

# Diagnosis and Management of Infection in Revision Shoulder Arthroplasty

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# Conflict of Interest

- DePuy – Synthes – Royalty
- DJO – Consulting and Royalties
- Tornier Royalties
- Custom Orthopaedic Solutions Equity
- Lippincott WW – Royalties
- None relevant to this presentation

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# Infection: Incidence

- Generally reported to be less than 1% in primary anatomic TSA
- Higher in reverse TSA about 2-3 %
  - Reasons: older patients prior surgery, larger dead space, hematoma
- Revision arthroplasty: 3-10% depending upon series

Wall B, Nové-Josserand L, O'Connor DP, Edwards TB, Walch G. Reverse total shoulder arthroplasty: A review of results according to etiology. J Bone Joint Surg 2007;7: 1476-1485.

Coste JS, Reig S, Trojani C, Berg M, Walch G, Boileau P. J Bone Joint Surg 2004;86-B:65-69

# Infection: Incidence

- Late infections (greater than one year post) are most common
- Incidence is likely more than reported
  - Many revisions are not accurately diagnosed
  - Indolent pathogens
  - Incomplete pre and intraoperative evaluation
  - Diagnosis of mechanical loosening but is infection
  - Loose humeral stem within 5 years of surgery should be considered infected until proven otherwise

# Timing of Diagnosis

- Many are diagnosed months to years after the surgery
- Indolent pathogens
  - P. acne is most common
  - 70% of larger series

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# Clinical Findings Vary: Pathogen and Host Specific

- Pain most common and may be only finding
- Local soft tissue findings rare
  - Draining, erythema, sinus (rare)
  - Hematoma – assoc. high incidence of + cx
    - Cheung et al, 2008
- Systemic findings rare
  - fever, chills, malaise

**In most cases local or systematic findings of infection are subtle or nonexistent**

# Classic Laboratory Diagnoses

- Pre op synovial aspirate
  - Useful if positive
  - Negative aspirate does not always correlate with tissue cultures (20%)
  - Many cases of P acne have a dry tap
- Serology: Serum Inflammatory Markers
  - ESR, CRP and IL-6
  - Useful if positive: High specificity with clinical suspicion
  - Often negative with infection: Low sensitivity

# Imaging Diagnoses

- Radiographs
  - Loose component within 5 years if placed correctly should consider infection until proven otherwise'
  - Most loose stems are infected
- Nuclear medicine scans
  - Low predicative value in the setting of a loose component



# Pathogens

- Gram positives most common
  - Propriobacterium Acne most common infection greater than 3 months post op
  - Staph epidermidis
  - Staph aureus

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# P. Acne

- Normal skin flora: in skin and around hair follicles: more common in men (Lives in the skin)
- Anaerobic gram positive rods
- Preferential site: Axilla, chest and back
- Sensitive to most antibiotics
- Need to maintain high index of suspicion for all failed shoulder replacements even those that have functioned well for many years
- Time to culture:
  - Anaerobic,
  - Aerobic and
  - Enriched broth
  - At least 14 days

## **“ The Incidence of Propionibacterium Acnes in Open Shoulder Surgery”**

- June 2015 Mook et al, - Duke group
- 117 surgeries: All cultured and held for 14 days
  - Patient with no prior surgery
  - Patients with prior surgery
  - Sterile culture to serve as control

# Results

- **No previous surgery had 18% + cultures**
- **Previous surgery had 26% + cultures**
- **Sterile control had 13% + cultures**

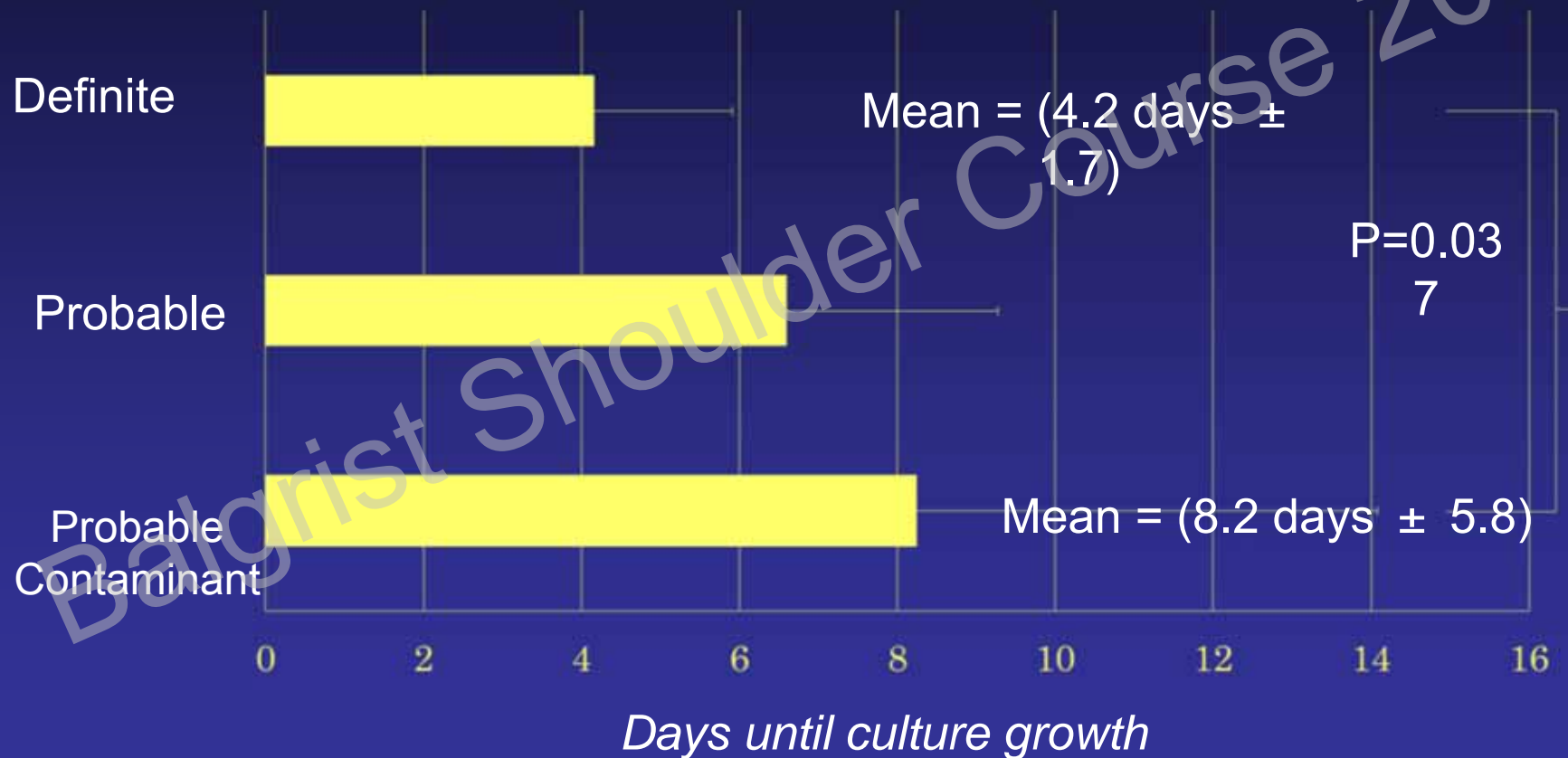
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# Their conclusions

- “Our data show that every + culture does not represent a true infection”
- “The presence of a commensal relationship between *P. Acnes* and the shoulder cannot be excluded”
- “Long hold cultures can be false +”

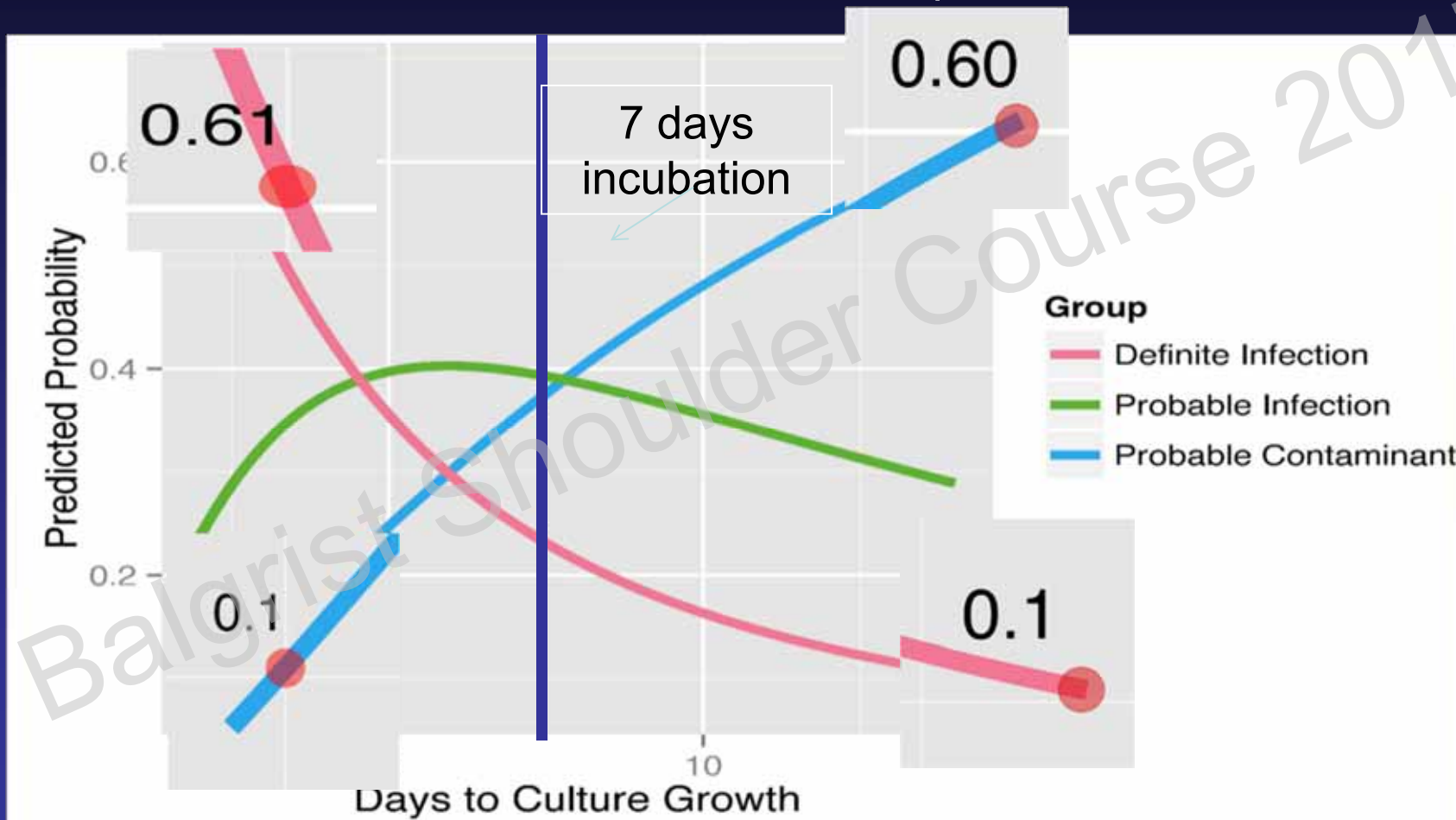
# Results: Infection classification

Relationship of Days until Detection and Infection Classification



# Results: Infection Probability Over Time

Predicted Probabilities Based on Proportional Odds Model



\*\*For each doubling in the number of days until detection, the odds of having a contaminant increased by a factor of .5 ( $p = 0.019$ )

# P. Acne

- Hold pre operative antibiotics (controversial)
- Pre operative testing to include aspirate
  - Fluid aspirate less likely to be positive than tissue samples
  - Arthroscopic tissue biopsy
- Intra – operative tissue samples for culture from at least three preferable five sites around the prosthetic:
  - Capsule,
  - membrane between the humeral and glenoid component,
  - joint fluid,
  - Periprosthetic tissue



# P. Acne: Clinical Exam

- Pain
- No systemic findings
- Sometimes no loosening but some lucent lines
- Some have subtle non blanching skin redness around the shoulder
- Intra – operative tissue may have areas of softer or edematous tissue around the implant

# Newer Tests: Synovial Alpha –Defensin (Synovasure™)

- Antibimicrobial peptides that represent a part of the innate immune system
- Expression of  $\alpha$ -defensins in synovial fluid in prosthetic shoulder joint infection

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# Results

Diagnostic parameters of  $\alpha$ -defensin compared to conventional tests.

Parameter	C-reactive protein	Erythrocyte sedimentation rate	$\alpha$ -defensin
Optimized cut-off	0.35 mg/dL	22 mm/hr	<b>0.48 ug/mL</b>
Area Under the Curve	0.69	0.69	<b>0.78</b>
Sensitivity (%)	71	43	<b>63</b>
Specificity (%)	67	90	<b>95</b>
Positive Likelihood ratio <sup>†</sup>	2.1	4.3	<b>12.1</b>
Negative likelihood ratio <sup>‡</sup>	0.43	0.63	<b>0.38</b>

# Newer Tests

## Synovial Interleukin-6

- Pro-inflammatory cytokine
  - Regulator of acute and chronic phase
  - Favors a transition from neutrophil to monocyte
  - Presence is critical for the persistence of inflammation <sup>4,5</sup>

# Results: *ROC curve*

## CONTROLS

20 underwent arthroscopic rotator cuff repair and fluid was obtained for analysis

## REVISIONS

32 patients underwent revision shoulder arthroplasty and fluid was obtained for analysis

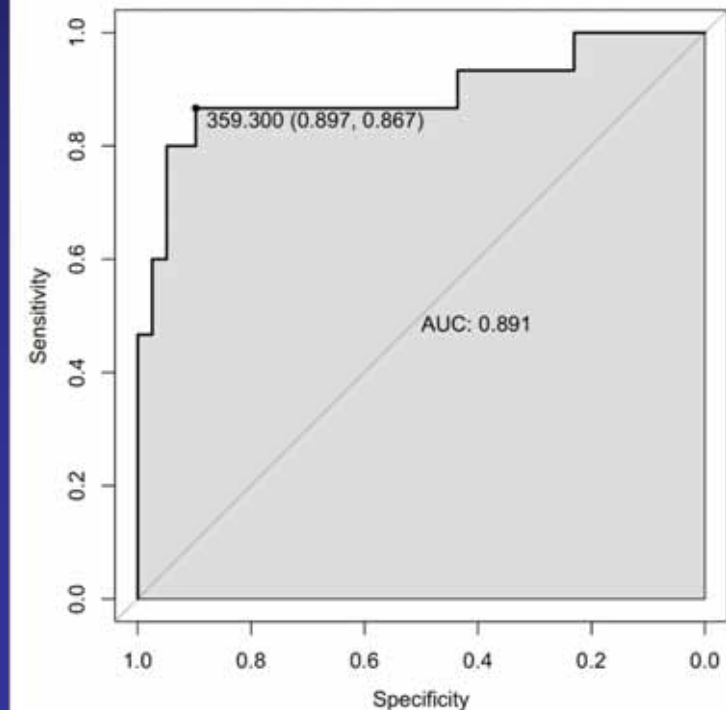
### Diagnostic parameters of interleukin-6

Parameter	Current Cohort
Sensitivity	<b>0.87</b>
Specificity	<b>0.90</b>
Positive Likelihood ratio <sup>†</sup>	<b>8.45</b>
Negative likelihood ratio <sup>‡</sup>	<b>0.15</b>

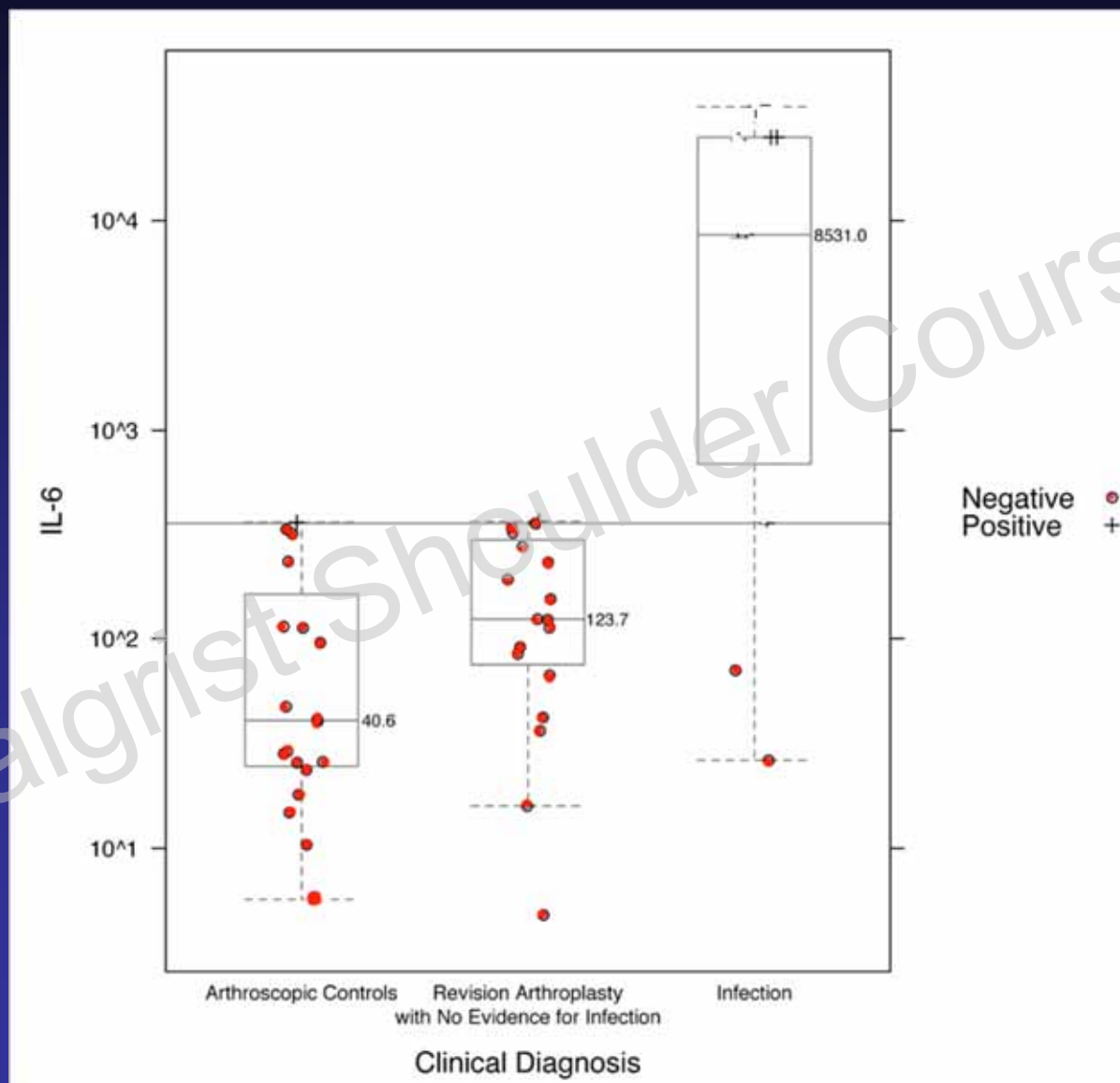
<sup>†</sup>A value > 5 is considered useful for ruling-in infection

<sup>‡</sup>A value < 0.2 is considered useful for ruling-out infection

Cut off: 359.3 pg/mL



# Results: Clinical Diagnosis



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# Treatment Options: Chronic Infection

1. Suppressive antibiotic and prosthetic retention: **Rarely Considered or Successful**
2. Debridement, synovectomy, antibiotics and prosthetic retention: **Rarely Successful**
3. Resection arthroplasty: **Rarely Accepted**
4. Single stage re-implantation with IV antibiotics: **Rarely planned as first choice, common unanticipated outcome**
5. Two stage re-implantation with spacer and IV antibiotics: **Preferred treatment best results but high morbidity.**

# Resection Arthroplasty

- Patient with poor health and low anticipated activity level
- Modest functional outcome
  - Waist level function
- Usually pain relief and cure of infection
- Improved management w/ less diagnostic delay

Maynou C, 2006



# Two Stage Revision

- Component removal
- Cement- antibiotic spacer (vanco and tobra)
- IV antibiotics (6 wks)
- Exchange prosthetic arthroplasty at 3 months, repeat w/u



# Infection after shoulder arthroplasty

- Of 2512 primary and 222 revision prosthetic shoulders, 19 primary and 7 revision shoulder arthroplasties deep periprosthetic infection.
- 7 primary shoulder arthroplasties and 1 with a revision were referred with deep periprosthetic infection.
- The average time to diagnosis of infection was 3.5 years (range, 0-14.8 years).

# Infection after shoulder arthroplasty

- Group I
  - 21 resection arthroplasty, 6/21 had recurrent infection.
- Group II
  - 6 debridement and prosthetic retention, 3/6 reinfection and underwent a resection arthroplasty.
- Group III
  - 2 shoulders who had removal of the prosthesis, debridement, and immediate reimplantation, 1 had reinfection with resection arthroplasty
- Group IV
  - 3 shoulders had removal of the prosthesis, debridement, and delayed reimplantation.
  - No Reinfection.

# Infection after shoulder arthroplasty

- At final followup, patients with a prosthesis in situ had better pain relief and shoulder function than patients treated with resection arthroplasty.
- Delayed reimplantation best chance for pain relief, eradication of infection, and maintenance of shoulder function.

# Personal Experience

## Two Stage Exchange Experience

- 27 infected arthroplasty cases treated by two stage revision one surgeon JPI from 2001-2009
- First stage- resection of prosthesis
  - Post op IV antibiotics for 6-8 weeks
  - Off antibiotics avg 6 weeks and then culture, ESR, WBC diff
- Antibiotic spacer for avg 12 weeks
- Second stage – re-implantation arthroplasty +/- bone graft

	<b>All Patients (n=27)</b>	<b>Stage 2: Reverse (n=16)</b>	<b>Stage 2: Hemi (n=9)</b>	<b>Stage 2 Reverse vs. Stage 2 Hemi p-values</b>
Complications	<b>8/27 (30)</b>	<b>7/16 (44)</b>	<b>1/9 (11)</b>	P=0.09
Postop FF (degrees)	117.5 (31.5)	<b>122.3 (32.1)</b>	<b>110.0 (34.3)</b>	P=0.38
Postop ER (degrees)	24.4 (11.1)	25.0 (5.3)	22.2 (19.2)	P=0.76
Baseline PENN	23.1 (19.2)	24.9 (22.3)	22.1 (13.3)	P=0.77
Last Follow-Up (months)	25.9 (20.6)	27.3 (19.9)	24.2 (25.8)	P=0.79
Last Follow-Up PENN	58.4 (22.4)	61.6 (19.3)	54.8 (29.1)	P=0.58

One Stage Revision  
Is it every appropriate or effective?

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# Clinical Scenario

- A patient is determined to require revision surgery for mechanical failure of a shoulder implant
- Patient undergoes a successful revision surgery, with routine intra-operative tissue samples sent into microbiology
- A few days later, after patient is dismissed from the hospital, microbiology calls to report that one of the tissue samples was positive for *Propionibacterium acnes*
- Since patient had no pre operative or intra-operative evidence for infection besides the intra-operative culture, what is the next step?



# Methods

- 187 patients undergoing revision surgery
  - 48 with at least one positive intraoperative culture
  - 17 without signs of a clinical infection
  - 31 with signs of a clinical infection

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# Results

- Only 1 of the 17 patients (5.9%) with a positive intraoperative culture developed a subsequent clinical infection
  - Interestingly, this was from a patient with a culture originally labeled as a contaminant
- The most common pathogen cultured at revision surgery was *Propionibacterium acnes* (10/17, 56%)
  - followed by coagulase negative *Staphylococcus* species (6/17, 35%)
- ESR and CRP were within normal levels for all 17 patients

# Results

- For the 31 patients treated for clinical infections with two stage revision and at least 6 weeks of IV antibiotics after the first stage,
  - 5 (16%) had minor complications related to antibiotic therapy,
  - 1 acquired a *C. difficile* infection
- Low virulence and clinically unexpected infections treated with only one stage revision without long term post operative antibiotics have a low risk for recurrent infection.

# Conclusion

- Low virulence and clinically unexpected infections treated with only one stage revision without long term post operative antibiotics have a low risk for recurrent infection.

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# After a one stage revision

- Keep patient on oral antibiotics until final culture results
- Clindmycin or doxycycline is preferred to cover P. Acne

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# Unexpected Positive Cultures

- More than one positive culture or
- One of four positive with 7 days or less
  - IF through full debridement with antibiotic cement all components
    - Consider no additional antibiotics
  - IF Incomplete removal then
    - 6 weeks IV antibiotics
    - Consider extended antibiotics

# Recommendations: Diagnosis

- Serum for ESR and CRP
  - If positive likely infection assuming not inflammatory arthritis
  - If negative poor predictor
- Synovial Fluid culture,  $\alpha$  defensin and IL6
  - If positive two stage revision
  - If negative one stage revision
- Minimum 4 tissue samples from both sides of the joint



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**Thank You for Your Attention**

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