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Dorrestijn, Oscar; Pruijn, Nathalie

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Low-grade *Cutibacterium acnes* shoulder infections do exist!

In response to the Letter to the Editor by Reinier WA Spek, Job N Doornberg, David Ring and Michel PJ van den Bekerom

Oscar Dorrestijn¹ and Nathalie Pruijn² 

We would like to respond to the commentary on our article “Pre- and peroperative diagnosis of *Cutibacterium acnes* infections in shoulder surgery: A systematic review.”

Cutibacterium acnes is housed in sebaceous glands. The moment the skin is cut with a scalpel, the *C. acnes* spreads through the surgical wound via the gloves and instruments of the surgeon. This is well demonstrated in the study of Falconer et al.¹ Probably, when the bacterial load is big enough and/or the local immune status of the patient is insufficient, these pathogens have the opportunity to develop into an infection. However, *C. acnes* is a low-virulence pathogen. Therefore, it takes time to develop into a true low-grade infection. The shoulder joint is deep and well covered by the deltoid muscle. Surgical wounds are probably healed before the infection becomes visible. There is a big difference with sternoclavicular interventions, where the joint is close under the skin. Between October 2012 and July 2018, 68 patients underwent sternoclavicular joint (SCJ) surgery in our clinic. Eight of these patients (11.8%) had an early wound infection (<6 weeks) caused by *C. acnes* (proven with cultures taken during debridement surgery).² Due to this high infection rate, two out of the three shoulder surgeons performing SCJ surgeries in our clinic started advising the preoperative application of benzoyl peroxide (BPO) gel since July 2018 to decolonize *C. acnes* in the surgical skin area. This advice was based on the results of a randomized blinded placebo-controlled study conducted in our clinic to measure the effect of BPO gel on *C. acnes* decolonization.³ Between July 2018 and June 2020, another 30 primary SCJ surgeries were performed in our clinic; 26 of these were advised to use BPO gel preoperatively. During the average follow-up period of 14 months (standard deviation 6 months), three early infections occurred (10%). One of these patients was not advised to use BPO gel preoperatively. His

infection was based on *C. acnes*. The cultures in the other two grew *Staphylococcus epidermidis*. Therefore, no early *C. acnes* infections occurred in patients who were advised to apply BPO gel on their skin preoperatively. This illustrates *C. acnes* can cause purulent infections when surgery takes place in a superficial joint like the SCJ. More importantly, when BPO is used to reduce *C. acnes* skin colonization, these early infections do not seem to occur. Therefore, it is likely these *C. acnes* infections are the result of surgical site contamination from the skin and not from bacterial growth of benign *C. acnes* commensals from the joint.

We work in a large orthopedic tertiary referral center. Around 50% of the patients we see in the outpatient clinic are second, third or fourth opinions. Often these patients have failures from previous surgeries, such as failed cuff repairs, failed stabilization procedures, mal- or non-unions in posttraumatic osteosynthesis cases and complications of shoulder arthroplasty. In order to protect the shoulders from persistent infections, we have a low threshold for taking cultures during revision surgery to identify low-grade shoulder infections. All these culture results are saved in a large database. Over the last 33 months, we have taken six samples for culture in 591 shoulder patients; 312 of these patients had no culture growth of virulent organisms or less than two cultures of the same low-virulence organism. The cultures of the other 279 patients grew two or more of the same low-virulence organisms or at

¹Department of Orthopaedics, University of Groningen, Groningen, the Netherlands

²Sint Maartenskliniek Research, Sint Maartenskliniek, Nijmegen, the Netherlands

Corresponding author:

Nathalie Pruijn, Sint Maartenskliniek, Hengstdal 3, Nijmegen 6500 GM, the Netherlands.

Email: nathalie.pruijn@hotmail.com

least one virulent organism. In nearly all patients, signs of purulent infection, such as wound leakage, fever and elevated infections were absent. However, 19 of the patients in this database were patients who had a post-operative wound infection within 90 days following primary or revision surgery. In 10 patients, the only pathogens grown in the cultures were *C. acnes*. The cultures of other patients grew *S. aureus* or *S. epidermidis*, with or without *C. acnes*. Another six patients had wound leakage between 90 days and 1 year after surgery. Half of these patients grew *C. acnes* in their cultures. In 163 out of the 279 patients, *C. acnes* was the only pathogen found; in 20 patients, just *S. epidermidis* was found; and in 12 patients, only *S. aureus* was found. Two out of the 12 patients with *S. aureus* had a purulent infection. The other patients had different organisms or a combination of organisms. The author(s) of the commentary article suggested just taking cultures or performing revision surgery in cases of purulent infections. By acting like this, organisms other than *C. acnes*, such as *S. aureus* and *S. epidermidis*, would not have been found as well. Or should these organisms be considered part of the native shoulder microbiome as well, likewise *C. acnes* as propagated by the commentators?

C. acnes surgical field contamination is an absolute problem, not just for causing shoulder infections but also in diagnosing them. Try to imagine a way of taking biopsies for culture from the deep surgical wound without contamination via the gloves and instruments of the surgeons from the superficial dermal layer. It seems impossible. You can continuously change gloves and use clean instruments, but they won't prevent spreading *C. acnes* from superficial to deep. Combine this with the knowledge that we have very sensitive methods for culturing *C. acnes* nowadays. This makes it very likely a certain amount of *C. acnes*-positive cultures are contamination and not infection. So, are all 163 patients with two or more positive *C. acnes* cultures we mentioned before infections? No, we don't think so, but we have no doubt there are low-grade *C. acnes* shoulder infections amongst them. We have treated many patients for this indication also with technically well-performed and well-fixed shoulder prosthesis with good clinical outcomes following revision surgery.

We think, for the reason of prevention of over diagnosing *C. acnes* infections, it is important to decrease the presence of *C. acnes* on the skin before taking cultures from the surgical field. *C. acnes* is part of the shoulder skin flora of most persons. In our BPO gel study, 71% of the participants had positive *C. acnes* skin cultures.³ All patients who will have shoulder arthroplasty revision surgery or will have diagnostic biopsies for cultures in our clinic are advised to use

BPO preoperatively according to a fixed protocol or are disinfected preoperatively with hydrogen peroxide.^{3,4} In case of arthroscopically obtained biopsies for culture, we used a cannula for prevention of skin contact while introducing the biopsy instruments.

It is true that there is no good definition for *C. acnes* low-grade periprosthetic shoulder infections. Garrigues et al. published, in 2019, the proceedings of an international consensus meeting of periprosthetic shoulder infections.⁵ They proposed a scoring system, including a sum of minor criteria for likelihood of a shoulder infection. As stated in the article, the absence of signs of definite infection certainly does not exclude the diagnosis of periprosthetic joint infection (PJI). Therefore, in those less distinct scenarios, three categories were established: probable PJI, possible PJI, and PJI unlikely. The committee fully expects that the definition will be tested and studied. Based on the weightings the proposed thresholds will be refined.

We reject the denial of existence of low-grade *C. acnes* shoulder infections. We think not doing so is harmful to the patients in three ways. In the first place, the surgeon won't be motivated to prevent these infections. As we know, current disinfection methods with chlorhexidine are ineffective in eliminating *C. acnes* from the skin, because it does not sufficiently penetrate the dermal layer of the skin to remove *C. acnes*.⁶ The same applies to preoperative antibiotics.^{6,7} However, preoperative application of BPO gel and hydrogen peroxide do effectively decolonize the skin.^{3,4} Secondly, untreated low-grade infections will lead to ongoing pain and deteriorated quality of life. In the latter, more in general, it will stop the search for new diagnostic methods and treatments of low-grade *C. acnes* infections.

Like all other joints, we consider the shoulder joint a sterile joint. The presence of *C. acnes* in the shoulder joint is a result of our interventions (cortisone infiltrations and surgeries). We think we have an obligation to our patients to solve complications related to this and not to wave them away as mentally grounded.

Authors' Note

Oscar Dorrestijn is also affiliated with Department of Orthopedic Surgery, Sint Maartenskliniek, Nijmegen, the Netherlands.

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ORCID iDNathalie Pruijn  <https://orcid.org/0000-0002-8967-7071>**References**

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