ORIGINAL RESEARCH

Evaluation Of The Effectivity Of Innovative And Cost Saving Method Of Negative Pressure Wound Management With Available Resources

Dr. Sameer Marediya

Assistant Professor, Department of General Surgery, BMCRI, Palanpur

Corresponding author
Dr. Sameer Marediya
Assistant Professor, Department of General Surgery, BMCRI, Palanpur

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Abstract

Background: The present study was carried out at our tertiary care center to bring the cost of the NPWT to a much lower range, using low-cost alternative materials and the resources available to us in a hospital setup along with a considerable focus on the end results and the ease with which the dressings are possible.

Materials & methods: A hospital based observational study was conducted with 60 patients to evaluate the effectivity of innovative and cost saving method of negative pressure wound management with available resources. Wound dimensions as well as surface area were assessed before the dressing and charted regularly. Culture swab (Pus culture/tissue culture) were taken before wound irrigation with normal saline with each dressing. The wound was assessed on each dressing and measurements were taken along with photographs. The gradual improvement thus can be measured if wound is contracting and granulation tissue is improving. The presence of granulation tissue, slough, discharge, exposed bone or tendon, necrosed tissue, bleeding etc. used for assessment and were recorded in the proforma. For the purpose of this study, a completely healed wound was defined as a wound where either, the skin could be approximated and ready for secondary suturing or the wound where granulation tissue has covered the wound surface up to the peri-wound skin and can now be considered for skin grafting.

Results: The meanage of the patients was 54.33 ±13.62years. The total days of negative pressure wound therapy (NPWT) in majority of the patients (36.6%) was ≥14 days followed by ≤7 days (31.7%) and 8-13 days (31.7%).46 (76.7%) patients underwent skin grafting while 14 (23.3%) patients underwent secondary suturing. There was significant difference in wound area during follow-up period as per ANOVA test ($p<0.05$). There was significant difference in wound area during follow-up period as per ANOVA test ($p<0.05$). The most common type of organism was Staphylococcus Aureus present in 12 (20%) patients on Day 0 followed by E.coli (13.3%), P. Aeruginosa (11.7%), MRSA (5%), Streptococcus Pyogenes (5%), Acinetobacter (3.3%), Aerumonas Species (1.7%), B.H. Streptococcus (1.7%) and Enterococcus species (1.7%). There was significant difference in type of organism during follow-up period as per Chi-Square test ($p<0.05$).

Conclusion: Management of wounds is always a challenging issue. Therefore; there is a need of application of newer and advanced modalities for management of wounds. Wound shows better outcome with negative pressure wound therapy when used as one of the treatment modalities.

Key words: Negative pressure, Wound

Introduction

It is recognized that effective wound management requires a comprehensive assessment of both the patient and the wound to determine the optimal treatment plan for achieving wound care goals. Numerous wound and patient risk factors are known to potentially complicate wound healing and increase health care costs.[1, 2] Wounds at risk for delayed healing include those with extensive tissue loss, critical colonization and/or infection, high levels of exudate or exposed critical structures. Compared with swabbing or bathing, wound irrigation is considered to be the most consistent and effective method of wound cleansing.[3] Negative pressure wound therapy (NPWT) is a tool commonly used to assist in preparing larger at-risk wounds for delayed closure. Porcine studies have shown that NPWT increased local blood flow and the rate of granulation tissue formation.[4- 6] Negative pressure has been used as part of the treatment of wounds in the form of various drains since the 1940s. NPWT has been

recommended for virtually all kinds of acute and chronic wounds to accelerate healing in pressure wounds, diabetic leg ulcers, lower leg wounds, surgical incision, traumatic wounds, burns, infected wounds, necrotizing fasciitis, infected sternal wounds and after skin grafting. The duration of the therapy varies from a few days to months, depending on the treatment aim and the nature of the wound.[6- 9] Hence the present study was carried out at our tertiary care center to bring the cost of the NPWT to a much lower range, using low-cost alternative materials and the resources available to us in a hospital setup along with a considerable focus on the end results and the ease with which the dressings are possible.

Materials & methods

A hospital based observational study was conducted with 60 patients to evaluate the effectivity of innovative and cost saving method of negative pressure wound management with available resources. The patients were informed and explained in detail about the study, following which the patient's written consent were taken in the preferred local language of the patients. The data was collected and entered with a specially designed Proforma, consisting of patient's details, history of illness, clinical examination, local examinations, and investigations. Wound were thoroughly debrided. Wound dimensions as well as surface area were assessed before the dressing and charted regularly. Culture swab (Pus culture/tissue culture) were taken before wound irrigation with normal saline with each dressing. Thorough debridement and removal of all devitalized tissue was done and wound were cleaned using normal saline. Authentic foam was used with open reticulated structure for NPWT. Sterile foam was cut to the approximate size of the wound with scissors. A 20 No. Nasogastric Tube (Ryle's Tube) was used as a drainage tube. The perforated end lie the distal end, was tunneled inside the sponge and proximal end was connected to the centralized suction system. Small hole equivalent to the diameter of drainage tube is cut over the outer surface of the foam. A tract of about 2-3cm was then created within the foam using an artery forcep through the same hole to ensure adequate drainage through the tube. Care was to be taken that the tract should stay within the foam and should not go on the inner surface of foam, else if the distal end of drainage tube comes in direct contact with the floor or edges of the wound, it led to localized areas of high pressure and resulting tissue necrosis. The inner surface of the foam was then gently placed in to wound cavity. The foam together with the first few inches of drainage tube and surrounding area of healthy skin was then covered with the adhesive transparent tape (e.g. Ioban). At this stage it is important to ensure that membrane (tape) forms a good seal both with surrounding skin and edge of ulcer. Also it was ensured that the skin around the wound is completely dry and clean. If needed the skin should be cleaned with benzoin tincture and should be allowed to dry for a minute. Adhesive transparent membrane should extend out on to skin around wound for about 2-3cms.Proximal end of perforated drainage tube (Ryle's tube 20 No.) was connected to the wall suction apparatus through a glass canister to collect the wound discharge. Continuous negative pressure was set at 100 to 150 mm of Hg on the pressure gauge attached to wall outlets. Once the vacuum was switched on, the air was sucked out of the foam and the foam dressing gets compressed ensuring sealing of the wound lie, there in no air leak. When suction was applied, the foam contracts to a raisin like appearance. The negative pressure was applied continuously for 4 days and fluid within the wound was taken up by the foam, transported into the glass canister of the suction apparatus through the drainage tube. Fluid was to be measured and discarded daily and record is maintained. Repetition of dressing and NPWT depend upon the response to the NPWT, as assessed on every dressing. Dressing was checked daily for air leak. Dressing was changed if it was found to have an air leak. On every dressing change the sample was collected for culture and sensitivity test of the wound discharge in order to assess the current infective status of wound. Also assessment of colony count of organism, was done by taking a small tissue biopsy from the floor of the wound and was recorded. HP was also performed on the sample tissue to assess the foreign body reaction. The wound was assessed on each dressing and measurements were taken along with photographs. The gradual improvement thus can be measured if wound is contracting and granulation tissue is improving. The presence of granulation tissue, slough, discharge, exposed bone or tendon, necrosed tissue, bleeding etc. used for assessment and were recorded in the proforma. For the purpose of this study, a completely healed wound was defined as a wound where either ,the skin could be approximated and ready for secondary suturing or the wound where granulation tissue has covered the wound surface up to the periwound skin and can now be considered for skin grafting. Quantitative data is presented with the help of Mean and Standard deviation. Comparison among the study groups is done with the help of unpaired t test as per results of normality test. Qualitative data is presented with the help of frequency and percentage table. Association among the study groups is assessed with the help of ANOVA test and Chi-Square test. 'p' value less than.

Results

The meanage of the patients was 54.33 ±13.62years. There was male preponderance (80%) while female patients constituted 20% of the study group. The most common location of wound was Right lower limb (20%) followed by Left foot (18.3%), Anterior abdominal wall (13.3%), Left lower limb (8.3%) and Right foot (8.3%). The location of wound in 2 (3.3%) patients each was Amputated right lower limb, Right knee, Right thigh and Scrotum while the location of wound in 1 (1.7%) patient was abscess over left foot, chest, Just above right ankle, Left lower limb, Left foot ulcer, Left knee, Left upper back, Nape of neck, Right ankle, Right gluteal and Right hand. The most common type of wound was Non healing ulcer (43.3%) followed by surgically debrided wound (41.7%) and Wound dehiscence (15%). The total days of negative pressure wound therapy (NPWT) in majority of the patients (36.6%) was ≥14 days followed by ≤7 days (31.7%) and 8-13 days (31.7%).46 (76.7%) patients underwent skin grafting while 14 (23.3%) patients underwent secondary suturing. The mean wound area of patients on Day 0 was 189591.67 ± 282863.42mm3 which significantly decreased to 126262.08 ± 226668.82 mm3 by Day 4, 78431 ± 132829.12 mm3 by Day 7, 63327.38 ± 113599.73 mm3 by Day 10 and 38823.86 ± 33945.32 mm3 by Day 14. There was significant difference in wound area during follow-up period as per ANOVA test ($p<0.05$). The mean wound area of patients on Day 0 was 189591.67 ± 282863.42mm3 which significantly decreased to 126262.08 ± 226668.82 mm3 by Day 4, 78431 ± 132829.12 mm3 by Day 7, 63327.38 ± 113599.73 mm3 by Day 10 and 38823.86 ± 33945.32 mm3 by Day 14. There was significant difference in wound area during follow-up period as per ANOVA test ($p<0.05$). It was observed on day 0 that the slough was present in 53 (88.3%) patients and absent in 7 (11.7%) patients while on day 4, the slough was present in 28 (46.6%) patients, minimal in 18 (30%) patients and absent in 14 (23.4%) patients. On day 7, the slough was present in 20 (33.3%) patients and absent in 40 (66.7%) patients. All patients (100%) showed no slough by Day 10. There was significant difference in slough during follow-up period as per Chi- Square test ($p<0.05$). The mean collected fluid of patients on Day 0 was 65.25 ± 23.71 ml which significantly decreased to 51.38 ± 24.72 ml by Day 4, 36.03 ± 20.55mlby Day 7 and 20.91 ± 11.25 ml by Day 10. There was no fluid present in all the patients by Day 14. There was significant difference in collected fluid during follow-up period as per ANOVA test ($p<0.05$). The most common type of organism was Staphylococcus Aureus present in12 (20%) patients on Day 0 followed by E.coli (13.3%), P. Aeruginosa (11.7%), MRSA (5%), Streptococcus Pyogenes (5%), Acinetobacter (3.3%), Aerumonas Species (1.7%), B.H. Streptococcus (1.7%) and Enterococcus species (1.7%). There was significant difference in type of organism during follow-up period as per Chi-Square test ($p<0.05$).

Table 1: Distribution of patients according to Type of Wound

Type of Wound	N	%
Non healing ulcer	26	43.3%
Surgically debrided wound	25	41.7%
Wound dehiscence	9	15%
Total	60	100%

Table 2: Distribution of patients according to Total days of NPWT

Total days of NPWT	N	%
≤7 days	19	31.7%
8-13 days	19	31.7%
≥14 days	22	36.6%
Total	60	100%
Mean ± SD	10.52 ± 2.93	

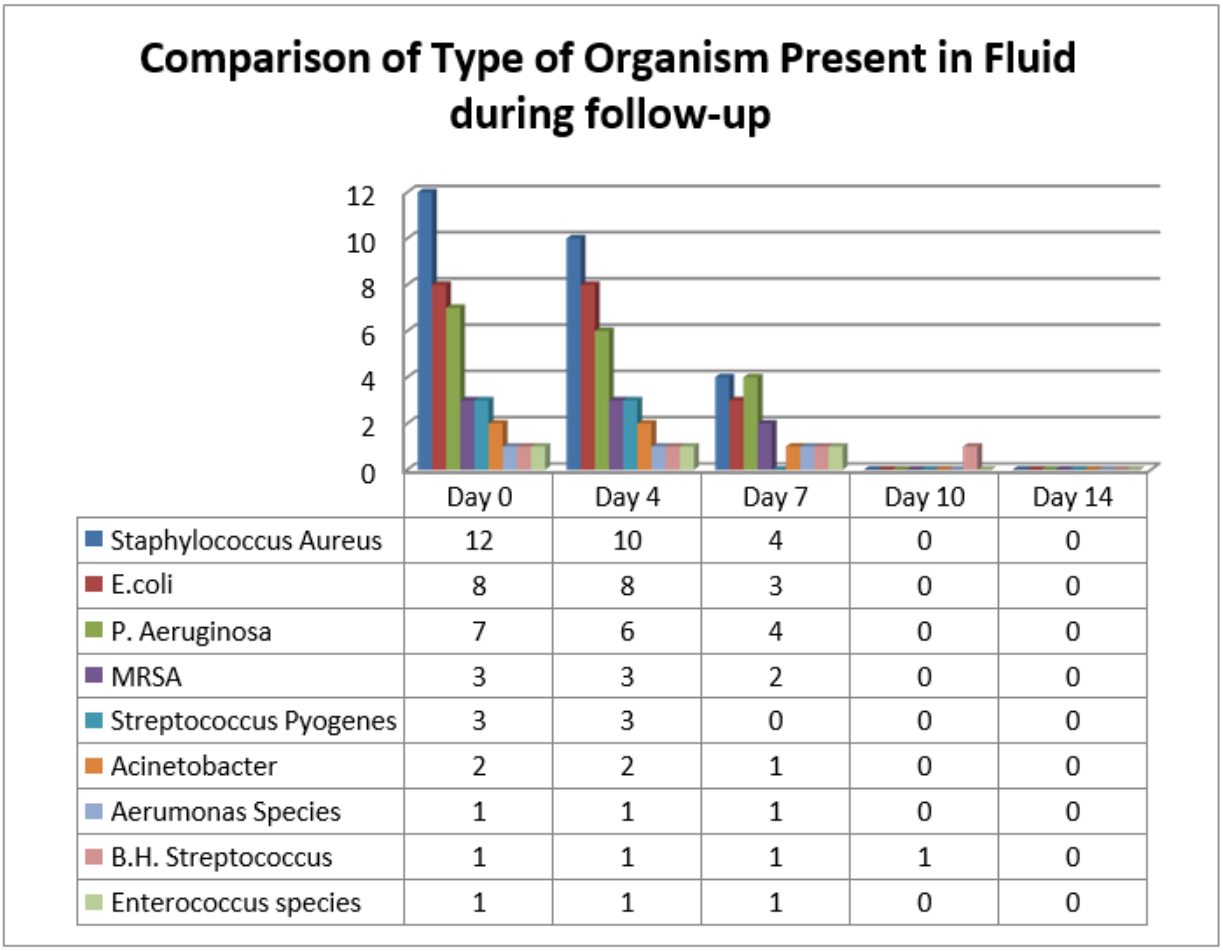
Table 3: Comparison of Wound Area during follow-up in patients

Follow-up Period	Area (mm3)		p-Value
	Mean	SD	
Day 0	189591.67	282863.42	-
Day 4	126252.08	226668.82	<0.05
Day 7	78431.25	132829.12	<0.05
Day 10	63327.38	113599.73	<0.05
Day 14	38823.86	33945.32	<0.05

Table 4: Comparison of Collected Fluid during follow-up in patients

Follow-up Period	Collected Fluid		p Value
	Mean	SD	
Day 0	65.25	23.71	-
Day 4	51.38	24.72	<0.05
Day 7	36.03	20.55	<0.05
Day 10	20.91	11.25	<0.05
Day 14	0	-	<0.05

Graph 1: Comparison of Type of Organism Present in Fluid during follow-up in patients



	Day 0	Day 4	Day 7	Day 10	Day 14
Staphylococcus Aureus	12	10	4	0	0
E.coli	8	8	3	0	0
P. Aeruginosa	7	6	4	0	0
MRSA	3	3	2	0	0
Streptococcus Pyogenes	3	3	0	0	0
Acinetobacter	2	2	1	0	0
Aerumonas Species	1	1	1	0	0
B.H. Streptococcus	1	1	1	1	0
Enterococcus species	1	1	1	0	0

Discussion

In the present study, majority of the patients (35%) were in the age group of 51-60 years followed by 61-70 years (26.7%), 41-50 years (16.7%), 21-30(10%), 31-40 years (5%), 71-80 years (3.3%), 11-20 years (1.7%) and 81-90years (1.7%). The mean age of the patients was 54.33 ± 13.62years. There was male preponderance (80%) while female patients constituted 20% of the study group.This is similar to the studies of Siddha LV et al, Kim JJ et al and Akpaloo J et al.[10- 12]The most common location of wound in our study was Right lower limb (20%) followed by Left foot (18.3%), Anterior abdominal wall (13.3%), Left lower limb (8.3%) and Right foot (8.3%). The location of wound in 2 (3.3%) patients each was Amputated right lower limb, Right knee, Right thigh and Scrotum while the location of wound in 1 (1.7%) patient had wound over left foot, chest, Just above right ankle, Left lower limb, Left foot ulcer, Left knee, Left upper back, Nape of neck, Right ankle, Right gluteal and Right hand. This is consistent with the study of Siddha LV et al[10].Siddha LV et al[10] prospective non-randomized comparative study evaluating the efficacy of the modified method of vacuum dressing in woundhealing in low resource Settings found ulcers are located predominantly over lower limbs and other sites also like upper limb, clavicular region, abdomen, amputation stump, back,

neck and scrotum.It was observed in the present study that the mean wound area of patients on Day 0 was 189591.67 ± 282863.42 mm^3 which significantly decreased to 126262.08 ± 226668.82 mm^3 by Day 4, 78431 ± 132829.12 mm^3 by Day 7,63327.38 ± 113599.73 mm^3 by Day 10 and 38823.86 ± 33945.32 mm^3 by Day14. There was significant difference in wound area during follow-up period as per ANOVA test ($p<0.05$). This is in concordance to the studies of Koppad SN et al[13], Fabio K et al[14], and Richhariya A et al[15].Fabio K et al[14] randomized, controlled, non-inferiority, unblinded trial evaluating two different methods of negative-pressure wound therapy in terms of healing time reported there was an increase in wound surface area in both groups. However, the rate of change was not significantly different between the groups. It was observed in our study that on Day 0 that the granulation was minimal in59 (98.3%) patients and healthy in 1 (1.7%) patient. The granulation was significantly healthy in 20 (33.3%) patients and 58 (96.7%) patients by Day 4 and Day 7 respectively. All patients (100%) showed healthy granulation by Day 10. There was significant difference in granulation during follow-up period as per Chi-Square test ($p<0.05$). Similar observations were noted in the studies of Fabio K et al[14], Koppad SN et al[13], Chandrashekar S et al[16], Siddha LV et al[10], Nagaraj S et al[17] and Priyatham K et al[18].Koppad SN et al[13] prospective randomized observational study evaluating the efficacy of topical negative pressure dressing with conventional moist wound dressings in healing of wounds reported percentage of granulation tissue formation in the study group was 81.0±8.29 and in the control groupwas 53.60±19.23, which was found to be statistically significant.Siddha LV et al[10] prospective non-randomized comparative study evaluating the efficacy of the modified method of vacuum dressing in wound healing in low resource settings reported in Culture 1 the predominant organisms being pseudomonas in 16 (40%) and 19 (38%) cases in experimental and controlgroup and Staphylococcus aureus in 16 (40%) and 24 (48%) cases in experimental and control group and Klebisiella in 4 (10%) and 2 (4%) cases in experimental and control group. In Culture 3 S. aureus in 12 (80.0%) and 27 (81.8%) cases in experimental and control group and Klebisiella in 3 (20%) cases in experimental group and proteus in 3 (9%) cases and pseudomonas in 3 (9%) cases of control group. Due to vacuum dressing in Diabetic patients in the experimental group 4 (9.8%) patients maceration of the skin was observed due to moisture retainment.

Conclusion

Management of wounds is always a challenging issue. Therefore; there is a need of application of newer and advanced modalities for management of wounds. Wound shows better outcome with negative pressure wound therapy when used as one of the treatment modalities. Negative pressure wound therapy uses negative pressure to assist wound healing and has positive impact for granulation tissue formation and wound closure.

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