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SRI LANKA SOCIETY OF NEPHROLOGY

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PRE-CONGRESS WORKSHOP

PAEDIATRIC DIALYSIS

Bridging Gaps
In Practice and Knowledge

20 November 2025

E- WORK BOOK

With Answers

IPNA
International Pediatric Nephrology Association

SRI LANKA SOCIETY OF NEPHROLOGY
SLSON

6th Annual Academic Sessions 2025

Sri Lanka Society of Nephrology

PAEDIATRIC DIALYSIS

Bridging Gaps in Practice and Knowledge

20 November 2025

E- WORK BOOK
With Answers

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Station 01:
Troubleshooting in Peritoneal Dialysis

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Station 02:
Infection Control in Peritoneal Dialysis

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Station 03:
Mathematics in Hemodialysis
Including Solute Clearance, UF and Kt/V

Prof Rupesh Raina
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Station 04:
BP & Fluid Management in Dialysis

Prof Rukshana Shroff
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Station 05:
Emergencies During Hemodialysis

Prof Kar Hui Ng
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Station 06:
Dialyzing the Hemodynamically Unstable Child

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Station 07:
Vascular Access and Catheter Care

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Station 01:

Troubleshooting in Peritoneal Dialysis

Speaker: Prof Yap Hui Kim

Moderators: Dr Dinesh Rangana and Dr B. Umaginy

Objectives:

At the end of the session, participants are expected to understand:
1. Site of insertion of Tenckhoff catheter in infants
2. Strategies to solve the problem of regurgitation after feeding while on peritoneal dialysis
3. Exit site care in different case scenarios
4. Evaluate the causes of the hemoperitoneum in children
5. Evaluate the problem of poor ultrafiltration

Case scenario 1

Baby boy born full term with birth weight of 2770 g. Noted to be oedematous and oliguric since birth and was started on frusemide infusion with urine output of 100-150 ml/day (1.5-2 ml/kg/hr).
Day 1- Renal USS - both kidneys are enlarged and echogenic with multiple anechoic cysts
Serial serum creatinine - Day 1- 70 umol/L rising to 368 umol/L by week 4.
Renal biopsy at week 4- Presence of diffuse mesangial sclerosis consistent with Denys-Drash syndrome.
Infant became progressively oliguric, and a decision was made to insert a Tenckhoff catheter as he will probably require long term dialysis.

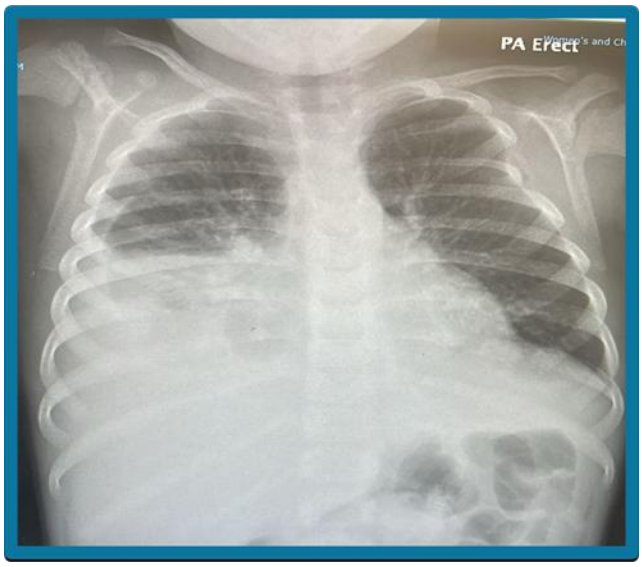
A. Where will you advise the surgeon to place the exit site of the Tenckhoff catheter in this infant?

Following Tenckhoff catheter (42 cm) insertion, patient was started on Nocturnal Intermittent Peritoneal Dialysis/NIPD at 200 ml/m^2 fill volume (50 ml) increasing gradually to 600 ml/m^2 (140 ml) by post-op day 21.
He started on milk feeds with EBM at 60 ml x 8 feeds.
On increasing feeds to 90 ml, he had frequent episodes of regurgitation after feeds resulting in failure to thrive.

B. What strategy can you offer to solve the problem of regurgitation after feeding?

The infant continued to vomit after increasing the PD fill volume while on NIPD.
Parents agreed to a gastrostomy tube insertion and simultaneous fundoplication.
After the surgery, PD commenced 2 days later. A week later he developed shortness of breath.

C. What is the most likely complication?



Case scenario 2

An 18-year-old boy has been on NIPD for the past 3 years.
He has been non-adherent to his dialysis plan and has not been doing his exit site care daily.
He finally turned up at the outpatient with this appearance of his exit site

(Image will be provided during the workshop.)

A. What is the complication?

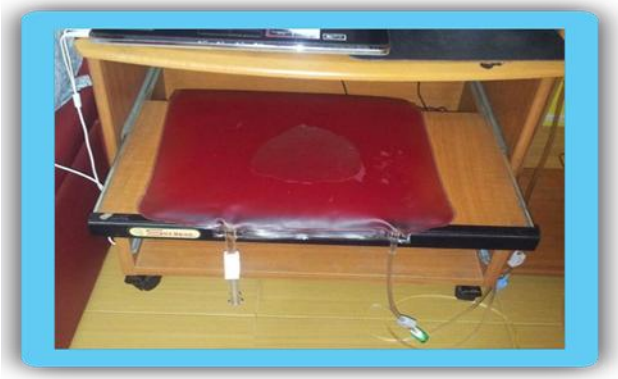
Extruded cuff was partially shaved off with a view to continue at next visit
Patient did not turn up again until 1 month later when he complained of yellowish fluid staining the exit site dressing
The Dialysis fellow believes there is a hole in the catheter

(Image will be provided during the workshop.)

B. What procedure will you perform now?

Case scenario 3

This 6-year-old boy with Jeune's asphyxiating thoracic dystrophy. He had bilateral polycystic kidneys and reached end-stage kidney failure at the age of 7 years and was started on APD. He also had congenital hepatic fibrosis with portal hypertension
One year after initiation of PD, he came to the outpatient with the drain bag as shown here.
Vital signs were stable: BP 110/60mmHg, pulse rate 90/min, respiratory rate 20/min.
Abdomen was soft and non-tender.
Exit site appeared clean.

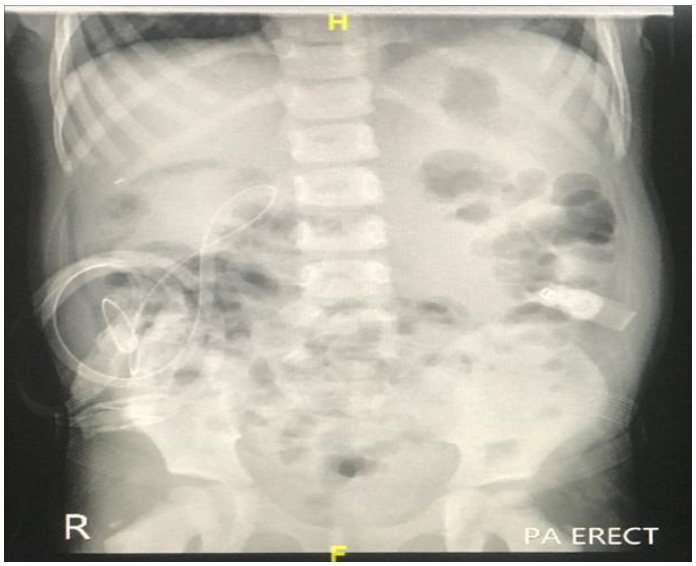


A. **What is the most likely cause of hemoperitoneum in this child?**

Case scenario 4

Miss HP was diagnosed with Denys-Drash syndrome. Following bilateral nephrectomy at 3 months of age, she was started on NIPD with increase in fill volume to 800 ml/m2, 2 hourly exchanges over 12 hours with 2.5% dextrose dialysate. Ultrafiltration was poor at between 10-50 ml per dialysis session and patient remained hypertensive.

A. What is the first investigation that you would do to evaluate the problem of poor ultrafiltration?



B. **Identify the investigation shown**

C. What is the abnormality?

D. What will you do next?

Station 02:

Infection control in peritoneal dialysis

Speaker: Prof Azmeri Sultana

Moderator: Dr Lasanthi Weerasooriya

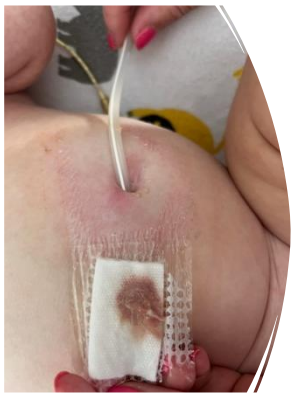
Objectives:

At the end of the session, participants are expecting to learn about how to diagnose and manage the following conditions.

1. Exit site infection
2. Tunnel infection
3. Peritonitis (gram +ve, gram -ve, fungal etc.)
4. Catheter contamination (wet and dry)

Case scenario - 01

2-year-old boy underwent CAPD primarily due to CAKUT with ESRD. He has been on CAPD for 6 months. His mother noticed spontaneous non purulent serous discharge from the exit site during routine care of it.
The exit site appeared otherwise normal & no tenderness on pressure

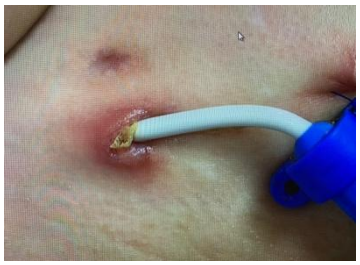
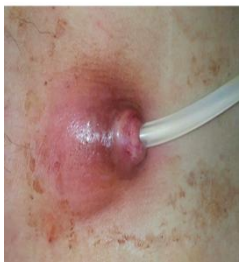


A. What immediate step will you take?

B. What is the diagnosis?

Case scenario - 02

A 3-year-old boy, with ESRD primarily due to dysplastic kidneys, started CAPD for the last 9 months. He presented to the dialysis OPD with complaints of pain in the exit site.
On examination, there is tenderness and induration of the exit site

A. **What is the exit site score?**

B. **What is the next best step you will consider?**

Case scenario - 03

6-year-old girl on CAPD (Continuous Ambulatory PD) for 8 months due to congenital nephrotic syndrome. Presents with fever, abdominal pain, and cloudy effluent. Effluent analysis Findings:
• Effluent WBC: 450 cells/mm³, 75% neutrophils.
• Gram staining of PD fluid revealed Gram positive cocci

A. **How do you confirm PD peritonitis?**

B. **Outline the management.**

Case scenario - 04

6-year-old girl on CAPD (Continuous Ambulatory PD) for 8 months due to congenital nephrotic syndrome.
Following three days of intraperitoneal vancomycin treatment, the patient's fever and abdominal pain subsided, and cultures confirmed the presence of methicillin-resistant Staphylococcus aureus (MRSA).

A. **What is your next course of action?**

Case scenario - 05

A 10-year-old child on automated peritoneal dialysis (APD) presents with wet contamination during a dialysis exchange. The caregiver notices fluid leakage at the catheter site.
What should be the immediate response of the caregiver?

Station 03:

Mathematics in haemodialysis including solute clearance, UF and Kt/V

Speaker: Prof Rupesh Raina

Moderator: Dr Achala Ratnayake

Objectives:

By the end of this session, participants should be able to:

1. Understand the key equations and parameters required to formulate a haemodialysis (HD) prescription for a child with newly diagnosed kidney failure.
2. Calculate total body water (V) and estimate the dialysis dose (Kt/V) and session duration to achieve desired clearance.
3. Select the appropriate dialyzer, blood flow rate, dialysate flow rate, and anticoagulation regimen, and determine priming requirements for a child.
4. Apply these principles safely in initiating the first HD session in a paediatric patient.

This station was intentionally designed as a principle-driven, interactive learning session. Therefore, no single case scenario is presented; instead, participants were guided through the prescription-writing process using practical examples and clinical judgement.

Station 04:

BP and Fluid Management in Dialysis

Speaker: Prof Rukshana Shroff

Moderator: Prof Shenal Thalgahagoda

Case scenario 1

An 8-year-old boy with posterior urethral valves and advanced CKD is seen in clinic. He has experienced increased lethargy and loss of appetite over the last 2-3 months. He passes good volumes of urine with a good stream and has not experienced any UTIs recently.
The family is from a poor socio-economic background with both parents being estate workers. They live in a small line room and do not have access to pipe borne water.
On examination he is found to be pale but well hydrated with no oedema.
His blood pressure is 90/60mmHg.

Anthropometric parameters are as follows;

Weight - 20kg
Height - 114cm
BSA - 0.8m2

Investigations reveal the following:

Hb 6.3 g%; MCV 85; MCH 28; RDW 14

Blood urea	- 28.2 mmol/L	(2.2 - 6.0)
Creatinine	- 587 µmol/L	(30 – 60)
Na	- 144 mmol/L	(135-145)
K	- 6.5 mmol/L	(3.5-5.5)
pH	- 7.20	(7.35-7.45)
HCO3	- 12 mmol/L	(22-28)

A. **What modality of dialysis would best suit this patient?**

B. **Outline the initial dialysis prescription**.

He is commenced on haemodialysis but frequently has episodes of symptomatic hypotension during dialysis.

C. **How would you alter your dialysis prescription?**

Three months into dialysis he is admitted with severe pyelonephritis with septicaemia and septic shock leading to AKI. He is resuscitated and treated with antibiotics. After this episode his urine output diminishes significantly and he becomes severely oliguric, passing only 100-200ml per day.

D. How would you alter his dialysis prescription at this stage?

He comes in for haemodialysis volume overloaded and hypertensive. His UF is prescribed accordingly and appropriately, and HD is commenced. One hour into dialysis he develops a headache with cramps. Blood pressure is found to be 85/45mmHg.

E. Why is the BP low?

F. How would you manage him at this stage?

With intense counselling he starts adhering to the recommended fluid intake and comes for dialysis with acceptable weight gain and is normotensive (110/70mmHg) at commencement of dialysis. However, blood pressure rises to 150/100mmHg during dialysis and goes up further to 170/110 immediately after dialysis.

G. How would you manage him at this stage?

Station 05:

Emergencies during haemodialysis

Speaker: Prof Kar Hui

Moderator: Dr Inoka Perera

Objectives:

At the end of the session, participants are expected to:

1. Understand the diagnosis, risk factors, prevention and management of dialysis disequilibrium syndrome.
2. Understand the diagnosis, causes and management of intradialytic hypertension
3. Understand the causes and management of intradialytic hypotension.
4. Diagnosis and management of a few other rare but potentially severe complications during HD

Case scenario 1

12 year old Geetha is admitted for acute renal failure secondary to newly diagnosed crescentic glomerulonephritis. She is mildly oedematous and weighs 40 kg (BSA is 1.3m^2) and has gained 1kg in weight since admission. Her lab results are as follows:

Urea - 50 mmol/l (300 mg/dl)
Creatinine - 700 umol/L (7.9 mg/dl)
Potassium - 6.5 mmol/l
Sodium – 138 mmol/l
Albumin - 28 g/dl

Size 12 Fr temporary, non-tunnelled dialysis catheter line was inserted through her right internal jugular vein. She is **afebrile** and **fully alert**. Her **heart rate is 90bpm** and her **blood pressure is 130/80 mmHg**. She is currently receiving her first haemodialysis treatment. Her dialysis orders are ;

Dialyzer - F6 (1.3 m^2) low flux
Targeted URR – 70%
Duration of HD – 2 hours
Blood flow rate – 200ml/min
Dialysate flow rate – 500ml/s
Targeted UF – 1litre

During the second hour of haemodialysis, she becomes **restless** and complains of **severe headache** and **nausea**. Her blood pressure is **140/100 mmHg**.

A. **What are the possible causes for her severe headache?**

Within a few minutes she **vomited** and complained of **muscle cramps**, **blurred vision** and **became confused**.

B. **What is the most likely cause for her symptoms?**

C. **What are the signs & symptoms of this condition?**

D. **What are the risk factors for developing DDS?**

E. **How will you manage suspected DDS?**

F. **How could the first HD prescription be amended to reduce the risk of DDS?**

G. **What other precautions can be taken to reduce the risk of DDS?**

Case scenario 2

12-year-old Molly with end-stage kidney disease secondary to bilateral dysplastic kidneys is receiving her regular dialysis treatment.-She has been on dialysis twice a week for 8 months and was last dialysed two days ago.

Her interdialytic weight gain is 1.5kg. She is on 3 anti-hypertensives, which were not served in the morning, and her pre-HD blood pressure was 120/70mmHg, heart rate 100 bpm and temperature 37^0C. Three hours into dialysis, she complains of a **headache**, and her **blood pressure measures 170/110 mmHg**, with a **heart rate of 120 bpm.**

A. What are the causes of intradialytic hypertension?

B. **How would you manage intradialytic hypertensive emergency?**

She then develops a generalized tonic-clonic seizure, which lasts a minute. She remained conscious after the seizure and on examination; there are no focal neurological signs.

C. What are the causes of dialysis associated seizures?

D. How will you manage the seizure?

E. What measures can be taken to prevent intradialytic hypertension?

Case scenario 3

10-year-old Akrum comes to the dialysis unit for his regular haemodialysis session with a interdialytic weight gain of 4 kg. His dry weight is 25 kg. The dialysis nurse attempts to achieve ultrafiltration to his dry weight over his regular 4-hour dialysis session.

After 2 hours of haemodialysis, he complains of **leg cramps**. His current **blood pressure is 85/60mmHg.**

A. **What are the causes of leg cramps during haemodialysis?**

B. **What are the causes of intradialytic hypotension?**

C. **How do you manage intradialytic hypotension?**

D. **How can you prevent intradialytic hypotension?**

Case scenario 4

15-year old Roy with end-stage renal failure is receiving his regular haemodialysis treatment via PermCath at the dialysis unit.

You are called by the dialysis nurse that Roy is **in distress** during 1st hour of haemodialysis. He is complaining of **chest pain** and visual **loss**.

The dialysis **machine is alarming** because there is **air in the circuit**. The dialysis nurse notices that the lumen of the catheter is cracked. Roy's **blood pressure has dropped, he is tachycardic** and **cyanosed.**

A. **What is the cause of Roy's symptoms and signs?**

B. **What are the causes for the above condition?**

C. **When will you suspect the condition?**

D. **How will you manage the patient in such a situation?**

E. **What are the precautions you can take to prevent this condition?**

Case scenario 5

8-year-old Susie with end stage kidney disease comes for her routine 3-hour dialysis. She weighs 30kg (BSA 1.1m^2) and starts dialysis with a F5 dialyzer.

Two hours into dialysis, the **alarm is activated,** and the **dialysate becomes pink**.

A. **What is the likely reason for the above?**

B. **What are the causes for the above condition?**

C. **What are the consequences of the above condition?**

D. **How will you manage the above situation?**

Station 06:

Dialysing the hemodynamically unstable child

Speaker: Dr Sidharth Sethi

Moderator: Dr Venuja Bandara

Objectives:

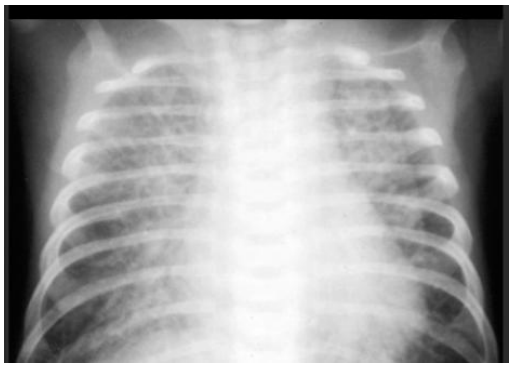
1) Understand modalities of dialysis in Acute kidney
2) Understand modality selection in a hemodynamically unstable child

Case scenario 1

A 2-month-old boy presented with fever, vomiting, and reduced urine output for 3 days. The child was lethargic and irritable on examination, with severe dehydration and delayed capillary refill time. Blood pressure was 60/40 mm Hg. He was resuscitated with fluids and started on inotropes.

Investigations showed:

Haemoglobin: 8 g/dL
Serum creatinine: 3.2 mg/dL (283 µmoll/L)
BUN: 98 mg/dL
Serum sodium: 130 mEq/L,
potassium: 6.2 mEq/L
Metabolic acidosis (pH 7.12, HCO_3 12 mEq/L)
Chest X-ray: as shown below



A. What is the diagnosis?

Despite initial resuscitation and medical management of hyperkalaemia, urine output remained minimal. The patient was hemodynamically unstable.

B. What modality of dialysis is preferred in this patient?

Case scenario 2

A 10-year-old girl with systemic lupus erythematosus presented with generalized oedema and shortness of breath. She had been on steroids and hydroxychloroquine. Examination revealed facial puffiness, pedal oedema, and fine basal crepitations. Her blood pressure is 80/50 mmHg.

Investigations revealed:

Serum creatinine: 5.8 mg/dL
BUN: 122 mg/dL
Serum albumin: 2.4 g/dL
Urinalysis: 3+ protein, active sediments
Complement C3 low, ANA positive
Chest X-ray: pulmonary oedema

A. What is the clinical diagnosis?

The child was hypotensive and had signs of pulmonary congestion, requiring immediate fluid removal. She was hemodynamically stable after antihypertensive management and oxygen support.

B. What dialysis modality is suitable in this scenario?

Case scenario 3

A 5-month-old infant post-cardiac surgery for VSD repair developed oliguria and progressive fluid overload in the postoperative period. The infant was intubated, on inotropes, and had rising serum creatinine and lactate levels.

Investigations revealed:
Serum creatinine: 1.8 mg/dL (baseline 0.3 mg/dL)
BUN: 65 mg/dL
pH 7.22, HCO_3 15 mEq/L
Weight gain of 12% from baseline weight
Echocardiography: mild ventricular dysfunction

a) What is the possible diagnosis?
b) What would be the best modality of dialysis at this stage?

Station 07:

Interactive Discussion on “Vascular Access and Catheter Care in Paediatric Haemodialysis”

Speaker: Ms Carmen Barton

Moderators: Dr Samanthika Egodawaththe and Dr Nayana Manorathne

Objectives:

At the end of the talk, participants are expected to

1) Understand the standard aseptic technique in haemodialysis catheter access including the hand hygiene and connection technique
2) Understand the parameters of vascular catheters that should be routinely monitored during routine haemodialysis
3) Understand the common catheter related complications and their preventive and management strategies

Answers

Station 01:

Troubleshooting in Peritoneal Dialysis

Case scenario 1

A. Where will you advise the surgeon to place the exit site of the Tenckhoff catheter in this infant?

Place catheter exit site away from the diaper line

a. Right hypochondrial region
b. Pre-sternal region

B. What strategy can you offer to solve the problem of regurgitation after feeding?
Limit dialysis period to 12 hours with lower feeding volume during dialysis /Place a gastrostomy tube

C. **What is the most likely complication?**
Hydrothorax – PD fluid passage through Foramen of Morgagni

Case scenario 2

A. What is the complication?
Extrusion of the superficial cuff

B. What procedure will you perform now?

Test the fluid on the dressing for glucose

Case scenario 3

A. **What is the most likely cause of hemoperitoneum in this child?**

Trauma caused by catheter tip

Notes

There are many causes for haemoperitoneum. The most common cause is trauma caused by catheter tip in an active child.

Other causes of haemoperitoneum include,

1.Menstrual bleeding:

Retrograde menstruation

Endometriosis

Mid-cycle bleed associated with ovulation

2.Catheter-related:

Post-catheter insertion or manipulation

Trauma or strenuous exercise

3.Bleeding disorder or anticoagulation therapy

4.Intra-abdominal pathology:

Hemorrhagic luteal cyst

Ruptured cysts - ovarian, liver or kidney

Ectopic pregnancy

Splenic rupture or infarct

Malignancy including liver carcinomatosis and renal cell carcinoma

Acute or chronic pancreatitis

Sclerosing peritonitis and peritoneal calcification

Vascular catastrophe

Case scenario 4

A. What is the first investigation that you would do to evaluate the problem of poor ultrafiltration?

X- ray abdomen

B. Identify the investigation shown

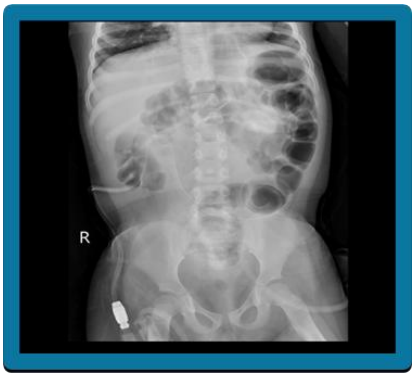
X -ray abdomen

C. What is the abnormality?

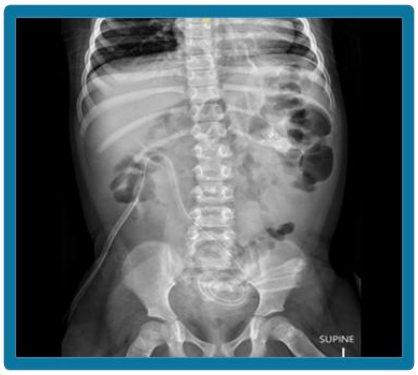
Catheter malposition and constipation

D. What will you do next?

Treatment of constipation



a) Catheter malposition



b) Post-rectal washout X ray

a) Catheter tip has migrated to left iliac fossa and there is evidence of constipation

b) Catheter tip is seen in the pelvis after post rectal washout.

Answers

Station 02:

Infection control in peritoneal dialysis

Case scenario 01

A. What immediate step will you take?

Collect a swab from the exit site to perform Gram staining and culture (which helps identify potential infectious pathogens)

B. What will be the diagnosis?

External cuff infection without ESI (exit site infection)

Case scenario 02

A. What is the exit site score?

>4

B. **What is the next best step will you take?**

a. Send exit site drainage for culture followed by empirical oral antibiotics
b. Ultrasound of dialysis catheter tunnel to exclude tunnel infection

Case scenario 03

A. How do you confirm PD peritonitis?

If Effluent contain - WBC >100 cells/mm³ with >50% PMNs + symptoms

B. Outline the management.

a. *Start IP antibiotics (e.g., vancomycin + ceftazidime)
b. Continue PD unless severe sepsis or fungal infection

Notes:
**Prophylactic treatment of oral fluconazole is recommended alongside antibiotics to prevent fungal peritonitis, as per ISPD guidelines*

Case scenario 04

A. What is your next course of action?

Stop Ceftazidime and continue with Vancomycin

Notes:
If response is poor, consider adding Rifampicin, duration 2 weeks

Case scenario 05

A. What should be the immediate response of the caregiver?

a. Clamp the PD catheter
b. Stop the PD exchange or procedure
c. Contact the medical team immediately

Answers

Station 04:

BP and Fluid Management in Dialysis

Case scenario 1

A. What modality of dialysis would best suit this patient?

Haemodialysis

- *Though on clinical grounds, continuous ambulatory peritoneal dialysis (CAPD) would be more suitable considering the normal urine output, blood pressure and euvolaemic status, the social circumstances preclude this.*

B. **Outline the initial dialysis prescription**.

1. Writing a dialysis prescription.

Consider:

1. Extracorporeal volume (circuit = dialyser + line)
2. Blood flow
3. Dialysate flow
4. Dialysate composition
5. Session length and frequency

Extracorporeal Volume (ECV)

- Maximum ECV tolerated without hemodynamic instability = 8-10% of the person's total blood volume (TBV)
- TBV = 70-80 ml/kg
- The volume of the lines + dialyser should not exceed the Max ECV

— Eg: Total blood volume – 70ml/kg

— Eg: 20kg child,

— TBW = 20 x 70
= 1400ml

Max ECV (8-10% of TBW)

= 112-140ml

In infants:

- Blood prime necessary if the ECV is exceeded (usually ~6kg body weight)
- There is no need for washback if blood primed

Central venous catheters

	Size	A	V	Approx child weight
Tesio (single lumen)	**6.5F 29cm/32cm**	**0.8**	**0.9**	**< 5kg**
Medcomp	**8 F 18cm**	**0.8**	**0.9**	**5-12kg**
Split Cath	**10 F 15cm**	**0.9**	**0.9**	**10-25kg**
	10F 18cm	**1.0**	**1.0**	**10-25kg**
	14 F 24cm	**1.6**	**1.7**	**> 25kg**
Permcath	**10 F 28cm**	**0.8**	**0.9**	**15-30kg**
	12 F 36cm	**1.3**	**1.4**	**>30kg**

Selection of the Haemodialyser

Dialyser types: High – mid – low flux

- Clearance of solutes
  – KoA of dialysers
- Ultrafiltration coefficient
  – KUF of dialysers
- Dialyser surface area = body surface area

- Priming volume

- Sterilant - ethylene oxide, steam, gamma irradiation

Range of dialyzers

Dialysers					**Clearance (ml/min)**				
Dialyser	SA (m^2)	Volume (ml)	Suitable for HDF?	UF Coefficient*	Urea	Cr	PO_4	Vit B_{12}	**Sterilant**
FX Paed**	0.2	18	No	7	76	64	57	34	Steam
FX 40***	0.6	32	Yes	20	170	144	138	84	Steam
FX 50***	1.0	53	Yes	33	189	170	165	115	Steam
FX 60***	1.4	74	Yes	46	193	182	177	135	Steam
FX 80***	1.8	95	Yes	59	197	189	185	148	Steam
FX 100***	2.2	113	Yes	73	198	194	189	161	Steam

* Ultrafiltration coefficient (ml/hr/mmHg)

** Values based on BFR 100mls/min, Dialysate flow 500mls/min

*** Values based on BFR 200mls/min, Dialysate flow 500mls/min

Range of paediatric lines available

- Mini neonatal 33mls
- Neonatal 41mls
- Paediatrics 75 - 85mls
- Adult 132-150mls

Fresenius

- Paediatric 107 mls
- PaediatricSN 142 mls
- Adult 192 mls

Note: ***In Sri Lanka, Fresenius also offers a baby line (70 mL).***

Blood flow

- As per ECV as ml/min
- Usually 6-8 ml/kg/min
- The higher the blood flow, the greater the venous pressure
- The higher the blood flow, the greater the volume of blood that will be processed
- Cut-off of solute clearance

Dialysate Flow

- 500 ml/min standard
- Variable rates (300 - 700 ml/min) may be possible
- Counter-current flow of dialysis fluid and blood enhances dialysis efficiency
- Co-current flow may be selected if less efficient dialysis is needed (e.g. high urea)

Dialysate Composition

Consider and adjust:

On the machine

- Sodium – Keep dialysate sodium within 10 mmol/L of serum sodium
- Default setting - 138mmol (range 134 – 140mmol/L)
- Bicarbonate - keep between 34 – 40mmol/L

Dialysate tank

- Glucose + / -: In paediatric practice, dialysate with glucose is usually used
- Combinations of Ca++ and K+ available
- Calcium 1.25 to 1.75mMol
- Potassium 1mmol, 2mmol, 4mmol
- Even with significant hyperkalaemia low potassium dialysates should be avoided due to the rapid clearance of potassium and consequent risk of hypokalaemia and related arrhythmias

Controlling ultrafiltration

- The UF should not exceed 5% of total body weight per session
- Therefore, over a 4 hour session:
  = 0.2 ml/kg/min
  = 12 ml/kg/hr

To increase UF	To improve tolerance of higher UF
• Isolated ultrafiltration • Profiling of UF rate • Sodium profiling (Dependent on vascular refilling)	• Slow / long / daily dialysis • Hemodiafiltration

He is commenced on haemodialysis but frequently has episodes of symptomatic hypotension during dialysis.

C. How would you alter your dialysis prescription?

How to prevent and manage intra-dialytic hypotension

- Careful assessment (and frequent reassessment) of dry weight, especially in infants and growing children – Better appetite after commencement of dialysis often leads to an increase in true/weight
- Avoid giving antihypertensives prior to dialysis – especially vasodilators
- Avoid rapid shifts of fluid
  - Slow and gentle UF - 'probing the dry weight'. Check blood volume.
  - Monitoring (BVM)
  - Sodium profiling
  - UF profiling
- Cooling the dialysate
- Avoid eating during dialysis – Consuming food leads to pooling of blood in splanchnic circulation
- Perform haemodiafiltration

Three months into dialysis he is admitted with severe pyelonephritis with septicaemia and septic shock leading to AKI. He is resuscitated and treated with antibiotics. Subsequent to this episode his urine output diminishes significantly and he becomes severely oliguric, passing only 100-200ml per day.

D. How would you alter his dialysis prescription at this stage?

- The concept of 'Dry weight' needs to be applied here, if not applied previously Dry-weight
  - The lowest tolerated postdialysis weight achieved via gradual change in postdialysis weight at which there are minimal signs or symptoms of hypovolemia or hypervolemia
- Oligo-anuric children need strict adherence to fluid restrictions as they are now

dependent on dialysis to remove fluid

- The interdialytic weight gain should not exceed the maximum recommended UF for a session

Further challenges in achieving dry weight:

He is stable for a while following the adjustments. However, he starts coming in for dialysis 2-3kg above his dry weight. He also is found to be hypertensive requiring 3 antihypertensive for blood pressure control.

- ***How would you manage him at this stage and how to increase the dialysis prescription?***

1. *Careful assessment (and frequent reassessment) of dry weight, especially in infants and growing children*
    - *Increase UF - 'probing the dry weight'. Check blood vol monitoring (BVM)*
    - *Sodium profiling*
    - *UF profiling*
2. *Reduce dialysate Na in steps of 2mMol/L – keep dialysate Na 5 mmol below serum sodium, provided the patient can tolerate it*
3. *Reassess fluid intake and dietary Na intake*
    - *The recommended maximum daily fluid intake should be calculated depending on the daily UOP, insensible losses, frequency of dialysis and the Max UF per session*
    - *The maximum fluid intake should include gravy and semi liquid foods. Encourage dry meals without gravy*
    - *The interdialytic weight gain should not exceed the maximum recommended UF for a session*
    - *Reduce salt intake. High salt promotes thirst*
4. *Stop antihypertensives, especially Ca channel blockers, as these prevent fluid removal due to vasodilatation*
5. *ACE-inhibitors / ARBs may help*
6. *Perform HDF*
7. *Perform frequent / daily dialysis*

He comes in for haemodialysis volume overloaded and hypertensive. His UF is prescribed accordingly and appropriately and HD is commenced. One hour into dialysis he develops a headache with cramps. Blood pressure is found to be 85/45mmHg.

E. Why is the BP low?

F. How would you manage him at this stage?

The concepts in the management of intradialytic hypotension need to be considered here as well.

- Careful assessment (and frequent reassessment) of dry weight, especially in infants and growing children – Better appetite after commencement of dialysis often leads

to an increase in true/weight

- Avoid giving antihypertensives prior to dialysis – especially vasodilators
- Avoid rapid shifts of fluid

Management includes:

- Slow and gentle UF - 'probing the dry weight'. Check blood volume.
- Monitoring (BVM)
- Sodium profiling
- UF profiling
- Cooling the dialysate
- Avoid eating during dialysis – Consuming food leads to pooling of blood in splanchnic circulation
- Perform HDF

If these measures fail remember:

Hypotension in the presence of fluid overload = cardiac failure
Assessment of cardiac status through a 2D Echocardiogram and adjustment of management is essential.

With intense counselling he starts adhering to the recommended fluid intake and comes for dialysis with acceptable weight gain and is normotensive (110/70mmHg) at commencement of dialysis. However, blood pressure rises to 150/100mmHg during dialysis and goes up further to 170/110 immediately after dialysis.

G. How would you manage him at this stage?

Causes of intra/post dialytic hypertension

- Fluid overload: the most significant factor
- Sympathetic Nervous System Activation
- Renin-Angiotensin System (RAS) over activity
- Arterial Stiffness

Contributory factors

- Erythropoietin
- Hyperparathyroidism

Management Strategies

- Volume Management: Lowering the target dry weight
- Dialysis Prescription:

    - Increase session time or frequency
    - Use lower dialysate sodium
- Consider subcutaneous EPO instead of IV
- Control hyperparathyroidism
- Medications:
    - Beta-blockers
    - ACE Inhibitors/ARBs
    - Calcium Channel Blockers (CCBs): Effective in volume-overloaded states

- Monitoring:
    - Home BP monitoring and ambulatory BP monitoring (ABPM) help track true levels.

HD Prescription Chart

Date						
Height (cm)						
Weight (kg)						
BSA (m^2)						
HD HDF(pre/post dilution) SN (single pump)						
Vo//Press control						
TBV (mls)						
ECBV: 8-10% (mls)						
Dialyser & SA (m^2)						
Dialyser Vol (mls)						
Dialysis Lines						
BFR (ml/min)Starting Session Washback						
Dialysate Temp						
Treatment Time						
Heparin iu/hr						
Heparin Stop Limit						
Sodium						
Bicarbonate						
Priming Solution						
GAMBRO (HD only)						
Type/Segment Size						
Line Vol (mls)						
TCV (mls)						
Dialysate Type						
Fluid Flow						
FRESENIUS (HD & HDF)						
Type/Line Vol (mls)						
TCV (mls)						
Dialysate Type						
HD/HDF Factor (2.0/1.3)						
AutoSub On/Off						
Autoflow On/Off						
BTM control On/Off						
BVM *passive/UF control						
Bolus Volume * 2.5mls/kg (max 5mls/kg)						
Signature						
Print Name/Designation						

Answers

Station 05:

Emergencies during haemodialysis

Case scenario 01:

A. What are the possible causes for her severe headache?

a. Dialysis disequilibrium syndrome (caused by an acute increase in brain water content due to osmosis).

b. Hypertensive encephalopathy

Within a few minutes she vomited and complained of muscle cramps, blurred vision and became confused.

B. What is the most likely cause for her new symptoms?

- Cerebral oedema related to Dialysis disequilibrium syndrome (DDS)

C. What are the signs & symptoms of DDS?

- Symptoms usually occur early in dialysis - within 1-2 hours into dialysis although it may happen later; identification of the at-risk patient is important
- Symptoms can be nonspecific and include,
  a. Headache
  b. Nausea and vomiting
  c. Restlessness and Confusion
  d. Muscle cramps or twitching
  e. Blurred vision
  f. Seizures
  g. In severe cases → coma or death (rare)

D. What are the risk factors for developing DDS?

a. First dialysis session

b. High pre-dialysis blood urea level (> 40mmol/l)

c. High rate of urea removal – high URR, blood flow rate

d. Infants and small children

e. Severe metabolic acidosis

f. Pre-existing neurological disease

g. Conditions causing cerebral oedema: eg hyponatraemia, hepatic encephalopathy

E. How will you manage suspected DDS?

- <u>For mild symptoms</u>

a. Slow down blood flow rate to reduce clearance (cannot be too low as it can cause access alarms).

b. Stop or slow down dialysate flow rate to reduce clearance

c. Stop HD if no clinical response to above in 30 minutes or symptoms worsens.

- <u>For moderate / severe symptoms or mild symptoms unresponsive to initial treatment</u>:

a. Stop dialysis immediately and call for help

b. Provide supportive care. – ABC, Oxygen via face mask

c. Increase the serum osmolarity by administering one of the following.

    - 20% Mannitol 1.25-5 ml/kg IV (maximum 62 ml) over 1-2 hours
    - 3% NaCl 3-5 ml/kg IV over 60 minutes
    - 50% dextrose 1ml/kg (maximum 50ml) IV slow bolus (not recommended in diabetes mellitus)

d. Send blood for BU, Cr, SE, Ca, Mg, VBG

d. Consider adjusting HD prescription for lower clearance, more frequent dialysis sessions, converting to daily slow, low efficiency HD or PD.

F. How could the first HD prescription be amended to reduce the risk of DDS?

a. URR

- Start with a low rate (< 40%) and gradually increase over the next sessions

eg; start with URR of 30% and increase to 60% followed by 90% during second and third HD sessions respectively.

b. Duration of HD

- Calculate the duration of dialysis according to the desired URR, blood flow, dialyzer size.

c. Blood flow rate

- Start with a low rate (3-5ml/kg/min) and use lowest possible for catheter size to maintain access pressure
- Gradually increase to 5-7ml/kg/min over the subsequent sessions

G. What other precautions can be taken to reduce the risk of DDS?

a. Administer 20% mannitol 1.25-5 ml/kg IV over 1-2 hours during HD session if the blood urea is > 40mmo/l. Mannitol should be given from the beginning of haemodialysis, not towards the end.

b. Consider prophylactic Phenobarbitone before start of haemodialysis if BU ≥ 60 mmol/l

c. Other possible measures if the risk of DDS is very high

- Using a small haemodialyzer – less than the patient's BSA
- Lower dialysate rate
- Co-current Qb and Qb
- Not to insert too large sized vascular catheter as this will cause the need for high blood flow
- Ramped hypertonic sodium dialysate (risk of hypertension)

Notes

Calculating the duration of dialysis for Geetha.

a) Dry weight = 40 – 3 = 37 kg, height = 150 cm, BSA = 1.2 m^2

b) Dialyzer = F5 (1.0 m^2 low flux) (80% - 100% of patient's BSA)

c) Blood flow rate = 3 x 37 = 111 = 100 ml/min

d) Target URR = 30% (first HD session)

e) The duration HD (t) can be calculated using the following equation.

$$\frac{Kt}{V} = -\ln \frac{C1}{C2}$$

- **Dialyzer urea clearance K for F5 dialyzer & blood flow rate 100 ml/min = 88 (check in Dialyzer Manufacturer's specifications)**

Dialyzer	KoA (urea) (ml/min)	Blood Flow (ml/min)								
		50	75	100	125	150	200	250	300	400
FX paed	170	40	52	**76**/60	-	-	-	-	-	-
FX CorDiax 40	547	45	67	88	107	124	**175**/151	170	-	-
Polyflux 6H	465	**50**/45	67	**97**/87	105	**136**/120	**167**/144	160	171	-
FX CorDiax 50	886	-	-	89	111	132	**191**/169	195	**255**/215	-
FX CorDiax 60	1164	-	-	-	-	133	**196**/174	205	**271**/229	**319**/263
Revaclear 300	1186	-	-	-	-	-	**196**/174	196/205	**272**/230	**323**/265
FX80	1292	-	-	-	-	-	**197**/175	208	**276**/234	270
Polyflux 140 H	998	-	-	-	-	-	**193**/159	185	**262**/206	**309**/236
Polyflux 170 H	1153	-	-	-	-	-	-	205	**270**/229	**321**/263
F4HPS	495	45	66	86	102	117	**170**/138	-	-	
F5HPS	606	-	67	88	106	122	**179**/148	165	**227**/177	-
F6HPS	746	-	-	-	109	127	**186**/157	177	**243**/192	213
F7HPS	789	-	-	-	-	128	**188**/159	180	**247**/196	218
F8HPS	848	-	-	-	-	-	**190**/162	184	**252**/201	**290**/224
Polyflux 14L	851	-	-	-	-	-	**190**/154	177	**252**/195	**293**/221

Numerals in bold are urea clearances obtained in manufacturer's in vitro testing.

- *Total body water V is calculated using Morgenstern equation for < 23 year olds*

Girls – 16.92 x BSA – 1.81

Boys - 20.88 x BSA – 4.29

V = 16.92 X 1.2 – 1.81 = 18.49 L = 18,494 ml

- *In $C_1/C2$ is given in the following table according to URR*

Urea reduction ratio (%)	C_1/C_0	$\ln(C_1/C_0)$
90	0.1	-2.302
80	0.2	-1.609
70	0.3	-1.204
60	0.4	-0.916
50	0.5	-0.693
40	0.6	-0.511
30	0.7	-0.357
20	0.8	-0.223
10	0.9	-0.105

In C1/C2 for URR 30% = 0.7 = - 0.35

- $t = - \ln C1 \times V = - (-0.357) \times 18{,}494 = 75$ minutes = 1 hour, 15 minutes

$\overline{C2} \quad \overline{K} \qquad \overline{88}$

Case scenario 2

A. What are the causes of intradialytic hypertension?

a. Volume-related causes

- Inadequate UF– excess extracellular volume remains leading to increased BP
- Overestimation of dry weight
- Rapid fluid removal – triggers sympathetic nervous system activation & vasoconstriction, raising BP

b. Dialysis-related causes

- High dialysate sodium concentration – sodium gain leads to volume expansion & vasoconstriction
- High dialysate calcium concentration – causes peripheral vasoconstriction
- Low dialysate temperature - causes peripheral vasoconstriction
- Contaminated dialysate (endotoxin exposure) – cytokine release causing vasoconstriction

c. Medication-related causes

- Erythropoietin administration during dialysis
- Withdrawal or missed dose of antihypertensive drugs

d. Sympathetic and hormonal activation

- Sympathetic nervous system over activity – in CKD
- RAAS activation during fluid shifts

e. Endothelial dysfunction with impaired nitric oxide release

f. Anxiety, pain, or stress during HD

B. How would you manage intradialytic hypertensive emergency?

a. **Review UF and slow down the UF rate if needed**

b. Recheck BP manually to confirm the elevation of BP

c. If elevated → start an IV antihypertensive to lower the BP **slowly**

- GTN – 1-10 mcg / kg/min (max 400mcg/min)
- Labetalol IV 0.25- 1 mg/kg slow IV push (max 40 mg per dose)
- Hydralazine IV 0.1 -0.2 mg/kg slow IV push (max 10 mg per dose)
- **Avoid rapid reduction in BP– target ≤ 25% fall in the first hour**

d. Reduce the blood flow rate or consider stopping dialysis if no response**.**

She then develops a generalized tonic-clonic seizure, which lasts a minute. She remained conscious after the seizure and on examination, there are no focal neurological signs.

C. What are the causes of dialysis- associated seizures?

a. PRES

b. Uraemic encephalopathy

c. DDS

d. Electrolyte and metabolic disorders – hypo & hypernatraemia, hypocalcaemia, hypoglycaemia

e. Haemodynamic instability - Hypertensive crisis, rapid onset hypotension

f. Hypoxemia

g. Air embolism

h. Removal of anticonvulsants by HD in patients with epilepsy

D. How will you manage her seizure?

a. Stop the dialysis session to identify the cause of the seizure

b. Resuscitate

- Airway, Breathing, Circulation (ABC)
- Give oxygen
- Place the child in lateral position

c. Seizure control

- If the seizure is prolonged (> 5 minutes) or recurrent, give IV midazolam 0.1 mg/kg

d. Immobilize the arm with AVF or AVG to protect the vascular access

e. Check bedside glucose and give dextrose if low.

f. Consider 20% mannitol if DDS is suspected

- Eg, if first dialysis, a high pre-HD urea level (>40mmol/l)

g. Check electrolytes immediately:

- Na^+, K^+, Ca^{2+}, glucose, BU

h. Consider isolated UF if severely volume overloaded

i. If the patient has a known cause for recurrent seizures, may continue dialysis with reduced blood flow rate.

j. Monitor BP, cardiac, GCS

E. What measures can be taken to prevent intradialytic hypertension?

a. Reassess true dry weight

b. Reassess UF rate

c. Reduce interdialytic weight gain – educate on salt and fluid restriction

d. Consider if antihypertensive should be given before or during dialysis.

- Antihypertensive drugs may be needed before HD to avoid sympathetic over activation during HD
- Antihypertensive drugs before HD may limit the rate of fluid removal

e. Optimize antihypertensive drug therapy if dry weight is achieved and the patient is still hypertensive

f. Consider additional dialysis sessions or longer dialysis time with intention to wean and stop anti-hypertensive medications

g. Avoid eating during dialysis

h. Correct anaemia slowly attaining target haemoglobin

i. Consider increasing dialysate temperature

j. Consider lower sodium in dialysate (5mmol/l below predialysate serum sodium)

Case scenario 03:

A. What are the causes of leg cramps during haemodialysis?

Tends to occur towards the end of a HD session.

<u>Predisposing factors:</u>

- Hypotension with plasma volume contraction (most common)
- Hyponatraemia / Low sodium dialysate
- Hypocalcaemia
- Hypomagnesemia
- Tissue hypoxia

- Carnitine deficiency

His leg cramps after 2 hours of haemodialysis are due to intradialytic hypotension as his blood pressure at the time was low (85/60 mmHg).

B. What are the causes of intradialytic hypotension?

a. Patient related factors

- Excessive interdialytic weight gain (>3% of body weight)
- Incorrect dry weight target (the child has gained weight!)
- Antihypertensive or other medications that lower the BP given before dialysis
- Food consumption during dialysis

b. Dialysis related factors:

- Too large extracorporal volume (> 10% of patient blood volume)
- Too rapid UF rate
- Blood and dialyzer membrane reactions

c. Cardiac causes: poor left ventricular function, arrhythmias, diastolic dysfunction

a. Septicaemia, anaemia

b. Rare causes: air embolism, occult haemorrhage

C. How do you manage intradialytic hypotension?

a. Decrease or stop UF rate depending on severity of hypotension.

b. Reduce the blood flow rate.

c. Place the patient in Trendelenburg position

d. Give oxygen

e. Give 0.9% saline or 5% albumin IV bolus 5 -10 ml/kg

f. Treat intradialytic hypocalcamia

g. Consider dopamine infusion if dialysis needs to be continued

h. Stop dialysis if refractory to initial treatment

i. If recurrent, consider midodrine

j. Investigate for possible causes

- Examine HD access or other sites for evidence of infection
- Urgent ECG to exclude acute myocardial infarction and pulmonary embolism

D. How can you prevent intradialytic hypotension?

a. Reassess patient's target dry weight

b. Advise patient to avoid large interdialytic weight gain by adhering to fluid restriction and limiting salt intake.

c. Advise patient to take antihypertensive medications after, and not before, HD

d. Avoid food consumption during dialysis

e. Review dialysis prescription:

- Decrease UF rate by increasing duration of ultrafiltration
- Isolated UF (iso –UF) or sequential UF-HD
- Additional dialysis sessions per week or longer dialysis duration

f. Crit line monitoring

g. UF profiling, iso-UF

h. Sodium profiling

i. Use of low dialysate temperature (35.5^0C): improves cardiovascular contractility and increasing venous tone

j. Consider selective alpha-1 adrenergic agonist midodrine

Case scenario 4

A. What is the cause of Roy's symptoms and signs?

Air embolism – air enters the venous system via the cracked catheter

B. What are the causes for air embolism?

a. Accidental disconnection of the HD catheter
b. Dislodgement of arterial needle in AV fistulas
c. Air entry during connection or disconnection of dialysis circuit
d. Loose connectors
e. Defects in HD catheter
f. Tubing fluid level in venous chamber becomes too low

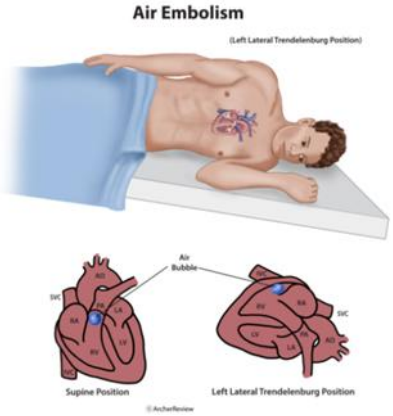
C. When will you suspect the condition?

Clinical suspicion during dialysis (especially with catheter use).

a. Usually sudden onset dyspnoea
b. Chest pain (sharp, pleuritic)
c. Tachypnoea
d. Tachycardia
e. Low oxygen saturation ($SpO_2 \downarrow$)
f. Cough or hemoptysis (if lung infarction occurs)
g. In seated patients- migration of embolus in to central venous system causes altered level of consciousness, seizures or neurological deficits
h. In severe cases → collapse, hypotension, or cardiac arrest

D. How will you manage the patient with air embolism?

- Act fast
- Stop dialysis immediately
- Position the patient correctly in the left lateral decubitus position to keep the air bubble out of the right ventricular outflow



- Prevent more air from entering the venous system.
    - Clamp the venous line immediately between the crack and the exit site
    - If you cannot get above the crack, cover the crack with an air-tight bandage

- Resuscitate as required and give 100% oxygen via face-mask
- If the patient is dialyzed through a central line, attempt to aspirate the air bubble.
- Arrange for removal and exchange of the cracked catheter immediately

E. What are the precautions you can take to prevent air embolism?

a. Avoid prolonged use of central venous catheters.
b. Use arteriovenous fistula whenever possible.
c. Ensure air detectors on dialysis machines are functioning properly.
d. Use anticoagulation appropriately during HD (unless contraindicated).
e. Encourage leg movement and ambulation between sessions to prevent DVT

Case scenario 5

A. What is the likely reason for the above?

Blood leak: Leakage of blood into the dialysate compartment due to damage to the dialyzer hollow fibre.

B. What are the causes for blood leak?

a. Manufacturing defect in the dialyzer
b. Excessive transmembrane pressure causes dialysis fibre rupture.
c. Mechanical stress or damage during setup or transport.

C What are the consequences of blood leak?

a. Loss of blood from the patient.
b. Contamination risk – dialysate is non-sterile, therefore blood leak can allow infection.

D. How will you manage?

- When the blood leak alarm detector alarms, blood pump stops automatically

a. Check dialysate effluent for gross blood staining.
b. If dialysate effluent is clear, check effluent with dipstick for blood
c. Stop dialysis immediately if blood is detected in the dialysate effluent.
d. **Do not return the extracorporeal blood to the patient**.
e. Clamp lines and disconnect safely.
f. Consider restarting dialysis with a new dialyzer and circuit on a different machine if necessary.
g. Send blood for culture and start empiric antibiotic treatment till culture results are back.
h. Investigate the cause (machine alarm, dialyzer batch, etc.).

Answers

Station 06:

Dialysing the hemodynamically unstable child

Case scenario 01:

A. What is the diagnosis?

Septic shock with oliguric AKI

B. What modality of dialysis is preferred in this patient?

Peritoneal dialysis using a rigid Tenckhoff catheter, with careful prescription and monitoring of dwell times and ultrafiltration.

Case scenario 02:

A. What is the clinical diagnosis?

Lupus nephritis flare with AKI and volume overload

B. What dialysis modality is suitable in this scenario?
Intermittent haemodialysis (IHD) was chosen over PD for faster solute clearance and fluid removal. Dialysis was initiated with a double-lumen catheter and monitored for blood pressure fluctuations

Case scenario 03:

A. What is the possible diagnosis?

Post-cardiac surgery AKI with fluid overload and metabolic acidosis.

B. What would be the best modality of dialysis at this stage?

Continuous renal replacement therapy (CRRT) was chosen as the modality of RRT. Continuous veno-venous hemodiafiltration (CVVHDF) was initiated using a paediatric circuit, with gradual fluid removal to maintain hemodynamic stability and optimize cardiac function.

Notes:

These cases highlight the spectrum of AKI in critically ill children and the need for individualized modality selection. PD remains the modality of choice in infants and hemodynamically unstable patients, IHD enables rapid clearance when tolerated, and CRRT provides continuous fluid and solute control in unstable postoperative or septic patients. A structured protocol-based approach ensures safety and better outcomes. Modality choice should be guided by clinical context, protocols, and available resources.