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A Study to Detect the Efficacy of Micro-Current Electrical Therapy on Decubitus Wound

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This study tries to point out the effectiveness of Micro-current electrical therapy on decubitus wound of patients in different hospitals. The analysis shows that Micro-current Electrical Therapy (MET) has significant effect on healing the wound. The analysis also show that wound of female patients are healing significantly better than that of male patients and age is significantly influence for slightly decreasing the healing of wound.

Key words: Decubitus wound, Micro-current Electrical Therapy (MET), multiple regression

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INTRODUCTION

Pressure ulcers are a common phenomenon in many different health care settings. Over the years several Dutch studies show indeed that the prevalence of pressure ulcers is high, especially in the intensive care unit (Bours, 2001). There is a need for an effective therapy of managing these ulcers. Pressure ulcers are medically known as decubitus ulcers. A decubitus ulcer is a pressure sore or what is commonly called a bed sore. It can range from a very mild pink coloration of the skin, which disappears in a few hours after pressure is relieved on the area, to a very deep wound extending to and sometimes through a bone into internal organs. There has been a trend in modern health care toward minimally invasive procedures, including reduced reliance on heroic and long term drug therapies (Kenneth, 2006). The trend for managing pressure ulcers has been towards the use of micro-current. living tissue possess direct current electro-potentials that appear to regulate, at least partly, the healing process. Micro-current therapy is the practice of applying low-intensity electric currents, usually at low frequencies that match the body's natural pulse rate. Micro-currents, or micro-amps, are electric currents with intensity less than one milliamp. Micro-currents are measured in the millionth of an amp range. However, the evidence that micro-current therapy predictably accelerates dermal (skin) repair remains less convincing (Mohammad, 2006). In view of recent scientific understanding of the wound-healing process, one would expect a beneficial outcome from electro-therapy that decreases ulcer size and accelerates healing in patients (Gentzkow, 1993). Chronic wounds, of which leg ulcerations make up a major share, are a therapeutic problem. It is estimated that 90% of leg ulcers are due to venous stasis, affecting 0.6 of men and 2.1% of women in their 60s (Stiller and Dermato, 1992; Nessler and Mass, 1985).

A statistical analysis of data and results from a prospective study, undertaken with the aim to detect the effect of Micro-current Electrical Therapy (MET) on patients hospitalized for a long time and therefore baring decubitus wounds.

MATERIALS AND METHODS

The data was collected from patients hospitalised for a long time and therefore suffering from decubitus wounds in Belgium. A total of 60 male and female patients, aged between 60 and 80, got enrolled into the study. These were from 6 different hospitals and got randomised into 2 different groups. The randomization was important so that bias is removed and the two groups are comparable. Patients from one group, MET group, were receiving micro-electronic therapy while those in the other group, CON group, were receiving visually the same therapy but with a micro-electronic device which was not working properly. This second group served as the control group. All patients were followed for 12 weeks and the surfaces of the wounds measured on a weekly basis. Some patients had more than one wound.

Table 1: The variable description, type and units of measure

Variable	Description	Levels /units of measure
Treatment	Treatment group to which the patient is allocated	*CON = 0, MET = 1
Sex	Patient's sex (gender)	0 = male, 1 = female
Age	Patient' age	Years
Hospital	Hospital at which the patient was enrolled	1, 2, …, 6
Wound id	The wounds on the patient	1, 2, 3
Weeks	Weeks of wound measurement	0, 1,…, 12
Base	The surface area of the wound at week 0, just before treatment commenced Square millimeters	
Surface	The surface area or the wound per week, from week 1 to week 12.	Square millimeters

*CON meant that the patient received micro-current therapy but from a device which was not working properly and therefore belonged to the control group, while MET meant that the patient received micro-current therapy from a properly working device and thus belonged to the treatment or case group

The variables were collected and made up the data set (Table 1). It also bares the names given to these variables in the data set and information on their units of measure.

Derivation of the response variable: Our data set contains 114 subjects; wounds. The measurement of surface area for each wound was taken for 12 consecutive weeks. We denote the measurements per a wound as shown below $Y_0, Y_1, Y_2, ..., Y_{12}$ where Y_0 is the base measurement of the wound and t = 0,1,2,...,12 weeks. Assuming that the surface of the wound at time t is a function of the surface at time t-1, we can derive the rate of change in surface area of a wound for the 12 weeks as follows.

Let Y_1 CY_{t-1}. This implies that, $Y_1 = CY_0$, $CY_2, = CY_1$, $Y_3 = CY_2, ..., CY_{12} = CY_{11}$ where C is unknown constant. Using mathematical equation, we come up with an equation that tracks the correlation between all 13 measurements.

$$Y_1 = CY_0,\ Y_2 = C^2Y_0,\ \ldots,\ Y_{12} = C^2Y_0$$

In general,

$$Y_t = C^tY_0 \qquad (1)$$

To solve for C, which is our main interest, we applied logarithms on Eq. 1

$$\ln (Y_1) = \ln (Y_0) +t (\ln C) \qquad (2)$$

$$\text{Let } Z_t = \ln (Y_t)\text{-in } (Y_0) \qquad (3)$$

Combining Eq. 2 and 3, we get,

$$Z_t = (\text{In } C)^* \, t \quad (4)$$

Equation 4 can be interpreted as a linear regression model without intercept, that is, $Z_t = (\text{in } C)^* \, t + \varepsilon$. There was no change in surface area of a wound at week 0. We regressed Z_t on t for each wound. The parameter estimate, $\hat{\beta}$ from the regression model is equivalent to ln C. That is, $\ln C = \hat{\beta} \Rightarrow C = \exp(\hat{\beta})$

Our response variable C is the rate of change in surface area of a wound, where

C = 1 corresponds to no change in the surface area
C<1 corresponds to improvement; the surface area is reducing
C>1 corresponds to deterioration; the surface area is increasing

Regression model: To examine the treatment effect, multiple linear regression models were used. Cohen and Hardy proposed that any combination of categorical and continuous variables can be analyzed within a multiple regression model framework simply through the dummy coding of the categorical variables (Cohen, 1968). In this study we, therefore, chose to assess the treatment effect using a multiple linear regression model (Kutner *et al*., 2005).

Therefore, in present study:

$$\mathbf{Y} = \beta_0 + \beta_1 \mathbf{X_1} + \beta_2 \mathbf{X_2} + \beta_3 \mathbf{X_3} + \beta_4 \mathbf{X_4} + \beta_5 \mathbf{X_5} + \beta_6 \mathbf{X_6} + \beta_7 \mathbf{X_7} + \beta_8 \mathbf{X_8} + \varepsilon; \ \varepsilon \sim N(0, \sigma^2)$$

Where,

$\mathbf{Y}$ = Rate of change in surface area of wound (C)
$\mathbf{X_1}$ = Treatment
$\mathbf{X_2}$ = Sex
$\mathbf{X_3}$ = Age
$\mathbf{X_4}, \mathbf{X_5}, \mathbf{X_6}, \mathbf{X_7}, \mathbf{X_8}$ = Hospital (H) 1, H2, H3, H4 and H5, respectively

$$X_1 = \begin{cases} 1 \text{ if a wound belong to the MET group} \\ 0 \text{ otherwise} \end{cases}$$

$$X_2 = \begin{cases} 1 \text{ if a patient gender is Female} \\ 0 \text{ otherwise} \end{cases}$$

$$X_4 = \begin{cases} 1 \text{ if patient is in hospital 1} \\ 0 \text{ otherwise} \end{cases} \quad X_5 = \begin{cases} 1 \text{ if patient is in hospital 2} \\ 0 \text{ otherwise} \end{cases}$$

$$X_6 = \begin{cases} 1 \text{ if patient is in hospital 3} \\ 0 \text{ otherwise} \end{cases} \quad X_7 = \begin{cases} 1 \text{ if patient is in hospital 4} \\ 0 \text{ otherwise} \end{cases}$$

$$X_8 = \begin{cases} 1 \text{ if patient is in hospital 5} \\ 0 \text{ otherwise} \end{cases}$$

RESULTS AND DISCUSSION

Overall, healing rate ranged from 0.7340 to 1.0838, with mean 0.9240 and standard deviation 0.0807. In the CON group, the healing rate ranged from 0.8551 to 1.0838, with mean 0.9455 and standard deviation 0.076, while it ranged from 0.7340 to 1.0511 in the MET group, with mean 0.9455 and standard deviation 0.0760 (Table 2).

Overall, the age ranged from 60 to 79 years in the CON group, with mean 69.33 and standard deviation 6.23. In the CON group, age ranged from 60 to 79 years, with mean 69.6 and standard deviation 5.93, while it ranged from 61 to 78 in the MET group, with mean 69.07 and standard deviation 6.72 (Table 2).

In general, 40.35% of wounds were from female and 59.65% from male patients. In the CON group the distribution of wounds by sex was about 23.33% from male and 76.76% from female, while in the MET group it was about 59.30% from male and 40.70% from female patients (Table 3).

Overall patients hospital 2 had the most wounds (33%). Most of the wounds in the CON group were at hospital 2 (43%), while most of the wounds in the MET group were at hospital 6 (30%) (Table 4).

About two-thirds (67%) of the patients had more than one wound on their bodies (Table 5).

It can be seen that the surface-base ratio is generally decreasing in both groups, but is decreasing at a faster rate in the MET group (Fig. 1), suggesting that healing rate in this group is better than in control group.

The wounds for patients in hospital 4 and 5 are reducing in surface-base ratio faster than other hospitals (Fig. 2). There is no much difference in the surface change of wounds for patients in Hospital 1, 2, 3 and 6. This led us to conclude that the healing rate was different among the hospitals.

Treatments are significantly related with sex and slightly related with hospital. Sex and hospital also significantly associated (Table 6).

The model explained approximately 46% of the total variation by the repressors (Table 7). Individually every variable has significant effect on healing rate except hospital 1. Here we also seen that average rate of change in surface area of wound decreases approximately 3% more using micro-current electrical therapy than control when all other variables hold constant. That is Micro-current Electrical Therapy (MET) significantly contribute for reducing the rate of change in surface area of wound. The average rate of change in surface area of wound

Table 2: Summary statistics for the rate of change of surface area of wound and age

Variable	Group	n	Mean	Standard deviation	Minimum	Maximum
Rate of change in surface area of wound (mm square per week)	Control	60	0.9455	0.0760	0.8551	1.0838
	MET	54	0.9002	0.0803	0.7340	1.0511
	Total	114	0.9240	0.0807	0.7340	1.0838
Age (in years)	Control	30	69.60	5.93	60	79
	MET	30	69.07	6.72	61	78
	Total	60	69.33	6.23	60	79

Table 3: Frequency distributions of sex in the control and the MET groups

	CON		MET		Total	
Sex	Frequency	Percent	Frequency	Percent	Total	Percent
Female	14	23.33	32	59.30	46	40.35
Male	46	76.67	22	40.70	68	59.65
Total	60	52.63	54	47.37	114	100.00

Table 4: Frequency distributions of sex and hospital in the control and the MET groups

	CON		MET		Total	
Hospital	Frequency	Percent	Frequency	Percent	Total	Percent
1	2	3.33	8	14.81	10	8.77
2	26	43.33	12	22.22	38	33.33
3	12	20.00	8	14.81	20	17.54
4	4	6.67	6	11.11	10	8.77
5	4	6.67	4	7.41	8	7.02
6	12	20.00	16	29.63	28	24.56
Total	60	52.63	54	47.37	114	100.00

Table 5: Frequency of wounds per patient

No. of wounds per patient	Frequency	Percentage
1	22	36.67
2	22	36.67
3	16	26.66
Total	60	100.00

Table 6: Cross-tabulation

Variable	Assymp. sig(2-sided)
Treatment versus	
Sex	$^{*}\chi^2_{(1)}$:15.24
Hospital	$^{**}\chi^2_{(5)}$:10.24
Sex versus hospital	$^{*}\chi^2_{(5)}$:20.24

$^{*}\chi^2<0.01$, $^{**}\chi^2<0.10$

Table 7: Multiple linear regression analysis of rate of change in surface area of wound

Variables	Coefficient	SE	t	Sig
(constant)	0.813	0.088	9.237	0.000
Treatment	-0.031	0.013	-2.505	0.014
Sex	-0.049	0.013	-3.669	0.000
Age	0.003	0.001	2.116	0.037
Hospital 1	0.007	0.025	0.290	0.772
Hospital 2	-0.046	0.017	-2.675	0.009
Hospital 3	-0.062	0.018	-3.352	0.001
Hospital 4	-0.171	0.026	-6.504	0.000
Hospital 5	-0.096	0.026	-3.650	0.000

$R^2 = 0.462$, $F_{8,105}<0.001$

reducing approximately 5% more of female patients than that of male patients keeping other variables constant. Similarly among hospitals, the average rate of change in surface area of wound decrease more (about 17%) those patients who are in hospitalized in hospital 4 than that of patients who are hospitalized in hospital 6 keeping other variables constant.

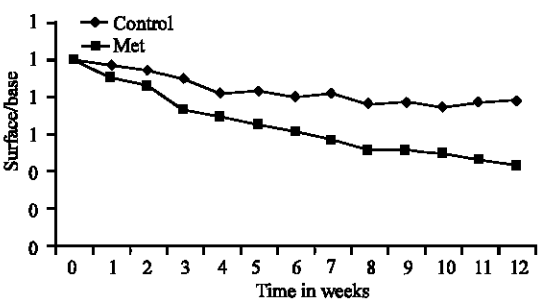

Fig. 1: Weekly surface-base ratio for the control and MET groups (Comparison of MET and control group)

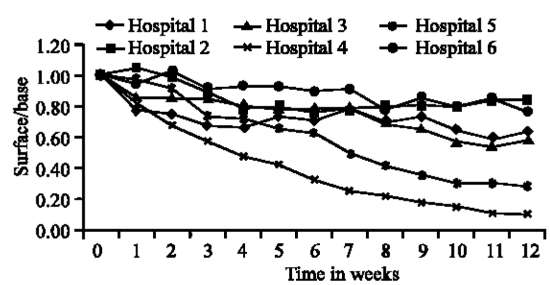

Fig. 2: Comparison of weekly surface base ratios at the hospitals

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