DIAGNOSIS OF PJI

The Challenges and New Developments

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CONFLICT OF INTEREST DISCLOSURE

- Clinical Orthopaedics and Related Research: Editorial board
- Alumni Association School of Medicine of Loma Linda University: Committee member
- Neufeld Society: Board member
- Health Services International: Board member

I have no relevant disclosures.

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INTRODUCTION: THE DILEMMA

- Prior to 2010
  - Musculoskeletal Infection Society (MSIS)
  - Clinical Orthopaedics and Related Research (CORR)
  - Papers presented, success/failures
  - Diagnostic tests used
  - No accepted set of diagnostic criteria
  - No “gold standard” definition

D-dimer

Fluid cultures

Tissue cultures

C-reactive protein

Neutrophils per high-power field

Periprosthetic Joint Infection (PJI) ???

Erythrocyte sedimentation rate

Histology

Leukocyte esterase

Draining sinus

Leukocyte count

Alpha-defensin

Neutrophil percentage

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Clin Orthop Relat Res (2011) 469:2992–2994
DOI 10.1007/s11999-011-2102-9

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SYMPOSIUM: PAPERS PRESENTED AT THE 2010 MEETING OF THE MUSCULOSKELETAL INFECTION SOCIETY

New Definition for Periprosthetic Joint Infection

From the Workgroup of the Musculoskeletal Infection Society

Javad Parvizi MD, Benjamin Zmistowski BS, Elie F. Berbari MD, Thomas W. Bauer MD, PhD, Bryan D. Springer MD, Craig J. Della Valle MD, Kevin L. Garvin MD, Michael A. Mont MD, Montri D. Wongworawat MD, Charalampos G. Zalavras MD

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OUTLINE

- Evolution of the definition
- Thresholds
  - Individual tests
  - Considerations
- Problems with detection
- Take home points
- Future direction

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REVISED DEFINITION OF PJI

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

The 2018 Definition of Periprosthetic Hip and Knee Infection: An Evidence-Based and Validated Criteria

Javad Parvizi, MD [a, *], Timothy L. Tan, MD [a], Karan Goswami, MD [a], Carlos Higuera, MD [b], Craig Della Valle, MD [c], Antonia F. Chen, MD, MBA [a], Noam Shohat, MD [a, d]

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2018 DEFINITION OF PJI

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

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EVOLUTION OF THE DEFINITION (2011–2018)

Based on the proposed criteria, definite PJI exists when:

(1) There is a sinus tract communicating with the prosthesis; or

(2) A pathogen is isolated by culture from at least two separate tissue or fluid samples obtained from the affected prosthetic joint; or

(3) Four of the following six criteria exist:

(a) Elevated serum erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP) concentration,

(b) Elevated synovial leukocyte count,

(c) Elevated synovial neutrophil 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 five neutrophils per high-power field in five high-power fields observed from histologic analysis of periprosthetic tissue at ×400 magnification.

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

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

Sens: 79%

Sens: 98%

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THRESHOLDS

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	10 /1mg/dL, 860 ng/mL	2	≥6 Infected
Serum	Elevated ESR	None / 30 mm/h	1	**2-5 Possibly Infected [a]**
Synovial	Elevated synovial *WBC count or LE*	10K / 3K	3	0-1 Not Infected
Synovial	Positive alpha-defensin	1.0 signal-cutoff	3	
Synovial	Elevated synovial PMN (%)	90% / 80%	2	
Synovial	Elevated synovial CRP	6.9 mg/L	1	

Intraoperative Diagnosis	Inconclusive pre-op score *or* dry tap [a]		Score	Decision
	Preoperative score		-	≥6 Infected
	Positive histology	>5/hpf in 5 hpf (400x)	3	**4-5 Inconclusive [b]**
	Positive purulence		3	≤3 Not Infected
	Single positive culture		2	

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ESR AND CRP

- Cut-off values

	Acute < 90 days	Chronic
ESR	Not helpful	>30 mm/h
CRP	>100 mg/L	>10 mg/L

- False Negative Tests (4%–11%)
  - Slow growing organisms (Cutibacterium acnes)
  - Pre-workup antibiotics

Pay attention to units
Also 1.0 mg/dL

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D-DIMER

- Fibrin degradation product
- Normalization after surgery
  - ESR: 6 weeks
  - CRP: 2 weeks
  - D-Dimer: 2 days
- Threshold: 850 ng/mL (based on one cohort study)
- Sensitivity: 89%
- Specificity: 93%

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WBC AND %PMN

- 2018 Consensus Thresholds
  - WBC:
    - 10K/µL for acute
    - 3K/µL for chronic
  - %PMN
    - 90% for acute
    - 80% for chronic

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The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Complications - Infection

How Reliable Is the Cell Count Analysis in the Diagnosis of Prosthetic Joint Infection?

Akos Zahar, MD, PhD [a, *], Christian Lausmann, MD [a], Camila Cavalheiro, MD [a, b], Anoop C. Dhamangaonkar, MS, DNB, D Ortho, FCPS Ortho [a, c], Tommaso Bonanzinga, MD [d], Thorsten Gehrke, MD [a], Mustafa Citak, MD, PhD [a]

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How Reliable Is the Cell Count Analysis in the Diagnosis of Prosthetic Joint Infection?

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[d] *Department of Orthopedics, Istituto Clinico Humanitas, Milan, Italy*

	Total Knee	Total Hip
WBC	1600/µL	3000/µL
%PMN	60%	66%

ALPHA DEFENSIN

- Human neutrophil-derived anti-microbial peptide
- Measured in synovial fluid

	Laboratory ELISA immunoassay	Point-of-care Lateral flow
Results	Lab sendout	Immediate
Pooled sensitivity	98%	85%
Pooled specificity	96%	90%

- False positives: Metallosis
- False negatives: Indolent infections (C. acnes)

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PRECAUTIONS WITH ALPHA-DEFENSIN

- Obtain synovial fluid (not blood, not lavage fluid)
- Blood contamination is OK
- Metallosis: 30% false positive rate
- Not to be used in the first 4–6 weeks after surgery
- Not validated in setting of spacer block

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CULTURE-NEGATIVE INFECTIONS

- Prevalence: 5%–42%
- Associated with
  - Older age
  - Smoking
  - Referral from outside institution
  - Preoperative antibiotics
  - Unusual organisms (fungi, mycobacteria)
- Strategies
  - Sonication
  - PCR

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REPEAT ASPIRATIONS

- Low value with
  - Low clinical suspicion
  - Sufficient first aspiration
- Useful with
  - Prior PJI
  - Insufficient first aspiration volume
  - High clinical suspicion

Complications - Infection

What Is the Role of Repeat Aspiration in the Diagnosis of Periprosthetic Hip Infection?

Jeffrey D. Hassebrock, MD [a], Michael G. Fox, MD, MBA [b], Mark J. Spangehl, MD [a], Matthew R. Neville, MS [c], Adam J. Schwartz, MD, MBA [a, *]

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[c] *Division of Health Sciences Research, Mayo Clinic, Phoenix, AZ*

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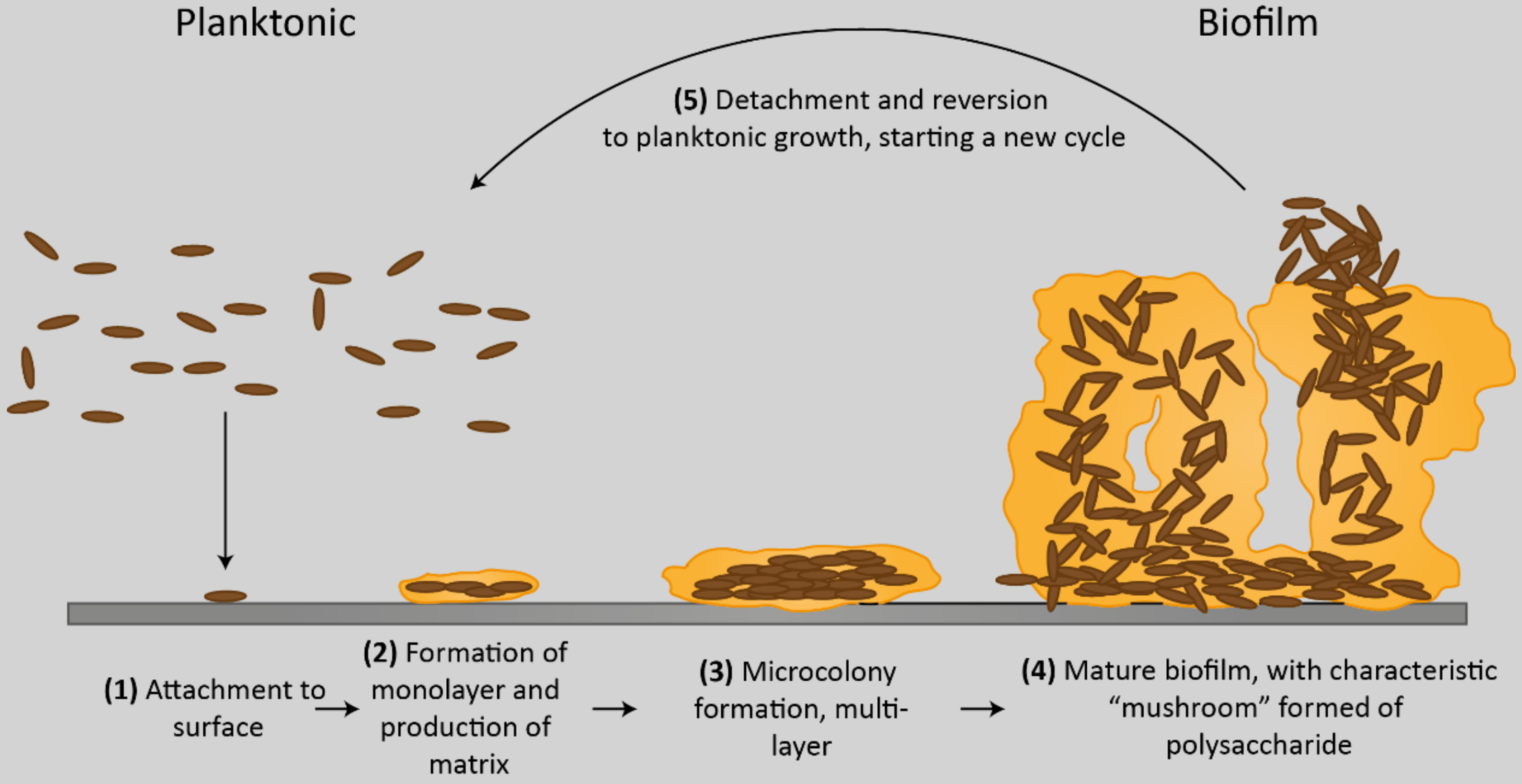
BIOFILM


Planktonic
Biofilm
(5) Detachment and reversion to planktonic growth, starting a new cycle
(1) Attachment to surface
(2) Formation of monolayer and production of matrix
(3) Microcolony formation, multi-layer
(4) Mature biofilm, with characteristic "mushroom" formed of polysaccharide

BIOFILM-FORMING ORGANISMS

- Staphylococcus
- Streptococcus
- Escherichia coli
- Pseudomonas
- Enterococcus
- Bacillus

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SONICATION / PCR

- Culture sonication fluid for better yield
- PCR amplifies bacterial DNA

- Combined
  - Sens: 75%
  - Spec: 96%

RESEARCH ARTICLE

Meta-analysis of sonication prosthetic fluid PCR for diagnosing periprosthetic joint infection

Kan Liu[1,2‡], Jun Fu[1‡], Baozhan Yu[1], Wei Sun[3], Jiying Chen[1*], Libo Hao[1*]

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2 Department of Orthopedics, Beijing University of Chinese Medicine Third Affiliated Hospital, Beijing, China,
3 Department of Intensive Care Unit, Nanyuan Hospital, Beijing, China

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TAKE HOME POINTS

- Obvious infection: 2 cx, sinus
- Elevated labs provide clue
- Thresholds higher for acute infection
- False negatives with
  - Indolent infections (C. acnes)
- Organism recovery and ID
  - Sonication, PCR

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- Molecular diagnosis
- Penetrating biofilm
- Point-of-care tests for immediate results
- Joint-specific definitions
  - Different thresholds for shoulder, hip, knee
  - Consideration for C. acnes

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Thank you