Don't Forget The Bubbles

SIRS, SEPSIS AND SHOCK

Learners Guide

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PRE-READING FOR LEARNERS

Expectation is for the learners to have read the basic pathophysiology links and some (not all) of the rest of the links
Sepsis/Shock Pathophysiology (video 10 minutes)
St Emlyns Blog: Paediatric Sepsis (20 minutes)
Surviving sepsis campaign international guidelines for the management of septic shock and sepsis-associated organ dysfunction in children (lengthy)
OR DFTB summary (10min)
RCEMlearning: Recognising Paediatric Sepsis (15 minutes)
Paediatrics for Primary Care: Sepsis (10 minutes)
DFTB: FEAST trial analysis (10 minutes)

Podcasts
Ideally, the learners should have listened to these podcasts too
PEM Playbook: Approach to Shock (40 minutes)
DFTB: Fluid Assessment in Sepsis (20 minutes)

Practical Procedure
OpenPediatrics: Placement of an Intraosseous (IO) Line (video 23 minutes)
PEM Playbook: Paediatric Vascular Access

Topic: **SIRS, Sepsis and Shock**
Author: **Michelle Alisio**
Duration: **2 hours**
Facilitator level **Senior trainee and above**
Learner level **Anyone who sees paediatric patients**
Equipment required: **Crunchie bars (x3), tongue depressors (x6), sleek tape, IO drill with needles (IO needles and 18 or 22G LP needles), saline flush, 3-way tap and giving set, gauze, umbilical clamp, micropore.**

OUTLINE

- **Basics (5 mins)**
- **Main session: (4 x 15 minutes) case discussions covering grey areas, diagnostic dilemmas; advanced management and escalation**
- **Quiz (10 mins) covering key points and evidence**
- **Practical Procedure (30min)**
- **Infographic sharing (5 mins): 5 take home learning points**

CASE SCENARIO 1

Zach's mum is very worried about her 3-week old son. This is her first child.
The pregnancy and birth were uncomplicated, except her 'water' broke early before she delivered. She said Zach hadn't breastfed well these last 2days and is more sleepy than usual today. He has no diarrhoea or vomiting and he feels hot to touch but she doesn't have a thermometer at home. On general appearance Zach is lethargic, HR 165, and his skin is mottled.
His glucose is 1.9 mmol/L and you notice a subtle twitching of his limbs. The team recognises that Zach could have sepsis and get on with administering high flow nasal cannula oxygen (HFNC), getting a scalp vein, correcting the glucose and giving antibiotics all within the first hour.

1. What is the most likely organism? In this age group, what other organisms would you consider in your differential and what first line antibiotics should you administer?
2. How else could the team have gained vascular access quickly?
3. Using an A,B,C,D approach; how would you have managed Zach?

CASE SCENARIO 2

12-year-old Martin known with sickle cell disease comes in febrile with chest pain, a cough, leg, and back pain. The leg and back pain are always typical of his disease. Sats 97%, tachypnoeic with a respiratory rate (RR) of 30. Heart rate (HR) 140 beats per minute, normal Blood Pressure (BP) 110/80 mmHg. He receives Morphine and Fluids. His legs feel better but his chest is still bothering him.
RR is still 30 and his HR still 140. You take some bloods. Hb 9.9 g/L, WCC 23.5x109/L, Platelets 143 x109/L. Chest-xray: plump looking cardiac silhouette but no pulmonary infiltrates. His BP drops to 90/60 mmHg and he is given face mask oxygen as his saturations drop to 86%.

1. Could this be septic shock? If so, what could the likely organism/s be?
2. Outline your approach to Martin's management with a focus on his fluid status.
3. Should Martin receive a fluid challenge? If so, which fluid, how much and how fast?

ADVANCED CASE SCENARIO 1

Johnny, an 8-month-old with chicken pox was brought to the emergency unit for persistent fever and vomiting for 3 days. The chicken pox rash had started a week prior to presentation. He had no diarrhoea, was awake, alert and able to drink from a bottle. His work of breathing was mild and he was not hypoxic.

The attending team concerned with his tachycardia and prolonged capillary refill time (CRT) of 4 seconds initiated fluid therapy and the relevant antibiotics. He received 3x 10mL/kg fluid boluses, Ceftriaxone and Aciclovir after bloods and cultures were taken.

After 2hours Johnny was still febrile but looking better, comfortable on handling, vitals unchanged, chest-xray had no infiltrates but there was a new concern regarding Johnny's abdominal rash which resembled cellulitis.

Blood Tests	
Hb	12
WCC	15.6
Platelet	299
Na	131
K	4.9
Urea	2.4
Creat	15
CRP	278

Blood Gas	
pH	7.39
pCO2	5.1
pO2	4.7
HCO3	23
BE	-2
Lactate	3
Glucose	4.6

Observations	
HR	180
RR	30
Sats	100%
BP	93/72
AVPU	A

1. How would you manage the persistent fever?
2. Is Johnny in septic shock? How reliable is a capillary refill time (CRT) in a shocked child?
3. What additional antimicrobial therapy should Johnny receive?
4. Should Johnny be intubated?
5. Can children with a proven viral illness also have a concomitant severe bacterial infection (SBI)?

ADVANCED CASE SCENARIO 2

14-month Ellie, with no past medical history presented with a 2-day history of fever, nasal congestion and a dry cough. Her father called the ambulance when Ellie became drowsy and somewhat unresponsive for a brief period.
On arrival at ED, she was clinging onto mum, tears in her eyes, her cheeks were bright red and she was very aware of everyone at her side. Her heart rate (HR) 145bpm, respiratory rate (RR) 20 breaths per minute, Temperature 38.3°C, Saturations (sats) fluctuated between 91-95% and if you looked carefully she had subtle intercostal recessions only. Her chest was otherwise clear, no organomegaly, no skin rash but her hands and feet were cool. Ellie's mum tells you that she gave her Calpol approximately 6hours ago.
Ellie's Paediatric Early warning score (PEWS) is 5 and is taken into majors.

Is Ellie at risk of sepsis? If so, why?
The nurse is concerned about Ellie and asks you to please see her next.
What do you think is wrong with Ellie?

You do a thorough joint and ENT exam. Her ears and tonsils look normal and her throat is a little red but you decide to give her a good nasal suction.
She hates it but you (and mum) are rather chuffed with the large amount of mucous you have managed to remove. You subsequently see her sats increase to 98% and her intercostal recessions have subsided. She's keen to drink and does very well without vomiting. You think she's more likely to have a viral infection.

Would any investigations assist you with her management?
What investigations and why?
Discuss how you would manage Ellie? Would you admit her?

QUIZ QUESTIONS (10 MINUTES)

Question 1.

Match the following columns:

Staphylococcus Aureus (c)	a. Toxic Shock Syndrome, Scarlet fever
Pneumococcus (f)	b. Meningitis, Sepsis in < 3months
Haemophilus (e)	c. Endocarditis, Osteomyelitis, Septic Arthritis
Group A Streptococcus (a)	d. UTI, Appendicitis, Hospital-Acquired
Neisseria Meningitidis (g)	e. Sinusitis, Orbital Cellulitis, Epiglottitis (less common due to vaccine)
Group B Streptococcus (b)	f. Bacterial Meningitis (invasive disease decreased with vaccine)
Gram negative sepsis (d)	g. Sepsis, Meningitis

Staphylococcus aureus is a gram positive, bacterium (looks like clusters of grapes under a microscope). Approximately 30% of the population are asymptomatic carriers; and can be found as part of normal flora of the upper respiratory tract and skin. Complications are included above as well as abscesses and pneumonias. Cloxacillin is the recommended antibiotic choice for sensitive staph (MSSA) and Vancomycin for resistant staph (MRSA).

Invasive disease of Haemophilus influenzae and Streptococcus pneumoniae are less commonly seen due to vaccinations.

Group A Streptococcus (GAS) is a gram positive, beta-haemolytic coccus in chains. It is responsible for diseases such as strep throat, impetigo and cellulitis. Complications include post strep glomerulonephritis, paediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS), rheumatic fever, scarlet fever and toxic shock syndrome (TSS). Treatment should include penicillin, and clindamycin added for TSS.

Meningococcaemia caused by the virulent gram-negative Neisseria meningitidis is relatively rare. Fever and petechial rash/purpura and poor perfusion can equate to meningococcaemia but not always. Leg pain and refusal to walk, cold hands and feet and abnormal skin colour are also important, subtle signs to be vigilant about when assessing a child with suspected meningococcaemia.

Group B streptococcus (GBS), Listeria monocytogenes and Escherichia Coli (E.Coli) are 3 important bacteria to remember in sick neonates. Early-onset GBS (<7days) presents commonly as acute respiratory distress or septicaemia. Late-onset GBS (7- 89days) present with meningitis, seizures. Intrapartum screening and antibiotic programs have not reduced incidence in late-onset GBS.

Question 2

Which of the following statements are true?

A. The meningococcal serum PCR result is affected by antibiotics therefore it is important to do this test prior to the administration of antibiotics in suspected meningococcal sepsis.

B. Balanced/buffered crystalloids are preferred (i.e. Plasma Lyte-148, Hartmanns's solution and Ringer's Lactate) over isotonic saline for resuscitation in septic shock.

C. Blood lactate levels provide a valuable indirect marker of tissue hypoperfusion and are not spuriously increased by squeezing of a limb, use of a tourniquet or stored for a prolonged period of time.

D. A Haemoglobin level (Hb), CRP and Blood Culture are investigations you can reliably interpret from bone marrow blood following intraosseous access (IO).

The pre-hospitalisation administration of parenteral benzylpenicillin normally renders blood cultures sterile, and lumbar puncture is undertaken less frequently, especially in young children. Sensitivity to meningococcal serum PCR is unaffected by prior antibiotic treatment. PCR is a rapid, sensitive test that may be used to confirm a diagnosis of meningococcal disease by using peripheral blood samples. Introduction of this test into clinical laboratories may in some cases obviate the need for lumbar puncture to be performed on patients with suspected meningococcal disease.

Squeezing of a limb when acquiring a blood sample can spuriously increase lactate by venous stasis, impaired local perfusion and distress/exertion of the child. Haemolysis does not affect lactate. Prolonged sample storage will spuriously increase lactate unless sent in an oxalate tube or on ice.
ILCOR guidelines and Surviving Sepsis suggest the use of balanced or buffered crystalloids over isotonic saline as a resuscitation fluid in sepsis as their tonicity and electrolyte content matches closely to that of blood plasma. Saline may be associated with decreased renal blood flow and promote inflammation.

Most laboratory tests cannot be performed on aspirated bone marrow blood as the particulate matter may block and damage laboratory equipment. Aspirated IO blood is suitable for blood culture bottles, bedside glucometers, handheld I-STAT instruments (pH, glucose, and lactate) and haematological and biochemistry testing. Sodium, potassium, CO(2), and calcium levels from IO blood should be interpreted cautiously as well as white cell counts (WCC appear elevated) and platelets (which tend to be lower).

Question 3

Which groups of patients are at increased risk of sepsis?

A. Children under 1 year of age
B. Patients with (functional) asplenia (sickle cell, SLE, splenectomy)
C. Patients with a breach to skin barrier function (burns)
D. Patients with congenital/acquired immunodeficiency (CVID, HIV,diabetes)
E. All of the above

Always be aware of certain groups who may be predisposed to sepsis, for example neonates or oncology patients (undergoing chemotherapy), who display less profound features. These individuals may maintain normothermia and also have diminished physiological responses e.g. less tachycardia.

PRACTICAL PROCEDURE (30-45MIN)

Intraosseous (IO) Access

Aims:

- To get a feel for the IO drill, how to assemble it and practice using it on substitute bone (Crunchie bars)
- Practice securing the needle and attaching a fluid giving set.

When to insert an IO?

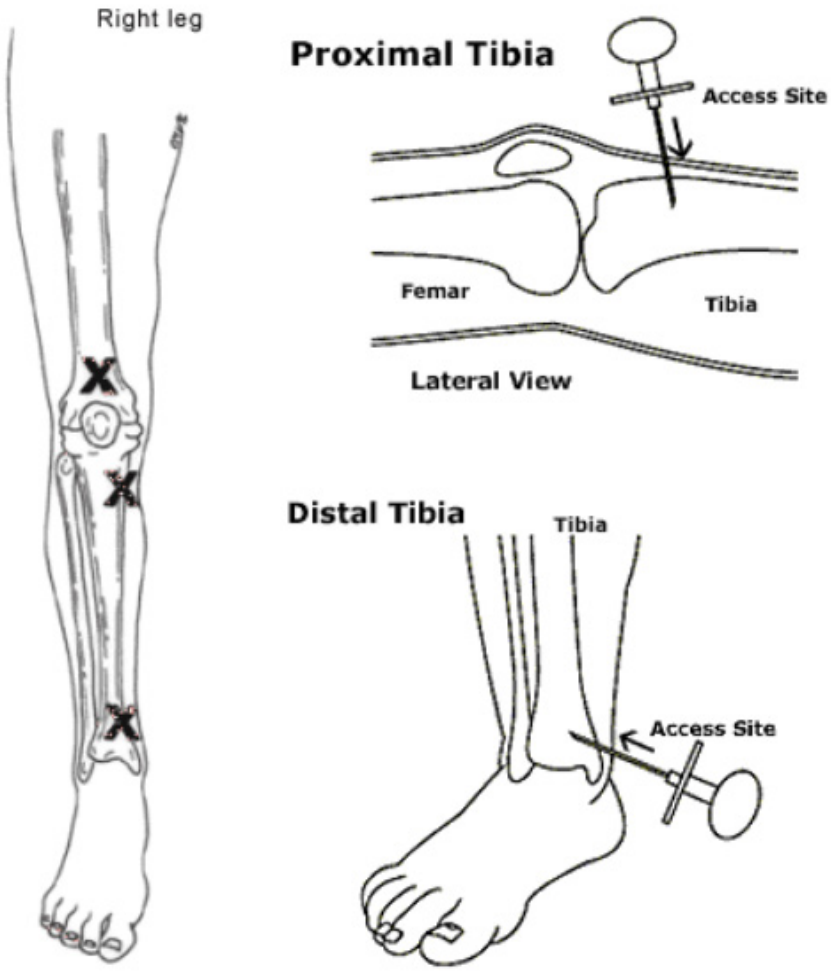
As soon as possible in septic shock and for circulatory access in cardiac arrest. Someone in the team should start getting the IO equipment in septic shock once the first IV vascular access attempt has been made. It should be ready to use when awaiting an out of hospital cardiac arrest case coming to the ED. Umbilical vein remains the preferred access in a neonate.

When not to insert an IO?

- Proximal ipsilateral fracture
- Ipsilateral vascular injury
- Osteogenesis imperfecta
- Cellulitis at the site of insertion

Where to insert an IO?

- Proximal tibia: Anteromedial surface, 2-3 cm below the tibial tuberosity
- Distal tibia: Proximal to the medial malleolus
- Distal femur: Midline, 2-3 cm above the external condyle



How to insert an IO? www.youtube.com/watch?v=RTxbWkHKH-M

How to secure an IO when using an 18/22G LP needle?
www.youtube.com/watch?v=Rer4pH3HgOc
You need gauze, umbilical cord clamp and micropore or opsite.

Complications:
- Failure to enter the bone marrow, with extravasation or subperiosteal infusion
- Through and through penetration of the bone
- Osteomyelitis (rare in short term use)
- Physeal plate injury
- Local infection, skin necrosis, pain, compartment syndrome, fat and bone micro-emboli have all been reported but are rare

Tips:
The 'cannulator' should give the antibiotics.
Take a crossmatch with the second cannulation.

Take-home messages

1. Diagnosing early sepsis is difficult. Its vague, non-specific and often distracts the clinician by another diagnosis. So thinking about sepsis is the first crucial step.

2. Once sepsis is recognised, call for help, deliver treatment and constantly reassess in the first hour. This will save lives.

3. Meeting SIRS criteria is common in the Paediatric Emergency Department (PED) but we send approximately 85% of children that meet SIRS criteria for sepsis home from the PED without antibiotics.

4. Clinical suspicion is better used to identify sepsis than a blood test. So, if you suspect sepsis, involve another (preferably senior) team member to assess.

5. Be particularly mindful when administering fluid boluses to septic children. Constantly reassess their need for fluid, their response to fluid and stop if there are signs of fluid overload.

REFERENCES

SIRS/Sepsis Spectrum

Sepsis/Shock Pathophysiology

DFTB: Rational Diagnostic Testing for Infection

DFTB: CRP POC-Testing in Serious Infection

BMJ: Diagnostic Markers of Infection

BMJ: PCT and CRP in sepsis

DFTB: Fever under 60 days

St Emlyns Blog: Paediatric Sepsis

DFTB: Fever under 60 days

Surviving sepsis campaign international guidelines for the management of septic shock and sepsis-associated organ dysfunction in children

RCEMlearning: Recognising Paediatric Sepsis

DFTB: FEAST trial analysis

Pedemmorsels: Group B Strep (GBS)

Pedemmorsels: Epinephrine for Shock

DFTB: Lactate

Invasive Group A Streptococcal Disease

NICE: Chickenpox

SPS: Do NSAIDs increase the risk of severe skin reactions in chicken pox?

JPED: Risk of Bacterial Coinfections in Febrile Infants 60 Days Old and Younger with Documented Viral Infections

Paedemmorsels: Meningococcaemia and Petechiae

RCT: Epinephrine vs Dopamine in Septic Shock

NICE: Sepsis: recognition, diagnosis and early management

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