

# Impact of negative pressure wound therapy and nanocrystalline silver dressings on the quality of life of patients with chronic non-healing ulcers: a preliminary study

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## ORIGINAL ARTICLE

**Abstract**— Therapeutic measures should be primarily directed to promote healing, but also to improve or at least to maintain HRQoL. This prospective randomized pilot study was conducted to assess the impact on HRQoL of negative pressure wound therapy (NPWT) combined with nanocrystalline silver dressings in outpatients with chronic nonhealing ulcers. A total of 17 patients were included in the study, 10 of which were treated with the combined method and 7 with NPWT only. Patients were followed for 6 weeks. The 36-item short-form (SF-36) questionnaire was administered to at baseline and at the end of treatment. Patients included in the study had multiple concomitant pathological conditions and a mean age of 70 years. Significant changes in different domains of the SF-36 questionnaire, including physical functioning, role limitations (physical), vitality, mental health, social functioning, bodily pain, and general health, before and after treatment were not found. The mean (standard deviation, SD) score of social functioning was 53.1 (31.8) before treatment and 66.3 (23.6) after treatment ( $P = 0.09$ ). The application of NPWT with nanocrystalline silver dressings or NPWT alone for 6 weeks was effective in wound healing promotion. The impact on HRQoL was non-significant except for somewhat better benefits in the social domain in patients treated with NPWT and silver dressings. The present preliminary data could be the basis for the design of future, more robust clinical studies.

**Keywords**—Nanocrystalline silver dressings; negative pressure wound therapy; chronic wounds; nonhealing ulcers; quality of life

## INTRODUCTION

CHRONIC non-healing wounds are a significant public health challenge, give rise to major costs and resource consumption in health care systems and have a great impact on quality of life.<sup>1-4</sup> In a systematic review and meta-analysis of 11 studies analyzing chronic wounds in the general population, a pooled prevalence of 2.21 per 1000

population was estimated, with 5.51 per 1000 population for chronic leg ulcers.<sup>5</sup> In a systematic review to establish the prevalence of pressure ulcers within published studies from Europe, the median prevalence was 10.8%, with consistently high rates across countries.<sup>6</sup>

Chronic wounds are associated with a marked impairment in health-related quality of life (HRQoL) with a negative impact on physical, psychological, and daily activities due to contributing factors, including pain, reduced mobility, unpleasant odor, sleep disturbances, social isolation, and frustration, anxiety, depression, and inability to perform everyday duties and leisure time activities.<sup>7-10</sup> Physical activity and social functioning have been recognized as the most commonly affected domains, but controlling pain can play a major role in improving wellbeing in patients with chronic wounds. The impact of chronic wounds on HRQoL, however, depends on several factors, including wound duration and location, etiology, and patient's age. It has been shown that satisfactory quality of life scores are higher in patients with smaller versus larger or complex wounds and wounds located on upper rather than lower limbs, as well as in younger and middle-aged versus older patients.<sup>11</sup> Although the treatment of chronic wounds includes many strategies, clinically effective interventions should lead to wound healing in a short period of time minimizing potential complications and improving quality of life. Efficient wound care is also associated with reduced consumption of health care resources.<sup>12, 13</sup>

Negative pressure wound therapy (NPWT) has increased in popularity over the past decade for the treatment of diverse open traumatic, non-traumatic, chronic wounds, coverage over skin grafts, and closed surgical wounds.<sup>14-16</sup> The mechanism of action on wound healing includes increasing blood circulation, removing edema, reducing bacterial colonization, increasing granulation tissue formation, and providing a moist wound healing environment.<sup>17, 18</sup> Although the inpatient costs associated with NPWT are reduced by the use of this therapy in the outpatient setting,<sup>19, 20</sup> the home environment requires therapy for the entire day, with a portable device that weighs approximately 1 kg and makes a small amount of noise, allowing for dressing changes every

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3-4 days, all of which may affect quality of life.<sup>19, 20</sup> The combination of NPWT with nanocrystalline silver dressings has been shown to reduce bacterial colonization and bacterial load on the surface of the wound and is more beneficial than conventional NPWT for decreasing infection.<sup>21-23</sup>

The effect of NPWT on quality of life has been explored in a limited number of studies. In a systematic review of five studies in which seven different questionnaires were used to measure HRQoL, quality of life was low during the first week of treatment (possibly due to anxiety), after which similar or better scores were reported compared with standard wound care.<sup>24</sup> In a quasi-experimental study, there were no differences in quality of life scores recorded during 12 weeks, but patients in the NPWT group showed an increase in the social life domain compared with standard wound care therapies.<sup>25</sup> In a comparative study of NPWT and alginate wound dressings, the NPWT group showed improvements in various domains of the EuroQol 5D (EQ-5D).<sup>26</sup>

In order to provide further HRQoL data in patients treated with NPWT, a pilot prospective study was conducted. The study aimed to assess the pre-treatment quality of life of patients with chronic non-healing ulcers, as well as the impact of the NPWT use combined with nanocrystalline silver dressings on HRQoL (in the outpatient setting, after 6 weeks of treatment).

## MATERIALS AND METHODS

### *Design and Subjects*

This prospective randomized parallel controlled and open-label pilot study was conducted at the outpatient clinics of the Department of Dermatology and Plastic Surgery of two teaching hospitals in Spain through a period of 6 weeks. The primary objective of the study was to assess the changes in HRQoL before and after 6 weeks of treatment with NPWT combined with nanocrystalline silver dressings in patients with chronic nonhealing wounds. The secondary objective was to compare HRQoL in patients treated with NPWT combined with nanocrystalline silver dressings and those treated with NPWT alone. Consecutive patients aged between 18 and 90 years, with wounds of maximum size of 35 cm in length and of more than 2 weeks duration, who were candidates to NPWT in the outpatient setting were eligible for the study. Patients with wounds of various origin and location were included, provided that wounds were not covered by thick, dry, black necrotic tissue, and previous surgical debridement had not been performed.

The study was conducted according to the 1975 Declaration of Helsinki principles and was approved by the Clinical Research Ethics Committee of the participating hospitals. All participants signed the written informed consent form.

### *Study Procedures*

Wound dressing was carried out following a protocol of wound irrigation with sterile distilled water and application of a nanocrystalline silver-coated polyurethane wound contact layer (Acticoat®, Smith & Nephew, Hull, UK) of a dressing size necessary to fill and cover the wound adequately.

The nanocrystalline silver dressing was covered with sterile gauze before application of the NPWT system (Renasys Go, Smith Nephew) with 125 mmHg constant negative pressure. According to the technical specifications of the product, the period of time between dressing changes was 3-4 days. Dressing changes were performed at the outpatient clinic of the hospital. The same protocol was used in subjects assigned to the control group except for the application of the nanocrystalline silver-coated polyurethane wound contact layer. A computer-generated table of random numbers was used to assign patients to the intervention group (NPWT combined with silver dressings) or the control group (standard NPWT). Populations were not age and sex matched.

### *Study Procedures*

A validated Spanish version of the Short Form-36 Health Survey (SF-36) was used to assess HRQoL.<sup>27, 28</sup> The SF-36 is a self-administered questionnaire extensively used to measure HRQoL constructed to provide a comprehensive assessment of physical, mental, and social components of health status. The questionnaire covers eight dimensions, including physical functioning (10 items), role physical (4 items), bodily pain (2 items), general health (6 items), vitality or energy/fatigue (4 items), social functioning (2 items), role emotional (3 items), and mental health (5 items). For each dimension, items are recodified, averaged together and transformed in to a 0-100 scale, with higher scores representing better health.<sup>29-31</sup>

### *Data Collection*

The duration of the study was 6 weeks, and patients were evaluated at baseline before NPWT treatment and at the final assessment at 6 weeks. Data collected at baseline included demographics (age, gender), concomitant diseases, wound location, and type of wound. The SF-36 questionnaire was administered at baseline and at the end of the study.

### *Statistical Analysis*

Categorical data are expressed as frequencies and percentages, and continuous data as mean and standard deviation (SD). The chi-square test was used for the comparison of categorical variables and the Wilcoxon rank-sum test for paired samples for the analysis of quantitative data. Statistical significance was set at  $p < 0.05$ . The Statistical Package for the Social Sciences version 19.0 for Windows was used for statistical analysis.

## RESULTS

Of 18 eligible patients, one of them assigned to the NPWT alone discontinued the study due to contact dermatitis to the film used in the NPWT system. The study population included 17 patients (12 men, 5 women) with a mean (SD) age of 69.6 (10.6) years. The characteristics of these patients have been previously reported in a study of our group aimed to assess the reduction of wound area and safety of NPWT with silver dressings in the management of chronic ulcers.<sup>21</sup>

Ten patients were treated with NPWT and silver dressings and seven with NPWT only. Concomitant systemic diseases, such as diabetes or cardiovascular disorders were present in 15 patients (88.2%), with more than one disease in nine (52.9%). The wound was located in the lower legs in 16 patients (94.1%) and in the sacral region in one. Causes of chronic ulcer included peripheral vascular disease in 10 patients (58.8%) followed by pressure ulcer, posttraumatic and surgical dehiscence in two patients each, and inflammatory/immune systemic disease in one.

The SF-36 was administered at baseline and at 6 weeks to 16 patients (NPWT group, n =9; NPWT only, n = 7). One patient treated with NPWT and silver dressings failed to complete the questionnaire at the end of the study. Changes in the mean scores of SF-36 scales are shown in (Fig. 1). Before the use of NPWT, scores ranged between 33.5 (12.9) for general health and 54.2 (45.3) for emotional role limitations. After 6 weeks of treatment with NPWT, scores were quite similar and without statistically significant differences as compared with baseline (Tab. I). Social functioning was the domain that showed the highest increase, from 53.1 (31.8) at baseline to 66.3 (23.6) at the end of the study, although statistical significance was not reached ( $P = 0.09$ ), mainly due to the low number of patients. A comparative analysis of responses to the 2 items of this scale between patients treated with NPWT combined with silver dressings and those treated with NPWT alone showed a higher improvement in the NPWT combined group (Tab. II). After 6 weeks of treatment, 8 out of 9 patients (88.9%) treated with NPWT combined with silver dressings and 3 out of 7 (42.8%) patients treated with NPWT only answered “not at all” or “slightly” to the question During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, etc.?. Also, 6 out of 9 patients (66.7%) in the group of NPWT and silver dressings as compared to 4 out of 7 (57.1%) patients treated with NPWT alone answered “a little of the time” or “some of the time” to the question During the past 4 weeks, how much time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?.

Improvement of wound healing was observed in all patients either in those treated with NPWT and nanocrystalline silver dressings (Fig. 2) or NPWT alone (Fig. 3). Therapy was well-tolerated and no adverse events were recorded.

## DISCUSSION

This pilot study carried out in a small clinical series of outpatients adds evidence of the effectiveness of NPWT combined with silver dressings or NPWT alone in the management of chronic nonhealing ulcers. After 6 weeks of use of NPWT, there was a tendency observed (although not significant) for an improvement in the patients' HRQoL using the SF-36, although it appears that benefits in the social functioning scale were somewhat greater for patients treated with NPWT combined with silver dressings than for those treated with NPWT only. The older age of the population

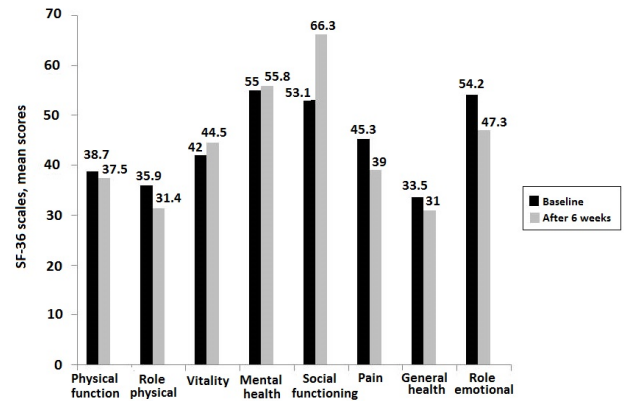


Figure 1. Changes in the mean scores of SF-36 scales



Figure 2. Wound healing process treated with NPWT and nanocrystalline silver dressing



Figure 3. Wound healing process treated with NPWT alone

Table I  
SCORES IN THE EIGHT SCALES OF THE SF-36 AT BASELINE AND AFTER 6 WEEKS OF TREATMENT WITH NPWT

Scales	Treatment with NPWT		<i>p</i> value
	Baseline (before treatment)	After 6 weeks (end of study)	
	mean (SD)	mean (SD)	
Physical functioning	38.7 (32.7)	37.5 (25.4)	0.390
Physical role limitations	35.9 (42.8)	31.4 (32.5)	0.910
Energy/vitality	41.9 (17.8)	44.5 (16.4)	0.960
Mental health	55.0 (18.8)	55.8 (21.7)	0.960
Social functioning	53.1 (31.8)	66.3 (23.6)	0.09
Bodily pain	45.3 (29.9)	39.0 (28.6)	0.530
General health	33.5 (12.9)	30.9 (16.3)	0.440
Emotional role limitations	54.2 (45.3)	47.3 (18.9)	0.200

NPWT: negative pressure wound therapy; SD: standard deviation.

Table II  
COMPARISON OF RESPONSES TO THE 2 ITEMS OF THE SOCIAL FUNCTIONING SCALE BETWEEN PATIENTS TREATED WITH NPWT COMBINED WITH NANOCRYSTALLINE SILVER DRESSINGS AND NPWT ALONE

Items	NPWT with silver dressings	After 6 weeks (n = 9)	NPWT alone	After 6 weeks (n = 7)
	Baseline (n = 9)		Baseline (n = 7)	
first question				
Not at all	6 (66.7)	6 (66.7)	1 (14.3)	1 (14.3)
Slightly		2 (22.2)	3 (42.8)	2 (28.6)
Moderately	1 (11.1)		1 (14.3)	
Quite a bit		1 (11.1)	1 (14.3)	2 (28.6)
All of the time	2 (22.2)		1 (14.3)	2 (28.6)
second question				
None of the time				
A little of the time	3 (33.3)	2 (22.2)		3 (42.8)
Some of the time		4 (44.4)	4 (57.1)	1 (14.3)
Most of the time	2 (22.2)	3 (33.3)	3 (42.8)	3 (42.8)
All of the time	4 (44.4)			

first question: During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

second question: During the past 4 weeks, how much time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

with a mean of 70 years and the presence of concomitant systemic diseases in 88% of patients requires using a larger cohort to account for multiple possible confounders. It is also possible that the present findings could have been influenced by the use of the SF-36 generic instrument for assessing HRQoL rather than a disease-specific tool such as the Wound Quality of Life (Wound-QoL) questionnaire. The Wound-QoL instrument was developed in German<sup>32</sup> and has still not been validated in Spanish. In relation to other quality measures, in a retrospective matched group analysis comparing patients with leg ulcers using and not using NPWT, those receiving NPWT experienced lower rates of hospitalization and emergent care for wound problems.<sup>33</sup> A better overall quality of life and general health satisfaction were observed in a study of wound dehiscence in patients undergoing post-bariatric abdominoplasty treated with NPWT than in those treated with conventional wound therapy.<sup>34</sup> A review of the UK National Health Service (NHS) agenda in relation to the use of NPWT in chronic wound management provided evidence of early discharge and faster healing, fewer readmissions, better patients' quality of life, and improved

cost-effectiveness associated with NPWT.<sup>35</sup> NPWT was also associated with decreasing duration of hospital stay, surgical site infection rates, and improvement of well-being and quality of life after reversal of double loop ileostomy as compared with patients treated with a standard sterile dressing.<sup>36</sup> In these studies, however, validated HRQoL questionnaires were not used.

In a quasi-experimental study (without random assignment) of 11 patients with chronic/acute wounds treated with NPWT and 10 patients with standard wound care, the Cardiff Wound Impact Schedule (CWIS), a condition-specific quality of life tool, was administered at week 1, 4, 8, and 12.<sup>25</sup> No differences in quality of life scores were recorded over the 12-week period, but patients in the NPWT had an increase in the social life domain. The authors hypothesized that exudate containment or the use of small portable devices would increase the confidence of the patients to go out.<sup>25</sup> We also found a higher increase in the social functioning scale scores with a trend of greater improvement in the group of patients treated with NPWT and silver dressings. It may be speculated that the spacing of dressing changes associated

with this type of therapy may account for these findings. On the other hand, it has been reported that NPWT might be associated with increased anxiety during the first week of treatment as compared with standard wound care, after which both modalities of treatment were similar regarding the quality of life.<sup>24</sup> Another study in patients with deep perivascular groin infection after vascular surgery, a comparison of NPWT and alginate wound dressings showed that patients in the NPWT group improved EQ-5D domains of “self-care”, “usual activities”, EQ-5D index value, and EQ-5D visual analogue scale (VAS) scores, and also significantly less pain using the Brief Pain Inventory (BPI) reported.<sup>26</sup> By contrast, in a randomized study of 345 patients with diabetic leg ulcers treated with NPWT or standard moist wound care, neither the wound closure rate nor the time to wound closure was significantly different between the treatment arms.<sup>37</sup>

It has been shown that the addition of silver dressings with NPWT effectively reduces bacteria in contaminated wounds and is more beneficial on the gram-positive bacteria, particularly ones contaminated with *Staphylococcus aureus*,<sup>23</sup> as well as for reducing bacterial contamination with *Pseudomonas aeruginosa*.<sup>21</sup> In experimental wounds produced in an in vitro porcine model, the use of NPWT with the intermittent application of silver-based polyurethane foam dressings was significantly superior against *S. aureus* colonization than non-antimicrobial polyurethane foam dressings.<sup>38</sup> However, to our knowledge, no previous studies have assessed HRQoL using validated questionnaires in patients with chronic wounds treated with the modality of NPWT combined with nanocrystalline silver dressings.

In summary, in this small study population using a generic HRQoL instrument, the application of NPWT with nanocrystalline silver dressings or NPWT alone for 6 weeks was effective in wound healing promotion. The impact on HRQoL was non-significant except for somewhat better benefits in the social domain in patients treated with NPWT and silver dressings. It is also possible that a longer follow-up would be needed to detect significant differences between the study groups. The present preliminary data could be the basis for the design of future, more robust clinical studies.

#### CONFLICTS OF INTEREST

None to be declared.

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