Diagnosis and Management of Prosthetic Joint Infection (PJI)

Clinical Presentation
Joint never felt good after surgery, Pain, Stiffness
Signs of inflammation, Presence of sinus
Imaging (not diagnostic): periosteal reaction, loosening of prosthesis with endosteal scalloping, bone resorption, involucrum.

Incidence:
1-2% primary arthroplasties
Up to 6% revision arthroplasties
Commonly gram-positive skin commensals, but incidence of atypical pathogens increasing
Sources: direct perioperative inoculation, haematogenous spread

Diagnosis
(2018 Definition – score based assessment)

Parvizi J, Tan TL, Goswami K, Higuera C, Della Valle C, Chen AF, Shohat N. The 2018 Definition of Periprosthetic Hip and Knee Infection: An Evidence-Based and Validated Criteria. J Arthroplasty. 2018 May;33(5):1309-1314.e2. doi: 10.1016/j.arth.2018.02.078. Epub 2018 Feb 26. PMID: 29551303.

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	

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

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

Others:
EBJIS: https://boneandjoint.org.uk/article/10.1302/0301-620X.103B1.BJJ-2020-1381.R1

PRO-IMPLANT foundation: https://pro-implant.org/tools/pocket-guide

*** always sample synovial fluid – priority to identify causative organism and sensitivity to tailor local antibiotics and systemic antibiotic regiment.

Classification

Tsukayama DT, Estrada R, Gustilo RB. Infection after total hip arthroplasty. A study of the treatment of one hundred and six infections. J Bone Joint Surg Am. 1996 Apr;78(4):512-23. doi: 10.2106/00004623-199604000-00005. PMID: 8609130.

Infection type/features	I. Positive intraoperative culture	II. Early postoperative infection	III. Acute hematogenic infection	IV. Late chronic infection
Symptoms start after baseline surgery	____	Up to 4 weeks	After an asymptomatic period	After 4 weeks
Mechanism	____	Exogenous	Hematogenic	Exogenous or hematogenic
Most common etiological agent	Coagulase-negative Staphylococci (epidermidis)	Staphylococci (Coagulase-positive and negative), Gram-negative Bacilli	Coagulase-positive Staphylococci +, Streptococci	Staphylococci (Coagulase-positive and negative), Gram-negative Bacilli
Clinical presentation	Painful arthroplasty	Fever, inflammatory signs, persistent drainage, no sinus tract	Fever, inflammatory signs, no sinus tract	Fever, sinus tract, drainage, pus accumulation, local edema

Guides the further management (based on our understanding of biofilm formation)

Management

Principles:

Presuming biofilm have not formed, good tissues: access all possible surface of microbial attachment

Remove if not essential, mechanical and chemical debridement of essential surfaces.

Chronic infections (>4 weeks) – remove all possible surface of microbial attachment

Strategies:

Treatment strategies based on McPherson staging system

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7282566/pdf/abjs-478-903.pdf

Systemic host grade		Timing		Local extremity grade	
A	No compromising factors	I	Early postop (<4/52)	1	No compromising factors
B	1-2 compromising factors	II	Early haematogenous (<4/52)	2	1-2 compromising factors
C	Multiple factors or: Absolute neutrophil count less than 1000 CD4 T cell count less than 100 Intravenous drug abuse Chronic active infection, other site Dysplasia or neoplasm of the immune system	III	Chronic infection (>4/52)	3	Multiple factors

Host factors		Limb factors
> 80 yo Alcoholism Chronic active dermatitis or cellulitis Chronic indwelling catheter Chronic malnutrition (albumin < 3.0 g/dL) Current nicotine use (inhalation or oral) Diabetes (requiring oral agent and/or insulin) Hepatic insufficiency (cirrhosis) Immunosuppressive drugs (methotrexate, prednisone, cyclosporine) Malignancy (history of or active) Pulmonary insufficiency (room air arterial blood gas O2 less than 60%)	Renal failure requiring dialysis Systemic inflammatory disease (rheumatoid arthritis, systemic lupus erythematous) Systemic immune compromise from infection or disease (human immunodeficiency virus, acquired immunodeficiency virus)	Active infection present more than 3-4 months Multiple incisions (creating skin bridges) Soft-tissue loss from prior trauma Subcutaneous abscess greater than 8 cm2 Synovial cutaneous fistula Prior periarticular fracture or trauma about joint (especially crush injury) Prior local irradiation to wound area Vascular insufficiency to extremity (absent extremity pulses, chronic venous stasis disease, significant calcific arterial disease)

Surgery

Mechanical and chemical debridement:
Debride ALL possible surface of microbial attachment (includes synovectomy, non-viable tissues)
Ample irrigation (variable evidence for different irrigation solutions)

Presume no biofilm – retain prosthesis
Debridement, Antibiotics and Implant Retention (DAIR)
Success rates: 50-80% (varies acc to causative organisms, centre, patient factors)
Variations of DAIR: Double DAIR, DAPRI

Biofilm formed:

1 stage exchange:
Removal of prosthesis, all possible surfaces of microbial attachment (prosthesis, synovium, non-viable bone)
Reimplantation of new components, use antibiotic impregnated cement

1.5 stage exchange: now gaining popularity, similar to 1 stage technique higher dose of antibiotic cement, poorer cement technique, inclusion of antibiotic dowels, less emphasis given on joint stability or fixation technique (acts as functional spacer)

2 stage exchange:
Removal of prosthesis, synovium, non-viable bone
Antibiotic cement spacer in the interim period (static or dynamic)
Re-implantation after completed acute phase of anti-microbials

Local antibiotics for spacers:
Heat stable, not sensitive to oxidation, doesn't interfere with polymerisation of cement,
https://icmphilly.com/questions/should-the-antibiotics-placed-in-a-cement-spacer-be-tailored-to-the-sensitivity-of-the-infective-organism/

Less commonly performed surgeries (poorer function, usually in treatment failures)
Candidates with poorer expected outcome: poor host, poor soft tissue, difficult to treat organisms

Resection Arthroplasy - severe bone loss.
Arthrodesis
Amputation: Last resort for uncontrollable infection or life-threatening sepsis.

Antibiotic therapy:
Follows debridement, choice dependent on sensitivity results
duration:
Minimum of 3 months, dependent on organism type, severity of infection, improvement of serum inflammatory markers.
Rifampicin – most preferred antibiotic after 1 or 2 stage (prevents formation of biofilm, however development of resistance can be quite high)

Emerging / controversial topics
Sonication of prosthesis for microbial identification

Bacteriophage therapy

Regular local antibiotic infusion

Further reading
ICMphilly 2018, Hip and Knee
https://icmphilly.com/hip-knee/

PRO-IMPLANT foundation pocket book: https://pro-implant.org/tools/pocket-guide