reported by Jerry et al. [4]. The nearly 5-fold increase in recurrence rates seen in patients with prior bone infection serves as a significant warning to surgeons to adequately debride as much contaminated surface as is feasible to allow for control of infection and subsequent implantation.

Based on the articles included in this review, there is no evidence to suggest that the implantation of prosthetic joints during an episode of sepsis is advisable. Often, however, joint arthroplasty procedures will need to be performed to alleviate the tremendous pain associated with infective destruction of a joint surface. Each of the included studies recommended a staged approach to surgical management of PJI with the most common approach being two-staged revision. There is very limited evidence to support retention of implants if a curative outcome is the main objective of the treatment. Also, there is a lack of evidence to suggest initiating antibiotic therapy to counter the systemic sepsis before the first-stage revision surgery. Though, identification and eradication of clinically obvious secondary foci, like indwelling catheters and skin, soft tissue, respiratory and genito-urinary infections, could be of vital importance for controlling the PJIs and preventing subsequent relapse. Therefore, like PJIs without systemic sepsis, a combination of effective debridement and concurrent intravenous antimicrobial therapy is the current best practice standard of care. The main limitation associated with the effective execution of this thorough and proven care strategy seems to be the accurate diagnosis of the complete clearance of infection to restore *aseptic* status to the patient.

It must be noted, as of the completion of this review, there are no studies that directly evaluate whether operative treatment should differ in patients with systemic sepsis in the setting of PJI. There are a number of closely related papers quoted above, but that is the limit of current knowledge. It is, however, our opinion that patients with systemic sepsis exhibiting constitutional symptoms are at serious risk and should be treated urgently. The best option of treatment is bioburden reduction which involves extensive soft tissue debridement and removal of infected prostheses.

## REFERENCES


[1] Wigren A, Karlstrom G, Kaufer H. Hematogenous infection of total joint implants: a report of multiple joint infections in three patients. Clin Orthop Relat Res. 1980:288–291.
[2] Cherney DL, Amstutz HC. Total hip replacement in the previously septic hip. J Bone Joint Surg Am. 1983;65:1256–1265.
[3] Southwood RT, Rice JL, McDonald PJ, Hakendorf PH, Rozenbilds MA. Infection in experimental hip arthroplasties. J Bone Joint Surg Br. 1985;67:229–231.
[4] Jerry GJ, Rand JA, Ilstrup D. Old sepsis prior to total knee arthroplasty. Clin Orthop Relat Res. 1988;236:135-140.
[5] Luessenhop CP, Higgins LD, Brause BD, Ranawat CS. Multiple prosthetic infections after total joint arthroplasty. Risk factor analysis. J Arthroplasty. 1996;11:862–868.
[6] Takwale VJ, Wright ED, Bates J, Edge AJ. Pasteurella multocida infection of a total hip arthroplasty following cat scratch. J Infect. 1997;34:263–264.
[7] David TS, Vrahas MS. Perioperative lower urinary tract infections and deep sepsis in patients undergoing total joint arthroplasty. J Am Acad Orthop Surg. 2000;8:66–74.
[8] Murdoch DR, Roberts SA, Fowler VG, Shah MA, Taylor SL, Morris AJ, et al. Infection of orthopedic prostheses after Staphylococcus aureus bacteremia. Clin Infect Dis. 2001;32:647–649. doi:10.1086/318704.
[9] Lee GC, Pagnano MW, Hanssen AD. Total knee arthroplasty after prior bone or joint sepsis about the knee. Clin Orthop Relat Res. 2002;404:226-231.
[10] Gallo J, Kolár M, Novotný R, Riháková P, Tichá V. Pathogenesis of prosthesis-related infection. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2003;147:27–35.
[11] Gristina AG, Naylor PT, Myrvik QN. Musculoskeletal infection, microbial adhesion, and antibiotic resistance. Infect Dis Clin North Am. 1990;4:391–408.
[12] Sendi P, Banderet F, Graber P, Zimmerli W. Periprosthetic joint infection following Staphylococcus aureus bacteremia. J Infect. 2011;63:17–22. doi:10.1016/j.jinf.2011.05.005.
[13] Vilchez F, Martínez-Pastor JC, García-Ramiro S, Bori G, Tornero E, García E, et al. Efficacy of debridement in hematogenous and early post-surgical prosthetic joint infections. Int J Artif Organs. 2011;34:863–869. doi:10.5301/ijao.5000029.
[14] Tande AJ, Palraj BR, Osmon DR, Berbari EF, Baddour LM, Lohse CM, et al. Clinical presentation, risk factors, and outcomes of hematogenous prosthetic joint infection in patients with Staphylococcus aureus Bacteremia. Am J Med. 2016;129:221.e11-e20. doi:10.1016/j.amjmed.2015.09.006.


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# QUESTION 3: What should be done for patients with persistent wound drainage (PWD) after total joint arthroplasty? What are the indications for surgical intervention?

**RECOMMENDATION:** Management of draining wounds after total hip arthroplasty (THA) or total knee arthroplasty (TKA) consists of two main steps; nonoperative and operative. The nonoperative measures include: modification of venous thromboembolism (VTE) prophylaxis, nutritional supplementation, dressing measures (such as negative pressure wound therapy (NPWT)) and restriction of range of motion. If draining continues for more than seven days after implementing the nonoperative measures, operative interventions may be indicated – including irrigation and debridement, synovectomy and single-stage exchange. In certain situations, superficial wound washout may be indicated (Fig. 1).

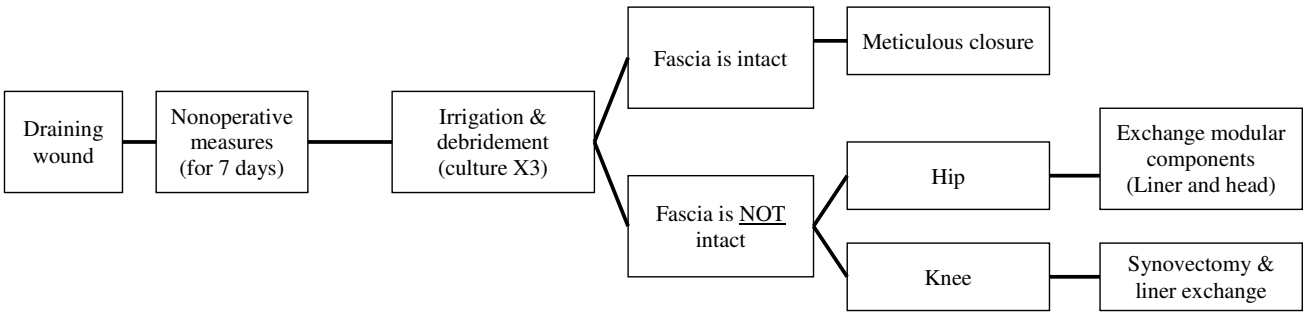


**Figure 1. Management of draining wounds after total joint arthroplasty.**

**LEVEL OF EVIDENCE:** Limited

**DELEGATE VOTE:** Agree: 89%, Disagree: 8%, Abstain: 3% (Super Majority, Strong Consensus)

## RATIONALE

Drainage after THA and TKA increases the risk of subsequent superficial or deep infection. Studies have shown that the risk of deep infection increases by 29% after TKA and 42% after THA with each additional day of drainage [1].

### Definition

Persistent wound drainage (PWD) by definition is an area of drainage greater than 2 x 2cm on the incisional gauze that persists over 72 hours postoperatively [2]. Drainage can be due to hematoma, seroma, fat necrosis or defects in arthrotomy closure [3].

### Nonoperative Measures

**Ceasing anticoagulation agents:** Anticoagulation agents for VTE prophylaxis have been shown to affect PWD after THA and TKA. Low molecular weight heparin (LMWH) leads to higher rates of prolonged wound drainage after THA and TKA compared to aspirin and warfarin [1]. Fondaparinux had fewer wound complications but no difference in infection after TKA compared to aspirin, LMWH or warfarin [4]. Dabigatran was found to have an increased rate of wound drainage and increased length of stay following TKA and THA [5]. Therefore, one of the first steps in patients with PWD is to cease the anticoagulation medications, if possible.

**Negative pressure wound therapy:** NPWT applied to closed incisions following TKA or THA has been shown to reduce the rate of superficial wound infection [6]. In patients undergoing primary total hip or knee arthroplasty, NPWT has been shown to reduce post-surgical wound exudate, number of dressing changes, a trend toward reduced length of stay and a trend toward reduced post-op surgical wound complications [7]. Using ultrasound to measure volume, NPWT has been shown to reduce the size of post-op seromas when compared to a standard dressing [8]. NPWT applied 3-4 days after THA for persistent drainage resulted in drainage resolution in 76% while 24% required further surgery [9]. As part of local wound care in the first 7 days of PWD, we recommend using incisional NPWT systems.

**Nutrition:** Malnourishment has several definitions. One of the most commonly used ones is: serum transferrin <200mg/dL, serum albumin <3.5g/dL or total lymphocyte count <1500/mm3. Poor nutritional status is associated with a significant (up to 5-fold) increase in risk of wound complications following THA and TKA [10–12]. Malnourished patients are more likely to fail nonoperative treatment (odds ratio (OR) 18.29), as well as surgical debridement (35% vs. 5%, p<0.0003) [3]. We strongly urge modifying the nutritional status of the patients prior to an elective arthroplasty procedure. In case of a PWD, postoperative nutritional supplements can help to improve the wound healing process.

### Surgical Intervention

Surgical intervention for drainage should be considered after five to seven days of PWD [1–3]. Saleh et al. [2] conducted a 20-year surveillance study and concluded that patients with longer than five days of drainage have 12.7 times higher likelihood to develop surgical site infection in comparison with those who had less drainage time. Therefore, we recommend proceeding with surgical intervention if the PWD continues for more than seven days.

The first step of the surgical intervention is irrigation and debridement (I&D) and obtaining at least three intraoperative cultures. Irrigation is recommended to be performed with at least 9 liters of an irrigation solution, such as normal saline or an aqueous iodophor solution. At this point if the fascia is found to be intact, we recommend meticulous closure. However, if the fascia is not intact, modular components should be exchanged [1,3]. Studies have shown promising results with single I&D. Jaberi et al. [3] reported that in THA and TKA patients with PWD, drainage stopped in 76% of patients after single-stage I&D. The remaining 24% required subsequent treatments such as repeat I&D, removal of implant or long-term antibiotic administration.

## REFERENCES


[1] Patel VP, Walsh M, Sehgal B, Preston C, DeWal H, Di Cesare PE. Factors associated with prolonged wound drainage after primary total hip and knee arthroplasty. J Bone Joint Surg Am. 2007;89:33–38. doi:10.2106/JBJS.F.00163.

[2] Proceedings of the International Consensus Meeting on Periprosthetic Joint Infection. Foreword. J Orthop Res. 2014;S2-S3. doi:10.1002/jor.22543.

[3] Jaberi FM, Parvizi J, Haytmanek CT, Joshi A, Purtill J. Procrastination of wound drainage and malnutrition affect the outcome of joint arthroplasty. Clin Orthop Relat Res. 2008;466:1368–1371. doi:10.1007/s11999-008-0214-7.

[4] Cafri G, Paxton EW, Chen Y, Cheetham CT, Gould MK, Sluggett J, et al. Comparative effectiveness and safety of drug prophylaxis for prevention of venous thromboembolism after total knee arthroplasty. J Arthroplasty. 2017;32:3524-3528.e1. doi:10.1016/j.arth.2017.05.042.

[5] Bloch BV, Patel V, Best AJ. Thromboprophylaxis with dabigatran leads to an increased incidence of wound leakage and an increased length of stay after total joint replacement. Bone Jt J. 2014;96-B:122–126. doi:10.1302/0301-620X.96B1.31569.

[6] Redfern RE, Cameron-Ruetz C, O'Drobinak SK, Chen JT, Beer KJ. Closed incision negative pressure therapy effects on postoperative infection and surgical site complication after total hip and knee arthroplasty. J Arthroplasty. 2017;32:3333–3339. doi:10.1016/j.arth.2017.06.019.

[7] Karlakki SL, Hamad AK, Whittall C, Graham NM, Banerjee RD, Kuiper JH. Incisional negative pressure wound therapy dressings (iNPWTd) in routine primary hip and knee arthroplasties: a randomised controlled trial. Bone Jt Res. 2016;5:328–337. doi:10.1302/2046-3758.58.BJR-2016-0022.R1.

[8] Pachowsky M, Gusinde J, Klein A, Lehrl S, Schulz-Drost S, Schlechtweg P, et al. Negative pressure wound therapy to prevent seromas and treat surgical incisions after total hip arthroplasty. Int Orthop. 2012;36:719–722. doi:10.1007/s00264-011-1321-8.

[9] Hansen E, Durinka JB, Costanzo JA, Austin MS, Deirmengian GK. Negative pressure wound therapy is associated with resolution of incisional drainage in most wounds after hip arthroplasty. Clin Orthop Relat Res. 2013;471:3230–3206. doi:10.1007/s11999-013-2937-3.

[10] Gherini S, Vaughn BK, Lombardi AV, Mallory TH. Delayed wound healing and nutritional deficiencies after total hip arthroplasty. Clin Orthop Relat Res. 1993;188–195.

[11] Cross MB, Yi PH, Thomas CF, Garcia J, Della Valle CJ. Evaluation of malnutrition in orthopaedic surgery. J Am Acad Orthop Surg. 2014;22:193–199. doi:10.5435/JAAOS-22-03-193.

[12] Greene KA, Wilde AH, Stulberg BN. Preoperative nutritional status of total joint patients. Relationship to postoperative wound complications. J Arthroplasty. 1991;6:321–325.