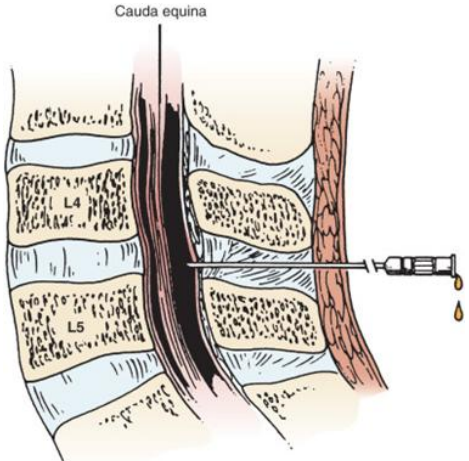
Laboratory tests interpretation in paediatrics

Anna Własienko, MD

Department of Paediatrics with Clinical Assessment Unit

Medical University of Warsaw, Poland

2025/2026



Plan of presentation

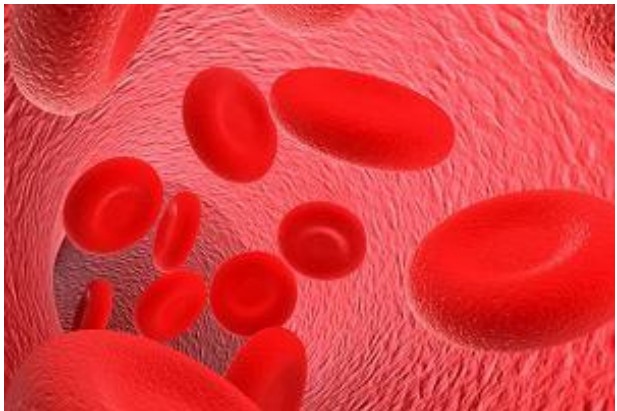
1st part- CSF interpretation & procedure of LUMBAR PUNCTURE (SPINAL TAP)

- Procedure of Lumbar Puncture (LP)
- CSF in meningitis of different etiologies
- EXAMPLES - CALCULATOR

2nd part - FULL BLOOD COUNT & BLOOD SMEAR

AIM

- To understand **general trends & abnormalities** in laboratory tests interpretation in children
- To understand that **normal ranges in paediatrics depend on age**
- **To know where to find them** not memorise them
- Laboratory tests **should be interpreted** together **with clinical picture of the patient**
- To practise on your own- examples



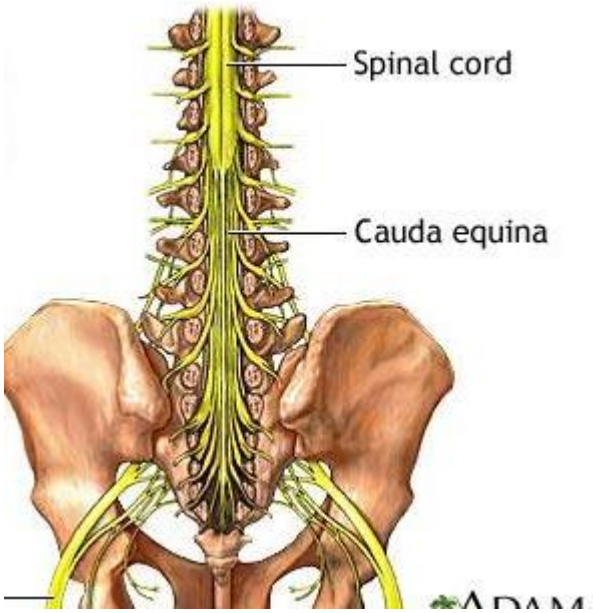
LUMBAR PUNCTURE (SPINAL TAP) & INTERPRETATION OF CSF

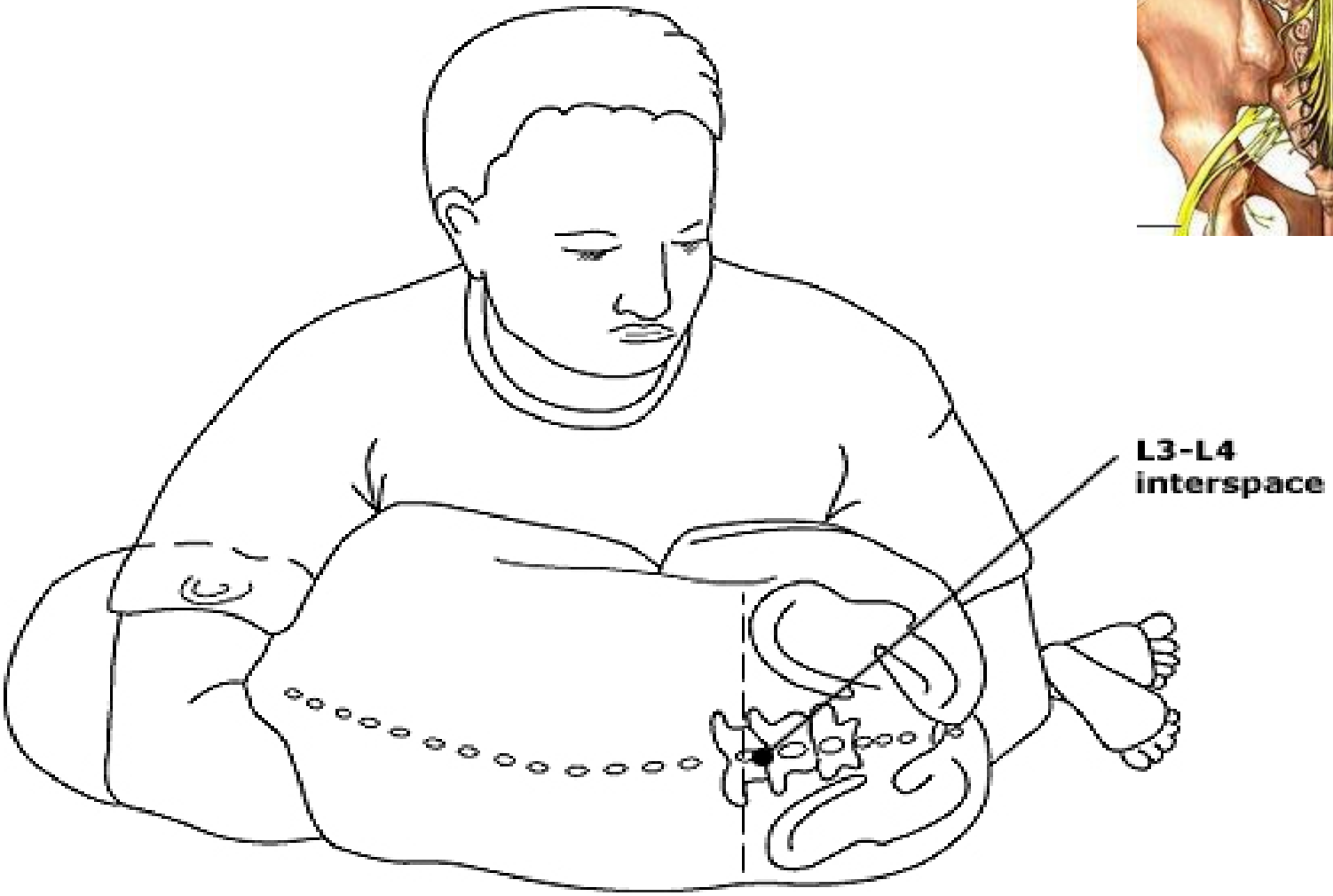
Why do we perform LP?

INDICATIONS

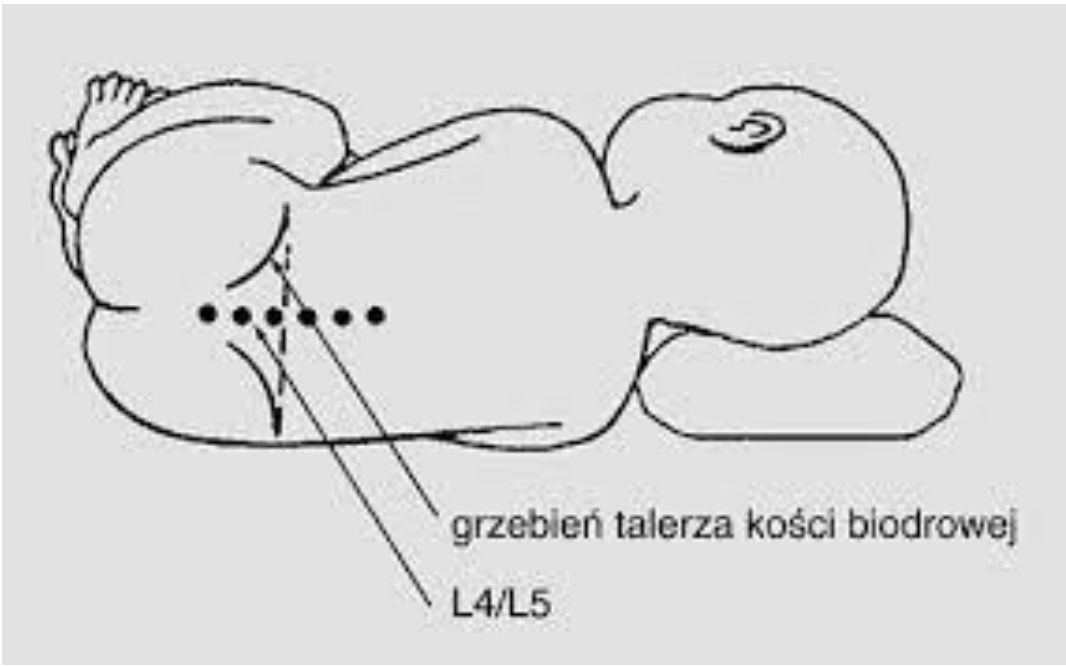
- **Suspected CNS infection** (to establish diagnosis, to make a provisional diagnosis of bacterial or viral etiology, to identify microorganism to start proper treatment)
- **Suspicion of malignancy with CNS involvement**
- **Installation of intrathecal chemotherapy**
- **the evaluation of various neurologic conditions (eg, normal pressure hydrocephalus, Guillain-Barré syndrome, Multiple Sclerosis, Creutzfeld-Jacob syndrome, metabolic disorders)**

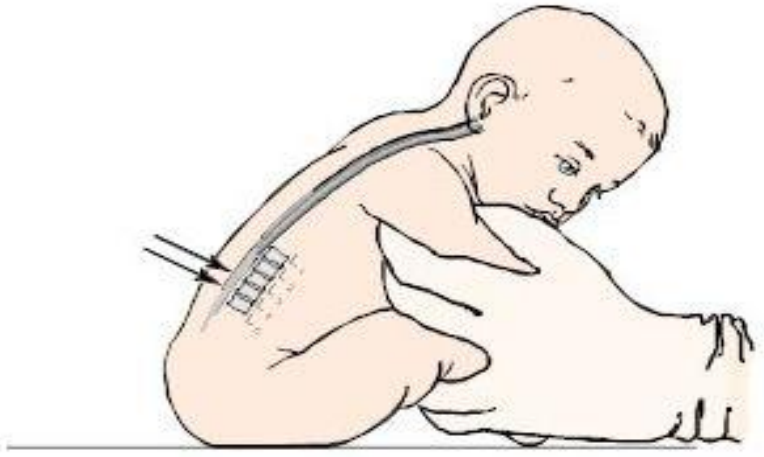
LP procedure





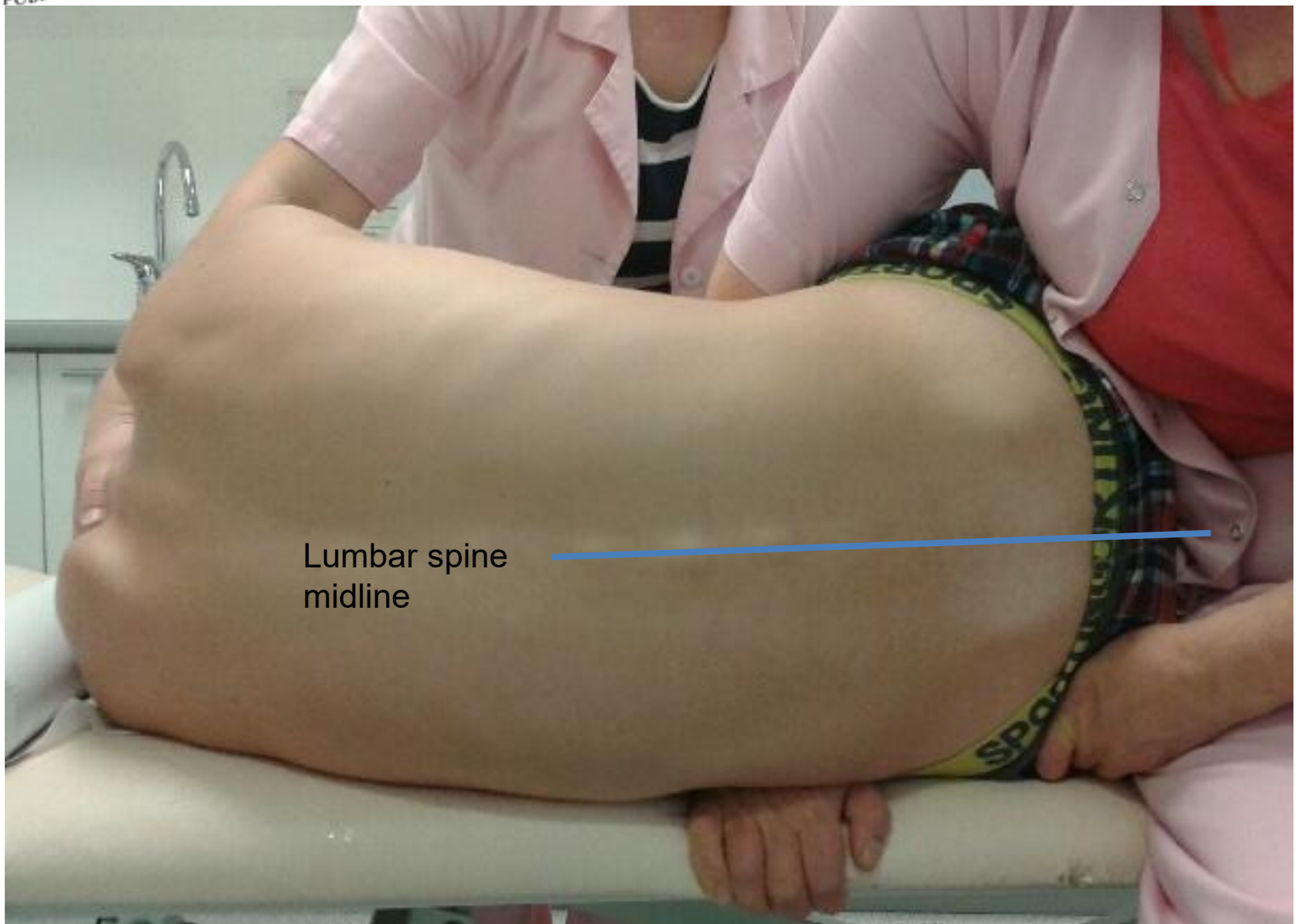
LP in neonates & infants



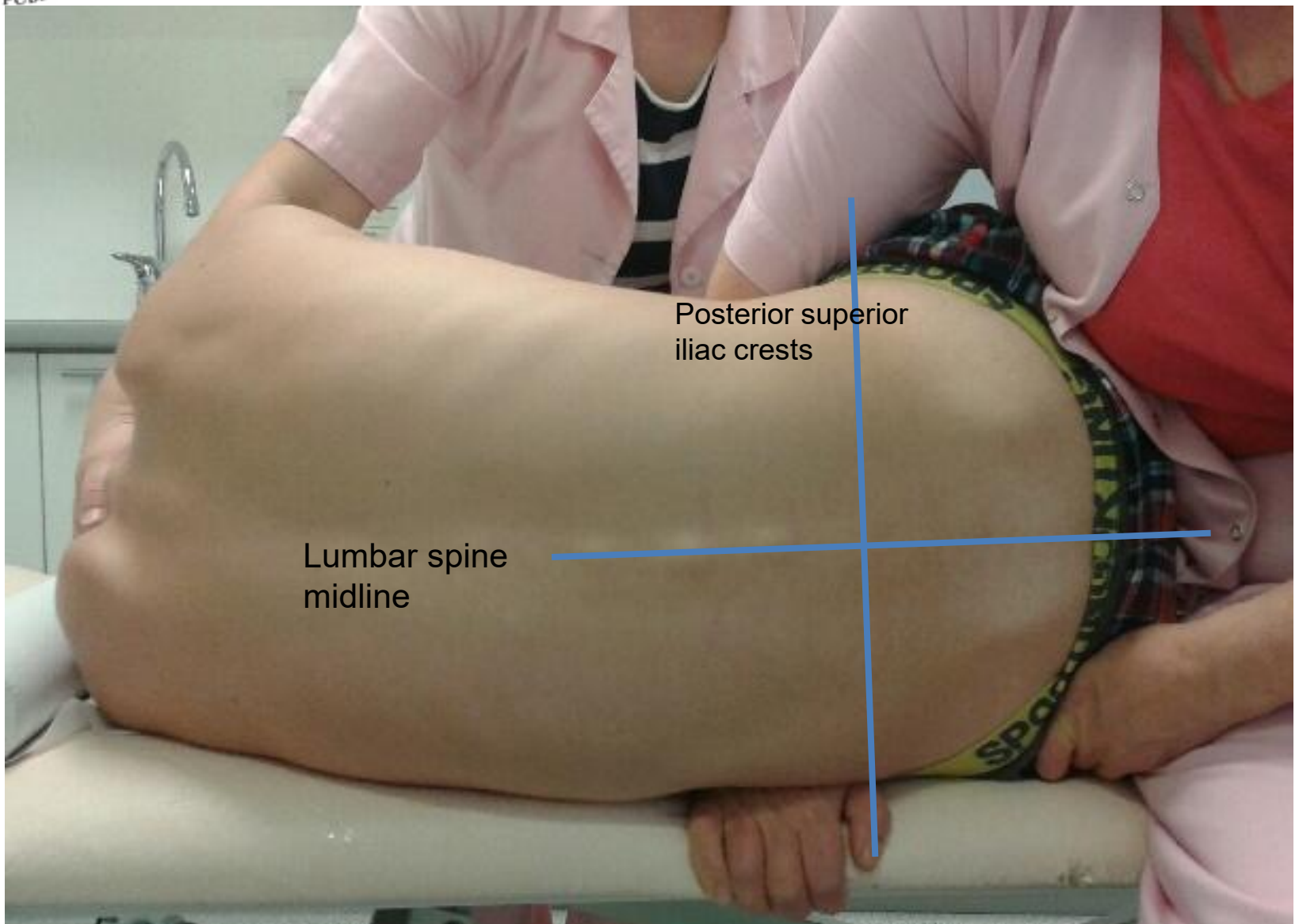


LP- procedure

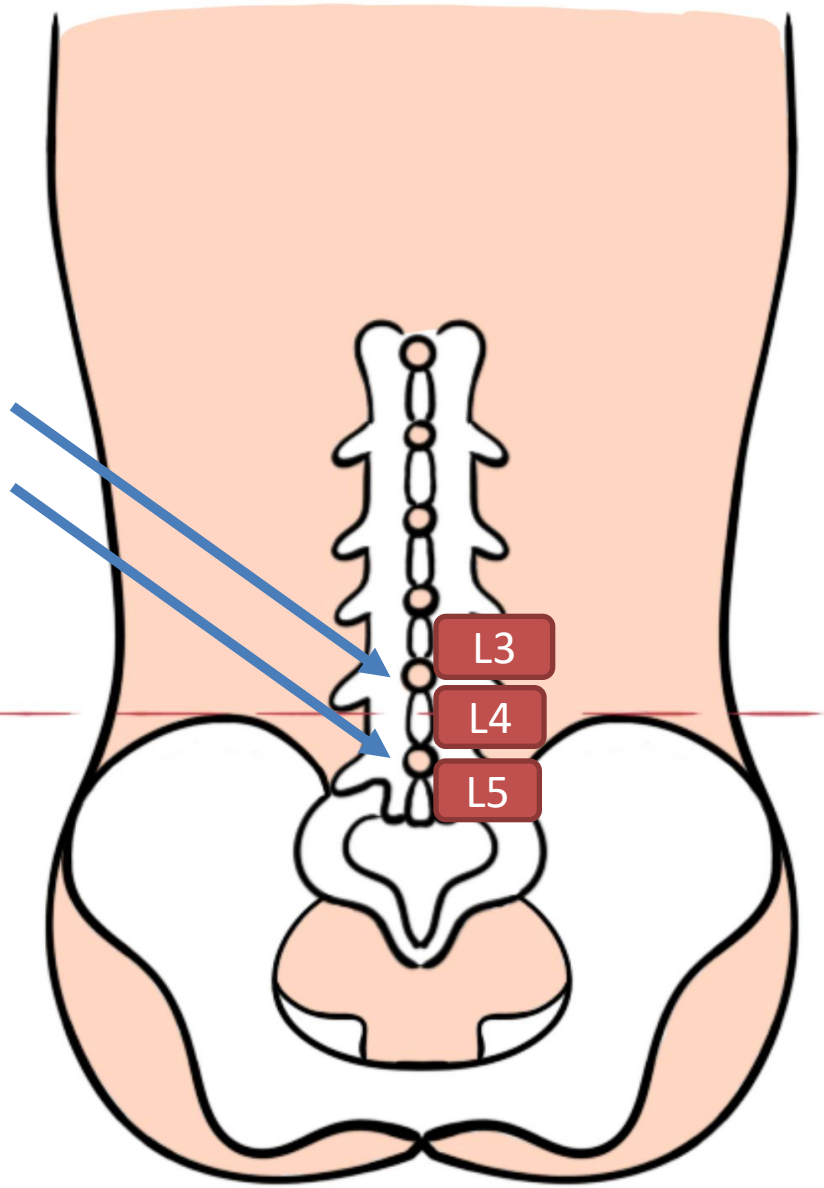
LP & CSF- procedure



LP & CSF- procedure

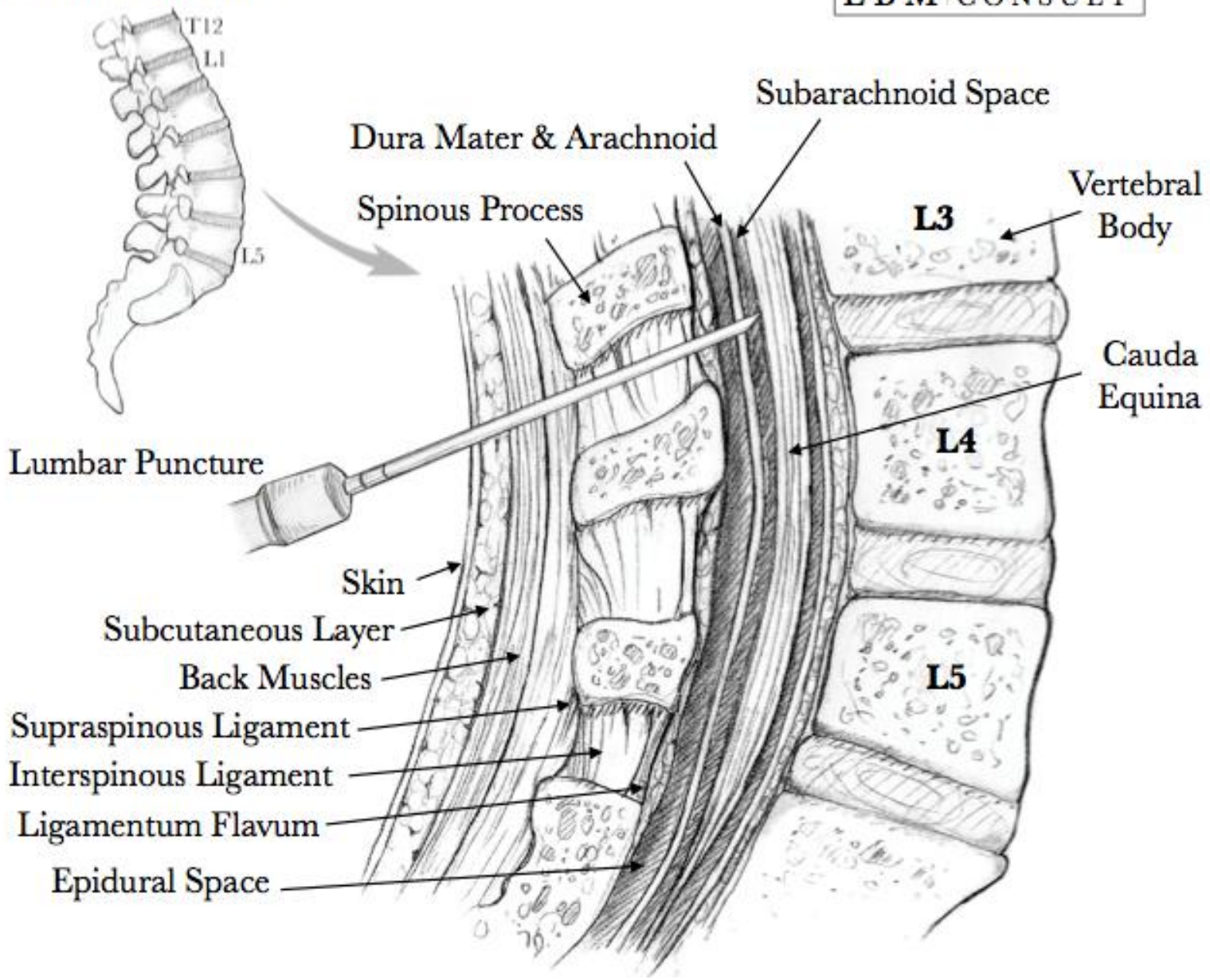


Tuffier's line

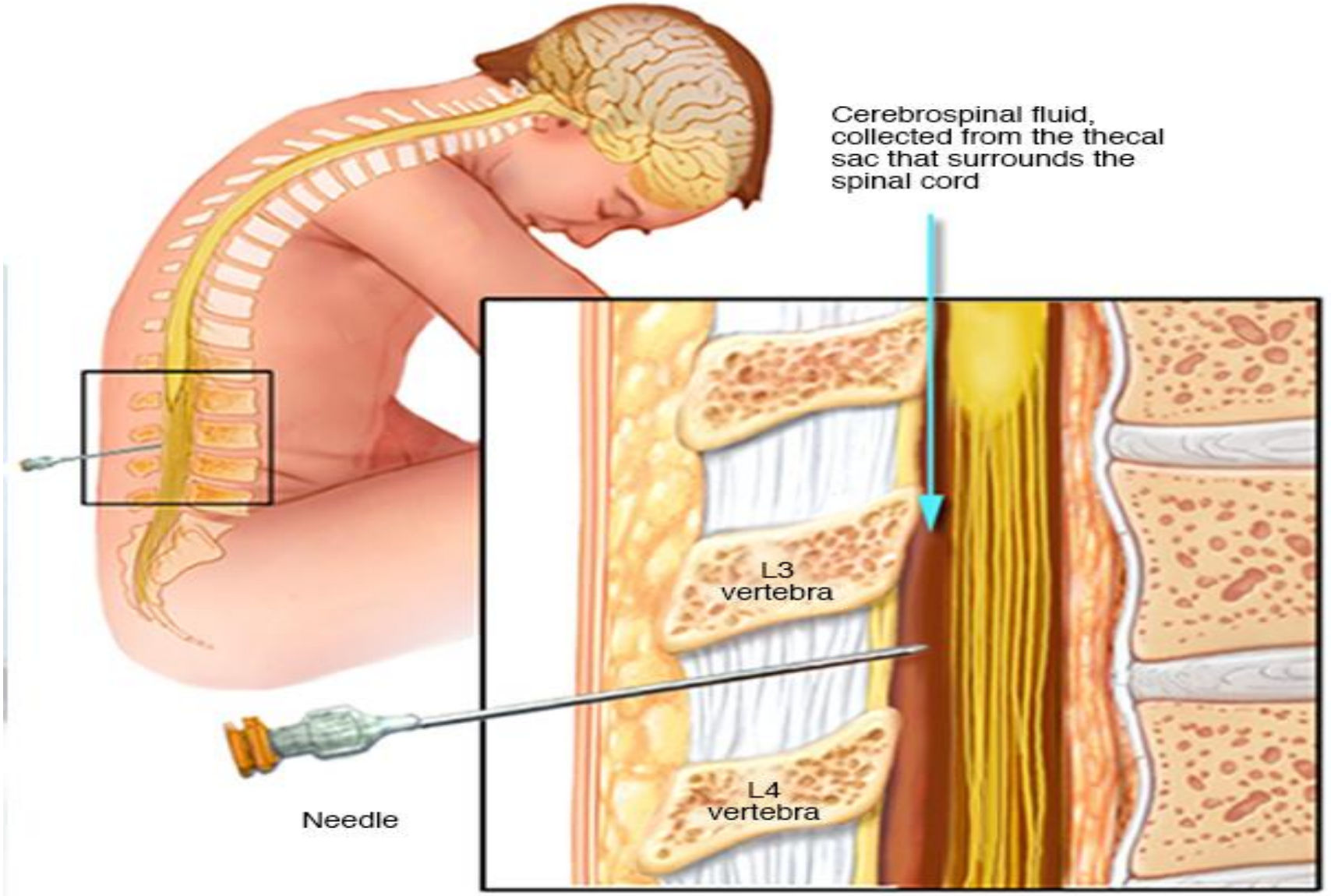


Lumbar Puncture

EBM CONSULT



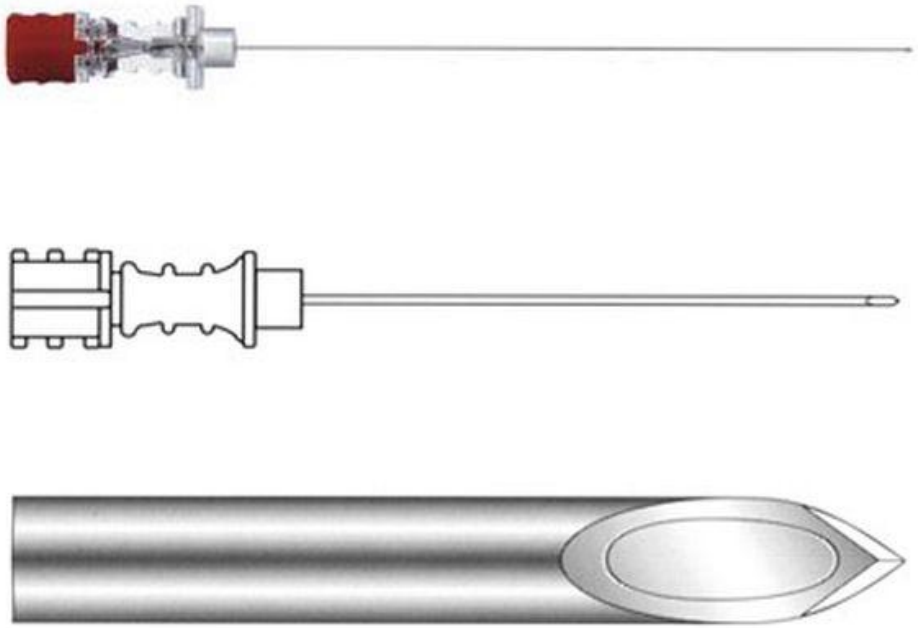
LP & CSF


Cerebrospinal fluid, collected from the thecal sac that surrounds the spinal cord
L3 vertebra
L4 vertebra
Needle

Analgesia in LP procedure

- Local anestetic (EMLA cream)
- Local anestetic (1% Lignocaine) sc
- Benzodiazepines iv/po
- General anaestesia

Needles to perform LP
-atraumatic needles




Nitrile Examination Gloves
medaSEPT
QUALITY TO PROTECT
nitrile PF
SIZE
7
LEFT
RIGHT


TIME OUT

Cerebrospinal fluid studies (CSF)

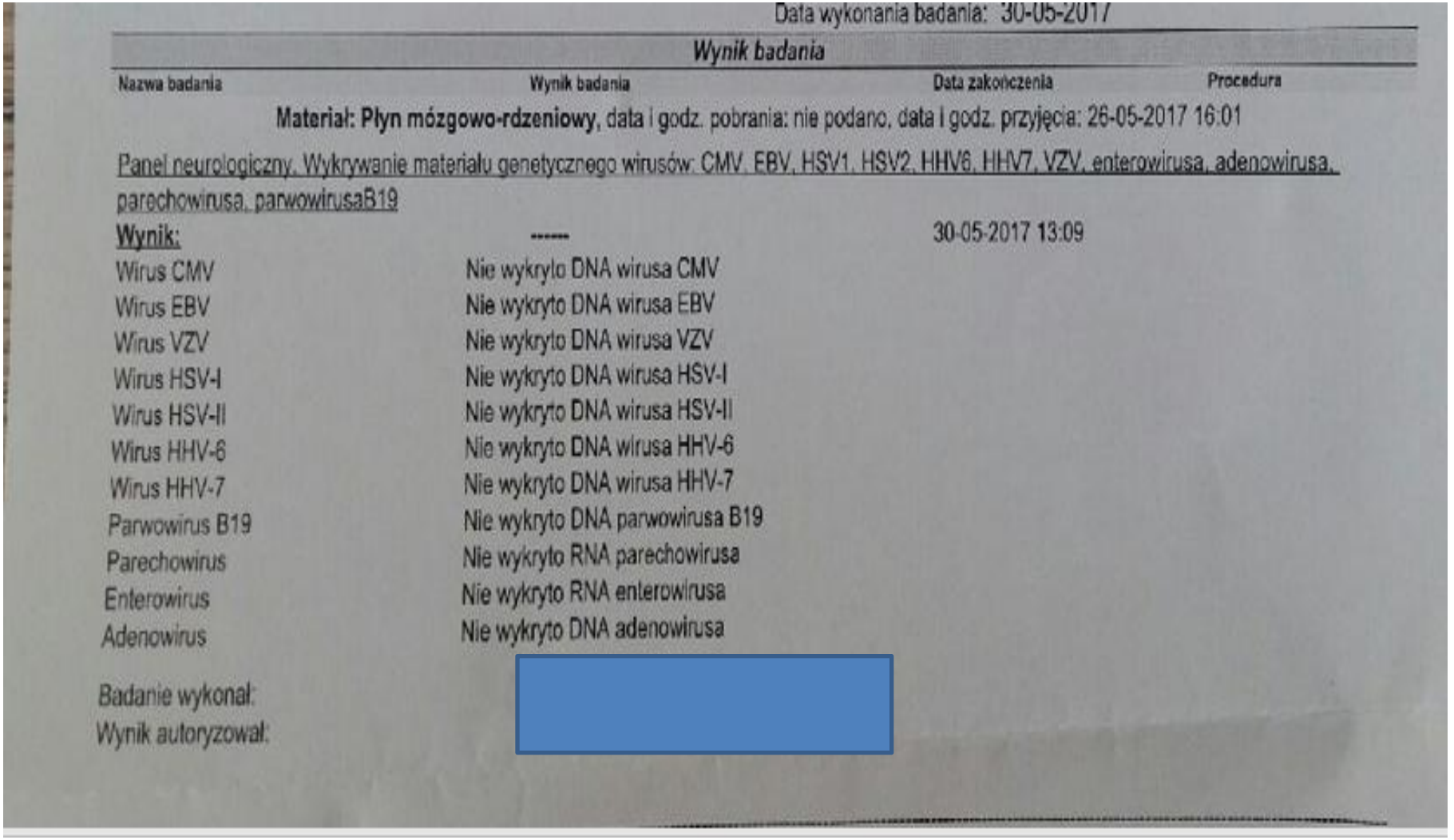
- 3 samples are needed

  (1 ml= 20 drops)

  - **Biochemical tests** (cell count, protein, glucose) +smear +Gram stain
  - **Microbiolology** (bacterial cultures)
  - **Other tests** (PCR, matabolic, serology, immunology, fluorescent antibody, pathogen-specific antibody tests, and/or cultures for fungi, and parasites may be necessary in special circumstances eg, in immunocompromised hosts)

  - **REMEMBER TO LABEL EACH SAMPLE!!!**
  - **REMEMBER TO CHECK SERUM GLUCOSE!!!**

PCR- kit



Data wykonania badania: 30-05-2017

Wynik badania

Nazwa badania	Wynik badania	Data zakończenia	Procedura

Materiał: Płyn mózgowo-rdzeniowy, data i godz. pobrania: nie podano, data i godz. przyjęcia: 26-05-2017 16:01

Panel neurologiczny. Wykrywanie materiału genetycznego wirusów: CMV, EBV, HSV1, HSV2, HHV6, HHV7, VZV, enterowirusa, adenowirusa, parechowirusa, parwowirusaB19

Wynik:	------	30-05-2017 13:09
Wirus CMV	Nie wykryto DNA wirusa CMV	
Wirus EBV	Nie wykryto DNA wirusa EBV	
Wirus VZV	Nie wykryto DNA wirusa VZV	
Wirus HSV-I	Nie wykryto DNA wirusa HSV-I	
Wirus HSV-II	Nie wykryto DNA wirusa HSV-II	
Wirus HHV-6	Nie wykryto DNA wirusa HHV-6	
Wirus HHV-7	Nie wykryto DNA wirusa HHV-7	
Parwowirus B19	Nie wykryto DNA parwowirusa B19	
Parechowirus	Nie wykryto RNA parechowirusa	
Enterowirus	Nie wykryto RNA enterowirusa	
Adenowirus	Nie wykryto DNA adenowirusa	

Badanie wykonał:

Wynik autoryzował:

KOROUN Krajowy Ośrodek Referencyjny
ds. Diagnostyki Bakteryjnych Zakażeń Ośrodkowego Układu Nerwowego

tel.: +48 22 841 12 33
fax: +48 22 841 00 65
koroun@nil.gov.pl

KOROUN

- Zespół KOROUN
- Czym się zajmujemy
- Metody badawcze
- Współpraca międzynarodowa
- Akredytacja
- Certyfikaty
- Publikacje
- Kontakt

Metody badawcze

Metody fenotypowe:

- identyfikacja drobnoustrojów z zastosowaniem podstawowych testów biochemicznych (również komercyjnych testów identyfikacyjnych);
- identyfikacja drobnoustrojów z zastosowaniem aparatów automatycznych;
- identyfikacja drobnoustrojów bezpośrednio w materiałach klinicznych pobranych od pacjentów z podejrzeniem inwazyjnego zakażenia z zastosowaniem szybkich testów lateksowych;
- określanie grup i typów serologicznych izolatów wybranych gatunków drobnoustrojów z zastosowaniem monoklonalnych surowic;
- określanie lekowrażliwości izolatów bakteryjnych referencyjnymi metodami oznaczania najmniejszych stężeń hamujących antybiotyków i chemioterapeutyków (metoda mikrorozcieńczeń w bulionie, metoda rozcieńczeń w agarze, metoda dyfuzji z paska z gradientem stężenia antybiotyku).

Metody molekularne:

- identyfikacja wybranych gatunków drobnoustrojów (również bezpośrednio w materiałach klinicznych i materiałach uzyskanych *post mortem*) poprzez wykrywanie gatunkowo-specyficznych sekwencji DNA w reakcji łańcuchowej polimerazy (PCR) oraz Real-Time PCR (RT-PCR);
- określanie grup serologicznych *N. meningitidis* oraz typów serologicznych *Streptococcus pneumoniae* i *Haemophilus influenzae* z zastosowaniem specyficznych reakcji PCR oraz RT-PCR;

NORMAL CSF

Before LP- our responsibilities

1. Explain indications and procedure to the child&parents
2. Take **informed consent** from parents and patients
3. **Check PLT and coagulation tests** (INR) !
4. **Ask for help** (2 nurses)
5. Prepare skin in a **sterile fashion**
6. **Prepare local anestetics**
7. **Prepare 2 needles & 2 pairs of sterile gloves**
8. **Check serum glucose**

CSF interpretation

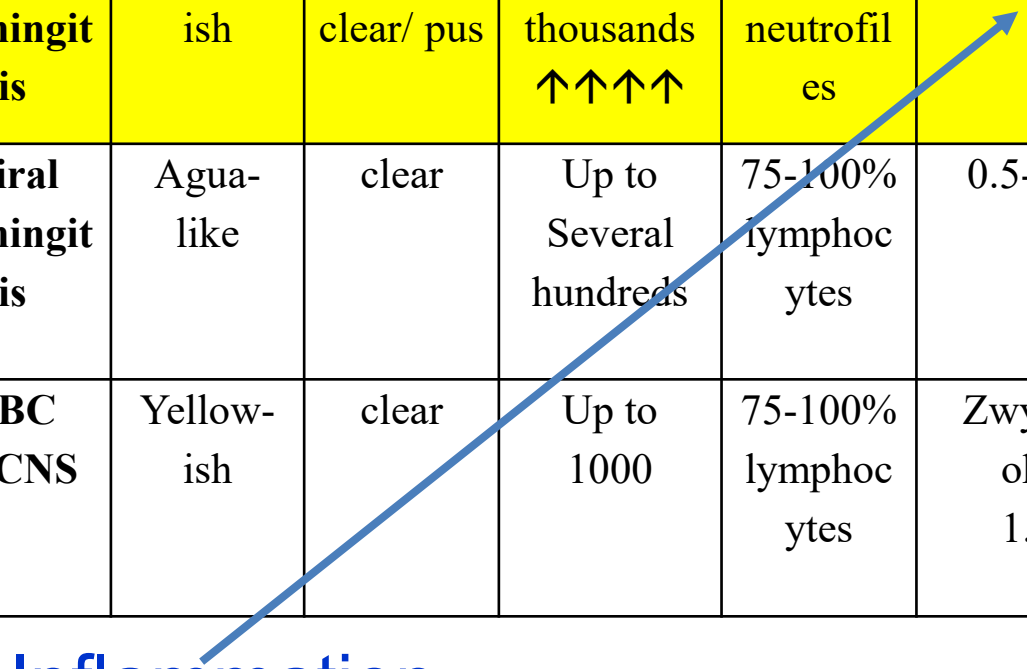
aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓

CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	**Yellow-ish**	**Not clear/ pus**	**Up to thousands ↑↑↑↑**	**90-100% neutrofiles**	**>1.0**	**<0.4**	**>4.0**	**↓**
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓

CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands ↑↑↑↑	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓



CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands ↑↑↑↑	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓

Bacteria use glucose

CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands ↑↑↑↑	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓

Anaerobic metabolism

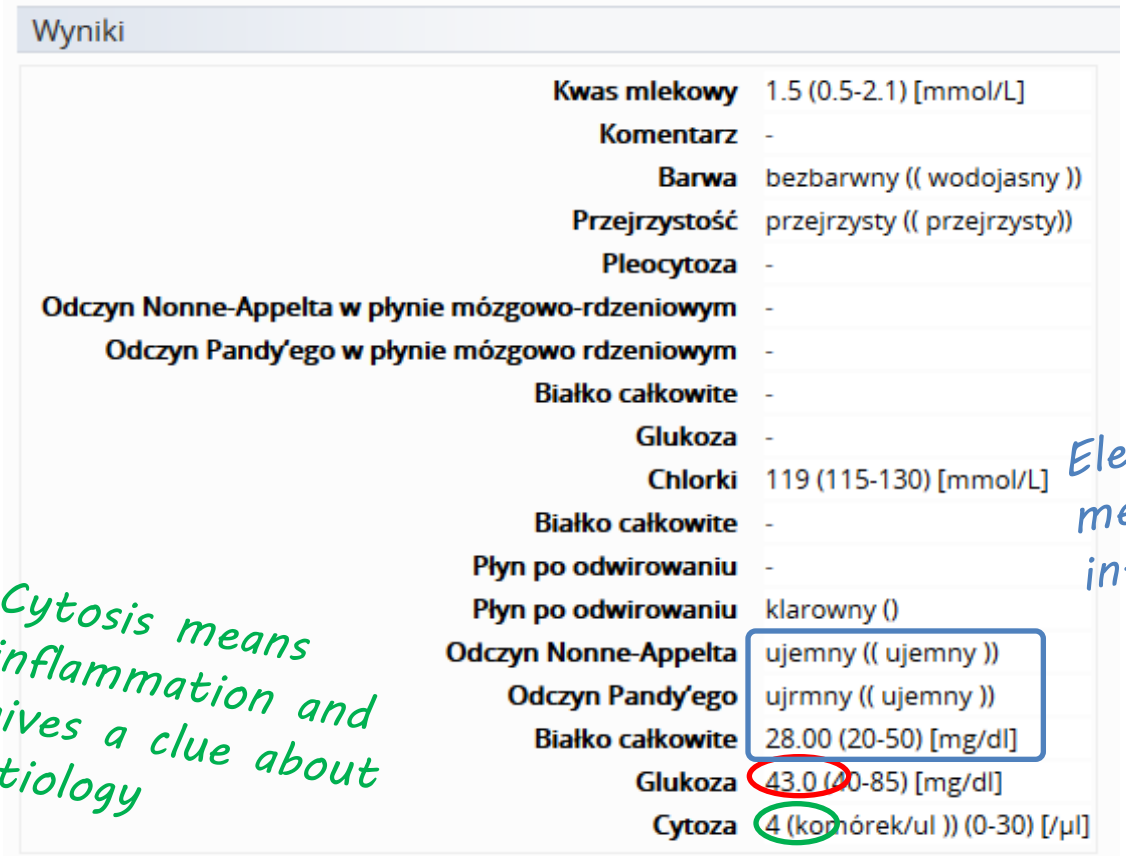
CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	**Agua-like**	**clear**	**Up to Several hundreds**	**75-100% lympho-cytes**	**0.5-2.0**	**>0.6**	**2.1-3.0**	**In a normal ranges or ↓**
TBC of CNS	Yellow-ish	clear	Up to 1000	75-100% lymphocytes	Zwykle ok. 1.0	<0.3	>4.0	↓

CSF interpretation

aetiology	colour	Clear-ness	Cells/ 1µl	smear	protein (g/l)	glucose (CSF/serum)	lactates (mmol/l)	Cl (mmol/l)
NORMAL	**Agua-like**	**complete**	**≤ 5 (neonates < 20)**		**<0.4 (neonates <1)**	**≥ 0.6**	**<2.1**	**>117**
bacterial meningitis	Yellow-ish	Not clear/ pus	Up to thousands	90-100% neutrofiles	>1.0	<0.4	>4.0	↓
Viral meningitis	Agua-like	clear	Up to Several hundreds	75-100% lymphocytes	0.5-2.0	>0.6	2.1-3.0	In a normal ranges or ↓
TBC of CNS	**Yellow-ish**	**clear**	**Up to 1000**	**75-100% lymphocytes**	**Zwykle ok. 1.0**	**<0.3**	**>4.0**	↓

Cerebro-spinal fluid (CSF) interpretation



Wyniki

Kwas mlekowy	1.5 (0.5-2.1) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	119 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny ()
Odczyn Nonne-Appelta	ujemny ((ujemny))
Odczyn Pandy'ego	ujrmny ((ujemny))
Białko całkowite	28.00 (20-50) [mg/dl]
Glukoza	43.0 (40-85) [mg/dl]
Cytoza	4 (komórek/ul)) (0-30) [/µl]

1

„Visual parameters"

2

Cytosis means inflammation and gives a clue about etiology

3

Elevated protein means inflammation

4

Glucose in CSF must be related to glucose in serum (2/3)

General rule - bacteria eat glucose

Questions!

Let’s practise……

Case 1

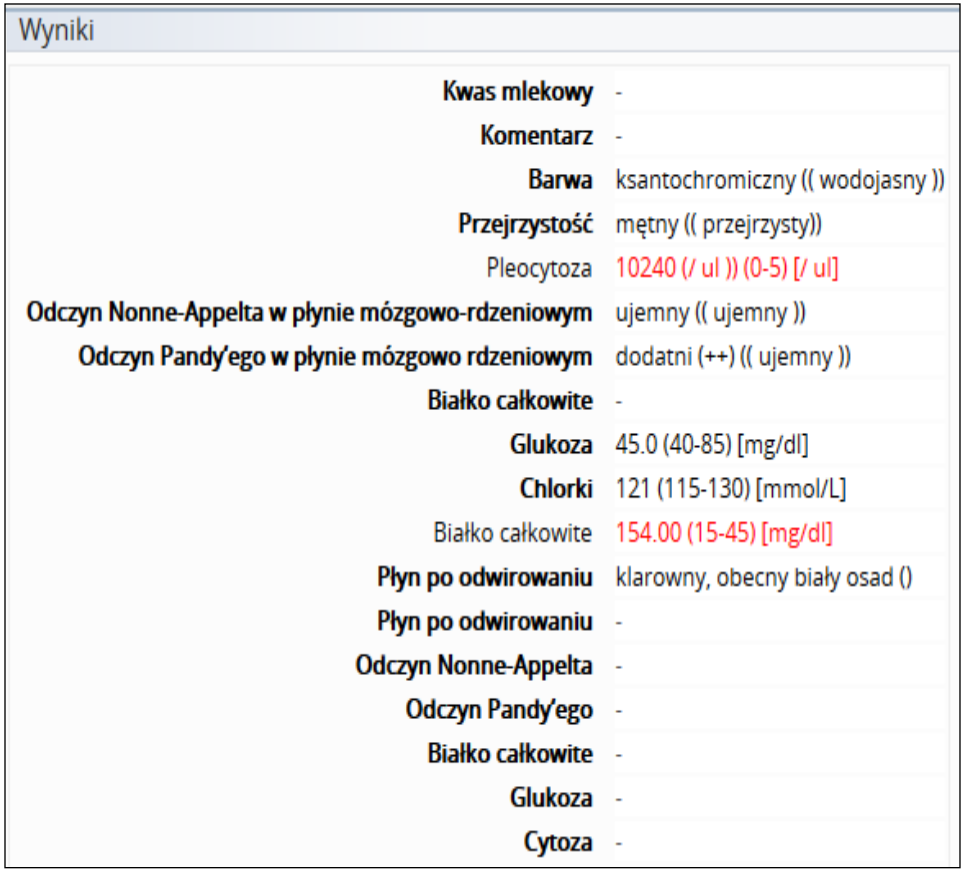
- PC: 8/12 girl with fever 40°C, vomiting for 2 days
- O/E: poor general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec

Case 1

Non blanching rash

- 8/12 girl with fever 40°C, vomiting for 2 days
- poor general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec

Case 1

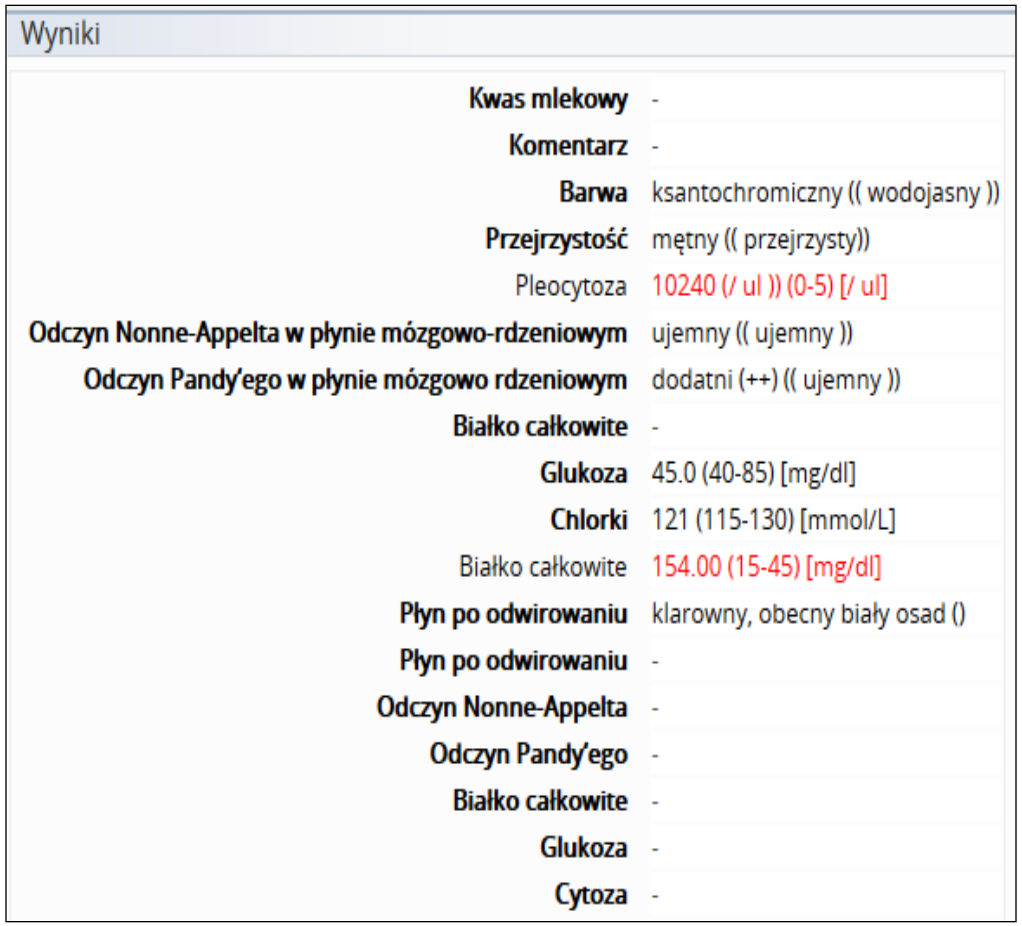


Wyniki

Kwas mlekowy	-
Komentarz	-
Barwa	ksantochromiczny ((wodojasny))
Przejrzystość	mętny ((przejrzysty))
Pleocytoza	10240 (/ ul)) (0-5) [/ ul]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	ujemny ((ujemny))
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	dodatni (++) ((ujemny))
Białko całkowite	-
Glukoza	45.0 (40-85) [mg/dl]
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	154.00 (15-45) [mg/dl]
Płyn po odwirowaniu	klarowny, obecny biały osad ()
Płyn po odwirowaniu	-
Odczyn Nonne-Appelta	-
Odczyn Pandy'ego	-
Białko całkowite	-
Glukoza	-
Cytoza	-

- 8/12 girl with fever 40°C, vomiting for 2 days
- poor general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec
- **Glucose** (serum)- **100 mg%**
- **CSF smear: 98% polymorphs**

Case 1



Wyniki

Kwas mlekowy	-
Komentarz	-
Barwa	ksantochromiczny ((wodojasny))
Przejrzystość	mętny ((przejrzysty))
Pleocytoza	10240 (/ ul)) (0-5) [/ ul]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	ujemny ((ujemny))
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	dodatni (++) ((ujemny))
Białko całkowite	-
Glukoza	45.0 (40-85) [mg/dl]
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	154.00 (15-45) [mg/dl]
Płyn po odwirowaniu	klarowny, obecny biały osad ()
Płyn po odwirowaniu	-
Odczyn Nonne-Appelta	-
Odczyn Pandy'ego	-
Białko całkowite	-
Glukoza	-
Cytoza	-

- 8/12 girl with fever 40°C, vomiting for 2 days
- grave general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec
- **<u>G(-) diplococcus in CSF</u>**

Case 1

Wyniki

Kwas mlekowy	-
Komentarz	-
Barwa	ksantochromiczny ((wodojasny))
Przejrzystość	mętny ((przejrzysty))
Pleocytoza	10240 (/ ul)) (0-5) [/ ul]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	ujemny ((ujemny))
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	dodatni (++) ((ujemny))
Białko całkowite	-
Glukoza	45.0 (40-85) [mg/dl]
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	154.00 (15-45) [mg/dl]
Płyn po odwirowaniu	klarowny, obecny biały osad ()
Płyn po odwirowaniu	-
Odczyn Nonne-Appelta	-
Odczyn Pandy'ego	-
Białko całkowite	-
Glukoza	-
Cytoza	-

- 8/12 girl with fever 40°C, vomiting for 2 days
- grave general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec
- **G(-) diplococcus in CSF**
- **PCR test of CSF reveales N.meningitidis**

Case 1

Wyniki

Kwas mlekowy	-
Komentarz	-
Barwa	ksantochromiczny ((wodojasny))
Przejrzystość	mętny ((przejrzysty))
Pleocytoza	10240 (/ ul)) (0-5) [/ ul]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	ujemny ((ujemny))
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	dodatni (++) ((ujemny))
Białko całkowite	-
Glukoza	45.0 (40-85) [mg/dl]
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	154.00 (15-45) [mg/dl]
Płyn po odwirowaniu	klarowny, obecny biały osad ()
Płyn po odwirowaniu	-
Odczyn Nonne-Appelta	-
Odczyn Pandy'ego	-
Białko całkowite	-
Glukoza	-
Cytoza	-

- 8/12 girl with fever 40°C, vomiting for 2 days
- grave general condition, bulging fontanel, nuchal rigidity, petechiae, CRT> 5 sec
- **G(-) diplococcus in CSF**
- **PCR test of CSF reveales N.meningitidis**
- **Dgn: bacterial meningitis- Neisseria meningitidis**

Case 2

- 14-year-old boy
- PC: History of fever, headache photophobia, vomiting for 1 day
- No PMH
- O/E: GCS 15, full contact, (+) meningeal signs

Case 2

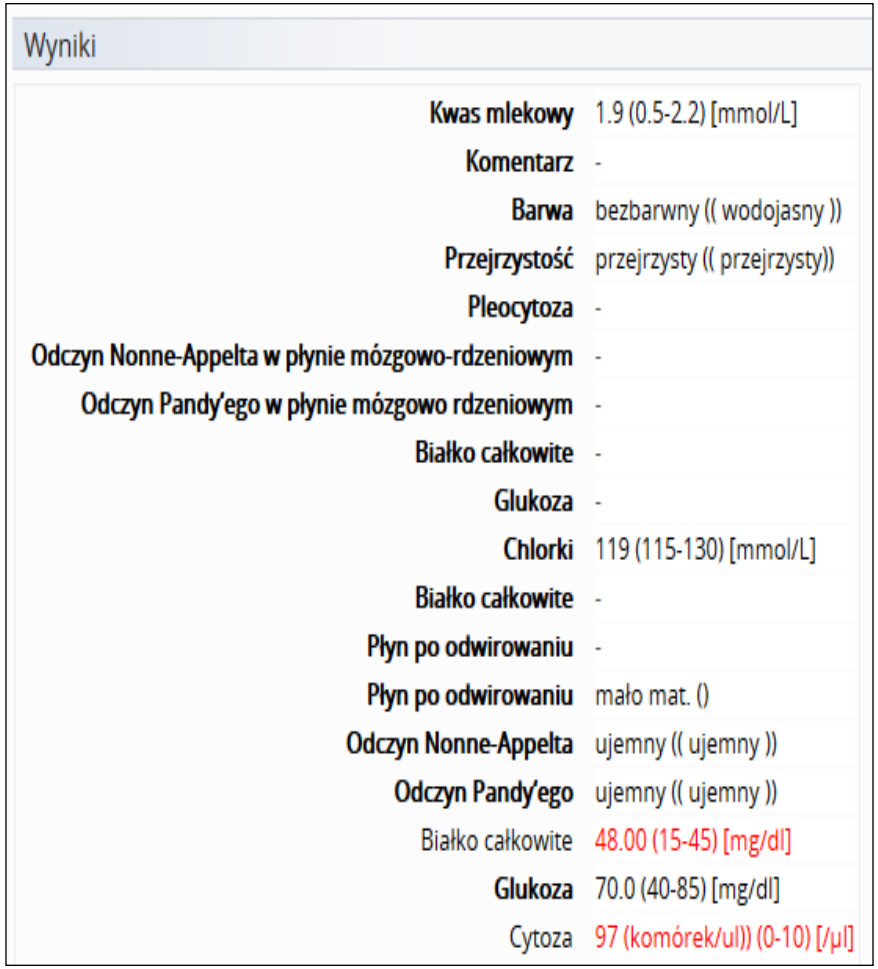
- 14 years old boy
- History of fever, photophobia, vomiting, nuchal rigidity for 1 day

Wyniki

Kwas mlekowy	1.9 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	119 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	mało mat. ()
Odczyn Nonne-Appelta	ujemny ((ujemny))
Odczyn Pandy'ego	ujemny ((ujemny))
Białko całkowite	48.00 (15-45) [mg/dl]
Glukoza	70.0 (40-85) [mg/dl]
Cytoza	97 (komórek/ul)) (0-10) [/µl]

Case 2

- 14 years old boy
- History of fever, photophobia, vomiting, nuchal rigidity for 1 day
- **Serum glucose: 91 mg/dl**
- **CSF smear: 80% lymhocytes**

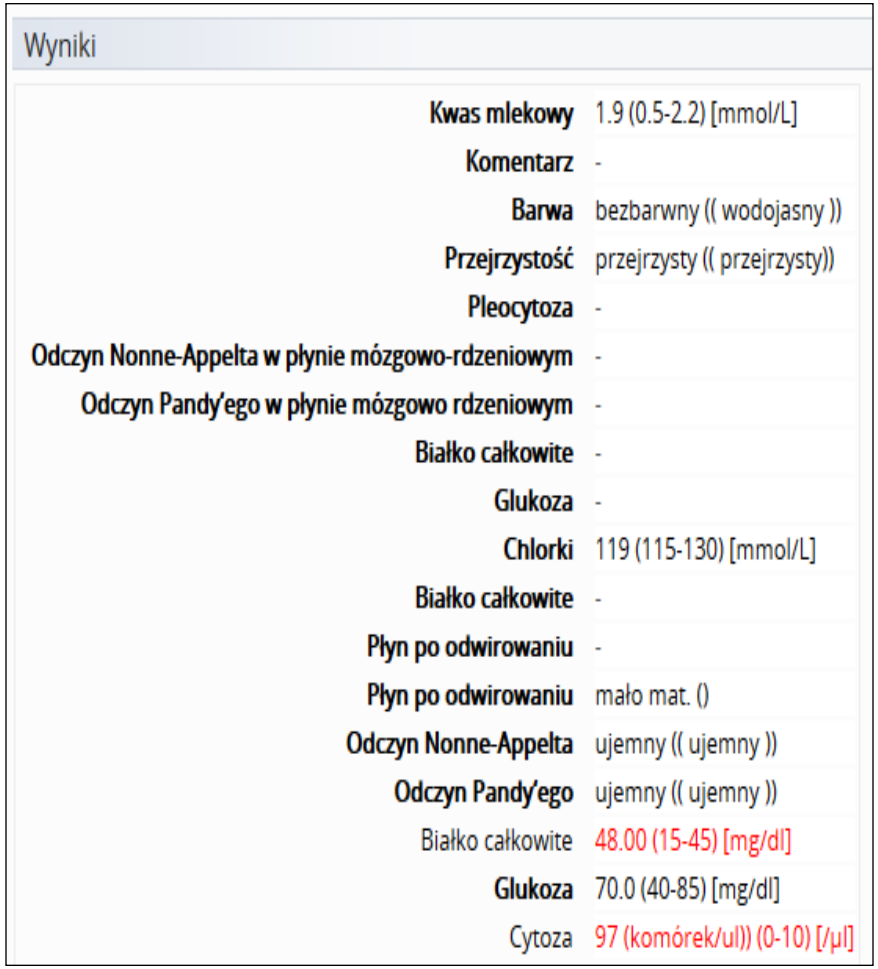


Wyniki

Kwas mlekowy	1.9 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	119 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	mało mat. ()
Odczyn Nonne-Appelta	ujemny ((ujemny))
Odczyn Pandy'ego	ujemny ((ujemny))
Białko całkowite	48.00 (15-45) [mg/dl]
Glukoza	70.0 (40-85) [mg/dl]
Cytoza	97 (komórek/ul)) (0-10) [/µl]

Case 2

- 14 years old boy
- History of fever, photophobia, vomiting, nuchal rigidity for 1 day
- **<u>Enterovirus found on PCR test of CSF</u>**

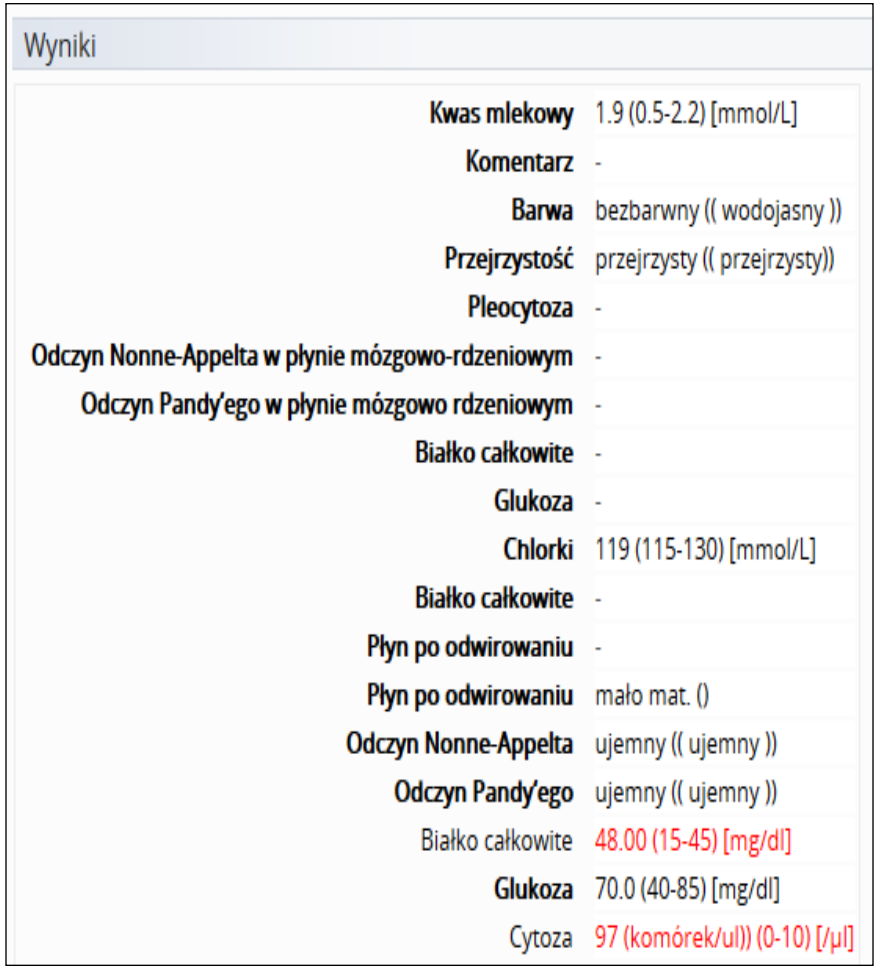


Wyniki

Kwas mlekowy	1.9 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	119 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	mało mat. ()
Odczyn Nonne-Appelta	ujemny ((ujemny))
Odczyn Pandy'ego	ujemny ((ujemny))
Białko całkowite	48.00 (15-45) [mg/dl]
Glukoza	70.0 (40-85) [mg/dl]
Cytoza	97 (komórek/ul)) (0-10) [/µl]

Case 2

- 14 years old boy
- History of fever, photophobia, vomiting, nuchal rigidity for 1 day
- **Enterovirus found on PCR test of CSF**
- **Dgn: viral meningitis due to Enterovirus**



Wyniki

Kwas mlekowy	1.9 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	119 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	mało mat. ()
Odczyn Nonne-Appelta	ujemny ((ujemny))
Odczyn Pandy'ego	ujemny ((ujemny))
Białko całkowite	48.00 (15-45) [mg/dl]
Glukoza	70.0 (40-85) [mg/dl]
Cytoza	97 (komórek/ul)) (0-10) [/µl]

Case 3

- 16 years old girl
- Suden onset od headache (bilateral temporal) , no nausea, vomiting, no fono- &fotofobia
- Family history of migraine headache in mother & aunt
- On examination- neck stiffness (3 cm) ,other meningeal signs negatitve

Case 3

- 16 years old girl
- Suden onset od headache (bilateral temporal) , no nausea, vomiting, no fono- &fotofobia
- Family history of migraine headache in mother & aunt

Kwas mlekowy	2.2 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	słabo dodatni (+) ((ujemny))
Białko całkowite	71.00 (15-45) [mg/dl]
Glukoza	62.0 (40-85) [mg/dl]
Cytoza	160 (komórek/ul)) (0-10) [/µl]

Case 3

- 16 years old girl
- Suden onset od headache (bilateral temporal) , no nausea, vomiting, no fono- &fotofobia
- Family history of migraine headache in mother & aunt
- **Serum glucose: 81 mg/dl**

Kwas mlekowy	2.2 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	słabo dodatni (+) ((ujemny))
Białko całkowite	71.00 (15-45) [mg/dl]
Glukoza	62.0 (40-85) [mg/dl]
Cytoza	160 (komórek/ul)) (0-10) [/µl]

Osoba odpowiedzialna za wynik: WIESŁAWA KRÓL , PWZ: 00610

Case 3

- 16 years old girl
- Suden onset od headache (bilateral temporal) , no nausea, vomiting, no fono- &fotofobia
- Family history of migraine headache in m[illegible] aunt
- On examina[illegible] stiffness

(3 cm) ,other n[illegible] signs negatitve

Kwas mlekowy	2.2 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	słabo dodatni (+) ((ujemny))
Białko całkowite	71.00 (15-45) [mg/dl]
Glukoza	62.0 (40-85) [mg/dl]
Cytoza	160 (komórek/ul)) (0-10) [/µl]

[illegible]na za wynik: WIESŁAWA KRÓL , PWZ: 00610

GRAN %	* (0-6) [%]
LYMPH %	* (40-80) [%]
MONO %	* (15-45) [%]
EOSYNO %	* () [%]
Komentarz	NEUTROCYTY 14 % LIMFOCYTY 68 % LIMFOCYTY POBUDZONE 2 % MONOCYTY 14 % KOMÓRKI PLAZMATYCZNE 2 %
Makrofagi	* () [%]

Case 3

- 16 years old girl
- Suden onset od headache (bilateral temporal) , no nausea, vomiting, no fono- &fotofobia
- Family history of migraine headache in mother & aunt

Enterovirus from CSF was detected (PCR kit)

Dgn: viral meningitis due to Enterovirus

Kwas mlekowy	2.2 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	przejrzysty ((przejrzysty))
Pleocytoza	-
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	121 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	słabo dodatni (+) ((ujemny))
Białko całkowite	71.00 (15-45) [mg/dl]
Glukoza	62.0 (40-85) [mg/dl]
Cytoza	160 (komórek/ul)) (0-10) [/µl]

Osoba odpowiedzialna za wynik: WIESŁAWA KRÓL , PWZ: 00610

Case 4

- 18-month-old boy
- History of fever up to 40°C for 6 days
- Received penicylin orally (due to suspicion of tonsillitis), then azytromycin orally (due to suspicion of bronchitis) – no result
- Sent to hospital
- Generally unwell, GCS 12
- Dehydrated
- Possititive all meningeal signs

Case 4

- 18-month-old boy
- History of fever up to 40°C for 6 days
- Received penicylin orally (due to suspicion of tonsillitis), then azytromycin orally (due to bronchitis) – no result
- Generally unwell, GCS 12
- **Serum glucose: 69 mg/dl**

Kwas mlekowy	6.8 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	lekko mętny ((przejrzysty))
Pleocytoza	700 (/µl)) (0-5) [/µl]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	114 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny, obecny osad erytrocytów ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	dodatni (++) ((ujemny))
Białko całkowite	82.00 (15-45) [mg/dl]
Glukoza	34.0 (40-85) [mg/dl]
Cytoza	-

Case 4

- 18-month-old boy
- History of fever up to
- Dihydrated
- Possititive meningeal signs

GRAN %	93.0 (0-6) [%]
LYMPH %	4.00 (40-80) [%]
MONO %	3.00 (15-45) [%]
EOSYNO %	* () [%]
Komentarz	-
Makrofagi	* () [%]

Osoba odpowiedzialna za wynik: ANNA JENCZELEWSKA , PWZ: 01748

Kwas mlekowy	6.8 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	lekko mętny ((przejrzysty))
Pleocytoza	700 (/µl)) (0-5) [/µl]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	114 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny, obecny osad erytrocytów ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	dodatni (++) ((ujemny))
Białko całkowite	82.00 (15-45) [mg/dl]
Glukoza	34.0 (40-85) [mg/dl]
Cytoza	-

Case 4

GRAN %	93.0 (0-6) [%]
LYMPH %	4.00 (40-80) [%]
MONO %	3.00 (15-45) [%]
EOSYNO %	* () [%]
Komentarz	-
Makrofagi	* () [%]

Osoba odpowiedzialna za wynik: ANNA JENCZELEWSKA , PWZ: 01748

Kwas mlekowy	6.8 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	lekko mętny ((przejrzysty))
Pleocytoza	700 (/µl)) (0-5) [/µl]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	114 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny, obecny osad erytrocytów ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	dodatni (++) ((ujemny))
Białko całkowite	82.00 (15-45) [mg/dl]
Glukoza	34.0 (40-85) [mg/dl]
Cytoza	-

- **<u>CSF culture- negative</u>**
- What is the diagnosis?

Case 4

GRAN %	93.0 (0-6) [%]
LYMPH %	4.00 (40-80) [%]
MONO %	3.00 (15-45) [%]
EOSYNO %	* () [%]
Komentarz	-
Makrofagi	* () [%]

Osoba odpowiedzialna za wynik: ANNA JENCZELEWSKA , PWZ: 01748

Kwas mlekowy	6.8 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	lekko mętny ((przejrzysty))
Pleocytoza	700 (/µl)) (0-5) [/µl]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	114 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny, obecny osad erytrocytów ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	dodatni (++) ((ujemny))
Białko całkowite	82.00 (15-45) [mg/dl]
Glukoza	34.0 (40-85) [mg/dl]
Cytoza	-

- **Possitive PCR TEST in CSF**
- **DNA of Str. Pneumoniae (+) was identified**
- **Dgn: ?**

Case 4

GRAN %	93.0 (0-6) [%]
LYMPH %	4.00 (40-80) [%]
MONO %	3.00 (15-45) [%]
EOSYNO %	* () [%]
Komentarz	-
Makrofagi	* () [%]

Osoba odpowiedzialna za wynik: ANNA JENCZELEWSKA , PWZ: 01748

Kwas mlekowy	6.8 (0.5-2.2) [mmol/L]
Komentarz	-
Barwa	bezbarwny ((wodojasny))
Przejrzystość	lekko mętny ((przejrzysty))
Pleocytoza	700 (/µl)) (0-5) [/µl]
Odczyn Nonne-Appelta w płynie mózgowo-rdzeniowym	-
Odczyn Pandy'ego w płynie mózgowo rdzeniowym	-
Białko całkowite	-
Glukoza	-
Chlorki	114 (115-130) [mmol/L]
Białko całkowite	-
Płyn po odwirowaniu	-
Płyn po odwirowaniu	klarowny, obecny osad erytrocytów ()
Odczyn Nonne-Appelta	słabo dodatni (+) ((ujemny))
Odczyn Pandy'ego	dodatni (++) ((ujemny))
Białko całkowite	82.00 (15-45) [mg/dl]
Glukoza	34.0 (40-85) [mg/dl]
Cytoza	-

- **Possitive PCR TEST in CSF**
- **DNA of Str. Pneumoniae (+) was identified**
- **Dgn: bacterial pneumococcal meningitis**

PART 2
FULL BLOOD

General distinctions in children

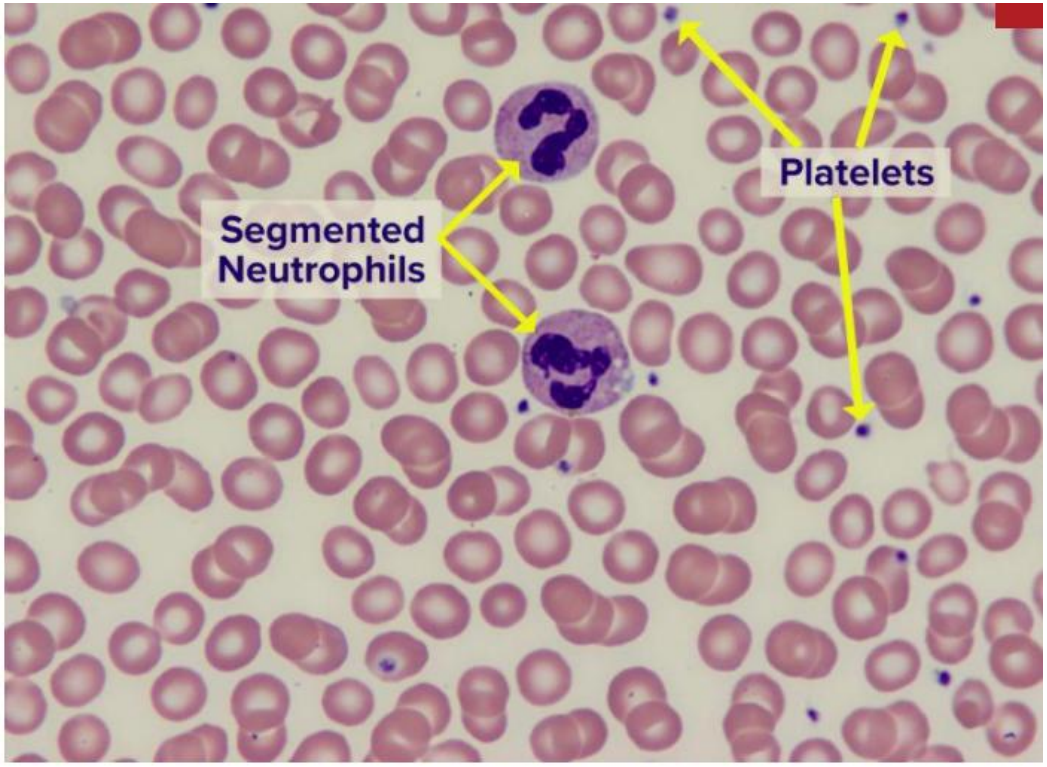
- Hematological & CSF values depend on age (**always check child's age before interpreting blood results!)**

- Blood smear change throughtout the childhood (1st shift- 4 day, 2nd shift – 4 year)

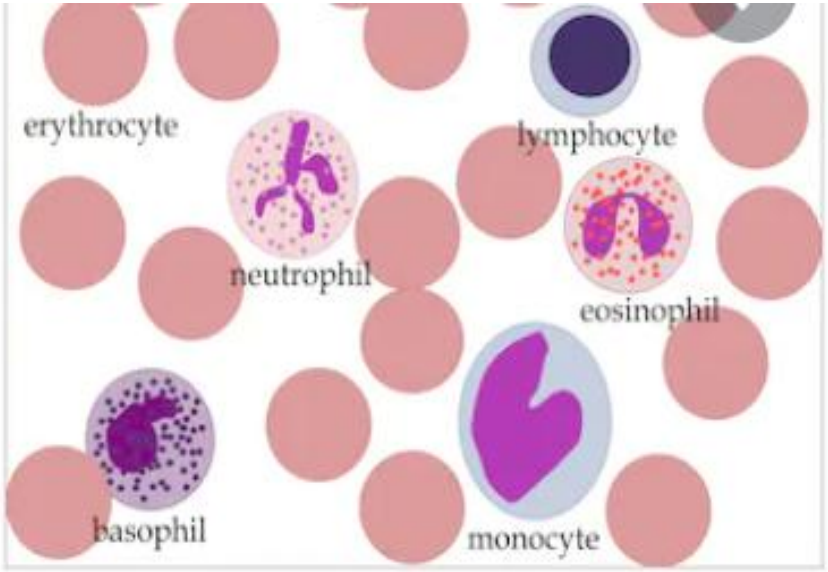
- Laboratory tests **should be interpreted** together **with clinical picture of the patient**

LEUKOCYTES IN CHILDREN- range strongly depends on age

	1. Day of life	7. day	1/12	2/12	3-6/12	1. Year old	2.-6 years	6.-12. years
RBC (x 10^{12}/l)	6,0 ± 1,0	5,1 ± 1,2	4,1 ± 1,2	3,7 ± 0,6	4,7 ± 0,6	4,5 ± 0,6	4,6 ± 0,6	4,6 ± 0,6
Hgb (g%)	18,0 ± 4,0	17,5 ± 4,0	14,0 ± 2,5	11,2 ± 1,8	12,6 ± 1,5	12,6 ± 1,5	12,5 ± 1,5	13,5 ± 2,0
Hct (%)	60 ± 15	54 ± 12	43 ± 10	35 ± 7	35 ± 5	34 ± 4	37 ± 3	40 ± 5
MCV (fl)	110 ± 10	107 ± 19	104 ± 12	95 ± 8	76 ± 8	78 ± 6	81 ± 6	86 ± 9
MCH (pg)	34 ± 3	34 ± 3	33 ± 3	30 ± 3	27 ± 3	27 ± 2	27 ± 3	29 ± 4
MCHC (g%)	33 ± 3	33 ± 5	33 ± 4	32 ± 3,5	33 ± 3	34 ± 2	34 ± 3	34 ± 3
WBC (x 10^9/l)	**18 ± 8**	**14 ± 8**	**12 ± 7**	**10 ± 5**	**12 ± 6**	**11 ± 5**	**10 ± 5**	**9 ± 4**
PLT (x 10^9/l)	100 – 450	160 - 500	200 - 500	210 - 650	200 - 550	200 - 550	200 - 490	170 - 450



Normal blood smear with red blood cells (majority of cells shown), white blood cells (segmented neutrophils) and platelets (small purple dots). Image credit: Bette Jamieson, MEd



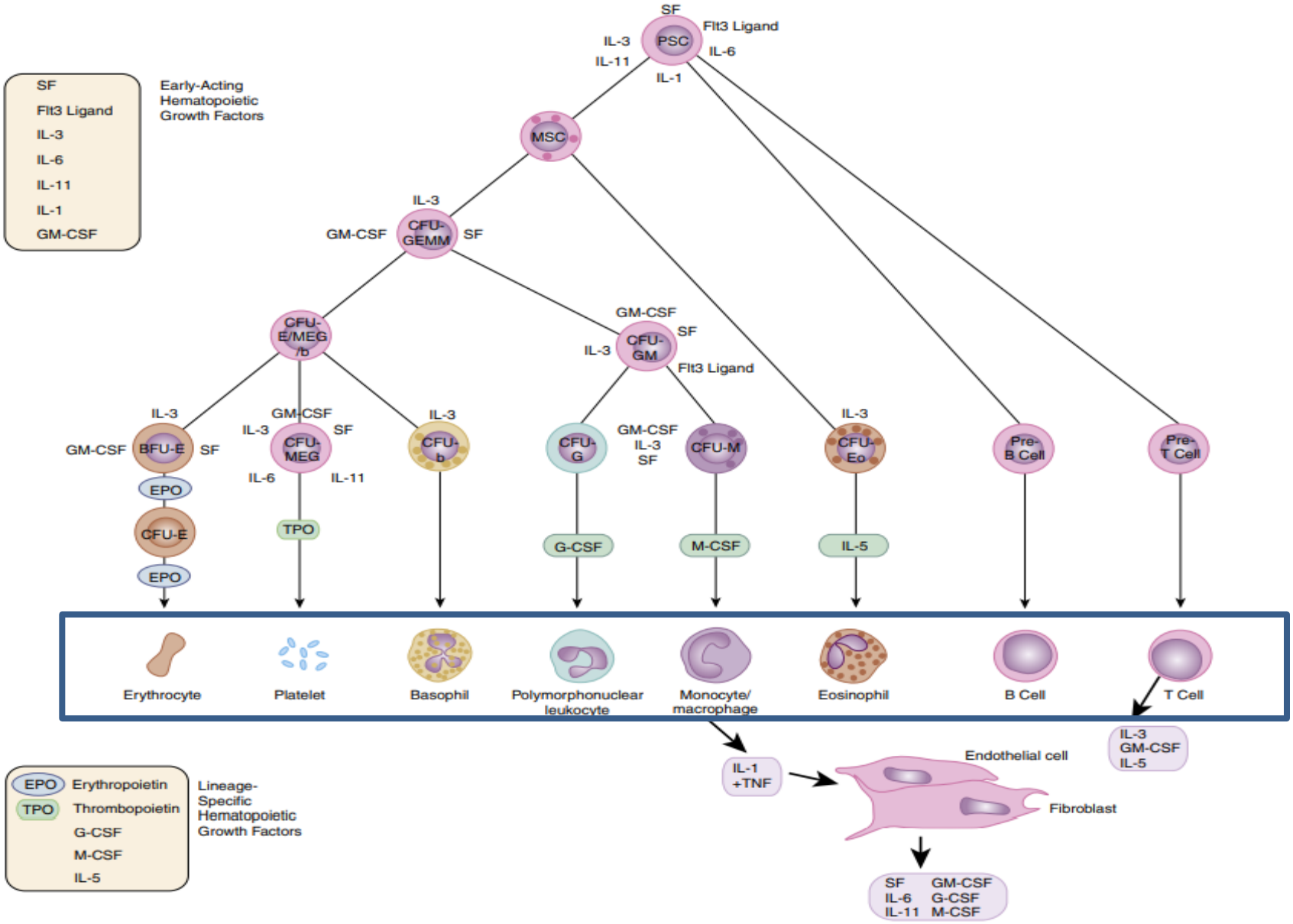
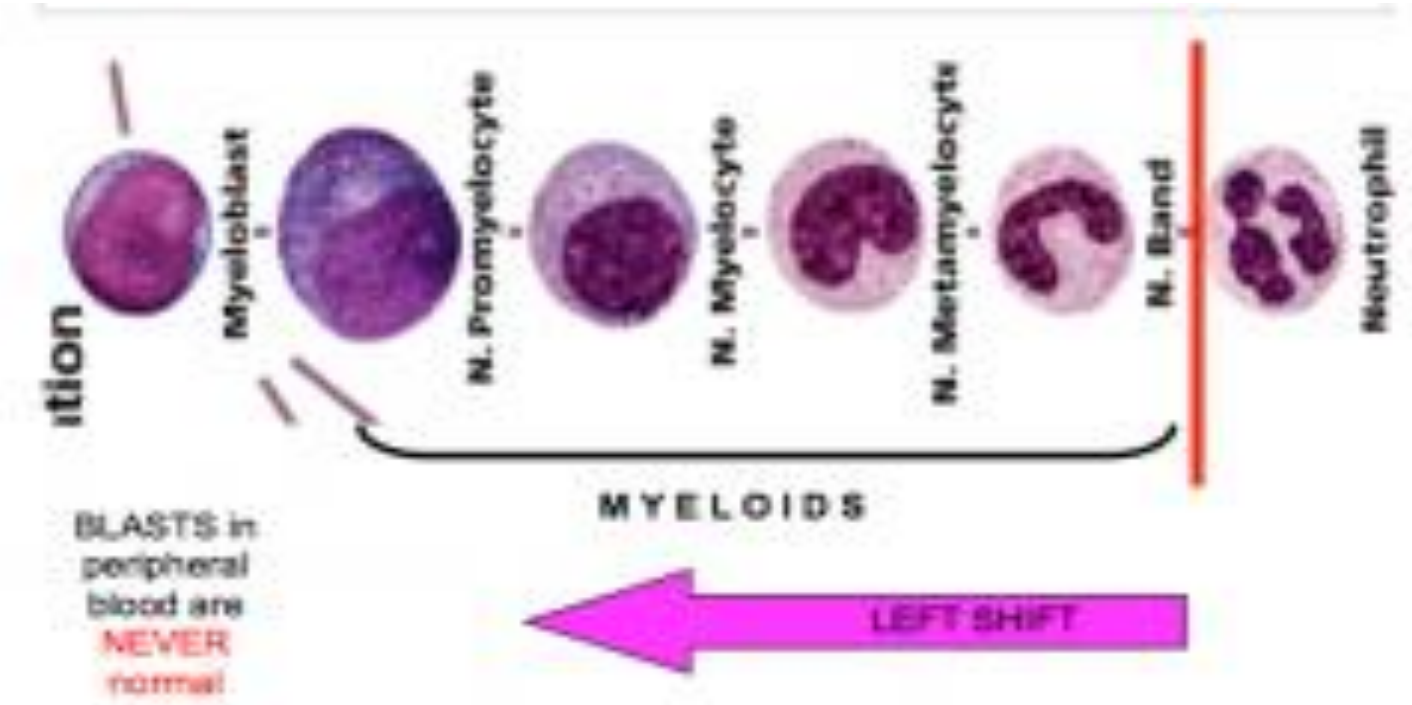


Figure 149-1 **Major cytokine sources and actions to promote hematopoiesis.** Cells of the bone marrow microenvironment, such as macrophages, endothelial cells, and reticular fibroblasts, produce macrophage colony-stimulating factor (M-CSF), granulocyte-macrophage colony-stimulating factor (GM-CSF), and granulocyte colony-stimulating factor (G-CSF) after stimulation. For all lineages, optimal development requires a combination of early and late acting factors. *BFU,* Burst-forming unit; *CFU,* colony-forming unit; *EPO,* erythropoietin; *IL,* interleukin; *MSC,* myeloid stem cell; *PSC,* pluripotent stem cell; *TNF,* tumor necrosis factor; *TPO,* thrombopoietin. *(From Sieff CA, Nathan DG, Clark SC: The anatomy and physiology of hematopoiesis. In Orkin SH, Nathan DG, editors:* Hematology of Infancy and Childhood, *ed 5, Philadelphia, 1998, WB Saunders, p 168.)*



Bone marrow

periferal blood

Teenagers & adults

Table 2. Normal White Blood Cell Distribution

White blood cell line	*Normal percentage of total leukocyte count*
Neutrophils	40 to 60
Lymphocytes	20 to 40
Monocytes	2 to 8
Eosinophils	1 to 4
Basophils	0.5 to 1

Information from reference 8.

Differential White Blood Cell Count
Normal Pediatric Values

Age	White Blood Cells ($x 10^3/\mu L$)	Neutrophils (%)	Neutrophils ($x 10^3/\mu L$)	Lymphocytes (%)	Lymphocytes ($x 10^3/\mu L$)	Monocytes (%)
Birth	9-30	41-81	6-26	26-36	2-11	0.4-3.1
1-3 days	9-38	41-81	6-26	21-41	2-17	
4-7 days	5-21	30-60	1.5-15	31-51	2-17	0.3-2.7
7-14 days	5-20	25-55	1.0-10	33-63	2-17	0.2-2.4
15-60 days	5-20	20-50		41-71		
2-5 months	5.5-18	20-50		44-74		
6 months-1 year	6.0-17.5	15-45	0.5-9.5	47-77	1.4-22	0-2.4
1-3 years	6.0-17.0	15-45		44-74		
3-5 years	5.5-15.5	25-57	1.5-7.5	35-65	1.5-8.5	0-0.8
6-10 years	4.5-14.5	38-68		25-54		
10-15 years	4.5-13.5	40-70	1.5-6.5	28-48	1.5-6.5	
15-20 years	4.5-12.5	42-72	1.5-7.5	25-45	1.5-5.0	0-0.8

Haemoglobin-
range strongly depends on age

	1. Day of life	7. day	1/12	2/12	3-6/12	1. Year old	2.-6 years	6.-12. years
RBC (x 10^{12}/l)	6,0 ± 1,0	5,1 ± 1,2	4,1 ± 1,2	3,7 ± 0,6	4,7 ± 0,6	4,5 ± 0,6	4,6 ± 0,6	4,6 ± 0,6
Hgb (g%)	18,0 ± 4,0	**17,5 ± 4,0**	**14,0 ± 2,5**	**11,2 ± 1,8**	**12,6 ± 1,5**	**12,6 ± 1,5**	**12,5 ± 1,5**	**13,5 ± 2,0**
Hct (%)	60 ± 15	54 ± 12	43 ± 10	35 ± 7	35 ± 5	34 ± 4	37 ± 3	40 ± 5
MCV (fl)	110 ± 10	107 ± 19	104 ± 12	95 ± 8	76 ± 8	78 ± 6	81 ± 6	86 ± 9
MCH (pg)	34 ± 3	34 ± 3	33 ± 3	30 ± 3	27 ± 3	27 ± 2	27 ± 3	29 ± 4
MCHC (g%)	33 ± 3	33 ± 5	33 ± 4	32 ± 3,5	33 ± 3	34 ± 2	34 ± 3	34 ± 3
WBC (x 10^9/l)	18 ± 8	14 ± 8	12 ± 7	10 ± 5	12 ± 6	11 ± 5	10 ± 5	9 ± 4
PLT (x 10^9/l)	100 – 450	160 - 500	200 - 500	210 - 650	200 - 550	200 - 550	200 - 490	170 - 450

HEMATOLOGICAL VALUES- NORMAL RANGE

Table 149-2 Hematologic Values During Infancy and Childhood

	HEMOGLOBIN (g/dL)		HEMATOCRIT (%)		RETICULOCYTES	LEUKOCYTES (per mm³)		DIFFERENTIAL COUNTS				
								NEUTROPHILS (%)		LYMPHOCYTES	EOSINOPHILS	MONOCYTES	NUCLEATED RED CELLS/100
AGE	MEAN	RANGE	MEAN	RANGE	(%) MEAN	MEAN	RANGE	MEAN	RANGE	(%) MEAN	(%) MEAN	(%) MEAN	WBCs
Cord blood	16.8	13.7–20.1	55	45–65	5	18,000	9000–30,000	61	40–80	31	2	6	7
2 wk	16.5	13–20	50	42–66	1	12,000	5000–21,000	40		48	3	9	3–10
3 mo	12.0	9.5–14.5	36	31–41	1	12,000	6000–18,000	30		63	2	5	0
6 mo–6 yr	12.0	10.5–14	37	33–42	1	10,000	6000–15,000	45		48	2	5	0
7–12 yr	13.0	11–16	38	34–40	1	8000	4500–13,500	55		38	2	5	0
Adult													
Female	14.0	12–16	42	37–47	1.6	7500	5000–10,000	55	35–70	35	3	7	0
Male	16.0	14–18	47	42–52									

From Behrman RE, editor: Nelson Textbook of Pediatrics, *ed 14, Philadelphia, 1992, WB Saunders.*
WBCs, White blood cells.

CBC

What's patient's AGE?

Wynik	-
WBC	6.12 (4.0-10.0) [x 10\^3/µL]
MID %	-
MID #	-
RBC	5.17 (4.7-6.1) [x 10\^6/µL]
HGB	14.6 (14.0-18.0) [g/dl]
HCT	43.7 (40-54) [%]
MCV	84.5 (78-95) [fL]
MCH	28.2 (26-32) [pg]
MCHC	33.4 (31-35) [g/dl]
RDW	13.8 (11.5-14.0) [%]
PLT	377 (150-400) [x 10\^3/µL]
PCT	0.36 (0.100-0.500) [%]
MPV	9.5 (7.4-11.0) [fL]
PDW	10.4 (10-18)
P-LCR	20.7 (14.0-43.0) [%]
LYMPH %	25.5 (28.9-46.5) [%]
NEUT %	61.2 (43-65) [%]
MONO %	11.9 (4.4-12.3) [%]
BASO %	0.7 (0-1) [%]
LYMPH #	1.56 (1.3-3.7) [x10\^3/µL]
NEUT #	3.75 (2.5-6.0) [x10\^3/µL]
MONO #	0.73 (0.18-0.78) [x 10\^3/µL]
EOSYNO #	0.04 (0.0-0.44) [x 10\^3/µL]
BASO #	0.04 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	0.7 (0.0-4.4) [%]
Komentarz	-

2 shifts:
1) 4 - 7days
2) 4 years

Final diagnosis should be set alltogether on history, findings in physical examinations & additional tests

Table 93-3 Differentiating Viral from Bacterial Infections

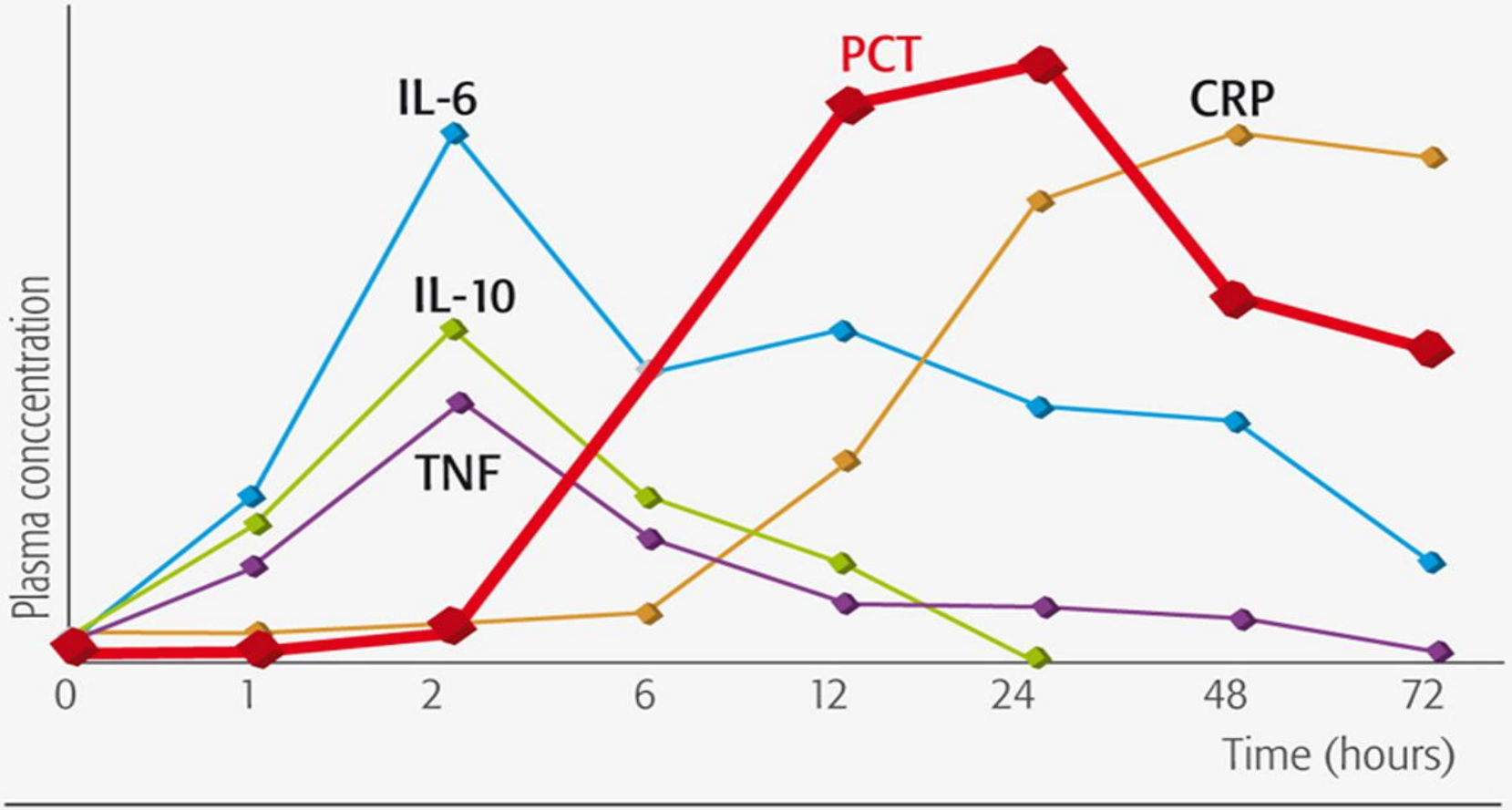
VARIABLE	VIRAL	BACTERIAL
Petechiae	Present	Present
Purpura	Rare	If severe
Leukocytosis	Uncommon*	Common
Shift-to-the-left (↑bands)	Uncommon	Common
Neutropenia	Possible	Suggests overwhelming infection
↑ ESR	Unusual*	Common
↑ CRP	Unusual	Common
↑ TNF, IL-1, PAF	Uncommon	Common
Meningitis (pleocytosis)	Lymphocytic†	Neutrophilic
Meningeal signs positive‡	Present	Present

CRP, C-reactive protein; *ESR*, erythrocyte sedimentation rate; *IL*, interleukin; *PAF*, platelet-activating factor; *TNF*, tumor necrosis factor.

*Adenovirus and herpes simplex may cause leukocytosis and increased ESR; Epstein-Barr virus may cause petechiae and increased ESR.

†Early viral (enterovirus, arbovirus) meningitis initially may have a neutrophilic pleocytosis.

‡Nuchal rigidity, bulging fontanelle, Kernig sign, Brudzinski sign.



Kinetic profiles of different biomarkers of bacterial infection.

Adapted from Meisner M.[1]

Review of Therapeutics

Procalcitonin Monitoring as a Guide for Antimicrobial Therapy: A Review of Current Literature

Elizabeth W. Covington ✉, Megan Z. Roberts, Jenny Dong

Classification of neutrophilia

Spurious
Platelet clumping
Mixed cryoglobulinemia
Primary (no other evident associated disease)
Myeloproliferative disorders (eg, CML, PV, ET)
Hereditary neutrophilia
Chronic idiopathic neutrophilia
Familial myeloproliferative disease
Congenital anomalies and leukemoid reaction
Down syndrome
Leukocyte adhesion factor deficiency
Familial cold urticaria and leukocytosis
Secondary
Infection
Stress (physical or emotional stress, vigorous exercise)
Cigarette smoking
Drugs
Glucocorticoids
Recombinant G-CSF or GM-CSF*
Catecholamines (epinephrine)
Lithium
All-trans retinoic acid
Isolated case reports for occasional other drugs
Nonhematologic malignancy
Heatstroke
Generalized bone marrow stimulation (as in hemolysis)
Asplenia and hyposplenism

Most commonly encountered causes of neutrophilia are shown in **bold**.

CML: chronic myelogenous leukemia; PV: polycythemia vera; ET: essential thrombocythemia; G-CSF: granulocyte colony-stimulating factor; GM-CSF: granulocyte-macrophage colony-

WBC

In children the most common reason for leukocytosis with neutrofilia is bacterial infection!!!

uptodate.com

Leukopaenia - main causes

-Viral infections !!!!!- the most common

- Bacterial infection- advanced SIRS& sepsis- poor prognosis
-**Leukemia-** Bone marrow gets damaged, and normal marrow cells are replaced with immature forms
-**HIV and AIDS**
- **Chemotherapy and radiation therapy-** kills cancerous cells along with healthy blood cells
- aplastic anemia- Failure to produce WBC and RBC, and also poor production of platelets
- **Myelofibrosis-** Fibrous tissue replaces the bone marrow
- **Hodgkin's lymphoma-** Damage the bone marrow
- **Rheumatoid arthritis**
- **Systemic Lupus Erythematosus-** This chronic anti-immunity connective disorder damages tissues, and causes infection
- Kostmann's syndrome: it has low neutrophil production

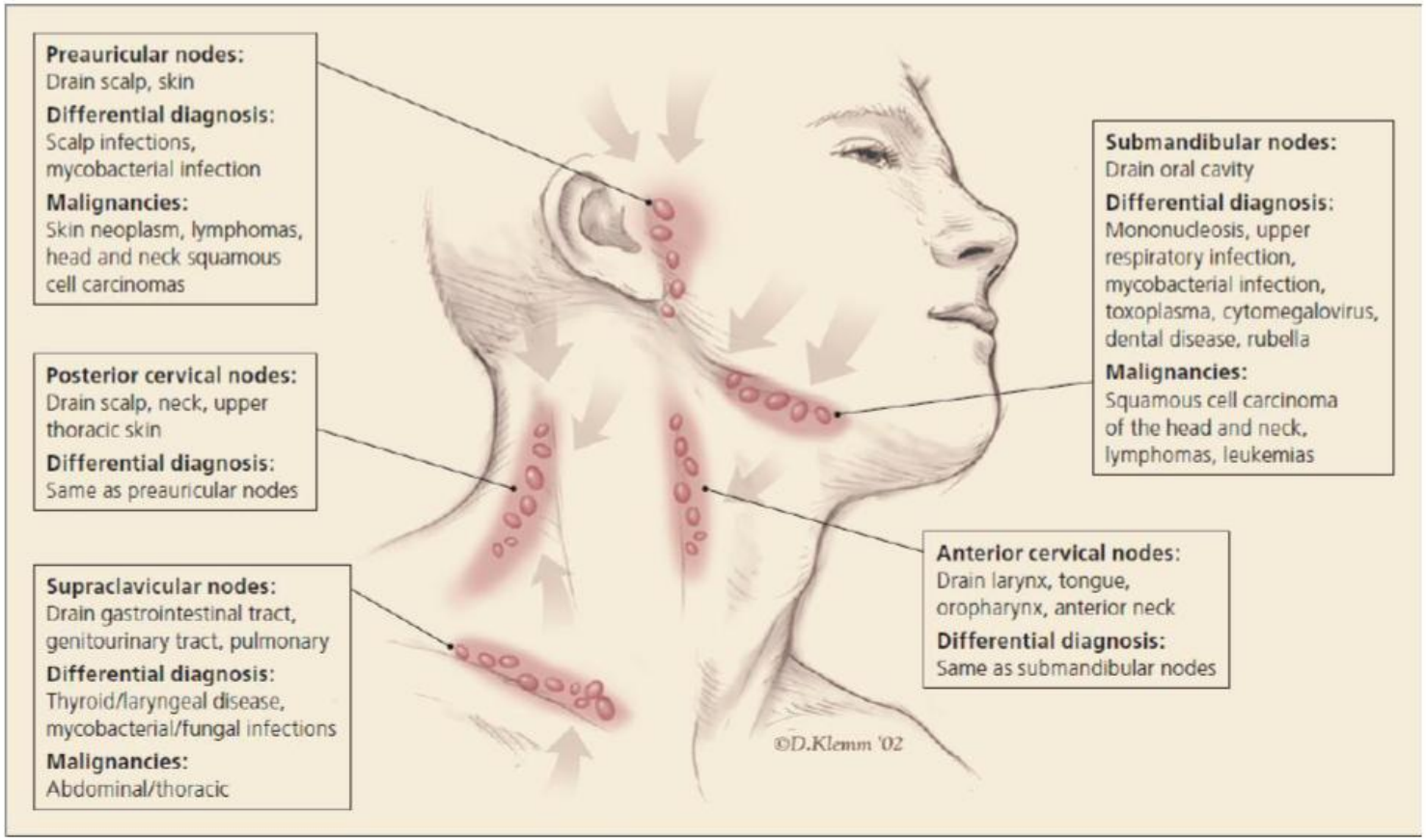
Key points in blood tests interpretation in infections

blood smear

- **Neutrofils → mainly bacteria**
- **Lymphocytes → mainly viruses**
- **A shift-to-left** is characteristic of the early stages of infection
- **bacterial infection (different stages)**
- **Early stage bands- leukemia if only 1 line dominant**
- **Atypical lymphocytes** (mature T lymphocytes) clasically seen in EBV infections, CMV, Toxoplasmosis, viral hepatitis
- **Eosinophilia**- characteristic for allergy, tissue invasive parasites, connective tissue disorders, drug reactions, sometimes in bacterial infections eg scarlet fever, Chlamydia pneumoniae, brucellosis& shigellosis during recovery)
- **Monocytes**- are typicaly seen on recovery from viral infection

CASE 1

- 5-year-old girl, otherwise heathy
- **PC**: fever 41◦C for 2 days, pain, refuse to eat
- **O/E**: general good state, GCS15, full contact, enlarged tonsills with white exudation,
- neck lymphadenopaty
- No other symptoms of infection (no cough)



Gaddey HL Am Fam Phys 2016

CASE 1

- 5-year-old girl, otherwise heathy
- **PC**: sudden onset, fever 41◦C for 2 days, pain, refuse to eat
- **O/E**: general good state, GCS15, full contact, enlarged tonsills with white exudation,
- neck lymphadenopaty
- No other symptoms of infection (no cough)

L 38 tys
(NEU 97%, LIMF1%, EOS1%, BAS 1%)
E 4.5 mln
Hb 13 g/dl
Hct 38%
PLT 290 tys
CRP 80 mg/dl (N: 0-1)

CASE 1

- 5-year-old girl, otherwise heathy
- **PC**: sudden onset, fever 41◦C for 2 days, pain, refuse to eat
- **O/E**: general good state, GCS15, full contact, enlarged tonsills with white exudation,
- neck lymphadenopaty
- No other symptoms of infection (no cough)

L 38 tys
(NEU 97%, LIMF1%, EOS1%, BAS 1%)
E 4.5 mln
Hb 13 g/dl
Hct 38%
PLT 290 tys
CRP 80mg/dl (N: 0-1)

- **<u>What is the diagnosis?</u>**
- **<u>What is your diagnostic/</u> therapeutic plan?**

CASE 1

- 5-year-old girl, otherwise heathy
- **PC**: sudden onset, fever 41◦C for 2 days, pain, refuse to eat
- **O/E**: general good state, GCS15, full contact, enlarged tonsills with white exudation,
- neck lymphadenopaty
- No other symptoms of infection (no cough)

- **Dgn. Tonsillitis (bacterial), Str. Pyogenes**
- **Treatment?**

CASE 1

- 5-year-old girl, otherwise heathy
- **PC**: sudden onset, fever 41◦C for 2 days, pain, refuse to eat
- **O/E**: general good state, GCS15, full contact, enlarged tonsills with white exudation,
- neck lymphadenopaty
- No other symptoms of infection (no cough)

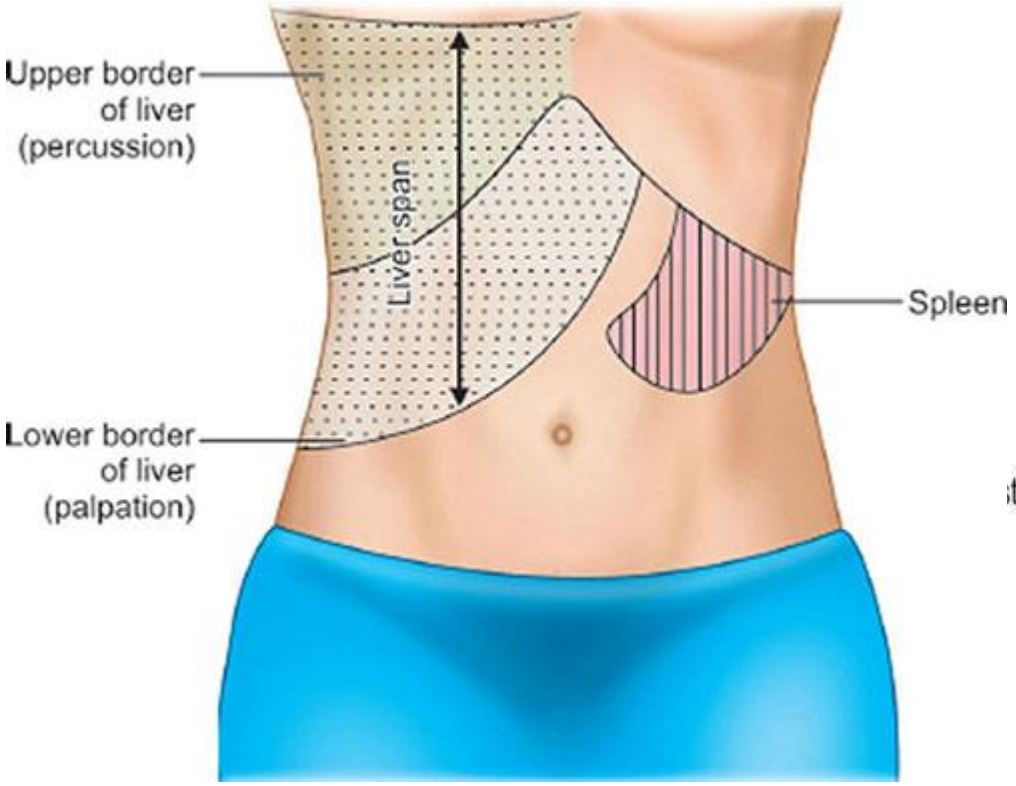
- **Dgn. Tonsillitis (bacterial), Str. Pyogenes**
- **Treatment? PENICYLLIN**

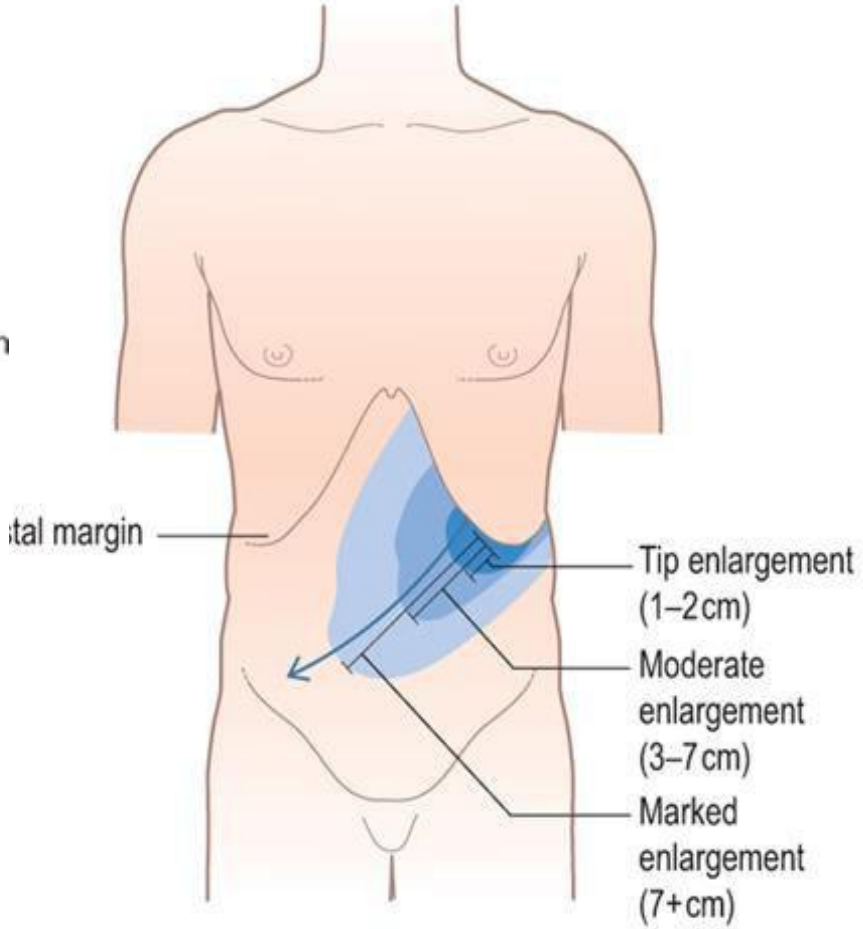
CASE 2

- 16-year-old girl
- **PC**: fever, lymphadenopathy, malaise
- Sent to the hospital due to hepatomegaly and lyphadenopathy due to suspition of malignancy
- **O/E**: enlarged with white/grey exudate,enanthem on soft palate, cervical lymphadenopathy, hepatosplenomegaly

CASE 2

Hepatomegaly, splenomegaly





CASE 2

- 16-year-old girl
- **PC**: fever, lymphadenopathy
- **O/E**: enlarged with white/grey exudate,exanthem on soft palate, cervical lymphadenopathy, hepatosplenomegaly

Wynik	-
WBC	16.20 (4.0-10.0) [x 10\^3/µL]
MID %	-
MID #	-
RBC	4.31 (4.2-5.4) [x 10\^6/µL]
HGB	12.4 (12.0-16.0) [g/dl]
HCT	35.7 (37-47) [%]
MCV	82.8 (78-95) [fL]
MCH	28.8 (26-32) [pg]
MCHC	34.7 (31-35) [g/dl]
RDW	11.9 (11.5-14.0) [%]
PLT	121 (150-400) [x 10\^3/µL]
PCT	0.12 (0.100-0.500) [%]
MPV	10.4 (7.4-11.0) [fL]
PDW	11.5 (10-18)
P-LCR	27.8 (14.0-43.0) [%]
LYMPH %	---- (28.9-46.5) [%]
NEUT %	10.8 (43-65) [%]
MONO %	---- (4.1-10.9) [%]
BASO %	0.3 (0-1) [%]
LYMPH #	---- (1.3-3.7) [x10\^3/µL]

CASE 2

Parameter	Result
Metamielocyte	1%
Bands	3%
Neutrofills	20%
Lymphocyte	41%
Activated lymphocytes	11%
Atypical lumphocytes	15%
Eosynofills	2%
Basofills	1%
Monocytes	6%

Wynik	-
WBC	16.20 (4.0-10.0) [x 10\^3/µL]
MID %	-
MID #	-
RBC	4.31 (4.2-5.4) [x 10\^6/µL]
HGB	12.4 (12.0-16.0) [g/dl]
HCT	35.7 (37-47) [%]
MCV	82.8 (78-95) [fL]
MCH	28.8 (26-32) [pg]
MCHC	34.7 (31-35) [g/dl]
RDW	11.9 (11.5-14.0) [%]
PLT	121 (150-400) [x 10\^3/µL]
PCT	0.12 (0.100-0.500) [%]
MPV	10.4 (7.4-11.0) [fL]
PDW	11.5 (10-18)
P-LCR	27.8 (14.0-43.0) [%]
LYMPH %	---- (28.9-46.5) [%]
NEUT %	10.8 (43-65) [%]
MONO %	---- (4.1-10.9) [%]
BASO %	0.3 (0-1) [%]
LYMPH #	---- (1.3-3.7) [x10\^3/µL]
NEUT #	1.75 (2.5-6.0) [x10\^3/µL]
MONO #	---- (0.18-0.78) [x 10\^3/µL]
EOSYNO #	0.05 (0.0-0.44) [x 10\^3/µL]
BASO #	0.05 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	0.3 (0.0-4.4) [%]
Komentarz	-
IG %	0.2 ()
IG #	0.03 () [x 10\^3/µL]
HFR	-
LFR	-
MFR	-

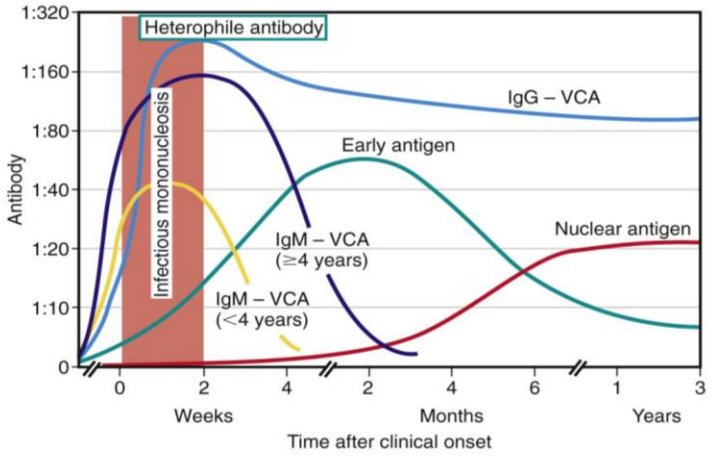
CASE 2

Parametr	21.11.2025	28.11.2025	Normal range
AST [IU/l]	211	120	< 30
ALT [IU/l]	162	88	< 30
CRP [mg/dl]	0.8	0.4	< 1 mg/dl
PCT (procalcytonin) [ng/ml]	< 0.5		<0.5 ng/ml

CASE 2

- 16-year-old girl
- **PC**: fever, lymphadenopathy
- **O/E**: enlarged with white/grey exudate,enanthem on soft palate, cervical lymphadenopathy, hepatosplenomegaly
- **What is the diagnosis?**
- **What is your diagnostic plan?**

CASE 2



- 16-year-old girl
- **PC**: fever, lymphadenopathy
- **O/E**: enlarged with white/grey exudate,exanthem on soft palate, cervical lymphadenopathy, hepatosplenomegaly

- **Dgn: Infectious mononucleosis**

CASE 3

- 18-month-old boy
- **PC**: high fever, rash, refused to eat and drink
- **O/E**: rash all over the body, blisters on foot and hands, painful ulcers in a throat

CASE 3

- 18-month-old boy
- **PC**: high fever, rash, refused to eat and drink
- **O/E**: rash all over the body, blisters on foot and hands, painful ulcers in a throat

L 2,1 tys
(NEU 20%, LIMF75%, EOS2%, BAS 2%)
E 4.5 mln
Hb 12 g/dl
Hct 37%
PLT 115 tys
CRP 2 mg/dl (N: 0-5)

CASE 3

- 18-month-old boy
- **PC**: high fever, rash, refused to eat and drink
- **O/E**: rash all over the body, blisters on foot and hands, painful ulcers in a throat
- **WHAT is this? What is your diagnostic and therapeutic plan?**

CASE 3

- 18-month-old boy
- **PC**: high fever, rash, refused to eat and drink
- **O/E**: rash all over the body, blisters on foot and hands, painful ulcers in a throat
- **DGN: HFMD (hand foot mouth disease)- Enterovirus**

Case 5

- 5 year-old boy with fever without known source, which begun after nose trauma, nasal bleeding for 3 days, poor apetite, petechial rash
- Parents noticed bruises on legs 2 days ago
- Afternoon nap since last month

Case 5

- 5 year-old boy with fever without known source, which begun after nose trauma, nasal bleeding for 3 days, poor apetite, petechial rash
- Parents noticed bruises on legs 2 days ago
- Afternoon nap since last month

Wynik	-
WBC	1.43 (4.5-13) [x 10\^3/µL]
MID %	-
MID #	-
RBC	1.67 (4.3-5.5) [x 10\^6/µL]
HGB	5.2 (10.9-14.2) [g/dl]
HCT	15.2 (34-41) [%]
MCV	91.0 (76-90) [fL]
MCH	31.1 (25-31) [pg]
MCHC	34.2 (32-35) [g/dl]
RDW	15.4 (11.5-15.0) [%]
PLT	16 (150-400) [x 10\^3/µL]
PCT	0.02 (0.100-0.500) [%]
MPV	11.4 (7.4-11.0) [fL]
PDW	11.1 (10-18)
P-LCR	35.8 (14.0-43.0) [%]
LYMPH %	88.1 (29.6-49.8) [%]
NEUT %	4.9 (45-50) [%]
MONO %	5.6 (4.2-12.2) [%]
BASO %	0.0 (0-1) [%]
LYMPH #	1.26 (1.7-3.6) [x10\^3/µL]
NEUT #	0.07 (1.7-7.5) [x10\^3/µL]
MONO #	0.08 (0.19-0.94) [x 10\^3/µL]
EOSYNO #	0.02 (0.0-0.52) [x 10\^3/µL]
BASO #	0.00 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	1.4 ((0.0. - 4.0)) [%]
Komentarz	Lekarz dyżurny telefonicznie poinformowany o wyniku.

Case 5

Blood smear (manual)

30% blasts

40% neutrofils

30% atypical lyphocytes

Wynik	-
WBC	1.43 (4.5-13) [x 10\^3/µL]
MID %	-
MID #	-
RBC	1.67 (4.3-5.5) [x 10\^6/µL]
HGB	5.2 (10.9-14.2) [g/dl]
HCT	15.2 (34-41) [%]
MCV	91.0 (76-90) [fL]
MCH	31.1 (25-31) [pg]
MCHC	34.2 (32-35) [g/dl]
RDW	15.4 (11.5-15.0) [%]
PLT	16 (150-400) [x 10\^3/µL]
PCT	0.02 (0.100-0.500) [%]
MPV	11.4 (7.4-11.0) [fL]
PDW	11.1 (10-18)
P-LCR	35.8 (14.0-43.0) [%]
LYMPH %	88.1 (29.6-49.8) [%]
NEUT %	4.9 (45-50) [%]
MONO %	5.6 (4.2-12.2) [%]
BASO %	0.0 (0-1) [%]
LYMPH #	1.26 (1.7-3.6) [x10\^3/µL]
NEUT #	0.07 (1.7-7.5) [x10\^3/µL]
MONO #	0.08 (0.19-0.94) [x 10\^3/µL]
EOSYNO #	0.02 (0.0-0.52) [x 10\^3/µL]
BASO #	0.00 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	1.4 ((0.0. - 4.0)) [%]
Komentarz	Lekarz dyżurny telefonicznie poinformowany o wyniku.

Case 5

- 5 years old boy with fever without known source, which begun after nose trauma, nasal bleeding for 3 days, poor apetite, petechial rash
- Afternoon nap since last month
- **Dgn: leukaemia (ALL)**

Wynik	-
WBC	1.43 (4.5-13) [x 10\^3/µL]
MID %	-
MID #	-
RBC	1.67 (4.3-5.5) [x 10\^6/µL]
HGB	5.2 (10.9-14.2) [g/dl]
HCT	15.2 (34-41) [%]
MCV	91.0 (76-90) [fL]
MCH	31.1 (25-31) [pg]
MCHC	34.2 (32-35) [g/dl]
RDW	15.4 (11.5-15.0) [%]
PLT	16 (150-400) [x 10\^3/µL]
PCT	0.02 (0.100-0.500) [%]
MPV	11.4 (7.4-11.0) [fL]
PDW	11.1 (10-18)
P-LCR	35.8 (14.0-43.0) [%]
LYMPH %	88.1 (29.6-49.8) [%]
NEUT %	4.9 (45-50) [%]
MONO %	5.6 (4.2-12.2) [%]
BASO %	0.0 (0-1) [%]
LYMPH #	1.26 (1.7-3.6) [x10\^3/µL]
NEUT #	0.07 (1.7-7.5) [x10\^3/µL]
MONO #	0.08 (0.19-0.94) [x 10\^3/µL]
EOSYNO #	0.02 (0.0-0.52) [x 10\^3/µL]
BASO #	0.00 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	1.4 ((0.0. - 4.0)) [%]
Komentarz	Lekarz dyżurny telefonicznie poinformowany o wyniku.

Case 6

- 5-year-old-boy with bruises and petechiae all over the body
- Good general condition

- **Blood smear-** normal
  (elevated monocytes- after viral infection)

Wynik	-
WBC	5.63 (4.5-13) [x 10\^3/µL]
MID %	-
MID #	-
RBC	3.83 (4.3-5.5) [x 10\^6/µL]
HGB	10.0 (10.9-14.2) [g/dl]
HCT	29.3 (34-41) [%]
MCV	76.5 (76-90) [fL]
MCH	26.1 (25-31) [pg]
MCHC	34.1 (32-35) [g/dl]
RDW	13.1 (11.5-15.0) [%]
PLT	0 (wynik liczby płytek z pobrania krwi na EDTA) (150-400) [x 10\^3/µL]
PCT	---- (0.100-0.500) [%]
MPV	---- (7.4-11.0) [fL]
PDW	---- (10-18)
P-LCR	---- (14.0-43.0) [%]
LYMPH %	18.3 (29.6-69.2) [%]
NEUT %	63.8 (35-45) [%]
MONO %	16.6 (4.2-12.2) [%]
BASO %	0.0 (0-1) [%]
LYMPH #	0.95 (2.3-6.9) [x10\^3/µL]
NEUT #	3.31 (1.5-7.0) [x10\^3/µL]
MONO #	0.86 (0.19-0.94) [x 10\^3/µL]
EOSYNO #	0.07 (0.0-0.52) [x 10\^3/µL]
BASO #	0.00 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	1.3 ((0.0. - 4.0)) [%]
Komentarz	Wynik liczby płytek krwi pobranej na cytrynian - 0 x 10^3/ul.

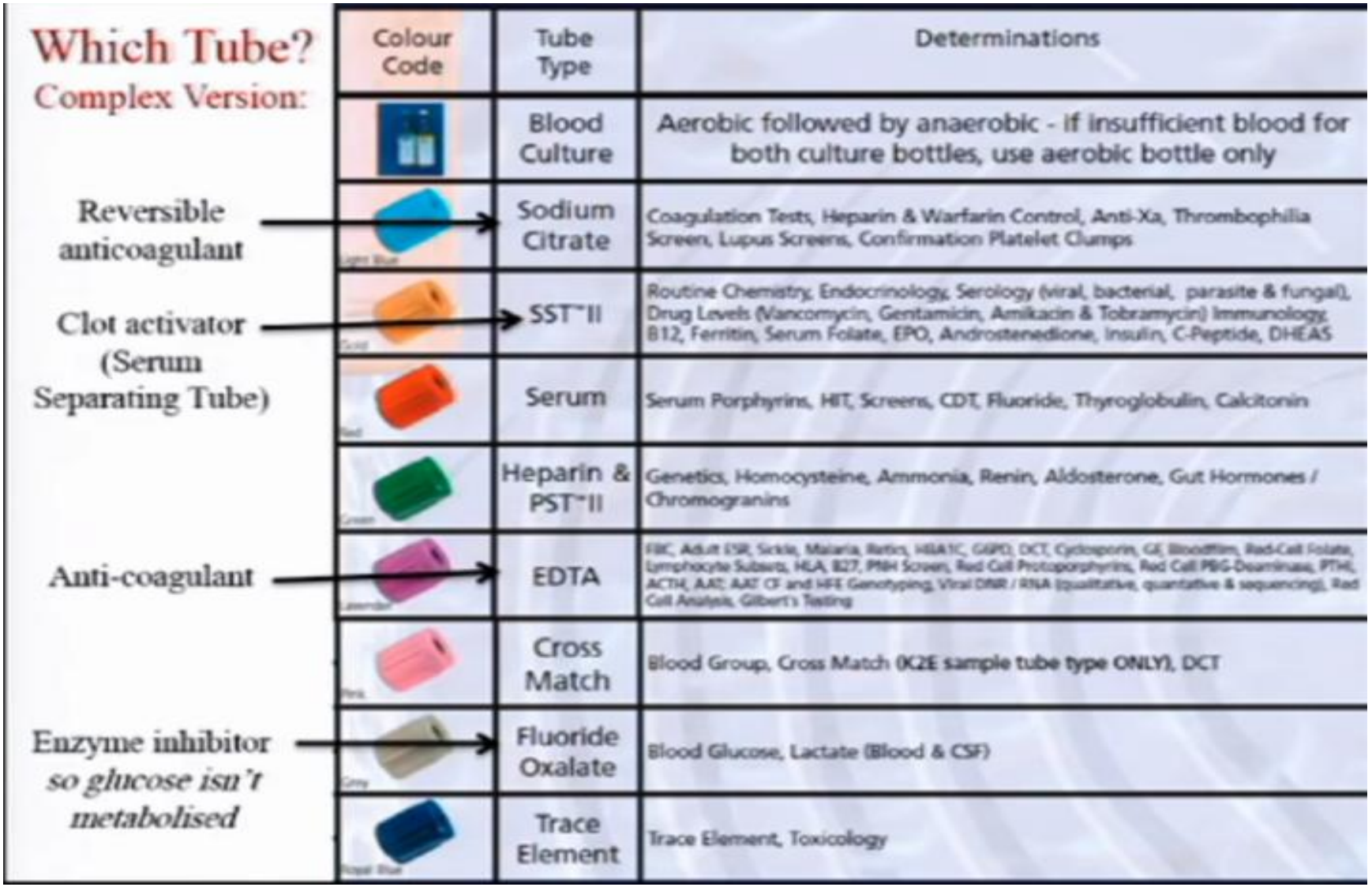
Case 6

- 3.5 years boy with bruises and petechiae all over the body
- Good general condition
- **Diagnosis: ITP**

- **ITP**= Immune thrombocytopenic purpura = idiopathic thrombocytopenic purpura= immune thrombocytopenia
- defined as an isolated low platelet count with a normal bone marrow in the absence of other causes of low platelets

Wynik	-
WBC	5.63 (4.5-13) [x 10\^3/µL]
MID %	-
MID #	-
RBC	3.83 (4.3-5.5) [x 10\^6/µL]
HGB	10.0 (10.9-14.2) [g/dl]
HCT	29.3 (34-41) [%]
MCV	76.5 (76-90) [fL]
MCH	26.1 (25-31) [pg]
MCHC	34.1 (32-35) [g/dl]
RDW	13.1 (11.5-15.0) [%]
PLT	0 (wynik liczby płytek z pobrania krwi na EDTA) (150-400) [x 10\^3/µL]
PCT	---- (0.100-0.500) [%]
MPV	---- (7.4-11.0) [fL]
PDW	---- (10-18)
P-LCR	---- (14.0-43.0) [%]
LYMPH %	18.3 (29.6-69.2) [%]
NEUT %	63.8 (35-45) [%]
MONO %	16.6 (4.2-12.2) [%]
BASO %	0.0 (0-1) [%]
LYMPH #	0.95 (2.3-6.9) [x10\^3/µL]
NEUT #	3.31 (1.5-7.0) [x10\^3/µL]
MONO #	0.86 (0.19-0.94) [x 10\^3/µL]
EOSYNO #	0.07 (0.0-0.52) [x 10\^3/µL]
BASO #	0.00 (0.0-0.1) [x 10\^3/µL]
EOSYNO %	1.3 ((0.0. - 4.0)) [%]
Komentarz	Wynik liczby płytek krwi pobranej na cytrynian - 0 x 10^3/ul.

DIFFERENT TUBES, DIFFERENT SOLVENTS



Colour Code	Tube Type	Determinations
	Blood Culture	Aerobic followed by anaerobic - if insufficient blood for both culture bottles, use aerobic bottle only
	Sodium Citrate	Coagulation Tests, Heparin & Warfarin Control, Anti-Xa, Thrombophilia Screen, Lupus Screens, Confirmation Platelet Clumps
	SST™II	Routine Chemistry, Endocrinology, Serology (viral, bacterial, parasite & fungal), Drug Levels (Vancomycin, Gentamicin, Amikacin & Tobramycin) Immunology, B12, Ferritin, Serum Folate, EPO, Androstenedione, Insulin, C-Peptide, DHEAS
	Serum	Serum Porphyrins, HIT, Screens, CDT, Fluoride, Thyroglobulin, Calcitonin
	Heparin & PST™II	Genetics, Homocysteine, Ammonia, Renin, Aldosterone, Gut Hormones / Chromogranins
	EDTA	FBC, Adult ESR, Sickle, Malaria, Retics, HbA1C, G6PD, DCT, Cyclosporin, GE, Bloodfilm, Red Cell Folate, Lymphocyte Subsets, HLA, B27, PNH Screen, Red Cell Protoporphyrins, Red Cell PBG-Deaminase, PTH, ACTH, AAT, AAT CF and HFE Genotyping, Viral DNR / RNA (qualitative, quantative & sequencing), Red Cell Analysis, Gilbert's Testing
	Cross Match	Blood Group, Cross Match (IC2E sample tube type ONLY), DCT
	Fluoride Oxalate	Blood Glucose, Lactate (Blood & CSF)
	Trace Element	Trace Element, Toxicology

TAKE HOME MESSAGE

- Hematological & CSF values depend on age (**always check child's age before interpreting blood results!)**

- Blood smear change throughtout the childhood (1st shift- 4 day, 2nd shift – 4 year)

- Laboratory tests **should be interpreted** together **with clinical picture of the patient**