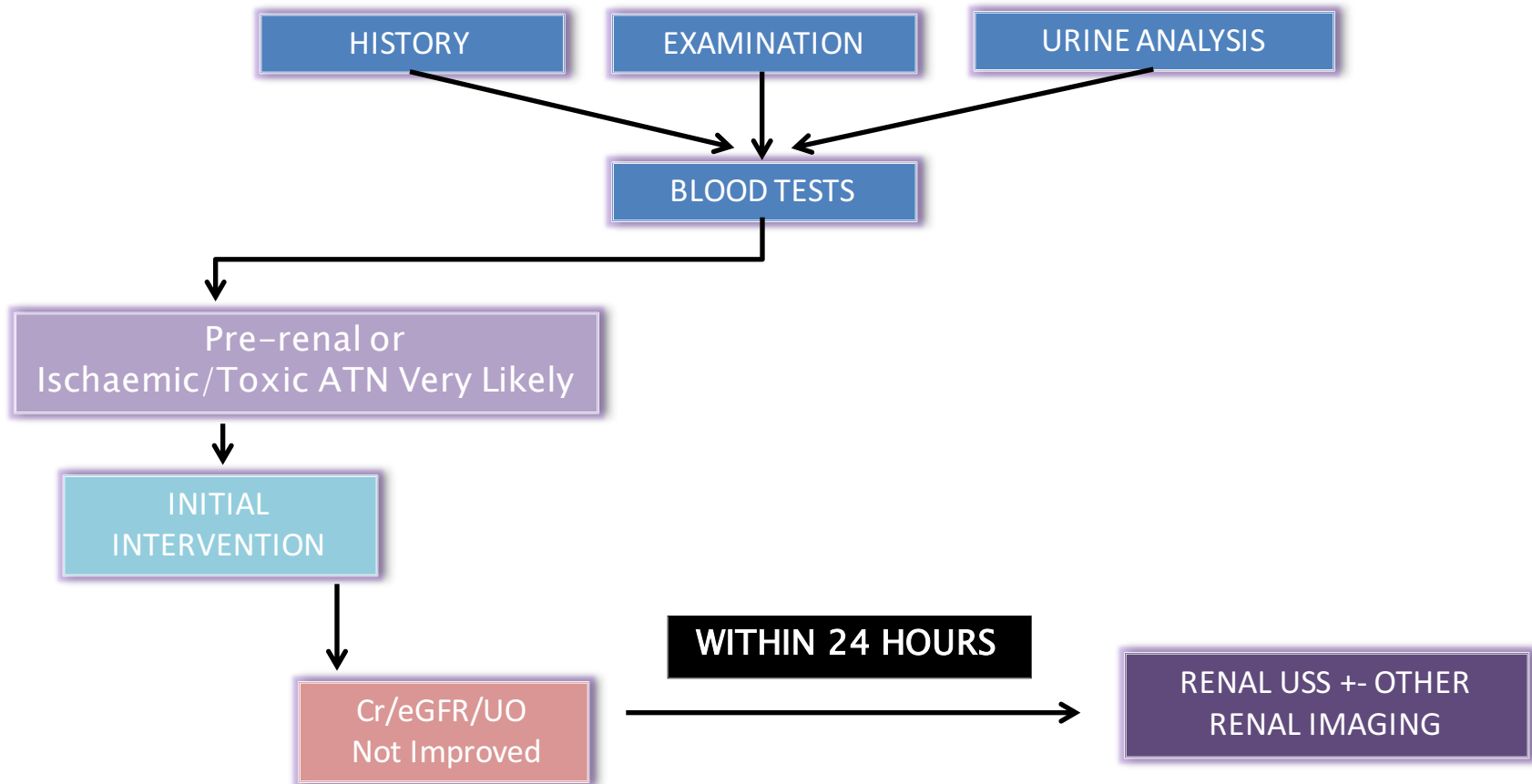
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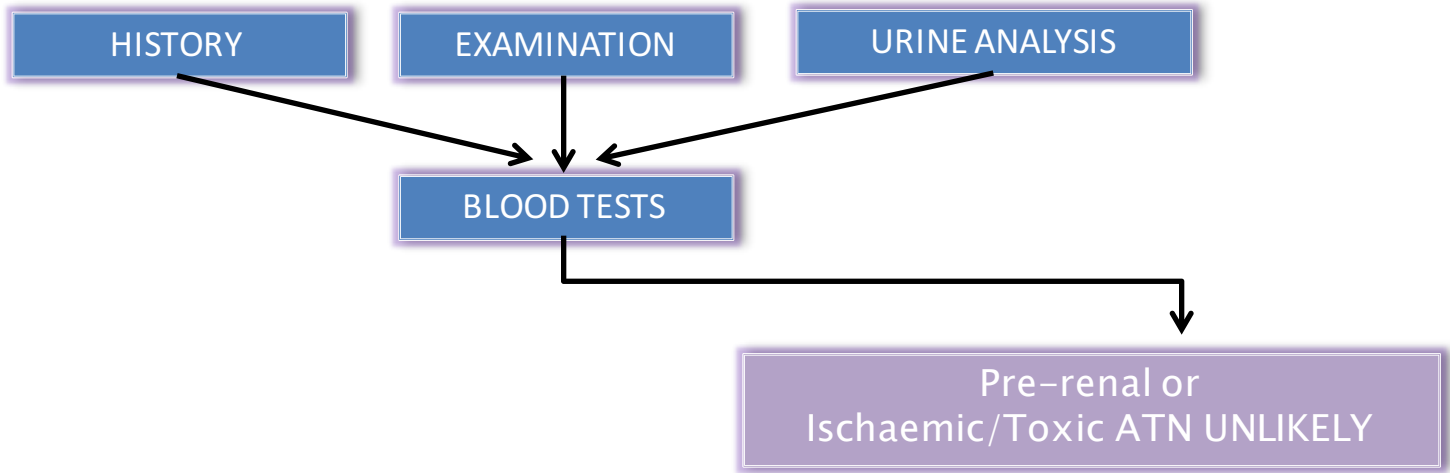
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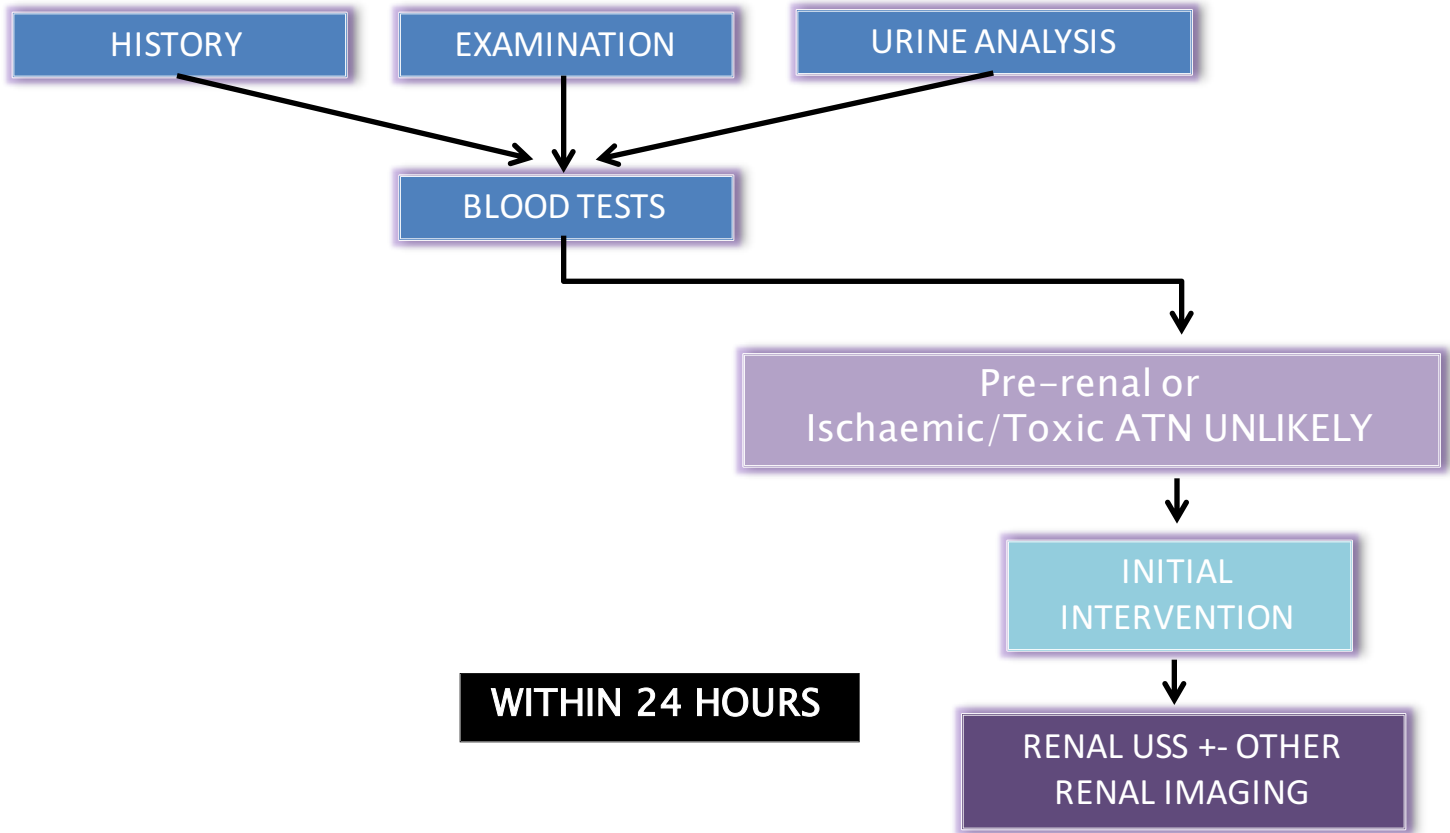
INITIAL
INTERVENTION

Cr/eGFR/UO
Improved









HISTORY

EXAMINATION

URINE ANALYSIS

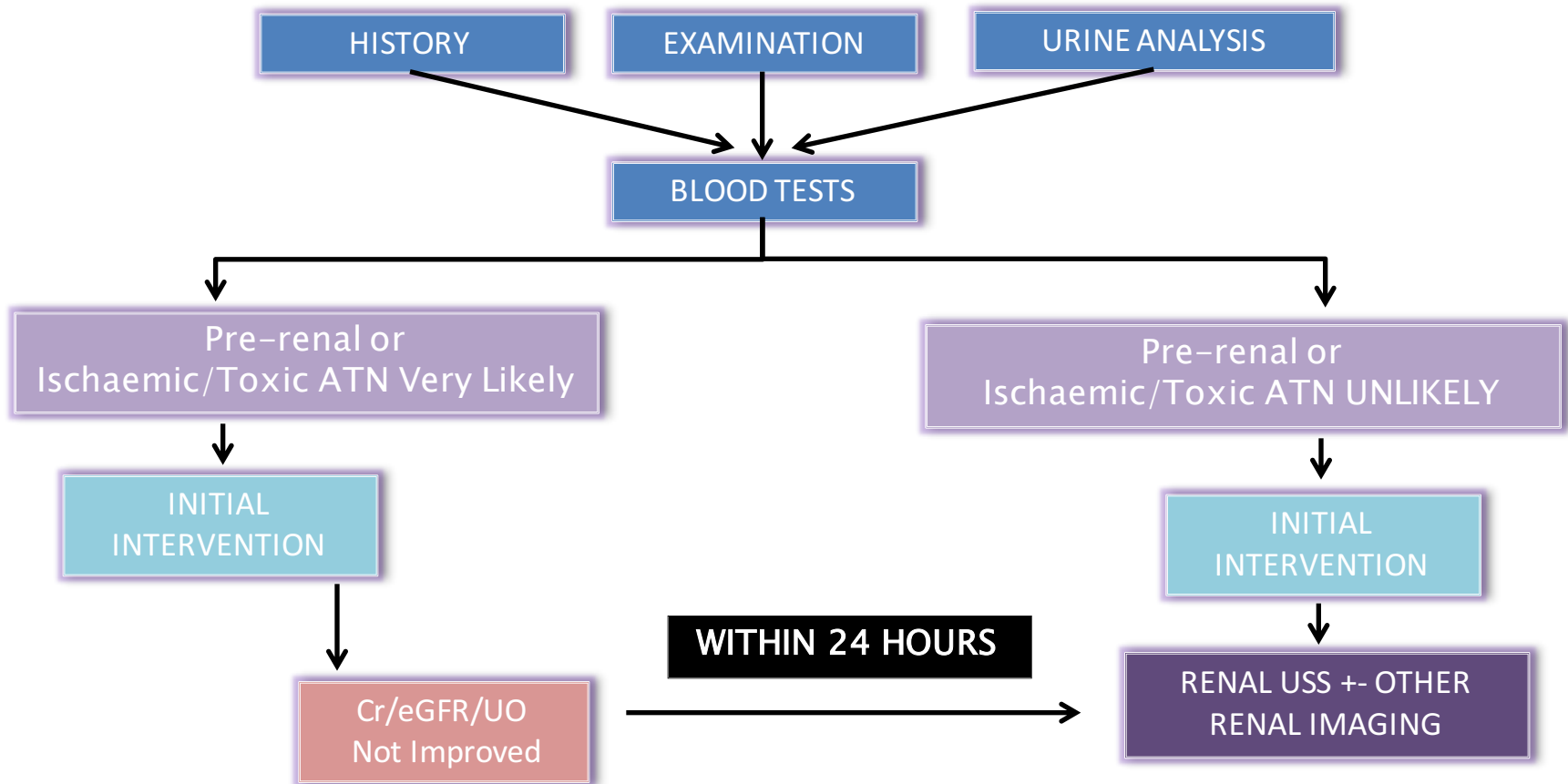
BLOOD TESTS

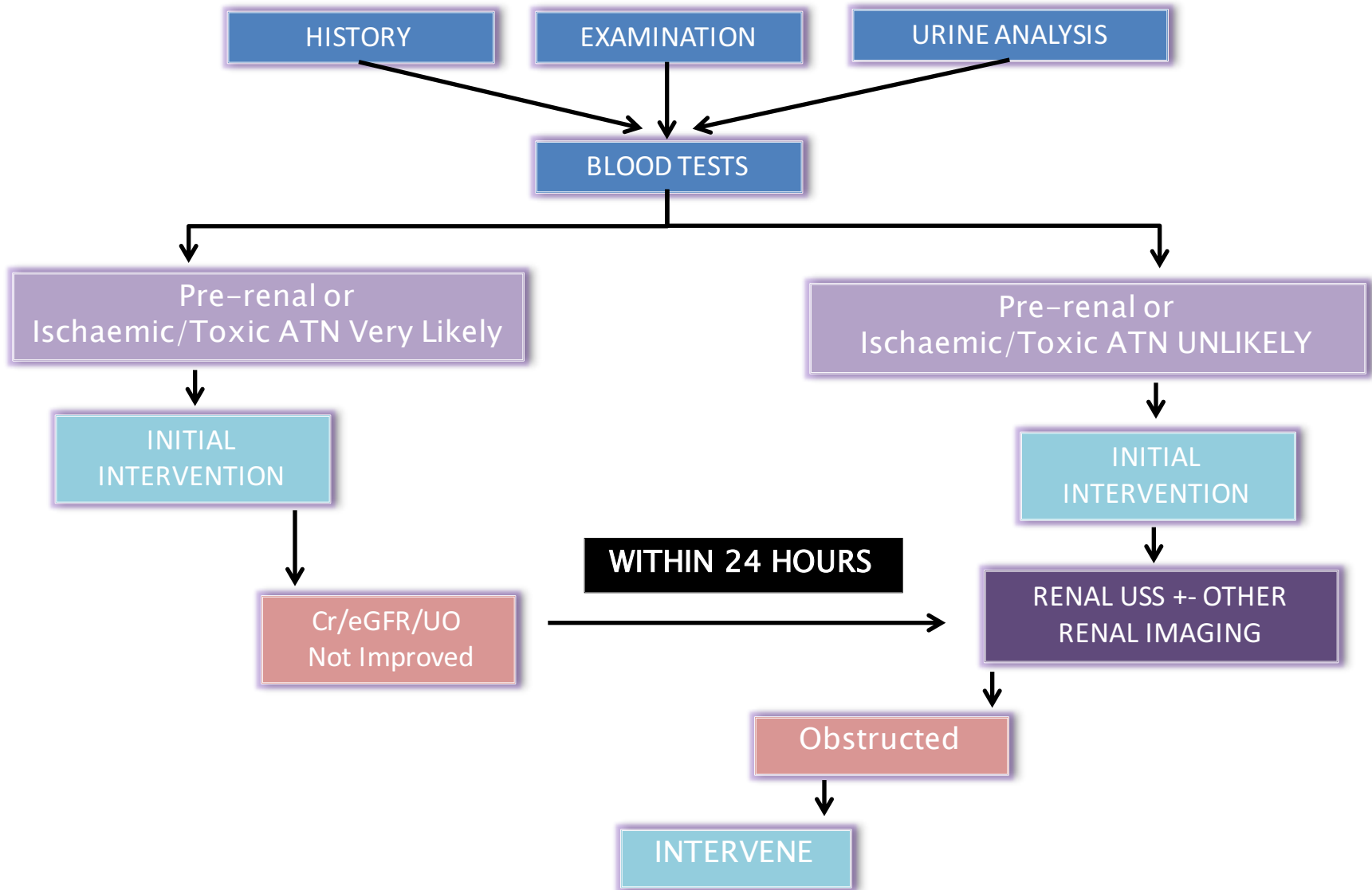
Pre-renal or
Ischaemic/Toxic ATN UNLIKELY

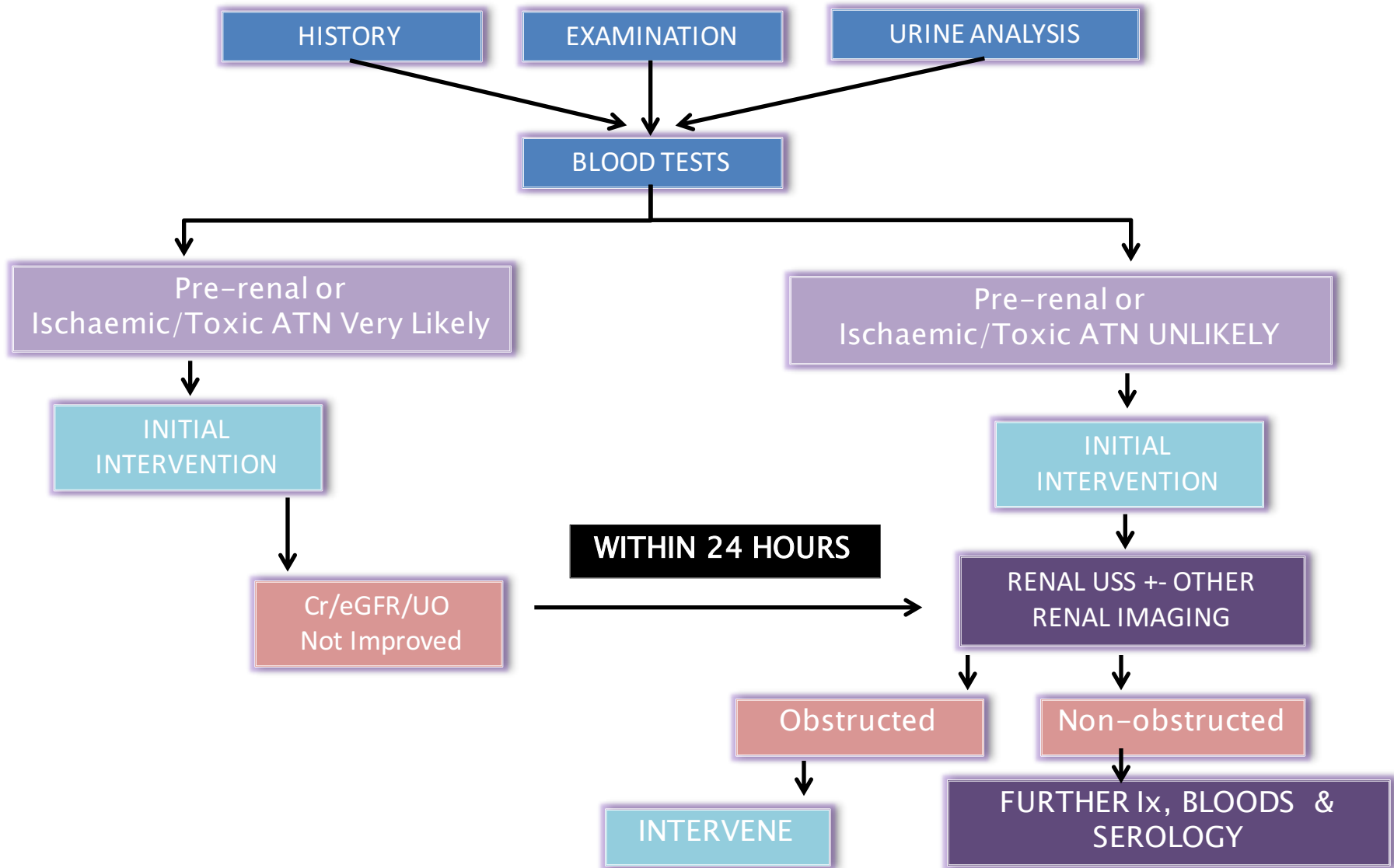
INITIAL
INTERVENTION

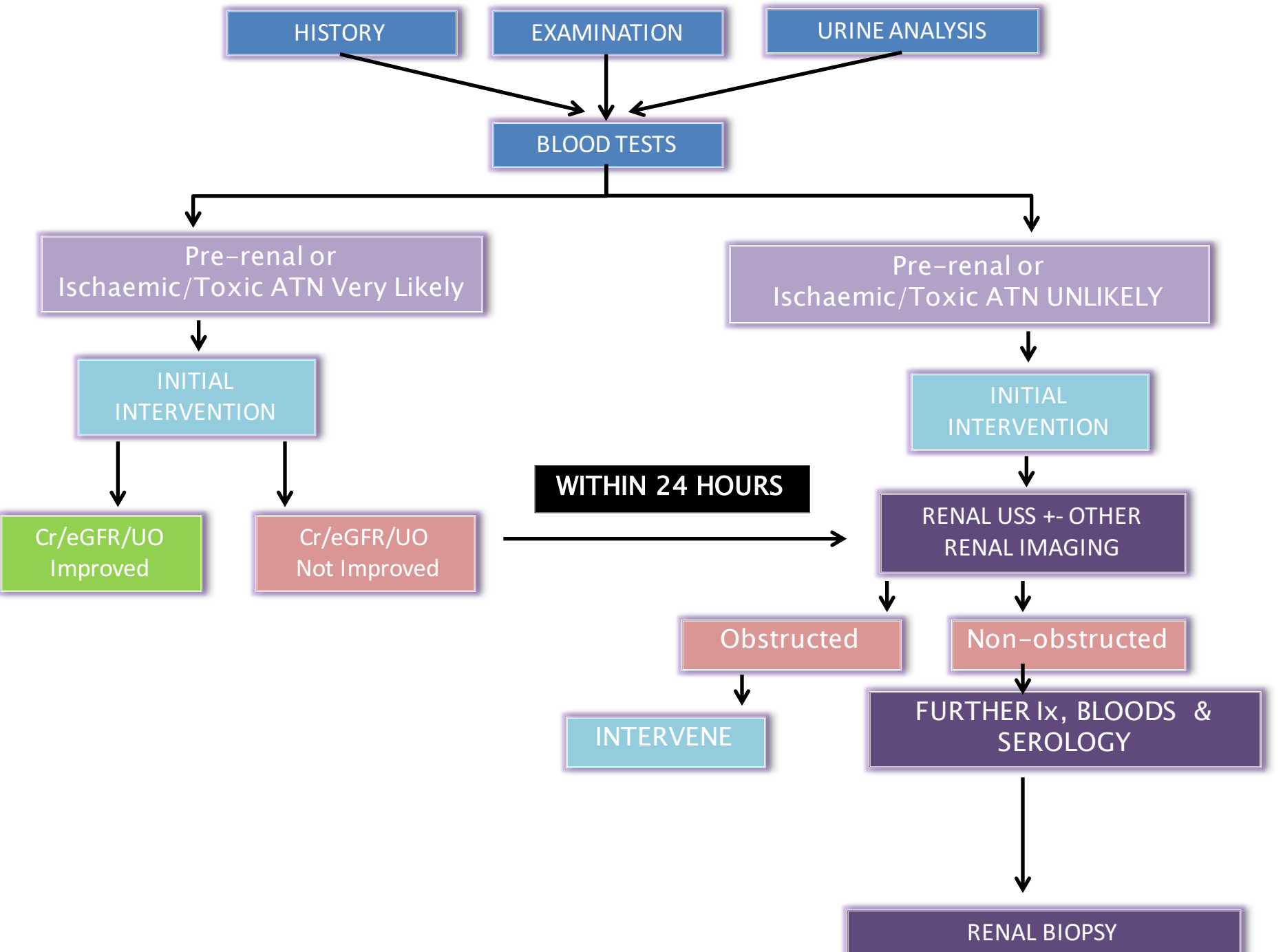
WITHIN 24 HOURS

RENAL USS +/- OTHER
RENAL IMAGING









HISTORY

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URINE ANALYSIS

BLOOD TESTS

Pre-renal or Ischaemic/Toxic ATN Very Likely

Pre-renal or Ischaemic/Toxic ATN UNLIKELY

INITIAL INTERVENTION

INITIAL INTERVENTION

Cr/eGFR/EO Improved

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WITHIN 24 HOURS

RENAL USS +- OTHER RENAL IMAGING

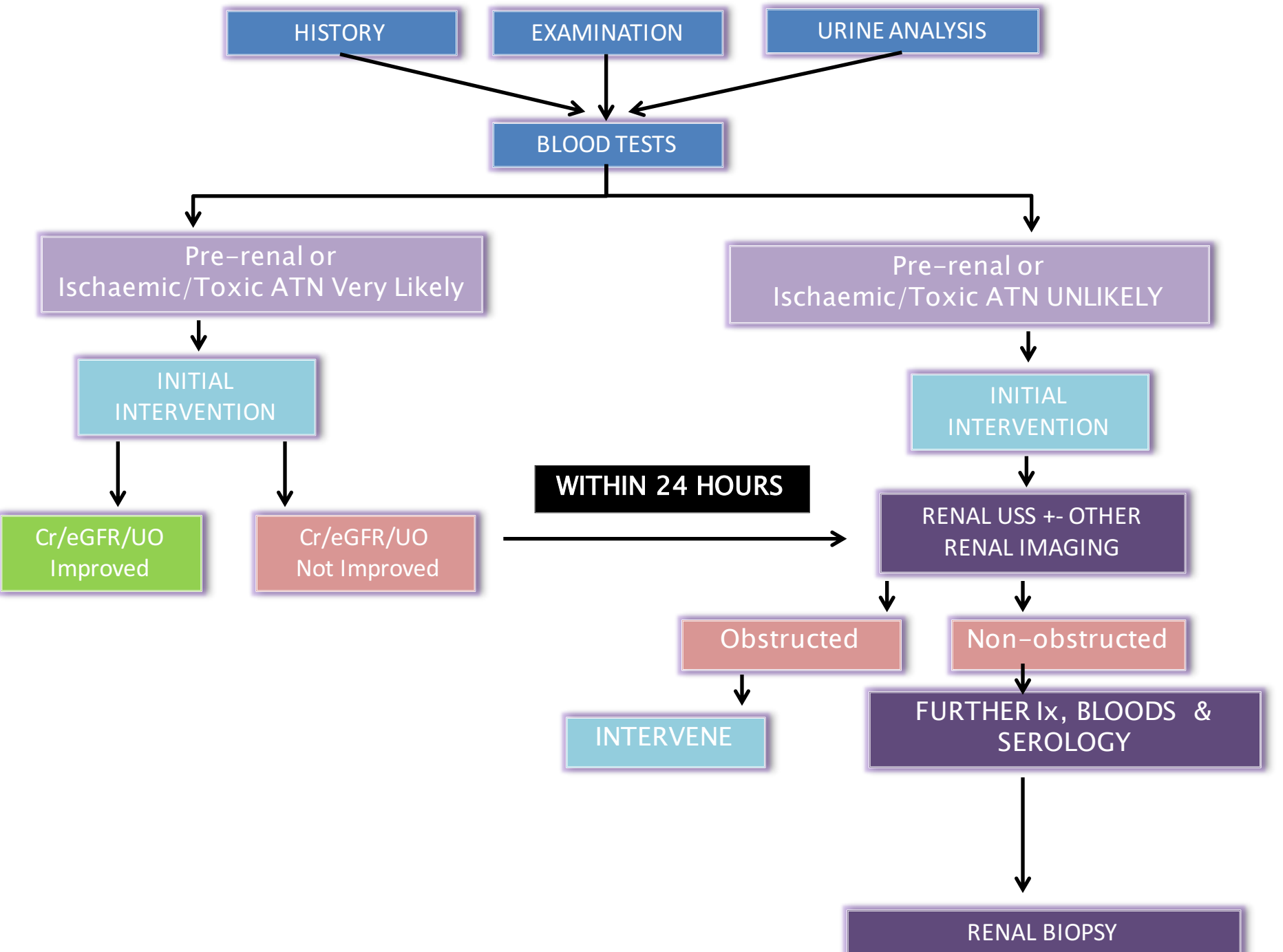
Obstructed

Non-obstructed

INTERVENE

FURTHER Ix, BLOODS & SEROLOGY

RENAL BIOPSY



HISTORY

EXAMINATION

URINE ANALYSIS

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Pre-renal or Ischaemic/Toxic ATN Very Likely

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INITIAL INTERVENTION

INITIAL INTERVENTION

Cr/eGFR/EO Improved

Cr/eGFR/EO Not Improved

WITHIN 24 HOURS

RENAL USS +- OTHER RENAL IMAGING

Obstructed

Non-obstructed

INTERVENE

FURTHER Ix, BLOODS & SEROLOGY

RENAL BIOPSY

Case 3



Case 3

- 78 ♀ total colectomy for cancer
 - Scheduled for Thursday morning
 - Operation late Friday late morning



Case 3

- 78 ♀ total colectomy for cancer
 - Scheduled for Thursday morning
 - Operation late Friday late morning
- Monday afternoon (Day 3)post op bloods
 - Cr 256
 - UO not measured



Case 3

What do you need to know in the history?



History

- ▶ Baseline Renal Function
- ▶ Clinical History
 - Age
 - Co-morbidities
 - Previous Renal Disease
 - Full history
 - Presenting complaint or hospital course
 - Travel/Occupation/Family history
 - Systemic features
 - LOW/nights sweats/fatigue
 - Joint pain/rashes/ulcers
 - ENT and U/LRT



History

▶ Drug History

- Nephrotoxics
- New Medications
- Over-the-counter/traditional

▶ Review of Hospital Charts

- Fluid balance/Periods of decreased intake
- Relative hypotension
- Operations/Procedures
- Investigations (i.e contrast etc)

▶ Review of previous records



Baseline Renal Function

- Baseline creatinine – 95

**Cr 2 x baseline
AKI 2**



Baseline Renal Function

- Baseline creatinine – 95

**Cr 2 x baseline
AKI 2**

CKD



Clinical History

- 78 years
- PMH
 - Type II DM
 - HTN
 - Ex-smoker

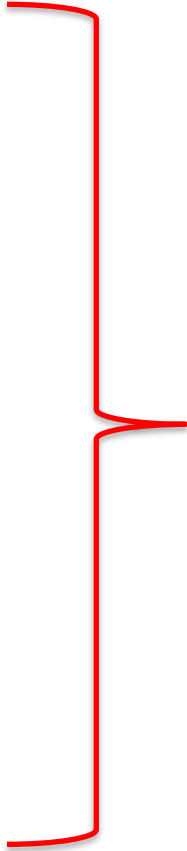


Clinical History

- 78 years
- PMH
 - Type II DM
 - HTN
 - Ex-smoker

In addition to

- CKD



**Increased
Risk of AKI**



Drug History

- ACEi
- Amlodipine
- Frusemide
- Metformin



Drug History

- ACEi → **Exacerbate AKI**
- Amlodipine → **Exacerbate Hypotension**
- Frusemide → **Exacerbate Hypovolemia**
- Metformin → **Lactic acidosis in abnormal renal fxn**



Review of Charts

- NBM prior to surgery
- Inadequate fluid intake
 - Venflon tissue
 - Nausea since procedure
- Negative fluid balance in first 48h

Volume Depletion

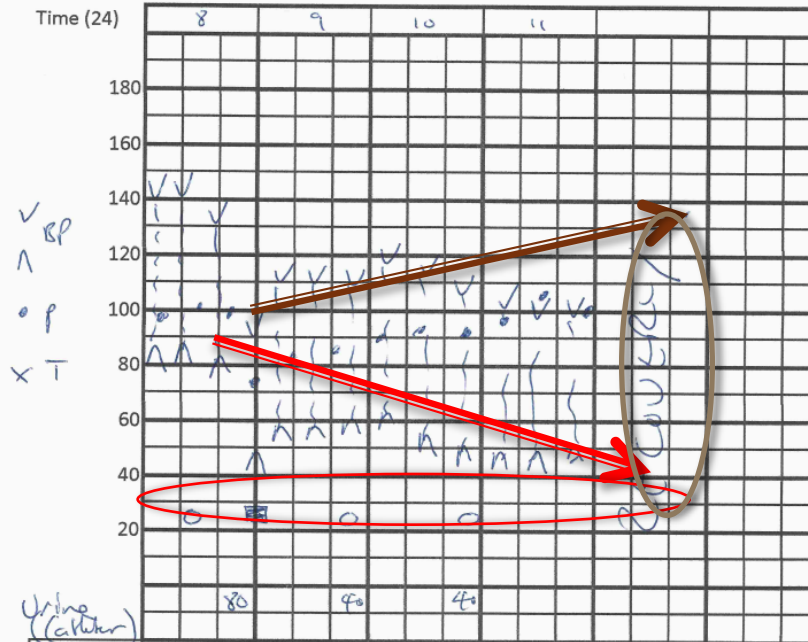
- Intra-operative hypotension
- Continued use of anti-hypertensives
- BP average 100 – 110/40 - 50

(Normal BP 140 – 150/80-90)

Relative Hypotension



Name: <u>Richard Bright</u>		procedure: <u>Hemi-colectomy RT</u>	
Number: <u>617 4003</u>		date: <u>22/9/12</u>	
DoB: <u>7/3/44</u>	Surgeon: <u>Sin</u>	Anesthetist: <u>Jones</u>	



Fluids: <u>CSL 1L</u>		<u>CSL 1L</u>	
Induction: <u>fentanyl 150 mcg</u> <u>propofol 150 cc</u> <u>Vecuronium 8 mg</u>		other meds: <u>metaraminol 0.1</u> <u>o-morphine 5 mg</u>	
ASA: <u>3</u>	Anesthetic: <u>GA</u> <u>Regional</u> <u>Spinal</u>	Airway: <u>oral</u> <u>nasal</u> <u>cuff (y/n) y</u>	Grade: <u>2</u>
		LMA: <u>ETT</u> <u>depth 22</u>	Position: <u>supine</u>
Monitor: <u>ECG</u> <u>SaO2</u> <u>ETCO2</u>	<u>NIBP</u> <u>Temp</u>	<u>NIRS</u> <u>BIS</u> <u>Other</u>	<u>Invasive art</u> <u>CVP</u> <u>trauma</u>
			<u>PAC</u> <u>CO</u>

Review of Charts



Review of Charts

- UO not measured initially
 - Catheter has been placed



Review of Charts

- UO not measured initially
 - Catheter has been placed
- < 100 mls residual



Review of Charts

- UO not measured initially
 - Catheter has been placed
- < 100 mls residual
- 35 – 30 mls/hour for 2 hours



Case 3

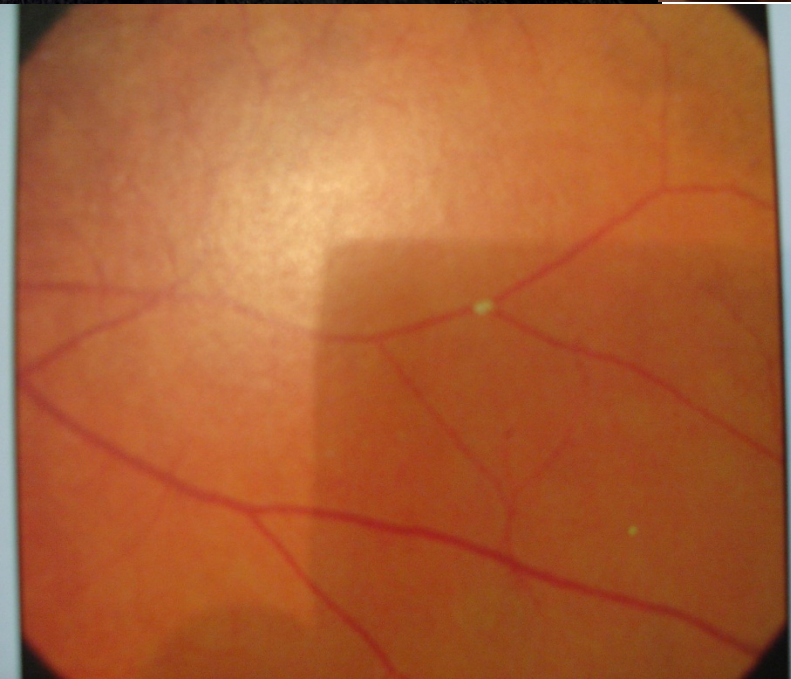
What do you need to include in your examination?



Clinical Examination

- ▶ Full and Comprehensive Examination
- ▶ Volume status
- ▶ Signs of sepsis and shock
- ▶ General
 - Fundoscopy/Eye changes
 - Skin changes
 - Swollen joints
 - Murmurs, splinters
- ▶ Signs of renovascular disease
 - Audible bruits
 - Impalpable pulses
- ▶ Abdominal Examination
 - Palpable bladder
 - Palpable kidneys



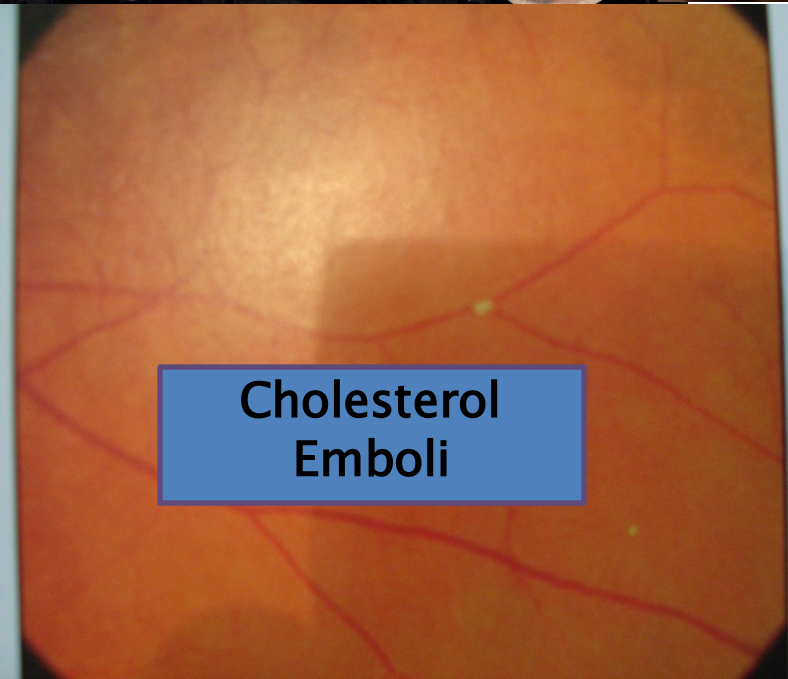




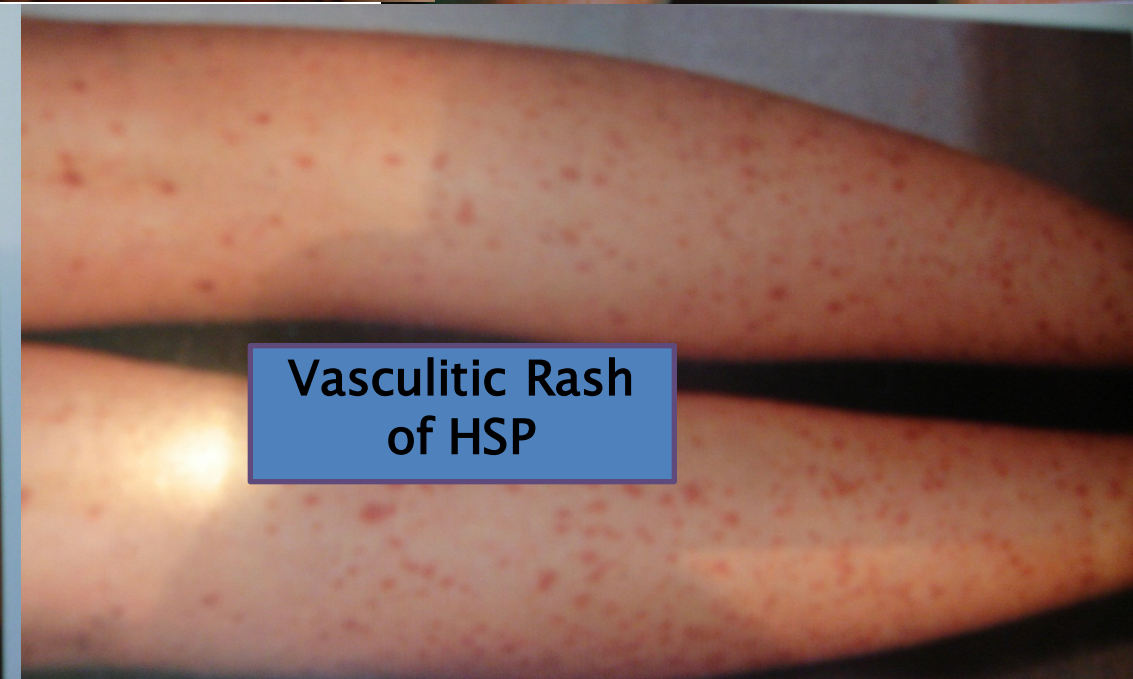
**Infective
Endocarditis**



**Scleroderma renal
Crisis**



**Cholesterol
Emboli**



**Vasculitic Rash
of HSP**

Examination

- Tachycardic, slightly thready pulse
- Dry mucus membranes
- Decreased skin turgor
- JVP not visible on lying down
- Some peripheral oedema, chest clear
- No systemic finding
- Bladder not palpable



Examination



Examination

- Tachycardic, slightly thready pulse



Examination

- Tachycardic, slightly thready pulse
- Dry mucus membranes



Examination

- Tachycardic, slightly thready pulse
- Dry mucus membranes
- Decreased skin turgor



Examination

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Examination

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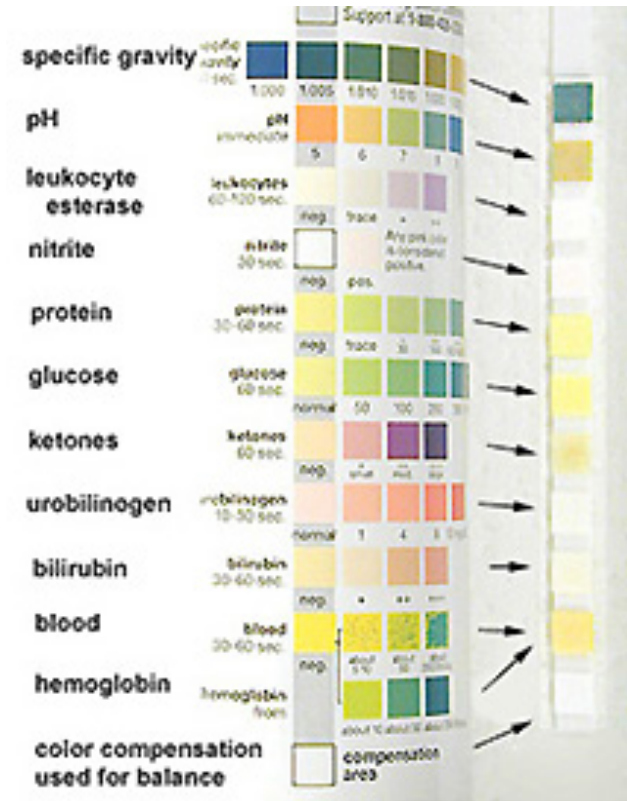
Case 3

What are you looking for on urinalysis?



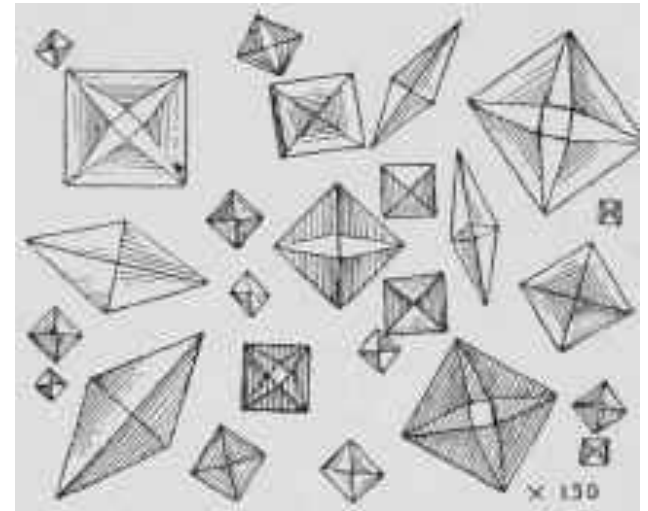
Urine Analysis

- Urine Dipstick
 - Blood and protein
 - Hemoglobin
 - SG
 - >1.018 - Pre-renal
 - <1.012 - Intrinsic

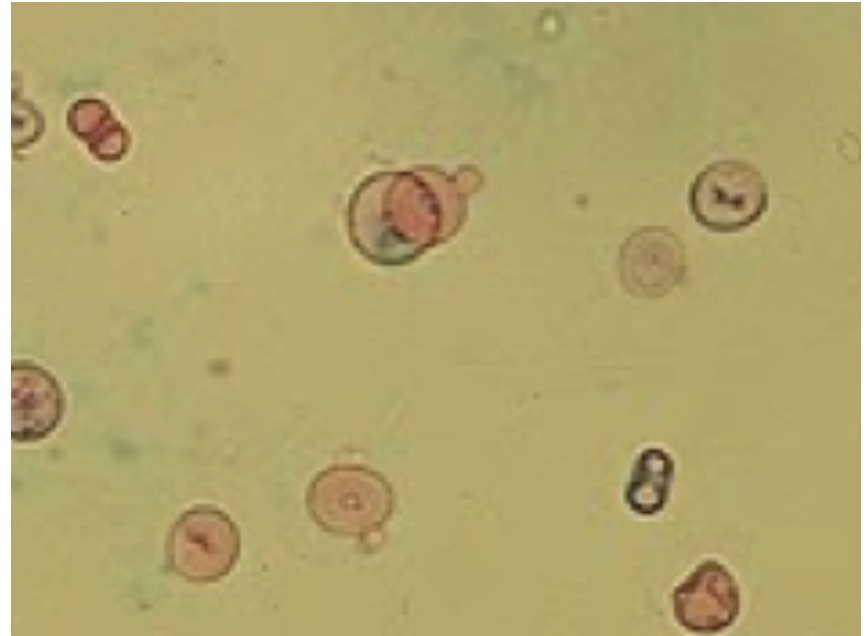
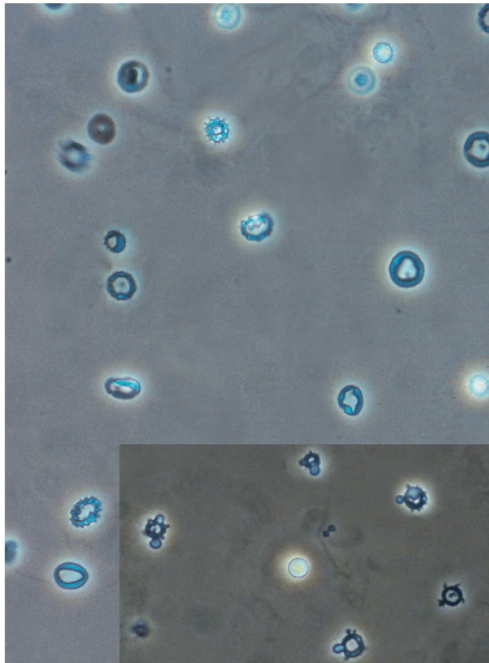


Urine Analysis

- Urine microscopy
 - RBC/WBC/Eosinophils
 - Dysmorphic RBCs
 - Casts
 - Hyaline
 - Granular
 - RBC
 - WCC
 - Crystals



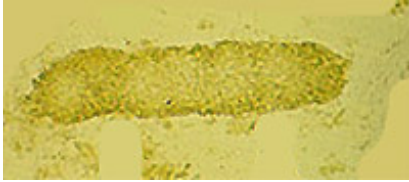
Urine Microscopy - Cells



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Urine Microscopy - Casts



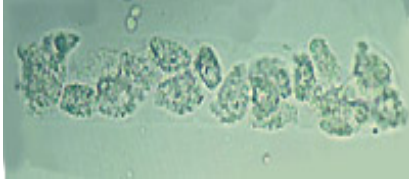
Hyaline Cast

→ Pre-renal AKI



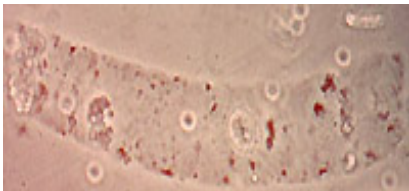
Granular Cast

→ Ischaemic ATI
Toxic ATI (exogenous)
Rare in HUS/TTP



Epithelial Cast

→ ATI (Toxic)
Acute Interstitial Nephritis
(Glomerulonephritis)

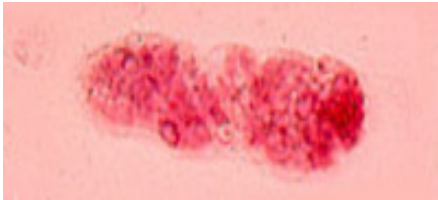


Waxy Cast

→ Malignant Hypertension
Rapidly Progressive GN
Advanced CKD



Urine Microscopy - Casts



RBC Cast



= Glomerular Bleeding
Glomerulonephritis
Endocarditis
Lupus
Rarely Renal Vein Thrombosis



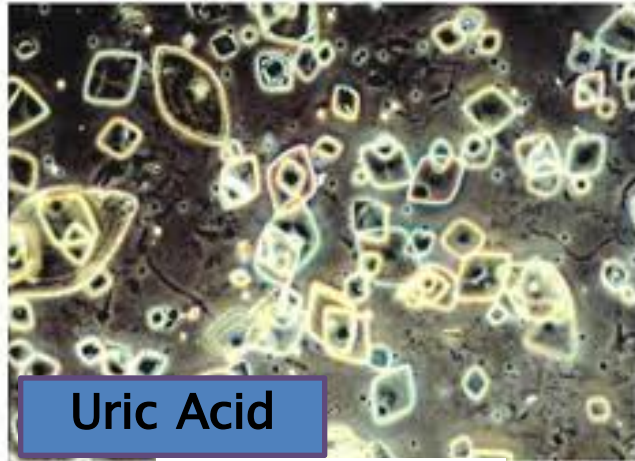
WBC Cast



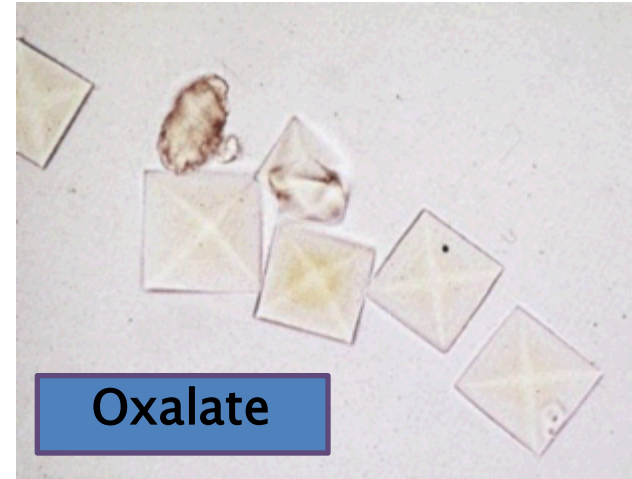
Acute Pyelonephritis
Interstitial Nephritis
Proliferative GN



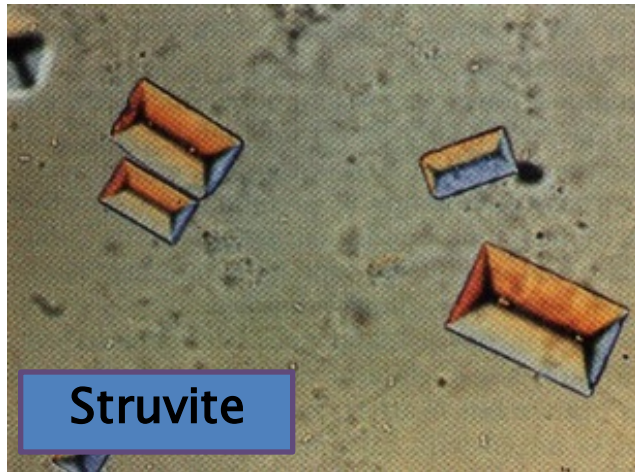
Urine Microscopy - Crystals



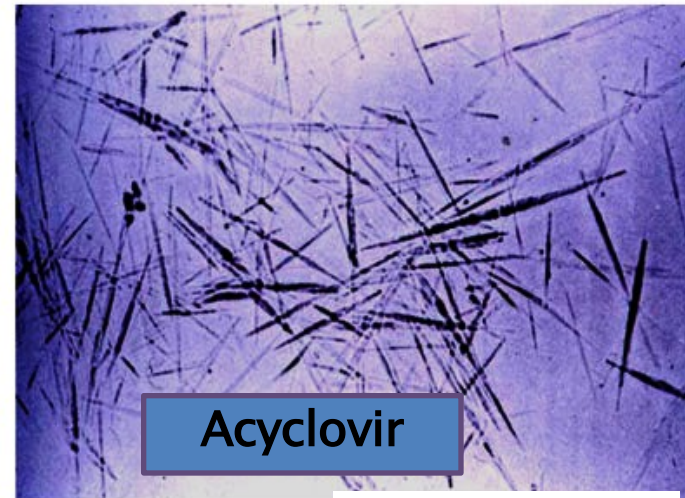
Uric Acid



Oxalate



Struvite



Acyclovir

ACYI



Urine Analysis

- Urine electrolytes
 - FeNA

FRACTIONAL EXCRETION OF SODIUM (FeNA (%))

$$\left[\frac{\text{Urine Sodium}}{\text{Plasma Sodium}} \right] / \left[\frac{\text{Urine Creatinine}}{\text{Plasma Creatinine}} \right] \star 100$$

- Urinary Na Concentration



	Pre-Renal	Ischaemic ATI
Fe NA (%)	< 1 %	> 2 %
Urinary Na	< 10 mmol/L	> 20 mmol/L
Urine Osmolality	> 500 mOsm/Kg H ₂ O	< 250 mOsm/Kg H ₂ O
Urine SG	> 1.018	< 1.012
Casts	Hyaline	Granular



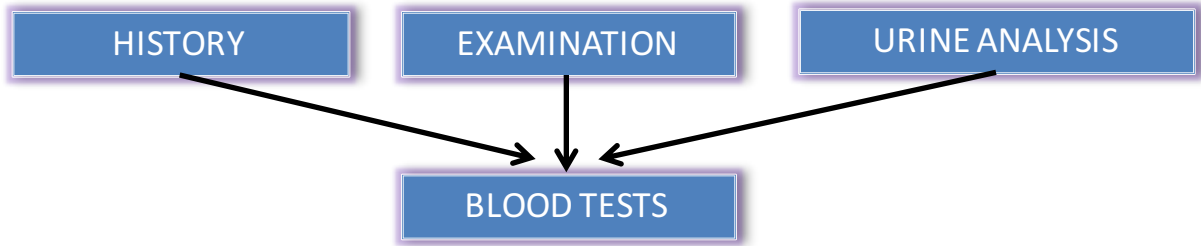
Urine Dipstick

- Trace blood
- No protein



“ The ghosts of dead patients that haunt us do not ask why we did not employ the latest fad of clinical investigations; they ask why did you not test my urine?”

Sir Robert Hutchison (1871–1960)



Initial Blood Tests

- ▶ Electrolytes
 - Creatinine
 - Urea (> 20:1 vs. <10-15)
 - Potassium and bicarb

- ▶ Full Blood Count
 - WCC/Eosinophils
 - Hb
 - Ptl

- ▶ CRP



Initial Blood Tests

▶ LFT/BONE PROFILE

- Liver failure
- Ca, Pi
- Urate

▶ Additional guided by history & severity

- CK
- Venous gas



Biochemistry

- Hyperkalaemia
- Hypocalcaemia
- Hyperphosphataemia
- Moderate hyperuricaemia



Biochemistry

- Hyperkalaemia
- Hypocalcaemia
- Hyperphosphataemia
- Moderate hyperuricaemia



Biochemistry

- Hyperkalaemia
- Hypocalcaemia
- Hyperphosphataemia
- HIGHER Uric Acid
($> 900\mu\text{mol/L}$)



Tumour Lysis Syndrome

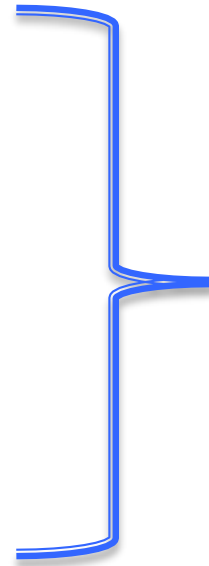
Uric Acid Nephropathy



Biochemistry

- Hyperkalaemia
- Hypocalcaemia
- Hyperphosphataemia
- Moderate hyperuricaemia

PLUS RAISED CK



Rhabdomyolysis

Biochemistry

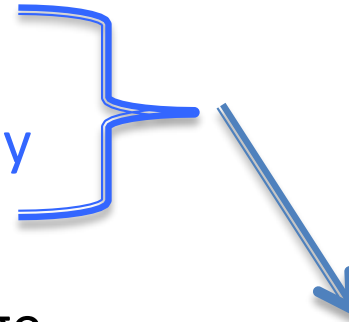
- Hyperkalaemia out of keeping
 - Obstructive
 - Hypercatabolic
 - Trimethoprim

Biochemistry

- Hypercalcaemia
 - Any cause (Primary HPT)
 - Sarcoid
 - Myeloma

Haematology

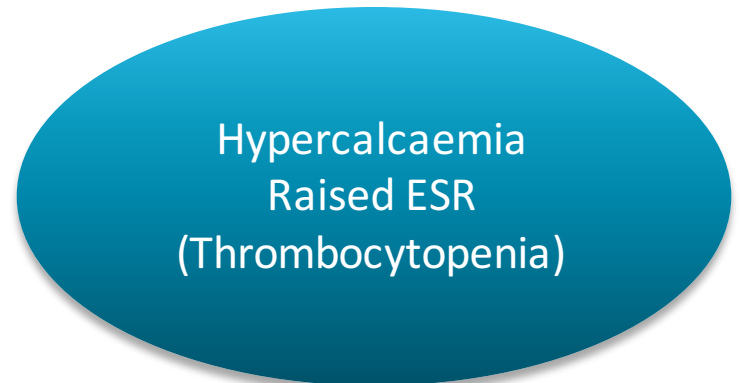
- Severe Anaemia without blood loss
 - Haemolysis
 - Thrombotic Microangiopathy
 - Myeloma
 - Retroperitoneal haemorrhage



Thrombocytopenia
Dysmorphic/fragmented RBC's
Schistocytes
Elevated LDH

Haematology

- Severe Anaemia without blood loss
 - Haemolysis
 - Thrombotic Microangiopathy
 - Myeloma
 - Retroperitoneal haemorrhage



Haematology

- **Thrombocytopenia**
 - Thrombotic Microangiopathy
 - Myeloma
 - Sepsis & DIC

- **Thrombocytosis**
 - Vasculitis
 - Infection

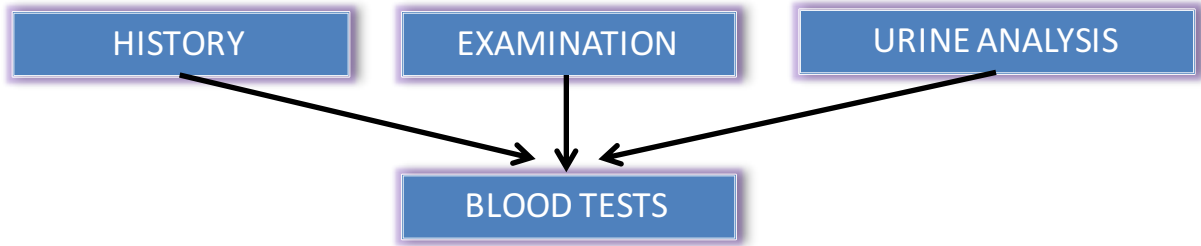
Haematology

- Raised WCC
 - Infection
 - Lymphoma or leucaemia
 - Myeloma

Haematology

- Eosinophilia

- Allergic Interstitial Nephritis
- Athero-embolism (cholesterol emboli)
- Churg-Strauss Syndrome
(Allergic granulomatosis and angiitis)



Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑ PTL)

Bland urine/minor change

↓Hb

↑Ca²⁺

- ANA (ENA/dsDNA)
- ANCA
- Anti-GBM Abs
- Complements
- Immunoglobulins
- (ASOT)
- (Cryoglobulins)
- (Rheumatoid Factor)
- (ECHO)

- nBP
- CK
- Uric Acid
- ?Eosinophils
- Myeloma Screen
- Anion Gap (EG/Oxalate Levels)

- ↑BP
- TMA Screen
- ANA (ENAs/dsDNA)
- (APL, ACLA)

- TMA Screen
- Myeloma Screen
- LDH
- ANA (ENA,dsDNA)

- Serum ACE
- Myeloma Screen
- PTH

↓Hb & ↓PTL

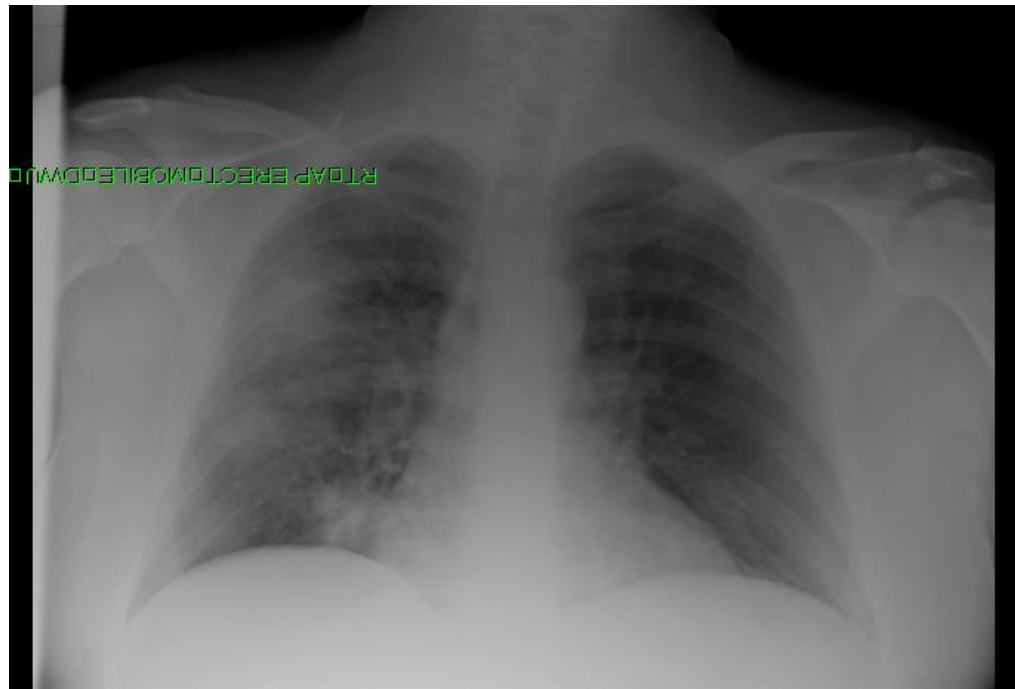
- D-Dimer/Fibrinogen
- (ADAMTS-13/Factor H&I)

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING



HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures



Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑ PTL)

Bland urine/minor
changes/protein alone

↓Hb

↑Ca²⁺

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

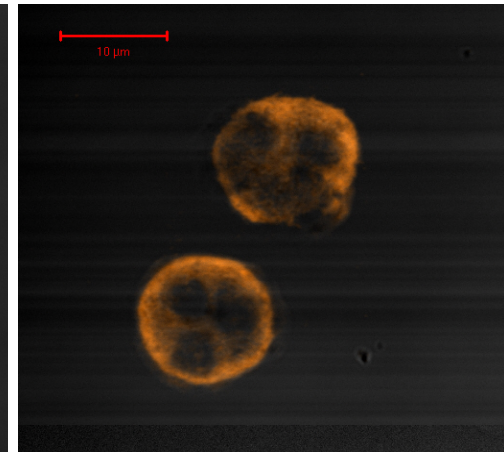
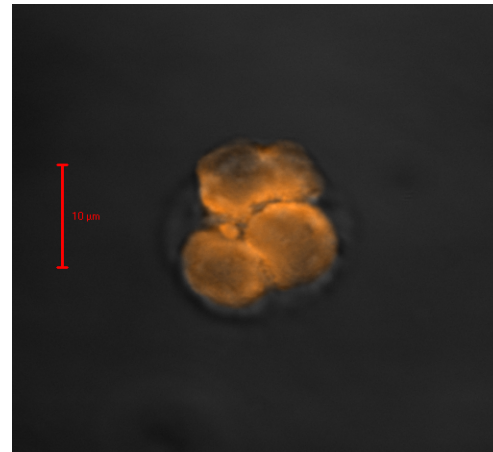
- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑ PTL)

- ANA (ENA./dsDNA)
- ANCA
- Anti-GBM Abs
- Complements
- Immunoglobulins
- (ASOT)
- (Cryoglobulins)
- (Rheumatoid Factor)
- (ECHO)

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑ PTL)



- ANA (ENA/dsDNA)
- ANCA
- Anti-GBM Abs
- Complements
- Immunoglobulins
- (ASOT)
- (Cryoglobulins)
- (Rheumatoid Factor)
- (ECHO)



Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

Bland urine/minor
changes/protein alone

n BP
· CK
· Uric Acid
· ?Eosinophils
· Myeloma Screen
· Anion Gap
(EG/Oxalate Levels)

↑ BP
· TMA Screen
· ANA (ENAs/dsDNA)
· (APL, ACLA)

Bland urine/minor
changes/protein alone

```
graph TD; A[Bland urine/minor changes/protein alone] --> B[n BP]; A --> C[↑ BP]; B --> B1[·CK]; B --> B2[·Uric Acid]; B --> B3[·?Eosinophils]; B --> B4[· Myeloma Screen]; B --> B5[· Anion Gap (EG/Oxalate Levels)]; C --> C1[·TMA Screen]; C --> C2[·ANA (ENAs/dsDNA)]; C --> C3[· (APL, ACLA)];
```

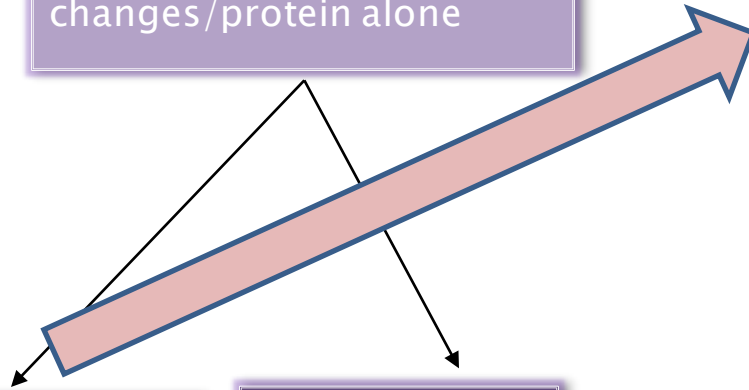
n BP

- CK
- Uric Acid
- ?Eosinophils
- Myeloma Screen
- Anion Gap (EG/Oxalate Levels)

↑ BP

- TMA Screen
- ANA (ENAs/dsDNA)
- (APL, ACLA)

Bland urine/minor
changes/protein alone



n BP
• CK
• Uric Acid
• ?Eosinophils
• Myeloma Screen
• Anion Gap
(EG/Oxalate Levels)

↑ BP
• TMA Screen
• ANA (ENAs/dsDNA)
• (APL, ACLA)

Myeloma Screen

- Serum Protein Electrophoresis
- Urine Protein Electrophoresis
- Serum Free Light Chains
- Immunoglobulins

Bland urine/minor
changes/protein alone

n BP
• CK
• Uric Acid
• ?Eosinophils
• Myeloma Screen
• Anion Gap
(EG/Oxalate Levels)

↑ BP
• TMA Screen
• ANA (ENAs/dsDNA)
• (APL, ACLA)

TMA

- Blood film
- Reticulocytes
- LDH/Bilirubin
- Haptoglobins
- Complements
- (ANCA)

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

↓Hb

↑Ca²⁺

· TMA Screen
· Myeloma Screen
· LDH
· ANA
(ENA, dsDNA)

· Serum ACE
· Myeloma Screen
· PTH

↓Hb & ↓PTL

· D-Dimer/Fibrinogen
· (ADAMTS-13/F actor H&I)

↓Hb

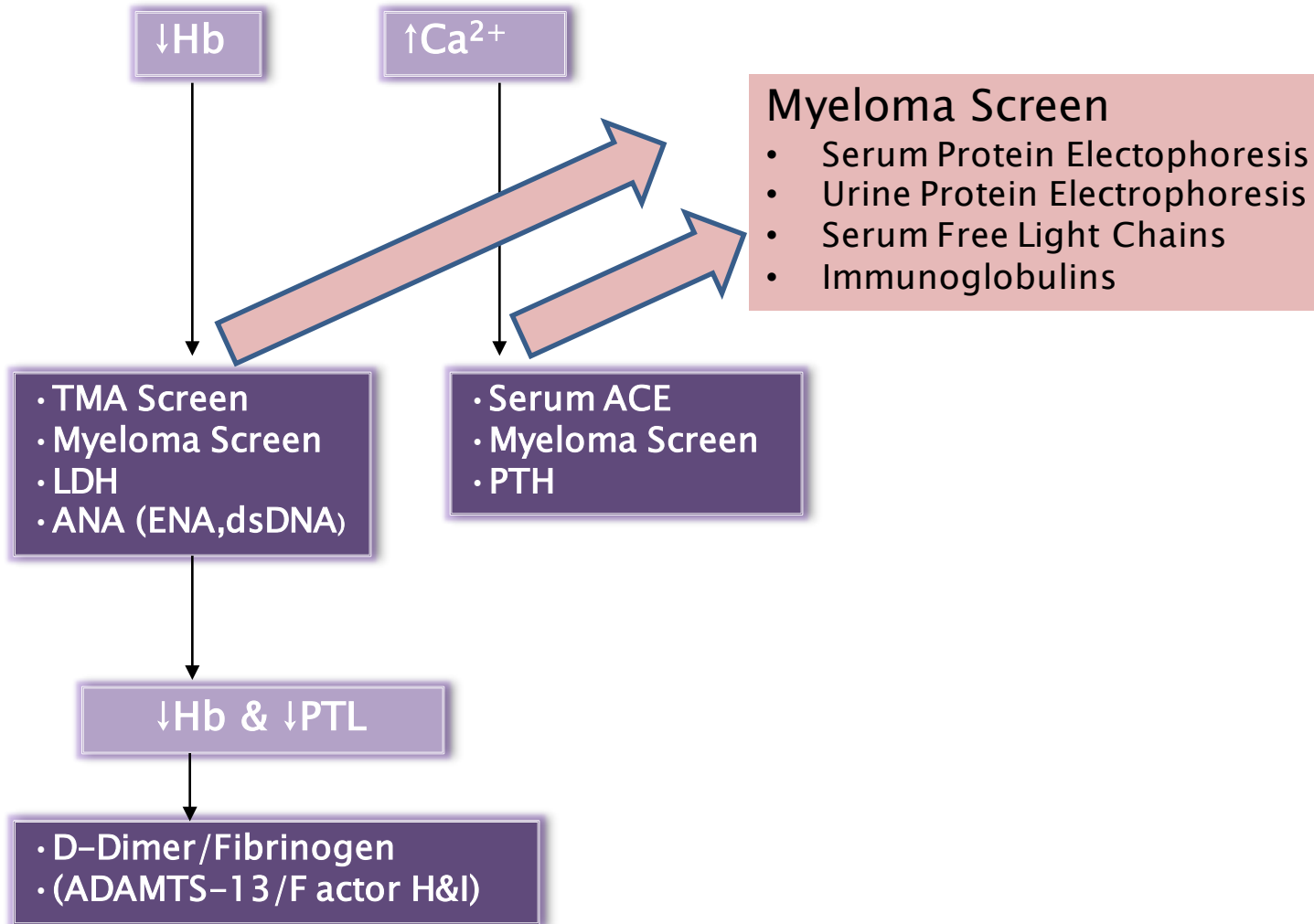
↑Ca²⁺

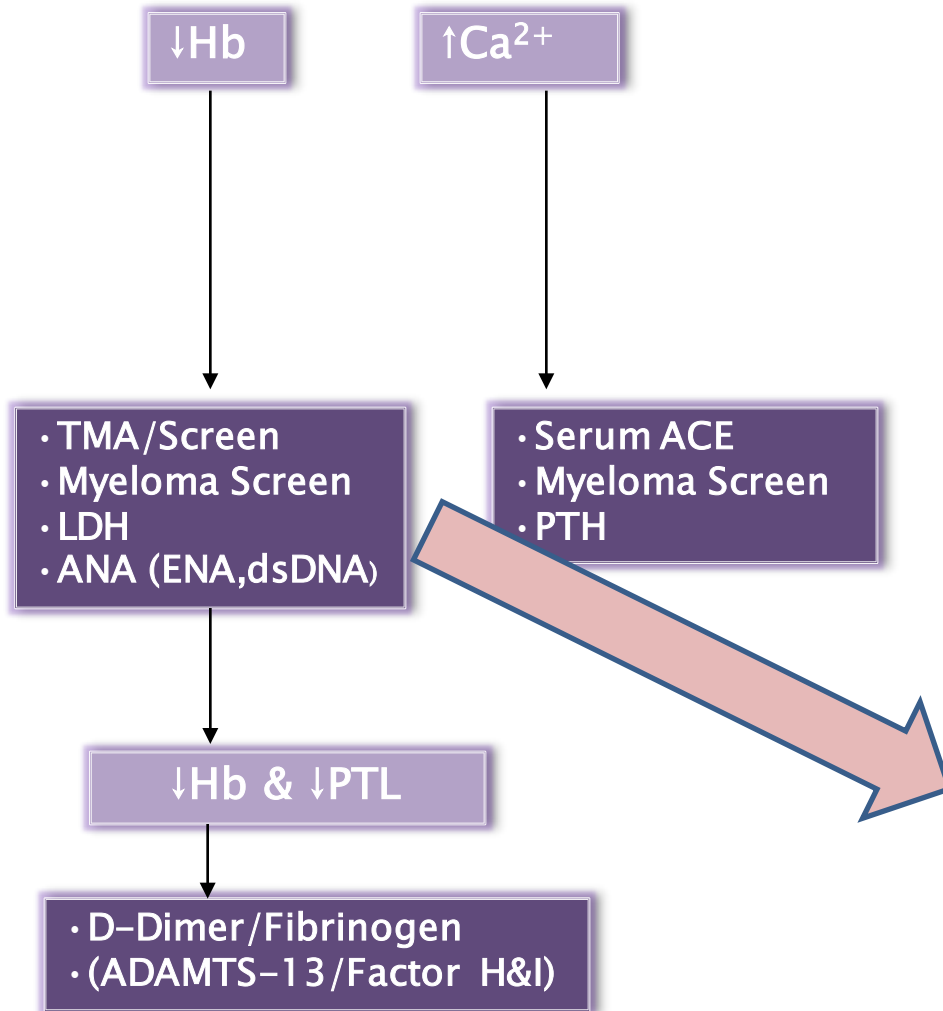
- TMA Screen
- Myeloma Screen
- LDH
- ANA (ENA,dsDNA)

- Serum ACE
- Myeloma Screen
- PTH

↓Hb & ↓PTL

- D-Dimer/Fibrinogen
- (ADAMTS-13/Factor H&I)





TMA/Haemolysis

- Blood film
- Reticulocytes
- LDH/Bilirubin
- Haptoglobins
- Complement
- (ANCA)

Case 4

- GP referral to A&E
- 52 year male
- Previously fit and well
- No previous renal history
 - Creatinine 67 (Work medical 8 months ago)
- PMH
 - Asthma



Case 4

- Presenting complaint
 - Increasing tiredness
 - HB 77
 - Creatinine 150



Case 4

- History
 - Some back pain
 - Postural dizziness
 - No other systemic symptoms



Case 4

- Examination
 - BP 128/96
 - HR 95
 - Dry mucus membranes
 - No rashes, arthralgia, ulcers



Case 4

- Urine Dipstick
 - Blood trace
 - Protein 2 +
 - Leucocytes negative



Case 4

- Urine Analysis

No crenated RBCs



Case 4

- Blood results

Hb **79**

Na 145

WCC 5.6 (normal diff)

K 3.7

PtI 330

Cr **166**



Case 4

- Blood results

CCa 2.9

Alb 31

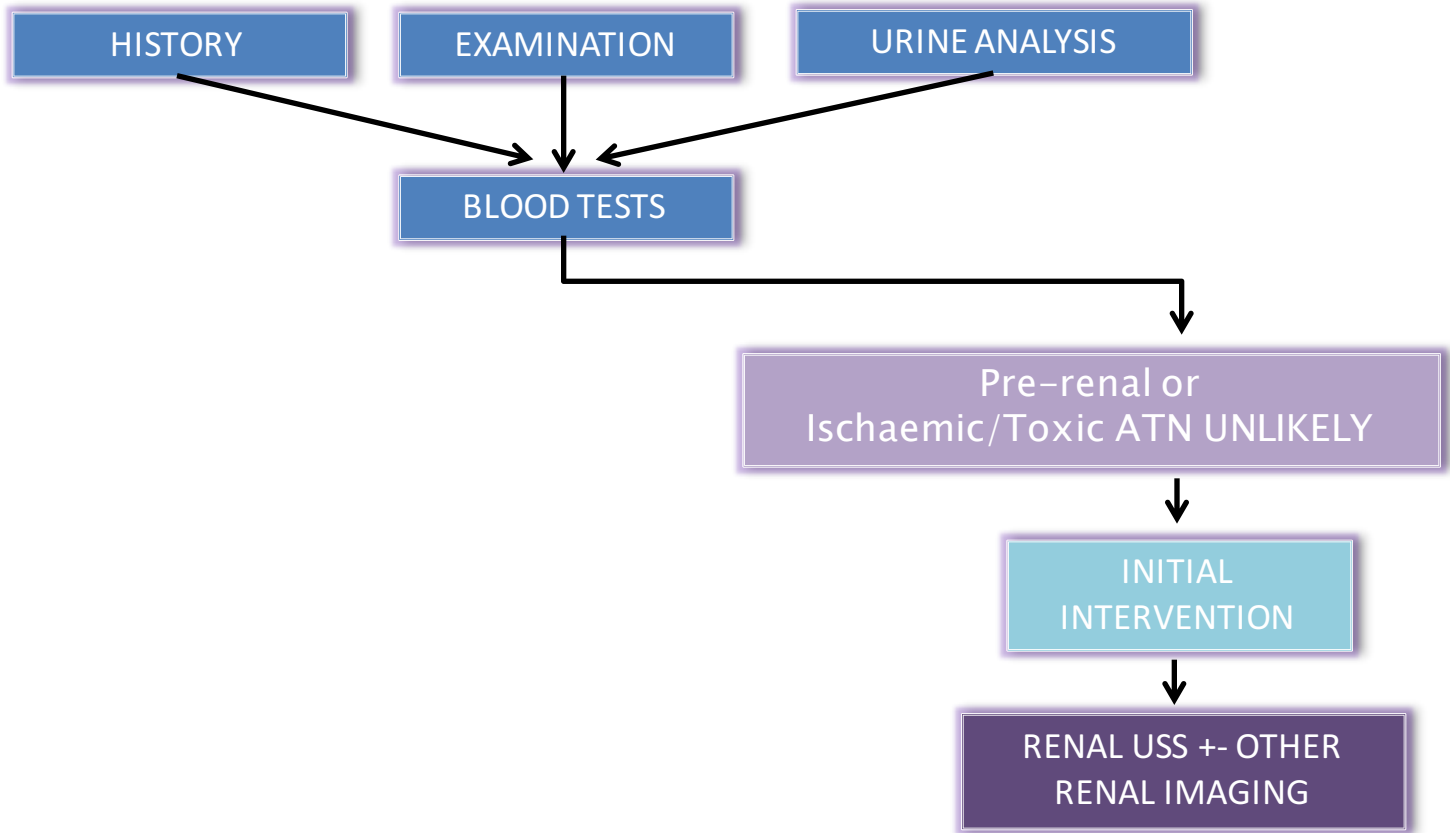
CRP 15

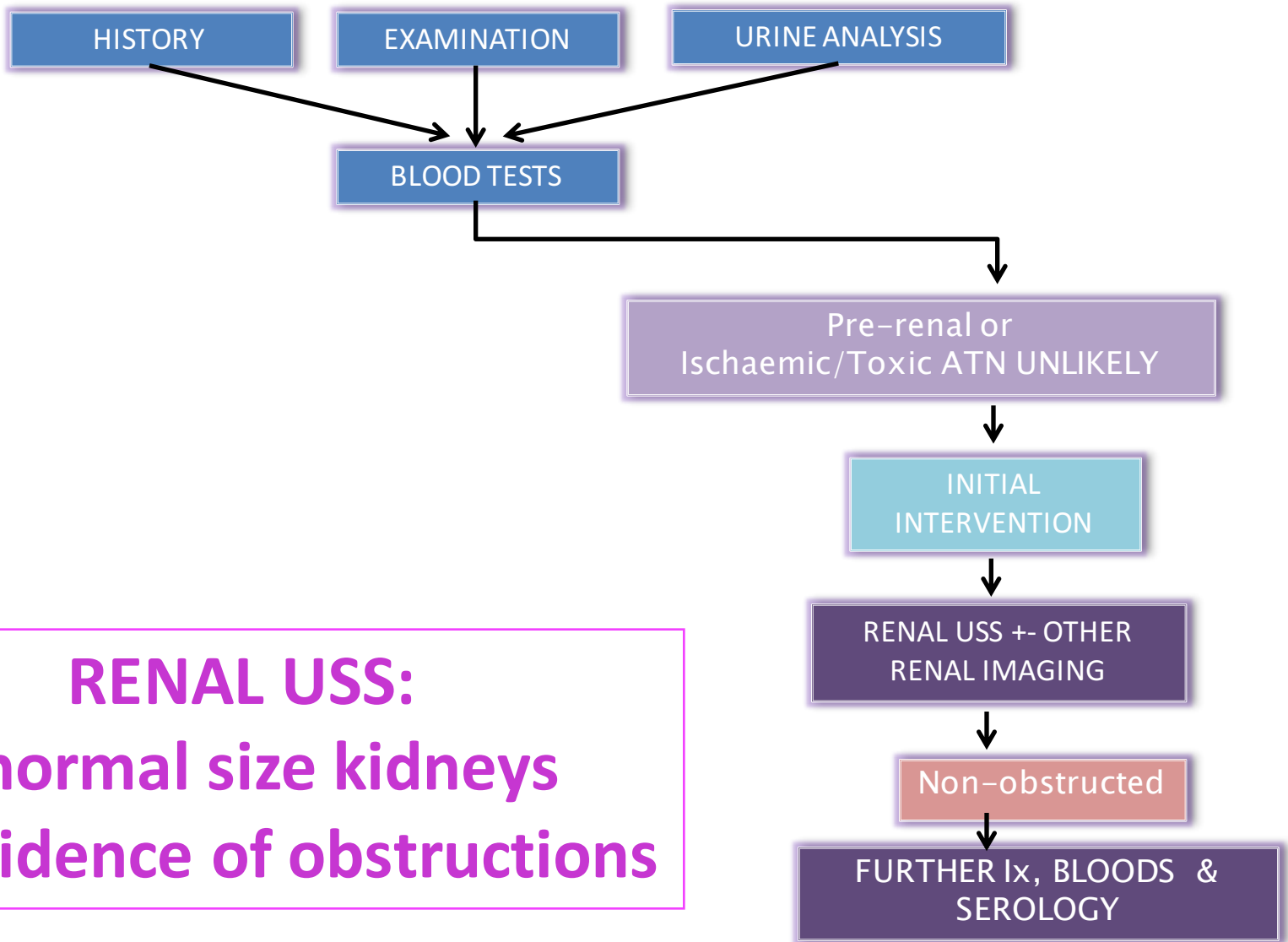


Case 4 – Care Bundle

- 1) Volume depleted but sepsis and distended bladder
- 2) 2 x bolus of fluid given. Appears euvolaemic. Maintenance fluid started
- 3) Potassium normal
- 4) Urine dipstick performed
- 5) No medications to review
- 6) Repeat creatinine next day 243
- 7) Renal USS requested urgently
- 8) Strict fluid balance chart started







RENAL USS:
2 normal size kidneys
No evidence of obstructions

Case 4

- Further Investigations

What else?



Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑PTL)

- ANA (ENA/dsDNA)
- ANCA
- Anti-GBM Abs
- Complements
- Immunoglobulins
- (ASOT)
- (Cryoglobulins)
- (Rheumatoid Factor)
- (ECHO)

Bland urine/minor
change/protein only

- n BP
- CK
 - Uric Acid
 - ?Eosinophils
 - Myeloma Screen
 - Anion Gap
(EG/Oxalate Levels)

- ↑ BP
- TMA Screen
 - ANA (ENAs/dsDNA)
 - (APL, ACLA)

↓Hb

- TMA Screen
- Myeloma Screen
- LDH
- ANA
(ENA, dsDNA)

↓Hb & ↓PTL

- D-Dimer/Fibrinogen
- (ADAMTS-13/Factor H&I)

↑Ca²⁺

- Serum ACE
- Myeloma Screen
- PTH

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

• Active Urine/Microscopy
• Systemic/ENT Symptoms
• Recent infection
• Rash
• (↑CRP, ↑PTL)

Bland urine/minor
change/protein only

↓Hb

↑Ca²⁺

• ANA (ENA/dsDNA)
• ANCA
• Anti-GBM Abs
• Complements
• Immunoglobulins
• (ASOT)
• (Cryoglobulins)
• (Rheumatoid Factor)
• (ECHO)

nBP
• K
• Uric Acid
• Eosinophils
• Myeloma Screen
• Anion Gap
(G/Oxalate Levels)

↑BP
• TMA Screen
• ANA (ENAs/dsDNA)
• (APL, ACLA)

• TMA Screen
• Myeloma Screen
• LDH
• ANA
(ENA,dsDNA)

• Serum ACE
• Myeloma Screen
• PTH

↓Hb & ↓PTL

• D-Dimer/Fibrinogen
• (ADAMTS-13/Factor H&I)

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
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Bland urine/minor
change/protein only

- n BP
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 - Uric Acid
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 - Myeloma Screen
 - Anion Gap
(EG/Oxalate Levels)

- ↑ BP
- TMA Screen
 - ANA (ENAs/dsDNA)
 - (APL, ACLA)

↓Hb

- TMA Screen
- Myeloma Screen
- LDH
- ANA
(ENA, dsDNA)

↓Hb & ↓PTL

- D-Dimer/Fibrinogen
- (DAMTS-13/Factor X&I)

↑Ca²⁺

- Serum ACE
- Myeloma Screen
- PTH

Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

- Active Urine/Microscopy
- Systemic/ENT Symptoms
- Recent infection
- Rash
- (↑CRP, ↑ PTL)

- ANA (ENA/dsDNA)
- ANCA
- Anti-GBM Abs
- Complements
- Immunoglobulins
- (ASOT)
- (Cryoglobulins)
- (Rheumatoid Factor)
- (ECHO)

Bland urine/minor
change/protein only

- n BP
- CK
 - Uric Acid
 - ?Eosinophils
 - Myeloma Screen
 - Anion Gap
(EG/Oxalate Levels)

- ↑ BP
- TMA Screen
 - ANA (ENAs/dsDNA)
 - (APL, ACLA)

↓Hb

- TMA Screen
- Myeloma Screen
- LDH
- ANA
(ENA, dsDNA)

↓Hb & ↓PTL

- D-Dimer/Fibrinogen
- (ADAMTS-13/Factor H&I)

↑Ca²⁺

- Serum ACE
- Myeloma Screen
- PTH

Case 4

- Further Investigations

- CXR
 - Normal
- Hepatitis Screen
 - Negative
- MSU
 - No growth
- uPCR
 - 150 mg/mmol



Case 4

- Further Investigations

– LDH	271
– Uric Acid	0.38
– CK	120
– Serum ACE	Normal
– ANA/ENAs	Negative
– PTH	Normal
– Anion Gap	18



Case 4

- Further Investigations

- Myeloma Screen

- ESR 65
 - Immunoglobulins Slightly raised IgG, IgA and IgM normal
?
 - S. Protein Electrophoresis IgG Kappa Paraprotein
?
 - U. Protein Electrophoresis IgG Kappa Paraprotein
 - (Serum Free Light Chains)



Case 4

- Renal Biopsy
 - Light chain deposition disease



Case 4

- BMA&T
 - Confirmation of diagnosis of myeloma



Not PRE-RENAL/Ischaemic ATN

Rapidly Progressive

RENAL USS +/- OTHER
RENAL IMAGING

24 hr

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

• Active Urine/Microscopy
• Systemic/ENT Symptoms
• Recent infection
• Rash
• (↑CRP, ↑ PTL)

Bland urine/minor
change/protein alone

↓Hb

↑Ca²⁺

24-48 hr

• ANA (ENA./dsDNA)
• ANCA
• Anti-GBM Abs
• Complements
• Immunoglobulins
• (ASOT)
• (Cryoglobulins)
• (Rheumatoid Factor)
• (ECHO)

n BP
• CK
• Uric Acid
• ?Eosinophils
• Myeloma Screen
• Anion Gap
(EG/Oxalate Levels)

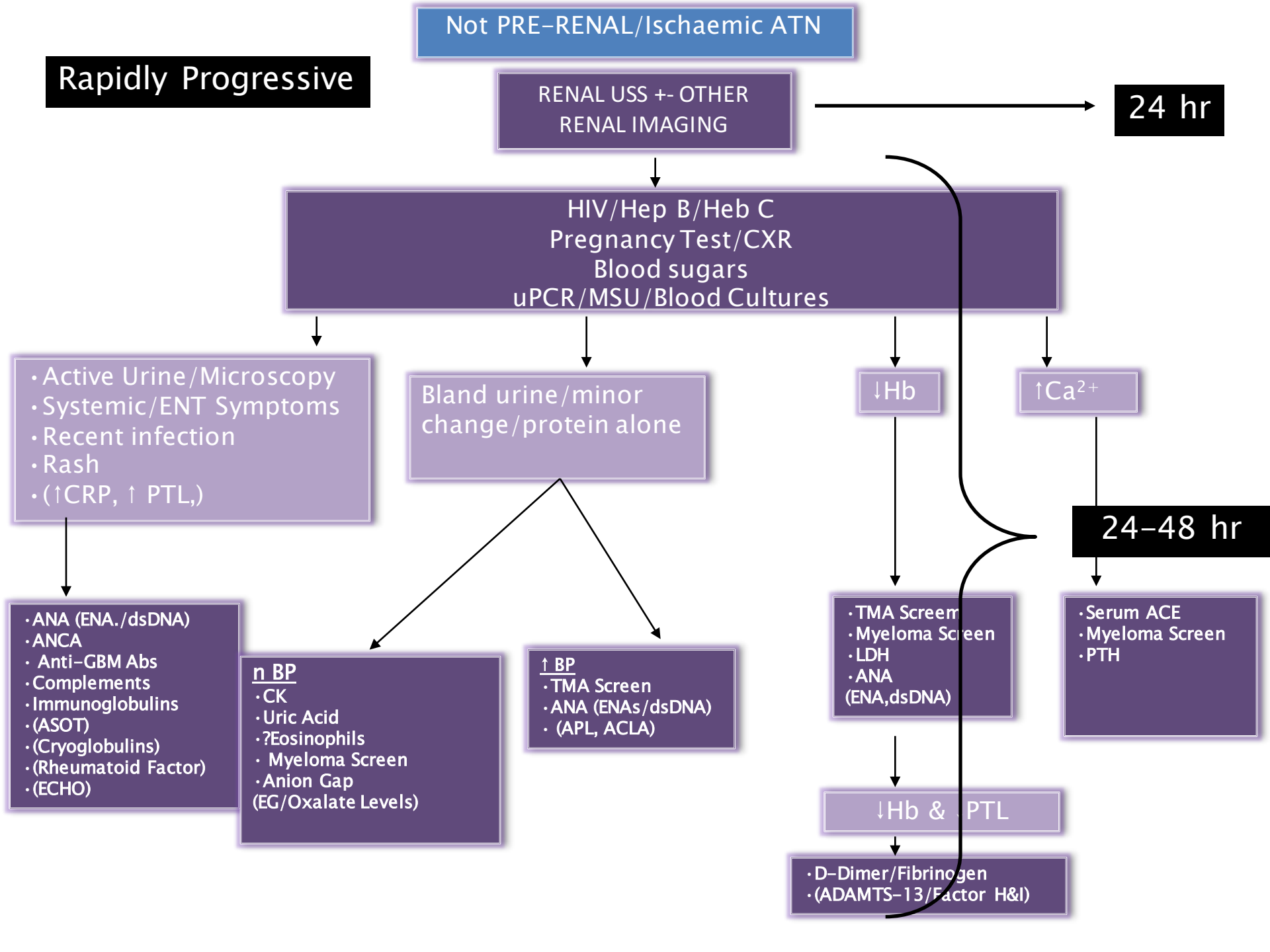
↑ BP
• TMA Screen
• ANA (ENAs/dsDNA)
• (APL, ACLA)

• TMA Screen
• Myeloma Screen
• LDH
• ANA
(ENA,dsDNA)

• Serum ACE
• Myeloma Screen
• PTH

↓Hb & PTL

• D-Dimer/Fibrinogen
• (ADAMTS-13/Factor H&I)



Not PRE-RENAL/Ischaemic ATN

Rapidly Progressive

RENAL USS +/- OTHER
RENAL IMAGING

24 hr

HIV/Hep B/Hep C
Pregnancy Test/CXR
Blood sugars
uPCR/MSU/Blood Cultures

• Active Urine/Microscopy
• Systemic/ENT Symptoms
• Recent infection
• Rash
• (↑CRP, ↑ PTL)

Bland urine/minor
change/protein alone

↓Hb

↑Ca²⁺

24-48 hr

• ANA (ENA./dsDNA)
• ANCA
• Anti-GBM Abs
• Complements
• Immunoglobulins
• (ASOT)
• (Cryoglobulins)
• (Rheumatoid Factor)
• (ECHO)

n BP
• CK
• Uric Acid
• ?Eosinophils
• Myeloma Screen
• Anion Gap
(EG/Oxalate Levels)

↑ BP
• TMA Screen
• ANA (ENAs/dsDNA)
• (APL, ACLA)

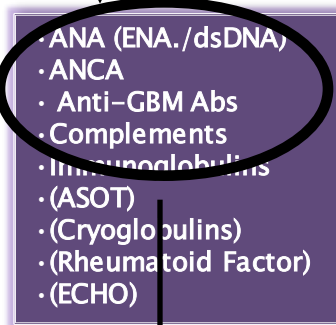
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(ENA,dsDNA)

• Serum ACE
• Myeloma Screen
• PTH

↓Hb & PTL

• D-Dimer/Fibrinogen
• (ADAMTS-13/Factor H&I)

12-24 hr



Case 5

- 37 year female presents to A&E
- Feels tired and exhausted
- Passing small amounts of urine



Case 5

- PMH
 - Pre-eclampsia , IOL 33/40 for hypertension 18/12 ago
 - Told everything fine
- Medication
 - OCP



Case 5

- Further History
 - Recent return from family holiday in Spain
 - Has had diarrhoea and vomiting (4 days)
 - Associated with fevers and abdominal pain
 - Settled 2 days ago
 - Other family members also sick



Case 5

- Systemic Features
 - Very fatigued
 - No arthralgia but generally achy
 - Rash developed today – purple spots
 - No heachaches



Case 5

- Examination
 - T 37.9
 - BP 150/95
 - HR 73
 - Clinically euvolaemic/No signs of sepsis
 - Purpuric rash over arms, trunk and legs
 - No distended bladder



Case 5

- Urine Dipstick
 - Blood trace
 - Protein 2+
 - Leucocytes trace
 - Nitrates negative
- Urine analysis
 - No crenated RBCs
 - Granular casts



Case 5

- Blood Results

Hb	74	Na	137
WCC	8.2	K	4.5
Plt	15	Cr	486
CRP	30		



Case 5

- Blood Results

CCa 2.45

Alb 35

Bilirubin 45



Case 5 – Care Bundle

- 1) Appears euvolaemic and not obviously septic clinically. Maintenance fluid started. Anuric
- 2) Fluid challenge – no response in UO
 - No further fluids yet
- 3) Potassium normal
- 4) Urine dipstick performed
- 5) No nephrotoxics
- 6) Repeat creatinine next day 513
- 7) Renal USS requested urgently
- 8) Strict fluid balance chart started



HISTORY EXAMINATION URINE ANALYSIS

BLOOD TESTS

Pre-renal or
Ischaemic/Toxic ATN Very Likely

Pre-renal or
Ischaemic/Toxic ATN UNLIKELY

INITIAL
INTERVENTION

INITIAL
INTERVENTION

WITHIN 24 HOURS

Cr/eGFR/UO
Improved

Cr/eGFR/UO
Not Improved

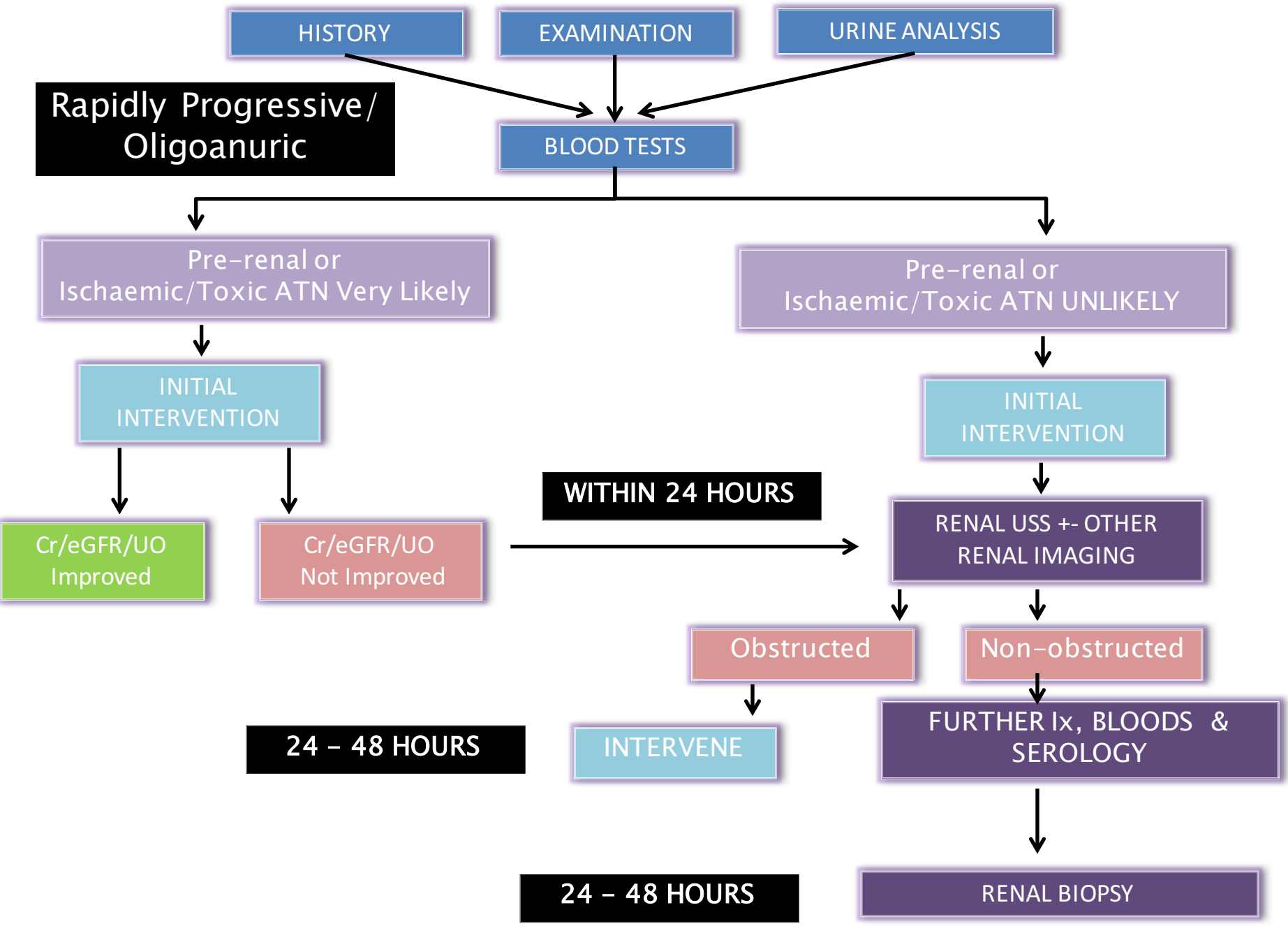
RENAL USS +- OTHER
RENAL IMAGING

Non-obstructed

FURTHER Ix, BLOODS &
SEROLOGY

RENAL BIOPSY

RENAL USS:
2 normal size kidneys
No evidence of obstructions



Not PRE-RENAL/Ischaemic ATN

RENAL USS +/- OTHER
RENAL IMAGING

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Pregnancy Test/CXR
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↓Hb & ↓PTL

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↓Hb & ↓PTL

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↓Hb & ↓PTL

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- (ADAMTS-13/Factor H&I)

↑Ca²⁺

- Serum ACE
- Myeloma Screen
- PTH

Case 5

- Further Investigation
 - CXR Normal
 - Virology Screen Negative
 - Pregnancy Test Negative
 - uPCR **110 mg/mmol**
 - MSU No growth
 - Blood cultures No growth
 - Stool cultures No growth



Case 5

- Further Investigations

ESR	10
LDH	768
Retics	4.5%
Haptoglobins	low
Blood film	Some fragments seen
INR	1.3
D-Dimers	Normal
Fibrinogen	Normal



Case 5

- Further Investigations

ANA/dsDNA/ENA	negative
ANCA	negative
Immunoglobulins	normal
Complement	normal
SPE/UPE	no paraprotein



Case 5

- Further Investigations

ADAMTS-13 Normal levels

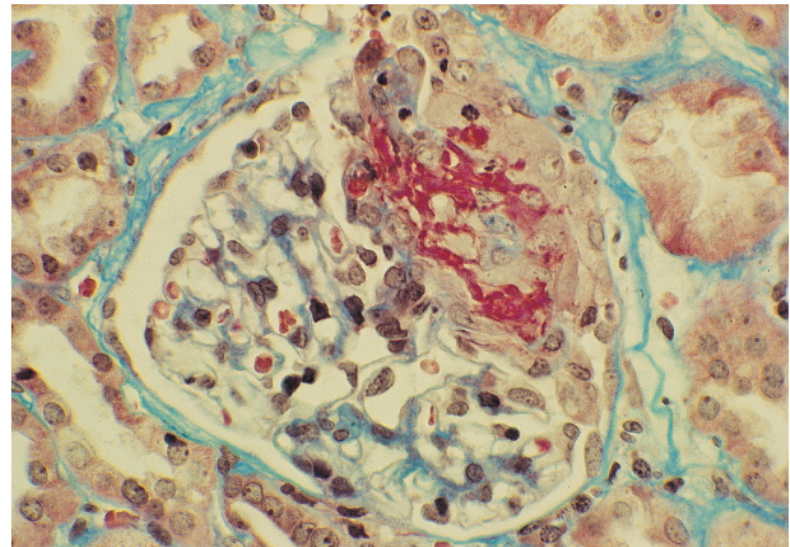
Atypical HUS Screen Pending



Indications for Biopsy

AIMS OF RENAL BIOPSY

- Establish a tissue diagnosis
- Assess prognosis
- Guide therapy



Indications for Renal Biopsy

- Unexplained AKI
 - Work up unhelpful/equivocal
- Suspected glomerular lesion
 - History/examination
 - Haematuria \pm casts, proteinuria
 - High BP (once controlled)
- Serological evidence of systemic disease
 - ANCA, ANA, Anti-GMB

Indications for Renal Biopsy

- Suspected Thrombotic Microangiopathy
- Presumed ATN/ATI
 - Non-recovery (2–4 weeks)
 - Prognostic value
- Pre-existing glomerular disease
- Presumed Tubulo-Interstitial Nephritis
- Presumed atheroembolic disease

Safe for Renal Biopsy

- BP controlled ($< 160/90$ mmHg)
- Ptl > 100
- Hb > 9 g/dL
- INR < 1.3 , APTT < 1.3
- Urea < 25 mmol/L
 - Dialysis to prepare if required

When not to jump the gun

- Unable to prepare patient safely
- Clinical Diagnosis pretty clear and
 - High Risk biopsy
 - Unable to prepare patient safely
 - Treatment option limited

Case 6

58 year male

- Presents with haemoptysis requiring ventilation
- AKI 3 requiring immediate filtration
- 3+Blood 4+ protein in urine

Case 6

- Hb 6.5
- Ptl 45
- Fragments on blood film
- ANCA negative 3 x
- ANA, Anti-GBM negative

Case 6

Biopsy?

Case 6

Biopsy?

- Initial treatment started (MP, PEX)
 - Assumed ANCA negative vasculitis
 - Treated for lung haemorrhage
- Poor response and clinical picture equivocal
- Biopsy would be really helpful!
- However:
 - Anaemic
 - Platelets – no incrementing
 - Then septic

Case 6

Biopsy?

Not fit for biopsy yet

Case 7

73 yr old man

Transfer from St Elsewhere for ECMO

- Nasal polyps and last onset asthma
- 2/52 history of haemoptysis
- Anuric
- ECMO
- Bronchoscopy – diffuse alveolar haemorrhage
- ANCA positive, PR3 Titre > 2000

Case 7

? Biopsy

Case 7

? Biopsy

- Clinical diagnosis seems pretty clear
- Treatment started for lung haemorrhage
- Intubated
- ECMO – anti-coagulated

NO BIOPSY

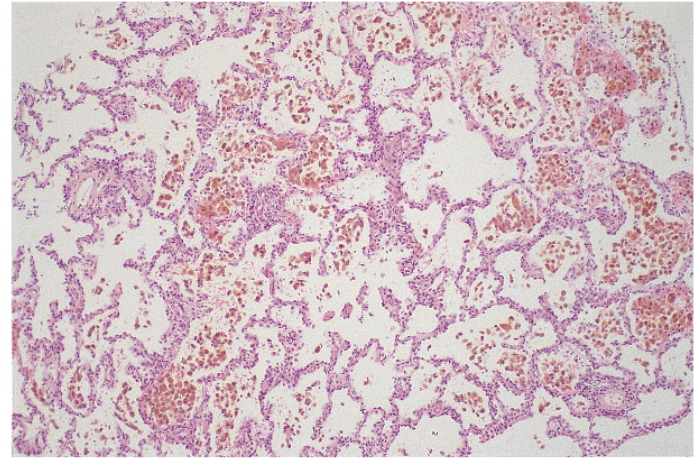
Case 8

68 year man, New Zealand

- Presented with haemoptysis
- Required intubation
- Creatinine 300 (baseline 78)
- 4+Blood and 3 + protein
- Anti GBM 534 U/MI

Case 8

Biopsy?

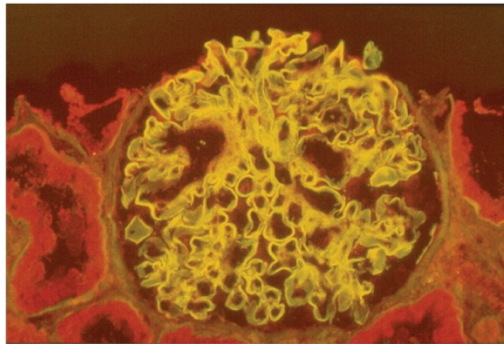


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Case 8

Biopsy?

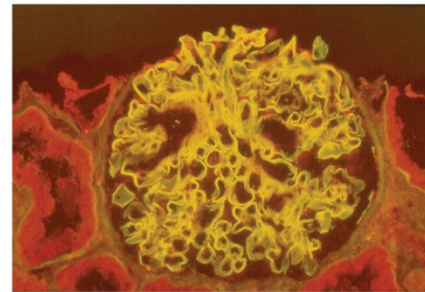
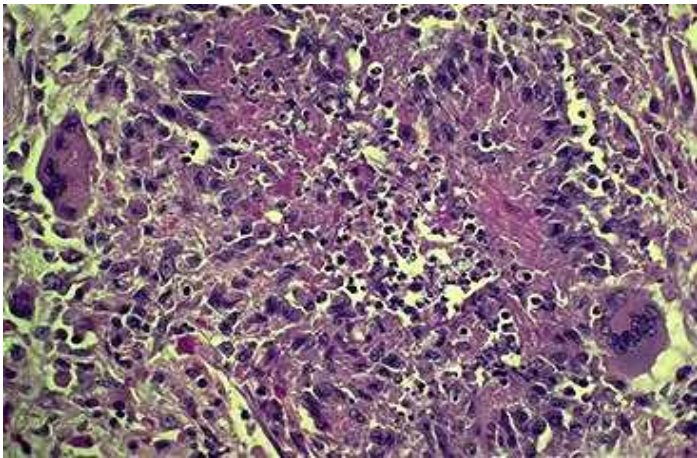
- Clinical diagnosis seems clear
- Respiratory function improved quickly on MP/PEX
- However renal function deteriorated to require



Case 8

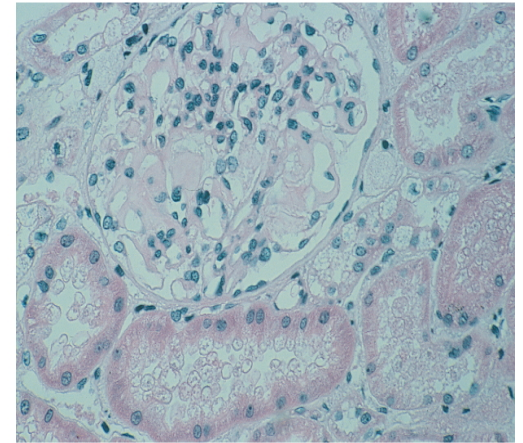
Biopsy was done

- Pauci-immune necrotising GN
 - 7 / 15 glomerular



Case 8

Biopsy was done



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- Pauci-immune necrotising GN
 - 7 / 15 glomerular
- Amyloid in remaining glomeruli
 - AL Amyloid
 - Rare inherited form of Amyloid