Healthcare associated infections

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Healthcare associated infections (HAI)
definitions

- **Nosocomial infections…**
- **Hospital acquired infections…**

- **Healthcare associated infections**

Healthcare associated infections (HAI)
definitions

Infections not existing on admission to healthcare facility (or not being in incubation period)

Infections acquired in direct relation to patient interaction with healthcare

Healthcare associated infections: means diseases or pathologies related to the presence of an infectious agent or its products in association with exposure to healthcare facilities or healthcare procedures or treatments

- exogenous / endogenous cases
- preventable / non-preventable cases
- hospital, primary, ambulatory, long-term care associated infections

Healthcare associated infections (HAI)
case definitions

Standard HAI case definitions

- **CDC definition system** (Center for Disease Prevention and Control, Atlanta, USA) – widely used (National Health Safety Network – NHSN)

- **Official HAI definitions valid for EU** prepared by ECDC (European Center for Disease Prevention and Control, Stockholm, Sweden), published in 2012

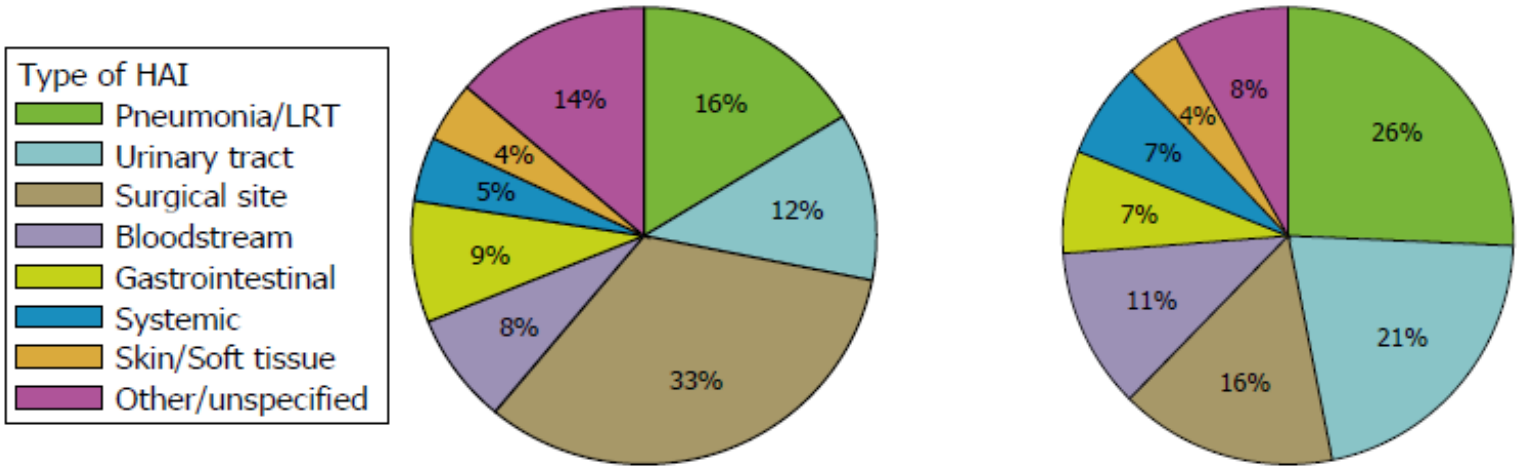
Healthcare associated infections
classification

- **Bloodstream infections, incl. catheter-related**
- **Surgical site infections**
- **Nosocomial pneumonia, incl. ventilator / intubation associated**
- **Urinary tract infections (catheter associated)**
- **…**
- **…**

Healthcare associated infections

epidemiology (European point prevalence survey 2012)

Figure 23. Distribution of HAI types by presence of HAI on admission (left) and HAI onset during hospitalisation (right), ECDC PPS 2011–2012



Nosocomial bloodstream infections – aetiology

trends 1975 - 89 (NNIS, CDC, Atlanta USA)

1975	%	1983	%	1986-89	%
St. aureus	**14.3**	**CN staph.**	**14.2**	**CN staph.**	**27.7**
E. coli	14.1	**St. aureus**	**12.9**	**St. aureus**	**16.3**
Klebsiella spp.	9.1	Klebsiella spp.	9.1	**enterococci**	**8.5**
CN staph.	**6.5**	**enterococci**	**7.3**	**Candida spp.**	**7.8**
Bacteroides spp.	6.3	Enterobacter spp.	6.9	E.coli	6.0
enterococci	**6.0**	Ps. aeruginosa	6.1	Enterobacter spp.	5.0
Enterobacter spp.	5.7	**Candida spp.**	**5.6**	Proteus mirabilis	5.0
Ps. aeruginosa	4.5	Bacteroides spp.	3.4	Klebsiella pneum.	4.5
Proteus spp.	3.9	Serratia spp.	2.8	Ps. aeruginosa	4.4
Serratia spp.	3.8	streptococci	2.8	streptococci	3.8

Nosocomial bloodstream infections
epidemiology

Nosocomial Bloodstream Infections in US Hospitals: Analysis of 24,179 Cases from a Prospective Nationwide Surveillance Study CID 2004:39 (1 August) • 309

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- **Surveillance of nosocomial BSI** (7 years in 49 hospitals)
  - average occurence — **60** cases per 10 000 adm.
  - median — **48** cases per 10 000 adm.
  - range — **6** to **252** cases per 10 000 adm.
  - intensive care related — **51.0**% cases

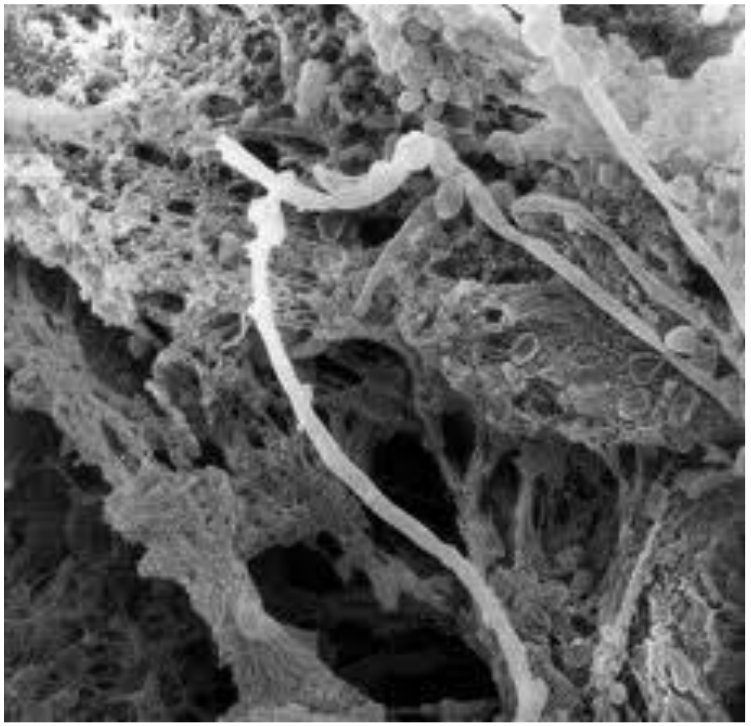
Nosocomial bloodstream infections
epidemiology (European PPS 2012)

Origin of bloodstream infections (BSI)[d]		
Total BSI	1585	100.0
Catheter-related (C) BSI[e]	626	39.5
C-CVC	527	33.2
Of which CRI3-CVC	345	65.5
C-PVC	99	6.2
Of which CRI3-PVC	52	52.5
Secondary (S) BSI[f]	456	28.8
S-Pulmonary infection	65	4.1
S-Urinary tract infection	127	8.0
S-Surgical site infection	79	5.0
S-Digestive tract infection	78	4.9
S-Skin/soft tissue infection	35	2.2
S-Other infection sites	72	4.5
BSI of unknown origin & missing	503	31.7
BSI of unknown origin[g]	310	19.6
Missing BSI origin	193	12.2

Bloodstream and cardiovascular infections
overview

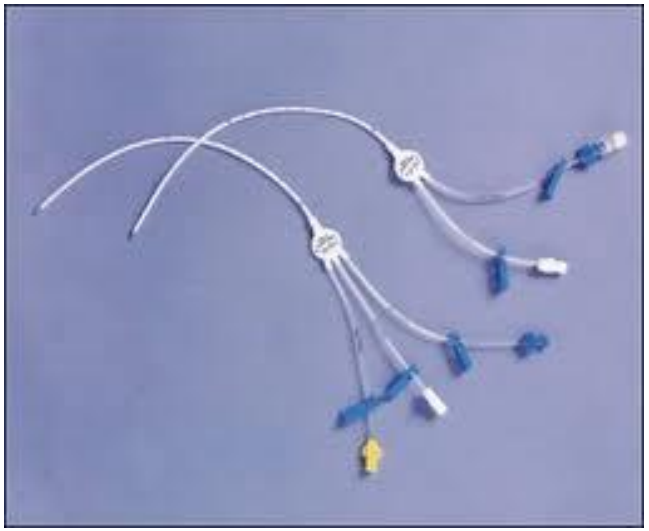
- **catheter-related bloodstream infections**
- **primary bloodstream infections of unknown origin**
- **secondary bloodstream infections** (UTI, RESP, GIT, SSI, SST…)

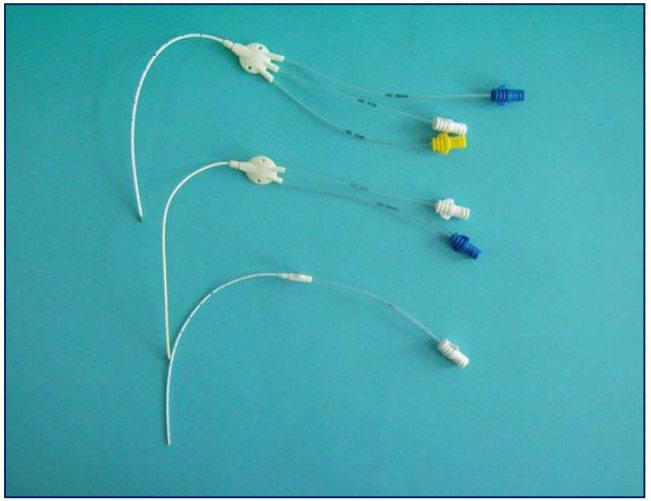
- **cardiovascular infections** (endocarditis, septic vasculis)
- **intravascular implants associated infections** (pacemakers,…)



Catheter-related infections

central venous catheters - types and insertion sites

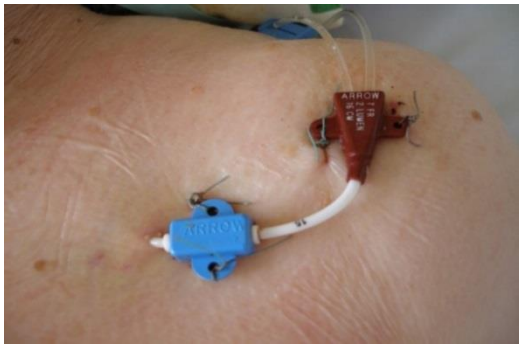


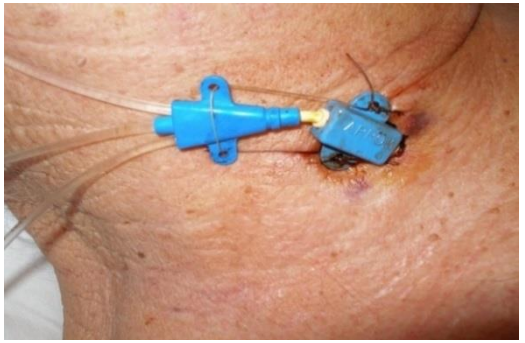


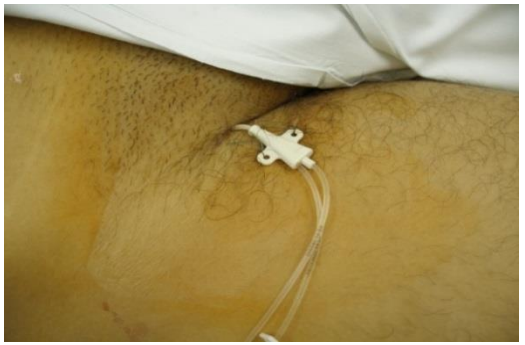
v. subclavia

v. jugularis

v. femoralis







Catheter-related infections
clinical forms and complications

- **Local catheter-related infection**
  - infection of insertion site, tunnelitis
- **Uncomplicated catheter-related BSI**
  - bloodstream infection
- **Complicated catheter-related BSI**
  - infective endocarditis
  - septic trombophlebitis
  - endarteritis, pseudoaneurysm
  - metastatic infection (spondylodiscitida, endoftalmitida, absc. pneumonie)
  - infections of endovaskular implants (vascular prostheses, pacemakers)

Catheter-related bloodstream infections
epidemiology

Catheter related BSI in ICUs (288) **in 5 European countries:**

- **median (countries):** **0,93-3,27** cases/1000 catheter days
- **median (total):** **1,5** cases/1000 catheter days
- **excesive occurence:** **6 - 14** cases/1000 catheter days

Hansen S. et al. National influences on catheter-associated bloodstream infection rates: practices among national surveillance networks participating in the European HELICS project. J Hosp Infect (2009) 71, 66-73

Catheter-related bloodstream infections

epidemiology and impact in 4 large Western Europe countries

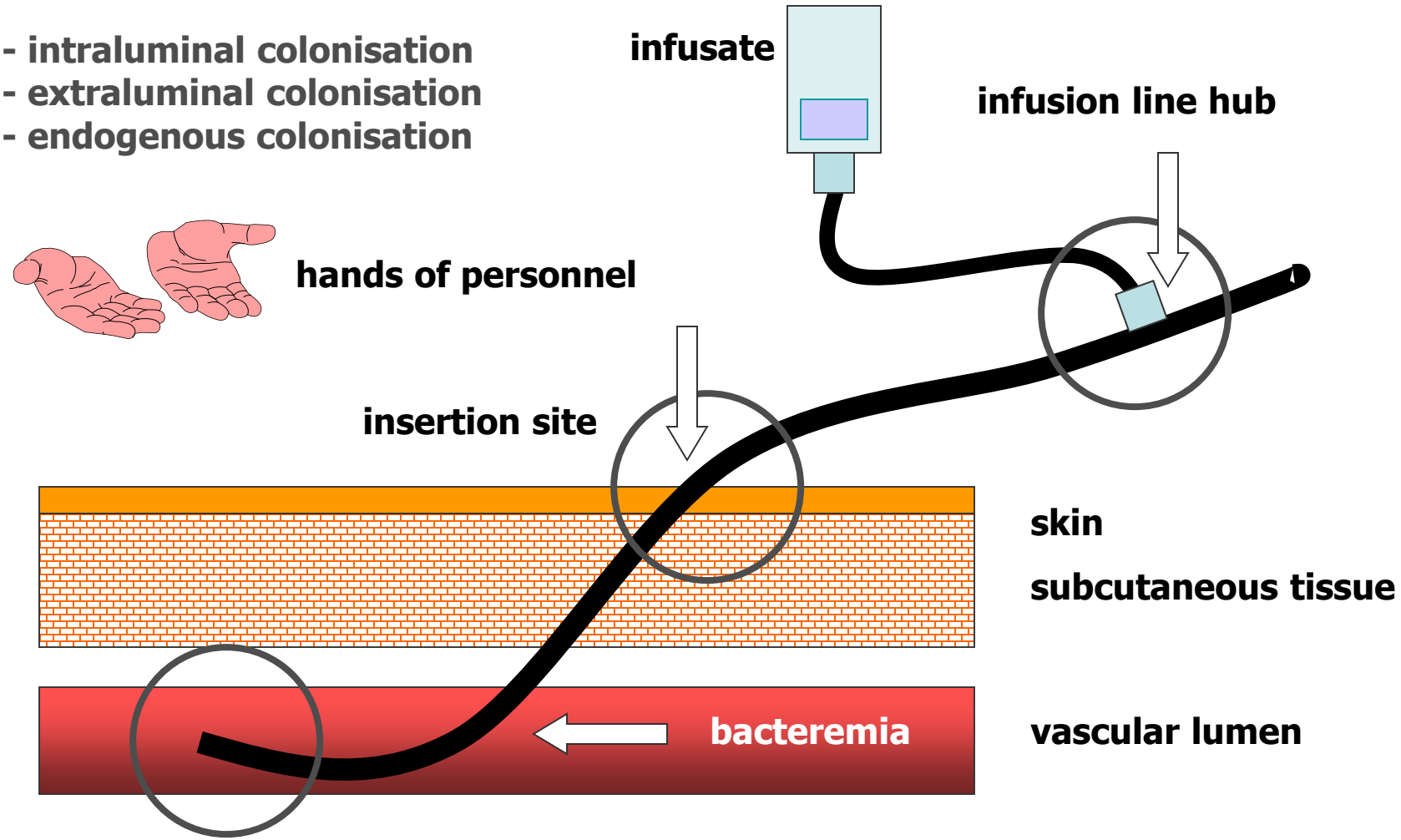
	France	Germany	Italy	UK
No. of inhabitants (ml.)	60.2	82.5	57.5	59.8
No. of inserted CVCs	1 000 000	1 750 000	490 000	210 000
incidence / 1000 cath.days	**1.23**	**1.5**	**2.0**	**4.2**
No. of in infections per year	14 400	8 400	8 500	8 940
No. of deaths úmrtí (th.)	**1.58**	**1.00 – 1.30**	**1.50**	**-**
Extra hospital stay (days)	9.5 – 14	4.8 – 7.2	12.7	1.9 – 4.0
cost per case (th. Euro)	**7.73 – 11.38**	**4.20**	**13.03**	**4.39 – 9.25**
yearly costs (ml.Euro)	100.0 – 130.0	59.6 – 78.1	81.6	28.5 – 53.9

Tacconelli E. et al. Epidemiology, medical outcomes and costs of catheter-related bloodstream infections in intensive care units of four European countries: literature- and registry-based estimates. J Hosp Infect (2009) 72, 97-103.

Pathogenesis of catheter-related infections

colonisation and infection

- intraluminal colonisation
- extraluminal colonisation
- endogenous colonisation



Aetiology of catheter-related bloodstream infections

pathogen-specific ability to develop bloodstream infection

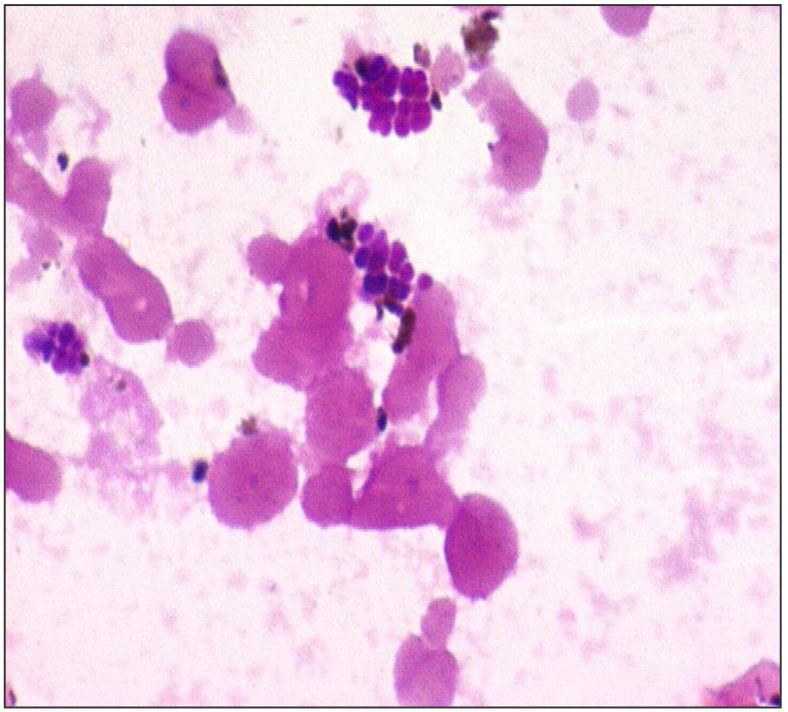
presence on vascular catheter		risk of bloodstream infection			
microorganism	**%**	**microorganism**	catheter	blood	**%**
CN staphylococci	**36,5%**	Candida albicans	20	15	**75%**
Ps.aeruginosa	**14,5%**	St.aureus	26	18	**69%**
Candida spp.	**8,3%**	Ent.cloacae	12	6	**50%**
enterococci	**7,9%**	E.faecalis	30	10	**33%**
St.aureus	**7,7%**	Ps.aeruginosa	32	10	**31%**
Enterobacter spp.	**4,2%**	CN staphylococci	99	29	**29%**

Sherertz RJ, et al. Three-year experience with sonicated vascular catheter cultures in a clinical microbiology laboratory. J Clin Microbiol 1990;28:76-82.

Catheter-related bloodstream infections – high risk pathogens

Staphylococcus aureus

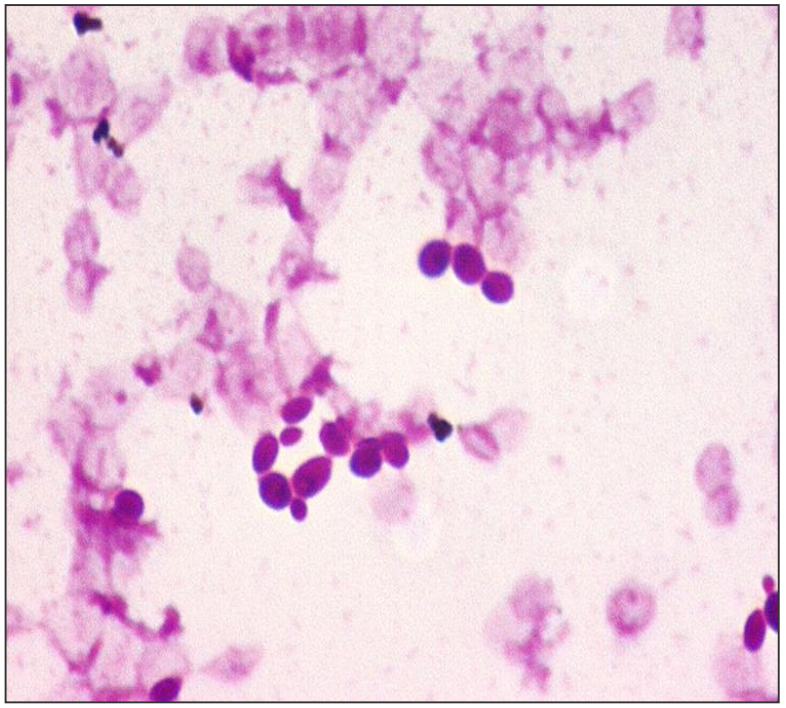
- high **virulence**
- frequently **sepsis** or **severe sepsis**
- important risk of **metastatic** and **recurrent infections**
- important risk of **complications** (septic vasculitis, endocarditis)
- risk of **endovascular implant infections** (hematogenous contamination)
- extraction of catheter is necessary, **antibiotic therapy is essential** (10-14 days)



Catheter-related bloodstream infections – high risk pathogens

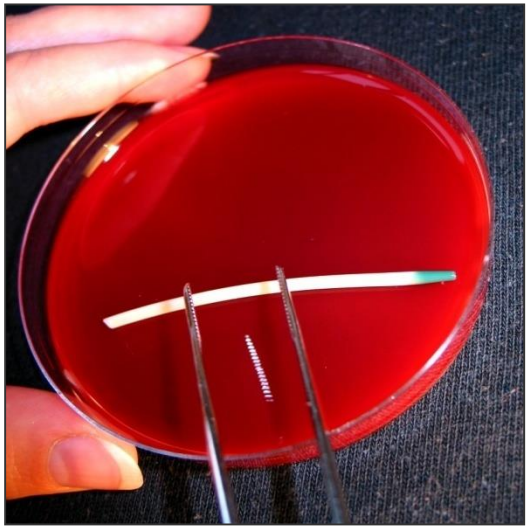
Candida spp.

- high ability to cause **severe infection** with poor prognosis
- important risk of **metastatic** and **recurrent infections**
- important risk of **complications** (endophthalmitis)
- risk of **endovascular implant infections** (hematogenous contamination)
- extraction of catheter is necessary, **antimycotic therapy is essential** (14 days)



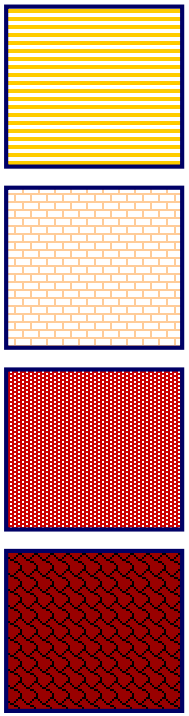
Catheted-retates bloodstream infections
microbiology diagnostics

- **Catheter examination**
  - semiquantitative „roll" technique (Maki method)
  - sonication



Surgical site infections (SSI)
clasification

surgical wound infections (former term)
surgical site infections



skin

subcutaneous

superficial incisional infection

fascia, muscles

deep incisional infection

organs, body spaces

organ-space infections

Surgical site infections (SSI)
aethiology

surgical discipline	SAU	CoNS	strep.	G- rods	anaerobes
Cardiothoracic surgery	XX	XX			
Vascular surgery	XX	XX			
Neurosurgery	XX	XX	X		X
Orthopedics	XX	XX		X	
Thoracic surgery	XX	XX	X	X	X
Head and neck surgery	XX		XX		XX
Abdominal surgery			X	XX	XX
Gynaecology/obstetrics			XX	XX	XX
Urology			XX	XX	

Surgical site infections (SSI)
pathogenesis

Precursor:

- microbial contamination during surgical procedure

$$\text{SSI risk} = \frac{\text{dose of microbial contamination} \times \text{virulence}}{\text{immune status of exposed host}}$$

Qualitative aspect:

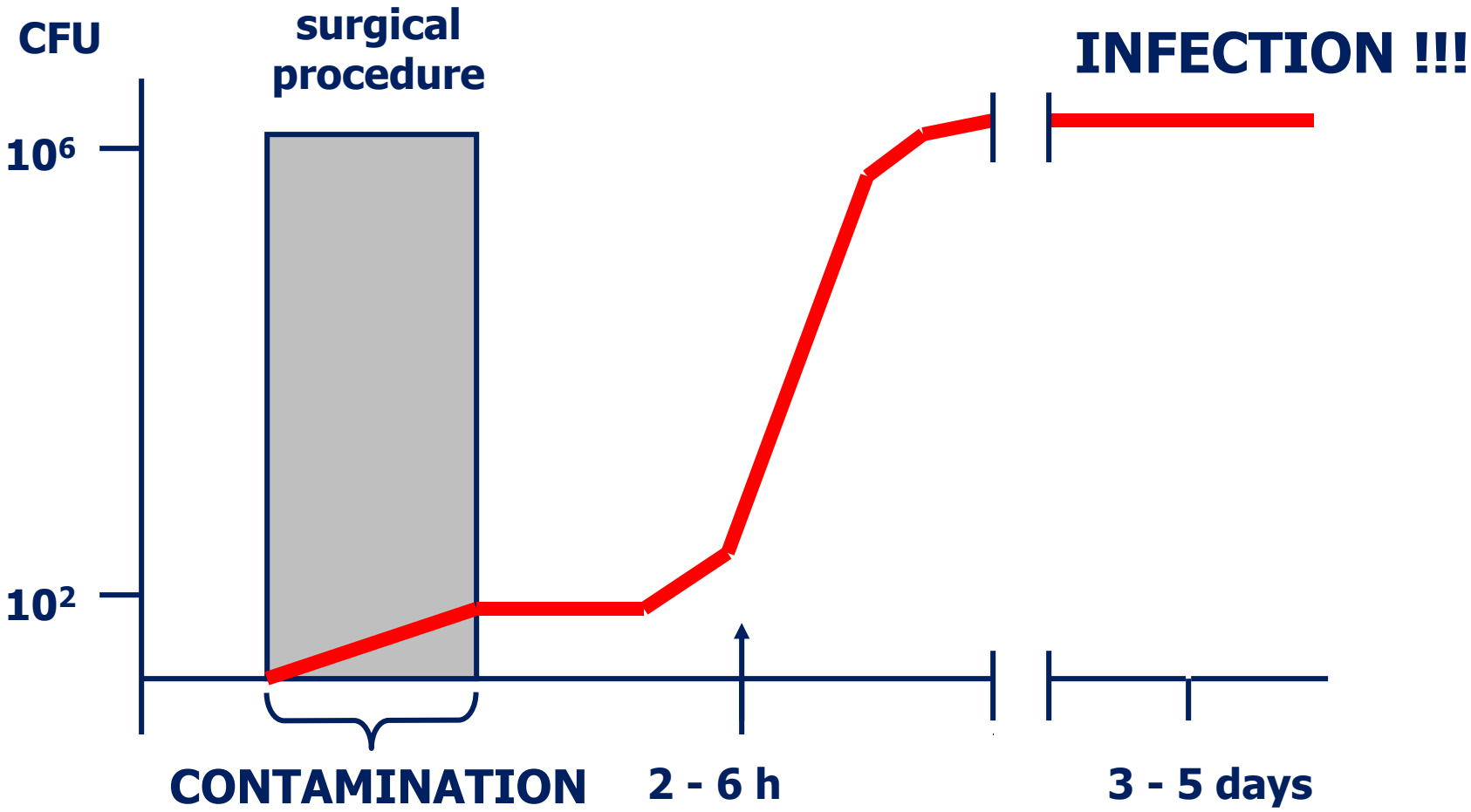
- microbial factors (virulence)

Quantitative aspects:

- without foreign body implant — **10^5** CFU per g of tissue
- with foreign body implant — **10^2** CFU per g of tissue

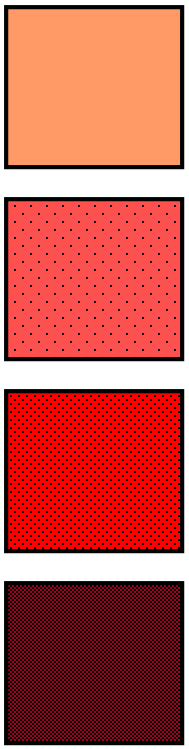
Surgical site infections (SSI)

pathogenesis, timing



Clasification of surgical procedures

according microbial contamination



clean procedures

clean – contaminated procedures

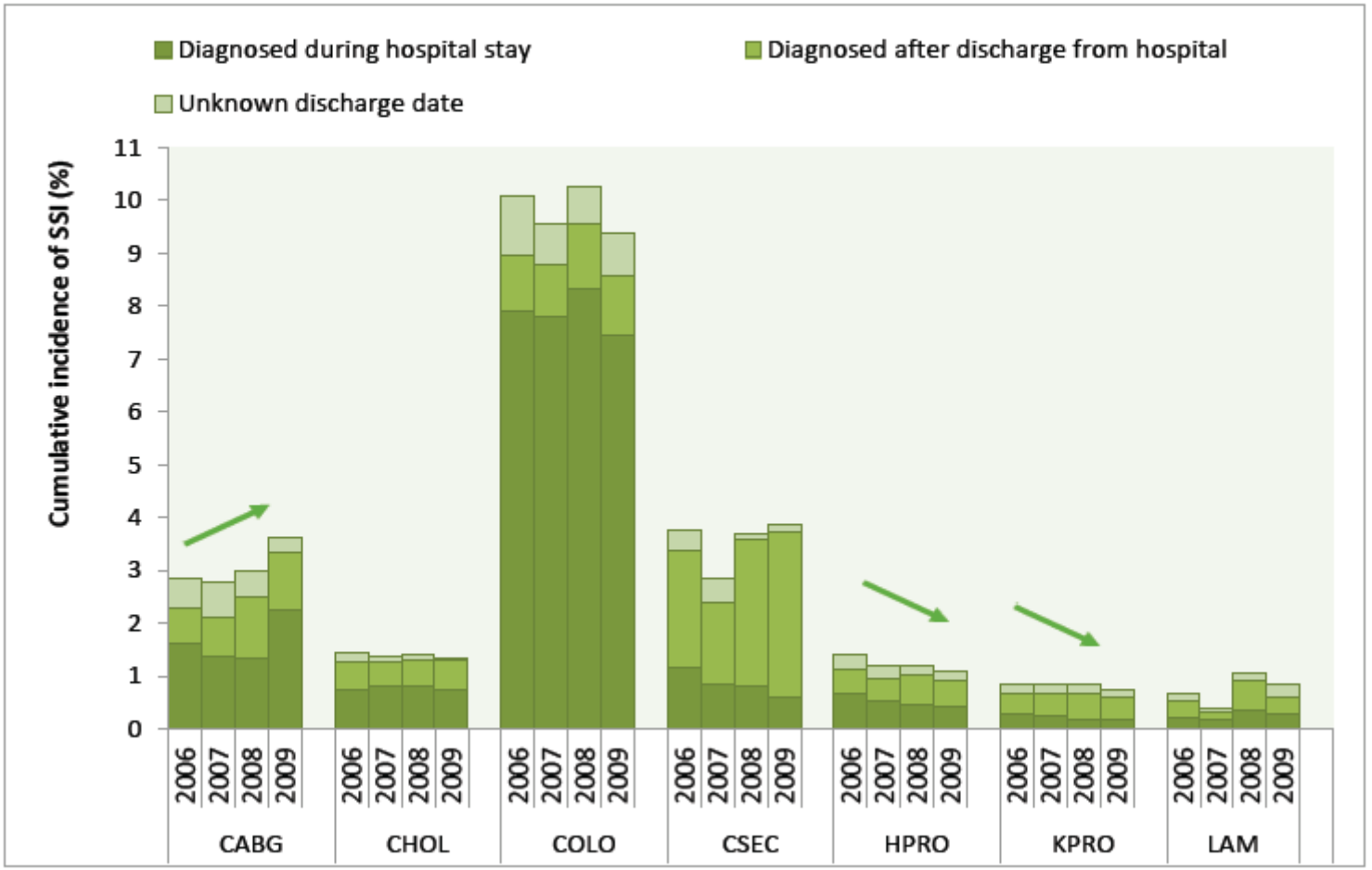
contaminated procedures

dirty/infected procedures

ECDC - HAI-Net surveillance - SSI component

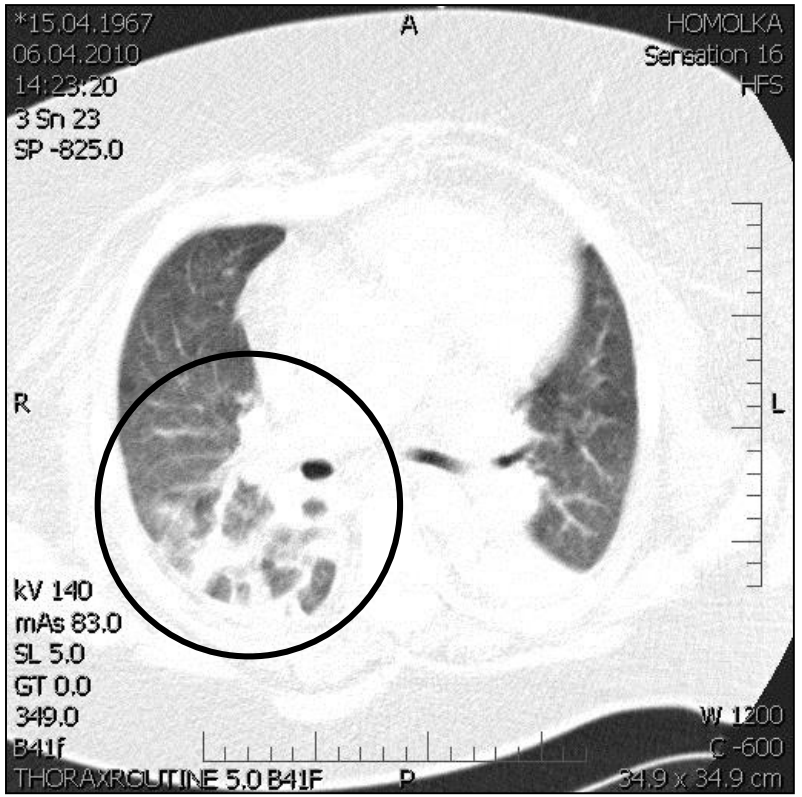
outputs

Figure 3.3. Distribution of cumulative incidence for SSI by year and operation type, EU/EEA countries contributing data for all years, 2006–2009



Nosocomial pneumonia
characteristics

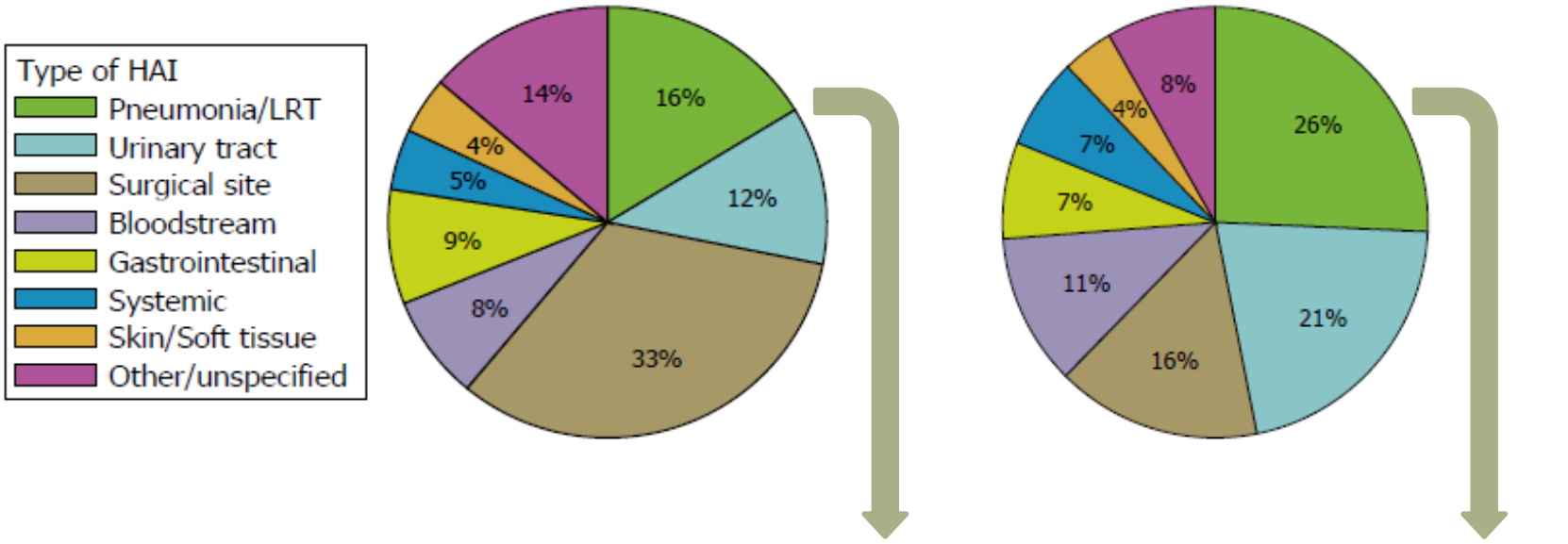
- **Nosocomial pneumonia**
- **Intubation (ventilator) associated pneumonia**



Nosocomial and ventilator- associated pneumonia

epidemiology (European PPS 2012)

Figure 23. Distribution of HAI types by presence of HAI on admission (left) and HAI onset during hospitalisation (right), ECDC PPS 2011–2012



pneumonia present on admission

hospital stay acquired pneumonia

Ventilator associated pneumonia
classification

- **VAP early onset**

- **VAP late onset**

Ventilator associated pneumonia
aetiology

- **VAP early onset**
  - *Staphylococcus aureus*
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - enterobacteria (*Escherichia coli*, *Klebsiella pneumoniae*)
- **VAP late onset**
  - *Staphylococcus aureus* (higher MRSA risk)
  - *Pseudomonas aeruginosa* (incl. MDRO)
  - enterobacteria (risk of MDRO)
  - *Acinetobacter* spp.
- **unlikely pathogens**
  - Candida spp. (except imunosuppressed individuals)
  - enterococci

Intubation associated pneumonia
epidemiology (ICU component HAI-Net, 2009)

- **Intubation associated pneumonia in European ICUs**
  - average (cases per 1000 intubation days) **13,5**
  - range (cases per 1000 intubation days) **3,4 – 21,7**

Table 2.6.2. Intubation-associated pneumonia rates by country, 2009

	Number of patients	Average length of ICU stay (days)	Intubation days per 100 patient days	Intubation-associated pneumonia episodes per 1 000 intubation days				
				Pooled country mean	Mean of ICUs	25th percentile	Median	75th percentile
Austria	6 975	10.2	59.1	13.5	10.9	0.0	7.6	20.5
Belgium	3 209	7.7	37.1	17.4	21.7	4.7	23.4	30.0
France	24 533	11.8	60.8	13.7	13.1	7.8	12.1	17.8
Italy	929	10.7	65.7	12.8	11.2	7.6	10.7	14.4
Lithuania	2 311	8.3	40.3	10.8	8.2	0.0	2.3	10.9
Luxembourg	2 307	9.8	31.4	3.4	3.6	0.7	4.5	5.9
Portugal	3 472	12.2	74.4	13.0	13.0	6.0	10.7	17.2
Slovakia	176	9.5	82.4	11.6	11.3	6.8	11.2	14.8
Spain	21 609	9.6	46.9	14.3	15.5	6.4	12.9	23.8
United Kingdom[a]	1 154	6.8	50.2	13.5	13.5	13.5	13.5	13.5
Total	**66 675**	**10.4**	**54.9**	**12.2**	**13.5**	**6.1**	**11.7**	**19.9**

Source: HAI-Net ICU. ICUs that reported data on less than 20 patients were excluded. Patients with discordant exposure data excluded. (a) Data from Scotland only.

Healthcare associated infections
impact and trends (USA)

- **2 000 000 cases of HAI per year (USA)**
- **500 000 cases intensive care associated (VAP, BSI)**

	hospitalisation	lenght	HAI/1000 pt. days
• **1975**	**38 000 000** ↓	**7.9 days** ↓	**7.2** ↑
• **1995**	**36 000 000**	**5.3 days**	**9.8**

- **90 000 deaths** yearly associated with HAI (the **5**th most frequent cause of death)

Stone et al. A systematic audit of economic evidence linking nosocomial infections and infection control interventions: 1999 – 2000. American Journal of Infection Control, Vol.30, No.3, May 2002

Impact of HAIs in Europe (EU 27 - 2009)
mortality, extra costs and hospital stay

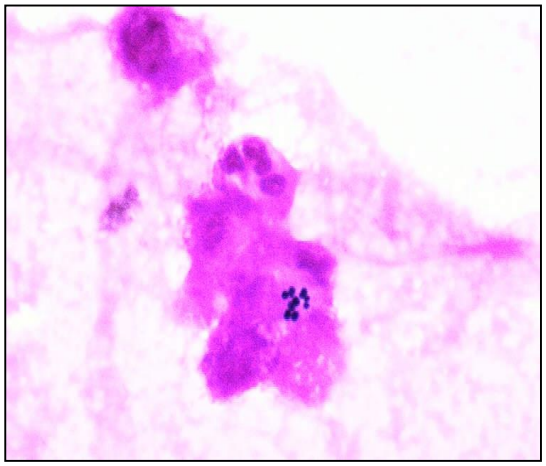
• No. of inhabitants (EU 27)	498 000 000
• No. of hospital admissions	81 000 000
• Admissions per 100 000	16 247
• No. of HAI cases	4 131 000
• **Incidence of HAI**	**5.1%**
• **No. of deaths (directly related)**	**37 179**
• No. of deaths (indirect)	111 537
• Extra hospital stay (pt. days)	16 000 000
• **Extra costs (Euro)**	**4 480 000 000**

Council reccommendation on patient safety incl. prevention and control of healthcare associated infections 2009, Impact assessment report

Impact of HAIs

bloodstream infections caused by *Staphylococcus aureus*

BSI – attributable mortality	**19-34%**
BSI – extra hospital stay	**3x longer** (4,5 - 14,3 dnů)
BSI – extra costs	**4x higher** (14 100 - 48 800 USD)



Preventability of HAIs

targeted infection control based on surveillance

SENIC study (USA, appr. 400 hospitals, 1975)**:**

surveillance + targeted interventions	**32 % decrease**
infection control interventions without surveillance	**6 % decrease**
no interventions	**18 % increase**

Preventability of healthcare associated infections

possibilities to decrease HAI occurence

HAI type	preventability
bloodstream infection (catheter related)	**60-70%** (100%)
surgical site infection	**55%**
ventilator associated pneumonia	**55%**
urinary tract infection (catheter assoc.)	**60-70%**

Umscheid CA, Mitchell MD, et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol. 2011 Feb;32(2):101-14.

HAIs and highly dangerous infections – MERS-CoV outbreak

nosocomial MERS-CoV outbreak in south-korean hospitals

- **MERS in South Korea:** single case transfered from Middle East (symptoms 11.5.2015), 21.7.2015 registered **186** cases (**37** deaths), all cases healthcare associated (excl. „index case"), **26** cases (14%) healthcare workers