Institute for Microbiology, Medical Faculty of Masaryk University
and St. Anna Faculty Hospital in Brno

Agents of bloodstream infections

Bloodstream infections

- **Bloodstream infections are not so common as e. g. respiratory of urinary tract infections, but they use to be severe and threatening the patient‘s life**
- **Types of bloodstream infections:**
  - **Infection of the complete bloodstream = sepsis**
  - **Infection of a part of bloodstream (endocarditis, tromboflebitis);**

    usually leads to sepsis

Bacteremia = mere presence of bacteria in blood. Nevertheless:

Bacteria (at least higher ammounts of them) = 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 cascade

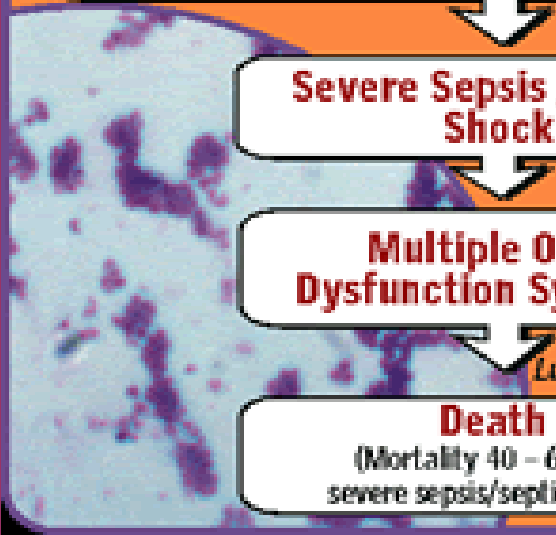
Invasive Infection
(Foreign antigens from cell walls of bacteria and fungi, bacterial DNA, RNA from viruses, etc.)

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)

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

Features of sepsis

Clinical:

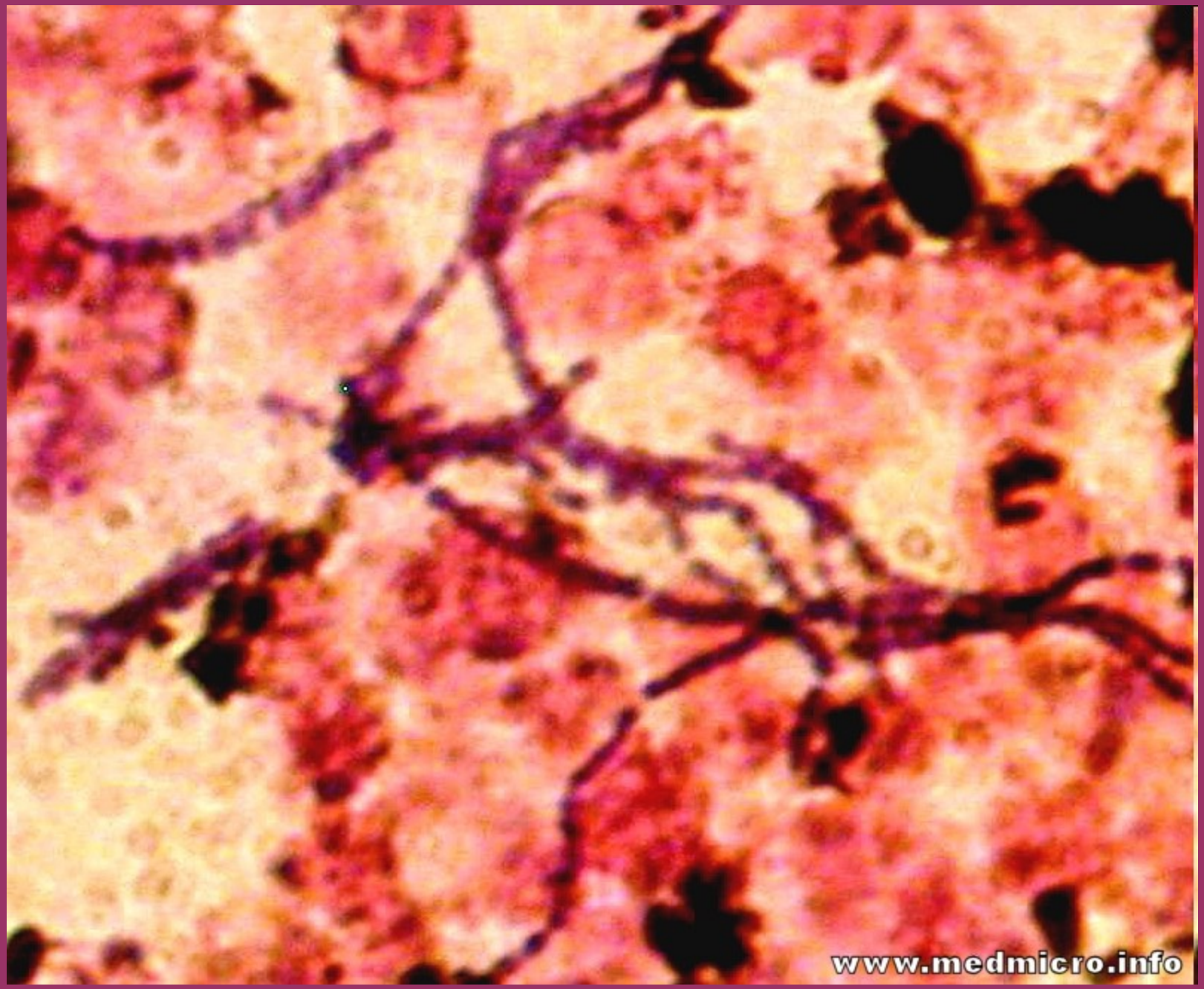
fever or hypothermia (often changing)	↑↓ T
tachycardia	↑ P
tachypnoe	↑ B
lowered blood pressure	↓ BP
confusion	

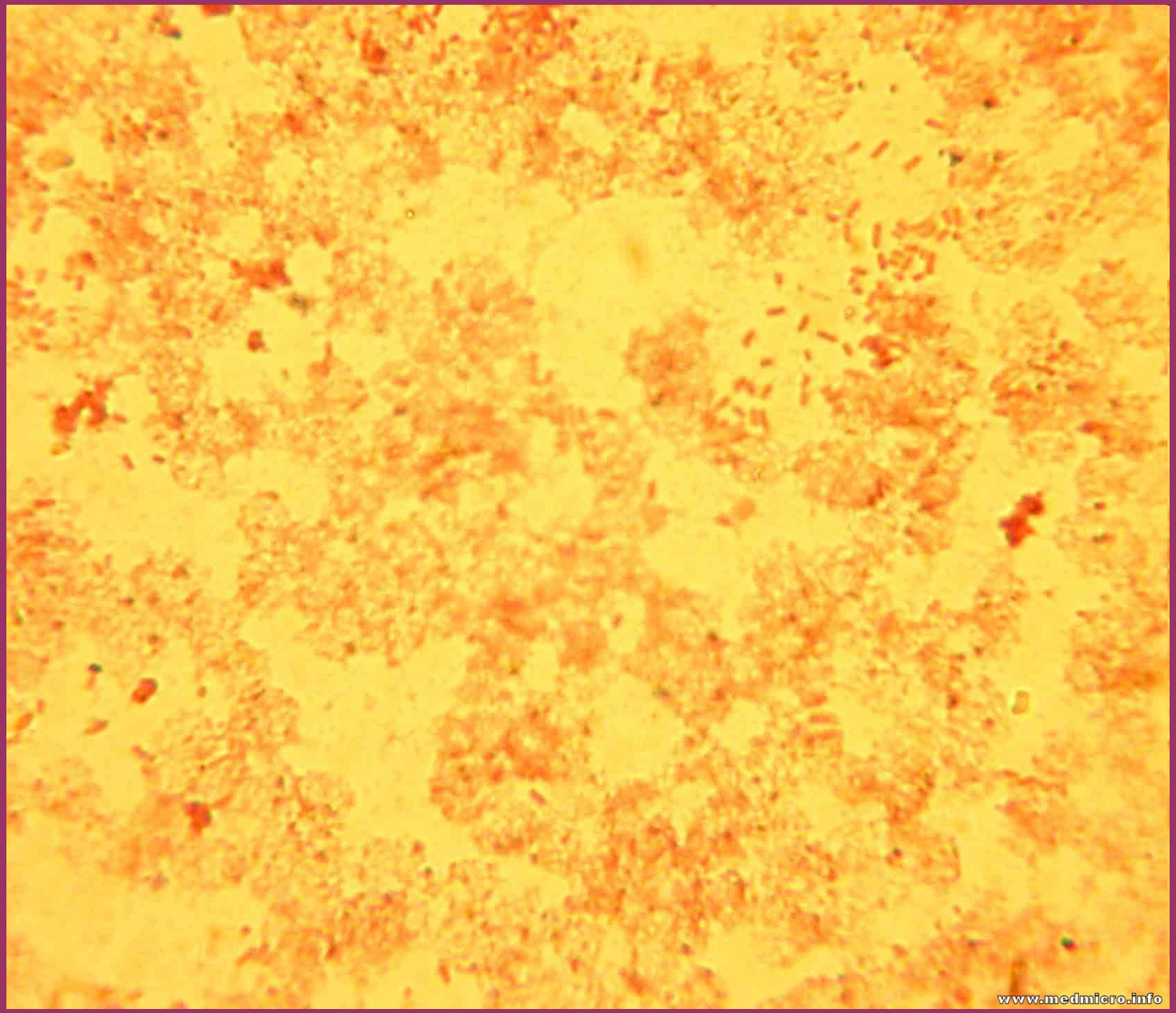
Pathophysiological:

- higher heart output
- lower peripheral vascular resistance

Laboratory:

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


www.medmicro.info


www.medmicro.info

Types of bacteremia – I

Intermitent bacteremia – 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 bacteremia – in generalized infections

typhoid fever (*Salmonella* Typhi)

brucellosis (*Brucella melitensis*)

plague (*Yersinia pestis*)

Pathogens, causing primary, continual bacteremia, 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 =
***H**aemophilus aphrophilus*
***A**ctinobacillus actinomycetemcomitans*
***C**ardiobacterium hominis*
***E**ikenella corrodens*
***K**ingella 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

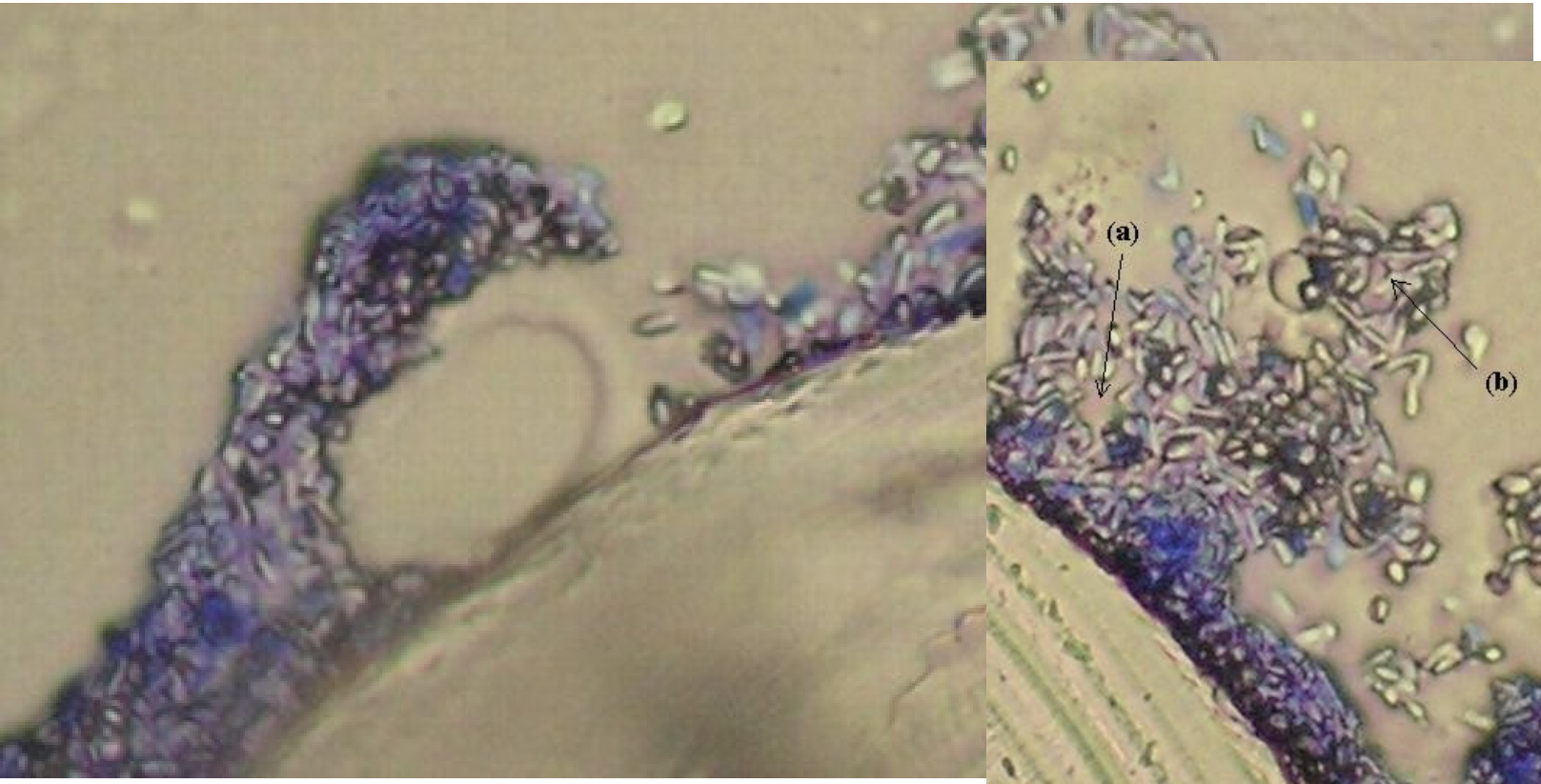
Bacteremia related to artificial material

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

More common in emergency units, immunocompromised, febrile neutropenia

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

As the majority of them are normal flora of skin, it is extremelly dificult to differenciate bacteremia from pseudobacteremia here!



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

- **sepsis from wounds (*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

Fulminant sepsis is a sepsis with 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)

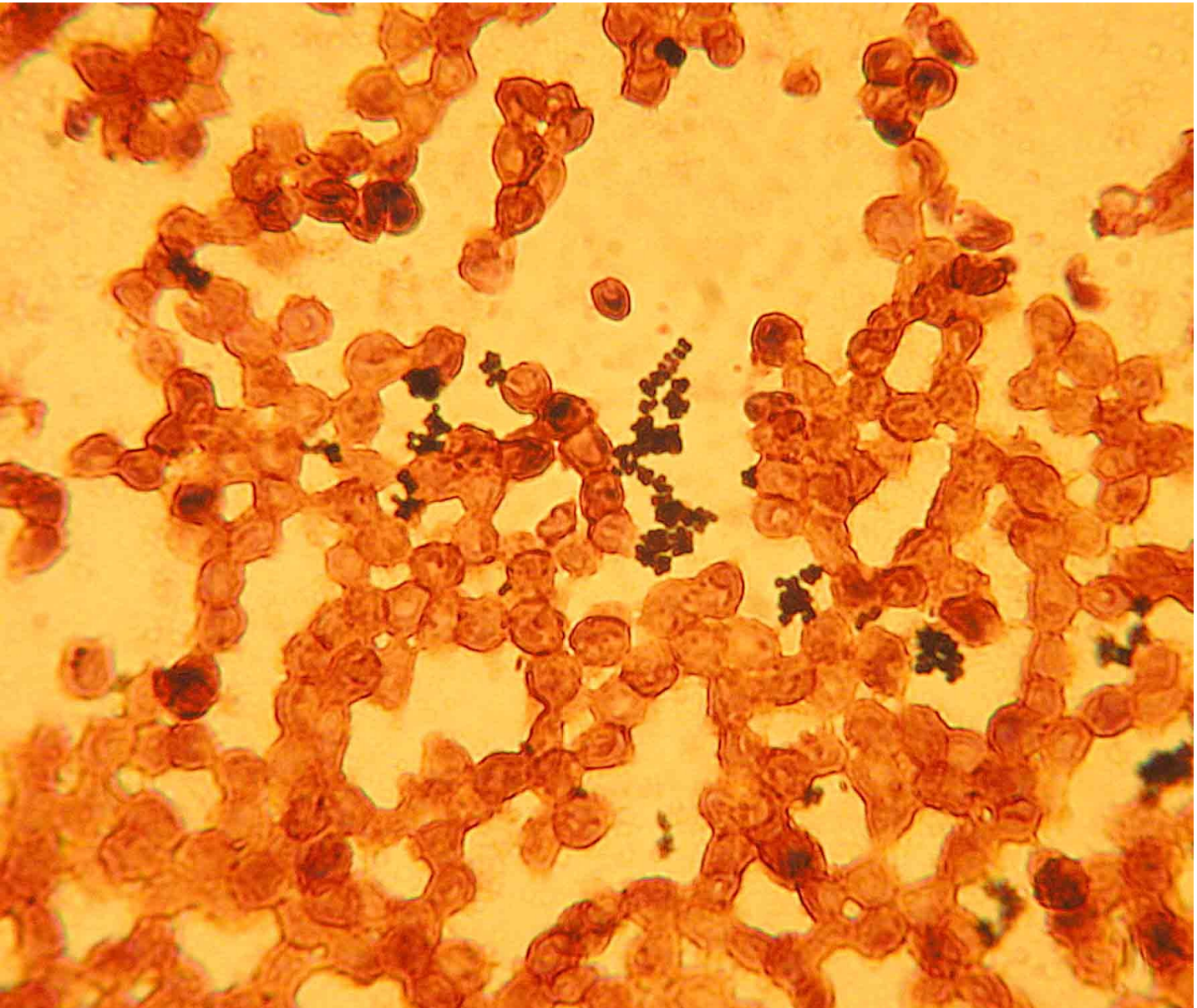
***E. coli* + other enterobacteria** (catheter-associated infections of the urinary tract)

Gram-negative non-fermenting rods (contaminated infusion fluids)

yeasts (catheter-associated sepsis, febrile neutropenia)

Enterococci and many other microbes

Staphylococci in blood culture



www.medmicro.info

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 culutres, 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. Skin cleaning is not sufficient, disinfection is necessary**
- **The disinfectant should be let to act enough (in alcohol disinfectants it is 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 order form carefully, to add the time of material taking**

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

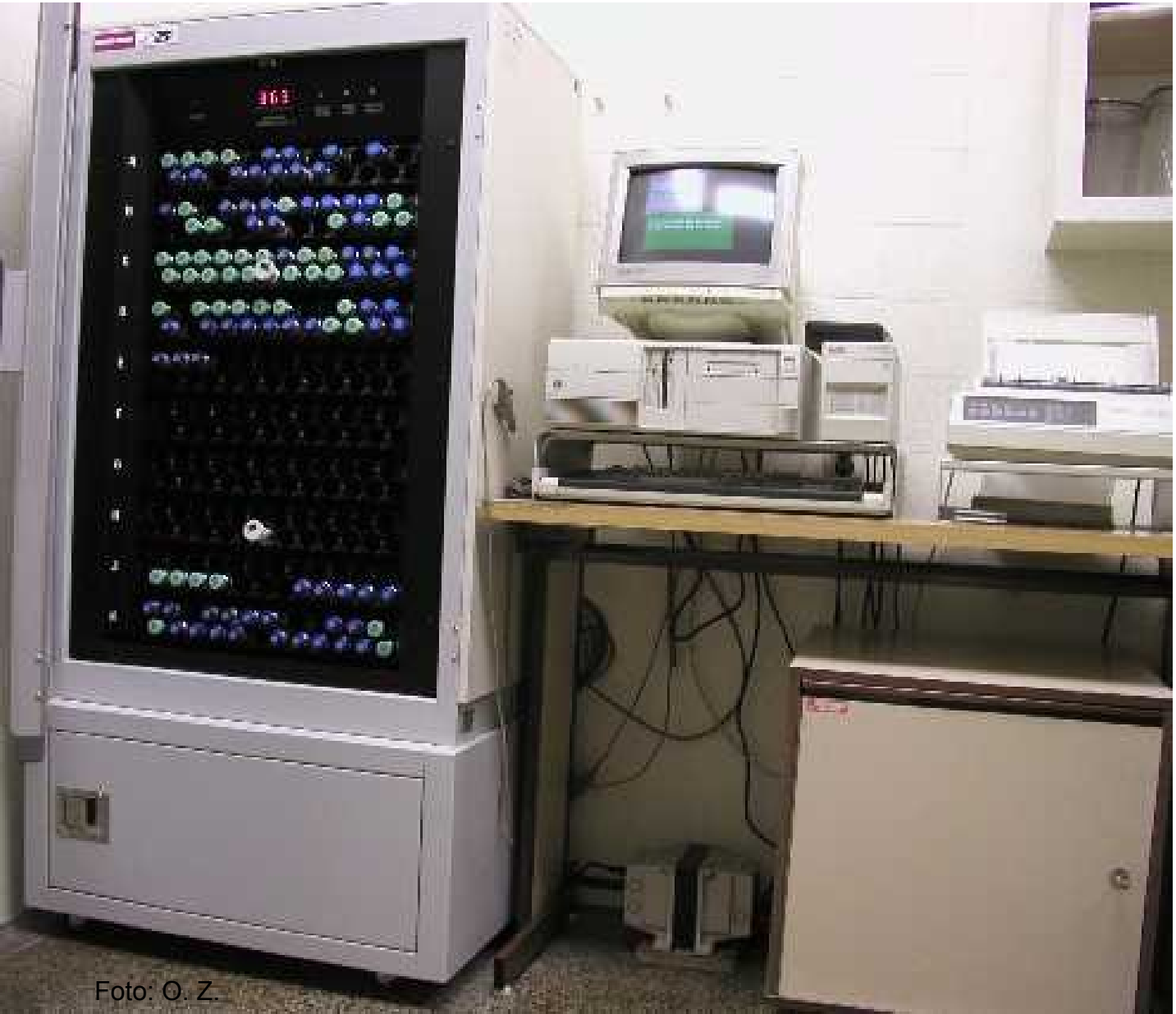


Foto: O. Z.

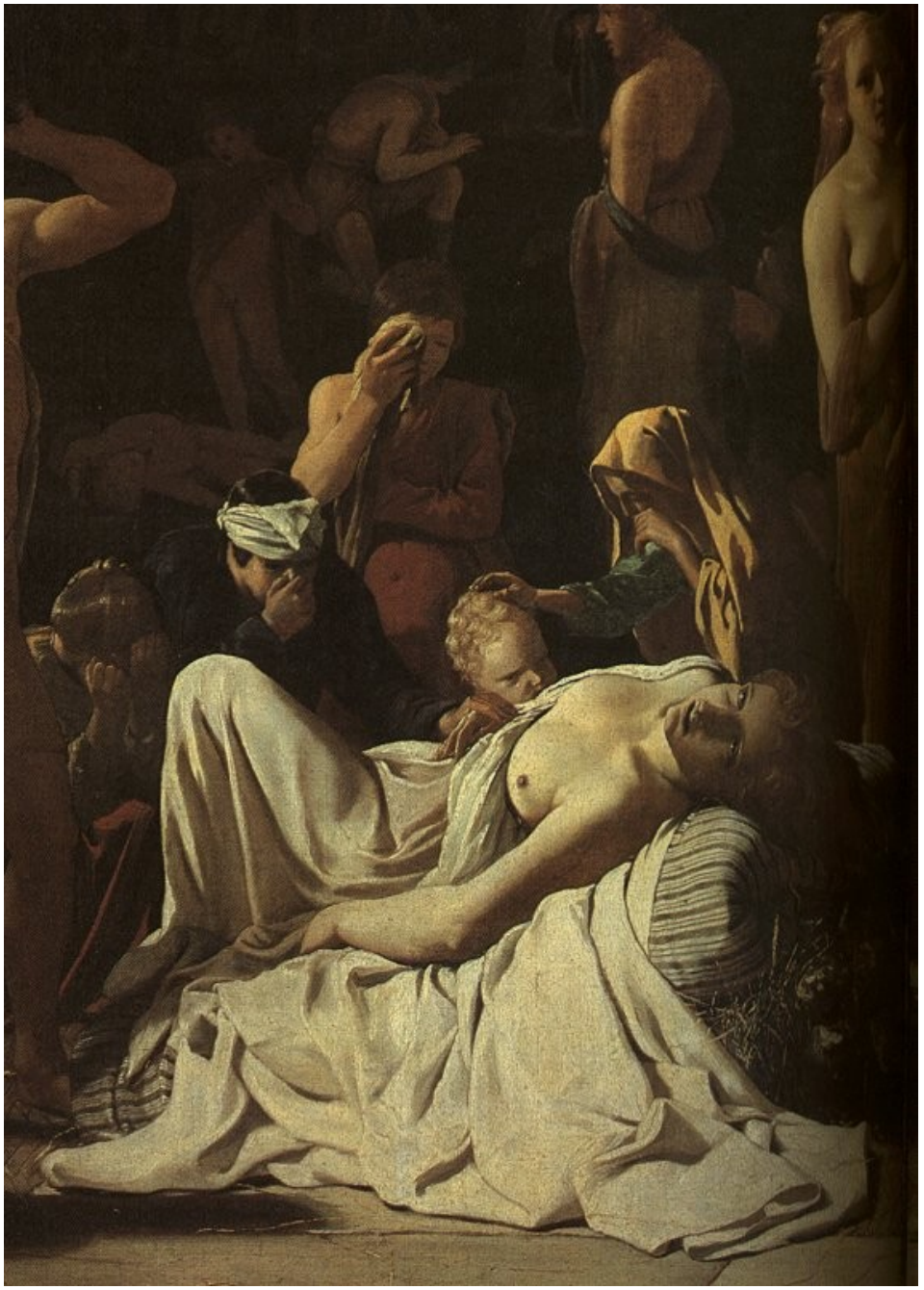
Treatment of sepsis

At intensive care units only

- **antibiotics – usually 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.)**

Homework 8 – solution

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



Homework 9