



# 5th International NPWT Expert Meeting Report - Unlocking the potential of NPWT. 21st and 22nd March 2014, Frankfurt

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**Abstract** — Chaired by Professors Don Hudson (South Africa), James Stannard (USA) and Norbert Runkel (Germany), the 5th International Negative Pressure Wound Therapy (NPWT) Expert Meeting was held this year in Frankfurt (21st and 22nd March 2014) and welcomed over 230 surgeons and clinicians from 30 countries to discuss and debate all aspects of NPWT. As the volume of research and published papers on NPWT continues to grow, attendees were the recipients of presentations and interactive discussions that exposed them to some of the most comprehensive new clinical developments in NPWT. New insights into the mode of action of NPWT were discussed and the role of NPWT on tissue perfusion debated. The use of NPWT on a variety of clinical indications was presented including skin grafts, the open abdomen, closed surgical incisions and fracture wounds. In comparison to past events, the topics seem to be moving more towards NPWT as a preventative therapy as opposed to the more traditional treatment of wounds.

**Keywords** — Negative pressure therapy, conference report, international congress.

Initially created to provide a forum for professionals to share their knowledge of NPWT, early meetings began to create a collaborative process for providing consensus guidelines on the use of the therapy. Supported by Smith & Nephew, an International NPWT Expert panel developed around the meetings held in Milan (2009), Hamburg (2010) and Amsterdam (2011) and culminated in the creation of three consensus papers describing evidence-based recommendations for the use of NPWT, which have been published in *Injury*, *JPRAS*, and the *Journal of Tissue Viability*<sup>1-3</sup>. In subsequent meetings a wider circle of indication-specific experts has developed and a further paper reviewing the growing evidence for NPWT in managing surgical incisions in orthopaedic surgery was recently

published in *Bone & Joint Research*<sup>4</sup> and will be presented at the 15th EFORT congress in June 2014. The 5th International NPWT Expert meeting saw the evidence for the prophylactic use of NPWT on closed incisions over a broader section of clinical specialities including cardiothoracic, colorectal, obstetrics and plastic and reconstructive surgery.

## INSIGHTS INTO MECHANISMS OF ACTION

After introductions from Co-Chair Professor Don Hudson, the meeting began with presentations giving new insights into the mode of action of NPWT, in particular the role of NPWT on tissue perfusion and the effect of different NPWT wound fillers on scar tissue formation under skin grafts.

**Don Hudson** began by challenging conventional understanding of the effects of negative pressure on tissue perfusion in the peri-wound area. The widely held belief that there is sub-atmospheric pressure adjacent to the wound and that NPWT increases blood flow stems from the early research from Wake Forest University<sup>5</sup>. This theory has been further supported by work from Lund University, where Prof. Malmstroj has previously presented evidence that in defect wounds there is a zone of hypo-perfusion close to the wound margin (0.5cm) and a zone of hyper-perfusion further from the wound margin (2.5cm)<sup>6</sup>. By contrast, when the team at Cape Town used intracranial pressure transducers to measure pressure, they found that pressure was always slightly *positive* (down to a depth of 1cm), and a *reduction* in tissue perfusion was observed using radioisotope perfusion imaging (mostly in intact skin)<sup>7</sup>. More recently they have used thermal imaging techniques to demonstrate a lack of increased tissue perfusion during NPWT<sup>8</sup>. Their findings suggest that NPWT decreases perfusion thereby stimulating angiogenesis and subsequent granulation tissue formation and suggest that laser Doppler may not provide the best measure of perfusion.

**Shigeru Ichioka** (Japan) produced equally compelling results to support the opposite hypothesis. Using an intra-vital microscopic technique to directly visualise wound bed microcirculation in an experimental mouse model, the Japanese team previously confirmed that NPWT increased microcirculatory perfusion at the wound bed<sup>9</sup>. In a follow up of their original work, it was found that the NPWT effect on blood flow enhancement was mediated by the release of Nitric

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Oxide, a powerful vasodilator that is produced by endothelial cells in response to mechanical forces<sup>10</sup>.

It's clear that the evidence available in this area is not yet conclusive, and that more studies may be required to clarify the real role of perfusion in the mode of action of NPWT. Possible explanations for differences in effects being observed between laboratories include different measurement techniques, measurement locations and different wound geometries (defect, circumferential, intact skin).

**Marco Fraccalvieri** (Italy) began investigating the effect of different NPWT wound fillers on scar tissue formation after the team at Turin University noted that skin grafts at follow up consultations were less pliable when foam was used to prepare the wounds compared to gauze. Although granulation tissue developed under foam and gauze based NPWT were different in appearance, biopsies taken from the wound bed prior to skin grafting showed no histological differences. However ultrasound and histology analysis revealed that 12-15 months later the resulting scar tissue appeared less fibrotic and more vascularised in gauze treated skin grafts, and was similar in thickness to healthy surrounding tissue. Foam based NPWT tended to generate a thicker, more disorganised layer of scar tissue which may explain the observed reduction in pliability<sup>11</sup>. Dr Fraccalvieri presented recent immunohistochemistry studies which revealed a greater presence of VEGF and MMP-9 in gauze treated tissue. Up-regulation of VEGF and MMPs are known to lead to neovascularisation and tissue remodelling and may explain the differences observed in scar tissue following gauze and foam based NPWT.



Fig 1. 5th International NPWT Expert Meeting

## DEVELOPING APPLICATIONS FOR NPWT

Speakers in this session discussed their experiences of using NPWT for new challenging clinical indications.

**Sudheer Karlakki** (UK) presented a recently published review of the evidence for the prophylactic use of NPWT on closed incisions<sup>4</sup>. Thirty three publications were identified across a variety of surgical specialities (orthopaedic,

cardiothoracic, abdominal, plastic and vascular), most of which were published in the last 3 years demonstrating that the use of NPWT on closed incisions is a fast developing concept. RCT's are emerging that demonstrate a reduced incidence of wound related complications with post-operative NPWT. Whilst the precise mechanism of action is still unclear, evidence suggests that incisional NPWT may lead to a reduction in haematoma and seroma, accelerated wound healing and increased clearance of oedema.

**Peter Maitz** (Australia) described the difficulties of providing immediate aid for trauma and emergency cases in his country where it may not be possible to get expert care to patients for hours or even days. Offering examples of highly challenging patient cases, Dr Maitz illustrated the use of NPWT, often as a last resort when other treatments had failed in major wounds. For example, an adolescent with meningococcal sepsis presented to their hospital days after contracting the disease had her legs debrided from the knee down to the ankle joints. With no possibility of finding flaps for such large wounds, they were covered with INTEGRA, wrapped in ACTICOAT<sup>®</sup> and left under NPWT. After months of treatment, these large and very difficult wounds healed successfully. Dr Maitz also described the successful use of NPWT to treat extensive and very deep self-inflicted petrol burns on the face, scalp, right upper extremity and upper body, and a successful two month treatment of NPWT to a hysterectomy wound that had failed to heal for three years.

A number of papers have been published recently reviewing the evidence for NPWT available on the use of NPWT over skin grafts and in reconstructive surgery. **Frank Duteille** (France) summarised this growing evidence and presented his own experience of when to use NPWT over skin grafts. Recent studies and evidence reviews further support the recommendations that were developed by the International NPWT Expert Panel for use of NPWT over split thickness skin grafts (STSG)<sup>2</sup>. NPWT helps maintain contact of the graft with the wound bed and avoid shear forces thereby enhancing vascularisation, minimising haematoma and removing exudate. NPWT has been shown to increase the quantity and quality of STSG take, particularly in technically difficult wounds, wounds with a sub-optimal wound bed or wounds with irregular contours<sup>12,13</sup>. Duteille described his experience of using PICO<sup>®</sup>, an ultra-portable form of NPWT, for the management of STSG, which facilitated earlier patient mobilisation and discharge from hospital.

In **James Stannard's** opening statement, he declared that a fracture is a soft tissue injury with a broken bone inside, and the most important determinant of its outcome is the management of the soft tissue. Published evidence for the use of NPWT in open fractures is conflicting with studies showing some benefit in deep infection rates with NPWT and the others finding no difference. Although prospective RCTs are difficult to carry out in severe open fracture patients, a recent study found that there was a statistically significant drop in infection rate in these challenging wounds treated with NPWT<sup>14</sup>. Professor Stannard suggests that the mixed results observed in the literature may be due to how NPWT is used. Evidence would indicate that rapid and appropriate use of



NPWT allows for early closure and coverage, and therefore reduces the likelihood of wound infection.

**Norbert Runkel** summarised the ongoing work of the NPWT Expert Panel with regard to management of the open abdomen (OA). Although the evidence for NPWT is growing, there is little consensus on how and when to use NPWT on the open abdomen, therefore the NPWT Expert Panel carried out a systematic review of the available literature and developed recommendations based on the strength of this evidence. Evidence shows NPWT is a key technique in the management of OA and can perform different actions at different stages of the disease. Specifically, NPWT can address issues relating to the protection of the open abdomen (e.g. against damage and bacterial ingress), management of the open abdomen (e.g. fluid handling) and closure of the open abdomen (e.g. extending the window for primary fascial closure). A treatment pathway has now been developed by the group for the use of NPWT in OA providing clear practical guidelines on when to use it, where to use it and for how long.

#### NPWT IN THE MANAGEMENT OF SURGICAL INCISIONS

Six speakers gave presentations of on-going independent investigator-initiated trials that are studying the potential of NPWT and the ultra-portable single-use PICO<sup>o</sup> device in the prevention of post-surgical complications in high risk patients. **Sandro Giannini** (Italy) also commented on the emerging evidence from RCTs and cohort studies to support the use of NPWT in the management of closed incisions in orthopaedic surgery. Following the review of existing literature in orthopaedic applications, an expert panel agreed that NPWT may be able to reduce the rate of wound complications when applied to the closed post-operative wound including lower extremity fracture, spinal surgery, primary arthroplasty, foot and ankle surgery and so on. Interim results were presented from a 100 patient randomised study from Prof Giannini's unit in which PICO is being compared to standard post-operative dressings in both hip and knee revisions. Preliminary observations suggest that incisions treated with PICO for 7 days post-surgery may show less bruising and swelling and require fewer dressing changes. The PICO system was also found to be comfortable and well tolerated by patients. A patient grading system, such as that developed by Professor Stannard is needed to ensure the most appropriate patients receive NPWT.

**Sudheer Karlakki** (UK) described the increasing difficulties of performing hip and knee replacements in a population that is aging and presenting with more co-morbidities and increasing BMI. In a busy orthopaedic unit, delayed wound healing can lead to unpredictable surgical outcomes, affecting mobilisation and length of stay, which directly impacts costs and bed planning. Mr Karlakki presented top-line results from two studies soon to be published from his own group. The first study explores the effects of NPWT or standard dressings (applied in theatre) on length of stay and wound related complications (6 week follow up) in 120 hip and knee revisions. The group are now awaiting 1 year follow up data.

In the second study, 220 patients undergoing primary hip or knee surgery were randomised to either PICO or standard dressings and discharged either on day 2/3 (PICO) or when the wound was dry. He concluded that NPWT may help to achieve predictable wound healing, minimise wound complications and reduce the number of patients that have extended LOS. Data analysis is on-going.

There is limited evidence for the use of NPWT in spinal surgery as a prevention tool according to **Matthias Brem** (Germany) who reported interim results of a prospective study from his department on patients with large surgical wounds following spinal fracture randomised to either PICO or standard dressings. Wounds were examined with ultrasound to measure the presence and volume of seromas 5 and 10 days post-surgery and the number of dressings and associated nursing time were also recorded. Preliminary results suggest a positive effect of NPWT on seroma prevention as well as a significant reduction of nursing time and dressing material associated with its use.

According to **Rene van der Hulst** (Netherlands) post-operative complications, particularly poorly perfused tissue flaps, are a major problem with breast reduction surgery. Published complication rates vary tremendously but have been shown to be as much as 53%, which is very high for elective surgery [15]. Hulst described a Smith & Nephew-sponsored prospective multicentre randomised controlled study currently on-going in the USA, Europe and South Africa, on breast reduction, where patients are acting as their own controls to evaluate the efficacy of PICO<sup>o</sup> compared to standard dressings (Steri-strip). Data is not yet available but Dr Hulst shared a number of cases showing improved scar formation in the first few weeks after surgery and still evident at one year follow up. One potential mechanism of action proposed for NPWT in improved cosmetic outcome is the effect of applying compressive forces or a 'splint' over the incision thereby minimising tension and preventing excessive production of collagen fibres.

**Luis Nuila** (Spain) has been looking at single use NPWT to prevent surgical wound complications in surgery for implantable cardioverter defibrillators (ICD). Post-operative complications commonly include haematoma, seroma, SSI and dehiscence and the reported incidence can be up to 14%. Nuila described an on-going study to compare the results obtained since the implementation of PICO in the department with the same period from the previous year. Preliminary results suggest that the incidence of any short term complication may be higher in the control group compared to the PICO group. The economic impact of this type of complication is significant, considering the additional costs for treating complications. The team from Spain are now investigating 1 year follow up data.

In Crohn's disease, abdominal surgery to resect sections of diseased bowel are prone to a high incidence of hospital-acquired infections which prolong hospital stay and can cause long-lasting or permanent disability. **Gianluca Pellino** (Italy) reviewed the published evidence for the impact of traditional full sized NPWT devices on reducing SSIs in high risk wounds and found that there was some benefit, but



the devices used in most of the studies were cumbersome and expensive. A new study, carried out at the Division of General and Geriatric Surgery of the Second University of Naples (Italy) directed by Prof. Silvestro Canonico, investigated the use of PICO on primary incisions compared to conventional dressings up to 1 year post-surgery<sup>16,17</sup>. Although the groups were not randomised, there was a significantly shorter LOS, less seroma formation and fewer SSIs in the PICO group. The advantage of PICO in this setting is that it allows faster and safe discharge of patients by reducing the incidence of SSI and wound related complications.

Reducing SSIs in Caesarean sections is important to reduce pain, immobility and delayed recovery in new mothers. **Sean Burns** and **Lindsey Bullough** (UK) were concerned about a high infection rate (12%) and the number of readmissions occurring in their institution and carried out an audit to identify problem areas. Audit findings showed that infection was typically occurring 11-14 days post-surgery, was possibly associated with removal of the dressing at day 1 for inspection of the wound site, lack of wound care education amongst staff and a high incidence of SSI in women with a BMI>35. Following an evaluation of six post-operative dressings OPSITE<sup>o</sup> Post Op Visible (Smith & Nephew) was selected as it allowed post-operative inspection of the suture line without dressing removal. The use of PICO was also implemented as a prophylactic measure in women with high BMI. A major education programme was also put in place and since the adoption of these changes the average infection rate has dropped substantially with no hospital readmissions and released significant cost savings<sup>18</sup>.

### BREAKOUT SESSIONS

A characteristic feature of these meeting has been the inclusion of all the attendees in discussions. The use of NPWT in the management of surgical incisions was discussed in more detail in informal breakout sessions that were organised on the second day of the meeting. Sessions were broken down by surgical speciality and included cardiovascular surgery, general/colorectal surgery, obstetrics/gynaecology, orthopaedic surgery and plastic surgery. The objective of these workshops was to discuss amongst peers how they would identify patients at high risk of post-surgical wound related complications in their practice, where the use of NPWT for the management of the surgical incisions could be recommended as well as the type of challenges faced and possible solutions for implementing its use in their own departments. According to the experts attending the conference, the use of NPWT in preventing the insurgence of post-surgical complications can be considered in patients who have two or more risk factors, including active smoking, diabetes, body mass index above 30, lengthy surgery (more than 5 hours), vascular disease, previous history of wound dehiscence, previous radiation or chemotherapy, immunosuppression, and age above 70 years old.

### A NEW FORM OF INTERACTION

For the first time at an NPWT Expert Meeting, interaction with the audience of almost 230 healthcare professionals was managed by a Tablet System, allowing for both interactive voting and for the ability to send in detailed questions in “real time” straight to the chairs of the conference during the sessions. “This was a very impressive system, which removes some of the barriers to ask questions for attendees who are not fluent in English, and I’m sure we will be using it again” confirmed Professor Stannard. The interactive voting allowed participants to see in real time the spread of clinical specialities in attendance at the meeting (Figure 2).



Fig 2 . Breakdown of participants present by speciality.

Attendee feedback at the end of the meeting revealed that 95% of the audience that voted (over 50% of the 226 attendees) will consider reviewing and changing some aspects of their clinical practice after having heard the evidence presented and discussed (Figure 3).

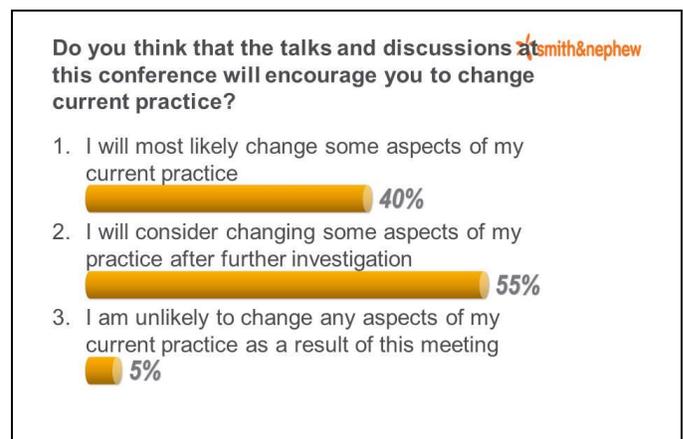


Fig 3. Using the interactive voting system, attendee feedback revealed that 95% of the attendees that voted (over 50% of the 226 attendees) will consider reviewing and changing some aspects of their clinical practice, after having heard about the available evidence and after the specialty-specific discussions on high risk patient identification and clinical protocol development.



The most frequently asked questions centred on treatment variables such as whether to use foam or gauze as a wound filler, when to use a wound contact layer and what were appropriate levels of pressure to be used in various indications. Questions still remain as to the precise mode of action for NPWT, in particular the role that NPWT plays in tissue perfusion and whether it is positive or negative pressure that creates these effects. Perhaps there is a role for both an increase and a decrease in tissue perfusion? And is it plausible that both positive and negative pressure related forces are at work? Clearly more research is needed. The emerging evidence for NPWT in preventing post-operative complications is already forcing us to challenge our current thinking around how NPWT works.

#### CONFLICTS OF INTERESTS

Elizabeth M Huddleston is an employee of Smith & Nephew. The 5th International NPWT Expert Meeting is an educational initiative funded by Smith & Nephew. The speakers prepared their contributions independently and received a compensation for their time, in accord with the Smith & Nephew Code of Compliance and national regulations.

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