Periprosthetic Joint Infections (PJI)

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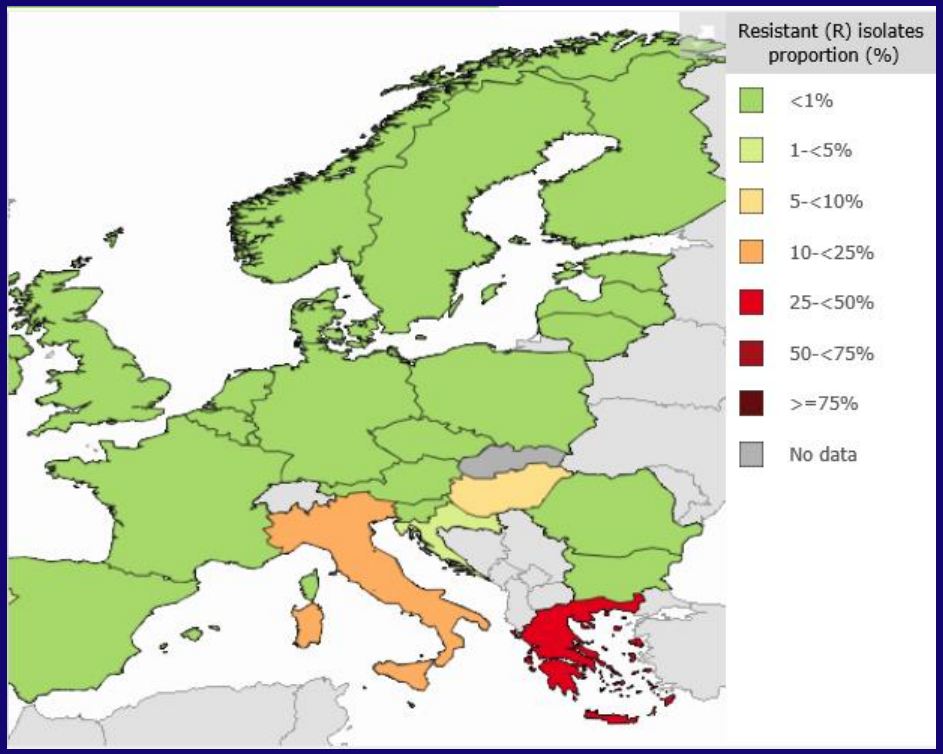
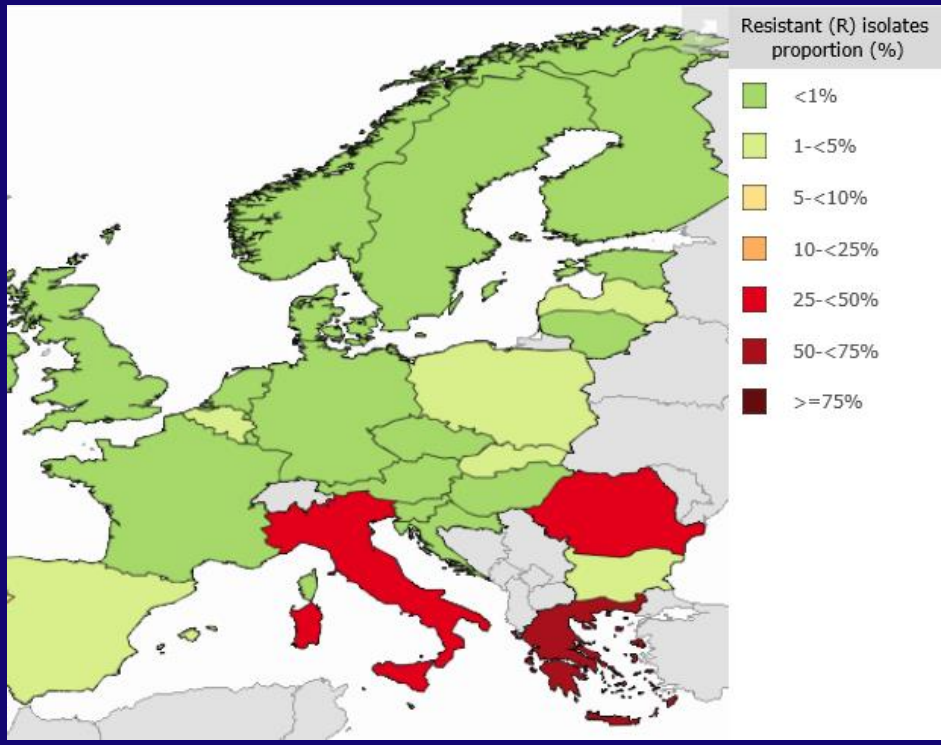
KPC CRE *Kleb pneumo* in Europe

2010



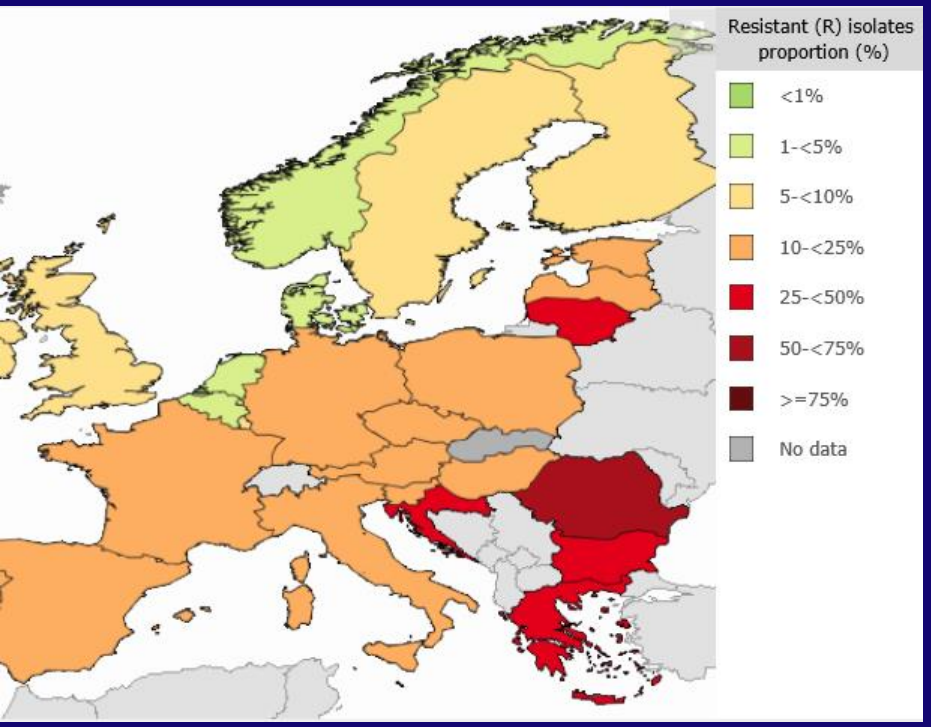
2016



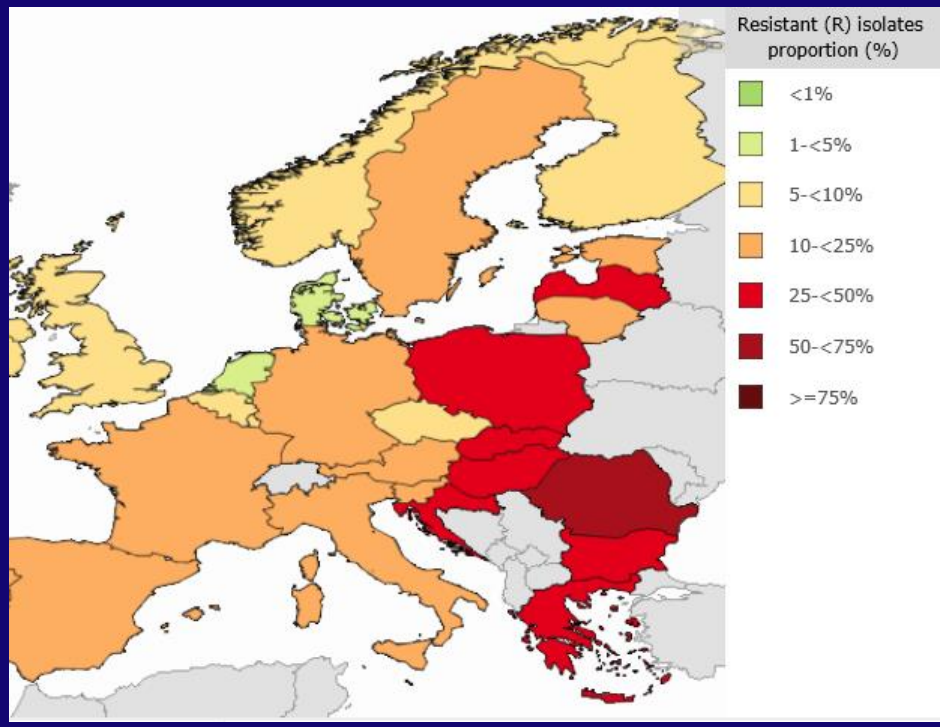
Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net) 2017. Stockholm: ECDC; 2018.
Grundmann H et al. The Lancet Infectious Diseases 17(2): 153–163, 2017

CR-*Pseudomonas aeruginosa* Europe

2010



2016



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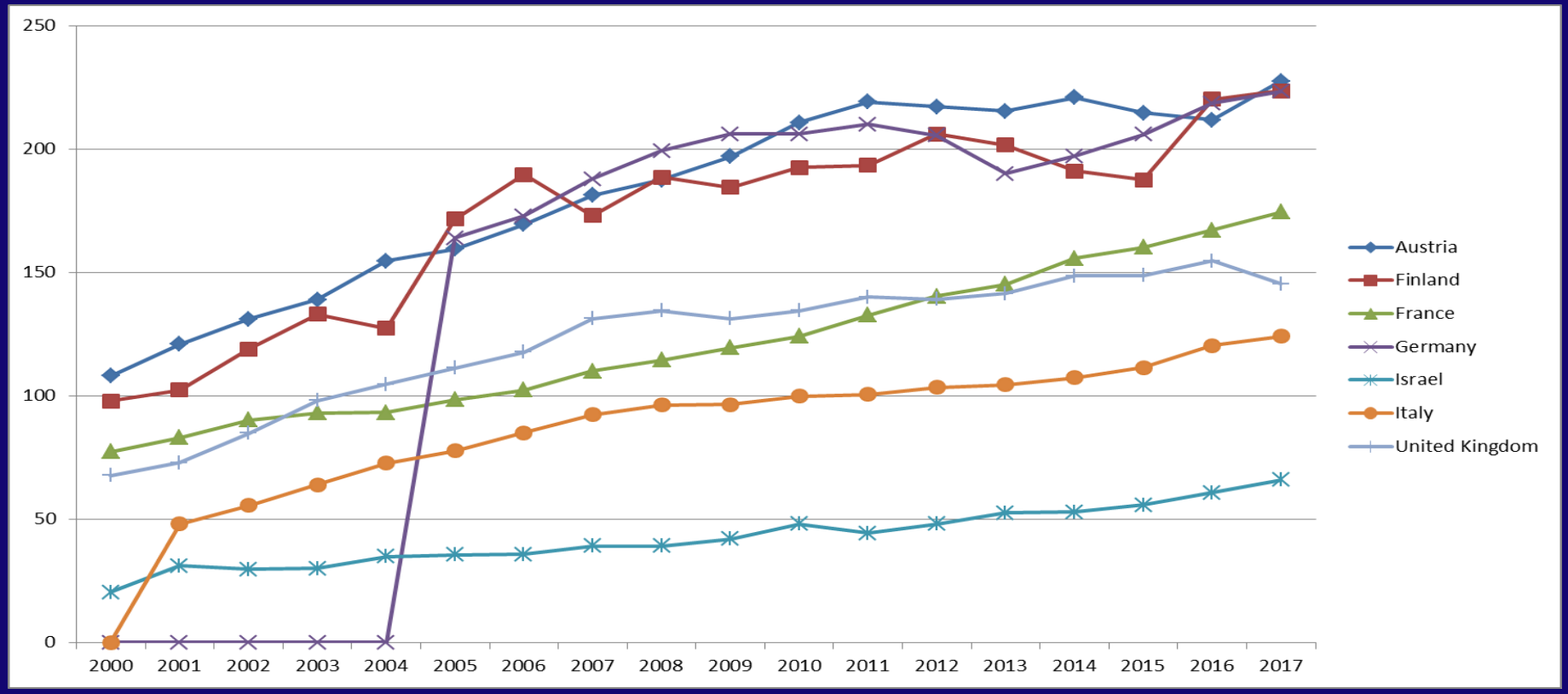
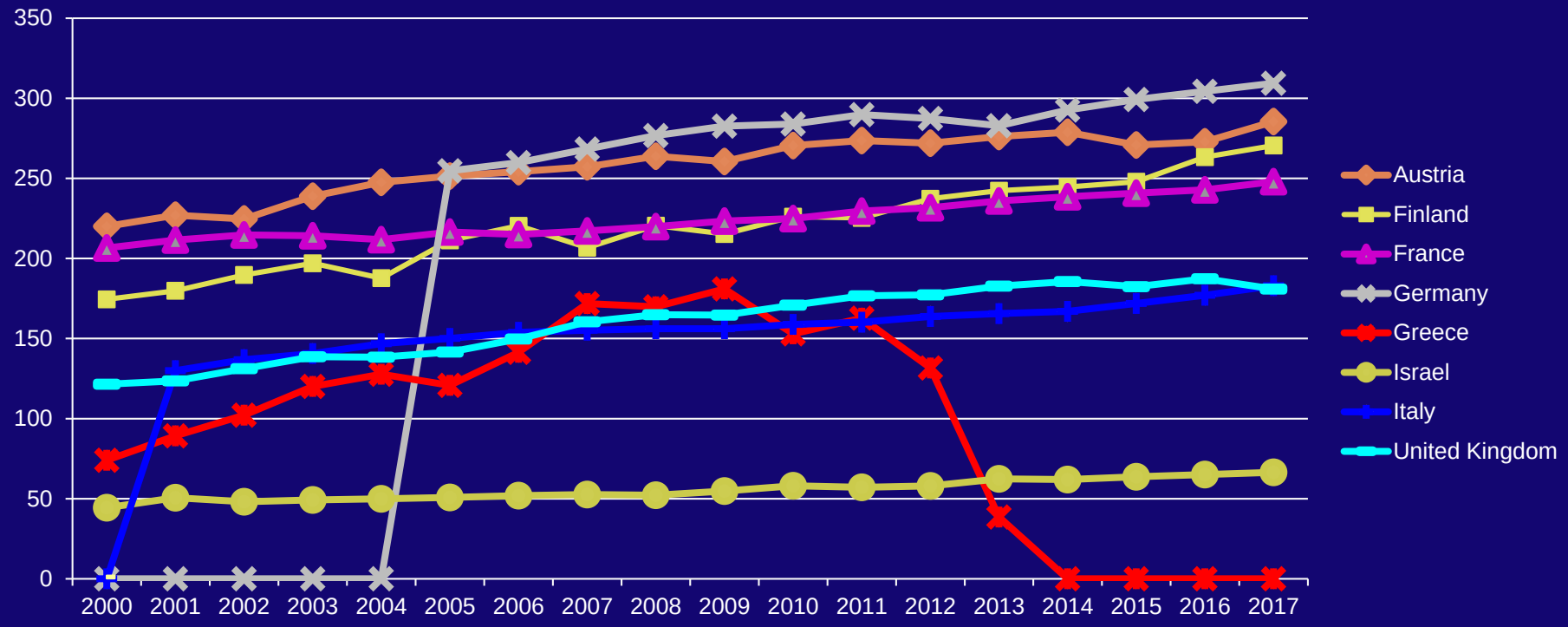
Total Knee Arthroplasty trends 2000-2017



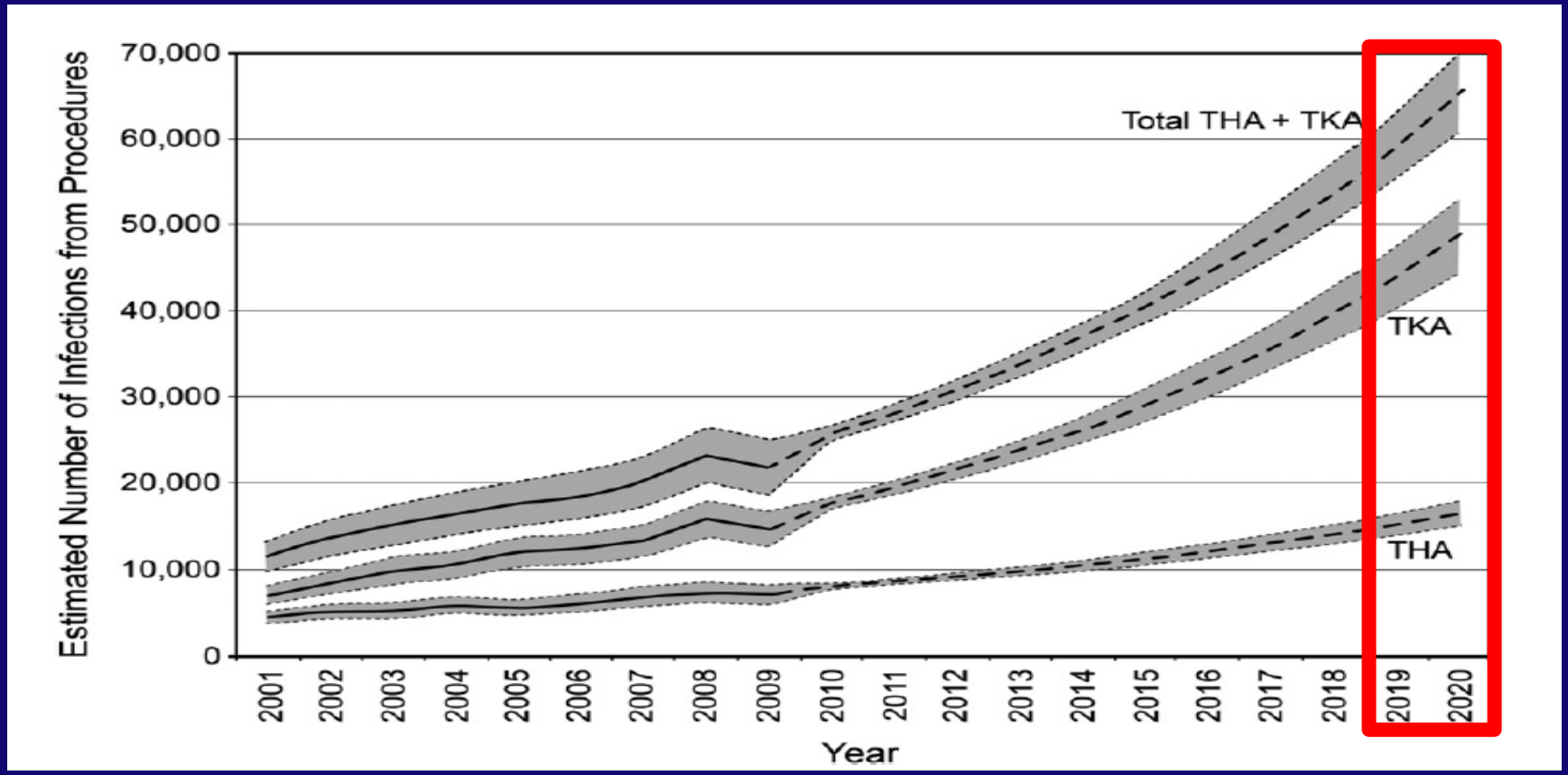
http://www.oecd-ilibrary.org/

Total Hip Arthroplasty trends 2000-2017

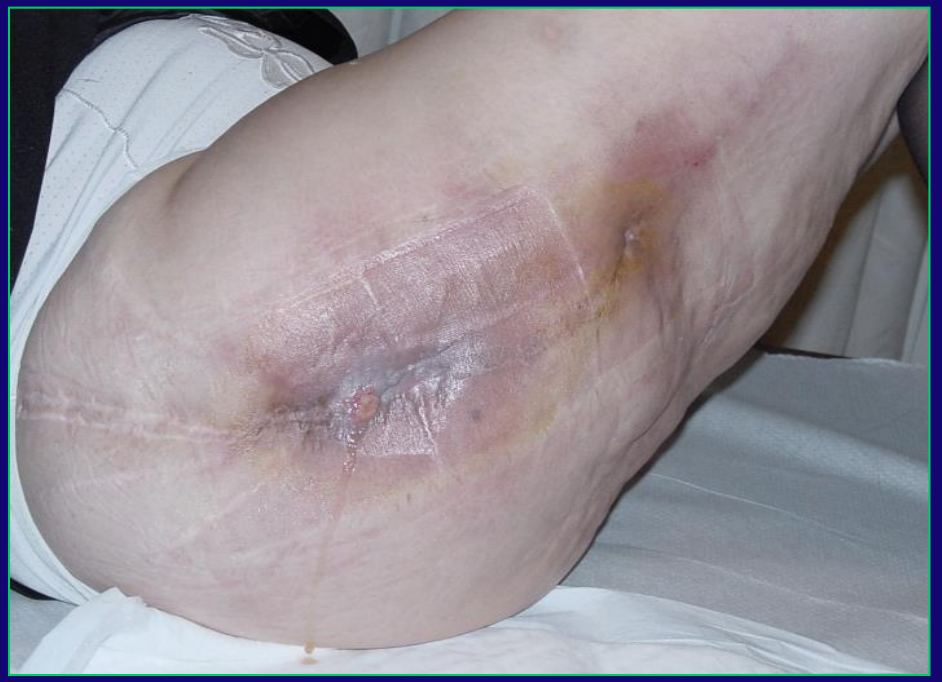


http://www.oecd-ilibrary.org/

Increase in PJI rates 2001 – 2009 (USA)



Kurtz, S et al The Journal of Arthroplasty Vol. 27 (8). 1 2012



- 0.5% to 1% of all THR
- 1% to 2% in TKR
- Generally poor outcome
- Very expensive to treat

Better Preventive Risk Assessment And Mitigation

Modifiable

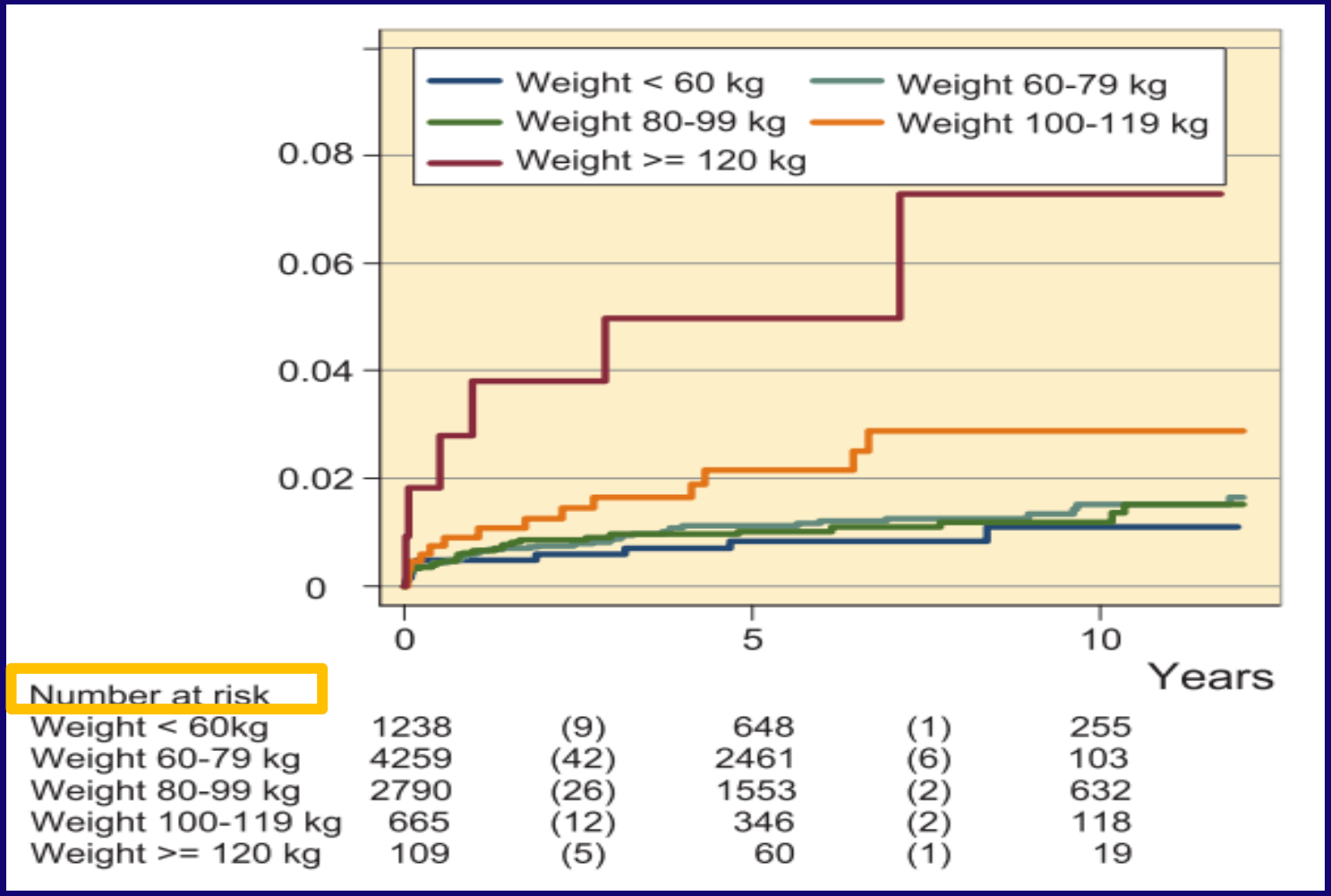
- Diabetes control
- Nutritional status
- Nicotine dependence
- Obesity
- *Staph aureus* colonization
- Lower extremity ulcers
- Lymphedema
- Immunosuppression

Less modifiable

- Congenital immunodeficiency
- Prior radiation
- Immunosuppression

- preoperative hospital stay
- duration of operation

Weight > 100kg; BMI >35 increase infection risk



Number at risk					
Weight < 60kg	1238	(9)	648	(1)	255
Weight 60-79 kg	4259	(42)	2461	(6)	103
Weight 80-99 kg	2790	(26)	1553	(2)	632
Weight 100-119 kg	665	(12)	346	(2)	118
Weight >= 120 kg	109	(5)	60	(1)	19

Lübbeke et al. Acta Orthopaedica 2016; 87 (2): 132–138

Prevention of infection

- Hospitals or surgeons with greater volumes of TJA have lower risks of preoperative adverse effects, including infection

- Postoperative urinary tract infection is a risk factor for deep periprosthetic infection

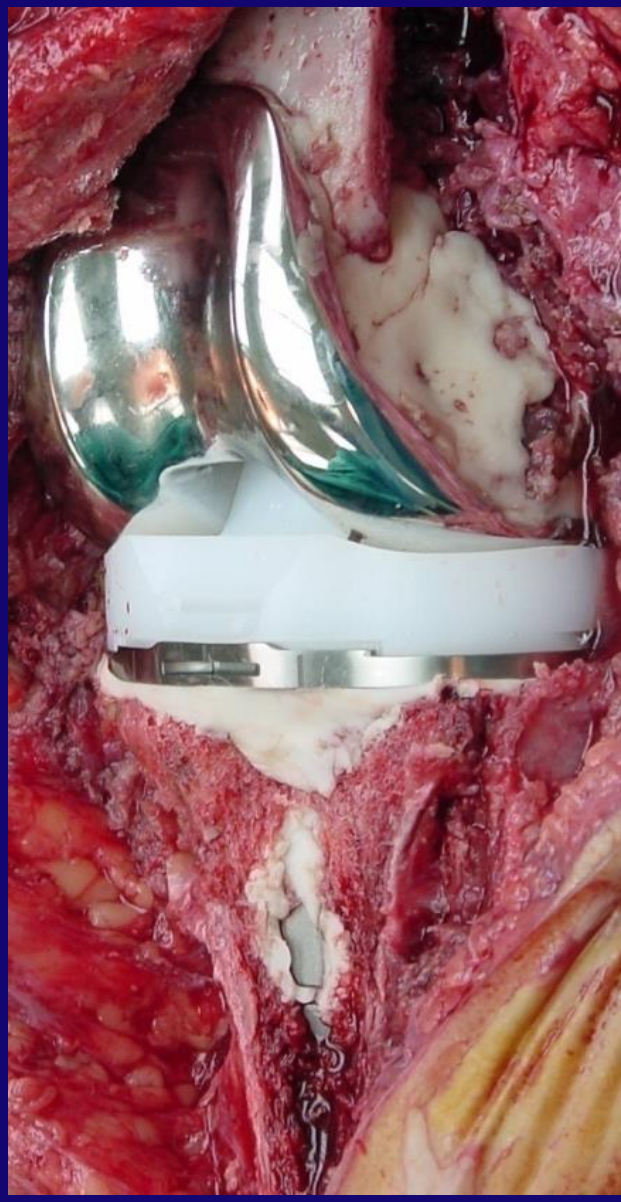
Prevention of infection

- Routine urinary catheterization after TJR does not increase the risk of deep infection.
- No evidence that the use of drains in TJR significantly influences the risk of infection postoperatively.
- Cultures of the suction and draining tips do not correlate with further infection and should not be used.

Prevention of infection

- Antibiotic Prophylaxis
  - Vancomycin (MRSA)
  - Cefazolin (non-penicillin allergic)
  - Clindamycin (penicillin allergic)

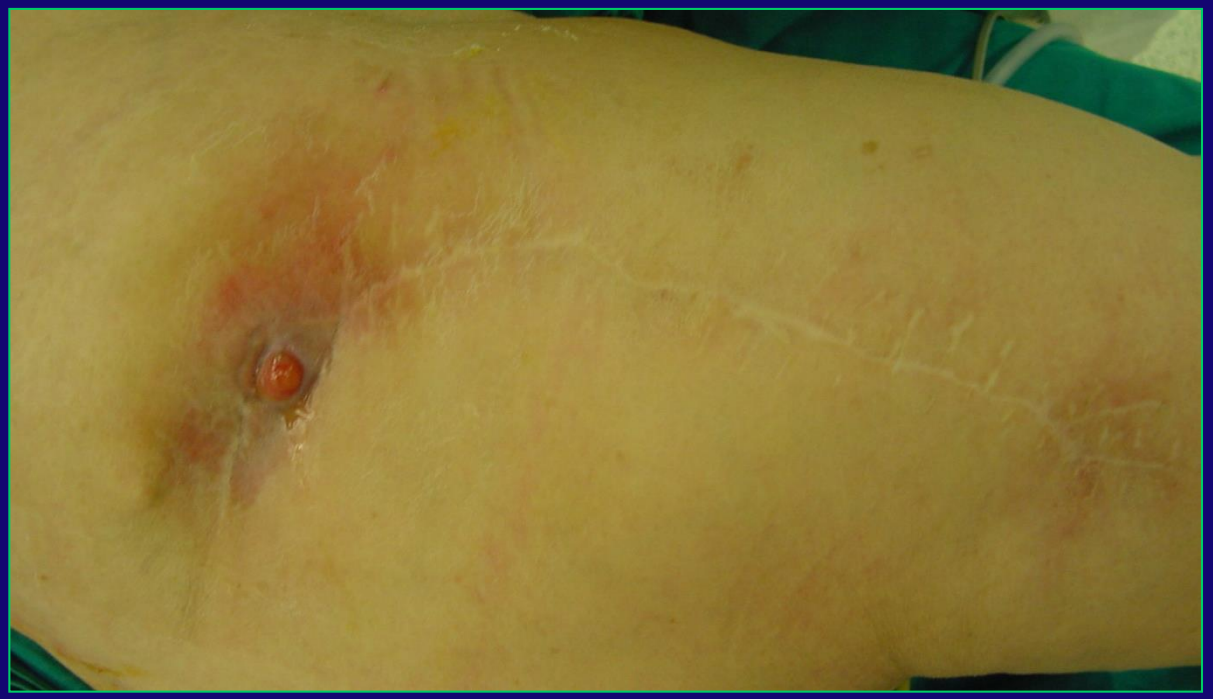
  - Antibiotic loaded bone cement in cemented TJR haw been shown to reduce the risk of infection.



Diagnosis

Diagnosis

- Not always obvious
- Different presentation



Diagnosis

Different clinical scenarios

Diagnosis

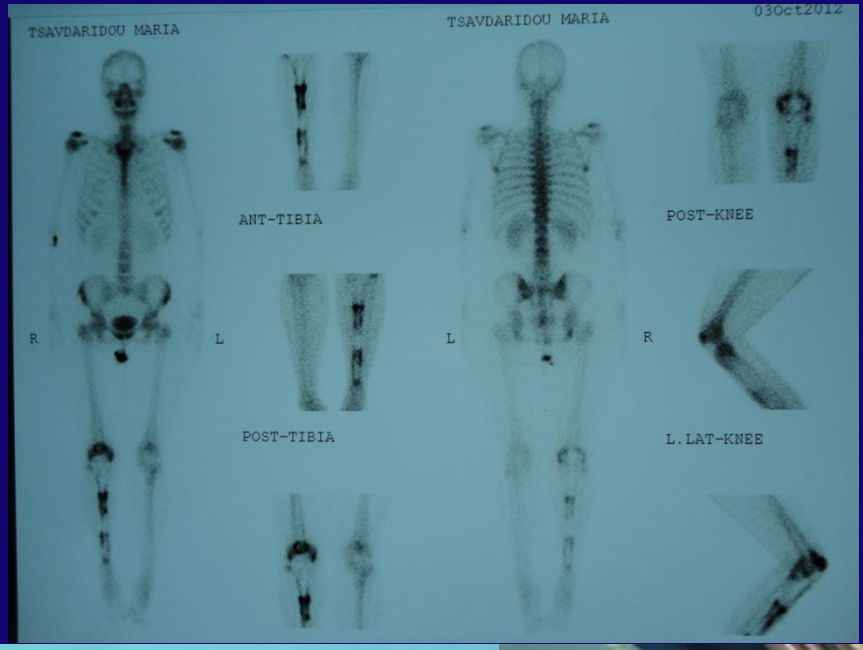
- Early (within 4 weeks)
- Ongoing drainage
- Poor wound healing
- Diagnosis in easy
  - Unremitting pain
  - Erythema and swelling
  - Drainage
  - Fever

Diagnosis

- Late (> 4weeks)
- Not always obvious
- Always suspect in painful TJR
- Always suspect in loose TJR
- Diagnosis is complex
  - Negative wound history
  - No other reason for elevated ESR
  - ESR<30
  - CRP<10

Diagnosis

- Acute Hematogenous
- Least common
- Acute presentation
- ? Within 2-4 weeks
- Best treated ASAP
- Presentation usually obvious
  - ESP usually>30 and CRP >10
- Aspiration of pus confirms diagnosis



9/2013

Staph Aureus

Diagnosis- Serological Tests

- The serum levels interleukin-6, CRP, ESR, & WBC count
- *Serum intereukin-6 level*
  - sensitivity of 1.0
  - specificity of 0.95
  - accuracy 97%

Di Cesare et al JBJS-Am 2005

Diagnosis- Serological Tests

- The combination of :

IL-6 >5.12 pg/mL

&

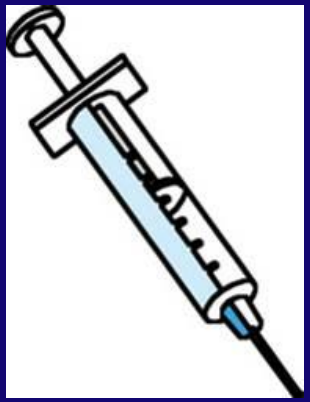
CRP >0.3 mg/L

correctly identified in 94% of pts having low-grade infection whereas just 6% of pts were aseptic.

Ettinger et al, Clin Infect Dis. 2015

Diagnosis - Joint aspiration prior to revision

- There is no need for routine aspiration
  - In the absence of a suspicious history
  - If no inflammatory conditions
  - If the ESR and CRP are negative



- A joint aspiration is required
  - if either the ESR or CRP are positive

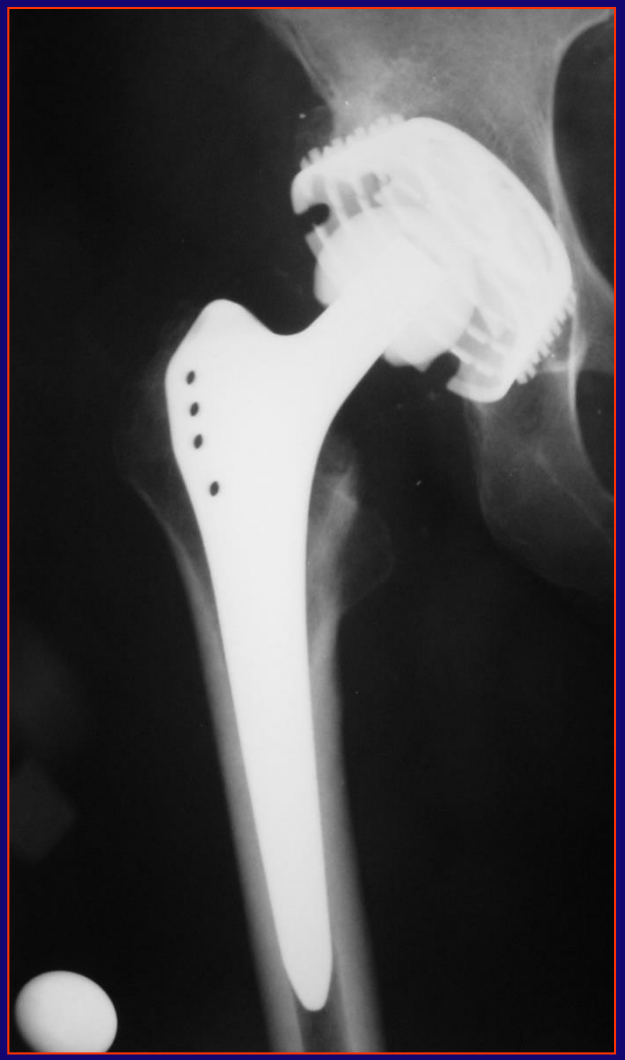
Diagnosis - Joint aspiration

- In THR: sensitivity 86% and specificity 94%
- In TKR, sensitivity 60% and specificity 95%
- WBC count of joint fluid with neutrophil > 60% - 65% are suggestive on infection
- Molecular techniques such intraoperative real time Polymerase Chain Reaction (PCR) techniques and histopathology of frozen sections is a good combination

Miyamae et al Acta Orthop. 2013

Diagnosis - Radiographs

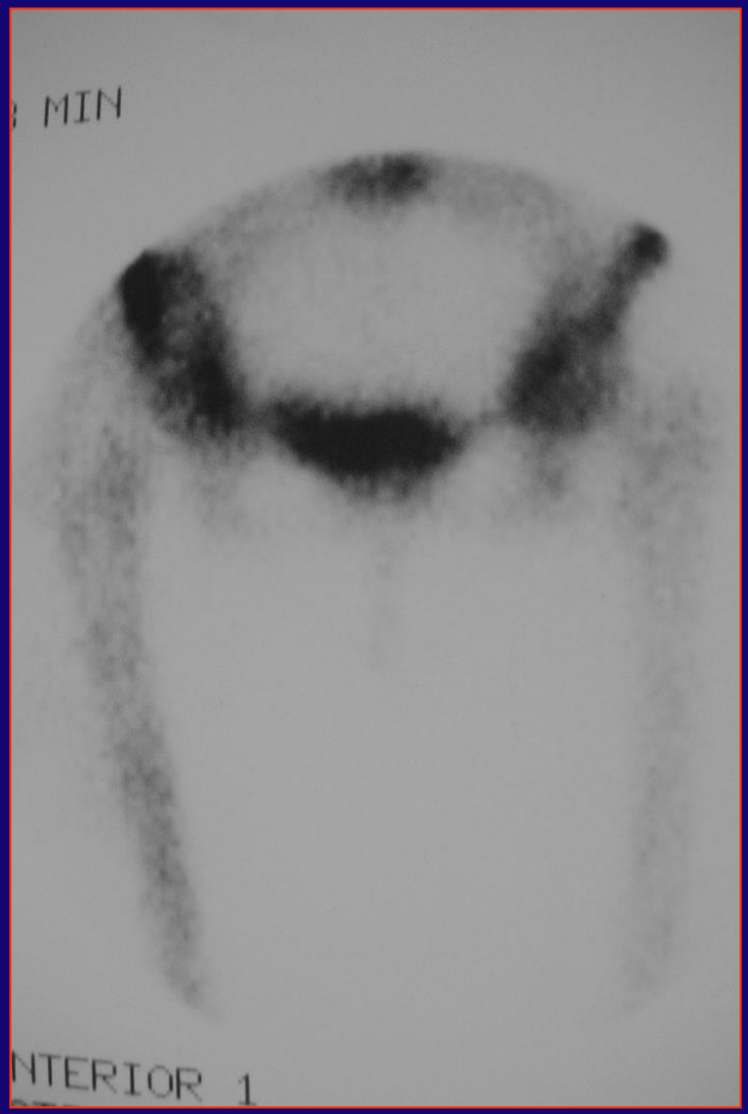
- Very little use in the diagnosis
- Deep infection may be suspected in pts with:
- rapid osteolysis
- endosteal scalloping
- marked periostitis



Diagnosis - Nuclear scan

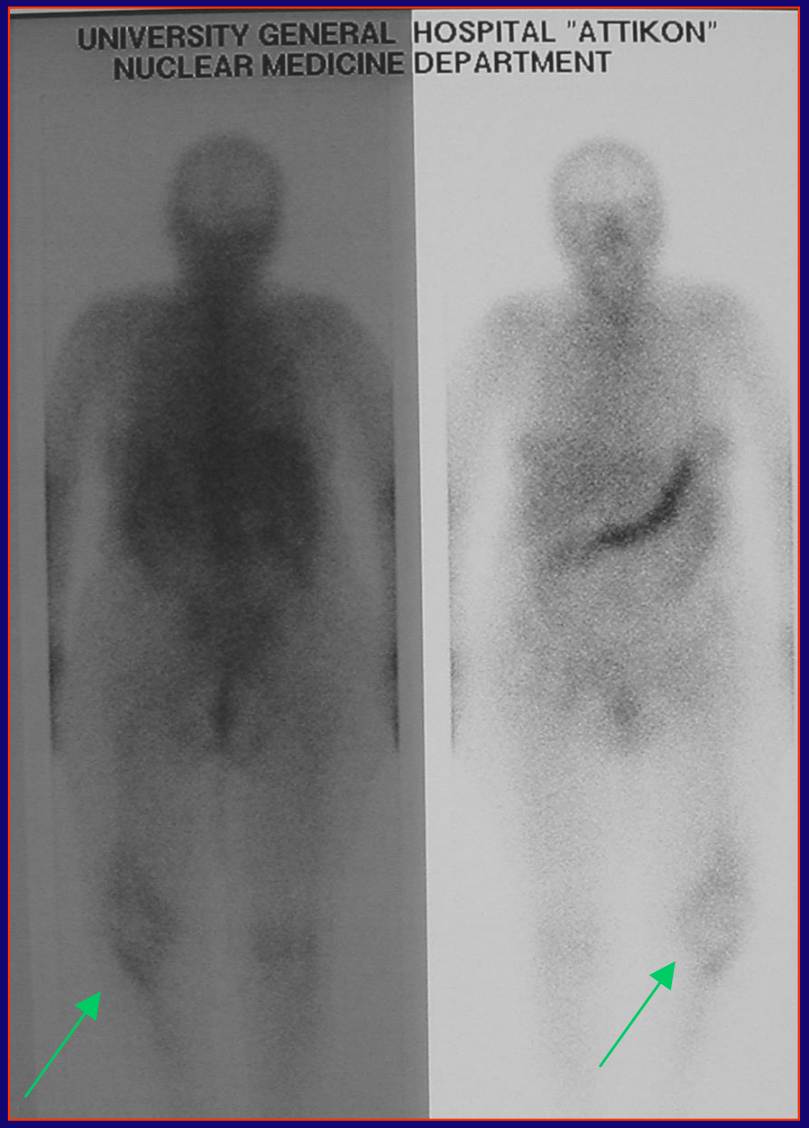
Technitium bone scan

- very sensitive but not very specific
- Bone scan (+) for up to 2 yrs post-op
- a (-) bone scan can exclude infection



Diagnosis - Nuclear scan

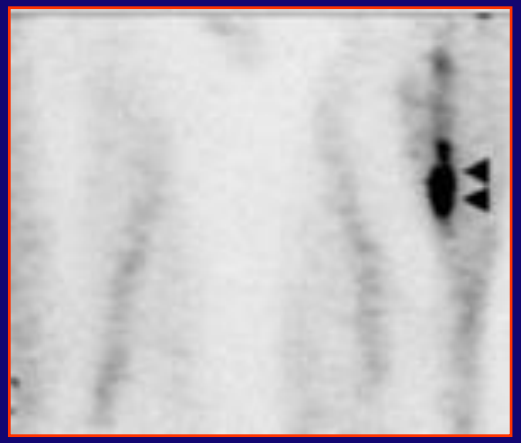
- Indium labeled white cell scan
  - if the uptake on the Indium scan is more intense than the uptake on the Te bone scan, it is likely that the prosthetic joint is infected

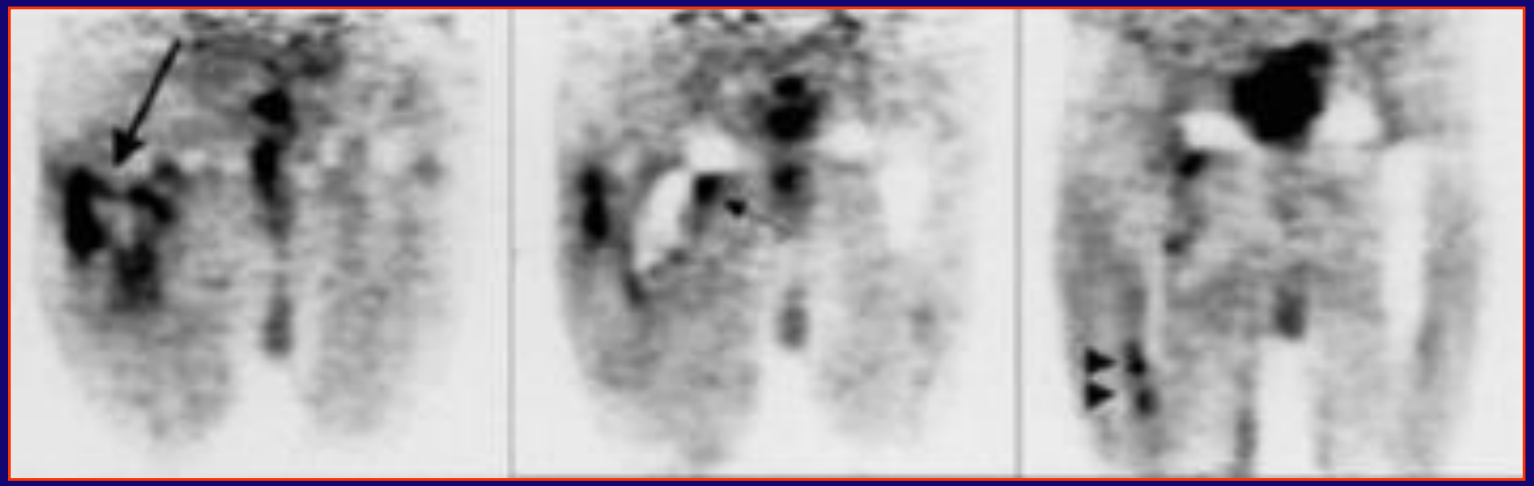


Diagnosis - FDG-PET scan

- Fluorodeoxyglucose-positron emission tomography (FDG-PET) in infected THA
  - Sensitivity 91%
  - Specificity 89%

Zhuang et al Orthop 2001

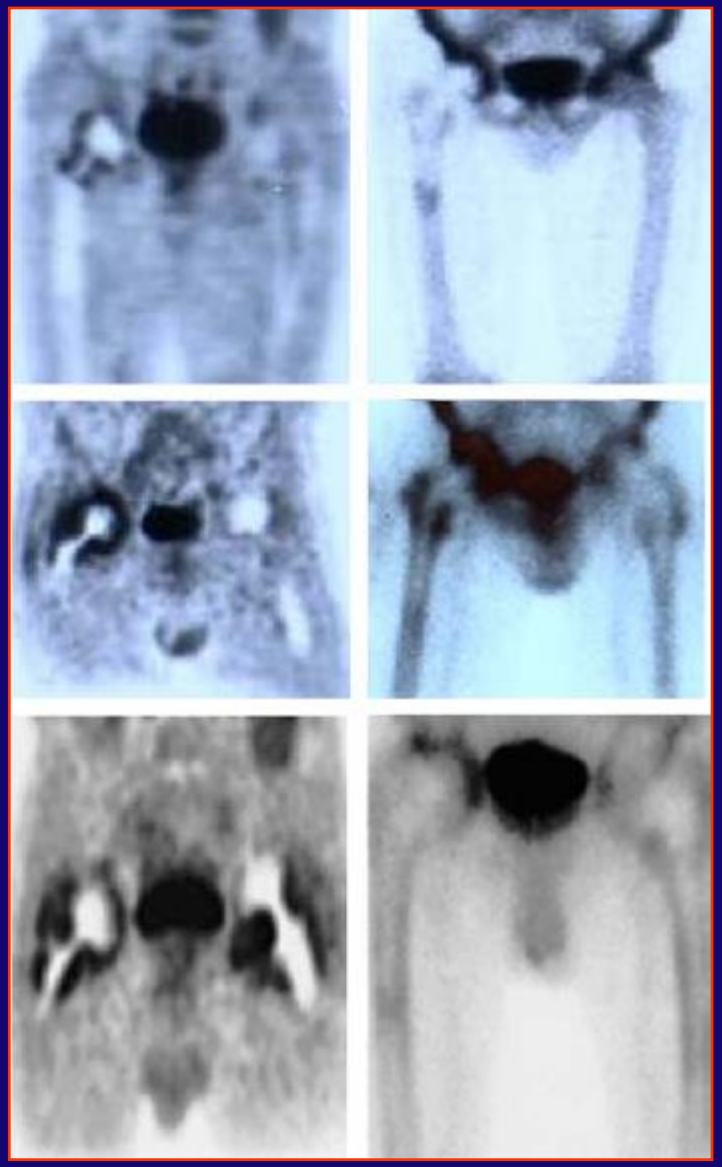




Diagnosis - FDG-PET scan

- FDG-PET scans were compared to Tc-bone scans
  - 50 patients, 70 TJR
    - 50 symptomatic
    - 20 asymptomatic
  - Sensitivity and specificity of the FDG-PET scan was 91% & 92% respectively
  - Specificity of the Tc-bone scan were 70% & 70% respectively

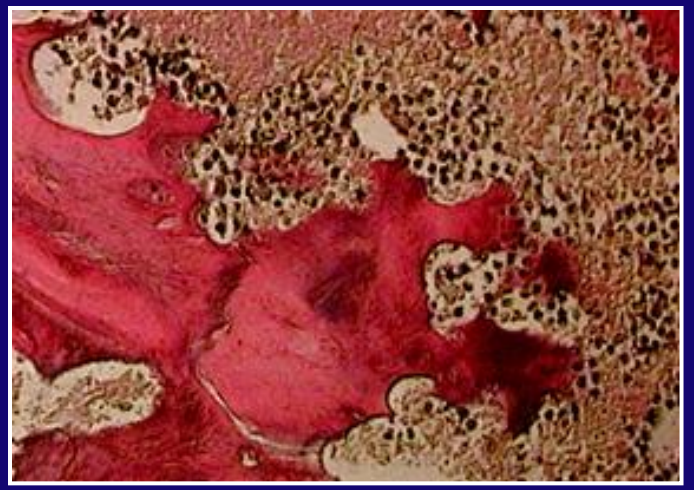
Mumme et al Acta Orthop 2005



Diagnosis

Role of Frozen Section

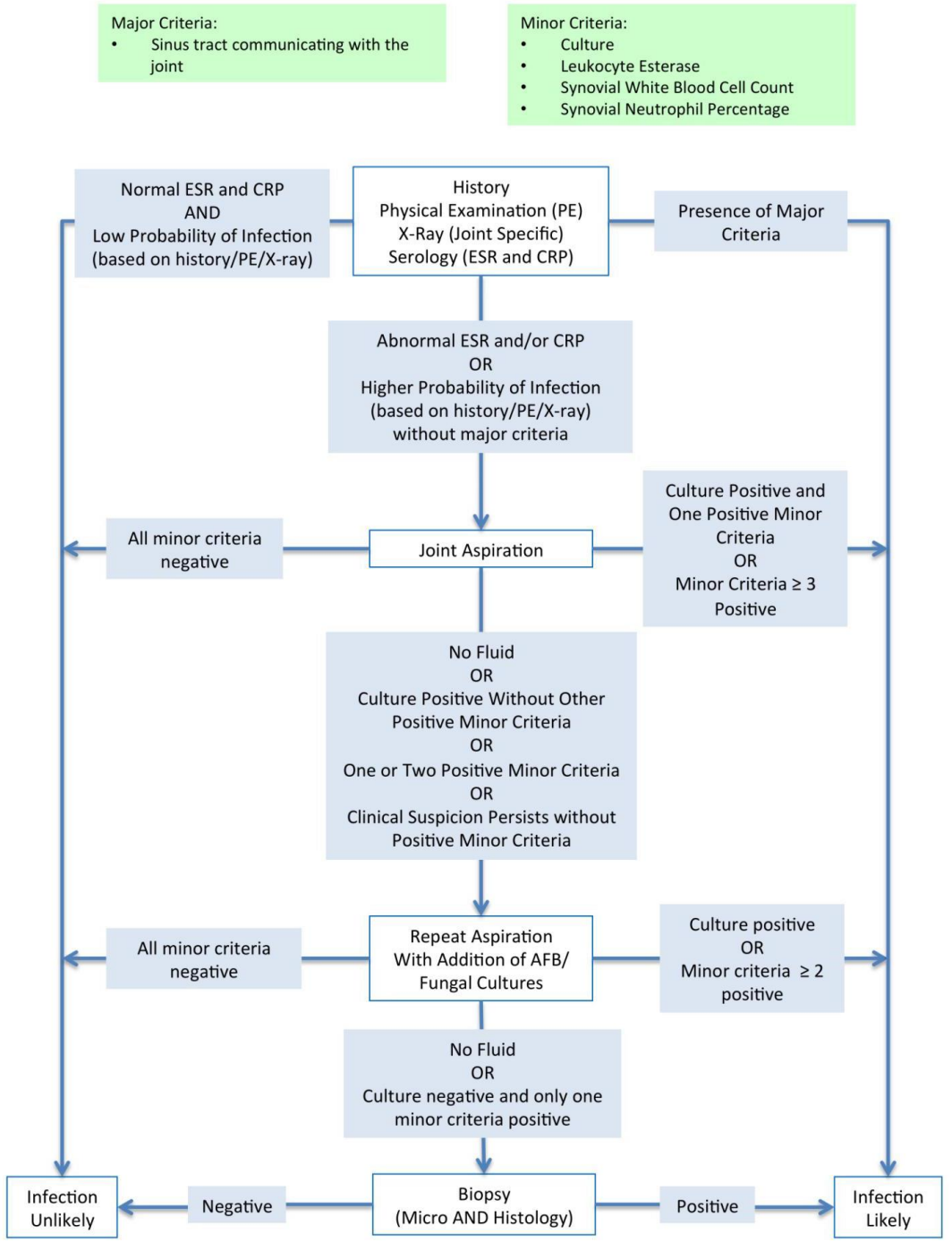
- Intraop findings suspicious
- Otherwise negative preop work-up
- Good pathologist



- Sampling
- >5 PMN/hpf
  - Sensitive 80-85%
  - Specificity 90-95%
- If criteria changed to >10 PMN/hpf
  - Sensitivity 84%
  - Specificity improved to 99%

AAOS

American Academy of Orthopaedic Surgeons



Karan Goswam et al . Curr Rev Musculoskelet Med (2018) 11:428–438

MSIS definition of PJI—PJI exists when: The **Musculoskeletal Society 2011 definition of PJI**

1. There is a sinus tract communicating with the prosthesis; or
2. A pathogen is isolated by culture from two or more separate tissue or fluid samples obtained from the affected prosthetic joint; or
3. When 4 of the following 6 criteria exist:
   a. Elevated serum erythrocyte sedimentation rate and serum C-reactive protein (CRP) concentration
   b. Elevated synovial white blood cell count
   c. Elevated synovial polymorphonuclear percentage (PMN %)
   d. Presence of purulence in the affected joint
   e. Isolation of a microorganism in one culture of periprosthetic tissue or fluid, or
   f. Greater than 5 neutrophils per high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at × 400 magnification

Table 2 The International Consensus Meeting (ICM) definition of PJI [14] (Reprinted with permission from Definition of Periprosthetic Joint Infection. Javad Parvizi and Thorsten Gehrke. The Journal of Arthroplasty. Elsevier; 2014. License number 4332751327806)

ICM definition of PJI			
	PJI is present if one of two major criteria or three of five minor criteria exists:		
Major criteria	1. There is a sinus tract communicating with the prosthesis; or		
Major criteria	1. Two positive periprosthetic cultures with phenotypically identical organisms; or		
Minor criteria	Having three of the following minor criteria:	Acute PJI (< 90 days)	Chronic PJI (> 90 days)
	1.1. Elevated ESR or CRP	ESR: no threshold CRP > 100 mg/L	ESR: > 30 mm/h CRP > 10 mg/L
	2. Elevated SF WBC count or Changes in leukocyte esterase strip	10,000 cells/μL + or ++	3000 cells/μL + or ++
	3. Elevated SF PMN %	90%	80%
	4. Positive histologic analysis of the periprosthetic tissue	> 5 neutrophils per high-power field in 5 high-power fields (× 400)	> 5 neutrophils per high-power field in 5 high-power fields (× 400)
	5. A single positive culture		

CRP C-reactive protein, *ESR* sedimentation rate, *SF WBC* synovial fluid white blood cell, *SF PMN* synovial fluid neutrophil differential

The Journal of Arthroplasty 33 (2018) 1309–1314

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[a] Rothman Institute, Thomas Jefferson University, Philadelphia, PA
[b] Cleveland Clinic, Cleveland, OH
[c] Rush University Medical Center, Chicago, IL
[d] Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

In the absence of a test with absolute accuracy, the diagnosis of a clinical condition needs to rely on a combination of criteria

Evidence-based, weight-adjusted scoring system for the definition of PJI of hip and knee

The new criteria demonstrated a higher sensitivity of 97.7% compared to the MSIS (79.3%) and International Consensus Meeting definition (86.9%), with a similar specificity of 99.5%

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Table 1
Characteristics of Patients Who Were Included in the Developmental Model (n = 1504).

Variable	Overall (n = 1504)	PJI Cohort (n = 684)	Aseptic Cohort (n = 820)	*P* Value
Age (y)	65.4 (10.9)	65.9 (11.0)	64.9 (10.8)	
Gender (male)	718 (47.7%)	366 (53.5%)	352 (42.9%)	<.001[a]
Race (white)	1270 (84.4%)	569 (83.2%)	70 (85.5%)	.05
Joint (knee)	841 (55.9%)	409 (59.8%)	432 (52.7%)	
Time from the most recent surgery (yr)	6.0 (8.7)	4.3 (9.3)	7.4 (7.9)	<.001[a]
Most recent surgery—revision procedure	416 (27.7%)	284 (41.5%)	132 (16.1%)	<.001[a]
Body mass index (kg/m^2)	31.1 (6.8)	31.4 (7.5)	30.9 (6.1)	
Charlson Comorbidity Index (mean)	1.80 (1.8)	2.2 (1.7)	1.3 (1.8)	<.001[a]
History of rheumatoid arthritis	99 (6.6%)	62 (9.1%)	37 (4.5%)	<.001[a]
History of malignancy	70 (4.7)	57 (8.3%)	s13 (1.6%)	<.001[a]
History of diabetes	261 (17.4%)	152 (22.2%)	109 (13.3%)	<.001[a]

Data are presented as mean (standard deviation) or number (%); kilogram (kg); meter (m); year (yr).
PJI, periprosthetic joint infection.
[a] Statistically significant.

Major criteria (at least one of the following)	Decision
Two positive cultures of the same organism	Infected
Sinus tract with evidence of communication to the joint or visualization of the prosthesis	

Preoperative Diagnosis	Minor Criteria	Score	Decision
Serum	Elevated CRP *or* D-Dimer	2	≥6 Infected
Serum	Elevated ESR	1	
Synovial	Elevated synovial *WBC count or LE*	3	**2-5 Possibly Infected [a]**
Synovial	Positive alpha-defensin	3	
Synovial	Elevated synovial PMN (%)	2	0-1 Not Infected
Synovial	Elevated synovial CRP	1	

Intraoperative Diagnosis	Inconclusive pre-op score *or* dry tap [a]	Score	Decision
	Preoperative score	-	≥6 Infected
	Positive histology	3	**4-5 Inconclusive [b]**
	Positive purulence	3	
	Single positive culture	2	≤3 Not Infected

Fig. 1. New scoring based definition for periprosthetic joint infection (PJI). Proceed with caution in: adverse local tissue reaction, crystal deposition disease, slow growing organisms. CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; LE, leukocyte esterase; PMN, polymorphonuclear; WBC, white blood cell. [a]For patients with inconclusive minor criteria, operative criteria can also be used to fulfill definition for PJI. [b]Consider further molecular diagnostics such as next-generation sequencing.

B Consider further molecular diagnostics such as next-generation sequencing

elevated serum CRP (>1 mg/dL)	2 points
D-dimer (>860 ng/mL)	2 points
erythrocyte sedimentation rate (>30 mm/h)	1 points
elevated synovial fluid WBC (>3000 cells/μL)	3 points
alpha-defensin (signal-to-cutoff ratio >1)	3 points
leukocyte esterase (++)	3 points
polymorphonuclear percentage (>80%)	2 points
synovial CRP (>6.9 mg/L)	1 points

Management
Goals of care

Pain-free Functional Joint

Eradicate Infection

Prevent Recurrences

SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

- **Goals of Treatment**
  - Eradicate infection
  - Restore function
  - Alleviate pain

SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

- **Temporal Stratification**
  - Positive intra-operative culture (PIOC)
  - Early post-operative infection (EPOI)
  - Acute hematogenous infection (AHI)
  - Late chronic infection (LCI)

SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

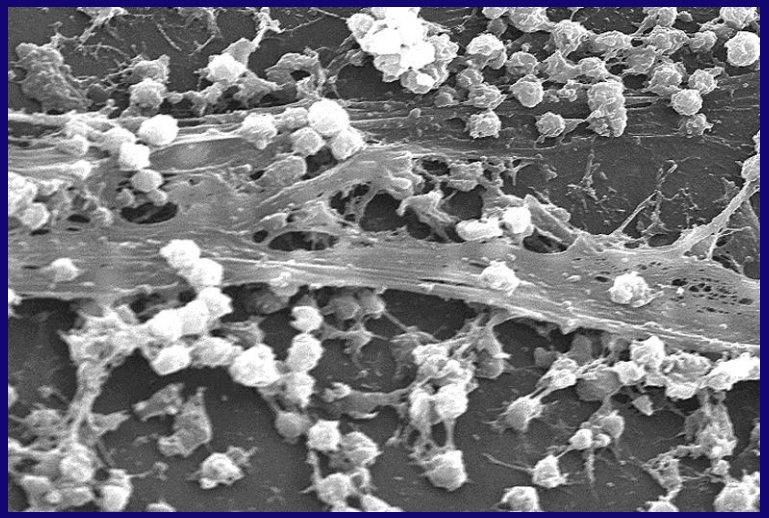
- **Systemic Factors**
  - Healthy patient (A Host)
  - Compromised patient (B Host)
  - Systemic conditions
  - Local condition

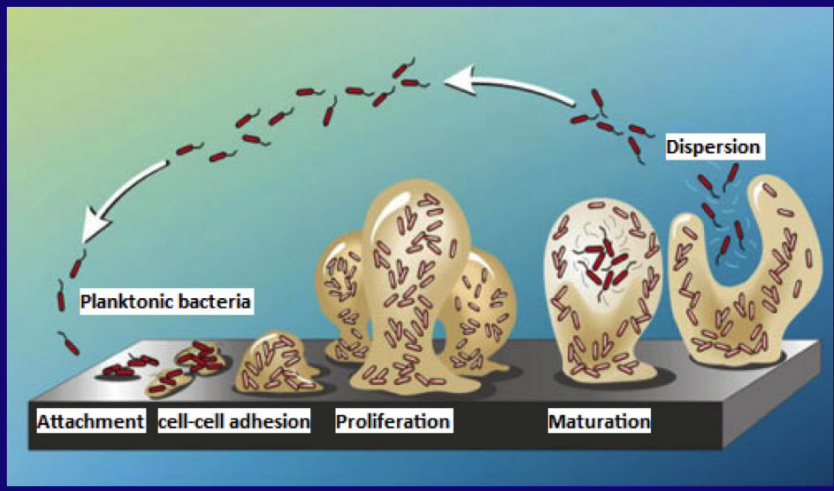
SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

- **Bacterial Considerations**
  - Gram positive
  - Gram negative
  - Polymicrobial
  - Antibiotic resistance
  - Non-virulent
  - Virulent

Bacteria in a biofilm

- It is impossible to remove bacteria in a biofilm. Local or systemic antibiotic treatment is not effective.
- Bacteria are protected by the biofilm from the host's defense system
- Inhibition of bacterial adhesion is regarded as the most critical step to prevent implant associated infection.





SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

SURGICAL MANAGEMENT OF INFECTED ARTHROPLASTY

- **Treatment Alternatives**
  - Antibiotic suppression
  - Debridement and component retention (DAIR)
  - **Resection arthroplasty:**
    - Reimplantation
    - Arthrodesis
    - Flair joint
  - **Amputation**

Management Options

- **Debridement, Antibiotics and Implant Retention (DAIR) of prosthesis**
  - +/- chronic oral antimicrobial suppression
- **Resection arthroplasty with**:
  - **Reimplantation**
    - Two stage exchange
    - One stage exchange
    - “destination articulating spacer”
  - Arthrodesis
  - No reconstruction (flail joint)
- **Amputation**

Prosthetic Joint infection
General Management Principles

- **Late infection**
  - Resection arthroplasty most often
    - One-stage versus 2-staged reimplantation
- **Early postoperative or Acute hematogenous infection**
  - Debridement, Antibiotics, Implant Retention (DAIR)
  - +/- Chronic suppression
- **Positive intra-operative cultures**
  - Similar to one-stage exchange but not as extensive debridement, component retention
  - +/- Chronic suppression

Antibiotic Suppression

- Indications
  - Medically infirm
  - Well-fixed prosthesis
  - Susceptible organism
  - Acceptable antibiotic

- Contra-indications
  - Active drainage
  - Loose prosthesis
  - Resistant organism

- Success 27%, failure 73% (combined literature 308 cases)

Resection Arthroplasty-flair joint

- Indications
  - Polyartricular rheumatoid arthritis
  - Minimal ambulatory demands
  - Poor soft tissues
  - Insufficient bone stock
  - Stage prior to knee arthrodesis
  - Stage prior to reimplantation

Resection Arthroplasty-flair joint

- Contra-indications
  - Single joint disease
  - High ambulatory demands

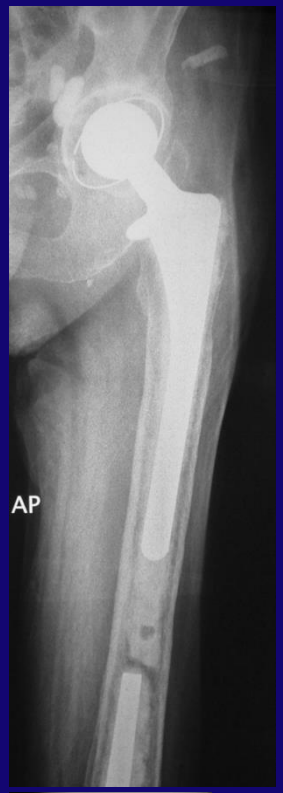
Resection Arthroplasty-flair joint

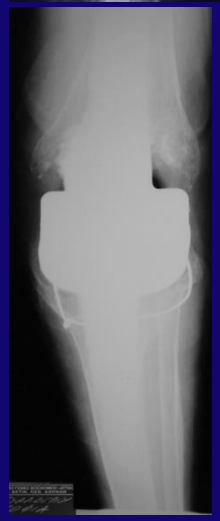
- Technique
  - Implant removal and meticulous debridement
  - Suture apposition of bone ends
  - Prolonged immobilization (6-12months)
  - Continued bracing thereafter
- Success 73%, failure 27% (combined literature 85 cases)
- (75% satisfied, 83% instability, 20% brace,20% persistent drainage, 13% nonambulatory, 17% subsequent arthrodesis)

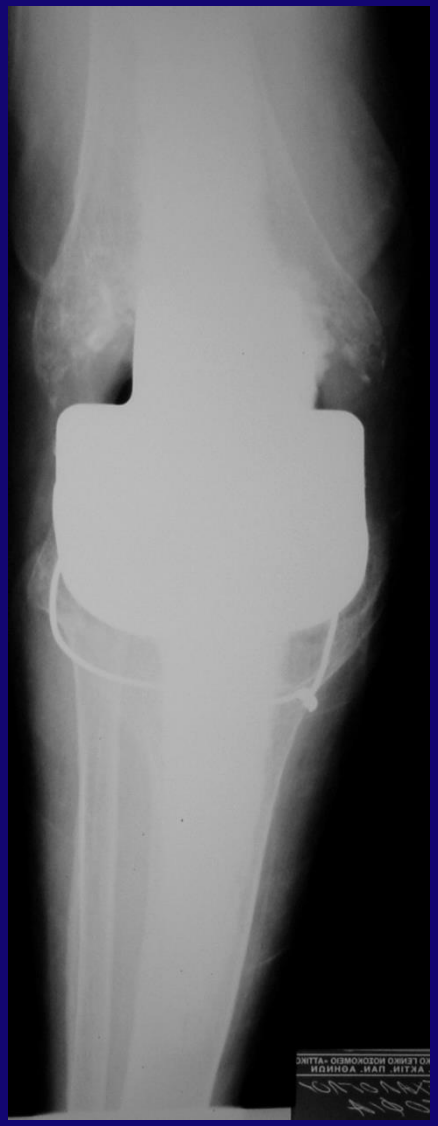
Amputation

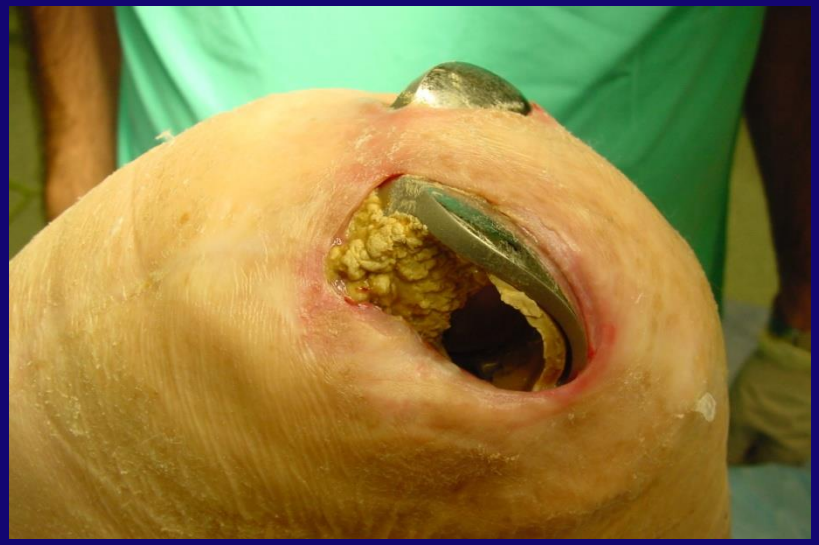
- Indications
  - Non-ambulator
  - Massive bone loss
  - Severe pain
  - Persistent infection
  - Life-threatening sepsis

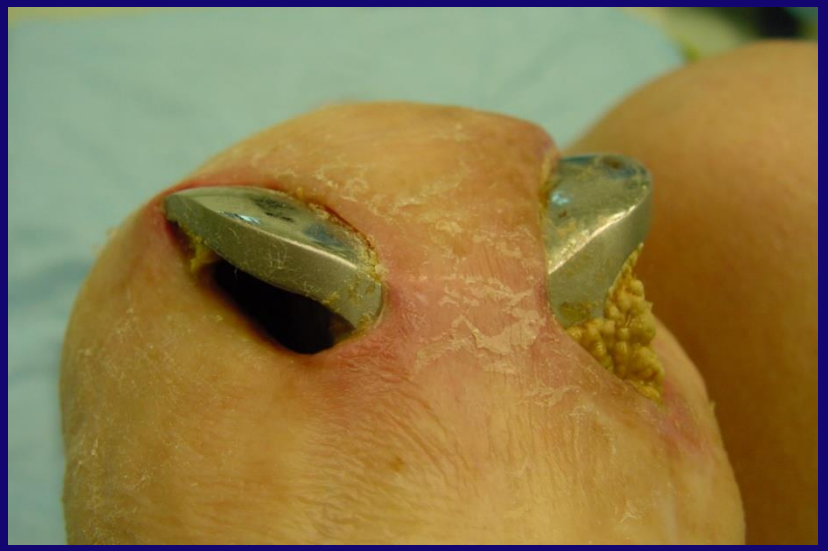
Infected TKA
Amputation



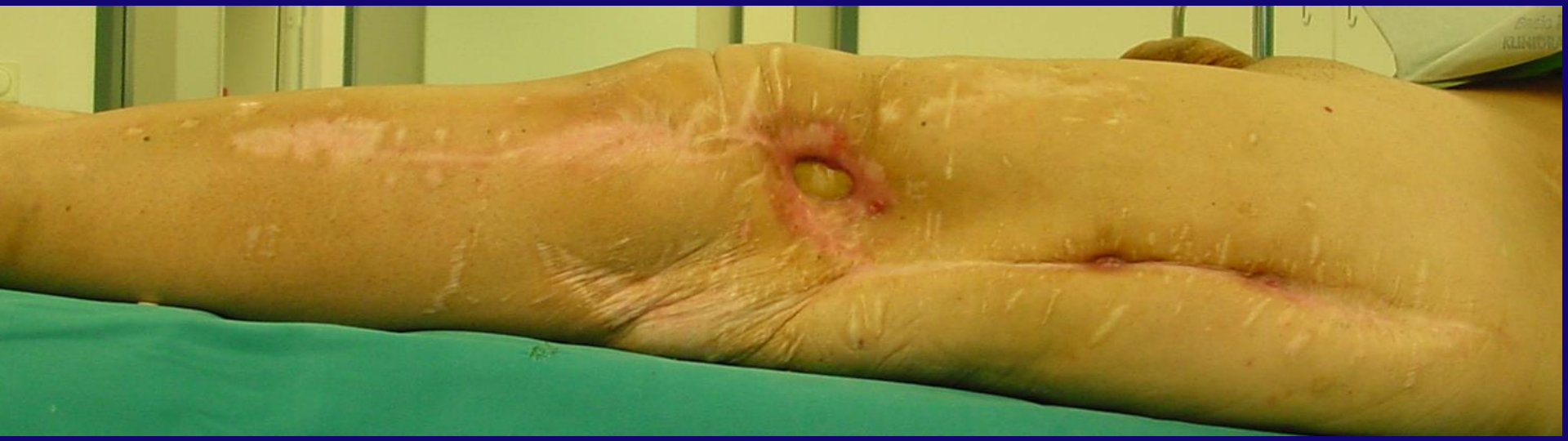








Knee Arthrodesis



Arthrodesis

- Indications
  - Unilateral disease
  - Resistant organism(s)
  - Failed attempted reimplantation
  - Poor soft tissue coverage
  - Absent extensor mechanism
- Contra-indications
  - Contralateral knee arthrodesis or amputation
  - Ipsilateral hip or knee disease
  - Several segmental bone loss

DAIR

Acute Debridement & Component Retention

- Indications
  - Acute infection(<72 hrs)
  - Sensitive gram positive organism
  - Well-fixed prosthesis
  - Good soft tissues
- Contra-indications
  - Chronic infections(>2 weeks)
  - Resistant organism
  - Loose prosthesis
  - Poor soft tissues
- Success 29%, failure 71% (combined literature 377 cases)
- Timing of debridement: <2wks 60% success
  >2 wks 20% success

Re-Implantation

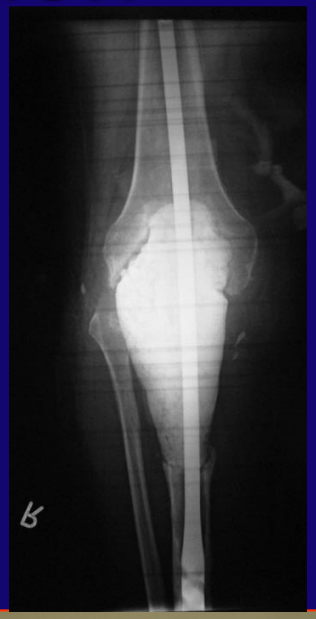
- One- stage Re-Implantation
  - Sensitive organism
  - Intact soft tissues
  - Overall 77% success rate
- Two- stage Re-Implantation (using antibiotic PMMA)
  - Resistant or virulent organism
  - Soft tissue defect
  - Overall >90% success rate

- Many different protocols and approaches employed by various authors

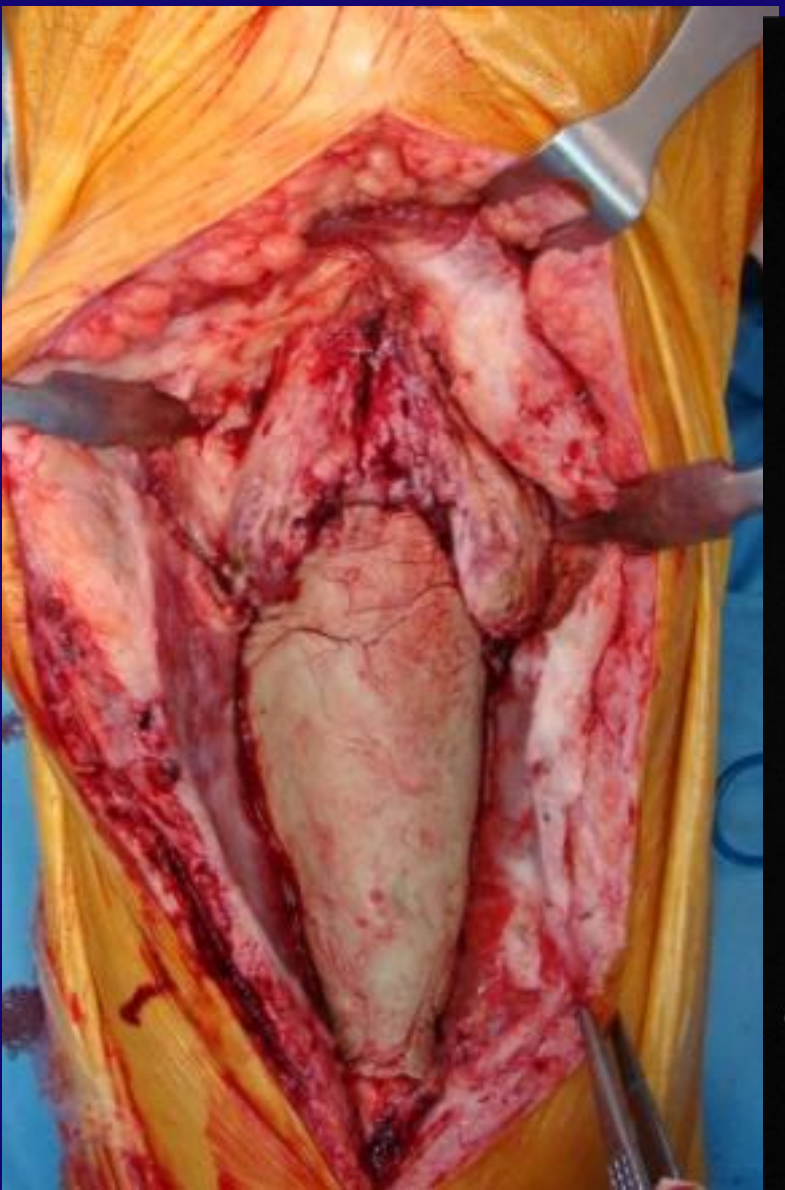
“Spacers” : temporary functional reconstruction

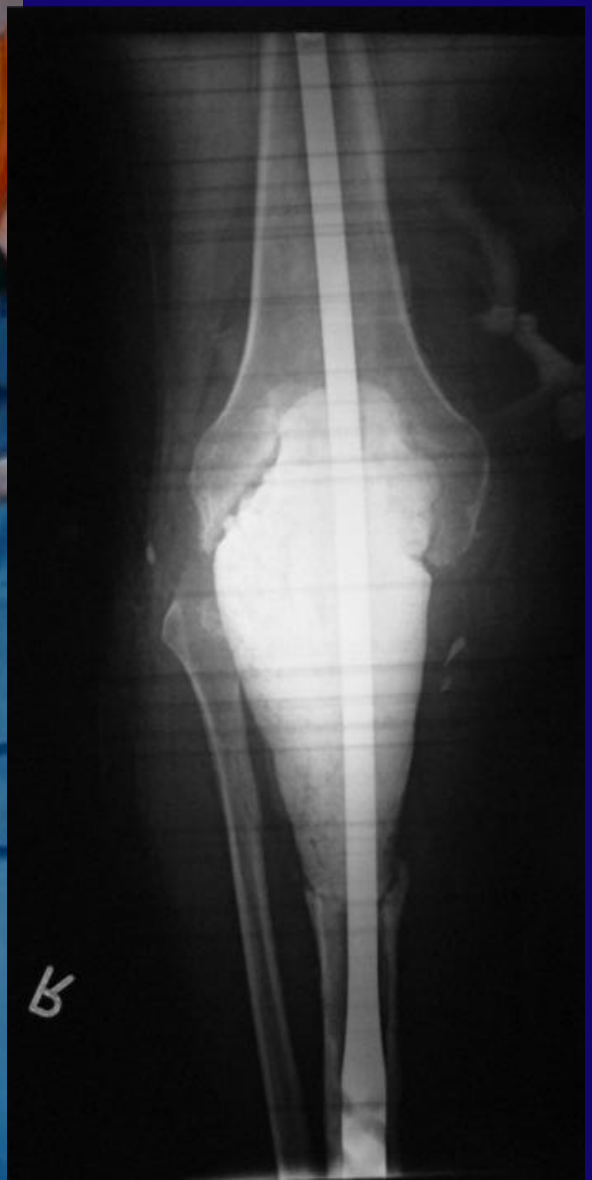
- Local antibiotic delivery- extremely high local concentrations
- Obliterate dead space
- Simultaneously preserve space for definitive reconstruction

- PMMA-static
- PMMA-articulating
- Composite – metal, PMMA

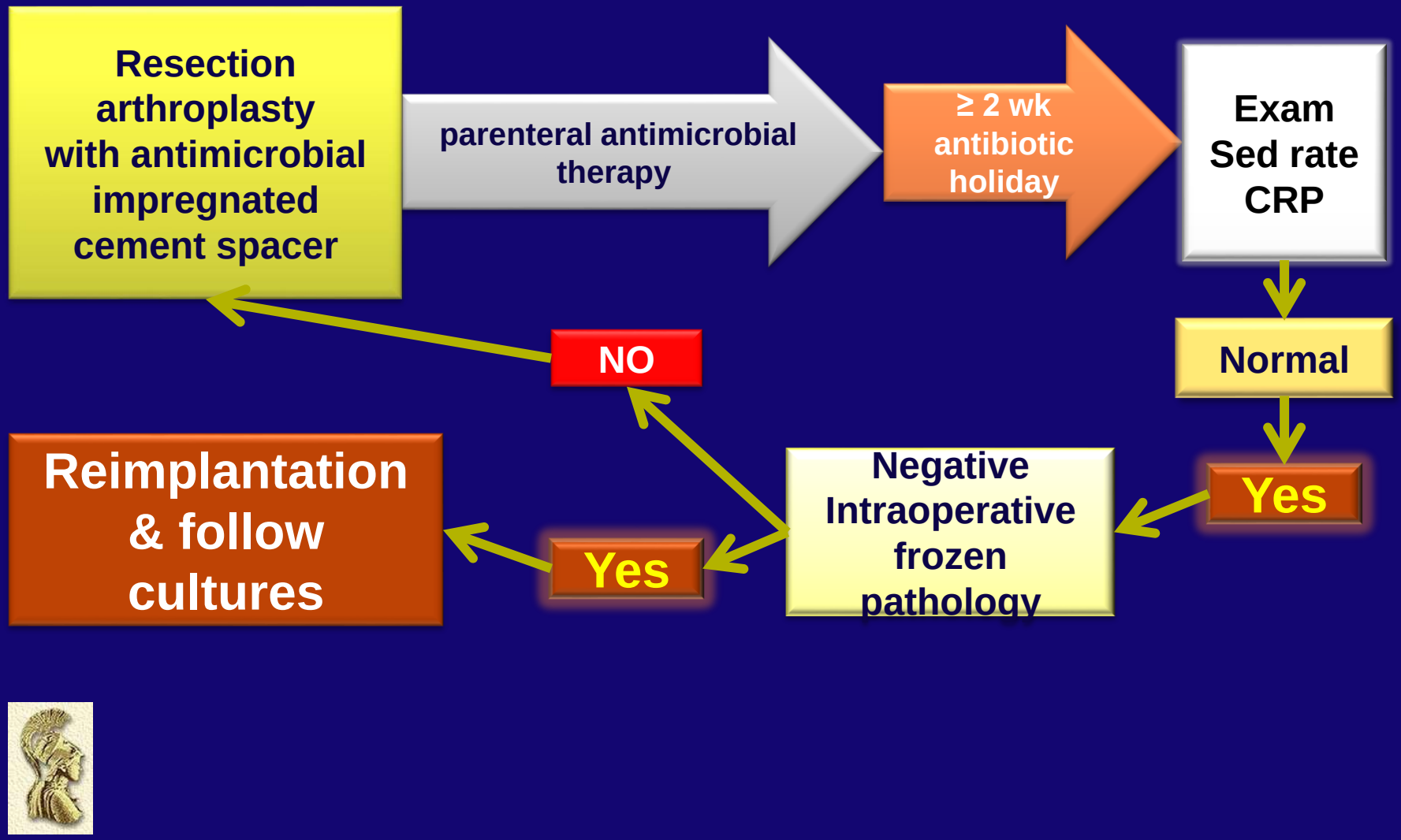


1nd Stage – Debridement - Spacer





Classic – 2-staged exchange approach

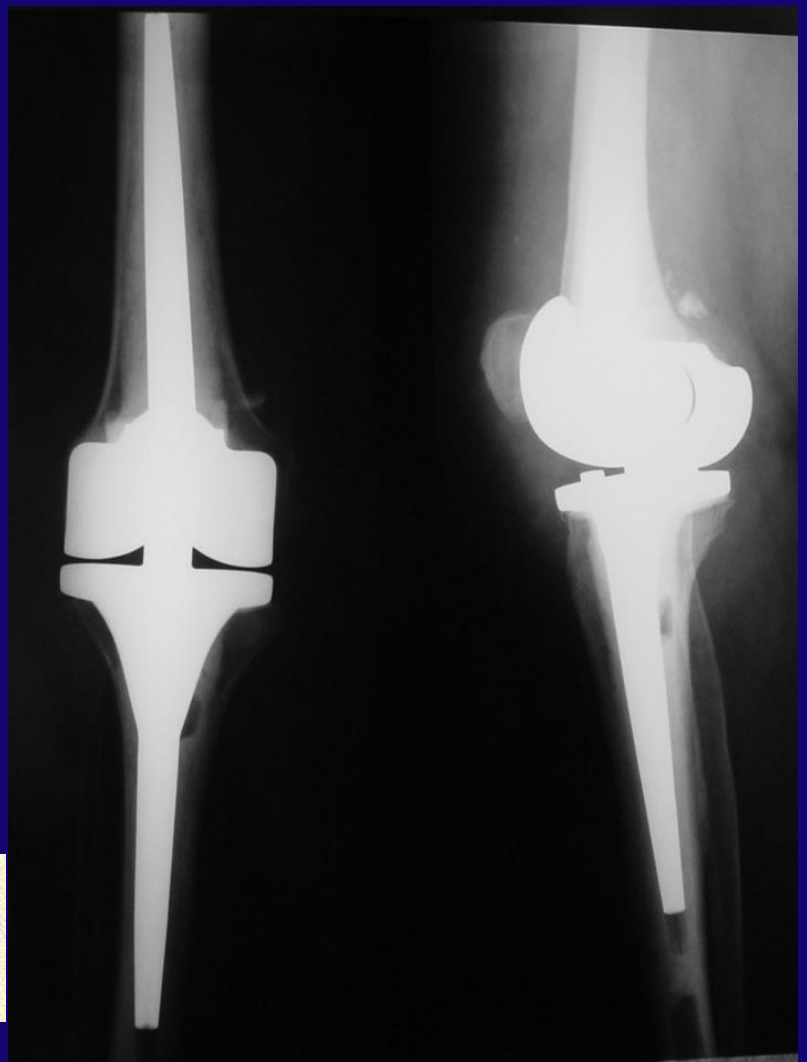


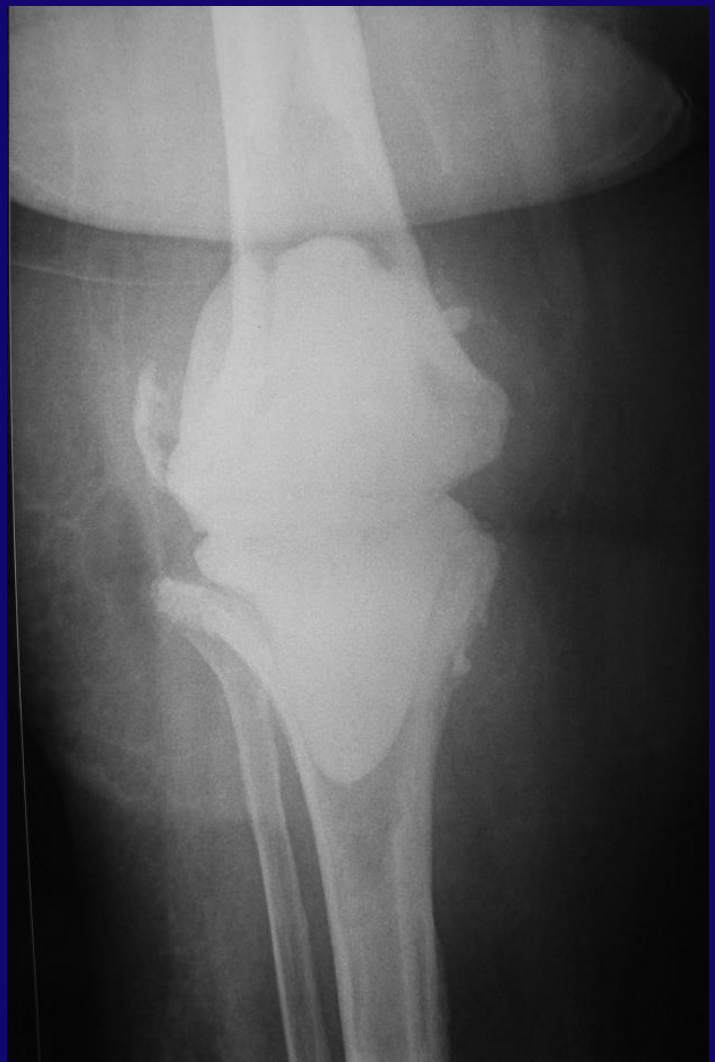
Outcomes of PJI over time 2000 - 2016

- Retrospective 17 years 2000-2016 (550 pts)
- 2-stage and DAIR (Debridement, Antibiotics, Implant Retention)
  - 123 patients not included as they did not have re-implantation
- Minimum 1 year follow-up
- Overall - 2-stage failure rate 19.8%
- **No difference in outcomes over 17 years - adjusted to age, sex, comorbidities**
- How can we improve outcomes?

Goswami et al. MSIS. 2019

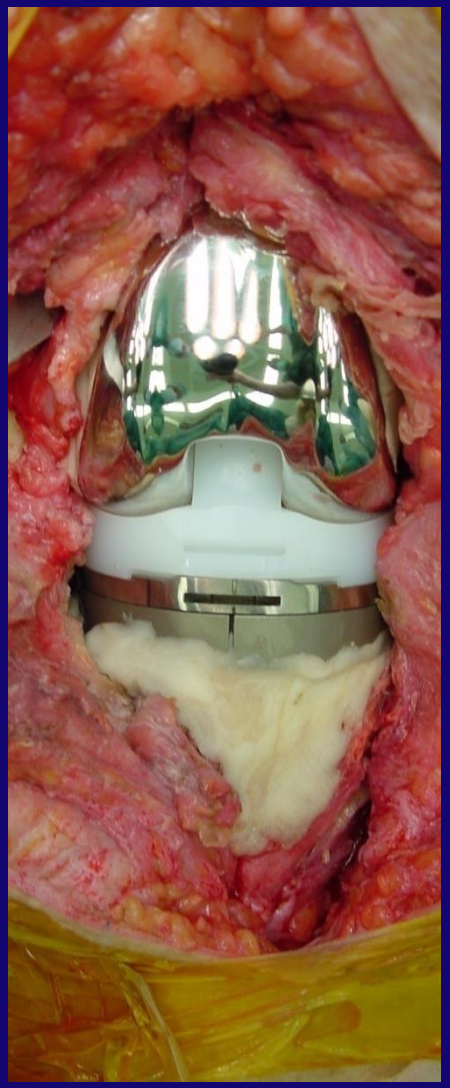
Infected TKA
2 Stage Re-implantation
Staph aureus MRSA

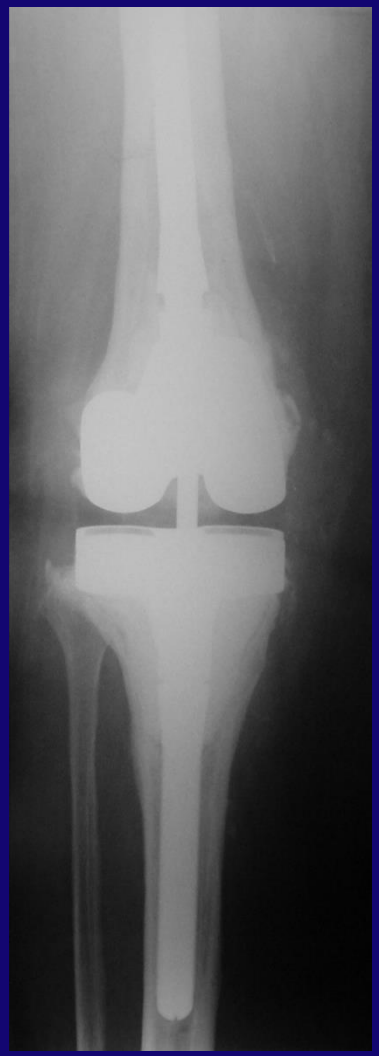


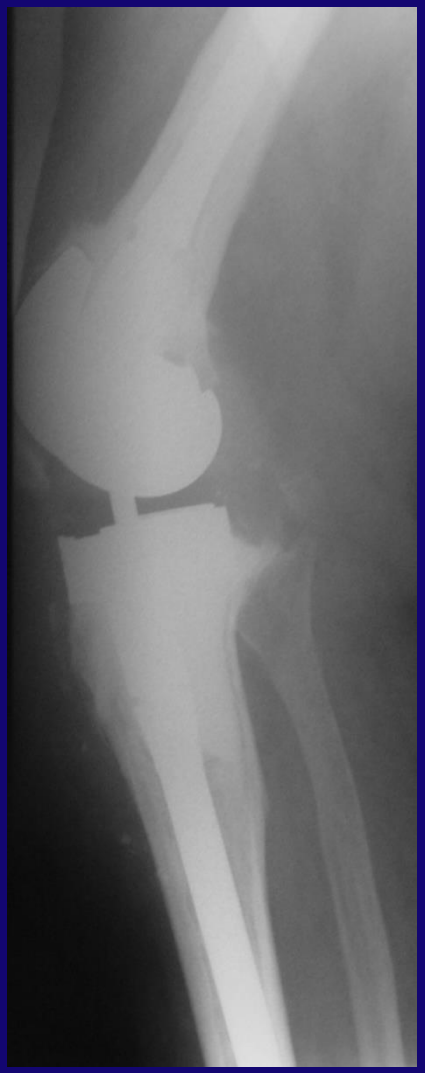


Infected TKA

2 Stage Re-implantation



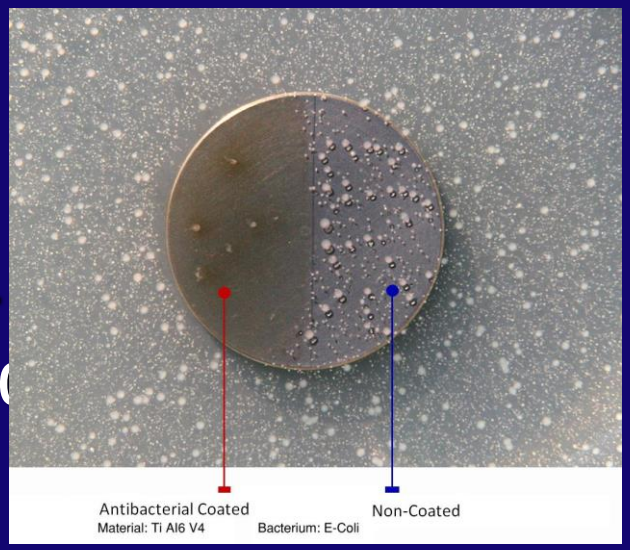




Silver-coated megaprostheses

- Among metals with antimicrobial activity, silver (in particular free silver ions) has broad-spectrum antimicrobial activity and lower toxicity to cells.

- In experimental studies, silver-coated megaprostheses proved their effectiveness in reducing infection rates after artificial colonization.



Silver-coated vs Titanium megaprostheses

- 51 pts, silver-coated megaprosthesis
  - proximal femur, n = 22; proximal tibia, n = 29
- 74 pts , uncoated titanium megaprosthesis
  - proximal femur, n = 33; proximal tibia, n = 41
- The infection rate
  - 17.6% in the titanium group
  - 5.9% in the silver group
- 38.5% of pts in the titanium group with infection had amputation

Hardes et al, J Surg Oncol. 2010

Silver-coated megaprostheses

- Silver compounds are poorly water soluble, resulting in the release of low concentrations of silver ions into the surrounding medium and blood. Local or systemic side effects were not observed.

- The future will no doubt see technical advances for infections of tumor prostheses in areas such as microbiological diagnostics and biofilm-resistant prostheses.

Conclusions

Infections of Orthopaedic Implants

- Recognition = Preoperative Assessment
- Planning = Evaluate Options
- Treatment = Staged Management
- Reconstruction = Patient-matched, Surgeon, Institution

Staged Treatment Protocol

- Atraumatic approach
- Complete debridement
  - All involved material-bone, soft tissue, implants
  - Dead space management

Staged Treatment Protocol

- Temporary functional reconstruction (spacers)
  - Local antibiotic delivery-extremely high local concentrations
  - Obliterate dead space.
  - Simultaneously preserve space for definitive reconstruction
  - Maintain ligament balance and soft tissue envelope
  - PMMA-static
  - PMMA-articulating
  - Composite – metal, PMMA

Staged Treatment Protocol

- Temporary functional reconstruction - Functional spacers
  - Immediate mobilization
  - Facilitates rehabilitation
  - Facilitates nursing care
  - Improved pain management

Staged Treatment Protocol

- Definitive reconstruction
  - Resection Arthroplasty
  - Amputation
  - Arthrodesis
  - Arthroplasty
  - Composite Spacers – PMMA, metal, bone

Decision Making Process

Define goals

‘Begin with the end in mind’

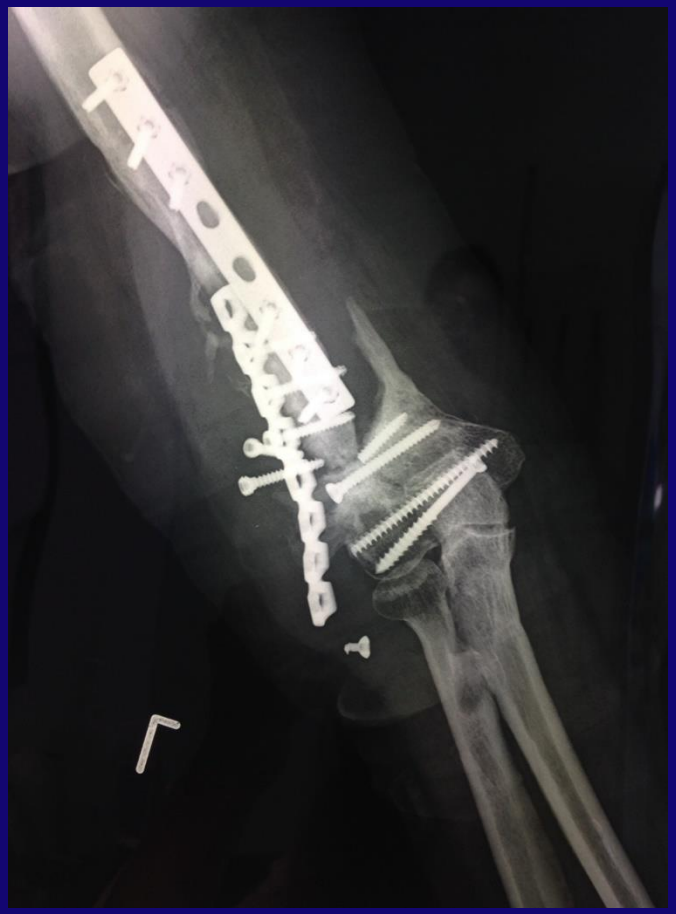
Decision Making Process

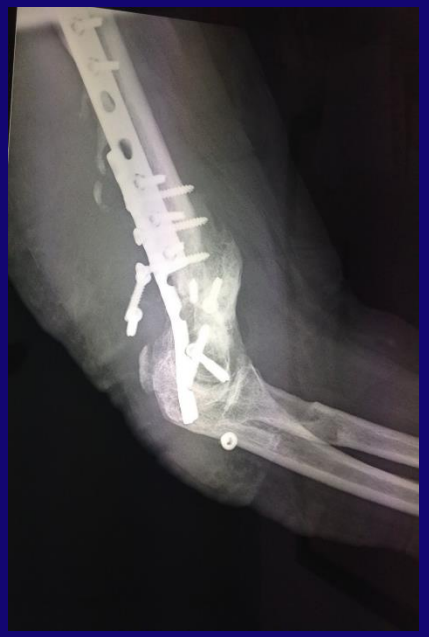
- Delineate options
  - Patient aspects
  - Surgeon capabilities
  - Institutional considerations

Decision Making Process

Match treatment option
with specific patient

fracture-related infection (FRI)





Archives of Orthopaedic and Trauma Surgery (2020) 140:1013–1027
https://doi.org/10.1007/s00402-019-03287-4

ORTHOPAEDIC SURGERY

General treatment principles for fracture-related infection: recommendations from an international expert group

Willem-Jan Metsemakers[1] · Mario Morgenstern[2] · Eric Senneville[3] · Olivier Borens[4] · Geertje A. M. Govaert[5] · Jolien Onsea[1] · Melissa Depypere[6] · R. Geoff Richards[7] · Andrej Trampuz[8] · Michael H. J. Verhofstad[9] · Stephen L. Kates[10] · Michael Raschke[11] · Martin A. McNally[12] · William T. Obremskey[13] · On behalf of the Fracture-Related Infection (FRI) group[1]

Table 1 Diagnostic criteria for FRI [3, 4]

Confirmatory criteria	Suggestive criteria
Clinical signs	Clinical signs
Fistula	Local/systemic (e.g. local redness, swelling, fever)
Sinus	New-onset joint effusion
Wound breakdown	Persistent, increasing or new-onset wound drainage
Purulent drainage or the presence of pus	
Microbiology	Laboratory signs
Phenotypically indistinguishable pathogens identified by culture from at least 2 separate deep tissue/implant specimens	Increased serum inflammatory markers (ESR, WBC, CRP)
Histopathology	Radiological and/or nuclear imaging signs microbiology
Presence of microorganisms in deep tissue specimens, confirmed by using specific staining techniques for bacteria and fungi	Pathogenic microorganism identified from a single deep tissue/implant specimen
Presence of > 5 PMNs/HPF in chronic/late-onset cases (e.g. fracture nonunion) [5]	

ESR erythrocyte sedimentation rate, *WBC* white blood cell count, *CRP* C-reactive protein, *PMNs* polymorphonuclear neutrophils, *HPF* high-power field

Table 2 Primary aims for the surgical treatment of FRI [2]

1. Fracture consolidation
2. Eradication of infection as the final outcome (in certain cases, initial suppression of infection until fracture consolidation is achieved)
3. Healing of the soft-tissue envelope
4. Restoration of function
5. Prevention of chronic infection/osteomyelitis

AO Principles

Implant retention in FRI

”The entire implant should be considered infected with a biofilm covering through its entire length, width and depth…”

“Fracture healing will not take place in presence of infection without mechanical stability…”

Stable implant

- YES → Retain until bridging → Supression
- NO → Remove and Ex-Fix → Eradication

AO Principles of Fracture Management _ Acute and chronic infections (2017)

AO Principles

Implant retention in FRI

”The entire implant should be considered infected with a biofilm covering through its entire length, width and depth…”

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Stable implant

- YES → Retain until bridging → Supression
- NO → Remove and Ex-Fix → Eradication

AO Principles of Fracture Management _ Acute and chronic infections (2017)

AO Principles

Infected Intramedullary nails

Retain , if stable / bridging / sensitive micro → In the end remove nail and ream

Nail

Remove and ream the canal 0.5-1.5mm to a distal opening (RIA : Reamer – Irrigator – Aspirator)

One stage nail exchange

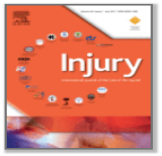
Two-stage nail exchange → antibiotic cement beads / antibiotic loaded nail + Ex-Fix

AO Principles of Fracture Management _ Acute and chronic infections (2017)

ELSEVIER

Injury

Volume 48, Issue 7, July 2017, Pages 1616-1622



Full length article

Masquelet technique versus Ilizarov bone transport for reconstruction of lower extremity bone defects following posttraumatic osteomyelitis

Kai Tong [a], Ziyi Zhong [a], Yulan Peng [b], Chuangxin Lin [c], Shenglu Cao [a], YunPing Yang [a], Gang Wang [a]

"In the treatment of segmental lower extremity bone defects following posttraumatic osteomyelitis, both IBT and MT can lead to satisfactory bone results while MT had better functional results, especially in femoral cases.

IBT should be preferred in cases of limb deformity and MT may be a better choice in cases of periarticular bone defects."

Soft tissue management

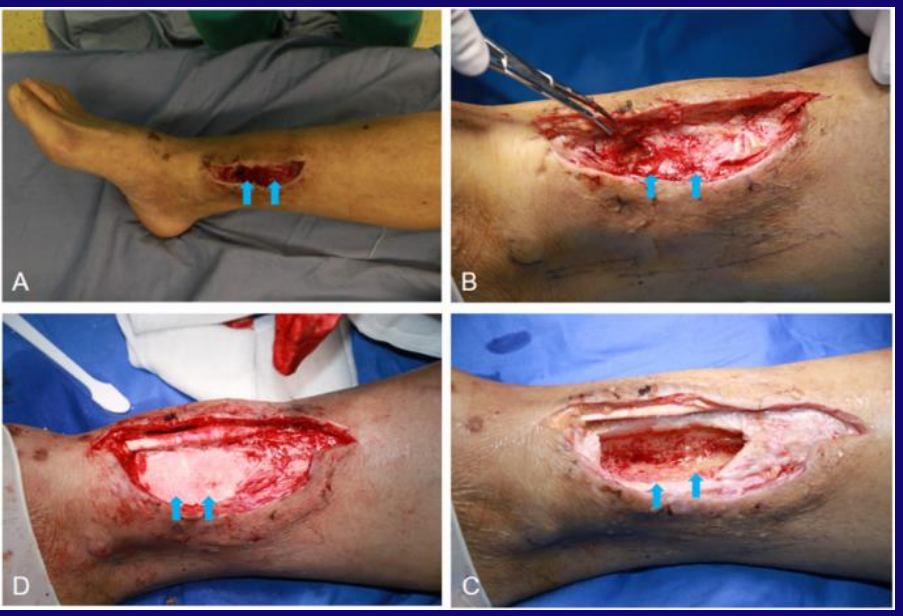
- In cases where the soft tissue is severely compromised, a two-stage procedure may be necessary. However, if possible, a one-stage procedure can be considered and is often possible in chronic/late onset infections
- Local muscle flaps are useful in the proximal tibia and distal femur but the lower third of the tibia will require free tissue transfer.
- there is little evidence to recommend one specific flap type over another in FRI cases

negative pressure wound therapy (NPWT)

- should only be used as a temporary bridge to definite soft tissue coverage. It should not be used for more than approximately 1 week and cannot serve as an alternative to definitive soft tissue reconstruction in FRI.
- Prolonged NPWT may lead to colonization with resistant organisms and possibly increased infection rates

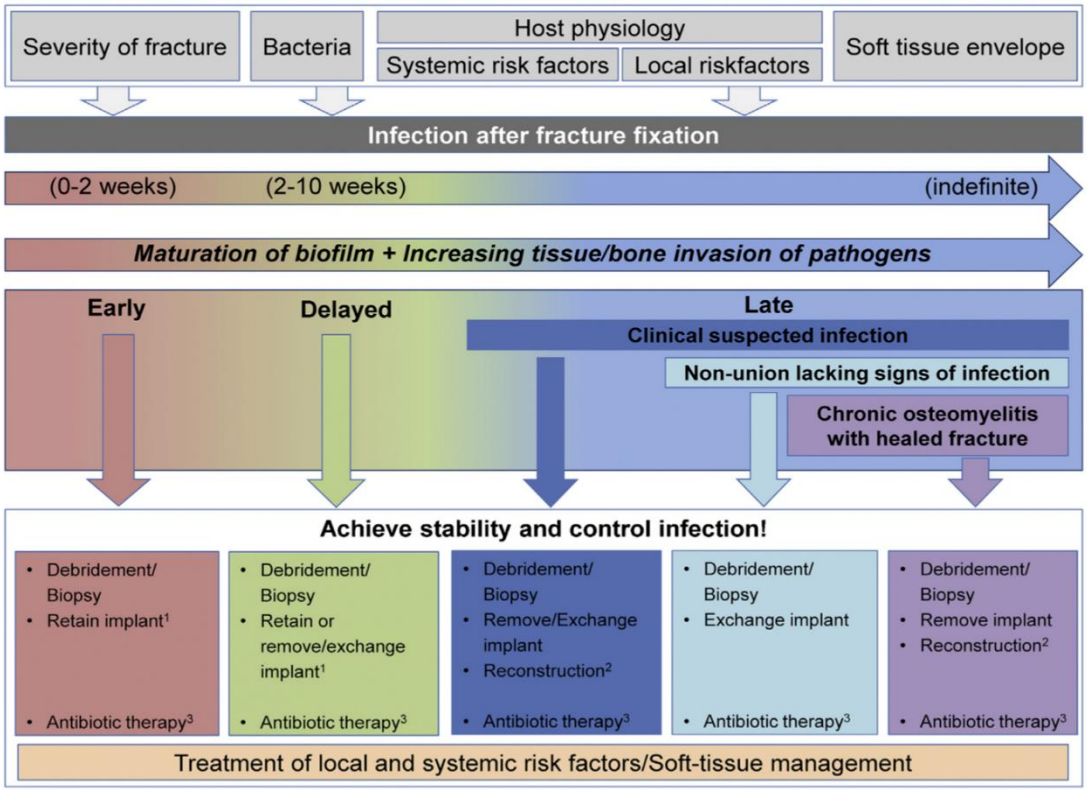
AO Principles

Debridement



a Debrided wound covered with a VAC dressing and adhesive seal
b Granulated wound ready for skin graft

FRI MANAGEMENT APPROACH SUMMARY



Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Review

Infection after fracture fixation: Current surgical and microbiological concepts

W.J. Metsemakers[a,*], R. Kuehl[b], T.F. Moriarty[c], R.G. Richards[c], M.H.J. Verhofstad[d], O. Borens[e], S. Kates[f], M. Morgenstern[g]

Table 4
Factors favoring implant removal and exchange.

1.	Nail osteosynthesis[a]
2.	Unstable osteosynthesis or insufficient fracture reduction[a]
3.	Compromised soft-tissue envelope, which does not allow sufficient wound closure
4.	Compromised host physiology (alcoholism, diabetes, vascular insufficiency, smoking)
5.	Difficult to treat pathogen[b]

[a] Exchange/removal strongly recommended.
[b] In general not available for primary revision since pre-operative pathogen identification often not possible (like in PJI by joint aspiration), if in retention of implant was chosen and microbiology analysis detect postoperatively a difficult to treat pathogen, removal of the implant should strongly be considered.

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THANK YOU