

QUESTION 8: Is the mapping of biofilm to a particular component or anatomical location an important consideration in management of implant related infections?

Authors: Paul Stoodley, Garth D Ehrlich, James P Moley, Alex C DiBartola, Joshua S Everhart

Response:

At present, mapping of biofilms is only possible in the laboratory, not in the clinical setting. Therefore, it is of unknown clinical importance in relation to management of implant-related infections.

Level of Evidence: Consensus

Delegate Vote: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

Post Meeting Rationale:

The exact location or predilection of biofilm growth on specific prosthetic components or materials remains an important, albeit understudied question. There is no evidence in the literature that has mapped biofilm formation to one specific material type or location, or demonstrated mapping's importance in management of implant related infections.

For the purpose of this consensus statement the authors performed a systematic search of the literature to identify existing publications on the topic of biofilm mapping on orthopaedic implants. Searches were performed of Pubmed, Scopus, Google Scholar, Cinahl, and Cochrane databases for articles published from 1950-August 2018. Inclusion criteria were: 1) investigation of preferential biofilm formation to a specific location or type of material on orthopaedic implants, 2) clinical or laboratory research, 3) human, animal, or in-vitro research, 4) original research or systematic review, and 5) study published in English. A Pubmed Medical Subject Headings (MeSH) search of the following terms yielded a total of 117 publications from 1950-August 2018: (total joint arthroplasty OR total joint replacement) AND (biofilm mapping OR mapping OR bacteria mapping OR biofilm location OR bacterial location OR surface location). Of the articles identified in PubMed and after further searches of the Scopus, Google Scholar, Cinahl and Cochrane databases, 3 papers (1 animal study¹, 1 clinical study² and 1 in-vitro study³) met our criteria for inclusion. The reference lists of these papers were also reviewed, and no additional studies were identified that met our inclusion criteria.

While mapping to particular components is not commonly a primary focus, some work has examined patterns of bacterial formation that offer preliminary insight. Stoodley et al. ³ have shown that colored fluorescent proteins can be expressed to directly observe *Pseudomonas aeruginosa* biofilms on 316L stainless steel screws. Patchy development was noted on screw shafts and between the threads of several screws, with no significant pattern of development noted.

Confocal laser scanning microscopy has also been shown to aid in biofilm visualization on implant materials and surrounding tissue ⁴, however no focused analysis exists regarding mapping or preferential formation of the biofilm on specific components or anatomic regions. Kobayashi et al. ⁵ and Nguyen et al. ⁶ have demonstrated the utility of ultra-sonication in detection of biofilms in PJI cases. However, few components were shown to harbor bacteria and those that did were not examined for anatomic or component-specific variability. Preliminary work by Gómez-Barrena ² showed no significant difference between hip and knee components in harboring bacterial biofilm formation. While this work focused primarily on the pathogenesis of various microorganisms and only classified components as “hip” or “knee,” the finding that component type did not affect adherence shows primary indications that mapping biofilm formation may not be important to the management of PJIs. Existing research regarding biofilm mapping is not complete and cannot definitely define the importance of its practice. There is a need for additional work to replicate preliminary experiments and directly study the location of biofilm formation on orthopaedic components.

Another aspect of mapping to be considered is the material composition of orthopaedic components and the possible varying ability of such materials to harbor biofilm formation. Sheehan et al. compared stainless steel and titanium components using isolated strains of *Staphylococcus aureus* and *Staphylococcus epidermidis* in a femoral intramedullary implantation model in rabbits ¹. This study demonstrated higher levels of biofilm adherence to stainless steel components within the first 48 hours. Both strains showed this preferential growth, with higher levels of adherence reaching nearly 150% on stainless steel compared to titanium. Tuke et al. expanded the analysis of implant failure to analyze the potential role of metal-on-metal bearing surfaces ⁷. A wear patch was noted to form on retrieved failed devices, indicating a potential loosening of the orthopaedic components and opportunity for colonization. These studies demonstrate the possibility of material-specific variation in biofilm formation that may allow for mapping.

Given the limited number of studies evaluating the location of biofilms on specific components isolated from PJI patients, either clinically or in the laboratory, we conclude that there is no strong evidence that biofilms formation favors either a specific location or material type in total joint arthroplasty. Anecdotally, it seems intuitive that knowledge of biofilm location would aid in surgical therapy, and a recent paper argues that an orthopaedic biofilm disclosing solution used intraoperatively would be a useful surgical tool ⁸, however the lack of evidence in the literature prevents the conclusion that mapping biofilms to a particular component is of clinical relevance.

References:

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