

## Role of negative pressure wound therapy in total hip and knee arthroplasty

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### Abstract

Negative-pressure wound therapy (NPWT) has been a successful modality of wound management which is in widespread use in several surgical fields. The main mechanisms of action thought to play a role in enhancing wound healing and preventing surgical site infection are macrodeformation and microdeformation of the wound bed, fluid removal, and stabilization of the wound environment. Due to the devastating consequences of infection in the setting of joint arthroplasty, there has been some interest in the use of NPWT following total hip arthroplasty and total knee arthroplasty. However, there is still a scarcity of data reporting on the use of NPWT within this field and most studies are limited by small sample sizes, high variability of clinical settings and end-points. There is little evidence to support the use of NPWT as an adjunctive treatment for surgical wound drainage, and for this reason surgical intervention should not be delayed when indicated. The prophylactic use of NPWT after arthroplasty in patients that are at high risk for postoperative wound drainage appears to have the strongest clinical evidence. Several clinical trials

including single-use NPWT devices for this purpose are currently in progress and this may soon be incorporated in clinical guidelines as a mean to prevent periprosthetic joint infections.

**Key words:** Negative-pressure wound therapy; Vacuum-assisted closure; Total knee replacement; Total hip replacement; Prosthesis-related infections

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**Core tip:** The application of negative pressure wound therapy (NPWT) in arthroplasty has generated much interest. Its proposed mechanisms of action include macrodeformation and microdeformation of the wound bed, fluid removal, and stabilization of the wound environment. There is little evidence to support the use of NPWT as an adjunctive treatment for surgical wound drainage. However, there appears to be strong clinical evidence for the prophylactic use of NPWT after arthroplasty in patients that are at high risk for postoperative wound drainage. Several clinical trials involving single-use NPWT devices for this purpose are currently in progress.

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## INTRODUCTION

The use of negative pressure for wound healing, also referred to as vacuum-assisted closure, is a well-established practice that dates back to the 1940s<sup>[1-3]</sup>. While this technique was originally intended for flaps, skin grafts, and radical neck and groin dissection, its success has led to a rapid expansion of indications with over 700 articles describing its use<sup>[4]</sup>. Current evidence-based indications for the use of negative pressure on wound healing are broad and include chronic, acute, traumatic, subacute and dehiscent wounds, partial-thickness burns, ulcers (such as diabetic or pressure), flaps and grafts<sup>[4-12]</sup>.

The rationale behind the use of subatmospheric pressure for wound healing is based upon a wide array of mechanisms that ultimately result in wound contraction, mechanical stimulation of epithelial growth, and prevention of fluid collection, drainage and bacterial growth<sup>[13,14]</sup>. Despite the extensive literature, there is considerable controversy regarding its efficiency and applicability in certain clinical situations. A recent systematic review identified thirteen randomized clinical trials studying the use of negative pressure wound therapy (NPWT) and suggested that there is still little evidence

to support its use in the treatment of acute and chronic wounds<sup>[15]</sup>.

Periprosthetic joint infection (PJI) can be a devastating complication after joint arthroplasty. With the potential to not only treat but also prevent wound complications, there has been some interest surrounding the use of NPWT in the setting of joint arthroplasty. Patel *et al*<sup>[16]</sup> have shown that specific patient characteristics are associated with prolonged wound drainage following total hip arthroplasty (THA) and total knee arthroplasty (TKA). Prolonged wound drainage (*i.e.*, greater than five days postoperative) puts a patient at 12.7 times higher risk of PJI<sup>[17]</sup>. The ability to preoperatively determine candidates at higher risk for prolonged wound drainage (and hence, PJI) would enable the surgeon to consider NPWT in those arthroplasty patients who could benefit most from its use. To date, however, there are no specific guidelines, indications, or reviews on the use of NPWT after TKA and THA. This review will provide a brief introduction on the history and rationale of NPWT, its basic mechanisms of action, current evidence in the field of TKA and THA, contraindications, complications, risk factors and perspectives for future research in this area.

## BRIEF HISTORY AND RATIONALE OF NPWT

Despite meticulous hemostasis and tissue-handling techniques, any operation that requires separation of tissue planes and extensive tissue manipulation will cause some amount of fluid collection within the surgical wound. Fluid build-up can be detrimental to wound healing as it impedes normal blood flow and eventually leads to the formation of dense fibrous tissue. Prior to NPWT, common strategies to deal with this problem included devices such as Penrose drains and pressure dressings<sup>[18]</sup>. Numerous cases of debilitated patients with chronic, dehiscent, and often infected wounds not amenable to closure led to the implementation of subatmospheric pressure systems<sup>[19]</sup>. This treatment modality provided not only complete coverage of the wound, but also constant interstitial fluid removal and mechanical stimulation of surrounding tissues. Sheppard<sup>[1]</sup> was the first to report the use of sealed drainage over surface wounds. However, the application of continuous subatmospheric pressure to this drainage system was first described by Raffi<sup>[2]</sup>. While initially intended for chronic, non-healing wounds on debilitated patients, the indications for NPWT expanded to include subacute and acute wounds<sup>[20-24]</sup>.

There are five basic components to any NPWT system: The foam, tube, drapes, pump and canister. The foam is placed in direct contact with the wound and can be tailored to its specific geometry. Typically, the foam is made of polyurethane ether and is composed of highly interconnected cells of size ranging between 400-600 µm in diameter<sup>[25,26]</sup>. The so-called open-pore foam allows the pressure to be evenly distributed throughout

its entire surface. A non-collapsible tube is embedded in the foam and connected to a vacuum pump. The ideal pressure applied by the pump may vary according to the fragility of the surrounding tissues but optimal granulation tissue formation has been reported with a subatmospheric pressure of 125 mmHg<sup>[27]</sup>. Semi-occlusive adhesive drapes cover the surface of the wound containing the foam and these ensure an airtight seal. Finally, the proximal end of the tube leads to a canister that functions as a remote storage recipient for effluent fluid<sup>[19]</sup>.

The first commercially available device that achieved widespread usage, in the early 1990s, was the Vacuum-assisted wound closure device and technology (V.A.C.) [Kinetic Concepts Inc. (KCI), San Antonio, TX]. Landmark publications by Argenta *et al.*<sup>[19]</sup> detailing the basic mechanism of NPWT and Morykwas *et al.*<sup>[14]</sup> describing its clinical utility contributed to increasing acceptance of the NPWT. Since then, significant advances have been made to the device to improve safety and functionality. First, the incorporation of computerized alarm systems made it possible to detect inadequate seal, excessive fluid output and bleeding. Second, the development of compact, lightweight devices allowed patients to remain ambulatory throughout the duration of treatment<sup>[28]</sup>. Third, newer models also allow the instillation of fluids without loss of negative pressure in an attempt to continuously remove particulate and bacterial matter. These have been particularly useful in the setting of deep, contaminated wounds<sup>[29,30]</sup>. The recent use of silver coated foam is intended to provide a local antibacterial effect<sup>[31,32]</sup>.

There is some concern regarding the overall quality and conflict of interest associated with the published studies supporting the use of NPWT in various clinical settings. One contributor to this problem is the heterogeneity of published articles in terms of wound types, comparisons and outcome variables<sup>[15]</sup>. Conflict of interest in NPWT-related research is also a matter of concern since the main research sponsors are the two leading device manufacturers. Despite the great commercial success, there is still a lack of data supporting the benefits of NPWT on wound closure<sup>[24]</sup>.

## MECHANISMS OF ACTION

The application of NPWT on wound beds has direct and indirect effects on wound healing. There are four main direct mechanisms by which NPWT has been suggested to work: (1) macrodeformation; (2) microdeformation; (3) fluid removal; and (4) stabilization of the environment<sup>[33]</sup>. Numerous indirect effects of NPWT on wound healing have also been proposed, including the modulation of inflammation<sup>[34]</sup>, angiogenesis<sup>[35]</sup>, granulation tissue formation<sup>[36,37]</sup>, peripheral nerve response<sup>[38,39]</sup> and alteration in bioburden<sup>[7]</sup>. This section will focus mainly on the four direct mechanisms as they are more broadly studied and widely accepted.

The concept of macrodeformation involves the con-

traction of the foam once subatmospheric pressure is applied. Foam contraction exerts centripetal traction at the wound-foam interface resulting in approximation of the edges and decreased wound surface area<sup>[40]</sup>. The increased pressure applied to the tissue below the wound bed also contributes to the compression of capillaries, creating a localized decrease in perfusion. As a result, local upregulation of hypoxia-inducible growth factor production, including vascular endothelial growth factor, stimulates directionalized vessel sprouting towards the wound<sup>[33]</sup>. The end result of macrodeformation of the wound bed is thus a decrease in wound surface area and increased local vascularity.

When exposed to subatmospheric pressure, the porous surface of the foam induces microdeformations in the underlying tissue by creating an undulated surface of the wound bed<sup>[41]</sup>. Cell deformation leads to cytoskeletal stretch which in turn provides an independent stimulus for cell proliferation, migration, and differentiation<sup>[42]</sup>. As a consequence, the conformational changes induced in the surface of the wound by the porous surface of the foam ultimately result in increased epithelial cell proliferation as compared to normal occlusive dressings<sup>[40]</sup>.

Fluid removal is an essential mechanism by which NPWT relieves the compressive effect of extracellular fluid on surrounding tissues<sup>[43]</sup> and clears the wound from toxins, exudates and bacteria<sup>[44]</sup>. Indirectly, this also reduces the amount of fluid that must be cleared by the lymphatics and induces a local increase in lymphatic density<sup>[45]</sup>. Less extracellular fluid build-up also translates into decreased capillary compression and increased tissue perfusion<sup>[43]</sup>.

Finally, NPWT dressings have the ability to transform an open wound into a closed wound. The semiocclusive drapes covering the foam and surrounding skin maintain thermal stability, prevent evaporative water losses<sup>[46]</sup>, stabilize osmotic and oncotic gradients at the wound surface<sup>[47]</sup> and reduce the risk of external contamination<sup>[48]</sup>. The semiocclusive aspect of the drapes also allows for limited permeability to vapor and other gases in order to maintain a moist wound environment<sup>[46]</sup>.

## CURRENT EVIDENCE IN HIP AND KNEE ARTHROPLASTY

The use of NPWT was pioneered in plastic surgery and subsequently adopted by other surgical fields, including vascular, cardiothoracic and abdominal surgery. In orthopaedic surgery, there is limited literature on the use of NPWT. In a systematic review, Karlakki *et al.*<sup>[49]</sup> identified 9 studies reporting the use of NPWT in orthopaedic surgery, five of which were Randomized controlled trials (RCTs). There is an even greater scarcity of published studies concerning the use of NPWT in adult reconstructive surgery. In this review, we identified eight studies reporting on the use of NPWT on either THA or TKA (Table 1).

Table 1 Literature on negative pressure wound therapy on hip and knee arthroplasty

Ref.	Origin	Type	Indication	Device, negative pressure delivery	Length of use	Results	Conflict of Interest
Gomoll <i>et al.</i> <sup>[50]</sup>	United States	Case series	Revision THA with history of multiple revisions ( <i>n</i> = 1 NPWT), hemiarthroplasty with bladder/bowel incontinence ( <i>n</i> = 1 NPWT)	V.A.C. <sup>®</sup> , 75 mmHg	3 d (average)	Incisions noted to be well healed at a minimum of 3 mo	No
Kirr <i>et al.</i> <sup>[51]</sup>	Germany	Case series	I and D for acute hip ( <i>n</i> = 3 NPWT) and knee PJI ( <i>n</i> = 2 NPWT)	V.A.C. <sup>®</sup> instill system with antibiotic instillation, amount of pressure delivery N/A	15.2 d (average)	Eradication of infection in all cases, complete wound healing achieved in 10-14 d	N/A
Lehner <i>et al.</i> <sup>[52]</sup>	Germany	Case series	I and D for acute hip ( <i>n</i> = 2 NPWT), and knee PJI ( <i>n</i> = 1 NPWT)	V.A.C. <sup>®</sup> instill system with antiseptic solution, 100-150 mmHg	6 d (average)	Retention of all 3 implants with no further signs of infection at a minimum of 8 wk	N/A
Kelm <i>et al.</i> <sup>[53]</sup>	Germany	Case series	I and D for acute hip PJI ( <i>n</i> = 28 NPWT)	Periprosthetic placement of V.A.C. <sup>®</sup> , 200 mmHg for 72 h, and 150 mmHg	6 d	Infection eradication in 26/28 cases with implant retention at a minimum of 12 mo	No
Howell <i>et al.</i> <sup>[54]</sup>	United States	RCT	Primary TKA with increased risk for postoperative drainage ( <i>n</i> = 24 NPWT <i>vs</i> <i>n</i> = 36)	V.A.C. <sup>®</sup> , 125 mmHg	2 d	No difference in days to dry wound; 1 PJI in each group. Study stopped because of skin blisters in 63% of patients in NPWT arm	Yes
Pachowsky <i>et al.</i> <sup>[55]</sup>	Germany	RCT	Primary THA for OA ( <i>n</i> = 9 NPWT <i>vs</i> <i>n</i> = 10)	Prevena <sup>TM</sup> , 125 mmHg	5 d	Decreased seroma development in NPWT group ( <i>P</i> = 0.021)	Yes
Hansen <i>et al.</i> <sup>[56]</sup>	United States	Retrospective cohort	Persistent wound drainage at POD 3 to 4 after primary THA ( <i>n</i> = 86 NPWT) and revision THA ( <i>n</i> = 23 NPWT)	V.A.C. <sup>®</sup> , 125 mmHg	24-48 h	83 (76%) had no further surgery, 26 (24%) had further surgery. No NPWT-related complications	No
Pauser <i>et al.</i> <sup>[57]</sup>	Germany	RCT	Hemiarthroplasty after femoral neck fracture ( <i>n</i> = 11 NPWT <i>vs</i> <i>n</i> = 10)	Prevena <sup>TM</sup> , 125 mmHg	5 d	NPWT group had fewer dressing changes, less days of wound secretion, less wound care time, and less dressing material used ( <i>P</i> < 0.05 for all)	Yes

V.A.C.<sup>®</sup>: Vacuum assisted closure system (KCI, San Antonio, TX); Prevena<sup>TM</sup>: Prevena incision management system (KCI, San Antonio, TX); THA: Total hip arthroplasty; TKA: Total knee arthroplasty; NPWT: Negative pressure wound therapy; PJI: Periprosthetic joint infection; I and D: Incision and debridement; RCT: Randomized controlled trial; OA: Osteoarthritis; N/A: Not available; KCI: Kinetic Concepts Inc.; POD: Post-operative day.

Gomoll *et al.*<sup>[50]</sup> reported their experience in five cases in which NPWT was used as a postoperative dressing for primarily closed incisions. Indications included either a high likelihood of prolonged wound drainage or procedures performed in areas prone to postoperative swelling. This was among the first reported prophylactic use of NPWT in orthopaedic surgery. Of the five cases, two involved hip reconstruction. In one patient, NPWT was used because of large dead space and extensive soft tissue dissection. In the other case, NPWT was used because of the increased risk of contamination secondary to bladder and bowel incontinence. Treatment duration averaged three days and negative pressure was set at 75 mmHg. At three months post-operatively, the incisions were well-healed without complications. The remaining three cases involved the use of NPWT after open reduction and internal fixation for comminuted pilon, intertrochanteric, and subtrochanteric fractures which are not discussed here.

A series of papers originating from Germany reported on the therapeutic use of NPWT after acute PJI. Kirr *et al.*<sup>[51]</sup> used a newer model of NPWT in which the direct instillation of fluids to the wound is made possible without the loss of negative pressure. The device was used on five cases after irrigation and débridement (I and D) for acute PJI in which the wound was left open. Fluids used for instillation included a local antibiotic (bacitracin with neomycin sulfate) and an antiseptic solution (polihexanide). Complete wound healing was achieved in all five patients after fourteen days of therapy. In a similar study, Lehner and Bernd<sup>[52]</sup> used the same device with instillation therapy to treat three cases of acute hip or knee PJI. Instillation was made with only a solution of polihexanide. At eight weeks, retention of all three implants was successfully achieved. Lastly, Kelm *et al.*<sup>[53]</sup> reported on 28 cases of acute hip PJI managed with I and D followed by an internal use of NPWT. This was the first study to report the placement of the foam either periprosthetically or into the resection cavity with an outgoing transcutaneous tube. The wound was closed and inflammation parameters monitored. After a mean duration of nine days, surgical removal of the foam was performed. The foam was exchanged in cases in which there were macroscopic signs of persistence of the



infection. At a mean follow-up of 36 mo, eradication of infection was achieved in 26 out of the 28 cases. These three preliminary case series suggest a potential role for NPWT in the treatment of PJI, which requires further testing with large scale, controlled studies to support this practice.

Howell *et al.*<sup>[54]</sup> conducted a RCT to establish the benefit of prophylactic NPWT after TKA in patients at high risk for prolonged wound drainage. High risk was defined as body mass index > 30 and the use of enoxaparin sodium for deep venous thrombosis prophylaxis. The trial was prematurely interrupted when a total of 60 knees were enrolled and a significant difference in blister formation was detected between the NPWT group and the control group. Among the 24 knees in the NPWT group, 15 (63%) developed linear blisters at the edges of the polyurethane ether foam, whereas only three out of 36 knees in the control group (12%) developed blisters. There was no difference in time to a dry wound or incidence of PJI between the two groups. In order to address the issue of blistering, a single fine-meshed, non-adherent film was recommended for use over unprotected skin in order to avoid direct contact with the foam<sup>[54]</sup>. This has already been incorporated in single-use, disposable devices such as Prevena™ (KCI, San Antonio, Texas) and PICO™ (Smith and Nephew, Hull, United Kingdom) and the blistering complication has not been reported in subsequent studies.

Another RCT evaluating the prophylactic use of NPWT for wound complications was conducted by Pachowsky *et al.*<sup>[55]</sup>. Inclusion criteria included normal-risk THA for osteoarthritis, with nine patients receiving a single use NPWT device for five days and ten patients receiving a standard occlusive dressing. The novelty of this study was its primary end-point: The development of post-operative seromas as detected through ultrasound measurements. On post-operative day ten, a seroma was present in 44% of patients in the NPWT group as compared to 90% in the control group, with a significantly decreased seroma volume in the NPWT group (1.97 mL vs 5.08 mL,  $P = 0.021$ ). Although reduction of postoperative seromas may potentially lead to increased blood flow and better apposition of the wound edges, there are no data to suggest that this is specifically linked to decreased rates of PJI and to justify the use of NPWT in normal-risk patients.

Hansen *et al.*<sup>[56]</sup> investigated the therapeutic use of NPWT for persistent incisional drainage after primary and revision THA. Indication for NPWT was persistent wound drainage at postoperative days 3 to 4. Interestingly, 83 patients (76%) had complete resolution of wound drainage without further surgical intervention. Of the 26 patients who required further intervention despite NPWT, 23 (88%) had complete resolution of drainage after a single I and D. This study was the first in the field of reconstructive surgery to attempt NPWT first instead of I and D. Furthermore, it was reported that failed therapy with NPWT did not compromise the results of a

subsequent I and D. Even though this was a retrospective study, it provided important data as to the value of NPWT as primary therapy for early wound drainage.

Lastly, Pauser *et al.*<sup>[57]</sup> conducted a RCT studying the prophylactic use of NPWT after hemiarthroplasties for femoral neck fractures. Eleven patients were randomized to the NPWT group and ten patients to a control group (occlusive dressing). The end-points chosen for analysis were the number of dressing changes ( $P < 0.0001$ ), days of wound secretion ( $P = 0.0005$ ) and wound care time ( $P < 0.0001$ ). Statistical significance was achieved in all three end-points favoring the NPWT group. Furthermore, there was a decreased incidence of seromas in the NPWT group (36% vs 80%). Despite the limited sample size, this study attempted to show not only the main benefits of NPWT in terms of wound healing, but also secondary gains such as less time spent by health care professionals and less consumption of wound care resources.

Overall, there is a clear lack of high-ranking scientific evidence in the field of adult reconstructive surgery concerning the use of NPWT. Studies are limited by a high variability of clinical settings and small sample sizes. The prophylactic use of NPWT after arthroplasty in high risk candidates seems to have the strongest clinical evidence<sup>[54,56,58]</sup>. The use of NPWT as an adjunctive therapy for acute PJI after I and D is only supported by small case series<sup>[51-53]</sup>. Finally, the use of NPWT as the main therapy for postoperative wound drainage is supported by a single retrospective study<sup>[56]</sup>.

## CONTRA-INDICATIONS, COMPLICATIONS AND RISK FACTORS

According to the Food and Drug Administration (FDA), due to the lack of appropriate studies, NPWT should be contraindicated in the following scenarios: (1) necrotic tissue or eschar present; (2) untreated osteomyelitis; (3) unexplored fistulas; (4) malignancy in the wound; and (5) exposed vasculature, nerves, anastomotic sites or organs<sup>[58]</sup>. These guidelines were based on two major concerns: (1) the inability of NPWT to replace surgical treatment when this is formally indicated; and (2) the mechanical strain that sub-atmospheric pressure can place upon fragile tissues.

Despite the rapid expansion in the use of NPWT across various clinical settings, the reported complication rates are surprisingly low. The most worrisome and potentially lethal complication has been exsanguination. Four fatal exsanguinations have been reported with use of NPWT and these occurred when the tube was attached to wall suction<sup>[59]</sup>. This practice is now strongly condemned and the use of safety alarms for excessive fluid drainage has been incorporated to NPWT devices. Safety alarms are also designed to detect air leaks, as this has been shown to increase wound size due to skin dehydration<sup>[27]</sup>. Fatal toxic shock syndrome has been reported in two cases, both of which had a purported blockage in the drainage system<sup>[60]</sup>. Retention

of foam within the wound, particularly when multiple, small fragments of foam were used, is also a known complication<sup>[33]</sup>. Lastly, blistering has been a minor complication in most studies within orthopaedic surgery, except for one<sup>[54]</sup>. This problem has largely been resolved with the addition of a protective adhesive layer between the foam and skin.

Patient-related risk factors that demand special attention when considering NPWT are: (1) high risk of bleeding and hemorrhage; (2) use of anticoagulants or platelet aggregation inhibitors; (3) patients with friable or infected blood vessels, vascular anastomosis, infected wounds, osteomyelitis, exposed organs, vessels, nerves, tendons, and ligaments, sharp edges in the wound, spinal cord injury, enteric fistulas; (4) patients requiring magnetic resonance imaging, hyperbaric chamber, defibrillation; (5) patient size and weight (increased dead space); (6) proximity to vagus nerve (with risk of bradycardia); (7) circumferential dressing application; and (8) mode of therapy (intermittent vs continuous negative pressure)<sup>[58]</sup>. The FDA report also stresses that the vast majority of adverse events and deaths related to NPWT has occurred either at home or in a long-term care facility. Nevertheless, despite the contraindications and risk factors, there are successful reports of NPWT in the settings of sternum osteomyelitis<sup>[61]</sup> and exposed organs<sup>[62]</sup>.

## AUTHOR RECOMMENDATIONS

At our institution, NPWT is applied for the aforementioned indications in total hip and knee arthroplasty. The quantum of negative pressure applied is typically either greater than 75 mmHg (for wound depth extending beneath fascia) or less than 75 mmHg (above fascia). Variations in pressure magnitudes for certain populations (such as pediatric and geriatric patients) are made in accordance with manufacturer guidelines and clinician judgment. Placement of NPWT must be done only after ensuring that the surrounding skin is dry enough for the adhesive material to provide an effective seal. Incisional NPWT is typically discontinued 3-5 d after surgery when there is no longer any drainage from the wound. However, NPWT dressings for deep, open wounds are changed every few days until satisfactory healing is eventually achieved. If drainage persists or is excessive in quantity, further surgical management may be necessary. In order to avoid skin maceration, the authors recommend placing the foam directly on the open wound and using protective material, such as a hydrocolloid dressing, for the surrounding skin.

## PERSPECTIVES

There are currently over 60 clinical trials registered online at [www.Clinicaltrials.gov](http://www.Clinicaltrials.gov), mostly concerning the prophylactic use of NPWT over high-risk closed incisions. In the adult reconstructive field, there are seven clinical trials on NPWT, all of which are evaluating its efficacy in

preventing wound complications and infections. Despite the substantial lack of evidence, the prophylactic use of single-use devices such as Prevena<sup>TM</sup> (KCI, San Antonio, Texas) and PICO<sup>TM</sup> (Smith and Nephew, Hull, United Kingdom) in patients at increased risk for postoperative drainage seems to be gaining acceptance and may potentially be incorporated in clinical guidelines for PJI prevention in the near future.

The therapeutic use of NPWT for prolonged wound drainage in an attempt to avoid the need for an I and D is still unsupported. Furthermore, Jaber *et al.*<sup>[63]</sup> showed that delaying surgical intervention after the onset of drainage predicts a higher failure rate once an I and D is undertaken. The role of NPWT in the management of prolonged wound drainage or acute PJI is still controversial and should not be a reason to delay surgical intervention.

## CONCLUSION

The efficacy of NPWT in wound healing and its secondary benefits in terms of improving cost-effectiveness and comfort for both patient and caregiver is irrefutable. The fast expansion of indications and wide range of clinical scenarios in which it has been adopted has precluded standardization of protocols and large scale studies. For this reason, the use of NPWT still relies heavily on empirical data. Within hip and knee reconstructive surgery, the most commonly accepted use of NPWT is for the prophylaxis of wound complications in high-risk closed surgical wounds. There is a dire need for unconflicted, standardized and larger volume studies to validate this practice and to establish the role that NPWT may have in the treatment of prolonged wound drainage and acute PJI.

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