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Agents of nosocomial infections

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Congenital and neonatal infections, definitions – revision

- **Congenital infections =**
  = intrauterine infections =
  = prenatal infections

- **Neonatal infections**
  - **perinatal infections (closely before and during the delivery)**
  - **postnatal infections (up to 4 weeks of life)**

- **Congenital and neonatal infections are caused by agents unusual in older children**

A little bit of immunology – revision

Fetus = an immunological paradox

Fetus and mother = two immune systems

To be able to get on well, both must be modulated

„Fetal immunodeficiency“

1. **Inability to produce cytokines**
2. **Defects in intracellular killing**
3. **Immature production of antibodies**

The protection of the fetus – revision

- Placenta and amnion
- Maternal IgG (halftime = 20 days)
  - actively transported through the placenta
  - IgG against capsular polysaccharides are active only up to circa 3 months after delivery
  - IgG against viruses are effective even up to 12-15 months
- Colostral IgA

Prenatal infections I – revision

Notes to the following Table:

- Crosses in the column Trimester mark the frequency of the transfer of an agent into the fetus, not the gravity of the affliction
- Gravity of the affliction tends to be the highest during the infection in the 1st trimester, when it may cause abortion

Prenatal infections II – revision

Agent	Trimester			Congenital defects	Postnatal persistence
	1.	2.	3.		
Treponema pallidum	-	+	+	+	+
List. monocytogenes	-	-	+	-	-
Rubella virus	++	+	-	+	+
CMV	+	+	+	+	+
Parvovirus B19		+		-	-
VZV	+	-	+		+
HSV	+	+	+	-	+
HIV	·	·	·	-	+
Toxoplasma gondii		+	++	+	+

Diagnostics of prenatal infection – revision

Examination of mother

– immensely important in syphilis (obligatory in most countries) and in toxoplasmosis

Examination of the newborn

– above all the detection of its IgM (IgM antibodies cannot be of maternal origin – they don't go through the placenta)

– sometimes the direct detection (e.g. CMV in urine)

Treatment & prevention of prenatal infection – revision

Treatment (of the mother):

- **PNC** in syphilis
- **spiramycin** in toxoplasmosis

Prevention:

- **healthy mother** (examined for syphilis, possibly for toxoplasmosis)

Infections proceeding more severely in pregnancy – revision

Malaria – because of lower cellular immunity

Virus hepatitis – especially VHE

Influenza – during pandemics

Poliomyelitis – more frequent paralysis

Urinary tract infections – pressure on the ureter, atonia of urinary bladder

Candidosis – vulvovaginitis

Listeriosis – beware of cheese

Agents activating themselves during pregnancy – revision

Polyomaviruses JC & BK – in kidneys

CMV – cervix and mammary gland

HSV-2 – in cervical area mostly

EBV – higher excretion from oropharynx

Perinatal infections – revision

„Immunologic immaturity and naivety of the newborn“

- Inability to produce antibodies against polysaccharides
- Low level of complement and few NK cells
- Small supply of neutrophils
- Insufficient function of neutrophils
- Low level of IgA (particularly in premature infants)
- Low mucosal immunity
- (Satisfactory cellular immunity)

Agents transmissible during delivery – revision

- ***Agents originating in vagina, cervix and rectum:***

GBS – sepsis and meningitis (early and late one)
***Chl. trachomatis* D – K – inclusion conjunctivitis**
***E. coli* & other enteric rods – sepsis and meningitis**
***Neisseria gonorrhoeae* – purulent conjunctivitis**
***Listeria monocytogenes* – meningitis and sepsis**
***Haemophilus influenzae* – meningitis and sepsis**
***Mycoplasma hominis* – pneumonia?**
***Candida albicans* – soor (thrush)**
HSV-2 – generalized herpes

- ***Agents originating in blood:***

HBV, HIV

Agents transmissible postnatally – revision

- ***From the mother:***

group B streptococci – sepsis and meningitis
***Staphylococcus aureus* – pyodermia, even sepsis**
***Mycobacterium tuberculosis* – tuberculosis**
CMV – ?
HIV – AIDS

- ***From the surrounding environment:***

enterobacteriae incl. salmonellae – diarrhoea and sepsis
***Pseudomonas aeruginosa* – serious diarrhoea**
***Staphylococcus aureus* – pyodermia, even sepsis**
respiratory syncytial virus (RSV) – bronchiolitis

Diagnostics of perinatal and postnatal infections – revision

The most rapid methods are essential

– therefore direct detection only

Microscopy – invaluable in CSF (Cocci or rods? G+ or G– ? In clumps, chains, or in pairs?)

Detection of antigens – CSF again: GBS, HIB, pneumococci, meningococci (group B ~ *E. coli* K1)

PCR – not yet standardized

Prevention of perinatal and postnatal infections – revision

Screening of the mother (examination of vaginal and rectal swab for GBS)

Prevention of premature labour (because of immune immaturity of the newborn)

Leading the delivery lege artis (examination per rectum, induction of labour after the rupture of membranes etc.)

Cleanness and tidiness in delivery room and at the newborn ward

…

Definition of nosocomial infections (NIs)

Nosocomial (hospital-acquired) infections =

= infections occurring in connection with the stay in a medical institution (as opposed to community-acquired infections)

At least 5 % patients are afflicted, probably more

Exogenous NIs:

source = other patients, environment, personnel

vector = mostly personnel's unwashed hands

Endogenous NIs:

source = the patient himself/herself

Consequences of NIs

- **Higher mortality** (†) – almost 40 % higher (a conservative estimate in this country is hundreds unnecessary deaths per year)
- **Longer** (by weeks) and **more expensive hospitalization** (by tens of thousands, even more CZK per case)
- **Economic losses** circa 1.5 billions CZK/year
- **Additional ATB** therapy (both higher costs and toxicity)
- Patients themselves = **source of infection** for others

More than 1/3 of NIs can be prevented!

Main types of NIs

1. Urinary tract infections in catheterized patients – up to 40 % of all NIs
2. Respiratory tract infections – about 20 %
   - Early ventilator-associated pneumonia
   - Late ventilator-associated pneumonia
   - Aspiration pneumonia
   - Other respiratory infections
3. Purulent infections of surgical wounds – about 20 %
4. Blood-stream infections (sepsis by inserted intravenous catheters) – at least 15 %

Etiology of nosocomial UTIs

Escherichia coli	25 %
other enteric bacteria	20 %
enterococci	15 %
Pseudomonas aeruginosa	10 %
other G– nonfermenting rods	10 %
yeasts	5 %

Etiology of respiratory NIs – I

Early VAP:

Staphylococcus aureus	25 %
Streptococcus pneumoniae	20 %
Haemophilus influenzae	15 %
enteric bacteria	10 %
other aerobically growing bacteria	5 %
anaerobes	1 %

(monomicrobial etiology, agents originate in community)

Etiology of respiratory NIs – II

Late VAP:

Gram–negative nonfermenting rods (*P. aeruginosa, Acinetobacter baumannii*)	**40 %**
enteric bacteria (klebsiellae, *E. coli*, enterobacters)	**30 %**
staphylococci (mainly *S. aureus*)	**20 %**
yeasts	**5 %**

(some cases have polymicrobial etiology, agents are of hospital origin)

Etiology of respiratory NIs – III

Nosocomial aspiration pneumonia:

Older studies emphasized anaerobes

Newer studies are discovering the same etiology as in VAP and put more emphasis on Gram-negative rods (non-fermenting rather than enteric ones)

Pneumonia in febrile neutropenia:

Initial days: G+ cocci (staphylococci, pneumococci) occur twice more often than G– rods (enteric bacteria and pseudomonads)

Later on: ↓ G+ cocci, ↑ candidae and aspergilli

After allogenic transplantation of bone marrow: mainly CMV

Etiology of surgical wounds suppuration

(depends on the terrain of the surgery)

Staphylococcus aureus

coagulase-negative staphylococci

Streptococcus pyogenes

enteric bacteria (*E. coli*)

bacteroids, prevotellae, peptostreptococci

Gram-negative non-fermenting rods

Clostridium perfringens

Etiology of sepsis during inserted i.v. catheter

coagulase-negative staphylococci (>50 %)

– because of biofilm

enterococci – because of cephalosporins

Staphylococcus aureus

enteric bacteria (*E. coli*, klebsiellae)

Pseudomonas aeruginosa

***Acinetobacter* spp.**

***Candida* spp.**

Etiology of nosocomial virus infections

influenza virus – mainly infants and older patients

RSV – newborns and suckling infants

adenoviruses – ophthalmologic wards

other respiratory viruses

CMV – after cytotoxic treatment

rubella virus – children (vaccination available now)

rotaviruses – mainly children

VHB – higher risk in longer hospitalization

HIV – in developing countries mostly

Predisposition to NIs

Age – both extremes of age

Treatment – cytotoxic drugs, steroids, ATB

Underlying disease

- hepatic disease
- diabetes mellitus
- cancer
- renal failure
- skin disorders
- neutropenia

Trauma – incl. surgery and i.v. catheters

Prevention of NIs – I

Four main strategies:

- **Excluding sources of infection from the hospital environment**
- **Breaking the chain of infection from source to host**
- **Improving the host's ability to resist infection**
- **Investigating hospital infection**

Prevention of NIs – II

1. Exclusion of sources of infection from the hospital environment

- Sterile instruments, dressings, medicaments and intravenous fluids
- Using only blood screened for infectious agents
- Clean linen, uncontaminated food
- Preventing contact with infected staff – both acutely ill or carriers of pathogens

Prevention of NIs – III

2. Breaking the chain of infection

- **Facilities**
  - ventilation systems & air flow (air-conditioning: legionellae, building work: aspergilli)
  - water systems (in particular warm water: legionellae)
  - patient isolation
    - to protect a particularly susceptible patient
    - to prevent the spread of pathogens from a patient to others
- **People**
  - facilitation of aseptic behavior of staff
  - the most important is **effective hand washing**

Prevention of NIs – IV

3. Improving the host's resistance

- **Immunization**
  - influenza (older patients)
  - pneumococcal infections (before transplantation or splenectomy)
  - VHB (in seronegative persons before hemodialysis)
  - varicella (zoster Ig in immunocompromised exposed to VZV)
- **Appropriate ATB prophylaxis**
  - in „dirty" surgery
  - In „super-clean" surgery (orthopaedics, neurosurgery)
- **Reducing the risk of postoperative infection**
  - correct operating technique
  - care of invasive devices and intravenous fluids
  - correct nursing techniques (prevention of pressure sores) and active physiotherapy

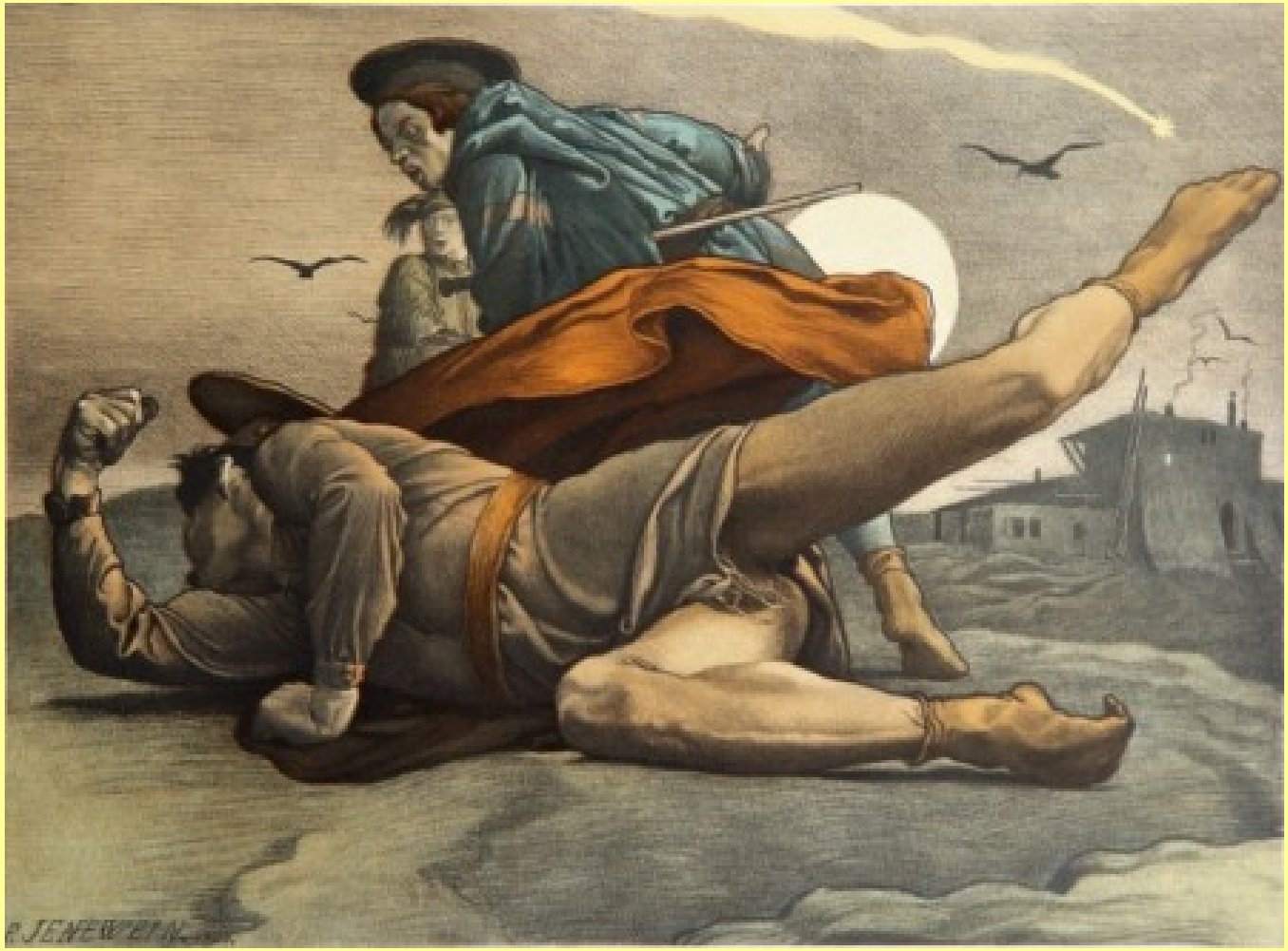
Prevention of NIs – V

4. Investigating hospital infections

- **Surveillance** (= regular monitoring) – allows early recognition of any change in the number or type of hospital infection
- **Investigation of outbreaks** from epidemiological and microbiological point of view
- **Establishment and monitoring of procedures** designed to prevent infection

Homework 14

The first part of the cycle mentioned in the previous lecture



Answer and questions

The solution of the homework and possible questions please mail (on Monday Dec. 12th at 6.30. at the latest) to the address

mvotava@med.muni.cz

Thank you for your attention