

# Nanocrystalline Silver as a Single Treatment for Decubitus Ulcer: A Case Report

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**Abstract:** The prevalence of decubitus ulcer is very high, especially in inpatient ward and intensive care unit. Adequate treatment for the wound and prevention measures for decubitus ulcer complication are all mandatory to reduce the health burden and cost. Previous studies already showed the positive effects of nanocrystalline silver (nAg) in ulcer healing progress. The purpose of this study is to evaluate the effect of using nAg dressing towards decubitus ulcer severity. A 31 years old female diagnosed with grade III decubitus ulcer sized 4.7 x 2.7 cm<sup>2</sup> was treated with debridement and nAg dressing which regularly changed every week for 4 weeks. Clinical improvement was evaluated using photography images and Pressure Ulcer Scale for Healing (PUSH) tool. The evaluation results showed that there was 57% reduction in overall ulcer size in just 4 weeks treatment. The value of PUSH scale was also found lower down from 14 at the beginning into 10 at the end of the study. This report highlights the antibacterial effect of nAg dressing as the most potential benefitting factor of the decubitus ulcer healing. No side effect found during the application of nAg dressing in this patient.

## 1 INTRODUCTION

Decubitus ulcer or widely known as pressure ulcer, bedsore, and pressure injury is a localized injury of the skin and underneath structures due to a combination of pressure and shear force.<sup>1</sup> The prevalence of decubitus ulcer, range widely from 0.4% at the lowest in acute ward up to almost 24% in chronic ward. In concordance, the high prevalence of decubitus ulcer is always followed by the increase of health cost and burden, which strongly correlated with the incidence of complications and prolonged hospital stay. (Norman, 2016).

The failure of healing process as a result of ischemia, prolonged pressure and trauma is the major pathogenesis of decubitus ulcer. (Powers, 2012) Bacteria plays a huge role in delaying the wound healing and thus need to be eradicated by using multiple kinds of antiseptic or antibiotic. However, both antiseptic and antibiotic have a flaw as a therapy; antiseptic may be toxic for the cells and antibiotic has been known to cause resistance when used improperly (Dabiri, 2016).

Silver, in its pure-active form, has been known to have antiseptic, antimicrobial, anti-inflammation and broad-spectrum antibiotic effect without inducing

toxic reaction (Fong, 2006). Though very beneficial, pure silver is very easy to deactivate thus need repeated application to achieve the treatment dose (Argirova, 2011). Nanocrystalline technology in nAg-impregnated dressing provide wider contact area with the active components while also give better absorbance of silver ion on the woundbed thus increasing its efficacy. We reported a 31 years old woman diagnose with grade III decubitus ulcer treated with nAg dressing.

## 2 CASE

A 31 years old female consulted to dermatology and venereology department of dr. Saiful Anwar Regional General Hospital by cardiovascular department for wound on the buttock. The wound has been recognized since 5 weeks before consulted. Patient never knew the size and appearance of the wound but felt mild pain and itch on the wound area (VAS for the pain is 3). There was no tingling sensation on the surrounding area of the wound. History of fever was denied. Patient was once admitted to dr. Saiful Anwar Regional General Hospital for 12 days for post-partum cardiomyopathy

about 6 weeks before consulted. During first admission, the wound was never treated and patient never received education for mobilisation. After discharged, patient stayed in bed almost all the time and only went to the bathroom 2-3 times a day. Patient stopped wearing diaper since 4 weeks before consultation and started wearing diaper again two days before consulted. The diaper was changed 1-2 times a day. History of fecal/urine inconsistency was denied. Patient never treat the wound and only consume medication for her heart disease which consist of furosemide 20 mg once a day, captopril 3 x 25 mg, bisoprolol 5 mg once a day, diazepam 2 mg once a day, laxadin once a day, NAC 3 x 200 mg, and cefixime 2 x 100 mg.

General physical examination was normal. Dermatological examination revealed single erythematous-based ulcer with irregular border localized on sacral region. The ulcer sized 5 x 3.5 cm, covered with yellowish crust and necrotic tissue with minimal clear exudate. The surrounding skin was

hyperpigmented and no edema. Gram examination revealed polymorphonuclear cells and gram-negative coccus. Laboratory examination showed renal azoemia with ureum level 74,5 mg/dL and creatinine level 1,01 mg/dL, hyperuricemia 11,0 mg/dl, increase of procalcitonin level 30,53 ng/ml, hyponatremia 129 mmol/L and hypoalbuminemia 3,04 g/dl. Blood count and blood sugar level was within normal limit.

Patient was diagnosed with grade III decubitus ulcer and treated with nAg dressing for 4 weeks in outpatient ward dermatology and venereology department of dr. Saiful Anwar Regional General Hospital. Clinical improvement was evaluated using photography images and PUSH scale. The evaluation results showed reduced of ulcer size of about 7.25 cm<sup>2</sup> (57% reduction) by the end of the evaluation on the fourth week (Figure 1). PUSH scale was also found lower down from 14 at the beginning into 10 at the end of the study (Table 1).



Figure 1. The weekly improvement of decubitus ulcer. The ulcer length and width were reduced significantly in each week of evaluation, counting for about 35% reduction in the first week, from 12.69 cm<sup>2</sup> (4.7 x 2.7 cm) (a) into 8.2 cm<sup>2</sup> (4.1 x 2.0 cm) (b). The reduction continued as the lesion shrank into 4.48 cm<sup>2</sup> (3.2 x 1.4 cm) on the third week (c). Though by the fourth week the ulcer was slightly enlarged, measured 5.44 cm<sup>2</sup> (3.4 x 1.6 cm) (d), this result did not change the grade of the ulcer severity. Overall reduction within four weeks was about 57%.

Table 1. Pressure Ulcer Scale for Healing Record

Pressure Ulcer Healing Record				
Week	0	1	3	4
Length x Width	12.69 cm <sup>2</sup> (9)	8.2 cm <sup>2</sup> (8)	4.48 cm <sup>2</sup> (7)	5.44 cm <sup>2</sup> (7)
Exudate	Moderate (2)	Moderate (2)	Minimal (1)	Minimal (1)
Tissue Type	Slough (3)	Slough (3)	Granulation (2)	Granulation (2)
<b>TOTAL</b>	<b>14</b>	<b>13</b>	<b>10</b>	<b>10</b>

Table 2: The results of Schirmer test.

Week	II	III	IV
Schirmer test	Different > 50%	Different > 50%	Different <25%

### 3 DISCUSSION

The National Pressure Ulcer Advisory Panel (NPUAP) has classified decubitus ulcer into four grades. First grade decubitus ulcer defined as solely a non-blanchable erythematous lesion located on bone-prominence areas. Second grade decubitus ulcer identified as loss of some part of dermis layer thus the lesion appears as a shallow, pink-based ulcer, without slough. Decubitus ulcer categorized into grade three when the damage affect all layer of the skin thus exposing subcutaneous fat, but not bone and/or muscle. Decubitus ulcer grade four defined as an ulcer accompanied by an exposure of bone and muscle while also having slough, necrotic tissue and scar (EPUAP, 2009). This patient was diagnosed with decubitus ulcer grade three.

The major factor of the pathogenesis of decubitus ulcer is prolonged inflammation. Within the environment of chronic ulcer there is an imbalance of biochemical and molecular components which mostly caused by bacterial colonization and infection. Bacterial infection will induce an increase of matrix metalloproteinase and inflammatory cytokines, decrease of matrix metalloproteinase inhibitor level and growth factors. All of the aforementioned mechanisms lead to delayed healing process and chronic ulcer development (Fong, 2006.)

The ideal topical therapy needs to fulfil several criteria such as having antibacterial activity, low resistance level, low evaporation level, prevent dehydration, low side effect, can control the pain, easy to use and having low toxic risk. Silver has a nature as an antiseptic, antimicrobial, anti-inflammation and a broad-spectrum antibiotic agent. The active form of silver, such as Ag<sup>+</sup> and Ag<sup>0</sup>, has many potent antimicrobial effects that can destroy microbes through cellular respiration blockade mechanism and disturb the function of bacterial cell membrane. The free silver kations bind the protein of the tissue, altering the structure of bacterial cell membrane and cause cell death. The silver kations also able to cause DNA and RNA denaturation thus hindering cell replication (Fong, 2006) .

The benefit of using wound dressing comprised of optimal control of moisture, temperature, fluid permeability, and pH of the wound while also minimize the infection, prevent the wound from excessive trauma and reduce the pain.<sup>7</sup> In terms of

silver ion, dressing helps to release the ion gradually, compensating the nature of silver ion that easily bound to sodium.

The structure of nAg dressing consists of three layers with silver-embedded mesh enclosed by two layers made from rayon/polyester. The nanocrystalline technology is a modern technology providing reactive small silver particles thus able to cover larger area of the wound. The silver kations are released subsequently and continuously, relieving the bad odour and exudate, reducing the risk of bacterial colonization and preventing the wound from secondary infection (Fong, 2006).

Several studies, either in vivo, in vitro and clinical test in human support the benefits of using nAg dressing as a new regiment for chronic wound treatment. Compared to the other types of topical silver, e.g. nitrate silver, silver sulfadiazine and mafenide acetate, nAg has an ability not only to kill bacteria faster but also effective for broader spectrum of bacteria, than the others (Wright, 1998; Thomas,2003).

In vivo study showed that nAg dressing effectively improve granulation and reduce the biomolecular inflammatory components<sup>10</sup>. Clinical test in human is still very scarce and have low quality of study. However, several researchers proved that nAg dressing is correlated with lower pain scale, reduced volume of the exudate, reduced infection of the wound and lessen the health cost (Fong, 2006; Tredget, 1998;Voight,2001). Even now, there is yet in vivo study that explain the toxicity of nAg towards keratinocytes and fibroblasts. Nevertheless, in vitro study has proven that the toxicity level of nAg is very low. (Fraser,2004)No incidence of resistance ever reported (Fong, 2006).

Patient was given nanocrystalline dressing treatment as patient was diagnosed with grade three decubitus ulcer with high prone to sepsis, indicating the urgent need of the patient of an adequate and effective antibacterial agent to prevent new focal infection development and other severe complications. Other than dressing, patient and paramedics also received education of reposition technique, maximum degree of bed elevation and the importance of changing the diaper regularly.

During follow up, we found a significant improvement, showed as decrease of PUSH scale from 13 at the beginning to 10 at the end of the study.

The ulcer size also found reduced from 12.69 cm<sup>2</sup> into 5.44 cm<sup>2</sup>. These results consentient with previous studies mentioning the role of topical silver in re-epithelialization, skin granulation, and vascularization acceleration thus improving the ulcer healing. (Demling, 2002; Wright, 2002) No side effect ever reported during this study.

## 4 CONCLUSIONS

A 31 years old woman was diagnosed with decubitus ulcer grade 3 based on history taking and physical examination. Patient received treatment with nAg dressing for four weeks. The wound was evaluated once a week. From the weekly evaluation we found a significant reduction of ulcer length and width. The PUSH scale also found 3 points decrease by the end of the evaluation.

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