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Review

Persistent Wound Drainage After Total Joint Arthroplasty: A Narrative Review

Frank-Christiaan B.M. Wagenaar, MD [a, *], Claudia A.M. Löwik, MD [b], Akos Zahar, MD, PhD [c], Paul C. Jutte, MD, PhD [b], Thorsten Gehrke, MD, PhD [c], Javad Parvizi, MD, PhD [d]

[a] Department of Orthopedic Surgery, OCON Center for Orthopaedic Surgery, Hengelo, The Netherlands
[b] Department of Orthopaedic Surgery, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands
[c] Department of Joint Surgery, HELIOS ENDO-Klinik, Hamburg, Germany
[d] Department of Orthopaedic Surgery, Rothman Institute at Thomas Jefferson University Hospital, Philadelphia, PA

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ABSTRACT

Background: Persistent wound drainage after total joint arthroplasty (TJA) is an important complication with potential substantial adverse consequences, in particular periprosthetic joint infection.
Methods: This review evaluated the available literature regarding several issues in the field of persistent wound drainage after TJA and offers a classification of persistent wound drainage and an algorithmic approach to the decision-making process.
Results: Available literature addressing the diagnosis and treatment of persistent wound drainage after TJA is scarce and an evidence-based clinical guideline is lacking. This is partially caused by the absence of a universally accepted definition of persistent wound drainage. In patients with persistent wound drainage, clinical signs and serological tests can be helpful in the diagnosis of a developing infection. Regarding the treatment of persistent wound drainage, nonsurgical treatment consists of absorbent dressings, pressure bandages, and temporary joint immobilization. Surgical treatment is advised when wound drainage persists for more than 5-7 days and consists of open debridement with irrigation and exchange of modular components and antimicrobial treatment.
Conclusion: Based on this literature review, we proposed a classification and algorithmic approach for the management of patients with persistent wound drainage after TJA. Hopefully, this offers the orthopedic surgeon a practical clinical guideline by finding the right balance between overtreatment and undertreatment, weighing the risks and benefits. However, this classification and algorithmic approach should first be evaluated in a prospective trial.

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* Reprint requests: Frank-Christiaan B.M. Wagenaar, MD, Department of Orthopedic Surgery, Center for Orthopaedic Surgery OCON, Geerdinksweg 141, 7555 DL Hengelo, The Netherlands.

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Persistent wound drainage (PWD) after total joint arthroplasty (TJA) is an important problem because of its potential adverse influence on the outcome following TJA, in particular development of a periprosthetic joint infection (PJI) [1–8]. PJI is associated with high morbidity and mortality, and a high socioeconomic burden due to prolonged hospital stay, surgical procedure(s), antimicrobial treatment, and wound care.

Remarkably, PWD is rarely reported in literature and thereby literature fails to provide conclusive scientific evidence on many issues related to PWD after TJA, including the definition and treatment of PWD. This lack of evidence results in wide variation in diagnosis and treatment in daily practice, often only founded by the surgeon's opinion. The absence of scientific consensus prompted this review of the available literature.

We performed a literature search and included all papers relevant to the subject of PWD (Table 1). Articles that were not written in English or did not have full text available were excluded. We included all relevant papers, regardless of the level of evidence [14]. Although most articles were of low level of evidence, we included these articles because of the small number of available papers on the subject of PWD and due to the lack of articles with a higher level of evidence. Based on this literature review, we developed a classification of PWD and an algorithmic approach to PWD after TJA that may guide clinicians in their decision-making process to select the appropriate treatment for PWD.

Incidence and Relevance

The reported incidence of PWD after TJA varies between 0.2% and 21% [3–5,8,9,13], with higher incidences after revision TJA [8]. This wide range in incidence is mainly caused by the variation in definitions of PWD (Table 1), illustrating the lack of consensus regarding the definition of PWD. Moreover, higher awareness results in higher incidences of PWD, as demonstrated by Maathuis et al [13] who found a 21% incidence of PWD when protocol-based surveillance was used to detect wound drainage after TJA.

Wound drainage is usually a noninfectious disturbance in wound healing of short duration that occurs during the first days after TJA [2], but it may be an early symptom of a (developing) PJI. Research published between 1973 and 1983 described PWD as one of the main risk factors for developing a PJI [5,15–19], even though several researchers could not observe a correlation between PWD and PJI [20–23]. Contemporary research underscored the adverse effects of wound complications, such as an increased risk of PJI, readmission, prolonged hospital stay, reoperations, and higher healthcare costs [1–4,6–8,12,24].

Regarding the consequences of PWD after total knee arthroplasty (TKA), Galat et al [2] found a 6% increased cumulative risk of PJI in patients who required early surgical treatment for any early wound healing complication after TKA. Moreover, these patients had 5.3% risk of major additional surgical intervention (resection arthroplasty, muscle flaps, or amputation) in the first 2 years following TKA [2]. A different study by Galat et al [25] showed an increased risk of 10.5% for PJI and 12.3% risk for major reoperation within 2 years after TKA in patients who required surgical intervention for postoperative hematoma.

Regarding the consequences of PWD after both total hip arthroplasty (THA) and TKA, Parvizi et al [26] demonstrated that patients who developed a PJI were more likely to have experienced PWD and hematoma than patients without PJI (16.8 and 12.6 times more likely respectively). Similar results were reported by Saleh et al [7].

Although most studies on wound-related complications after TJA have focused on the risk of developing PJI, wound-related complications also predispose patients to worse functional outcome [1–4,7–9,12,24,27–32]. Mortazavi et al [31] found substantially worse patient satisfaction and lower Harris Hip Scores in patients requiring additional surgery for hematoma after THA. Adelani et al [9] observed similar worse functional outcome for patients with wound complications after TKA. Moreover, published data suggest that patients with PWD after TKA have an increased risk of residual pain and poor functional outcome, similar to patients who develop an infectious complication after TKA [9]. Patient expectation after wound complications following TJA should therefore be tempered, even if wound complications do not result in PJI.

Theoretical and Practical Considerations

Wound drainage after TJA can be physiological in the first days after index surgery. However, it is unknown when wound drainage should be perceived as persistent or abnormal. Many other issues related to wound complications remain unanswered as well, such as the following: To what extent will wound drainage impair wound healing and/or offer a retrograde gateway for entry of pathogens into the joint space? [8] Where does wound drainage originate? If it originates from deeper layers of the joint, does it represent an early deep infection or merely normal drainage from defects in the soft tissues? If it originates from outside the joint, does it represent normal wound drainage or a draining hematoma or abscess? [1] All these issues are important for the decision-making process but remain difficult to clarify.

Definition of PWD

Literature lacks a proven definition of PWD in terms of both duration and amount of drainage. Previous studies used a definition of duration of wound drainage varying from 2 to 9 days after index surgery (Table 1) [3,8]. In 2013, the first International Consensus Meeting (ICM) on PJI defined PWD as $>2 \times 2$ cm of drainage in the wound dressing beyond 72 hours after index surgery [27,33]. This consensus stated that limiting the definition of PWD to 72 hours postoperative allows for early intervention that may prevent the adverse consequences of PWD. However, the definition of PWD should be further specified and evaluated.

Clinical and Serological Signs of a Developing Infection

Clinical signs of wound infection (superficial or deep) include systemic and local signs. Systemic signs involve fever, chills, and tachycardia. Local signs include induration, painful skin erythema (especially around the sutures), warmth, purulent drainage, and presence of a sinus tract [34]. However, some of these clinical signs are frequently observed in the first days after uncomplicated TJA surgery as an early physiological response to surgical trauma.

Fever or pyrexia (generally defined as temperature >38.5°C/>101°F) is physiological in the first 3-5 days after index surgery [35–45]. In this postoperative phase, additional tests for an underlying infectious cause of fever is unwarranted as it results in patient discomfort, has minor clinical yield, and is accompanied by considerable healthcare costs [35,36,39–46]. However, temperatures >39°C, particularly if present for multiple days and/or later than 3-5 days after surgery, require further diagnostic tests [46].

Described blood serology parameters in the diagnosis of PJI are C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and white blood cell count (WBC). After uncomplicated TJA surgery, the CRP level increases rapidly and reaches maximum level (up to 200-400 mg/L) within 2-3 days, followed by a quick decrease and normalization to preoperative level in 2-8 weeks after uncomplicated TJA, even in patients with rheumatoid arthritis [47–61]. An

Table 1
Overview of Literature Addressing Wound Drainage After Total Joint Arthroplasty.

Author	Study Type and Sample Size	Level of Evidence	Definition		Incidence of Wound Drainage	Results
			Duration of Drainage	Amount of Drainage		
Adelani [9]	Retrospective N = 2221 TKAs	3	N/A	N/A	0.2%	Seventeen patients had noninfectious wound complications (including persistent wound drainage) and 12 patients had deep infection. Patients with complications had lower knee society function scores and a higher incidence of mild or greater pain
Dennis [10]	Opinion	N/A	>7 d after TJA	N/A	N/A	Persistent wound drainage (not associated with erythema or purulence) can be managed with wound care and immobilization. If wound drainage persists beyond 5-7 d, spontaneous cessation of drainage is unlikely and surgical debridement is indicated
Hansen [11]	Prospective N = 5627 THAs	4	>3-4 d after TJA	Drainage that has soaked through the postoperative dressings	2.0%	NPWT was started after 3-4 d of wound drainage in 109 patients and applied for 2 d. Seventy-six percent did not need additional surgery, 10% needed superficial debridement, 11% needed deep debridement, and 3% required component removal. Predictors for additional surgery were International Normalized Ratio >2, previous hip surgery, and NPWT >48 h
Jaberi [3]	Retrospective N = 11,785 TKAs/THAs	3	>2 d after TJA	Drainage that has soaked through the postoperative dressings	2.9%	Three hundred patients with wound drainage >48 h were treated with local wound care and oral antibiotics. Wound drainage stopped between 2 and 4 d in 72%. The remaining patients underwent single debridement (76%) or additional treatment (repeat debridement, resection arthroplasty, or long-term antibiotics). Timing of surgery and malnutrition predicted failure of the first debridement
Lonner [12]	Opinion	N/A	Several days after TJA	N/A	N/A	Wound drainage beyond several days after surgery may increase the risk of infection. Drainage will usually stop after 24-48 h of immobilization.

(*continued on next page*)

Table 1 (*continued*)

Author	Study Type and Sample Size	Level of Evidence	Definition		Incidence of Wound Drainage	Results
			Duration of Drainage	Amount of Drainage		
						If not, open debridement should be performed, including obtaining cultures, irrigation, and meticulous wound closure. Exercises may be resumed once the wound is stable
Maathuis [13]	Retrospective N = 558 TKAs/THAs	3	>5 d after TJA	N/A	16.5%	Comparison of an algorithmic approach to an ad hoc approach. In the algorithmic approach, registration of persistent wound drainage was 2-fold (21% vs 11%), but the number of open debridements was lower (17% vs 30%) and the salvage rate higher (94% vs 85%)
Patel [4]	Retrospective N = 2437 TKAs/THAs	2	>5 d after TJA	≥2 × 2 cm area of gauze covering the wound is wet or when the fluid is noted to be originating from the surgical wound	20.1%	Persistent wound drainage results in longer hospital stay. Each day of wound drainage after day 5 increased the risk of wound infection by 42% following THA ($P <$ .001) and by 29% following TKA (not significant after correction for BMI)
Saleh [7]	Prospective N = 2305 TKAs/THAs	3	Wound drainage	N/A	N/A	Thirty-three patients developed a superficial wound infection. Hematoma formation and days of wound drainage were significant predictors of superficial wound infection. Fifty-eight percent developed a prosthetic joint infection. Patients with >5 d of wound drainage had 12.7 times more risk of developing a prosthetic joint infection
Surin [5]	Retrospective N = 803 THAs	3	N/A	N/A	12.6%	One hundred fifteen patients had superficial wound drainage and cultures were positive in 70 wounds. Thirty-four patients developed a prosthetic joint infection. Patient with superficial wound drainage had a 3.2 times higher risk of developing a prosthetic joint infection. The risk was further influenced by the character of the exudate and the use of prophylactic antibiotics
Vince [1]	Review/opinion	N/A	Limited amount of time	N/A	N/A	Persistent wound drainage should be treated by wound care and immobilization. If

(*continued on next page*)

Table 1 (*continued*)

Author	Study Type and Sample Size	Level of Evidence	Definition		Incidence of Wound Drainage	Results
			Duration of Drainage	Amount of Drainage		
						drainage does not stop after 3-7 d, open debridement should be performed. Aggressive surgery may prevent sepsis. Drainage that starts in the late postoperative phase is a great concern as it usually results from a prosthetic joint infection
Weiss [8]	Retrospective N = 597 TKAs	4	≥4 consecutive days beyond day 5 after TJA	≥2 × 2 cm area of gauze covering the wound is wet or when the fluid is noted to be originating from the surgical wound	1.3%	Eight patients with persistent wound drainage. Open debridement was performed at an average of 12.5 d after index surgery. Twenty-five percent of patients had positive tissue cultures. All patients were successfully treated with adjuvant antibiotics

N/A, not applicable or not described; THA, total hip arthroplasty; TKA, total knee arthroplasty; TJA, total joint arthroplasty; NPWT, negative pressure wound therapy; BMI, body mass index.

infectious complication in patients with PWD should be suspected if CRP levels increase later than 72 hours after TJA, or remain elevated beyond 7 days after TJA [52,57–59,61,62].

The WBC and ESR are less appropriate for the diagnosis of PJI in case of PWD, since the WBC increases only slightly after surgery and returns to normal within 7 days after index surgery, while the ESR increases only gradually, with peak level between day 5 and 14 and normalization in 19 days up to 9 months after index surgery [47,54,55,59–61,63].

An Algorithmic Approach to the Decision-Making Process

In clinical practice, assessment of the origin (intra-articular or extra-articular) and type of wound drainage (physiologic or infectious secretion) is often difficult. Weiss and Krackow [8] concluded that wound drainage can offer a pathway where pathogens can enter the wound and joint, acting as a retrograde pathway for infection. This implies that PWD should be perceived as potential imminent PJI, hence justifying a low threshold for early surgical intervention [1,64]. However, advocating early surgical intervention may result in unnecessary operations, while delaying early surgical intervention may result in the development of PJI.

An evidence-based algorithmic approach on PWD may ease the decision-making process in the diagnosis and timing of treatment. In literature, some authors merely provided general statements on the evaluation of wound complications [1,2,27]. Only few studies specifically addressed PWD [3–8,13] and only one of these studies described an algorithmic approach [13]. In this study, the algorithmic approach was compared to an ad hoc approach in which the surgeon decided upon own discretion. Even though the reported percentage of PWD was 2 times higher in the algorithmic cohort (21% vs 11%), the number of surgical interventions was lower (17% vs 30%) and the salvage percentage was higher (94% vs 85%) [13]. This suggests that an algorithmic approach may lead to increased awareness of PWD and an improved decision-making process with a lower frequency of surgical interventions and better outcome.

Timing of Treatment

The optimal timing of starting nonsurgical or surgical treatment in patients with PWD remains to be established. Patel et al [4] stated that each day of PWD beyond day 5 after TJA surgery increased the risk of wound infection with 42% after THA and 29% after TKA. Saleh et al found a 12.7 times higher risk of developing PJI when the wound drained for more than 5 days after THA/TKA compared to patients with shorter duration of wound drainage. Based on these findings, they advised on performing open debridement in case of hematoma or PWD for more than 7 days postoperative [7].

More recently, Jaberi et al [3] (defining wound drainage as persistent when drainage soaked postoperative dressing for more than 2 days) showed that draining wounds after THA and TKA healed uncomplicated within 2-4 days of nonsurgical treatment (wound care and antimicrobial treatment) in 72% of patients. The remaining 28% underwent open debridement. This was successful in 76% of patients, while the remaining 24% underwent subsequent treatment including repeated debridement, resection arthroplasty, or suppressive antimicrobial treatment. These authors recommended early surgery within 7 days after index surgery even though their successful debridement antibiotic and implant retentions were performed at a mean of 14 days (range 4-32 days) after index surgery [3]. Based on these studies, the ICM formulated the statement that surgical treatment should be performed if wound drainage persists for longer than 5-7 days after index surgery [27].

Nonsurgical Treatment Strategies

Nonsurgical treatment strategies are usually performed prior to surgical intervention [27]. Since PWD is associated with an increased risk of PJI, observation only is highly discouraged [3,4,7,8]. Acceptable nonsurgical treatment is adequate wound care by using absorbent dressings and pressure bandages (hand-made spica for the hip), supplemented by several days of joint

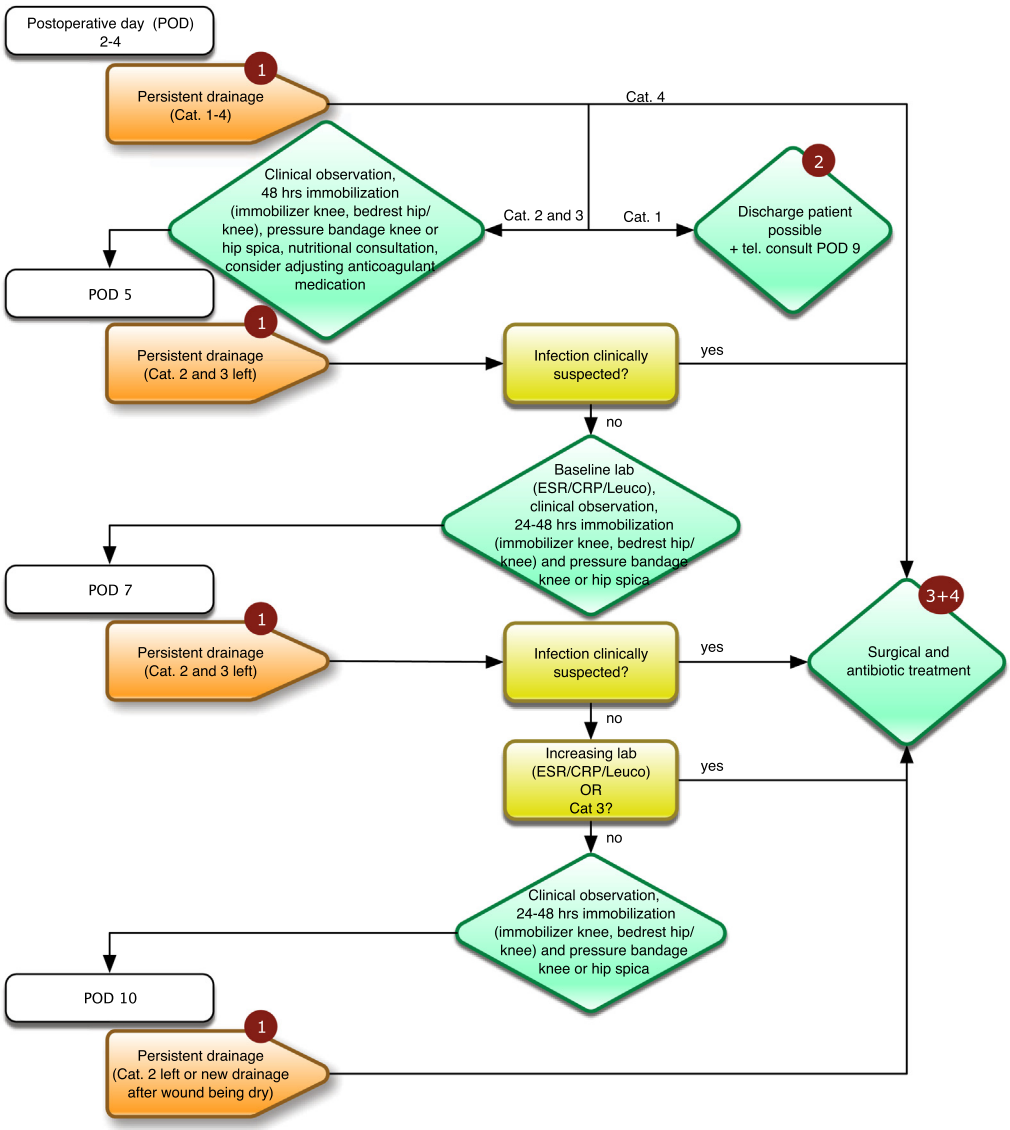

Figure 1. Proposed algorithm for diagnosis and treatment of persistent wound drainage after total joint arthroplasty.

immobilization and interruption of physical therapy [3,65]. Bed rest and braces may impair early rehabilitation, but this outweighs the potential risk of prolonging the duration of PWD and increasing the risk of PJI [1,12]. Good results were reported on the use of silver-impregnated dressings [66] and negative pressure wound therapy (NPWT) [11,67–69]. However, a Cochrane meta-analysis could not find definitive evidence for the effectiveness of NPWT [69].

The ICM advised on early analysis and correction of anticoagulation, anemia, glucose regulation in diabetic patients, and malnutrition [27]. One study retrospectively evaluated 11,785 THAs/TKAs and found malnutrition to predispose for failure of surgical debridement and an increased risk of PJI in patients with PWD. Therefore, they recommended consultation of a nutritional physician in order to treat in case of wound drainage persisting longer than 48 hours [3]. With regard to anticoagulation, Parvizi et al showed that patients with a mean International Normalized Ratio higher than 1.5 had an increased risk of developing wound complications and PJI after THA/TKA. Hence, they stressed the importance of cautious anticoagulant treatment in order to prevent formation of a hematoma and subsequent wound drainage [26].

Although antimicrobial treatment during PWD has been described [3], current consensus discourages antimicrobial treatment due to a lack of evidence on decreasing the risk of PJI [11,12]. Furthermore, it may confound culture results thus impairing the diagnosis of an early PJI. And finally, concerns about the increase in antimicrobial resistance cannot be ignored [34].

Surgical Treatment Strategies

Most publications advocate early surgical treatment in case wound drainage persists despite a period of adequate nonsurgical treatment [1,3,10,27]. Surgical treatment typically consists of open deep debridement and thorough irrigation, using 6-9 L of saline administered by low-pressure pulsatile jet lavage [70]. Optionally, diluted povidone-iodine or chlorhexidine gluconate can be used to irrigate the joint cavity [71–73]. However, it should be recognized that these recommendations on irrigation are derived from literature on primary TJA and trauma surgery, mostly from animal and basic science studies.

Whenever possible, modular components should be exchanged as it offers a better potential for thorough debridement and

irrigation deep to these modular components. Moreover, modular component exchange is advised because the polyethylene component (acetabular liner or tibial inlay) may be colonized by pathogens [8]. The soft tissue should be meticulously closed in a multilayer fashion [12,27]. NPWT is a plausible alternative when wound closure is not possible [69]. In these cases, consultation of a plastic surgeon is recommended.

Administration of prophylactic antimicrobial treatment is advised prior to incision [34,74]. Various deep tissue samples for bacterial cultures are obtained, preferably 5 samples to increase pathogen detection. Each tissue sample is obtained using a clean instrument to avoid contamination. Tissue swabs are not advised [34]. Tissue samples should be cultured up to 14 days and antimicrobial treatment is continued until culture results are definitive [34]. In case of positive culture results, targeted antimicrobial treatment should be continued in consultation with an infectious disease specialist, usually 6-12 weeks. Jaberi et al found positive deep periprosthetic tissue cultures in 34% (28 of 83 cases) after surgical treatment for PWD after THA/TKA. Cultures were more often positive in the failure group (17 of 20, 85%) compared to the success group (11 of 63, 17%) [3]. Weiss and Krackow [8], reporting PWD in 8 of 597 primary TKAs, showed that 25% (2 of 8 cases) had positive cultures after surgical debridement at a mean of 12.5 days after surgery (range 8-18 days). However, issues can be raised on the statistical power of this study cohort.

Summary

The reported incidence of PWD after TJA varies between 0.2% and 21%, with higher incidences after revision TJA. This wide range in incidence is mainly caused by the variation in definitions of PWD. The ICM formulated a definition that defines PWD as >2 × 2 cm for longer than 72 hours, but this definition should be further specified and validated.

Clinical signs of infection and blood serology can be helpful in diagnosing PJI in case of PWD, although some clinical signs can be a normal physiological response in the first days after TJA. An increase in CRP later than 72 hours after index surgery or persistent elevated levels of CRP beyond 7 days can indicate development of an infectious complication.

Nonsurgical treatment of PWD generally involves absorbent dressings, pressure bandages, and temporary joint immobilization. Present consensus discourages the use of antimicrobial treatment. Nutritional consultation and correction of anticoagulation and metabolic imbalances should be considered.

Surgical treatment should be performed when wound drainage persists for more than 5-7 days after index procedure despite adequate nonsurgical treatment. Nonetheless, establishing this time frame needs validation in future research. Surgical treatment should include thorough open debridement and irrigation, obtaining tissue samples (cultured up to 14 days) and exchange of modular components. Empirical broad spectrum antimicrobial treatment is administered in consultation with an infectious diseases specialist.

Proposed Algorithm

Based on this literature review, the authors developed an algorithm to facilitate the decision-making process of PWD after TJA (Fig. 1). Although we aimed to differentiate between PWD in THA and TKA in this algorithm, we did not find enough scientific evidence to make this distinction. In addition to the algorithm, we also propose a classification of PWD that divides wound drainage into 4 categories based on the amount of drainage (Table 2). As this classification is merged into the algorithm, the amount of drainage is combined with the duration of drainage (Fig. 1), in which larger amounts of wound drainage are tolerated for a shorter period. Hopefully, this algorithm offers the orthopedic surgeon a practical clinical guideline by finding the right balance between overtreatment and undertreatment, weighing risks and benefits. Currently, a multicenter randomized controlled trial on the optimal treatment of PWD after TJA is being conducted to examine the validity and applicability of such a classification and algorithm in daily clinical practice [75].

Table 2
Proposed Classification of Persistent Wound Drainage After Total Joint Arthroplasty.

Category	Description
1 (Limited)	A stripe of blood in the wound dressing in the line of the wound or less than 2 × 2 cm in size[a]
2 (Moderate)	More than 2 × 2 cm drainage in absorbent gauze or dressing but without the need for change in the wound dressing (ie, dressing is not soaked)
3 (Excessive)	One dressing change per day due to soaked absorbent gauze or dressing
4 (Massive)	Two or more daily dressing changes due to soaked absorbent gauzes or dressings

[a] According to the 2013 International Consensus Meeting on Periprosthetic Joint Infection [28,33].

Conclusion

This review summarizes the available literature addressing several issues in the field of PWD after TJA. There are limited scientific data on PWD and absence of an evidence-based guideline regarding diagnosis and treatment, partially caused by the lack of a universally accepted definition. We developed a classification of PWD and an algorithmic approach for the management of PWD after TJA to offer the orthopedic surgeon a practical guideline for daily clinical practice.

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