COURSE AND FORMS OF INFECTION

The last lecture for 2nd-year students of Dentistry intended for May 25th, 2011
What is the pathogenesis? – Revision

Pathogenesis explains the origin and development of pathological symptoms

What does the pathogenesis of infection include?

• The way the agent spreads through the macroorganism
• Mechanisms of defence against it
• Actual causes of symptoms:
  a) either the infectious agent itself,
  b) or the reaction of macroorganism to it
Spreading by means of lymph – revision

Skin → regional lymphatic nodes: pyogenic cocci, *F. tularensis*, *Y. pestis*; arboviruses

Oropharynx, tonsils → cervical nodes: *S. pyogenes*, *C. diphtheriae*, *M. tuberculosis*, anaerobes (*Actinomyces israelii*, *Prevotella*), *T. gondii*

Lungs → hilar nodes: *M. tbc*, *B. anthracis*, other respiratory pathogens

Genital mucosa → inguinal nodes: *Treponema pallidum*, *Ch. trachomatis* L1-L3, *H. ducreyi*

Peyer plaques → mesenteric nodes: *Yersinia enterocolitica*, enteric adenoviruses, enteroviruses
Spreading by means of blood – revision

Agents of all generalized infections:
exanthematic viruses, enteroviruses, arboviruses, *Treponema pallidum*, *Salmonella Typhi* and many others

Agents of pneumonia commonly appear in blood: especially *Strept. pneumoniae*

Sometimes agents of other systemic and local infections: during meningitis, pyelonephritis (urosepsis), suppurating wounds and suchlike
Spreading *per continuitatem* – revision

From cell to cell: HSV, RSV, listeriae, yersiniae

By means of secretion down the mucosa: agents of respiratory, enteric and urogenital infections

From the site of arthropod biting to its vicinity: arboviruses, *Borrelia burgdorferi*

From the wound to adjacent tissue: *Streptococcus pyogenes, Clostridium perfringens*

From the middle ear to meninges: *S. pneumoniae, Haemophilus influenzae type b*

From lungs to pleura: agents of pneumonia
Spreading along nerves – revision

Either axonally (within nerve fibres)
or by progressive infection of Schwann sheath

HSV, VZV, B-virus, rabies virus
Mycobacterium leprae
Naegleria fowleri
tetanic toxin
Elimination of agent from the body – revision

From the **mucosa** of respiratory tract and oral cavity, intestine, urogenital tract, eye

From **skin** lesions

By means of **urine**

From **blood**
Elimination from respiratory tract – revision

Sneezing:
in particular agents of common cold (rhinoviruses, coronaviruses), from bacteria e.g. *Neisseria meningitidis*

Coughing:
other respiratory viruses (primarily *influenza virus*),
exanthematic viruses (*VZV, morbilli virus, rubella virus*),
*Neiss. meningitidis, Bordetella pertussis, Mycob. tuberculosis, Yersinia pestis*
Elimination from alimentary tract – revision

**Saliva:**
HSV, EBV, mumps virus, *Str. pyogenes*

**Stool:**
enteroviruses (incl. poliovirus), HAV, HEV
salmonellae incl. *Salm. Typhi*, shigellae, EPEC, ETEC etc., *V. cholerae*, *C. difficile*
*Entamoeba histolytica*, *Giardia lamblia*
*Ascaris lumbricoides*, *Taenia saginata*
Elimination from urogenital tract – revision

From diseased mucosae:

Agents of classic venereal infections: in Europe
Neiss. gonorrhoeae, Treponema pallidum

Agents of other sexually transmitted diseases (STD): Chlamydia trachomatis serotypes D-K, papillomaviruses, HSV-2

By means of urine:

Salmonella Typhi

Agents of congenital infections (rubella virus, CMV)

Exotic viruses of hemorrhagic fevers (Ebola)
Elimination from skin lesions – revision

Staphylococcus aureus
Streptococcus pyogenes
Varicella-zoster virus (agent of chickenpox and shingles)
Papillomaviruses (agents of warts)
Dermatophytes (e.g. Trichophyton rubrum, Microsporum canis, Epidermophyton floccosum)
Sarcoptes scabiei (itch-mite)
Elimination from blood – revision

By means of vectors:
- tick-borne encephalitis virus – ticks, yellow fever virus – mosquitoes
- Malaric plasmodia – mosquitoes

By means of small cracks in mucosa: HBV, HIV

...
Infection

Definition:
Infection = a relation between the pathogenic microbe and the macroorganism (= ecological point of view)

Infection colonization:
Infection = situation when an etiological agent
1) penetrates into an organism and multiplies in it, or
2) it settles and unfavourably affects bodily surfaces (skin and mucosae)

Colonization = situation when
1) a non-pathogenic microbe settles on a bodily surface, or
2) a pathogen located there does not cause pathological symptoms
Relationship between the microbe and the host – revision

The relationship is a dynamic one and influenced by the environment:

- microbe
- host
- environment

Illness is not a rule – peaceful coexistence is usually better for the parasite

In spite of that the host tries to get rid of the parasite – to destroy, remove or at least to keep it in one spot
Course of infection – I

Four components can be distinguished during the course of infection:

- Incubation time
- Prodromes
- Typical syndrome (= complex of symptoms) of the infectious disease
- Convalescence
Course of infection – II

*Incubation time*
- salmonellosis $\frac{1}{2}–1$ day, influenza 1–2 days,
- tbc 2–8 weeks, hepatitis B 90–100 days

*Prodromes*
- not always; nonspecific (↑T, headache, feeling ill etc.), several hours to days

*Typical syndrome of infectious disease*
- as described in textbooks

*Convalescence*
- from subsiding troubles till normalization of results
Course of infection – III

Relapse
the same agent, infection comes on again during the convalescence

Recurrence
the agent remains in the body, infection comes on again only after recovery (Brill-Zinssser disease = recurrence of epidemic typhus)

Reinfection
new infection by the same agent from outside

Superinfection
infection by another agent before recovery from the first infection
Forms of infection

**Inapparent infection (without symptoms)**
sole consequence: development of immunity (usually by means of antibodies)

**Manifest infection (with symptoms)**
subclinical: non-characteristic signs only
abortive: only some symptoms or slightly manifested ones
clinical: typical signs as in textbook
foudroyant, fulminant: very abrupt, with dramatic symptoms
Duration of infection

**Acute**: days (common cold, salmonellosis) to weeks (majority of infections)

**Subacute**: months – either as a complication of any infection, or as the rule (some kinds of hepatitis, warts, sepsis lenta)

**Chronic**: years (tbc, lepra, dermatomycoses, parasitic infections)

**Fulminant, foudroyant**: very rapid course – hours (meningococcal sepsis)
Extent of infection

**Local**: portal of entry & regional nodes, or a specific organ (common cold, ringworm, warts, uncomplicated gonorrhoea, abscessus in an organ)

**Systemic**: whole organ system (influenza, lung tbc, meningitis, extensive pyodermia, pyelonephritis, pelvic inflammatory disease)

**Generalized**: regularly (exanthematic viroses, typhoid fever, exanthematic typhus), or as a complication (sepsis after injury, during cystitis or cholecystitis, salmonellosis in a newborn)
Focal infection

**Focal infection theory:**
chronic infection limited to a certain focus can result in a systemic illness with symptoms in quite a different site

Concept of focal infection used to be very fashionable formerly in diverse medical branches

In the name of so-called sanation of focuses thousands of patients were bona fide subjected to tooth extractions, tonsillectomies, cholecystectomies and other surgical interventions without proving the usefulness of these procedures by controlled studies
Focal infection – II

The connection between systemic disease and a local infection has been proved only in

- **rheumatic fever** – inflammation of heart, kidneys and joints after tonsillar infection by *Streptococcus pyogenes*
- **Reiter’s syndrome** – reactive arthritis after
  1. sexually transmitted urogenital infection by *Chlamydia trachomatis* serotypes D-K,
  2. intestinal infection caused by pathogens from genus *Salmonella, Shigella, Yersinia* or *Campylobacter*
- **hemolytic-uremic syndrome** after intestinal infection by *Escherichia coli* serotype O157:H7
- **sterile mykids** e.g. on palms during tinea pedis
Special types of chronic infections

Inapparent chronic infections can be classified as

1. latent: agent hides in a non-infectious form, or it escapes from the infected cell after an activation of infection only
   - HSV and VZV: nerve ganglia cells, CMV: kidney and salivary glands cells, EBV: lymphocytes

2. persistent: agent can be detected by routine methods, because it is present mostly in an infectious form

Both types are markers of failing immunity
Both types can be activated
Examples of persistent infections

Bacterial: *Rickettsia prowazekii* (activation of exanthematic typhus = m. Brill-Zinssser, *Salmonella Typhi* (carriers), *Mycob. tbc* (lymphatic nodes)

Viral: HBV (hepatocytes), adenoviruses (adenoids), JCV and BKV (kidneys), congenital infections by CMV and rubella virus

Parasitary: hypnozoites of *Plasmodium ovale* and *P. vivax* (liver), *Toxoplasma gondii* bradyzoites (nodes, muscles, brain)
Primary infections

**primary** secondary infection: before the first (primary) infection is over the secondary infection (superinfection) supersedes caused by another microbe

**primary** postprimary infection: in tbc only; in postprimary infection the late hypersensitivity has developed

**primary** recurrent infection: during latent infections, e.g. HSV: primary infection = gingivostomatitis aphthosa; recurrent one = herpes labialis
Other types of infection – I

**Opportunistic infection**: infection on a weakened terrain, often secondary one

During **AIDS**: CMV retinitis, CMV or candidal esophagitis, herpes zoster, cryptococcal meningitis, toxoplasmatic encephalitis, cryptosporidial or microsporidial enteritis, colibacillary and other types of sepsis

**Nosocomial** (hospital-acquired) infection: in connection with the stay in hospital, often opportunistic one

**Iatrogenic** infection: caused by a medical intervention
Other types of infection – II

Community-acquired infection: infection obtained in common population

Pyogenic infection: is manifested by suppuration

Specific infection: usually with typical pathology and histology, therefore syphilis or tuberculosis

Exogenous infection: agent enters the body from the outside

Endogenous infection: agent = member of normal microflora (the disease is not contagious, it is not possible to determine the incubation time)
Other types of infection – III

**Anthroponoses** = infections transmissible among human beings only (typhoid fever, shigelloses, exanthematic viroses, venereal infections etc.)

**Zoonoses** = infections transmissible from animals to man and vice versa (salmonelloses, tularemia, lyme borreliosis, tick-borne encephalitis, some types of ringworm etc.)

**Sapronoses** = infections acquired from the environment in which the agent actively multiplies (tetanus, gas gangraene, legionellosis, histoplasmosis, amoebic meningoencephalitis etc.)
Other types of infection – IV

**Active infection:** still proceeding, possibly even without apparent signs

**Subsided infection:** without signs of activity, but sequelae or at least antibodies remain

**Recent infection:** occurred at best several weeks ago

These attributes are typical for the interpretation of serologic results.
Outcome of infection – I

It depends on both participants:

Microorganism:
- pathogenicity
- virulence
- dosis
- portal of entry

Macroorganism: species resistance
- individual’s immunity
- non-specific (innate)
- specific (acquired)
- intensity of reaction
Outcome of infection – II

Complete recovery (restitutio ad integrum):
banal respiratory, urogenital, intestinal and infant generalized infections

Recovery with sequelae:
paralysis after encephalitis, deafness after otitis, scar after abscess, cavern after lung tuberculosis

Persistent infection:
if the immune system is not able to eliminate the agent

Death (exitus letalis)
Outcome of infection – III

- Species pathogenicity
- Strain virulence
- High dosis
- Uncommon portal of entry
- Exaggerated reaction

- High species resistance of the host
- High non-specific resistance of the individual
- No risk factors
- No functional or anatomical defects
- Specific immunity and its quality

\[ V \Rightarrow \text{recovery, or no infection} \]
Recommended reading material

Paul de Kruif: Microbe Hunters
Paul de Kruif: Men against Death
Axel Munthe: The Story of San Michele
Sinclair Lewis: Arrowsmith
André Maurois: La vie de Sir Alexander Fleming
Hans Zinsser: Rats, Lice, and History
Michael Crichton: Andromeda Strain
Albert Camus: Peste
Victor Heisser: An American Doctor Odyssey
Richard Preston: The Hot Zone
Mika Waltari: The Egyptian

Richard Gordon: Doctor in the House, Doctor at Large, Doctor at Sea
(& many other books)

Please mail me other suggestions at:

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Thank you for your attention. Good luck at exams!