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Research Article

Observational Study of pH and Temperature Behavior in Chronic Wounds and Its Correlation with the Bacterial Colonization Phase

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Summary

A study on 28 assessment in ulcers were performed at the healing service. In the Hospital Municipal de Tigre. Basal pH and temperature measurements were also included in the procedure. After scraping the wound bed with Fluid Thioglycollate Medium (FTM), Levine EMB agar, a Gram staining and Giemsa staining was performed in order to determine the cellularity as the phase in which it is located.

Aim of the Work

The study of the correlation of pH, Temperature and Bacteriological local phase parameters, determining the influence of those determinations in the wound healing and the current phase of the beds of those wounds.

Keywords

Bacterial Colonization; Wounds; pH

Introduction

The complex evolution of chronic wounds compels us to improve their local state diagnosis before and during the treatment in order to optimise the cost.

Materials and Methods

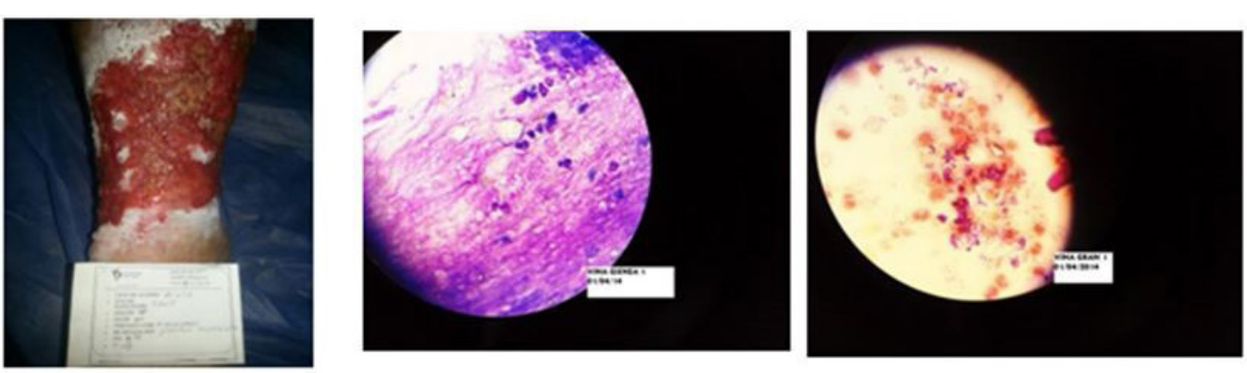
The study on 28 assessments in ulcers were performed in the healing service of the hospital. Measurements are done to determine Basal pH and temperature randomly on chronic wounds, under all kind of conditions, with Lutron pH 206 equipment. The procedure consists in measuring the temperature immediately after the removal of the healing method in order not to alter the local conditions, and the same procedure is done with pH determinations. After that, we proceed to the scraping of the wound bed and the sample obtained is put in two glass slides without fixation in order to follow with the Gram staining and the Giemsa staining in order to determine the cellularity as the phase in which it is in. The data sheet is completed with the following parameters (The most important data is filled in tables 1 and 2).

Patient, date of taking, kind of ulcer, starting date of the lesion, treatment of the last healing previous to taking, treatment post taking and measuring, pain, smell, pH, temperature, Giemsa.

Patient	Date	Kind of Ulcer	pH	T	Giemsa
VIMA (Figure 1)	01 April 2014	VENOUS	8.1	28	C0 L3 CV1 F3 H1 G1
VE..	01 April 2014	VENOUS MIXED	8.3	24.5	C3 L2 F1 H2 G1
ACRO (Figure 2)	08 April 2014	MIXED+LYNPHATIC	8.15	25.2	C1 L3 G3
GIAY (Figure 3)	08 April 2014	TRAUMATIC	8.1	26.9	C0 L2 F0 H3 G1
TECA	08 April 2014	ON STUDY	8.06	27.06	C0 L2 F3 G1
ACRO	11 April 2014	MIXT+LYNPHATIC	7.58	24.6	C3 L2 F3 H3 G1
ACRO	15 April 2014	MIXT+LYNPHATIC	8.22	26.8	C0 L3 F2 G3
VE..	29 April 2014	VENOUS MIXED	8.22	25.5	C+ F0L3G2 CV1
ACRO	13 May 2014	VENOUS	7.48	29	C1 F1 L2 G2
VIMA	13 May 2014	MIXT	7.95	30.4	C2 L1 F1 G1
SAMU	20 May 2014	TRAUMATIC	8.56	24.9	C1 F1 L3
COAN	20 May 2014	VENOUS	8.46	25.3	C2 F2 L2
JAGR (Figure 4)	20 May 2014	RHEUMÁTIC	7.89	28.9	C2CV2L2 EOS3
BIAT	20 May 2014	TRAUMATIC	8.15	28.7	C0 L2 CV 2
OJEL	10 June 2014	ARTERIAL	8.26	24	C0 L0 F1
COAN	10 June 2014	VENOUS	8.22	25.7	C0 F2 L2
VAES	10 June 2014	VENOUS	7.02	26.9	C0 L2 G2 F1
JAGR	17 June 2014	RHEUMÁT	7.85	26.4	C1 F1 L1 E1
RU..	17 June 2014	VENOUS	7.99	28	C1 L1 F1
VIMA	17 June 2014	VENOUS	7.05	28.3	C1 L3 G3
VIMA	17 June 2014	VENOUS	8.15	26	C1 L3 G3
GB..	15 July 2014	ARTERIAL	7.6	30.1	C2 L2
GA	15 July 2014	TRAUMATIC	8.5	28	C1 CV1 L3 G3
BM	15 July 2014	VENOUS	8.7	28.8	C1 F2 L1
BM	15 July 2014	VENOUS	7.3	28.3	C1 L2 G2
OL	15 July 2014	VENOUS-RHEUMAT	7.81	27.3	C1 F2 L2
CORVA	17 July 2014	VENOUS	8.15	26.8	C1 L3 G3
VIMA	17 July 2014	MIXED	8.01	26	C1 L3 G3

Table 1: pH, Temperature and Giemsa Staining, C: Epithelial Cells, L: Lymphocytes, F: Fivers, CV: Vacuoles Cells, G: Germs.

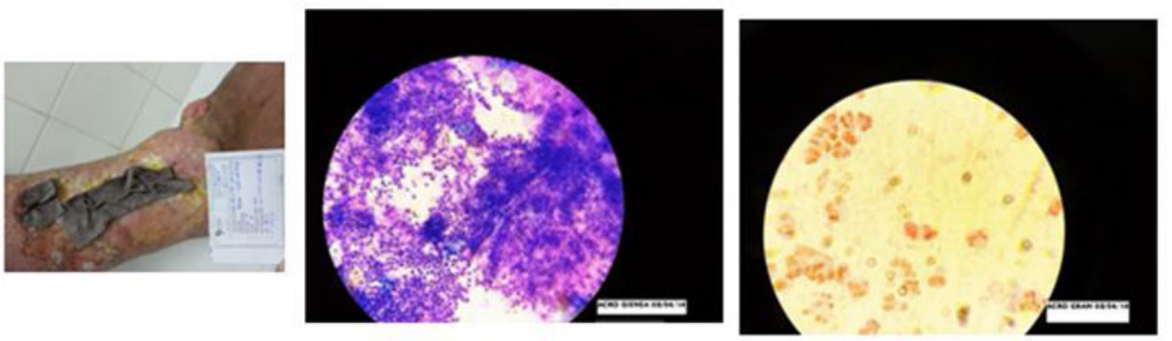
VIMA 01 April 2014



- Mixed Ulcer - Starting date 2013
- Pain ++ Smell ++
- PH: 8.1 T: 28
- GIEMSA: C0-L3-CVAC1-F3-H1-G1
- GRAM: Cocci + vasilli –

Figure 1: VIMA 01 April 2014.

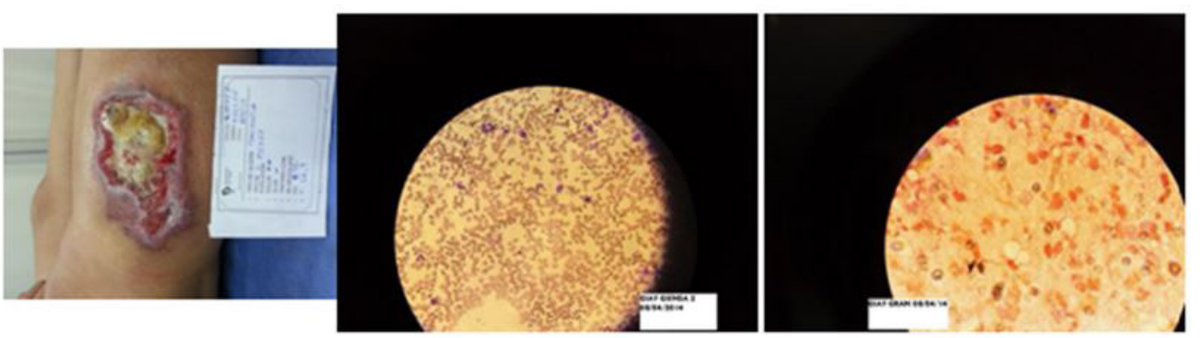
ACRO 08 April 2014



- Mixed Ulcer - Starting date 2013
- Pain + Smell +
- PH: 8.15 T: 25.2
- GIEMSA: C+L+++G+++
- GRAM: Abundant Basilli

Figure 2: ACRO 08 April 2014.

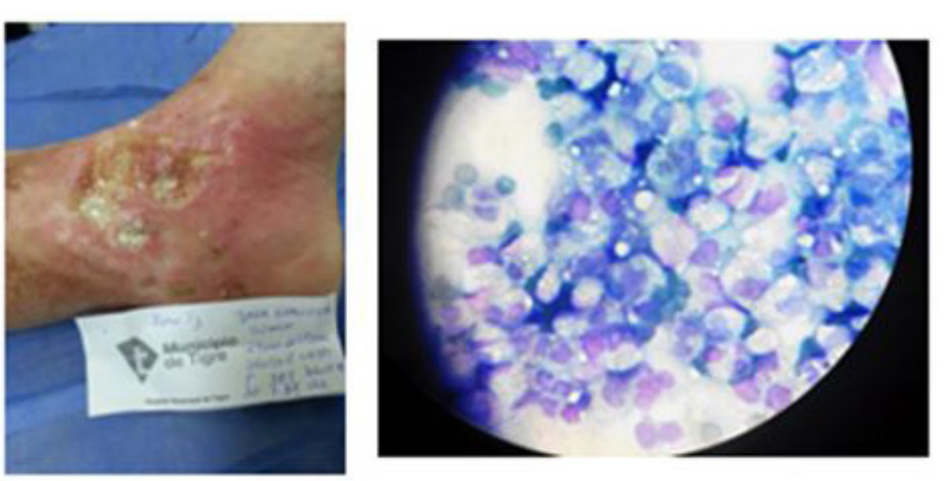
GIAY 08 April 2014



- Traumatic Ulcer - Starting date 2/2014
- Pain ++ Smell -
- PH: 8.1 T: 26.9
- GIEMSA: C0 L++ F0 H+++ G+
- GRAM: Isolated cocci + gathered, isolated B-

Figure 3: GIAY 08 April 2014.

JAGR 20 May 2014



- Venous Ulcer - Starting date: 24 years
- Pain XX Smell ++
- PH: 7.89 T: 28.9
- GIEMSA: C++ CEL VAC++L++ eosinophils +++
- GRAM: No

Figure 4: JAGR 20 May 2014.

Patient	Date	Gram	Culture
VIMA	01 April 2014	COCCI+, BACILLUS-	S/C
VE..	01 April 2014	BACILLUS-	S/C
ACRO	08 April 2014	ABUNDANT BACILLUS-	S/C
GIAY	08 April 2014	ISOLATED COCCI + GATHERED ISOLATED B-	S/C
TECA	08 April 2014	ISOLATED COCCI + GATHERED	S/C
ACRO	11 April 2014	BACILLUS -	S/C
ACRO	15 April 2014	ABUNDANT B-	Ps. Spp R : cip, gen
VE..	29 April 2014	REGULAR B-, RARE C+, RARE B+	S/C
ACRO	13 May 2014	REGULAR B-	S/C
VIMA	13 May 2014	REGULAR B-, RARE C+	S/C
SAMU	20 May 2014	B-, C+	S/C
COAN	20 May 2014	ISOLATED C+ ,B-	S/C
JAGR	20 May 2014	No observed	No development
BIAT	20 May 2014	ISOLATED C+, B-	S/C
OJEL	10 June 2014	BACTERIA ARE NOT OBSERVED	S/C
COAN	10 June 2014	BACTERIA ARE NOT OBSERVED	S/C
VAES	10 June 2014	ABUNDANT B-, ISOLATED C+ AGRUP.	S/C
JAGR	17 June 2014	ISOLATED B-	sc
RU..	17 June 2014	B-, C+	sc
VIMA	17 June 2014	C+ agrup Cadena	Punction: ST AUREUS METI S+ Enterococo sp
VIMA	17 June 2014	Abundances bacilos -	SWAB: Ps. Spp
GB..	15 July 2014	ISOLATED C+	sc
GA	15 July 2014	C+, B-	sc
BM	15 July 2014	C+ GATHERED	Swab: negative
BM	15 July 2014	Abund cocos + agrup	PUCION: ST AUREUS METI R
OL	15 July 2014	B-	sc
CORVA	17 July 2014	Abund basi -	SWAB: Ps. Spp
VIMA	17 July 2014	Abund basi -	SWAB: Ps. Spp

Table 2: Staining Gram and Culture.

Photographic file of the lesion is performed and also of its evolution, jointly with the results of Gram and Giemsa, putting them by the side of the wound in order to compare its state.

The pH device is assessed once a month with acid and basic buffers (Figures 5 and 6).

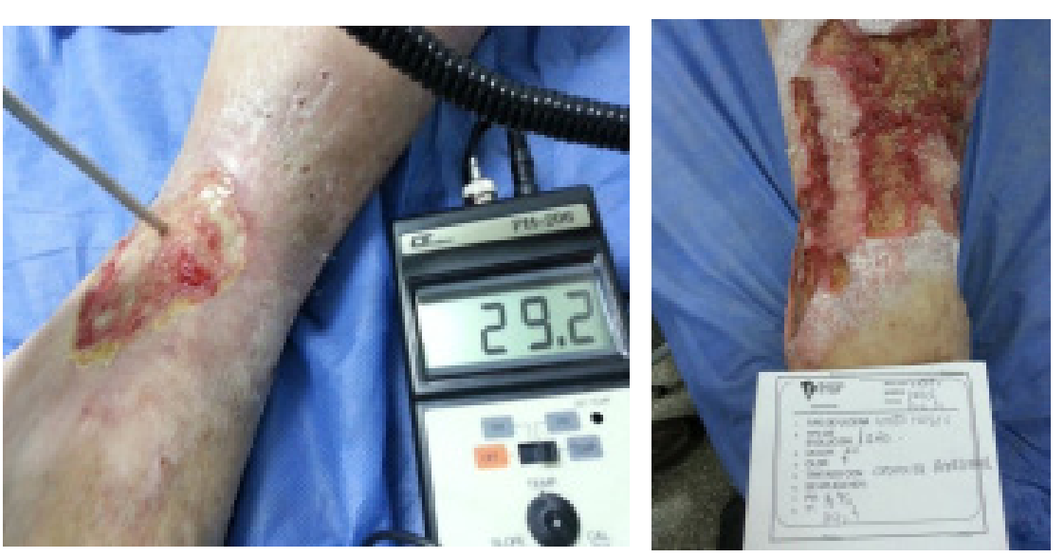


Figure 5: Temperature measuring device- data of ulcer PH probe and staining in one cell.

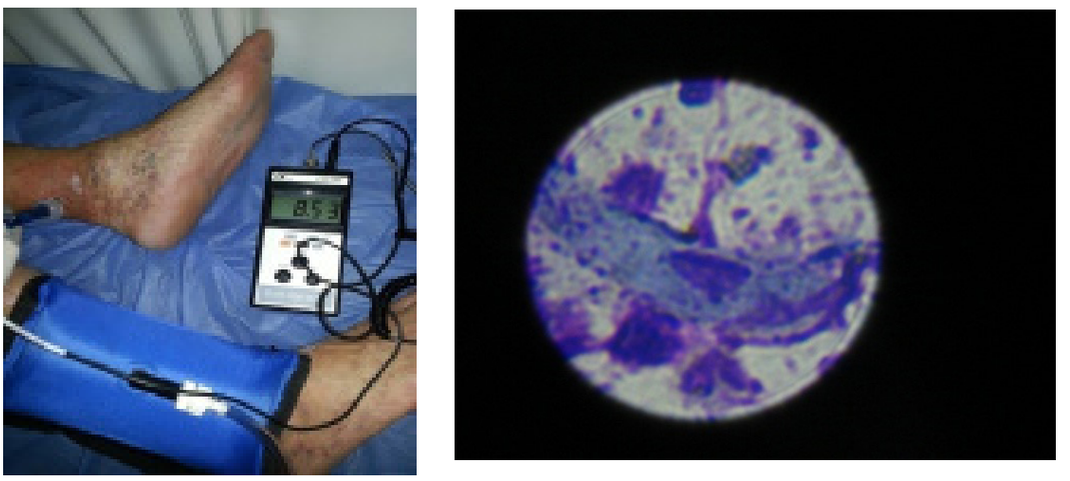
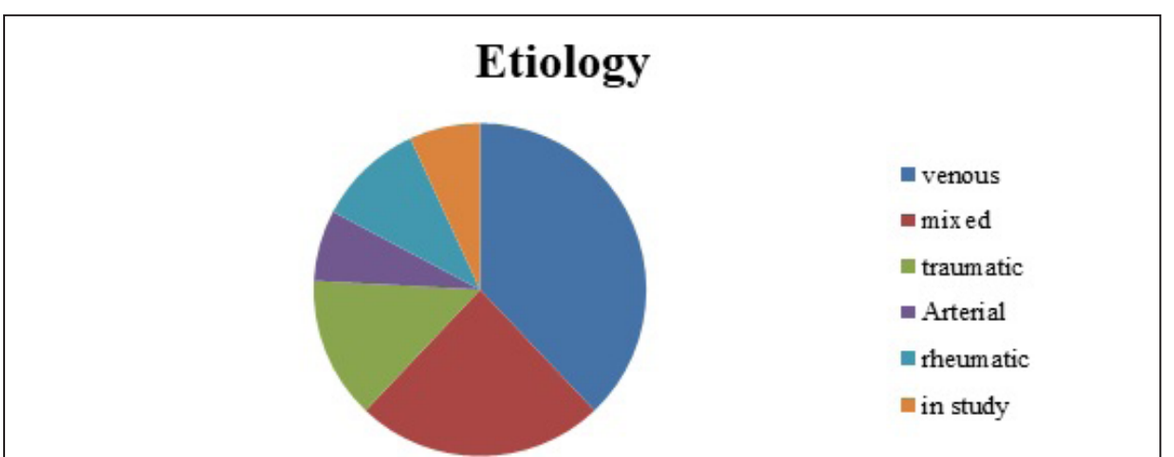


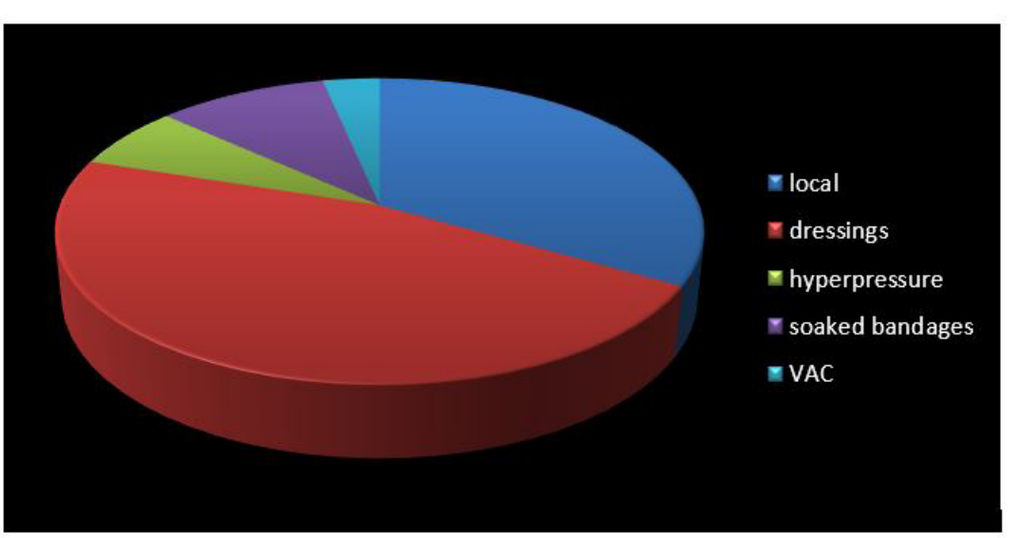
Figure 6: Temperature measuring device- data of ulcer PH probe and staining in one cell.

Results

The assessments were performed between April and July 2014. Most of the evaluated ulcers were vascular, being the venous ulcers the most frequent, followed by the mixed, the traumatic, the arterials, by rheumatological diseases and two ulcers which are still being studied (Graphic 1). All the patients chosen for the study had an ulcer with a minimum of one year of evolution. In our study the ulcer which presented the longest time of evolution was of 10 years. Treatments performed can be found in graphic 2.



Graphic 1: Etiology.



Graphic 2: Treatments performed.

Nine patients had pain in their wounds and eight referred smell. The pH range of all the determinations varied between 7.02 and 8.56; and the range of temperature varied between 24 and 30.1 grades.

As regards observational conclusions we can list the following findings:

- The patients with pain showed as a whole a minimum pH of 7.89. It could also be observed a higher quantity of leucocytes in the Giemsa smear.
- The presence of leucocytes in the Giemsa smear was correlated with positive cocci and negative bacilli in the Gram staining; being pH higher than 8 in colonization with aeruginosa and Proteus spp, and higher than 7.5 with colonization of positive cocci.
- The patients with cellulites 2 and 3 in the Giemsa staining developed a small quantity of germs and showed PH lower to 7.90 regardless the temperature. Only one patient does not fit this parameter, showing abundant bacilli in the Gram, which suggests a recent critical colonization that alters the wound bed with a stable healing rate.
- It was proved that the temperature of the wound is highly changeable and volatile exposed to de environmental air, for which reason the measuring has to be taken immediately after the removal of the healing devise.
- The PH, the Gram and the Giemsa are stable, non-invasive and fast determinations for the wound and the cell bed evaluation and enables us to determine a change in the therapeutic approach.

Discussion

A chronic wound has a different evolution than an acute one. A chronic wound is a wound that does not heal in an orderly set of stages and in a predictable amount of time the way most wounds do; wounds that do not heal within three months are often considered chronic [1]. A chronic wound shows a high number of pro-inflammatory cytokines and proteases in the exudate [2]. There are also, in those, a low cellular mitosis, low levels of growth factors and cellular senescence. However, from the stand point of medical practice, it is very difficult to make these determinations. This is not the case with measurement of parameters such as pH, temperature and exudate components from frequent stainings. The pH range handled in a chronic wound is of 7.15 to 8.9 [3]. Acute and chronic wounds that have an elevated alkaline pH, show a lower rate of healing than those with a neutral or lower pH [4]. As the ulcer advances, the pH tends to be neutral and then acid. The presence of dead and devitalized tissue causes in the wound an increase of metabolism which produces tissue hypoxia [5]. These wounds have an important destruction of the Extracellular Matrix (MEC), which occurs faster in an alkaline medium.

The PH medium also influences the oxygen liberation to the tissues. The oxygen delivery to the damaged tissues, particularly in chronic wounds, not only depends on the perfusion but also on the dissemination. A pH decrease of 0,6 units liberates almost 50% more oxygen [6], as it is the case observed during the second and third determination pre and post hyper pressure treatment in a mixed ulcer (Table 1). Any factor that could provoke a small change in the wound pH, can alter the oxygen intake of the tissues. This condition has frequently observed during this study, on the infected patients with increased pH.

The pH reduction to a more acid medium reduces the final toxicity of the bacteria products, such as ammonia; it stimulates angiogenesis, increases fiver blasts and macrophages activity with control of the enzymatic activity. We have evidence of this activity in the present study with the low pH in Giemsa richer in epithelial cells and fibers, and lesser cells of the white progenie. This comes along with negative Gram culture in these samples.

A study of Gethin and Cowman reported that the wounds that presented a PH lower to 7,6 showed a 30% reduction in the size of the wound after two weeks. On the other hand, those with a pH of 8.0 or more, increased their size [4]. The same tendency was evidenced in our sample.

As regards the treatment and the pH and temperature variations, with the occlusive treatment and the use of bandages, the Winter investigations are respected, in which the concept of cure in a humid environment is developed, showing in an experimental way that skin lesions covered by a laminate of impermeable film, heals twice faster than those exposed to the air [7]. This is shown with an increase of the temperature of the wound bed, avoiding the cooling which causes a decrease of the cellular mitosis and a slowing of the granulation. Moreover, importance has to be given to certain antibacterial topics that can change dramatically the wound pH.

It has been demonstrated that a low temperature of the tissue of the wound bed delays the healing, mainly because of a reduction of the liberation of oxygen. The temperature of the wound bed, in chronic ulcers of the leg, ranges between 24°C and 26°C when the ulcer is not occluded [8]. The use of a hydrocolloid occlusive dressing makes the temperature rise, enhancing the healing process. This phenomenon could not be demonstrated is our case study because of the volatility shown by the temperature at the moment of its measuring. For this reason, we consider it a non-reliable parameter taken as an isolated data in wounds measuring, short after the removal of the dressing.

Conclusion

The local conditions of the wound bed are fundamental in chronic wounds to increase their healing. Trying to keep stable and favorable in pH and temperature conditions enhances the patient's prognosis. Using as parameter of evolution the pH, the Giemsa and the Gram on a daily basis, evolution of the chronic wounds can be followed and modified easily and economically. The temperature appears as a very volatile factor to accompany the other three.

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