

Learning Pack: Acute Paediatrics / Paediatric Intensive Care

This learning pack can be used for local teaching and for individual reading and reflection. Several activities have been designed and they have been mapped to the RCPCH Progress curriculum. Feel free to use any or all of this pack in your department. If you wish, you can reflect on the learning activity and upload to your e-portfolio linking to the relevant domains.

Other learning packs are available on <https://londonpaediatrics.co.uk/>

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1.0 The Deteriorating Child with Abdominal Pain

Activity duration: 45 mins

Objectives

- Learn to recognise and assess the deteriorating child within a ward-based setting
 - Recognise potential difficulties/pitfalls in the management of acutely unwell children in the ward-based setting
 - Explore differences in the presentation and evaluation of children with abdominal pain, with particular focus on PIMS-TS versus appendicitis
 - Appreciate the benefits and risks of different inotropes
 - Understand the practical prescription of inotrope infusions
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Activity 1.1: Case based discussion (40 mins)

(5 minutes reading time, 35 minutes group discussion of questions and case)

Facilitator: Consultant or registrar

- To only provide the clinical vignette to the participants (not the questions)
- To chair discussion of the case using the discussion points below.
- Discuss the current best practice supportive care for a shocked child, with differentials and highlight the importance of early intensive care discussion in fluid refractory shock

Participants: SHOs, SpR, nurses

- Read the clinical vignette below
- Discuss as a group your next management steps

Activity 1.1 continued

Clinical vignette:

Ahmed is a 7-year old boy, who presented to your emergency department 8 hours ago. His mum reported he had diarrhoea for 5 days with vomiting for 2 days. She had been attempting to manage this at home with water and bland food but in the last 24 hours Ahmed has not tolerated anything orally. His mum states he had been febrile for 2-3 days, but had not been himself for at least 5 days. He had been complaining of dull abdominal pain in the ED. He had analgesia and has failed an oral fluid challenge. He was assessed to be clinically dehydrated and was commenced on IV fluid therapy with 5% correction and admitted to the ward. Bloods were sent prior to admission.

Ahmed was admitted to the inpatient paediatric ward 2 hours ago for IV fluid therapy and further observation, and a nurse has asked you to review him as she has become concerned about Ahmed's observations.

On review:

- Obs: HR 130, central CRT 4s, BP 70/40, RR 35, Temperature 39.3C, Sats 98% in room air
- Medication: PRN paracetamol and iv ondansetron
- Fluids: Maintenance, 5% correction for dehydration
- On examination:
 - Generally pale, cracked, dry lips with poor skin turgor. GCS 15
 - Respiratory: Tachypneic, no significant work of breathing, good air entry Bilaterally
 - CVS HS 1+11+0
 - Abdomen generally tender, guarding in the RIF, BS present
 - No rash, swollen joints, or other focal sign of infection.

What are the next most important steps in management? What other investigations would you ask for?

Activity 1.1 continued

Venous blood gas

pH 7.28; CO₂ 4.5, pO₂ 5.7, Na 147, K 2.6, Glucose 3.0, HCO₃ 17, BE -6, Lactate 4

Despite 60ml/kg of fluid boluses, his blood pressure fails to remain above 70 systolic, and repeat blood gases show a worsening acidosis.

- **What is the current differential diagnosis? How does the diagnosis of PIMS-TS versus appendicitis change the acute management of a shocked child in the first hour?**
- **What are the main challenges in managing the patient on an inpatient paediatric ward versus ED?**
- **Identify what resources may be required in the management of the child in refractory shock, and where these would be located on your paediatric inpatient ward? (for e.g. inotropes, pressure bags, intraosseous access kit, arrest trolley, syringe drivers)**

You may wish to move on to activity 2.

Resources:

1. [NICE guidance: Sepsis risk stratification tools: children aged 5-11 in-hospital](#)
2. [Harwood et al \(2021\) A national consensus management pathway for paediatric inflammatory multisystem syndrome temporally associated with COVID-19 \(PIMS-TS\): results of a national Delphi process. The Lancet: Vol 5 Issue 2 P133-141](#)
3. [RCPCH Paediatric Sepsis Podcasts](#)
4. [Paediatric Emergencies Podcast: Recognition of the Sick Child](#)
5. [RCPCH: Paediatric multisystem inflammatory syndrome temporally associated with COVID-19 \(PIMS\) - guidance for clinicians](#)

Author: Mike Willis

Activity 1.2: Inotropes (30 minutes)

5-10 minutes prescribing tasks, 20 mins teaching task

Facilitator: Consultant/registrar/paediatric pharmacist +/- senior nurse with experience in inotropic support of children.

- This activity may be used as a follow-on activity from **Activity 1**
- Provide drug charts and IV charts

Participants: SHO, SpR,

1.2.1 Work through the following example prescribing cases

- Trainees to come together and share answers as a group for consensus
- Reflect on prescribing practice in portfolios

7 year old Ahmed (not weighed yet - estimate using WETFLAG)

Received 60ml/kg iv crystalloids since presentation to ED

STRS/CATS request the child is started on an IV adrenaline infusion

- Prescribe the IV adrenaline infusion for this child to start at 0.1mcg/kg/min You may wish to use the STRS/CATS drug calculator or your local IV fluid chart
- How does the infusion rate change for a 1 day old 3kg baby? What practical considerations are required when delivering IV adrenaline at this rate?
- Prescribe iv noradrenaline infusion as well
- Prescribe full maintenance iv fluids with 5% deficit corrected over 48hours (Last K+ on ven gas was 3.1)
- What practical considerations do you need to be aware of and prepare for when starting all the above?

1.2.2. Your FY2 has asked if you could explain how inotropes work and which ones to chose. In pairs, one person to formulate possible questions (risks, mechanisms, access, monitoring, ED or PICU) and 1 person to deliver 10min teaching. Please spend 10mins preparing to deliver 10min teaching to your colleague.

Resources:

[CATS drug calculator](#) or [BNFC](#)

[Paediatric Emergencies App](#)

[RCPCH Paediatric Sepsis Podcasts Episode 007](#)

[Round, J. Inotropes Made Simple. Paediatricfoam.com](#)

[Flannigan C, Peripheral vasoactive drugs in kids, 2016. Paediatricemergencies.com](#)

Author: Mike Willis

2.0 Escalation of Care in the Acutely Unwell Child

Objectives

- Learn to recognise the deteriorating child who may need escalation of treatment
- Be able to effectively and safely communicate a referral for transfer of an acutely unwell child using SBAR
- Review region-specific guidance for referrals to acute transport teams (CATS/STRS) and the STOPP tool

Activity 2.1: Case Based Discussion (45mins - 1hr)

Facilitator: Consultant/Registrar to chair discussion. Provide copy of [STOPP tool](#)

Participants: SHOs, SpRs

Read through the clinical vignette below and work through the following discussion points:

- What are the red flags/concerning features in the story given?
- What investigations/treatment would you initiate?
- When would you consider escalation of care and how would you go about doing this?
- Would you manage this differently if this child was admitted on the ward and deteriorated?

Clinical vignette:

Tommy is a 9-month old, who presents to your ED one night. Tommy's mother, Jenny, reports that Tommy was not himself when he woke up this morning and didn't eat his breakfast which is unusual as Tommy usually loves his food. Tommy ate a small amount of lunch but then promptly vomited it all back up. Before Tommy went for his nap, Jenny checked his temperature and it was 38.3°C so she gave him some calpol. Since waking from his nap, Jenny is concerned that Tommy still seems a bit sleepy and she has noticed a red pinprick rash appearing on Tommy's legs and torso.

Tommy was born at term and is usually fit and healthy. He lives with his mum, dad and 2 older siblings (3yrs & 6yrs).

The triage nurse is concerned and brings Tommy straight through for assessment.

Observations: HR 180, RR 40, SpO2 93%, BP 70/30, temperature 38.5°C

What are your initial thoughts & management?

Activity 2.1 continued

OE: Tommy seems listless and does not object to you examining him, his anterior fontanelle is closed. His peripheries are cool to touch and his central capillary refill time is 3secs. His chest is clear to auscultation. Abdomen is soft, non-tender. Jenny shows Tommy's rash on his legs/torso which is non-blanching and Jenny thinks this has spread since they set off from home. ENT examination is unremarkable other than a slightly erythematous throat.

Venous blood gas: pH 7.29, pCO₂ 5.9kPa, pO₂ 5.1kPa, glucose 4.1, lactate 3.5

What bloods do you want sending to the lab? Any other investigations? What are your next management steps? Where would you admit Tommy?

Despite appropriate management, Tommy remains lethargic. His peripheries continue to be cool and his central capillary refill time is now 4secs. He is requiring face-mask oxygen to maintain his saturations >94%

Observations: HR 190, RR 40, SpO₂ 86% (RA), BP 68/25, temperature 37.3°C

You repeat a blood gas: pH 7.24, pCO₂ 6.6kPa, glucose 4.0, lactate 4.1

His blood results come back:

Hb 121	Sodium 145mmol/L
WCC 24.6	Potassium 5.0 mmol/L
Neutrophils 12.4	Urea 7.1mmol/L
Lymphocytes 5.3	Creatinine 73
Plt 77	
	CRP 131
INR 1.3	
APTTR 1.4	
Clotting corrects with 50:50 mix	

What steps would you take now? Where do you want to manage this child?

Complete a [STOPP Tool](#) for this child – would this change your management?

Author: Christine Hesketh

Activity 2.2: SBAR Communication Simulation (30mins)

Facilitator: Consultant/Registrar

- Review the local Acute Transport Team (STRS/CATS) referral process and relevant aide memoires
- Facilitate simulation of referral to the local Acute Transport Team

Participants: SHOs, SpRs, nurses

- Divide into two teams – one is the DGH team, the other is the transport team (it may be relevant to have a more junior team making the referral and a more senior team receiving the referral)
- Using the case in Activity 2.1 (or another case in this learning pack/that the team has recently experienced) the groups should have a separate 10 minute discussion about what information is pertinent to the referral process in this case
- Each team nominates a roleplayer and the receiving group is given the local referral form
- Place chairs back-to-back and roleplay the call
- Debrief facilitated by the consultant



Resources:

[NICE Guidance \(NG143\): Fever in Under 5s](#)

[Deirdre Philbin. Septic for sure..., Don't Forget the Bubbles, 2021](#)

[STRS South Thames retrieval service - how to refer](#)

[CATS Children's Acute Transport Service - Making a referral](#)

[STOPP Tool](#) Safe transport of the paediatric patient

Author: Christine Hesketh

3.0 Escalating breathing support in an infant with respiratory failure

Activity: 45min -1 hr session

Objectives

- Understand concepts in assessment of respiratory failure
- Explore the mechanisms of action for non-invasive respiratory support modalities
- Appreciate the benefits and draw-backs of the different modalities available

Activity 3.1 - Case based discussion

Facilitator: Consultant or senior registrar with experience in clinical use of non-invasive respiratory support in infants

Participants: Read the case vignette then discuss how you would assess her and consider what interventions might be required.

Key Concepts (See resources for additional material)

- Signs of respiratory distress in infancy and how do these translate into “impending respiratory failure”
- How to assess severity of hypoxia
- How does a “normal” gas in the context of severe respiratory distress influence assessment.

Clinical Vignette

Mariam is an 8-month old girl, who was admitted to your general ward 24hrs ago having been unwell for the past 3 days. She initially had a runny nose but had developed a worsening cough and had been off her food.

On admission, she was breathing hard with RR 40 bpm, had fine crackles and wheeze on auscultation and O₂ sats of 90% in RA. She had not been drinking well for 24hrs and had reduced wet nappies. Her saturation and breathing effort improved to 98% with 1 l/m nasal cannula oxygen and she was admitted to the ward with NGT feeds. Today a naso-pharyngeal aspirate PCR has confirmed RSV.

You are called to review her at 1am because of concerns about her breathing and low oxygen saturations. Her oxygen has been increased to 2l/m but her saturations are only 92%. She is breathing fast but not as fast as earlier that night. One of the nurses has done a capillary blood gas and tells you the pH and pCO₂ are “normal”.

Resources

- [Spotting the Sick Child: Home](#) - Useful videos of respiratory distress. You will need a login to view the videos. Following videos might be particularly useful examples:
 - [Spotting the sick child: difficulty in breathing - accessory muscles](#)
 - [Spotting the sick child: difficulty in breathing - work of breathing](#)
 - [Spotting the sick child: difficulty in breathing - respiratory examination video](#)
- [CATS Bronchiolitis guideline 2020](#)
- [Paediatric Critical Care: Severe Bronchiolitis, Evelina London Guideline Group, December 2018](#)
- [Henry Goldstein. Bronchiolitis, Don't Forget the Bubbles, 2013](#)
- [Bronchiolitis in children: diagnosis and management. NICE guideline \[NG9\] 2015](#)

Activity 3.2: Debate (30mins)

Facilitators: Divide the group in two, allow 10-15 mins research (resources below) and preparation time in order to undertake a debate

Participants: Divide into two groups and take 10-15 minutes to prepare a debate on the following topic using real-time evidence based medicine strategies:

“CPAP or HFNCO; which is better for Mariam?”

Key Concepts:

- Each group should define the modality they have been allocated
- They should briefly describe how it works
- They should argue why their modality is a superior choice
- Also identify the drawbacks of their modality

Resources

1. [Padmanabhan Ramnarayan. High flow therapy – when and how?, Don't Forget the Bubbles, 2021](#)
2. [Jat KR, Mathew JL. Continuous positive airway pressure \(CPAP\) for acute bronchiolitis in children. Cochrane Database of Systematic Reviews 2019, Issue 1. Art. No.: CD010473](#)
3. [Piedra, Pedro A. Stark, Ann R. Bronchiolitis in infants and children: Treatment, outcome, and prevention In: UpToDate, Post, TW \(Ed\), UpToDate, Waltham, MA, 2021.](#)
4. [Nagler, Joshua. Cheifetz, Ira M. Noninvasive ventilation for acute and impending respiratory failure in children In: UpToDate, Post, TW \(Ed\), UpToDate, Waltham, MA, 2021.](#)

Author: Tobias Mitchell

4.1 Journal Club – ‘Everything is Awesome’

Objectives

- Establish a systematic approach to critically appraising a research paper
- Critically appraise a paper and discuss concepts of evidence-based medicine

Activity (30mins)

Read the ‘Everything is Awesome’ paper as well as the [“Critical Appraisal of a Journal Article”](#) and discuss amongst your group. If you are able to plan the session in advance you may wish for someone to present the paper – this should focus predominantly on results to allow group appraisal.

[Everything is awesome: Don't forget the Lego](#)

[Tagg A, Roland D, Leo GSY, Knight K, Goldstein H, Davis T. *J Paediatr Child Health* 55 \(2019\) 921-923](#)

Questions to consider:

1. How was the included population group defined?
2. What intervention was studied? What was the control?
3. What were the outcomes?
4. Is this study applicable to your own patient population?
5. What are the strengths and limitations of this study?
6. Will this change your practice?
7. How might you design a search to look for other papers to answer your questions

Resources:

- [UCL “Critical Appraisal of a Journal Article”](#):
- [Team DFTB. Don't Forget The Lego, Don't Forget the Bubbles, 2018](#) discussion of their paper: <https://dontforgetthebubbles.com/dont-forget-the-lego/>

Author: Christine Hesketh

5.0 Emergency ventilation

(30 -45 mins duration)

Objectives

- Understand basic principle of ventilation
- Appreciate the technical aspects of commonly used ventilation systems used in babies and children
- Learn to support non-specialist anaesthetic colleagues in using unfamiliar equipment

Activity 5.1: Practical session on how to use emergency ventilators for babies and children

Equipment

- BabyPac and Parapac Plus Ventilator, correct tubing, HME filter, ETCO₂ monitors
- Optional Oxylog ventilator but this is more familiar to Anaesthetists so less important for paediatricians
- **(Or local equivalents)**

Facilitator - Consultant/senior registrar/PICU nurse with experience in clinical use of emergency ventilators (from Paeds/ED/Anaesthetics)

- The introduction to the session can involve a basic discussion on principles of positive pressure ventilation: Pressure or volume limited flow driver devices that provide a controllable mixture of gas in timed phases via an endo-tracheal or supra-glottic airway to the lungs. This article might be helpful Basics of Ventilation, paediatricfoam.com
- Either use the images below or set up real life local equivalents to create a multi-station part-task session

Key Skills:

- Set up tubing correctly including filters and EtCO₂ Sampling systems
- Understand that some of these devices do not need an electric power supply - just pressurised oxygen
- Know how to turn them on
- Set PEEP; PIP; Pressure limits; Alarm Meaning; Rate; FIO₂ (if possible)
- Understand why HME filter is important and where it can be placed in the circuit

Author: Tobias Mitchell

Activity 5.1 continued

Pneupac babyPAC Ventilator

- Designed for <20kg but more suited to smaller babies and children
- Aim to use low dead-space in-line equipment for babies <7kg (Eg HygroBaby or HygroBoy HME filters and “Yellow” EtCo2 monitor - See last end images for examples)
- (For some more detail see <https://media.gosh.nhs.uk/documents/Babypac.pdf>)

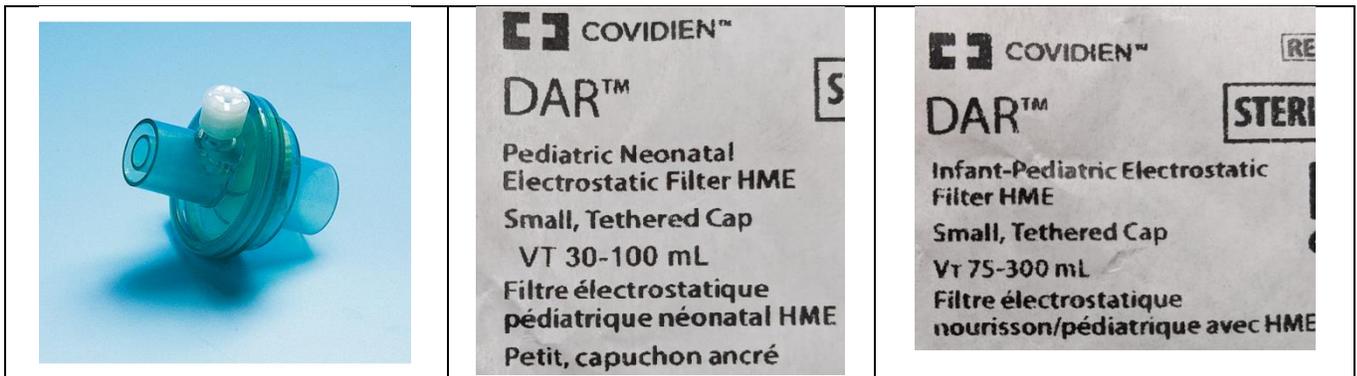


Opening patient connection
 5. Set Alarm to safe level, but above \hat{P}
 6. Set O₂ concentration as required

		Frequency (1/min)					
		0.25	0.35	0.50	0.70	1.00	2.00
T _{EXP}	0.25	120	100	80	63	48	27
	0.50	80	70	60	50	40	24
	1.00	48	44	40	35	30	20
	2.00	27	26	24	22	20	15
	4.00	14	14	13	13	12	10
T _{INS}		0.25	0.35	0.50	0.70	1.00	2.00

Protected by Patents babyPAC 100, Pnc

MR Compatible (with MRI Ba
 Testing has confirmed compatibility at 3 Tesla and 4300
 125.5MHz but intended use is with this control modu



Pneupac ParaPac plus

- Cannot be safely used for tidal volumes <150ml (Around 30Kg) without accessory hyperventilation circuit



- Volume controlled, pressure limited device



Oxylog

- Can be used for Tidal Volume 50-250ml with paediatric tubing
- More comprehensive ventilator that anaesthetist are more familiar with
- Battery operated



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