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

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

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)

PRE-MEETING RATIONALE

Total joint replacement has become a vital tool for the treatment of end-stage osteoarthritis of the knee and hip and has the potential to substantially improve a patient's quality of life when successful. However, periprosthetic joint infection (PJI) is a dreaded complication of arthroplasty procedures that often results in expensive intravenous antibiotics, longer hospital stays and numerous negative effects related to patient morbidity [1]. Occurring at a rate of around 0.5-2% across all primary total joint procedures, these PJIs often involve bacteria growing in a composite of cellular and extracellular matrix material complex, known as biofilms [2,3]. 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.

Previous research examining the role of biofilms in PJI virulence is primarily focused on detection methods, imaging modalities and bacterial classification. 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. [4] 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 [5]; however, focused analysis does not exist regarding mapping or preferential formation of the biofilm on specific components or anatomic regions. Kobayashi et al. [6] and Nguyen et al. [7] have demonstrated the utility of ultra-sonication in detection of biofilms in PJI cases, showing that brief exposure of one to five minutes of infected components to ultra-sonication is effective in detecting bacterial adherence. 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 et al. [8] 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 [9]. 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 [10]. 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. It appears possible that specific components, due to their composition or anatomical position, may be more susceptible to bacterial colonization with strains associated with PJI. However, there is a lack of evidence regarding materials commonly used in implant devices, with only preliminary and speculative data suggesting variation that may lead to improved surgical management.

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 biofilm 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 [11]. However, the lack of evidence in the literature prevents the conclusion that mapping biofilms to a particular component is of clinical relevance.

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