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Agents of bloodstream infections

Bloodstream infections

- less common than respiratory or urinary tract infections, but severe and lifethreatening

- Types of bloodstream infections:

  1) Infection of the complete bloodstream = sepsis

  2) Infection of a part of bloodstream (endocarditis, tromboflebitis), leads to sepsis

Bacteremia = mere presence of bacteria in blood.

Nevertheless,...

.....Bacteria (at least in higher ammounts) = starting mechanism of sepsis

.....Interaction of microbial products with macrophages releases a lot of cytokines

→ systemic inflammatory response syndrome (SIRS) characterized by:

- **elevated temperature**
- **accelerated pulse and breathing**
- **leukocytosis**

Sepsis

Sepsis = suspect or proved **infection + systemic inflammatory response syndrome**

Severe sepsis = **sepsis + organ dysfunction** (hypotension, hypoxemia, oliguria, metabolic acidosis, thrombocytopenia, confusion, DIC)

Septic shock = **severe sepsis + hypotension** despite adequate supply of fluids

Sepsis cascade

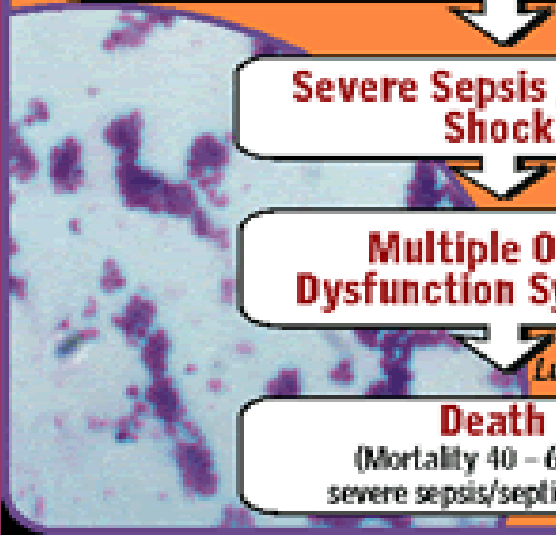
Invasive Infection
(Foreign antigens from cell walls of bacteria and fungi, bacterial DNA, RNA from viruses, etc.)

Body's Immune Cells
(Macrophages, neutrophils, endothelial cells, monocytes)

Cytokine Release
(Interleukins, interferons, tumor necrosis factor, etc.)

Damage to blood vessel linings

Inflammation ↑ (Vasodilation, capillary leak) **Coagulation** ↑ **Fibrinolysis** ↓



Severe Sepsis / Septic Shock

Multiple Organ Dysfunction Syndrome

Lung, Liver, Kidney

Death
(Mortality 40 – 60% in severe sepsis/septic shock)

Features of sepsis

Clinical:

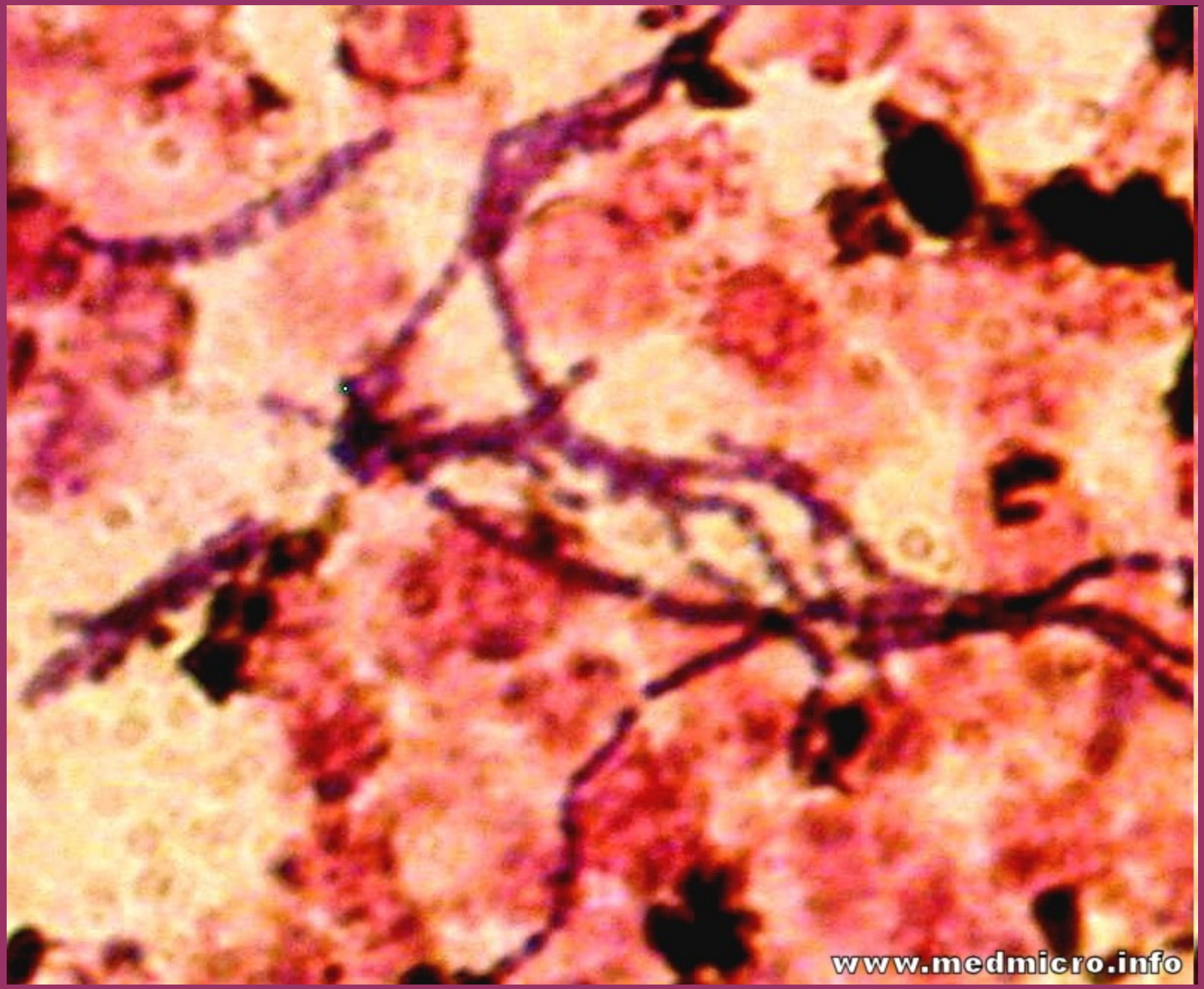
- fever or hypothermia (often changing) ↑↓ T
- tachycardia ⇈ P
- tachypnoe ↑ B
- lowered blood pressure ↓ BP
- confusion

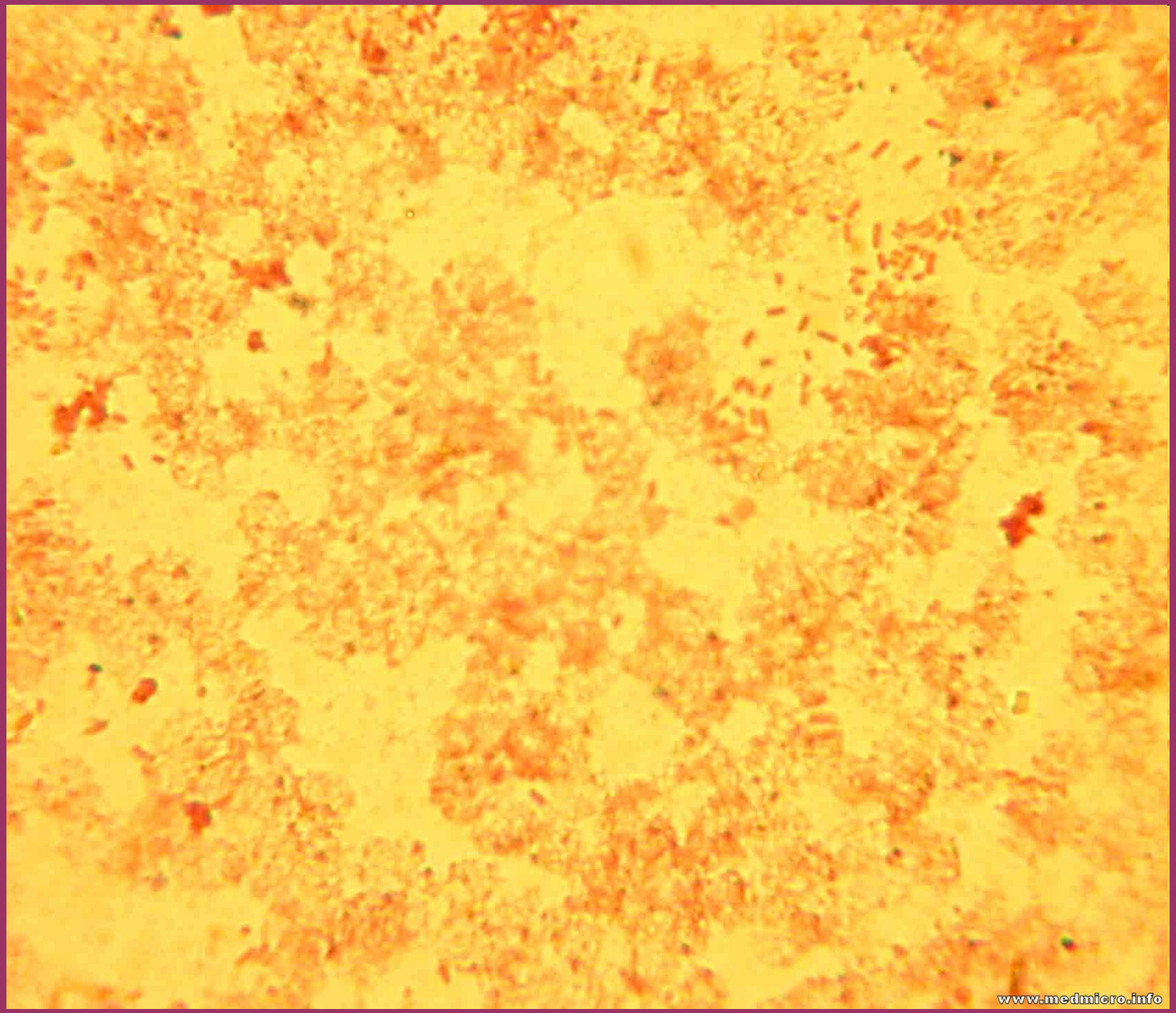
Pathophysiological:

- higher heart output
- lower peripheral vascular resistance

Laboratory:

- leucocytes ↑↓ Leu
- serum bicarbonate ↓ HCO_3^-
- bacteremia may not be already demonstrable


www.medmicro.info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Types of bacteremia – I

Intermitent – in localized infections

pneumonia (for example pneumococci)
meningitis (for example meningococci)
pyelonephritis (*Escherichia coli*)
osteomyelitis (*Staphylococcus aureus*)
septic arthritis (*S. aureus*, gonococci)
and others

Types of bacteremia – II

Continual – in generalized infections

typhoid fever (*Salmonella* Typhi)

brucellosis (*Brucella melitensis*)

plague (*Yersinia pestis*)

....are quite rare today.

But under some circumstances, also pathogens from „group I“ may perform a continual bacteremia, or rather sepsis

Types of bacteremia – III

Bacteremia in bloodstream infections

thrombophlebitis (***S. aureus, S. pyogenes***)

acute endocarditis (***S. aureus, S. pyogenes, S. pneumoniae, Neisseria gonorrhoeae***)

subacute bacterial endocarditis = sepsis lenta
(viridans streptococci, enterococci,
HACEK group =
Haemophilus aphrophilus
Actinobacillus actinomycetemcomitans
Cardiobacterium hominis
Eikenella corrodens
Kingella kingae)

„culture-negative“ endocarditis (bartonellae, coxiellae, legionellae)

Types of bacteremia – IV

Special circumstanses

Bacteremia in some malignities (colonic Ca – Streptococcus bovis, leukemia - various bacteria)

Bacteremia in intravenous drug users (mostly skin flora – staphylococci, corynebacteria; sometimes also mouth flora and bacteria from the environment)

!!Bacteremia in iatrogenic infections
(e. g. mouth floora after tooth extraction, pharyngeal flora after bronchoscopy etc.)

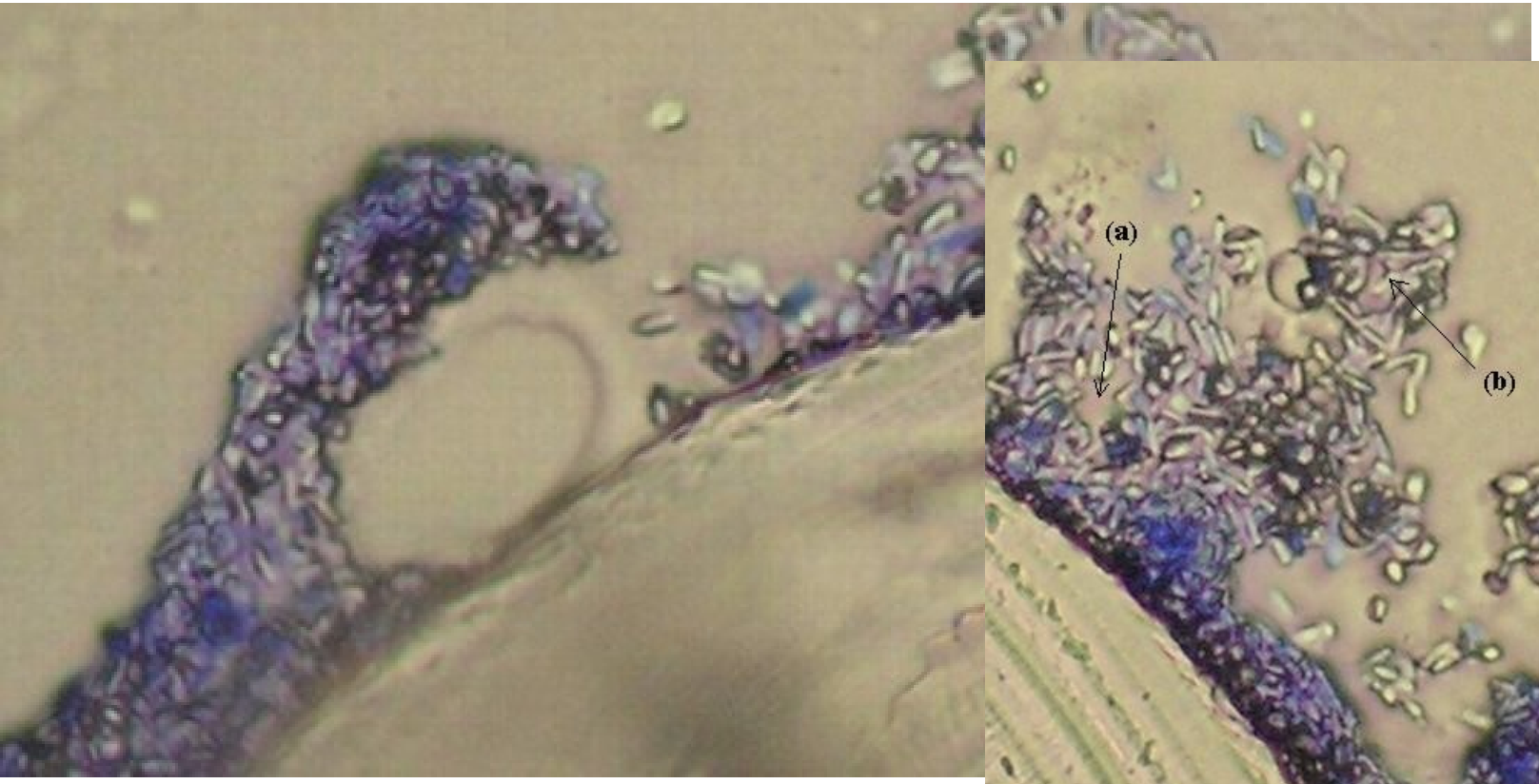
Types of bacteremia – V
Bacteremia related to artificial material

Typically on vascular catheters, invasive devices and implants, endoprotheses etc. (biofilm)

More common in ICU, immunocompromised, febrile neutropenia

Caused by coagulase-neg. staphylococci, *S.aureus,* enterococci, corynebacteria, yeasts etc.

As the majority of them are normal skin flora, it is extremelly difficult to differenciate true bacteremia from contaminants!



Biofilm on a catheter (stafylococci and candidae):

a) - canaliculus, b) - porous structure

Photo: Dr. Veronika Holá, MÚ

Candida

Sepsis caused by yeasts is very dangerous, especially because the initial treatment by antibiotics is not effective.

http://medicalimages.allrefer.com/large/candida-flourescent-stain.jpg

Sepsis according to the origin

- **Wound sepsis (*Staphylococcus aureus, Streptococcus pyogenes* and other beta-hemolytic streptococci, *Pseudomonas aeruginosa* in burns)**
- **Urosepsis (*Escherichia coli, Proteus mirabilis* and other enteric bacteria)**
- **Abdominal sepsis (often polymicrobial etiology, anaerobes (Bacteroides etc.) and facultative anaerobes (Escherichia coli…)**

Fulminant sepsis

... a quick course; when it is not diagnosed in time, it often kills the patients

Clonal strains of *Neisseria meningitidis* (sepsis with or without meningitis)

Streptococcus pyogenes **(often together with necrotizing fasciitis of muscle fasciae)**

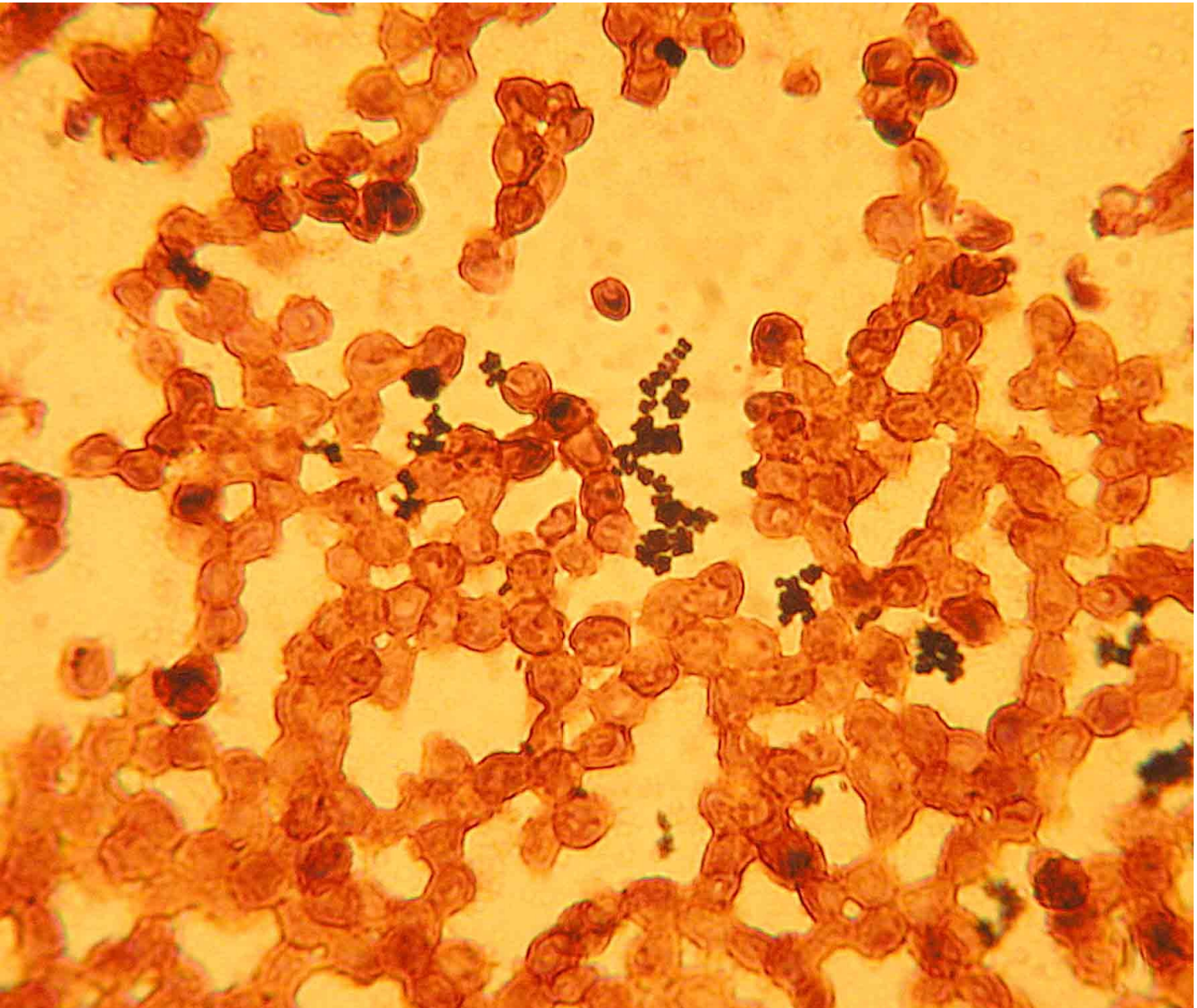
Yersinia pestis

Nosocomial sepsis

Often related with artificial materials

- **Staphylococci, coagulase-negative**
  (intravenous catheter-associated sepsis, infections of plastic devices *in situ*, febrile neutropenia)
- ***Staphylococcus aureus*** **(infected surgical wounds)**
- ***E. coli*** **+ other enterobacteria (catheter-associated infections of the urinary tract)**
- **Gram-negative non-fermenting rods**
  (contaminated infusion fluids)
- **yeasts (catheter-associated sepsis, febrile neutropenia)**
- **Enterococci and many other microbes**

Staphylococci in blood culture



Diagnostics of sepsis

- **Blood cultures (not clotted blood; ≠ blood for serological examintion!)**
  - **Today mostly in special vessels for authomated culture**
  - **At least two, but better two blood cultures, usually at the temperature increase**
  - **At least one blood culture should be taken from a new venepunction (i. e. not only central venous cathether)**
- **parts of blood catethers**

Blood sampling

- **Aseptically! Not only because of the patient, but also because of the sample.**
- **The disinfectant should be let to act enough (alcohol disinfectants - necessary to let them dry)**
- **Mostly use three identical type vessels, eventualy one for anaerobic culture (especially in suspicion for abdominal origin of sepsis)**
- **It is necessary to fill in the request form carefully, inclusive the time of sampling**

Contaminants

- Inproper sampling, insufficient disinfection
- Sampling from cathehers only and not venepunction (the bacterium colonizing the venous catether is not necesarilly a real bloodstream pathogen)
- Coagulase-negative staphylococci

Examples of blood culture vessels

Blood culture device

Foto: O. Z.

The same device open

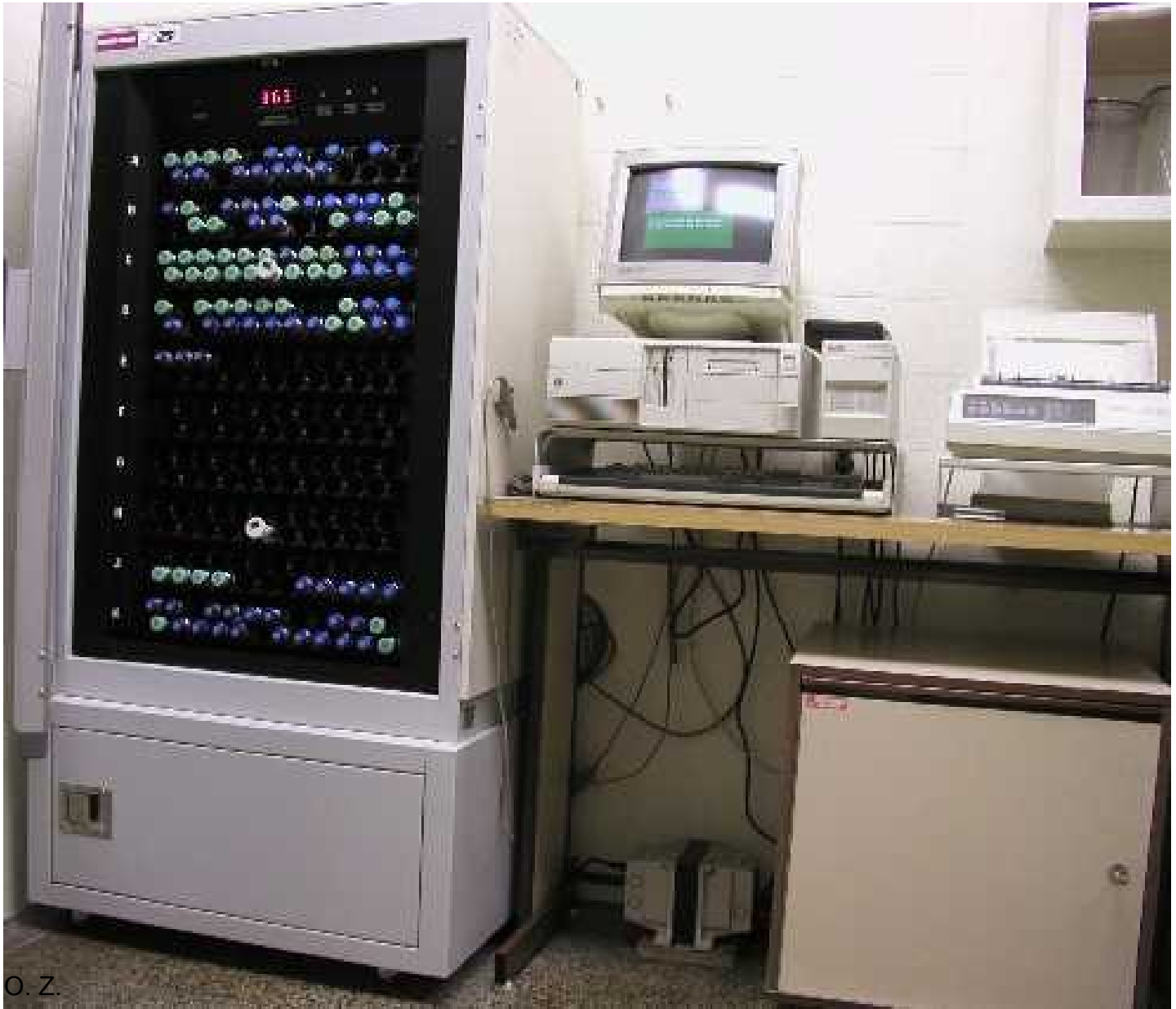


Foto: O. Z.

Treatment of sepsis

Usually ICU:

- **antibiotics – empiric therapy in the beginning, targeted therapy later**
- **removal of all infected tissues or devices**
- **support of breathing and hemodynamics (artificial ventilation, oxygen, fluids, vasopressors etc.)**

Michael Sweerts (1618-1664): Plague in an Ancient City