

ETIOLOGY AND CONSEQUENCES OF SURGICAL SITE INFECTIONS

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- (1) Surgical wound classification
- (2) Consequences of SSIs
- (3) Most common microorganisms
- (4) SSI after joint replacement
- (5) Controversies in AB-prevention
- (6) Risk factors for surgical site infection
- (7) Conclusions



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SURGICAL WOUND CLASSIFICATION

- **Clean:** Uninfected, no inflammation, not colonized, closed primarily
- **Clean-contaminated:** Resp. or GIT entered, no unusual contamination
- **Contaminated:** Open wounds, major break in sterile technique
- **Dirty:** Old traumatic wounds, perforation

TYPE OF SSI ACCORDING TO THEIR DEEPNESS

- *Superficial incisional SSI:* Involves only skin or subcutaneous tissue of the incision.
- *Deep incisional SSI:* Involves deep soft tissue (e.g., fascial and muscle layers) of the incision.
- *Organ/Space SSI:* Involves any part of the anatomy

CONSEQUENCES OF SSI

Postoperative infection is second most frequent medical error after pressure ulcer in the USA (data from 2008):

- Estimate of postop. infections: 265,000
 - Number caused by medical error: 250,000
- >90% of postoperative infections are estimated to be caused by medical errors

ANNUAL COSTS OF POSTOPERATIVE INFECTION

Postoperative infection is the most costly medical error (US 2008):

- 250,000 postoperative infections by error
- 13,300 \$ per postoperative infection
- 3.4 billion \$ total medical cost of postoperative infections

CONSEQUENCES OF POSTOPERATIVE INFECTION: RATE OF REHOSPITALISATION

Surg. Procedure	Postop.infect. related readmission	
• Lung resection	175/9,722	= 1.8%
• Pancreas resection	48/1,200	= 4.0%
• Colon resection	305/16,945	= 1.8%
• All procedures combined	736/36,800	= 2.0%

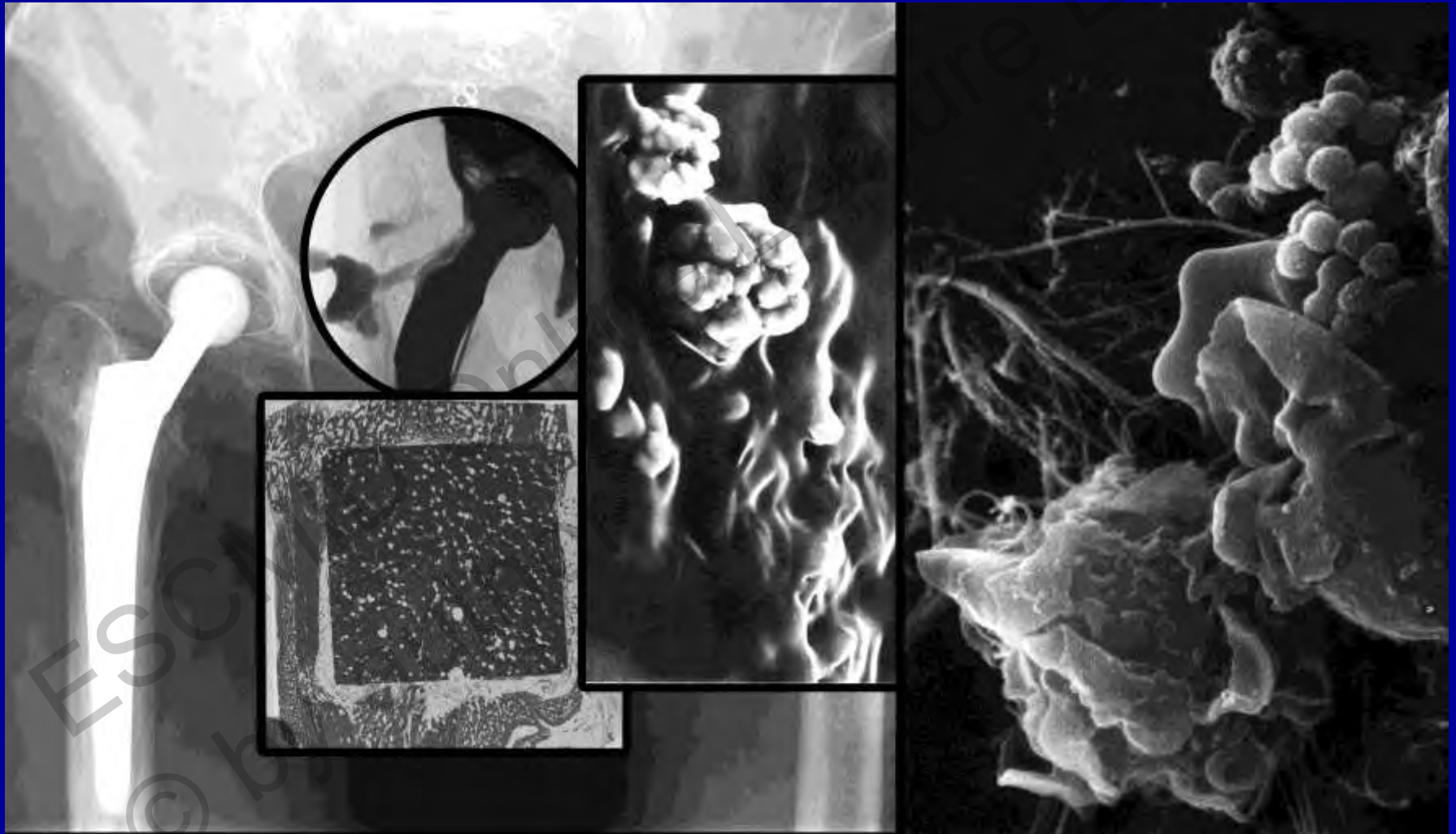
ADDITIONAL LENGTH OF STAY DUE TO SSI AFTER ABDOMINAL SURGERY

Type of SSI	Additional LOS attributable to SSI	
	Colon	Rectum surgery
• Superficial	4.5 d (95%CI 4.4-4.5)	2.8 d (2.7-2.8)
• Deep	6.8 d (6.7-6.9)	8.5 d (6.4-8.6)
• Space/organ	7.8 d (7.6-7.9)	9.5 d (9.4-9.6)

MICROORGANISMS IN DEEP SSI AFTER ABDOMINAL SURGERY

Microorganism	Deep SSI (n=1362)
<i>Escherichia coli</i>	22.8%
<i>Enterococcus spp.</i>	15.7%
<i>Pseudomonas aeruginosa</i>	8.0%
<i>Candida spp.</i>	5.5%
<i>Enterobacter spp</i>	4.6%
<i>S. aureus</i>	4.1%

SURGICAL SITE INFECTION AFTER JOINT REPLACEMENT



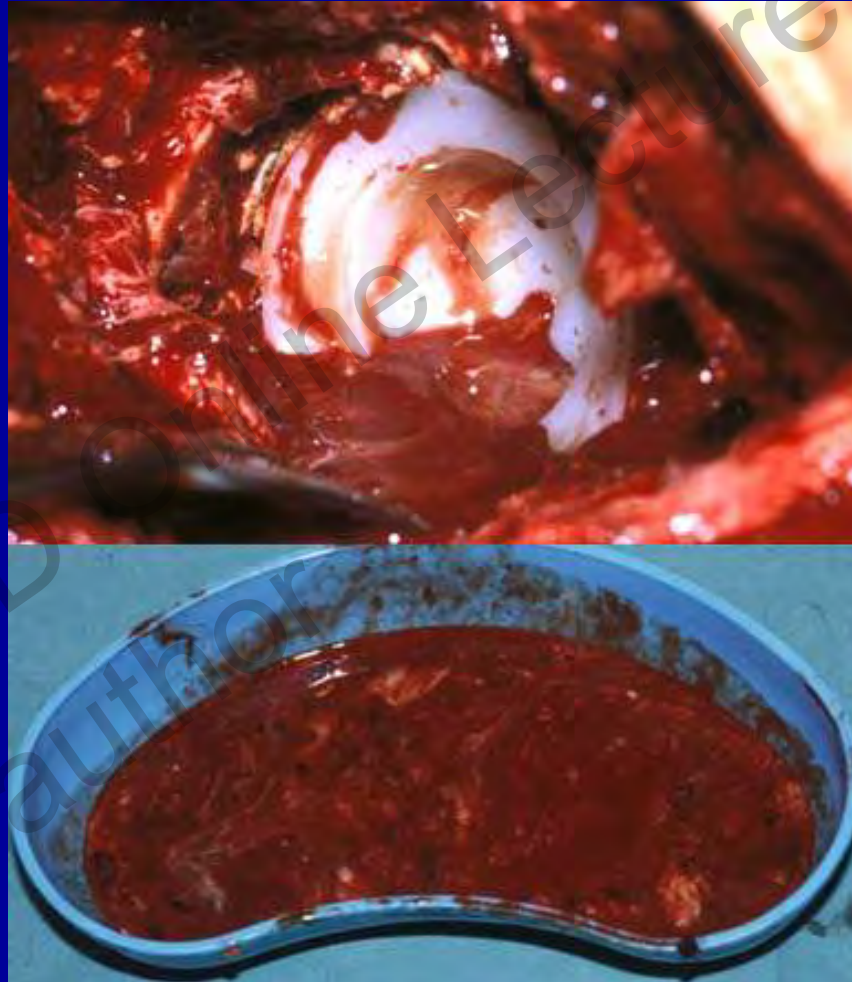
SSI IN PATIENTS WITH PROSTHETIC JOINT: SUPERFICIAL VS DEEP?



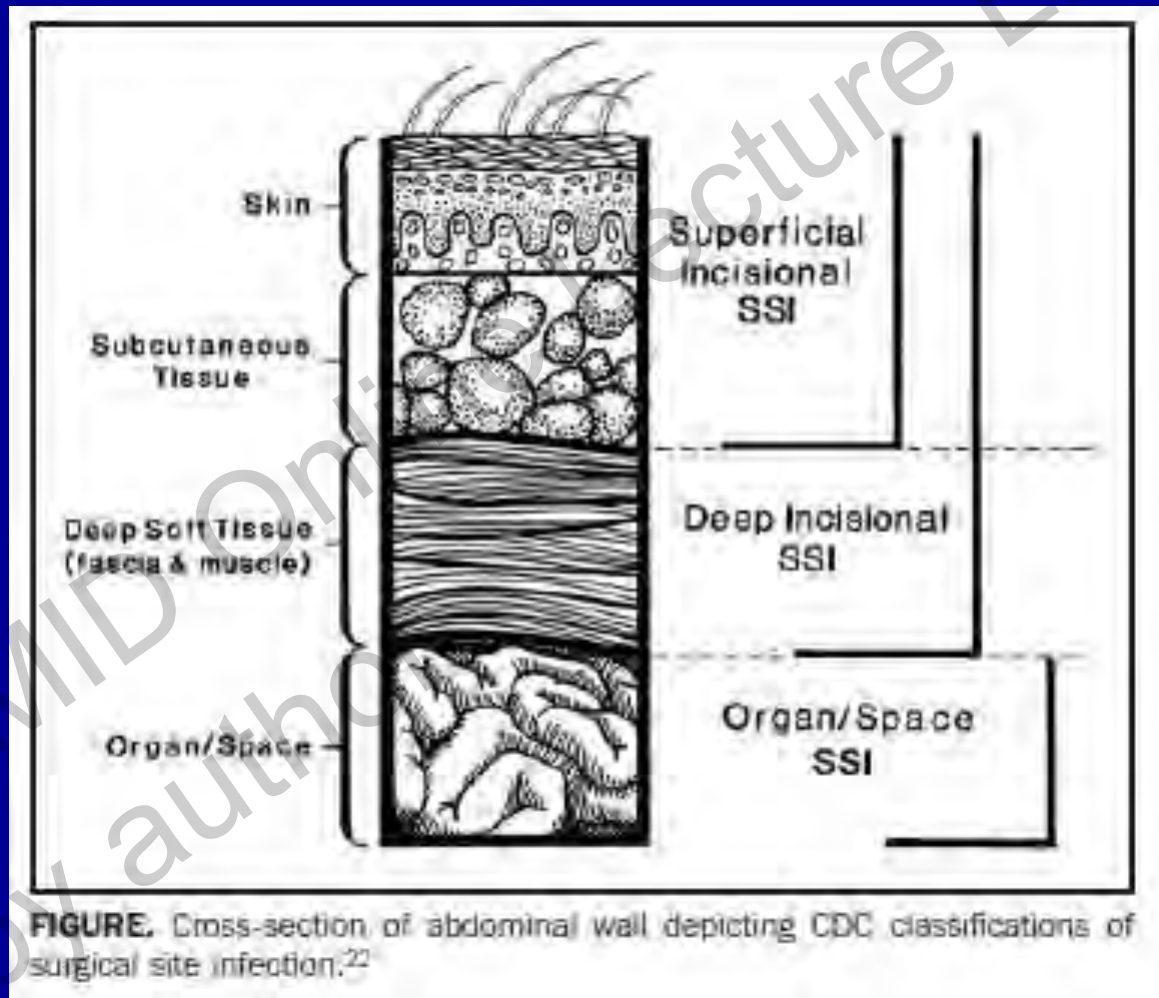
SSI: superficial or deep infection?



AT LEAST IN THIS PATIENT THERE IS NO DOUBT ABOUT DEEP SURGICAL SITE INFECTION



CDC CLASSIFICATION OF SSI



RISK FACTORS FOR PJI

Risk factor	Matched OR (95% CI)	P value
Postoperative surgical site infection	35.9 (8.3–154.6)	≤.01
NNIS System surgical patient risk index score		
1 vs. 0	1.7 (1.2–2.3)	≤.05
2 vs. 0	3.9 (2.0–7.5)	≤.01
Systemic malignancy	3.1 (1.3–7.2)	≤.01
Prior joint arthroplasty	2.0 (1.4–3.0)	≤.01

NNIS score: wound class, ASA score, >120min length of surg in THA (0-3 points)

→ Involvement of the device can never be excluded!

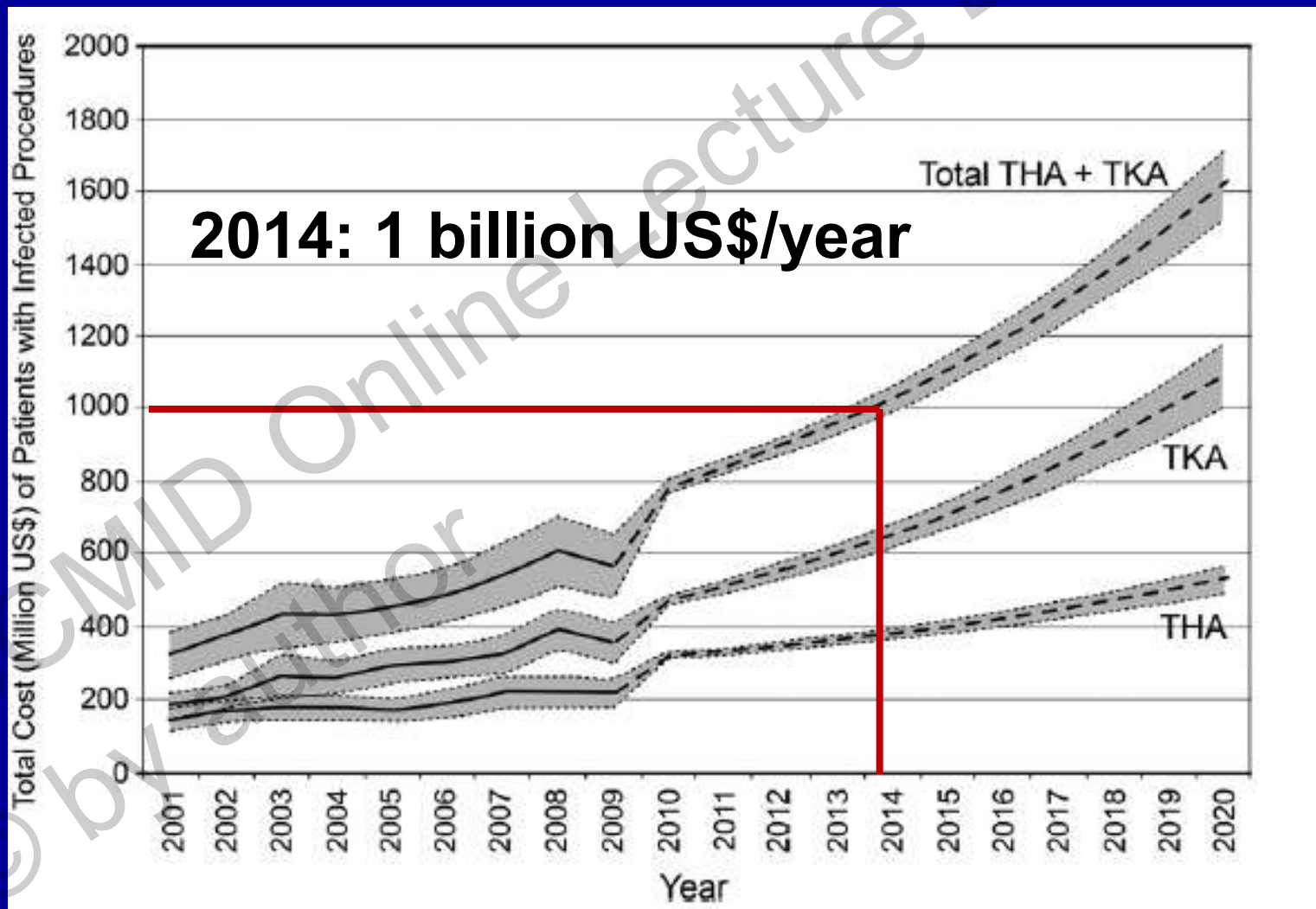
FINANCIAL CONSEQUENCES OF SSI AFTER JOINT REPLACEMENT

- **Primary THA:** \$ 30,000.-
- **Revision for PJI** \$ 94,000.-
- **Primary TKA:** \$ 24,000.-
- **Revision for PJI** \$ 75,000.-

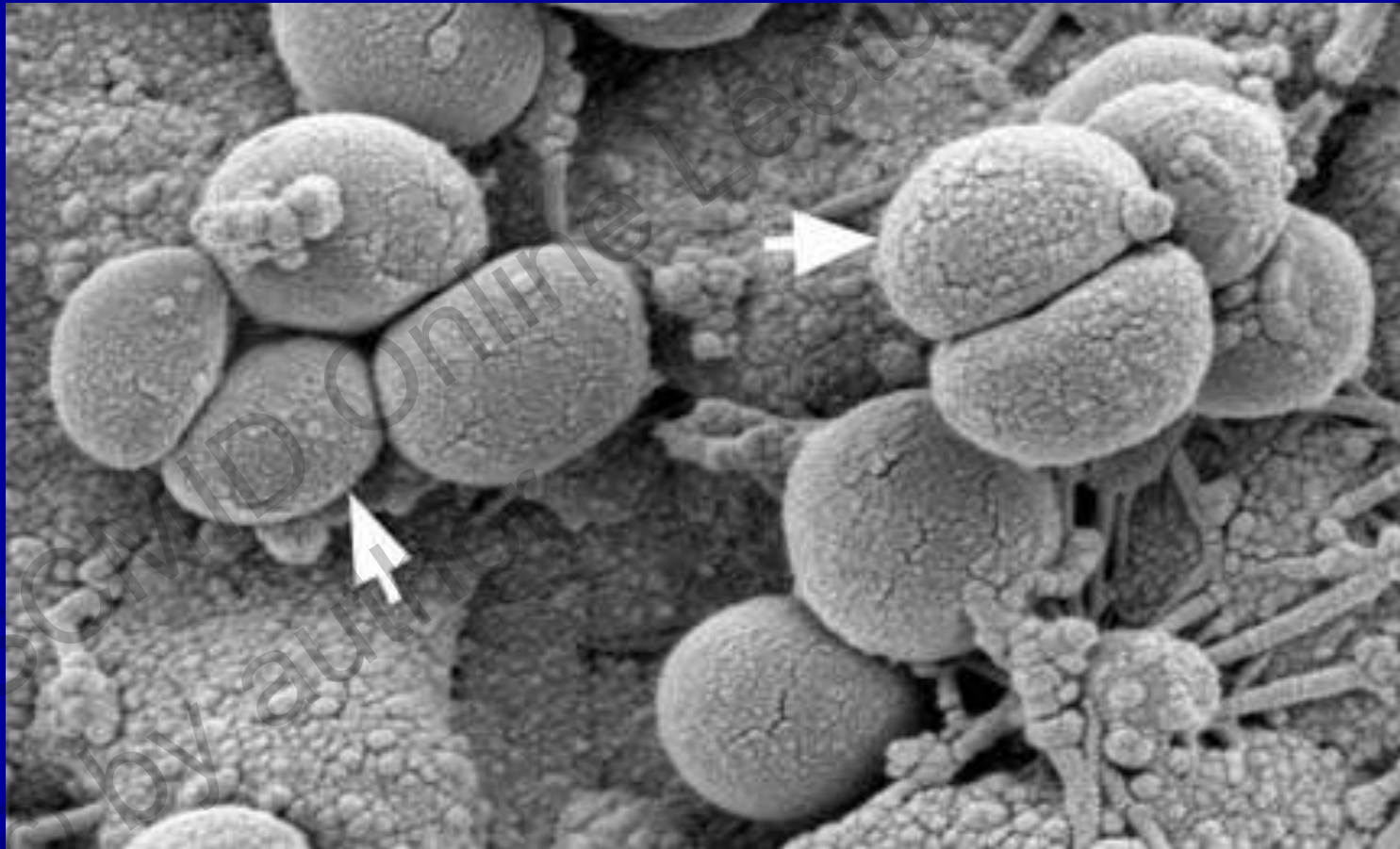
→ **Surgery for PJI is >3x more expensive than primary implantation**

TOTAL INPATIENT COSTS OF TKA- AND THA- ASSOCIATED INFECTIONS IN THE USA

[Kurtz et al. J Arthroplasty 2012]



CONTROVERSIES IN ANTIBIOTIC PROPHYLAXIS



DURATION OF ANTIMICROBIAL PROPHYLAXIS?

- **Single dose?**
- **Two doses (long OP or blood loss)?**
- **As long as surgery?**
- **As long as exogenous infection possible: drains, wet wound etc.?**

CONSEQUENCES OF ANTIBIOTIC PROPHYLAXIS ON MICROBIOME

Microorganism	Preop swab*	Postop swab*	P-value
<i>S. aureus</i>	32%	23%	0.06
CNS	98%	95%	0.4
<i>S. lugdunensis</i>	16%	23%	0.2
Gram-negative bacteria	12%	22%	0.02
No bacteria	0%	1%	1.0

* Microbiome in groin and nose before and after 3 doses of antibiotic prophylaxis
[Stefansdottir A et al. Acta Orthop 2013]



You cannot eliminate the microbiome, but only switch the microbiome to a more difficult to treat one

PROSPECTIVE TRIALS OF ANTIMICROBIAL PROPHYLAXIS IN ORTHOPEDIC IMPLANT SURGERY

Procedure	Infect rate Short	Infect rate Long	P-value	Reference
THA/TKA	1d: 1.6%	7d: 2.3%	NS	Nelson et al 1983
THA	Single: 0.5%	3d: 1.2%	NS	Mauerhan et al 1994
TKA	Single: 0.6%	3d: 1.4%	NS	Mauerhan et al 1994
Internal fixation device	Single: 5%	1d: 1%	0.06	Gatell et al 1987



Single dose to max 1 day is enough

SHOULD THE STANDARD CEFALOSPORIN PROPHYAXIS BE CHANGED?

Because

- cefalosporins are no more à la mode?
- SSIs are caused by more resistant microorganisms?
- skin microbiome has nowadays more microorganisms resistant to cefalosporins?

MICROORGANISMS IN PERIPROSTHETIC HIP AND KNEE INFECTION

Microorganism	THA (n=118)	TKA (n=500)
<i>S. aureus</i>	43.2%	30.4%
Coag.neg. staphylococci	18.6%	28.4%
<i>Streptococcus spp.</i>	9.3%	8.6%
Gram-neg. bacilli	5.9%	6.6%
Polymicrobial	7.6%	5.8%
No growth	9.3%	8.8%

[5 case series reported in Zimmerli & Sendi in Bennett's PPID, 8th ed. 2015]

SUSCEPTIBILITY OF MICROORGANISMS INVOLVED IN PJI

Only 62/128 (48%) Gram-positive and 36/63 (57%) Gram-negative microorganisms causing PJI are susceptible to the prophylactic agent (cefazolin) [Peel TN et al. AAC 2012]



Should prophylactic agent be changed (MRSA, *Enterobacter* spp.!) or is this just relevant for empirical treatment?

SHOULD PROPHYLACTIC AGENT BE CHANGED?

NO,

it seems logical that SSIs are caused by microorganisms resistant to the prophylactic agent



If prophylactic agent is broader, SSIs will be caused by multiresistant bacteria or fungi (selection pressure)

SHOULD PROPHYLACTIC AGENT BE CHANGED?

YES,

if the skin microbiome is generally resistant to the routine prophylactic agent, e.g. in regions with high MRSA prevalence



Consider to add vancomycin as prophylactic agent

RISK FACTORS FOR SURGICAL SITE INFECTIONS



RISK FOR SURGICAL SITE INFECTION

Characteristic (n=26'837 patients)	Adjusted OR (95%CI)
Age >65 y	1.3 (1.1-1.5)
ASA >2	1.9 (1.6-2.2)
Relative duration of surgery (>75th percentile)	1.8 (1.5-2.1)
Preop. duration of hospitalisation \geq 48h	1.5 (1.3-1.8)
Emergency surgery	1.5 (1.3-1.7)
Endoscopic surgery	0.5 (0.4-0.6)
Duration of follow-up \geq 15 days	1.8 (1.4-2.2)
Orthopedic surgery	1.0 (ref)
Genitourinary	3.0 (2.1-4.4)
Cardiovascular	2.2 (1.5-3.1)
Gynecologic	3.4 (2.3-5.0)
Gastrointestinal	3.6 (2.8-4.7)

[Rioux c et al. Infect Control Hosp Epidemiol 27:817-24,2006]

RISK SCORE FOR SSI AFTER OPEN VENTRAL HERNIA REPAIR

Variable	OR;95% CI
Hernia repair during other procedure	2.1; 1.4 - 3.3
Skin flaps created	2.3; 1.6 - 3.4
ASA score ≥ 3 (severe comorbidity)	2.1; 1.4 - 3.2
BMI ≥ 40	3.2; 1.7 - 5.9
Wound class 4 (dirty contaminated)	6.8; 3.2 -15.4

[Berger RL et al. J Am Coll Surg 217:974-82,2013]

RISK SCORE FOR PJI

Variable	HR (95%CI) multivar.	P-value
BMI <25	1.0 (ref)	BMI: p=0.003)
BMI 25-30	0.52 (0.31-0.85)	
BMI 31-39	0.49 (0.30-0.81)	
BMI \leq 40	1.05 (0.55-2.03)	
Prior arthroplasty	2.09 (1.36-3.22)	<0.001
Immunosuppression	1.98 (1.40-2.80)	<0.001
ASA 3	2.26 (1.05-4.86)	ASA: p<0.001
ASA 4	8.92 (1.62-49.0)	
Procedure time >4h	1.52 (0.78-2.98)	Proc.time: p=0.013

[Berbari EF et al. *Infect Control Hosp Epidemiol* 33:774-81,2012]

CONCLUSIONS

- **Postoperative infection is the most costly medical error (3.4 billion \$/y)**
- **SSI causes prolonged LOS and readmissions**
- **SSI after arthroplasty cannot be reliably classified in superficial versus deep infection (PJI)**
- **1 (– 2) dose of antimicrobial prophylaxis is enough except in centers with very high rate of SSI after orthopedic interventions**
- **1st or 2nd generation-cefalosporin is still ok, except in centers with high prevalence of MRSA**
- **Main risk factors for SSI: ASA_≥3, high age, BMI_≥40, long procedure**



**Thank you for
your attention**