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Authors: In Jun Koh, Adrian Taylor, Tae-Kyun Kim, Prashant Meshram

QUESTION 4: Does exchange of all modular components during debridement, antibiotic and implant retention (DAIR) reduce the rate of surgical site infection (SSI)/periprosthetic joint infection (PJI) recurrence?

RECOMMENDATION: Yes. Exchange of all the modular components during DAIR reduces the risk of PJI recurrence.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 94%, Disagree: 4%, Abstain: 2% (Super Majority, Strong Consensus)

RATIONALE

Prosthetic joint infections in the early stage are commonly treated with DAIR. If successful, the outcomes of PJI treated by DAIR show functional outcomes and patient reported outcomes equivalent to those of primary total joint replacements [1]. During this procedure, the removal of modular components allows for better visualization of the knee, especially in the posterior aspect, thereby facilitating proper debridement and potential bio-burden/bio-film elimination. However, it is difficult to judge the necessity of exchanging the modular components during DAIR surgery due to the lack of conclusive evidence.

Our literature review identified several studies that support the exchange of modular components to reduce the rate of PJI recurrence [1–7]. Amongst these, six are retrospective and one is a meta-analysis [7] involving 39 retrospective case-control and cohort studies. Notably, all the studies included in this meta-analysis were also retrospective, making its strength of evidence inherently limited. Furthermore, the success rates after modular exchange during DAIR shows a wide range of variation from 18-83% among different cohorts in various studies. Such wide variations in the impact of modular component exchange suggests that the outcome of DAIR may be associated with multiple factors such as patient selection, thoroughness of debridement, type and virulence of the microorganisms, choice and duration of antibiotic regimen and the definition of treatment failure rather than the exchange of modular components itself. However, a recent systematic review [7] of DAIR performed for total hip arthroplasty showed that the mean proportion of success rate in studies where modular components were exchanged was significantly higher (73.9%) than studies in which no components were exchanged (60.7%). A multicenter review article [5] of 349 patients with *Staphylococcus aureus* PJI of both hip and knee replacements reported that modular exchange reduced the risk of failure by 33%. In addition, PJI review articles [8,9] and Choi et al. [2] study suggest that in total knee arthroplasty, not exchanging the polyethylene was an independent predictor of failure of DAIR (100% failure versus 59% success with modular exchange). Moreover, a recent case-controlled study [3] has shown the ten year implant survival rate of 86% with modular component exchange in DAIR (as compared to 68% without modular exchange) along with a fourfold increase in eradication rate. In contrast, there are several other studies which suggest that modular component exchange is not related to higher success rate of DAIR [8,10–15].

Due to the lack of conclusive evidence in the form of well-designed prospective randomized trials and standardized protocols, only a moderate strength of recommendation is provided for exchanging the modular components during DAIR to reduce the PJI recurrence rate.

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Authors: Wayne G. Paprosky, Evan Schwechter, Linda I. Suleiman, Jeremy Loloi, FosterChen

QUESTION 5: What is the minimum necessary volume of irrigation solution to use in debridement, antibiotics and implant retention (DAIR) treatment of acute periprosthetic joint infection (PJI)?

RECOMMENDATION: We recommend that 6-9L of irrigation solution, including saline or antiseptic solution such as sterile dilute povidone-iodine, is used during DAIR treatment of acute PJI.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 90%, Disagree: 7%, Abstain: 3% (Super Majority, Strong Consensus)

RATIONALE

To date, there are no reported clinical studies relating to the optimal volume of irrigation required during DAIR treatment of PJI. However, variable outcomes have been reported with different institutions employing individual protocols for volumes of irrigation.

Few studies provide limited secondary data with regards to the ideal volume of irrigation to be used during total joint arthroplasty (TJA) in general and treatment of an infected joint in particular. In one such study, the authors were able to determine that four liters of sterile saline pulse lavage were sufficient to remove bone and polymethyl methacrylate (PMMA) debris exceeding 1µm in size from the joint during TJA. The authors extrapolated from their results that bacteria might effectively be removed with the same amount of irrigation given the similarity in size to the particulates assessed [1]. This model did not consider the effect of the developing bacterial biofilm on infected arthroplasty implants. DAIR has traditionally been thought to reduce the bacterial load and be effective in the acute period given that bacteria theoretically had not yet formed a glycocalyx biofilm. In another study, the authors used an in vitro model to determine the efficacy of biofilm removal from arthroplasty implants using high-pressure pulsatile lavage. Three liters of normal saline were used over an area measuring 1cm^2 recreating a prosthesis covered in *Staphylococcus aureus* biofilm. The authors concluded that pulse lavage is not able to sufficiently debride pre-existing biofilm. The volume of irrigation solution required was not investigated as a primary endpoint and the authors caution against extrapolating the results to clinical scenarios as their in vitro model potentially overestimated the amount of biofilm debrided by three liters of sterile saline pulse lavage [2]. More important than the volume of irrigation, researchers have found that the presence of staphylococcal infection, an elevated American Society of Anesthesiologists (ASA) score, or purulence were more likely to determine failure.

A comprehensive systematic review of the literature relating to open DAIR treatment of acute postoperative and hematogenous periprosthetic hip and/or knee joint infections, with or without modular component exchange, was performed. Databases searched include: PubMed, Embase, Cochrane Review and Google Scholar. Initial query generated 664 articles. Review articles and book chapters were excluded, while all references from such sources were screened for inclusion (spanning from 1990-2017). We included all Level I-IV studies that specified a certain volume of irrigation used per procedure and recorded the type of solution(s) used, mode of lavage administration, use of additive(s) and number of irrigation and debridements (I&Ds) performed. We included cases whereby some of the modular components may have been exchanged, but excluded those with dedicated planned staged exchanges. A total of 14 studies met the aforementioned criteria (Table 1) [3–16].

Typically, around 6 to 9L of solution were used during a single DAIR treatment, with 12 of the 14 studies utilizing up to 9L or more of irrigation solution. The evidence base for the specific irrigation volume is poorly defined within all studies, and recommendations for specific volumes in both primary and review articles reference consensus data obtained from previously published guidelines or individual protocols. [17–22] Therefore, this systematic review represents the body of evidence of actual irrigation volumes reportedly used in the literature.

No studies currently exist directly linking the necessary volume of irrigation to use in DAIR in acute PJI. Based on several retrospective studies, we extrapolate that the use of 6-9L of irrigation solution may be required when treating acute PJI. Prospective studies evaluating the volume of irrigation used as a study endpoint are required to better elucidate the optimal volume of irrigation in DAIR treatment of PJI.