Dressing of bacterial cellulose for the treatment of pressure injuries in hospitalized patients

Curativo de celulose bacteriana para o tratamento de lesões por pressão em pacientes hospitalizados

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RESUMO

Objetivou-se monitorar a evolução do processo cicatricial das lesões por pressão (LP) em pacientes hospitalizados em Unidades de Terapia Intensiva (UTI), a partir da aplicação da cobertura de celulose bacteriana (CB). Trata-se de uma série de casos, amostra constituída por 10 pacientes internados na UTI. Foram excluídos crianças, adolescentes, e pacientes com outros tipos de lesões de pele. Foram aplicadas as escalas preditivas de Braden e a de MEASURE. Realizado monitoramento fotográfico pelo programa MOWA®. A pesquisa foi desenvolvida no setor de terapia intensiva de um hospital universitário em Recife, Pernambuco. A maioria dos pacientes era do sexo feminino (60%), com média de idade de 60±12anos. Quanto as comorbidades, 3 pacientes apresentavam diabetes mellitus (DM), 2 hipertensão arterial sistêmica (HAS), 3 DM e HAS e 2 negaram doença crônica. Sete pacientes foram acompanhados por 30 dias, em média. O risco avaliado pela escala de Braden foi de 9,66. As LP localizavam-se na região sacral, com área média de 84,48cm2 à avaliação inicial. Após 30 dias de acompanhamento observou-se redução da área média das LP (-14,7cm²). A CB funcionou como barreira física e indutor do remodelamento tecidual.

Palavras -chave: Cicatrização; Lesão por pressão; Celulose; Cana-de-açúcar.

ABSTRACT

The objective of this study was to monitor the evolution of the cicatricial process of pressure lesions (LP) in patients hospitalized in Intensive Care Units (ICU), from the application of bacterial cellulose (CB) coverage. This is a series of cases, a sample consisting of 10 patients hospitalized in the ICU. Children, adolescents, and patients with other types of skin lesions were excluded. Predictive scales of Braden and MEASURE were applied. Photographic monitoring carried out by the MOWA® program. The research was developed in the intensive care sector of a university hospital in Recife, Pernambuco. The majority of the patients were female (60%), with a mean age of 60 ± 12 years. As for comorbidities, 3 patients had diabetes mellitus (DM), 2 systemic arterial hypertension (SAH), 3 DM and SAH and 2 denied chronic disease. Seven patients were followed for 30 days, on average. The risk assessed by the Braden scale was 9.66. LPs were located in the sacral region, with a mean area of 84.48 cm2 at the initial evaluation. After 30 days of follow-up, we observed a reduction in the mean area of LP (-14.7 cm²). CB worked as a physical barrier and inducer of tissue remodeling.

Keywords: Wound healing; Pressure injury; Cellulose; Sugar cane.

NOTA

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INTRODUCTION

Pressure injury (LP) is an identified damage to the underlying skin and / or soft tissues, usually over a prominent bone or referring to the use of a medical device or other artifact. LP can manifest in whole skin or as an open ulcer and can be pungent[1]. The origin of LP is multifactorial and originates from extrinsic and intrinsic risk factors[2]. Resistance of soft tissue to pressure and shear can also be impaired by microclimate, nutrition, perfusion, comorbidities and by its condition[1].

Constriction of the sensitive tissue on bone prominence subsequently results in decreased blood flow and ischemia of the site, causing dermal hypoxia, necrosis, rupture of the epidermis and possibly bacterial contamination[2].

The occurrence of LP is common in elderly people and in patients affected by chronic-degenerative diseases. This aggravation causes a cost increase to the institution due to the increase in length of hospitalization and the costs associated with the treatment, besides increasing the workload of the health team[3].

Intensive Care Unit (ICU) clients are the most disadvantaged in maintaining intact skin from the first day of ICU, and are at high risk, mainly due to the restriction of physical activity and mobility[4].

The production and research of new biomedical products are of great relevance for the development of new health treatments and for the improvement of the quality of life[5]. In this sense, the bacterial cellulose membrane, derived from sugar cane molasses, produced at the Experimental Station of Sugar Cane in Carpina (EECC), Federal Rural University of Pernambuco (EECA / UFRPE)[6], is shown as an alternative promising in the treatment of wounds.

A recent study on the effects of acute cytotoxicity, genotoxicity and antigenotoxicity of CB, prepared in the in vitro and in vivo tests in male and female wistar rats, showed that the sugarcane biopolymer tested was neither cytotoxic nor genotoxic, characterizing CB as a biocompatible and non-toxic product[7]. Thus, in addition to its therapeutic potential, CB contains attributes in terms of safety[7,8] .

An experimental study of CB cytotoxicity was examined in vitro against two other biomaterials: polypropylene and e-PTFE. CB showed low cytotoxicity comparable to e-PTFE by adhesion index, nitric oxide production and cellular viability of alveolar macrophages in rats[8].

Biocompatibility analysis of CB as a filling agent in the rabbit bladder, expressed a lower inflammatory response and was better integrated into the host tissue than the dextranomer-treated group (Deflux®)[9].

The CB gel was also tested in rabbit subcutaneous tissue, aiming to analyze the local sensitivity reaction and biocompatibility. The authors found that there was formation of neovasal in 84.4% in the area of gel implant, intensity of statistically significant inflammatory infiltrate and grade 1 fibrogenesis with higher prevalence in the CB groups. Corroborating biocompatibility, tissue induction and CB integration in the subcutaneous tissue of rabbits[10].

In a pioneering study using CB membrane in the treatment of lower limb wounds resulting from vascular diseases in humans, it can be observed that in the CB group, in more than 80% of the patients (versus 60% in the control group) the ulcers were more superficial at the end of the observation time[6].

LPs cause pain and suffering to the patient, as well as increase the patient's hospitalization time, which is a costly problem, which is usually experienced in the hospital setting. The production of new products is of fundamental importance, mainly synthesis of the biomaterials, that allow a reduction in the costs in this therapeutics. The cellulosic biopolymer is a low-cost, curable, and renewable source coating.

METHOD

Study Design

This is a series of cases (10) methodologically aligned to experimental research, inserted in the line of studies with biopolymers of sugarcane. The studies that cover individuals are considered as case reports, case series reports, cross-sectional studies and observational studies[11].

Sampling was by convenience, constituted from the selection of 10 patients hospitalized in a long stay regime in the HC / UFPE, according to the inclusion and exclusion criteria previously defined. Sampling for convenience is shaped and often used to generate ideas in exploratory research, especially[12].

We included adult LP patients hospitalized at the HC / UFPE at the time of data collection for research and who were enrolled in the degrees of tissue injury, as defined by the National Pressure Ulcer Advisory Panel (2016) regardless of the number of ulcers or location, yet that there was a need for debridement to remove necrotic or devitalized tissue, regardless of the main diagnosis associated with hospitalization[1].

Children and adolescents were excluded from the study. Adult patients with other types of ulcers / skin lesions other than those especially by pressure were also excluded from the study.

All the patients recruited, after clarification about the research and approval of the relatives, since they were not mentally fit to respond, received the BC dressing and were followed from inclusion in the survey until discharge or death.

This research was approved by the Committee of

Ethics in Research with Human Subjects (CEP), Federal University of Pernambuco (No. 1,114,716) and in the Brazilian Platform CAAE (No. 33099314.9.0000.5208), obeying the Ethical Principles of Research with Beings Human Rights determined by the National Health Council in resolution 466/2012 (CNS, 2012) and in accordance with the revised Declaration of Helsinki in 2000.

The dressing

The cellulosic biopolymer is an exopolysaccharide, obtained from sugar cane molasses, produced at the Carpina experimental station, a unit belonging to the Federal Rural University of Pernambuco (UFRPE). CB dressings were supplied by POLISA Biopolímeros para a Saúde Ltda.

Perforated membranes were used, coupled to a sponge, both of biopolymer, in the form of sterile films, in the dimensions of 10x8cm and 0.01 to 0.02mm in thickness, packed in surgical grade envelopes, separately.

CB expresses low cytotoxicity, high biocompatibility, elasticity, flexibility, tensile strength, and can even be modeled in various forms, thus fulfilling the requirements necessary for the manufactures of biological implants[8].

Clinical Procedures

Stages of nursing care guided by the Systematization of Nursing Assistance (SAE) were established, which in a general sense correspond to the identification of the problem (data collection and diagnosis) following planning of interventions, implementation of nursing care and, finally, reassessment of the plan of care.

Data collection and diagnostics

Na etapa inicial, foram utilizados dados primários (anamnese, exame físico, aplicação de escalas de Braden e MEASURE) e dados secundários (prontuários, fluxograma de exames, familiares). A partir dos dados coletados foi realizada uma análise do(s) problema(s), sua etiologia, sinais e sintomas (Formulário de coleta de dados).

Planning of interventions

The care plan was elaborated based on the priorities identified, for the critical patients the priority is physiological, aiming the reestablishment of the same. However, the social and psychological dimensions can be included in addition to the cutaneous lesion. Therefore, the establishment of the expected results, such as: reduction of risks, reduction of pain and induction of the cicatricial process.

Implementation of care

Based on scientific principles and the individualization of the subject, performed according to the needs of the patient, after the clinical evaluation, the dressing was performed according to the Standard Operating Procedures in the Intensive Care Unit, in accordance with the guidelines of the Control Service Hospital Infection, HC / UFPE, following the following steps: **Debridement:** Performed to remove the necrotic or devitalized tissue, in order to promote an acceleration of tissue repair and regeneration processes and making the coverage application feasible; Cleaning: Saline solution (SF 0,9%) to perform the cleaning, in order to avoid injury in the bed of the injury, in an irrigation jet with ideal pressure, using moistened gasses to exert gentle pressure and friction; **Photographic record:** Photographic recording was performed at the initial evaluation and weekly reassessments to monitor responses to therapeutic measures, with the camera of the MotoG5 plus cellular apparatus; and, **Coverage:** After application of the CB cover, a secondary gauze dressing was performed, in some cases as a physical

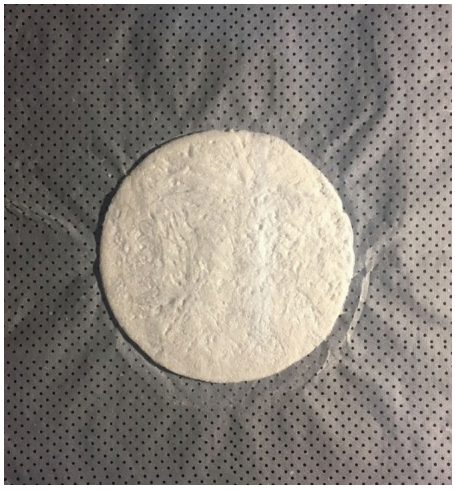

FIGURE 1 – Cellulosic biopolymer membrane

barrier the transparent film was used in order to waterproof the dressing site.

The primary outcome was the healing process (tissue characteristics) and secondary healing time.

Reassessment of care plan

During the weekly reassessments, the clinical aspects of the patient were analyzed, the need for interruption of the therapeutic plan, continuation or modification, according to the needs presented. The reevaluations occurred weekly with the use of predictive scales, such as Braden's assessment of the risk for the development of LPs and MEASURE for clinical evaluation of the wound (Reevaluation Form).

The Braden scale is supported by the pathophysiology of pressure lesions and allows assessment of important aspects of lesion formation, according to six parameters: sensory perception, moisture, mobility and activity, nutrition, friction and shear. The first five subscores receive a score ranging from one to four, while the subescore friction and shear, from one to three[4].

MEASURE summarizes the characteristics of the wound that should be addressed in the analysis. The letters of the acronym mean: M (measure-measure), E (exudate-exudate), A (appearance-appearance), S (sufferer), U (undermining), R edge)[13], (Table 1).

Statistical Procedures

Descriptive statistics were performed, where the frequencies were represented in percentage and the continuous data were presented as mean and standard deviation. Tables were used to summarize the results.

RESULTS

The study included 10 participants, 60% female and 40% male. Age ranged from 41 to 75 years, mean age 60 ± 12 years.

The anthropometric measures were measured and the participants' mean weight was 68.2 ± 11.16 kg. The mean height was 1.61 ± 0.09m. The mean Body Mass Index (BMI) was 26.67 ± 5.31 for overweight.

As for comorbidities, 3 patients (30%) had diabetes mellitus (DM), 2 systemic arterial hypertension (SAH, 20%), 3 DM and associated hypertension (30%) and 2 had no chronic disease (20%).

Regarding medications, half of the patients (50%) used antihypertensive drugs, 40% used oral hypoglycemic agents and 60% were taking insulin therapy.

The reasons for hospitalization of study participants are described below in Table 2.

Serum hematocrit (Ht) and hemoglobin (Hb) levels were recorded and presented an overall mean value of 23.91 ± 0.97% and 8.76 ± 2.39 g / dL, respectively. The mean value of Ht in women was 24.02% and for males was 23.91%. Hb levels had an average value of 8.56g / dL for women and 8.90g / dL for men.

The risk for the development of pressure lesions evaluated by the BRADEN scale was 9.6 ± 0.7.

All lesions were located in the sacral region. The evaluation of MEASURE lesion characteristics are described in Table 3.

Figures 2, 3 and 4 illustrate the healing process with the use of the CB membrane in the initial phase and after 7 and 15 days of reevaluation.

TABLE 1 – MEASURE classification for clinical evaluation of wounds14

Parameter	Content
M *Measure*	Length, width, depth and area
E *Exsudate*	Quantity and quality
A *Appearance*	Wound bed, type and amount of tissue
S *Suffering*	Type and intensity of pain
U *Undermining*	Presence or absence
R *Re-evaluation*	Periodic monitoring of all parameters
E *Edge*	Condition of edges and adjacent tissue

Source: Crozeta 14

TABLE 2 – DESCRIPTION OF REASONS FOR HOSPITALIZATION

Diagnosis(s) Main Doctor(s)	Number of Patients
Decompensated Heart Failure (CI)	1
Infective Endocarditis	1
Lowering of Consciousness Level (RNC) secondary to Cerebral Vascular Accident	1
Ureterolithiasis	1
Cardiorenal Syndrome	1
IC, RNC and Vasculopathy	1
RNC secondary to Hepatic Encephalopathy	1
Breast cancer	1
Prostate adenocarcinoma	1
Hodgkin's Lymphoma and Cerebellar Injury	1

Figure 2: Pressure injury, patient 2. Initial evaluation (0 days). Location Sacral, presence of devitalized fibrinous tissue (black arrow), scarce granulation tissue (yellow arrow).

Figura 3: Lesão por pressão, paciente 2. Primeira reavaliação (7 dias). Localização Sacral, presença de tecido fibrinoso desvitalizado (seta preta), leve melhora no tecido de granulação (seta amarela)

Figure 4: Pressure injury, patient 2. Second reassessment (15 days). Sacral localization, presence of devitalised fibrinous tissue (black arrow), improvement in granulation tissue (yellow arrow).

DISCUSSION

The evaluation of the sociodemographic profile showed that the female gender was the one that ob-

TABLE 3 – Evaluation of lesions by MEASURE and MOWA® parameters

Parameters	CB		
	Initial Evaluation	1ª Revaluation	2ª Revaluation
Wound area[1] *(average±DP, cm²)*	84,48±66,58	63,23±23,48	69,78±26,71
Tissue Characteristics[1] *(%)*			
Necrose2	45,75±35,70	54,6±33,64	40,55±35,10
Fibrin	37,93±26,10	35,7±33,17	45,2±27,55
Granulation	16,37±13,88	9,73±8,81	14,25±17,88
Unknown	0	0	0
Amount of Exudate(%)			
None	0	0	0
Little	70	50	30
Moderate	30	20	10
Great	0	0	0
Exudate Quality (%)			
None	0	0	0
Serous	40	30	10
Seropurulent	20	0	10
Serossanguinolento	10	30	20
Bloodthirsty	30	10	0
Intensity of pain (analogue scale) (%)			
0	30	30	10
2	10	10	0
4	10	30	30
6	30	0	0
8	20	0	0
Temporality of pain (%)			
Removing the cover	30	30	30
Continuous pain	30	0	0
Did not mention	40	40	10
Appearance of the lesion (%)			
Appearance of the lesion	30	20	0
Loss of Subcutaneous	30	10	20
Total skin loss	30	40	20
Completely necrotic wound	10	0	0
Detachment *(%)*			
Absent	100	100	100
Present	0	0	0
Edge Type *(%)*			
B2 Delimited	50	30	20
B3 Irregular	50	40	20
Kind of fabric *(%)*			
Necrotic	10	0	10
Esfacelos + Granulation	30	0	30
Esfacelos + Granular + Necrotic	10	0	0
Granulation + Necrotic	20	40	0
Epithelial + Necrotic	30	10	0
Necrotic	0	20	0
Coloring *(%)*			
Red	10	0	0
Yellow	70	0	20
Black	10	10	0
Mixed	10	60	20

1Assessment of the area of the lesion and its tissue characteristics performed by the MOWA program.

tained more predominance in the study, about 60%. Differing from the literature, which indicates that 58% of patients admitted to the intensive care unit of a university hospital were male and 42% female[15]. However, this may be related to the reduced number of the sample.

Another characteristic evaluated in this study was the Body Mass Index (BMI), where the majority of the patients were overweight, according to the classification of the World Health Organization (WHO). There may be involvement of the BMI in the healing process, where high indexes can delay the cicatricial process, according to the Manual of Pipelines for Neurotrophic and Traumatic Ulcers (2002)[16].

However, the mean age of 60 years was maintained

FIGURE 2 – Pressure injury, patient 2. Initial evaluation (0 days). Location Sacral, presence of devitalized fibrinous tissue (black arrow), scarce granulation tissue (yellow arrow).

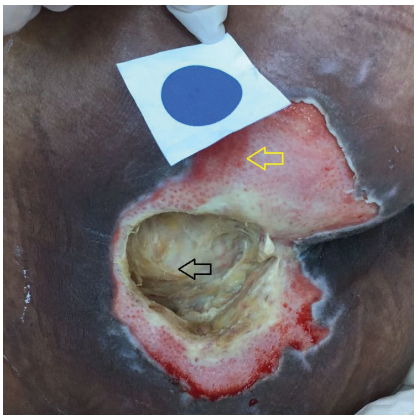

FIGURA 3 – Lesão por pressão, paciente 2. Primeira reavaliação (7 dias). Localização Sacral, presença de tecido fibrinoso desvitalizado (seta preta), leve melhora no tecido de granulação (seta amarela)

FIGURE 4 – Pressure injury, patient 2. Second reassessment (15 days). Sacral localization, presence of devitalised fibrinous tissue (black arrow), improvement in granulation tissue (yellow arrow).

according to the literature. Increasing age is a risk factor for LP advancement and this is due to changes in the skin and subcutaneous tissue, decrease in dermal thickness, collagen and muscle atrophy, evidencing bony prominences[17].

The main comorbidities found in the patients in this study were DM (30%), SAH (20%) DM and SAH associated (30%). This finding corroborates the retrospective study, in which 222 patient charts of different pathologies were submitted to surgeries with more than two hours, where the authors related the onset of LP to the decrease in tissue perfusion due to hypertension and diabetes[18].

There are several factors related to the appearance of LP in critically ill patients. The extrinsic pressure associated with the advanced age group, nutritional deficit, humidity, bed rest, reduced tissue perfusion, vasoactive drugs, sedation and comorbidities such as diabetes mellitus and vascular disease are prominent[19].

Serum levels of hematocrit (Ht) and hemoglobin (Hb) were recorded and evaluated, presenting values below the expected rate, this finding directly impacts on wound healing, as described in the study that emphasizes the decrease of molecular oxygenation in cases of anemia , and that in the context of healing, this fact contributes to the delay of the process, due to the lack of meeting the demands of the damaged tissue[20].

The ICU, in general, is a hostile environment, predisposing to the appearance of LPs. Although it is the ideal place to treat critical patients, it is also classified as one of the most aggressive, tense and traumatizing hospital environments[17].

The average score found by the Braden scale was 9.6 ± 0.70, where the highest score was 10 and the lowest score was 8, corresponding to a high and very high risk of patients developing pressure injuries. These findings corroborate the study where a high risk score (<11) was observed by the Braden scale in 11 clients with LP in the adult intensive care unit of a public hospital in Rio de Janeiro[21].

All pressure lesions were located in the sacral region, this anatomic predominance is also described in other studies[17,22]. 4 studies that corroborate the sacral predominance are summarized in the table.

The evaluation of the characteristics was performed by MEASURE protocol, intended for wound evaluation, commonly performed in the hospital and outpatient routine. This protocol is used for studies of cutaneous lesions[14]. As for wound healing, a reduction was observed between the initial area and the final area of the lesions (-14,7 cm²).

The tissue characteristics were evaluated by the *Mobile Wound Analyzer (MOWA®)* program, whose advantages are: easy use, clear and permanent registration, avoid contact with skin, allow evaluation of planimetry, accurate calculation of wound area, treatment , allows telemedicine.

Regarding the tissue characteristics evaluated by MOWA®, an increase of the granulation tissue was verified in the third evaluation of the patients, when compared with the second evaluation from 9.73% to 14.25%, respectively. This finding suggests that CB behaved as an inducer of granulation tissue, as is suggested in the study of the biopolymer mesenchymal cells, this phenomenon is fundamentally important in reducing the depth of cutaneous lesions[23].

In a randomized study, it was observed that ulcers were more superficial at the end of the observation period (120 days) in more than 80% of the patients with venous ulcers who received BC dressing than in the control group (60%). This may indicate, according to the authors, that BC dressings acted as inducer of tissue remodeling[6].

It is important to note that there were no signs of toxic reactions associated with the biopolymer, showing that this is a non-toxic and biocompatible membrane8. It presented essential characteristics as an ideal dressing, which is a possible coverage option..

The results obtained in this research, although preliminary, provide an incentive for the continuity of the study and possible innovations in the field of biomaterials.

CONCLUSION

The bacterial cellulose membrane was effective for the treatment of pressure lesions, since it behaved as an

TABLE 4 – Studies that corroborate with sacral predominance.

Author (date)	Region	%
Borghardt (2015)	Sacral	47%
	Trochanteric	19%
	Maleolar	16%
Sousa (2006)	Sacrococcygeal	60,7%
	Buttock	28,6%
	Calcaneus	27,1%

inducer of the granulation tissue, reducing the depth of the lesion. Being an innovative dressing, low cost and important therapeutic alternative to the problematic.

Many factors influence the success of the cicatricial process, such as: age, chronic diseases, nutritional status, cardiovascular problems, bed restriction, and still impact the friction, shear and pressure forces in this process. The population of this study, coming from the intensive care sector, is affected by some of these factors, which interfere in the healing process of the wound. In this way, the problem experienced becomes more delicate. However, the holistic view about these patients and the multiprofessional performance can optimize and make feasible this process with greater chances of success.

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