Authors: Stephen Kates, Christof Wagner

QUESTION 2: What is the definition of implant "colonization" vs. implant-related infection?

RECOMMENDATION: Colonization is the presence of microbiota in a joint with growth and multiplication of the organism, but without interaction between the organism and the host's immune response thus avoiding any clinical expression. Infection is the invasion of a joint by disease-causing organisms that results in an interplay with the host's immune response, causing a clinical expression and disease state.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 83%, Disagree: 8%, Abstain: 9% (Super Majority, Strong Consensus)

RATIONALE

Over the last few years, extensive research efforts have been invested in the diagnosis of implant-related infection or periprosthetic joint infection (PJI) and numerous definitions have been proposed [1–3]. Infections result in an immune response, thus all definitions rely on a combination of clinical findings, laboratory results from peripheral blood and synovial fluid, microbiological data, histological evaluation of periprosthetic tissue and intraoperative findings. The advancements in the field of diagnostics and statistics have allowed us to establish a validated, evidence-based definition for PJI as presented in another section.

On the other hand, research into colonization of a prosthetic joint implant is scarce and currently there is no universally-accepted definition for implant colonization. Colonization and infection are two different processes. There are approximately 10 times as many bacterial cells in the human flora as there are human cells in the body, thus all multicellular organisms are colonized to some degree by extrinsic organisms. The human microbiome is the collection of all the microorganisms living in association with the human body. Microbiome and host form a complex relationship, where microorganisms can confer symbiotic benefits to the host in many key aspects of life [4]. However, defects in the regulatory circuits of the host-microbiome interaction may disturb this symbiotic relationship and promote disease [5]. The difference between an infection and colonization is often only a matter of circumstance. Non-pathogenic organisms can become pathogenic given specific conditions, and even the most virulent organism requires certain circumstances to cause a compromising infection.

Analysis using next-generation sequencing (NGS) has improved understanding of the microbiome [6,7]. Recent studies suggest the presence of microbiome in aseptic deep tissue [7–9]. This is a fascinating discovery, as it suggests that microorganisms may inhabit organs previously thought to be sterile, given that they do not communicate with the outside world. In a recent study using NGS, an organism was identified in 6 of 17 patients undergoing primary arthroplasty, with no clinical or laboratory evidence of infection [10]. In another recent study NGS frequently identified multiple organisms in an infected sample and the question remains whether these infections are the result of a single dominant organism or multiple pathogenic organisms [11]. This becomes of particular concern when considering that the majority of patients who fail treatment for infection are infected with a different organism [12,13].

As we forge new alliances in our quest to eliminate prosthetic joint infections, we should also consider a call to new and mutually-beneficial ways of coexisting with the microbial flora of the world. Novel molecular techniques for organism detection provide comprehensive information on the organisms occupying the joint and thus hold the promise for a better understanding of joint colonization.

REFERENCES

[1] Parvizi J, Zmistowski B, Berbari EF, Bauer TW, Springer BD, Della Valle CJ, et al. New definition for periprosthetic joint infection: from the workgroup of the Musculoskeletal Infection society. Clin Orthop Relat Res. 2011;469:2992–2994. doi:10.1007/s11999–011–2102–9.

[2] Osmon DR, Berbari EF, Berendt AR, Lew D, Zimmerli W, Steckelberg JM, et al. Executive summary: diagnosis and management of prosthetic joint infection: clinical practice guidelines by the Infectious Diseases Society of America. Clin Infect Dis. 2013;56:1–10. doi:10.1093/cid/cis966.

[3] Parvizi J, Gehrke T, Chen AF. Proceedings of the international consensus on periprosthetic joint infection. Bone Joint J. 2013;95–B:1450–1452. doi:10.1302/0301–620X.95B11.33135.

[4] Jones S. Symbiosis: Who does what in the microbiome? Nat Rev Microbiol. 2008;6:256–257. doi:10.1038/nrmicro1880.

[5] Eloe–Fadrosh EA, Rasko DA. The human microbiome: from symbiosis to pathogenesis. Annu Rev Med. 2013;64:145–163. doi:10.1146/annurev–med–010312–133513.

[6] Aagaard K, Ma J, Antony KM, Ganu R, Petrosino J, Versalovic J. The placenta harbors a unique microbiome. Sci Transl Med. 2014 May 21;:237ra65.

[7] Hieken TJ, Chen J, Hoskin TL, Walther–Antonio M, Johnson S, Ramaker S, et al. The microbiome of aseptically collected human breast tissue in benign and malignant disease. Sci Rep. 2016;6:30751. doi:10.1038/srep30751.

[8] Urbaniak C, Gloor GB, Brackstone M, Scott L, Tangney M, Reid G. The microbiota of breast tissue and its association with breast cancer. Appl Environ Microbiol. 2016;82:5039–5048. doi:10.1128/AEM.01235–16.

[9] Urbaniak C, Cummins J, Brackstone M, Macklaim JM, Gloor GB, Baban CK, et al. Microbiota of human breast tissue. Appl Environ Microbiol. 2014;80:3007–3014. doi:10.1128/AEM.00242–14.

[10] Tarabichi M, Shohat N, Goswami K, Alvand A, Silibovsky R, Belden K, et al. Diagnosis of periprosthetic joint infection: the potential of next–generation sequencing. J Bone Joint Surg Am. 2018;100:147–154. doi:10.2106/JBJS.17.00434.

[11] Tarabichi M, Shohat N, Goswami K, Parvizi J. Can next generation sequencing play a role in detecting pathogens in synovial fluid? Bone Joint J. 2018;100–B:127–133. doi:10.1302/0301–620X.100B2.BJJ–2017–0531.R2.

[12] Mittal Y, Fehring TK, Hanssen A, Marculescu C, Odum SM, Osmon D. Two–stage reimplantation for periprosthetic knee infection involving resistant organisms. J Bone Joint Surg Am. 2007;89:1227–1231. doi:10.2106/JBJS.E.01192.

[13] Zmistowski B, Tetreault MW, Alijanipour P, Chen AF, Della Valle CJ, Parvizi J. Recurrent periprosthetic joint infection: persistent or new infection? J Arthroplasty. 2013;28:1486–1489. doi:10.1016/j.arth.2013.02.021.