The Patient-related Risk of Infection

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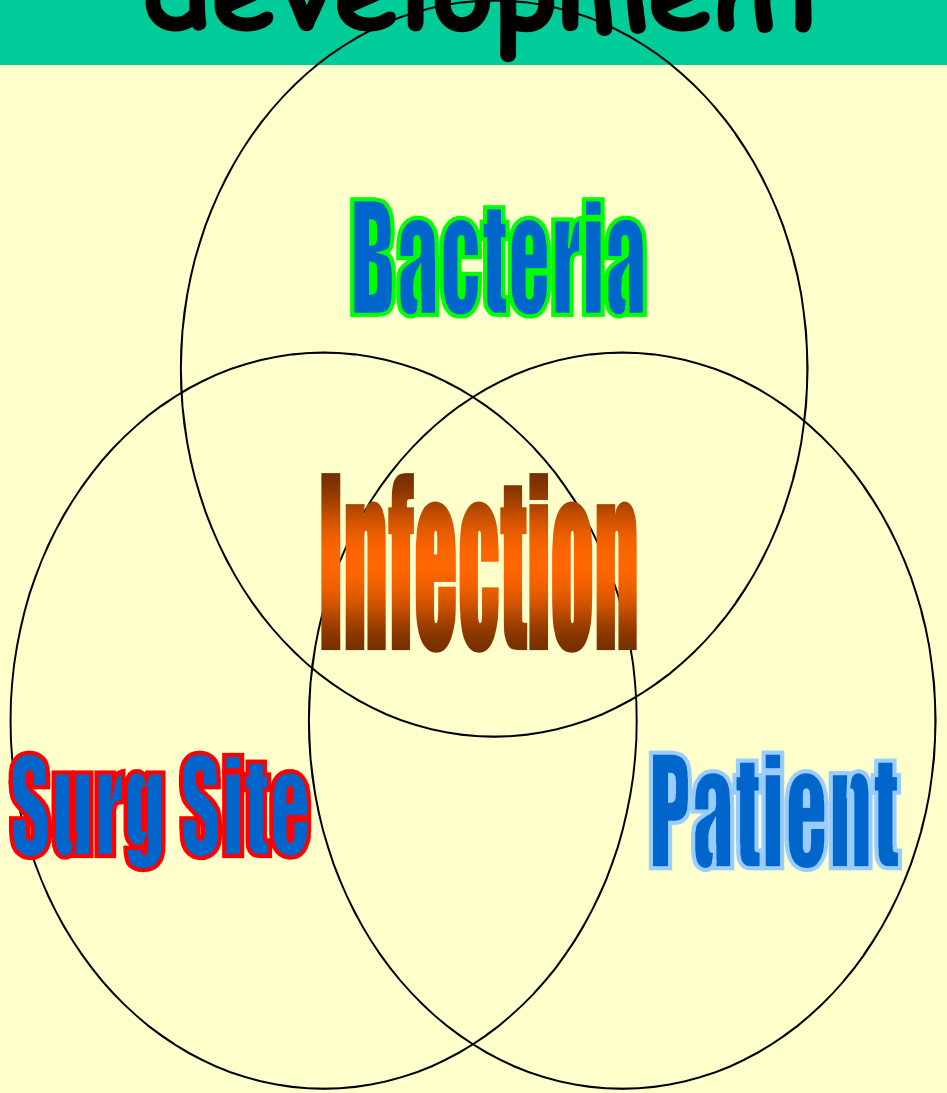
« We can operate more and more frail elderly patient… » *Surg Gen 2010*

- ASA Score getting Worse (ASA3)
- Increase with Comorbidities (Charlson)
- Anesthesia Improvment with mortality reduced (x 10)
  Lienhardt A Anesthesiology 2006

- Excluding: Emergency practice as Femoral neck Fracture , Traumatology Care…

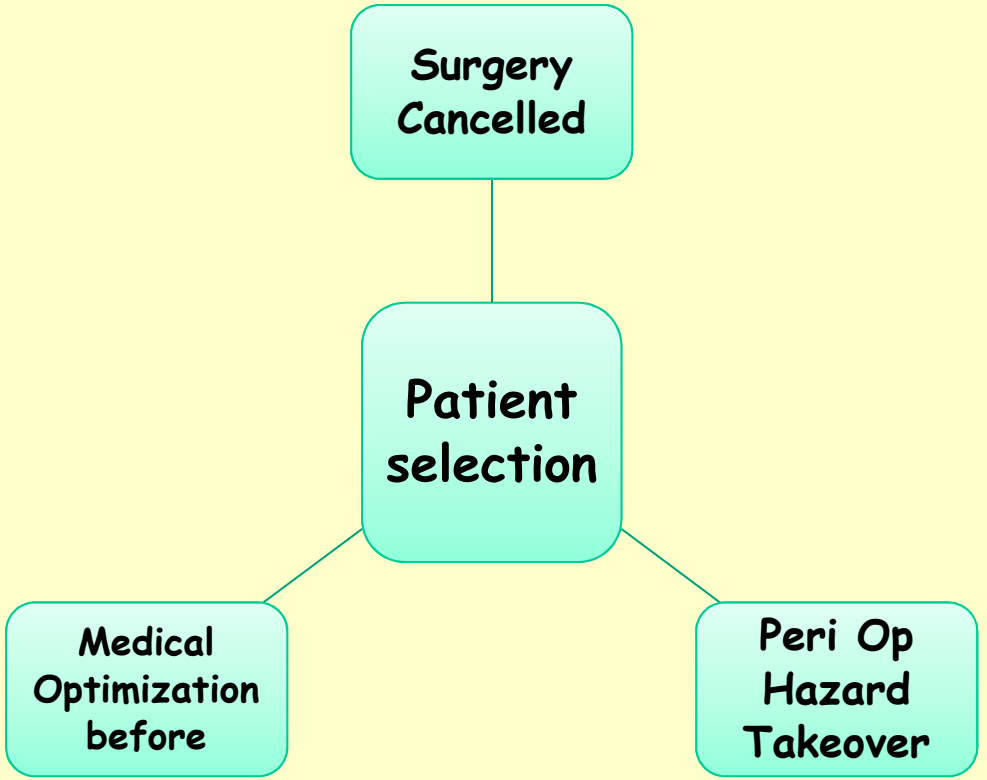
Mecanism with infection development



	Pre op	Intervention	Post-op
Bacteria	Pre op Pyuria Pressure sores, dental abcess Prior arthritis infection previous hospitalisation	Sterilization Staff surgeon Ultra clean air Cut cleaning Surgeon Cl. Wound dressing	Foley Urin Cath IV Lines., Nosocomial infection ABprophylaxy
Patient	Immunosupp. Diabetes mel., rheum.arthrit, age, malnutrition, ASA	Hypothermia Blood Transfusion	Rheumatoid Arthitis, immunosuppres
Surg Site	Extensive Leg scar, obesity, infectious history, bad cutaneous aspect	Surgery duration, Cemented vs Uncem, AB cemented allograft coagulation wound drainage Skin closure	Wound Hematoma , Surgical drain, Wound dehisc, skin necrosis , metallosis

D'apres Berbari E F Hanssen A.D JBJS 1998

So…What do we want for?



Analytic factors

- Metabolic (nutritional status – Diabetes mellitus)
- « Immunological » Factors
  - Chronic Inflammatory diseases
  - Viral diseases
  - Cancer
  - Drugs
- « Surrounding » factors
  - Microbiological colonisation or infection
  - Prior arthitis infection
  - Skin disease
  - Hepatic And renal dysfunction (or comorbidities)

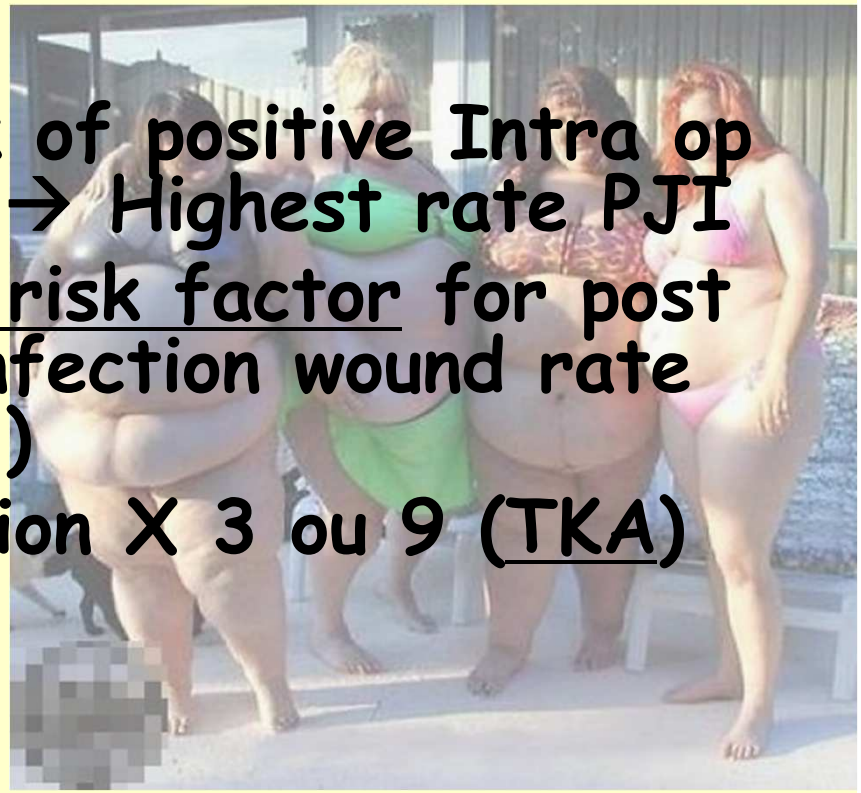
Age
Much debated question!

- Mahomed et al (JBJSAm 2003) 61 568 Pat Five-year age strata Older age, 75-79 and 85-89 years, was associated with an increased risk for infection (compared with younger age of 65-69 years). 70-74 years: OR, 1.16 (0.69-1.94) 75-79 years: OR, 1.67 (95% CI, 1.01-2.77) 80-84 years: OR, 1.25 (95% CI, 0.69-2.28) 85-89 years: OR, 2.66 (95% CI, 1.41-5.03)
- Ridgeway et al (JBJS Br 2005) 16 291 pat Age categories: <65, 65-74, 75-79, and ≥80 years The risk of SSI increased with age≥80 years: OR, 1.66 (95% CI, 1.24-2.21; P = .001)
- Muilwijk et al (J Hosp Infect 2006) 70 000 orthopaedic procedures Age categories: 1-44, 45-64, 65-74, ≥75 years There was no association between Age and deep SSI.
- Jain NB Clin Orthop Relat Res 2005: NIS Database 900 000 pat Only Comorbidities HTA Diab Obesity increase Complication rate +++
- More over if aged

Obesity

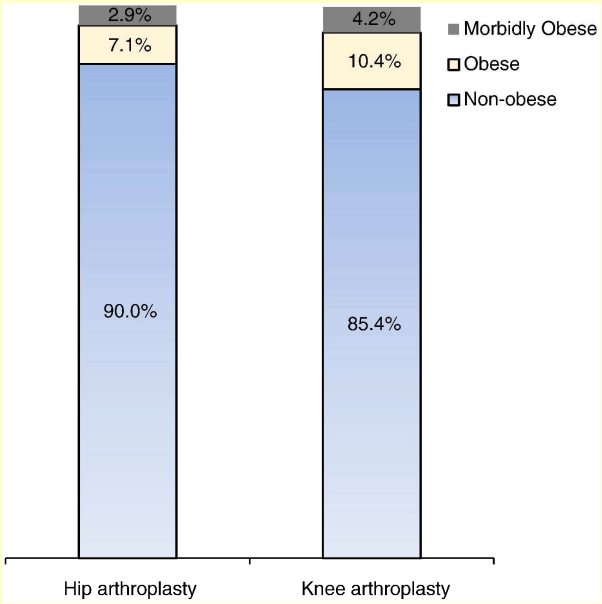
- Grade BMI>30(I) 30-35(II) >35(III)

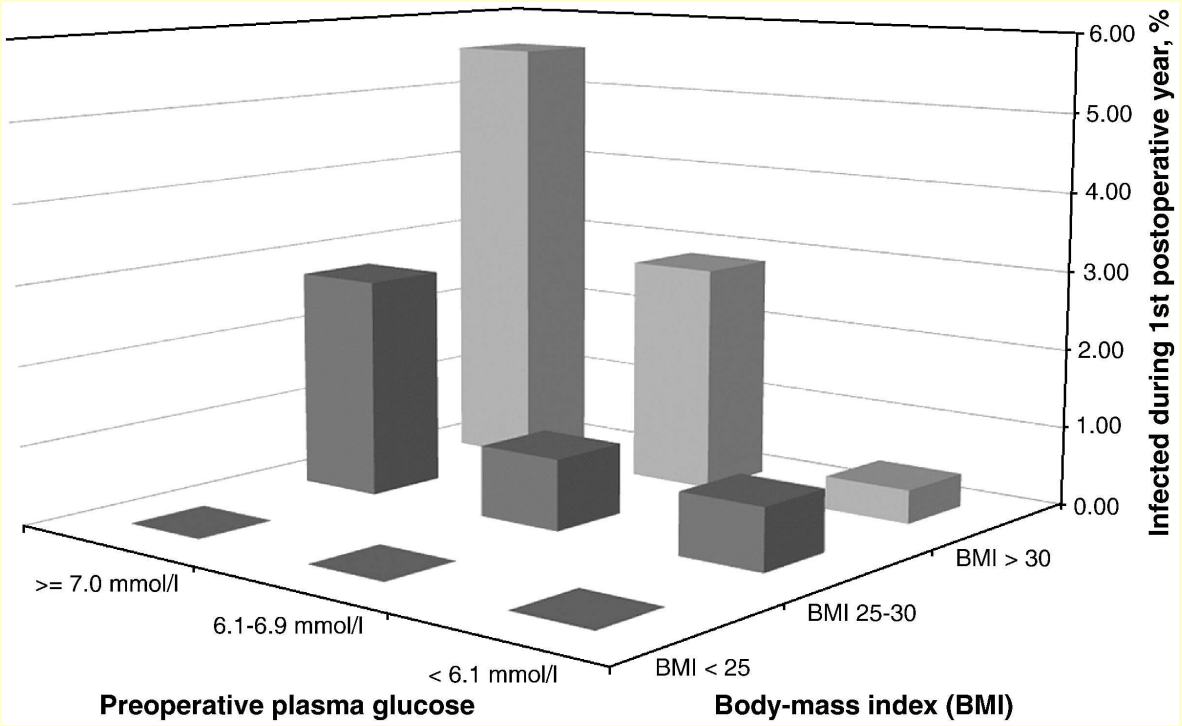
- BMI>35 ->Higher Risk of positive Intra op Positive culture (SCN) → Highest rate PJI
- Obesity alone is not a risk factor for post op complication but… infection wound rate Higher… (Lancet 2003)
- Deep Prosthetic infection X 3 ou 9 (TKA)



Dindo et al Lancet 2003
Font-Vizcarra l et al Int J Artif Organs 2011
Samson AJ et al ANZ J Surg 2010
Hamlin BR et al Othop Clin North Am 2011

Obesity Bias… Comorbidities!





1500 TKA retrosp

Jamsen E et al Europ J Int Med 2010

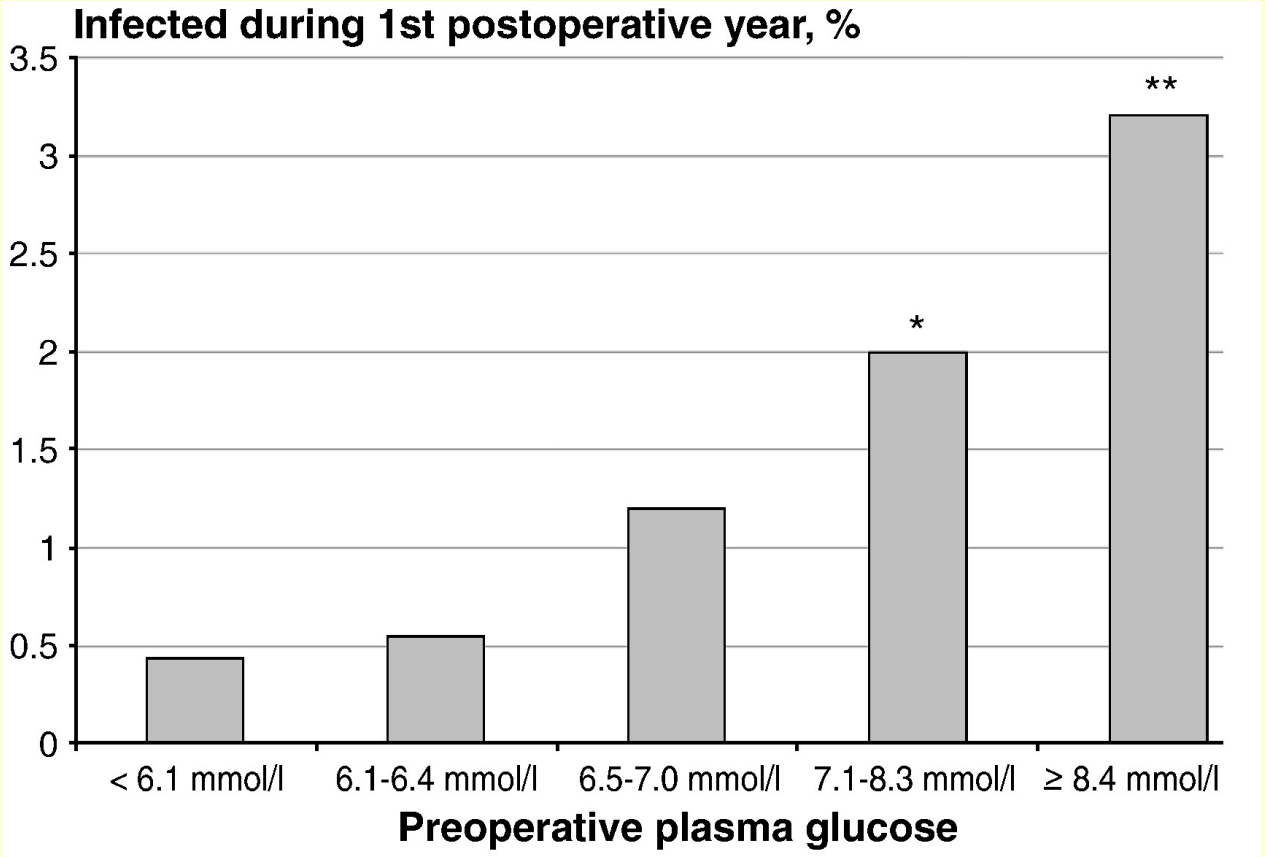
Diabetes mellitus

- Diabetes Type I and II
- Uncontrolled → Higher mortality
- Increased Odds ->Surgical Systemic Complications (elective & emergency orthopedic) Infection OR 2,28 (95% CI 1,36-3,81 p 0,002)
- Hyperglycemia >>HbA(1c)
- Long term glycemic control Hb A(1c) <7%

Marchant MH et al JBJS 2009
Dronge A et al Arch Surg 2006
Mraovic B et al J Diabetes Sci Technol 2011
Bolognesi MP et al J Arthroplasty 2008

Diabetes mellitus

1565 TKA
retrosp.
Hyperglycemia



Jamsen E et al Europ J Int Med 2010

Inflammatory disease

- Rheumatoid polyarthritis
- Disseminated Lupus
- Spondylarthritis
- 3 mixed aspects:
  - Immunodepression
  - Therapeutics
  - Local: Articular infiltration

Rheumatoid arthritis (RA)

- 1996-2004 Mayo Clinic
- 462 RA =3,7% infection

- 657 THA /TKA (RA) vs matched cohort Osteo arthritis (HR 4,08- 95 CI 1,35-12,33)

Bongartz T et al Arthritis Rheum 2008
Bongartz T et al J rheumatol 2007

Rheumatoid arthritis (RA) And treatment

- Norwegian register
- TJR->6,629 RA vs 102,157 OA
- Revision for Infection X 1,6
- MTX = Ok
- Biological DMARDs Vs non biological OR 5,69 (95 CI 2,07-15,69)
  - Etanercept OR 9,16 Infliximab OR 9,80
  - ->Increased risk of SSI

Schrama JC et al Arthr Care Res 2010
Momohara S et al Mod rheumatol 2011

Rheumatism societies Consensus 2011

Club Rhumatismes et Inflammation

Risque septique per-opératoire :		Faible	Moyen	Elevé	Très élevé
Molécule	Demi-vie	2 demi-vies	3 demi-vies	4 demi-vies	5 demi-vies
Etanercept	(70h) :	10j ~ 2 sem	15j ~ 2 sem	20j ~ 3 sem	25j ~ 4 sem
Infliximab	(~10j) :	20j ~ 3 sem	30j ~ 4 sem	40j ~ 6 sem	50j ~ 8 sem
Adalimumab	(~15j) :	30j ~ 4 sem	45j ~ 6 sem	60j ~ 8 sem	75j ~ 10 sem
Certolizumab	(10-15j) :	30j ~ 4 sem	45j ~ 6 sem	60j ~ 8 sem	75j ~ 10 sem
Golimumab	(10-15j) :	30j ~ 4 sem	45j ~ 6 sem	60j ~ 8 sem	75j ~ 10 sem

Mushtaq s et al Am J Ther 2011 18(5) 426-34

Viral infection

- AIDS & HIV
  - 102 TJR 18% Deep Infection
    Hicks JL et al JBJS 2001- Parvizi J et al J of Arthoplasty 2003
  - CD4 Count > 300 And Viral Copying =0
- Viral hepatitis: HCV cirrhosis
  Foreman M et al Chest 2003 , POUR AE et al JBJS Am 2011
- Common viruses→ Cf Pediatrics

Guild NG et al Clin Orthop Relat Res 2011

Cancer

- **Solid Tumours (Colonic Cancer -> Hematogenous infection)** Chodos MD et al J Arthroplasty 2009
- **Hemopathies (Myeloma- leukemia)**
- **Chemotherapy immunosuppression**

  Aplasia Poly Neutroph < 500/mm3 30% sepsis in limb salvage surgery after bone tumours chemotherapy (Mc Donald DJ et al Cancer 1990)
- **Infect.rate 13-18% with lower extremity oncologic surgery**

  Mavrogenis et al Rizzoli Institute Orthopedics 2011
  Morii T et al J Orthop Sci 2010
  Morris CD An Surg Onc 2003

Environmental factors Comorbidities

- Chronic Liver failure
  - Cirrhotic
  - Hepatitis C (QS)
- Renal insufficiency (Cl <35ml/mn) →(OR 1,97 95% CI 0,12-32,5) Saleh K J Orthop Res 2002
- Bacterial colonisation (QS) (Prior chronic hospitalisation)
- Urinary, respiratory, Dental (QS) infection
- Local infection

Urinary Tract Infection (UTI)

- Men ≠ Women
- Cystitis vs Prostate infection
- Always feared but rarely factor of SSI
- →ABxy choice…

- 83.011Medicare Pat 1998 – 2007
- Risk PJI no related UTI HR 1.09 95%CI 0,97-1,21
  - Bozic KJ et al Clin Orthop Relat Res 2012 Berbari EF et al CID 1998
- 19.735 Pat 2009 Case-control study SSI no related OR 0.341 CI 95% 0.0086-1.357
  - Koulouvaris P et al Clin Ortop Relat Res 2009

Local environment

- Skin disease
  - Psoriasis
  - Erysipeloid lesion
  - Chronic skin lesion

- Prior Bone And Joint infection

- → Surgical Inquieries & Optimizing First → Patient information

The Burden of EBM !

- **Too few Epidemiological studies**
  Methodological Problems (Cohorting vs Retrospective or register) Cf Cardiac risk
- **Too many case reports…**
  - PJI criteria variability
  - Monocenters
  - Low incidence of infection
- **Finally… No stratification of Patient related risk**

Synthesis ?

TKA 1181 THA 1124
Veterans Inst Prospective 6 y
Factors of DeepWound Inf
9 preoperative
5 intraoperative
5 post operative

Only…Hematoma
Prolonged drainage
Factors corr. with DWI & SSI

Saleh K et al J of Orth Res 2002

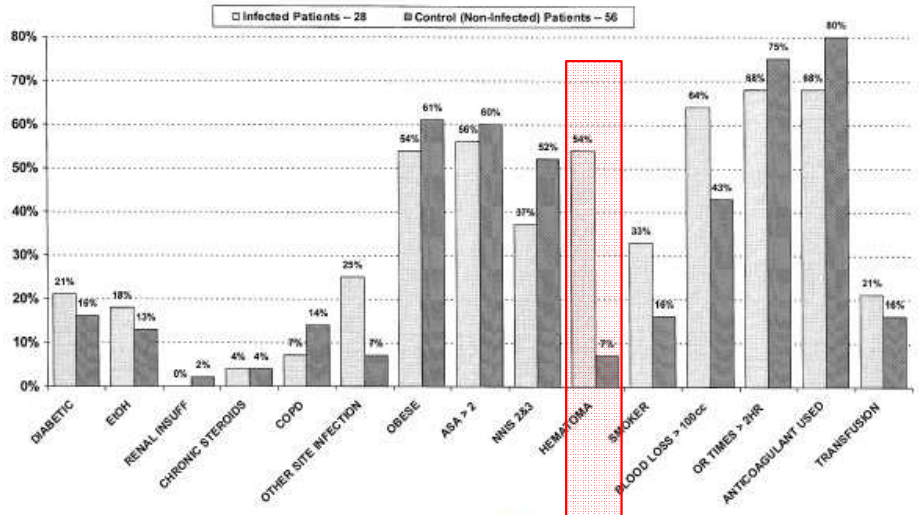


Fig. 1. Comparison of factors TKA and controls.

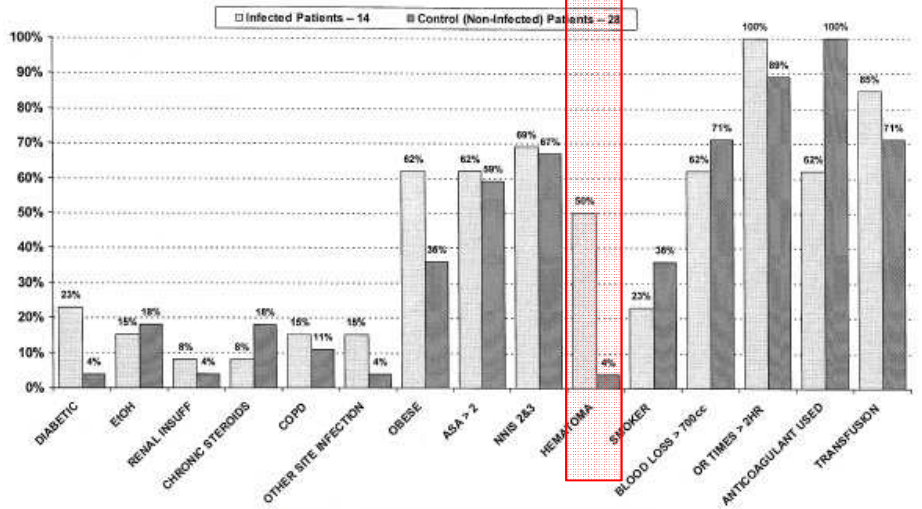
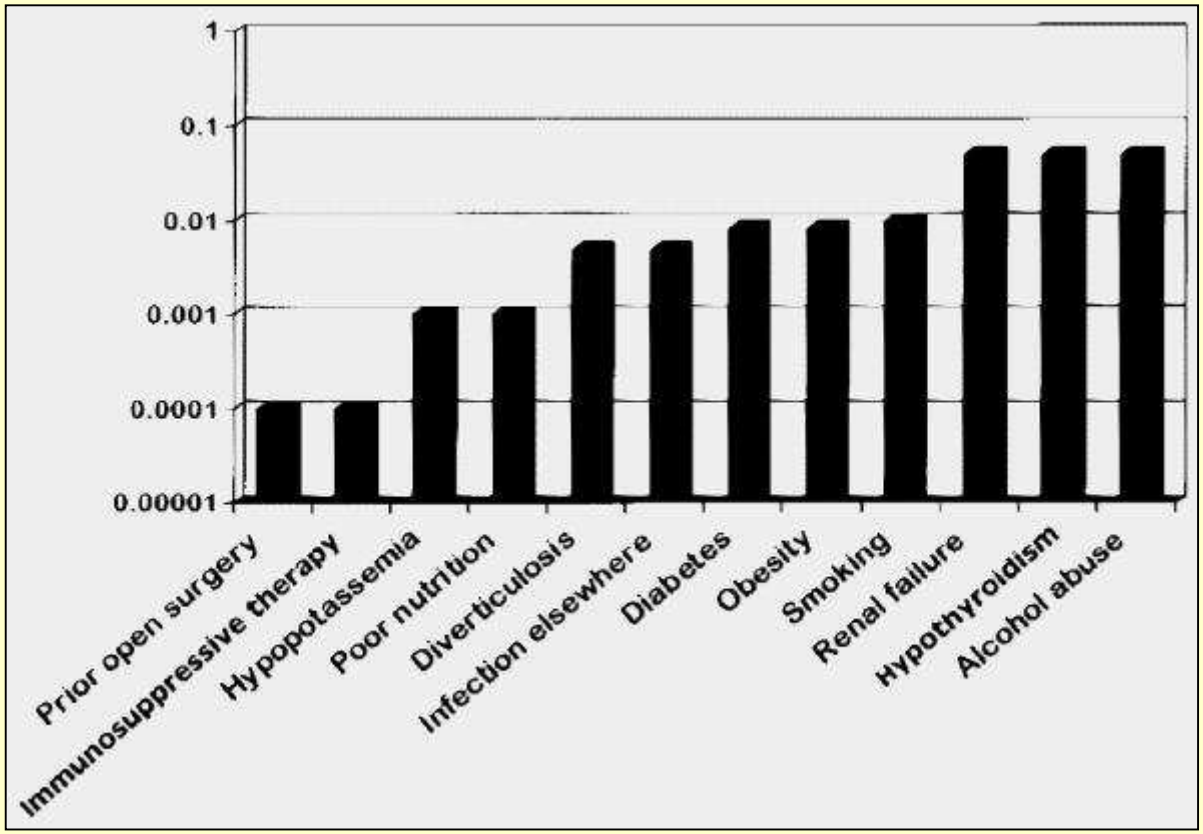


Fig. 2. Comparison of factors infected THA and controls.

64 controls, 61 (95%) subjects received Cephazolin, one SSSI

Infection in Total Knee Replacement: A Retrospective Review of 6489 Total Knee Replacements.
Peersman, G; Laskin, R; Davis, J; Peterson, Margaret
Clinical Orthopaedics & Related Research. 392:15-23, November 2001.



Those comorbid factors that had a statistical significance of $p < .05$ as related to the development of infection are shown.

NY Spec. Surgery Hosp.

PJI Predisposing Factors

9245 THA –TKA Prospectif 2001-2006

Table 1. Continuous and categorical variables used to identify possible predictors of joint infection

Preoperative variables
Demographic factors: Gender, age, ethnicity, height, weight, body mass index
Patient medical factors: American Society of Anesthesiologists score, alcohol abuse, hypertension, hyperlipidemia, diabetes mellitus, rheumatoid arthritis, cardiac arrhythmias, coronary heart disease, peripheral vascular disease, congestive heart failure, cardiac transplant, cardiac valvular disease, dementia, stroke, neurologic disease (paralysis, dyskinesia, Parkinson), renal insufficiency, renal failure and dialysis, anemia (aplastic, autoimmune, iron deficiency), coagulopathy, urinary tract infection, liver disease (hepatitis B, hepatitis C, hepatic insufficiency), malignancy (all visceral, metastatic and melanoma), tuberculosis, venous thromboembolic disease
Preoperative laboratory values: Hemoglobin, international normalized ratio (INR), leukocyte count, glucose, creatinine, albumin
Surgical and postoperative variables
Surgery: Joint operated (hip versus knee), side (unilateral, simultaneous bilateral), operative time (minutes)
Blood management: Transfusion (yes or no, number of units transfused, type of transfusion—allogenic versus autologous)
Postoperative laboratory values: Hemoglobin, INR, leukocyte count, glucose, creatinine, albumin
Postoperative medical complications: Urinary tract infection, pneumonia, Clostridium difficile-associated diarrhea, pulmonary embolism, acute myocardial infarction, arrhythmia, congestive heart failure, atrial fibrillation, stroke, deep venous thrombosis, lung aspiration, fever
Postoperative local complications: Cellulitis, hematoma, wound infection, wound drainage, wound dehiscence, blisters, vascular injury, compartment syndrome, dislocation

Pulido L et al Clin Orthop Relat Res 2008

PJI Predisposing Factors

9245 THA -TKA Prospectif 2001-2006

Table 4. Independent predisposing factors for periprosthetic joint infection*

Independent factors	Slope	Standard error	Odds ratio	95% Confidence interval	p Value
Body mass index > 40 kg/m^2	1.17	0.36	3.23	1.6–6.5	0.001
American Society of Anesthesiologists > 2	0.67	0.33	1.95	1.0–3.7	0.04
Simultaneous bilateral surgery	1.77	0.44	5.85	2.5–13.9	< 0.0001
TKA	1.05	0.34	2.85	1.5–5.6	0.002
Allogenic blood transfusion	0.75	0.31	2.11	1.1–3.9	0.02
Postoperative atrial fibrillation	1.83	0.78	6.22	1.4–28.5	0.02
Postoperative myocardial infarction	3.02	1.16	20.4	2.1–199.9	0.009
Postoperative urinary infection	1.7	0.84	5.45	1.0–8.7	0.04
Longer hospital stay	0.09	0.02	1.09	1.0–1.1	0.0003

*multivariate, adjusted analysis.

Pulido L et al Clin Orthop Relat Res 2008

And what else ? Register Scandinavian etc..

- Dannish register 80 000 THA
  - Sex male Yes , Age no corr.
  - Avascular femoral head necrosis
  - Comorbidities (Charlson Index)
  - Osteoarthritis = other inflammatories
- Norwegian register 45 000 THA
  - Age 70-89
  - ASA>2 & Great severity of preexisting illness
  - Emerg Surgery
  - NNIS R Index > 2

Pedersen AB et al Acta Orthop Scand 2010
Dale H et al Acta Orthop Scand 2011

Patient related Factors
« Stratification Tools? »

- Variability of Factors
- Differences Between centers And type of surgery

- Epidemiological & Surveillance Tool = « National Nosocomial Infection Surveillance Risk Index » (NNIS)

Haley RW et al Am J Epidemiol 1985

Risk infection score epidemio 1991

- **NNIS Score= 1+2+3**

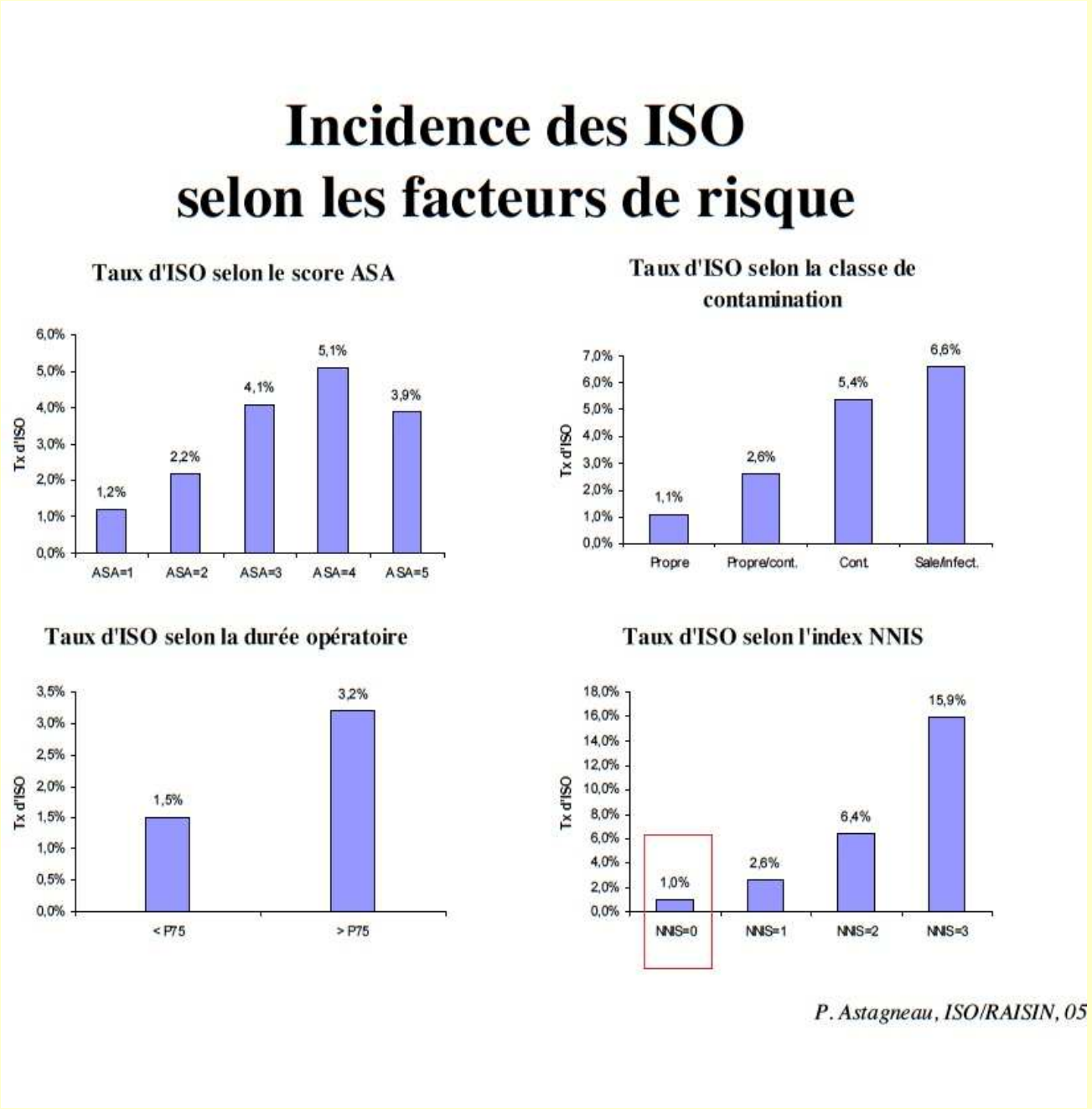
1 ASA Class* > 2 = 1 pt
2 Altemeir Class* > II = 1 pt
3 Length of intervention > 75 percent =1 Pt

**ASA= functionnal severity of comorbidities Classification 1 to 5*
**Altemeir = Type of wound -> 4 stages*

Culver DH et al Am J Med 1991
Clements ACA J Hosp Inf 2007

French ISO RAISIN Surveillance system Astagneau P et al J Hosp Inf 2009

1999- 2006
964 000 Surg pat
14 845 SSI



So What can we Do With the Patient? →S.P.I

- **S**creen all comorbidities and severity (ASA)
- **P**revent
  - Treat Another site or local infection
  - Wait for immunocompetency
  - Metabolic & Nutritionnal status
  - Modify the drugs (Immuno-metabolic)
- **I**nform
  - Patient Involvment with Prevention
  - Consent

Thank You

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