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Factors predictive of leg ulcer healing in people with sickle cell disease: a retrospective cohort

Fatores preditivos para a cicatrização de úlceras da perna em pessoas com doença falciforme: coorte retrospectivo

Factores predictivos de la cicatrización de úlceras de la pierna en personas con anemia falciforme: cohorte retrospectivo

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ABSTRACT
Objective: to identify the healing rate and predictive factors for healing of leg ulcers in people with sickle cell disease. **Method:** retrospective cohort, carried out from June to August 2020, in a specialized service for the treatment of people with wounds, covering a period of nine years, with a sample of 52 ulcers that met the eligibility criteria. Research protocol approved by the ethics committee. **Results:** healing rate was 76.9%. The factors that contributed to cure in a shorter time were non-recurrence (HR= 3.03; 95% CI: 1.07-8.60) and extension below the median 7.25 cm2 (HR= 2.25; CI 95%: 1.19-4.27). Factors for non-healing were: calcium alginate dressings (HR=0.29; 95% CI: 0.13-0.62), charcoal with silver (HR=0.06; 95% CI: 0.02- 0.21) and others (HR=0.35; 95% CI: 0.15-0.80). **Conclusion:** the ulcer healing rate was high. Recurrence, ulcer area and certain dressings can influence the healing process.
Descriptors: Enterostomal Therapy; Nursing Care; Anemia, Sickle Cell; Leg Ulcer; Wound Healing.

RESUMO
Objetivo: identificar a taxa de cicatrização e os fatores preditivos para cura das úlceras da perna em pessoas com doença falciforme. **Método**: coorte retrospectivo, realizado de junho a agosto de 2020, em um serviço especializado de tratamento de pessoas com feridas, contemplando um período de nove anos, com amostra de 52 úlceras que atenderam os critérios de elegibilidade. Protocolo de pesquisa aprovado pelo comitê de ética. **Resultados**: a taxa de cicatrização foi 76,9%. Os fatores que contribuíram para cura em um menor tempo foram a não recidiva (HR= 3,03; IC 95%: 1,07-8,60) e extensão abaixo da mediana 7,25 cm^2 (HR= 2,25; IC 95%: 1,19-4,27). Fatores para a não cicatrização foram: coberturas de alginato de cálcio (HR=0,29; IC 95%: 0,13-0,62), carvão com prata (HR=0,06; IC 95%: 0,02-0,21) e outras (HR=0,35; IC 95%: 0,15-0,80). **Conclusão**: a taxa de cicatrização da úlcera foi elevada. Recidiva, área da úlcera e determinadas coberturas podem influenciar no processo de cura.
Descritores: Estomaterapia; Cuidados de Enfermagem; Anemia Falciforme; Úlcera da Perna; Cicatrização.

RESUMEN
Objetivo: identificar la tasa de curación y los factores predictivos para la curación de las úlceras en las piernas en pacientes con enfermedad de células falciformes. **Método:** cohorte retrospectiva, realizada de junio a agosto de 2020, en un servicio especializado para el tratamiento de personas con heridas, cubriendo un período de nueve años, con una muestra de 52 úlceras que cumplieron con los criterios de elegibilidad. Protocolo de investigación aprobado por el comité de ética. **Resultados:** La tasa de cicatrización fue del 76,9%. Los factores que contribuyeron a la curación en menor tiempo fueron la no recurrencia (HR= 3,03; IC 95%: 1,07-8,60) y extensión por debajo de la mediana de 7,25 cm2 (HR= 2,25; IC 95%: 1,19-4,27). Los factores de no cicatrización fueron: apósitos de alginato de calcio (HR=0,29; IC 95%: 0,13-0,62), carbón con plata (HR=0,06; IC 95%: 0,02-0,21) y otros (HR=0,35; IC 95%: 0,15-0,80). **Conclusión:** la tasa de curación de la úlcera fue alta. La recurrencia, el área de la úlcera y ciertos revestimientos pueden influir en el proceso de curación.
Descriptores: Estomaterapia; Atención de Enfermería; Anemia de Células Falciformes; Úlcera de la Pierna; Cicatrización de Heridas.

INTRODUCTION

Leg ulcers are one of the complications of sickle cell disease (SCD), which is characterized by loss of skin integrity or underlying tissues affecting the lower limbs. Leg ulcers are usually restricted between the ankle and the knee[1].

The prevalence and incidence of leg ulcers in people with SCD varies geographically with age and with the type of disease. The prevalence is 18.6% in Ghana, 3.5% in Italy and 2.4% in the United States[2]. Leg ulcers are more frequently found in the HbSS[2-4] genotype and in males, reaching a ratio of 4:1[5], 2:1[6]. It appears for the first time in people who are between 10 and 20 years old, with low education and low economic level[4].

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The pathogenesis of ulcers is still not fully understood, but there is a consensus that it is multifactorial and there are several theories to explain it, such as vaso-occlusion, hemolysis, venous incompetence, hypercoagulability and thrombosis, autonomic dysfunction and genetic factors[7]. They can arise spontaneously or due to trauma[1]. These ulcers can last for years, and a six months ulcer can be defined as recalcitrant. The recurrence rates are high reaching 77.8%[3,4].

Ulcers cause physical disorders such as chronic pain, psychological disorders such as depression, social disorders such as isolation, and economic disorders such as unemployment[1,8]. Ulcers most often occur around the malleolus. Most of the times they are single, have well-defined margins, slightly raised edges and a wound bed of granulation tissue covered by slough[3,4].

There are studies that address the factors associated with the appearance of ulcers in people with SCD, however those related to predictive factors for ulcer healing are scarce. The only study published and identified was a prospective cohort carried out in France with 98 patients with leg ulcers resulting from SCD. The authors[4] identified ulcers with an area of less than 8 cm^2 and duration of less than nine weeks as predictive factors of healing. Considering that patients with SCD from a European country may have different predictive factors than those residing in developing countries, the following hypothesis was established for this study: Brazilian patients with SCD have predictive factors for healing of leg ulcers which are different from those found in the study conducted in France.

Knowing the factors that influence the healing process of ulcers resulting from SCD will contribute to its care. It will make it possible to establish recommendations to mitigate or eliminate negative factors or strengthen those that enhance ulcer healing. In addition, the knowledge generated is crucial for clinical reasoning and therapeutic decision-making by nurses. Adopting a standardized care model can support knowledge sharing in the teaching area. Given the above, this study aims to identify the healing rate and predictive factors for healing leg ulcers in people with SCD.

METHOD

This is a retrospective cohort study with the main outcome of healing leg ulcers. The research setting was the Wound and Ostomy unit of a dermatology outpatient clinic of a university hospital in Brazil. Specialist nurses are responsible for the direct care of people with ulcers in this service. Patients are treated according to the institutional protocol, the dressing is changed once or twice a week, and interactive dressings are used. Inelastic compression therapy (Unna's boot) is standardized for managing edema. No new technologies were incorporated in the period covered by the study, and the protocol of dressing changes was maintained. There was also no change in the manufacturer brand. This fact may be justified because it is a public institution, so the purchase of inputs is through the bidding process, meeting the criteria of the least expensive product with adequate quality.

The study covered a period of nine years, during which 58 leg ulcers of people with SCD were treated. The following criteria for the eligibility of ulcers which composed the sample were considered: healed ulcer, topical treatment with interactive dressings, cleaning the wound with saline irrigation, use of Unna's boot, and registering the evolution of ulcer healing on the patient's record. Ulcers submitted to cleaning with an antimicrobial solution, or incomplete recording of two or more variables in the medical records were excluded from this study.

Among the 58 leg ulcers treated during this period, 52 were considered eligible, as two were excluded due to incomplete data and four were undergoing treatment at the time of collection. Data collection was carried out from June to August 2020 by two researchers. Data were extracted from the patient's medical record and recorded in an instrument specifically designed for the study.

The ulcer healing was considered a dependent variable. The choice of independent variables was supported by a study carried out in France[4] and was restricted to variables only related to the wound, thus excluding patient data such as demographic, clinical and social characteristics. The independent variables were: ulcer pain intensity at admission, categorized[9] as no pain (score 0), mild to moderate pain (score >0 and score < 6) and severe (score ≥6 and score ≤10), recurrence, cause ulcer (trauma; spontaneous), location (medial and lateral malleolus; lower and middle third), area in cm^2, depth in cm, percentage of necrosis, type of dressing used (calcium alginate; activated charcoal with silver; hydrocolloid; foam polyurethane with silver; others (hydrofiber with silver and Acticoat®), presence of infection, dermatitis, leg edema and use of oral antibiotics during treatment and treatment time. Categorizations for numerical variables were performed using the median as the cut-off point, aiming to build two homogeneous groups that distinguished values considered low and high.

Data analysis was performed using the Statistical Package for Social Sciences® software program (version 22.0, SPSS, Inc., Chicago, IL, USA). Univariate and multivariate regression analyzes were conducted using the COX proportional hazards model, which identified possible predictive factors for leg ulcer healing in patients with SCD. The results are

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expressed as Relative Risk (RR) and their respective 95% confidence intervals (95% CI). Statistical modeling used outpatient follow-up time as the counting process. After univariate analysis, variables with $p < 0.20$ entered the multivariate model. Then, variables with $p \leq 0.05$ were considered as factors associated with healing of leg ulcers in the adjusted analysis (multivariate).

The adequacy of the final model fitting was estimated by drawing the logarithmic graph of the survival function versus healing time for each covariate included in the model in order to validate the assumption of proportional hazards. The plausible interactions between the variables that remained in the final model were also tested. The Kaplan-Meier method was used for survival analysis, with significance based on the log-rank test. The admission date to the outpatient service was considered the beginning of the survival time.

The study research protocol was approved by the research ethics committee. The signing of a Free and Informed Consent Form was not requested, since it is an observational study, and the data were extracted from a secondary source.

RESULTS

Characteristics of leg ulcers in people with sickle cell disease and data related to "healed" outcome variable are showed in Table 1.

TABLE 1: Characteristics of leg ulcers in people with sickle cell disease according to the "healed" outcome variable (n=52). Belo Horizonte, MG, Brazil, 2020.

			Leg ulcer healed			
Variables		**Total*(%) (n=52)**	**Yes (%) (n=40)**	**No (%) (n=12)**	**p-value†**	**RR_{gross}‡ [95%CI]§**
Ulcer recurrence ‖	Yes	31 (81.6)	26 (83.9)	5 (71.4)		1.00 (ref.)
	No	7 (18.4)	5 (16.1)	2 (28.6)	**0.037**	3.03 [1.07-8.60]
Ulcer cause¶	Trauma	11 (21.2)	7 (17.5)	4 (33.3)	0.254	0.59 [0.24-1.47]
	Spontaneous	41 (78.8)	33 (82.5)	8 (66.7)	0.254	1.70 [0.68-4.24]
Location of the ulcers¶	Medial malleolus	24 (46.2)	17 (42.5)	7 (58.3)	0.658	0.87 [0.46-1.63]
	Lateral malleolus	14 (26.9)	10 (25.0)	4 (33.3)	0.826	0.92 [0.45-1.89]
	Lower third	6 (11.5)	6 (15.0)	0 (0)	0.122	2.01 [0.83-4.90]
	Middle third	2 (3.8)	2 (5.0)	0 (0)	0.347	2.00 [0.47-8.51]
	Lower and middle thirds	6 (11.5)	5 (12.5)	1 (8.3)	0.478	0.71 [0.28-1.83]
Pain intensity upon admission‖	No pain	18 (36.0)	15 (39.5)	3 (25.0)		1.00 (ref.)
	Light to moderate	17 (34.0)	12 (31.6)	5 (41.7)	0.931	1.04 [0.47-2.30]
	Intense	15 (30.0)	11 (28.9)	4 (33.3)	0.882	1.07 [0.46-2.47]
Ulcer area	Above median (7.25 cm^2)	26 (50.0)	19 (47.5)	7 (58.3)		1.00 (ref.)
	Below median (7.25 cm^2)	26 (50.0)	21 (52.5)	5 (41.7)	**0.013**	2.25 [1.19-4.27]
Ulcer depth	Above median (0.05 cm^2)	26 (50.0)	23 (57.5)	3 (25.0)		1.00 (ref.)
	Below median (0.05 cm^2)	26 (50.0)	17 (42.5)	9 (75.0)	0.102	0.58 [0.30-1.12]
Ulcer necrosis	Above median (92.5%)	26 (50.0)	19 (47.5)	7 (58.3)		1.00 (ref.)
	Below median (92.5%)	26 (50.0)	21 (52.5)	5 (41.7)	0.711	1.13 [0.60-2.13]
Infection‖	No	42 (84.0)	34 (89.5)	8 (66.7)		1.00 (ref.)
	Yes	8 (16.0)	4 (10.5)	4 (33.3)	0.213	0.52 [0.18-1.46]
Dermatitis in the peripheral area‖	No	35 (70.0)	30 (78.9)	5 (41.7)		1.00 (ref.)
	Yes	15 (30.0)	8 (21.1)	7 (58.3)	**0.027**	0.41 [0.19-0.90]
Edema‖	No	22 (44.0)	22 (57.9)	0 (0)		1.00 (ref.)
	Yes	28(56.0)	16 (42.1)	12 (100.0)	**<0.001**	0.25 [0.12-0.51]
Type of dressing¶	Calcium alginate	22 (42.3)	14 (35.0)	8 (66.7)	**<0.001**	0.27 [0.14-0.53]
	Charcoal with silver	13 (25.0)	6 (15.0)	7 (58.3)	**<0.001**	0.12 [0.04-0.34]
	Hydrocolloid	42 (80.8)	37 (92.5)	5 (41.7)	0.165	2.32 [0.71-7.57]
	Foam with silver	8 (15.4)	6 (15.0)	2 (16.7)	0.073	0.45 [0.18-1.08]
	Others	17 (32.7)	11(27.5)	6(50)	**0.008**	0.38 [0.19-0.78]

*Refers to total leg ulcers. †p-value: differences in proportions (Cox regression). ‡RR - Relative Risk. §CI - confidence interval.
¶not for reference ‖Variations in total n are due to missing

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A total of 40 ulcers out of the 52 leg ulcers eligible for the study healed completely, and 12 did not. The ulcer healing rate was 76.9% (95% CI: 65.1-88.8%). The median time of outpatient follow-up of people with ulcers was 148.5 days (interquartile range 77.0-373.3 days), with 30 (57.7%) of the ulcers having a follow-up time of less than six months, 8 (15.4%) between six and 12 months, and 14 (26.9%) for more than 12 months.

Considering the total amount of leg ulcers (n=52), 41 (78.8%) had spontaneous onset, 24 (46.2%) were located in the medial malleolus, 8 (16.0%) had infection in the ulcer, 15 (30.0%) presented dermatitis in the peripheral area, and edema was present in 28 (56.0%).

The median extent of the ulcers was 7.25 cm^2 (interquartile range 2.76-25.66 cm^2) and the depth was 0.05 cm^2 (interquartile range 0.00-0.20 cm^2). All lesions had necrosis, with a median of 92.5% (interquartile range 90.0-100.0). The most used type of dressing was hydrocolloid (80.8%).

From the univariate analysis, the predictive factors which contributed to leg ulcer healing in a shorter follow-up time included: no recurrence of ulcers (RR=3.03; 95%CI: 1.07-8.60) and ulcer area below the median (RR=2.25; 95%CI: 1.19-4.27). The following factors in the same analysis which made it difficult for ulcers to heal were: use of calcium alginate dressing (RR=0.27; 95%CI: 0.14-0.53), charcoal with silver dressing (RR=0.12; 95%CI: 0.04-0.34), other dressings (RR=0.38; 95%CI: 0.19-0.78), as well as the occurrence of dermatitis (RR=0.41; 95%CI: 0.19-0.90) and edema (RR=0.25; 95%CI: 0.12-0.51). These results are illustrated through the cumulative survival curves using the Kaplan-Meier method (Figures 1 and 2).

After adjusting for confounders, the independent variables that remained in the final model for non-healing ulcers were: calcium alginate dressing (RR=0.29; 95%CI: 0.13-0.62), charcoal with silver dressing (RR=0.06; 95%CI: 0.02-0.21) and other dressings (RR=0.35; 95%CI: 0.15-0.80), according to Table 2.

TABLE 2: Final model of COX proportional hazard adjustment for time to occurrence of "leg ulcer healing" outcome in people with sickle cell disease. Belo Horizonte, MG, Brazil, 2020.

Variables	$RR_{adjusted}$*	95%CI†	p-value‡
Charcoal with silver			
No	1.00 (ref.)		
Yes	0.061	0.018-0.212	**<0.001**
Calcium alginate			
No	1.00 (ref.)		
Yes	0.285	0.132-0.616	**0.001**
Other dressings			
No	1.00 (ref.)		
Yes	0.348	0.152-0.799	**0.013**

*RR_ Relative Risk.
†Confidence interval. ‡ differences in proportions (Cox regression).

The final model fit was satisfactory according to the interpretation of the logarithmic graphs of the survival function versus time, indicating that the proportional odds assumption was not violated. There was no interaction between the covariates contained in the final model.

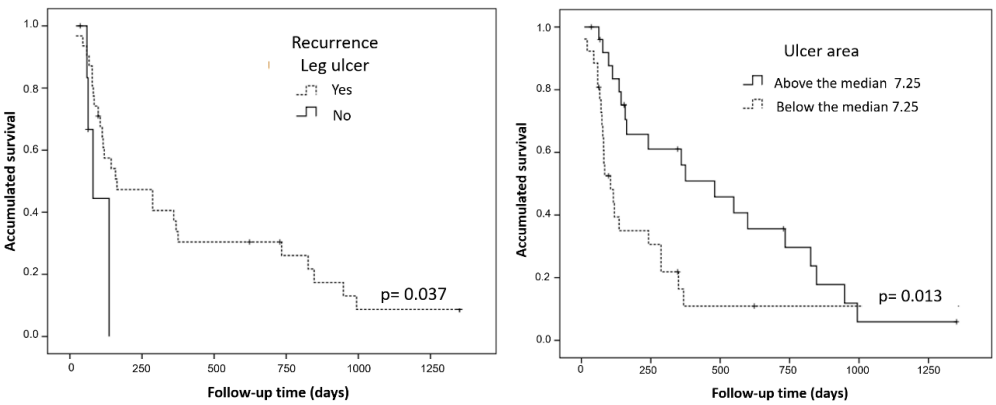

FIGURE 1: Kaplan-Meier curves according to baseline and clinical characteristics for factors which contributed to leg ulcer healing. Belo Horizonte, MG, Brazil, 2020.

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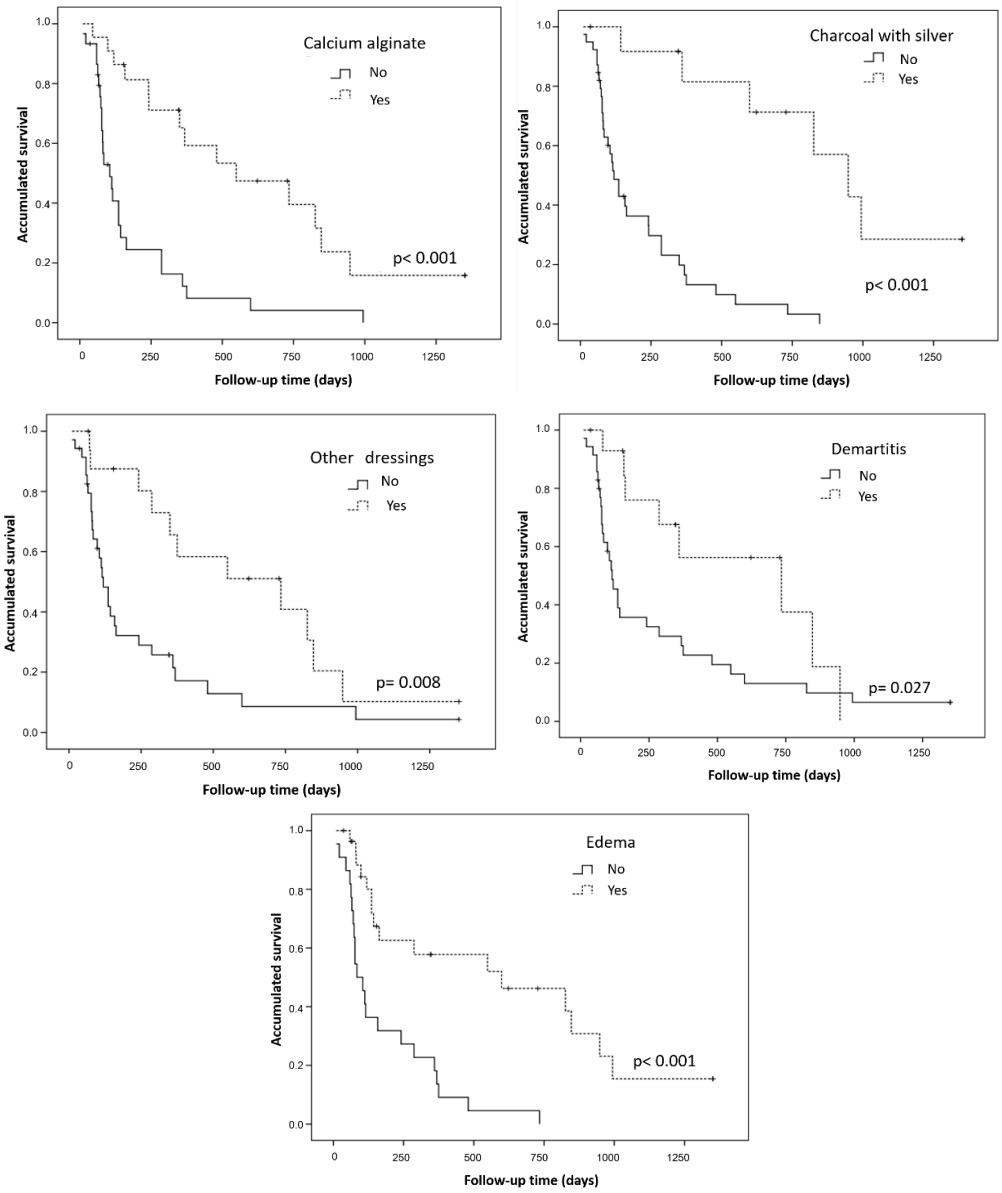

FIGURE 2: Kaplan-Meier curves according to baseline and clinical characteristics for factors which made difficult for ulcers to heal. Belo Horizonte, MG, Brazil, 2020.

DISCUSSION

The leg ulcer healing rate in this study was 76.9%, which is high considering that patients with SCD usually have a low baseline hemoglobin rate, which makes it difficult or prevents ulcer healing. Basal hemoglobin <5 is indicative of non-healing, values between 5 and 8 indicate healing (but it is not ideal), and values between 8 and 10 are acceptable for ulcer healing[10].

The healing rate of the study may be related to the care provided to patients, which in addition to being supported by an institutional protocol, is performed by nurses specialized in wound care, especially Enterostomal Therapy nurses. The presence of edema was evidenced in the univariate analysis as a factor that hinders the healing of ulcers. It is essential that the implemented conducts are in accordance with evidence-based recommendations[11].

The predictive factors for healing were ulcers that appeared for the first time and with an area of less than 7.25 cm^2, and the latter corroborates certain authors[4] who identified ulcers with an area of less than 8 cm^2 as being a

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predictive factor for healing. These data reinforce the need for protocols which also establish cure prognoses and specific interventions to achieve this outcome[11].

The treatment of leg ulcers due to SCD must follow protocols updated with the available literature[11]. Thus, the dressings used must ensure that the wound bed remains moist without causing maceration, at the ideal temperature and pH for the healing process and does not require frequent changes[12,13]. It is important that dressings are able to absorb and retain excess exudate, preventing its leakage and contact with the skin around the ulcer[13]. This fact can cause the appearance of dermatitis, especially when there is excess production of endotoxins by ulcer bacteria[14]. In this study, the occurrence of dermatitis was evidenced as a factor which hinders ulcer healing.

The recommendation for the first step in ulcer treatment to ensure the previously mentioned requirements is the use of dressings such as calcium alginate, hydrogel sheet, hydrocolloid and acrylic, foam, hydrofiber and dressings with silver or polyhexamethylene biguanide (PHMB), according to wound assessment[7,11].

Although indicated in this study, occlusive dressings such as calcium alginate, charcoal and hydrofiber with silver, as well as Acticoat with Nanocrystalline Silver® were predictive factors for non-healing of the ulcer. These results need to be analyzed with caution, considering that these dressings were used when the ulcers showed deterioration or stagnation of the injured area or signs of infection.

Alginate is a naturally occurring biopolymer which is considered interactive, as it is able to absorb wound exudate and form a gel which provides a physiologically moist environment; in addition, it has the ability to minimize bacterial infections, enhancing the proliferation of epithelial cells and the formation of granulation tissue[12,15].

However, when compared to hydrofiber with silver, calcium alginate presents inferior results. In a prospective randomized controlled trial conducted with patients with diabetic foot ulcers, it was observed that Aquacel® Ag^{+} was associated with favorable clinical outcomes compared to calcium alginate Ag, specifically in reducing ulcer depth[12].

The dressing containing hydrofiber, specifically Aquacel®, is designed for use on moderately to heavily exudating wounds, as it absorbs the exudate in its fibers, thus protecting the surrounding skin. It has been shown to be effective in pressure injuries, leg ulcers and surgical wounds, producing an ideal microclimate for healing[16]. The carboxymethylcellulose core of the hydrofiber dressing is intended to absorb exudate, stimulating the controlled release of 1.2% ionic silver to the wound, and this release can occur for up to two weeks. The controlled release of silver ions reduces the biological load within the dressing, minimizing microbiota imbalance and decreasing the risk of infection. Microscopic *in vitro* scanning studies have shown that these dressings help to reduce bacterial load by sequestering and retaining bacteria in their structure. They are effective against anaerobic pathogens, *Methicillin-resistant Staphylococcus aureus (VRE), Methicillin-resistant Staphylococcus aureus (MRSA),* and *P. aeruginosa*[17].

When considering the activated carbon coating with silver, it is impregnated with 0.15% metallic silver. Unlike hydrofiber, which has its action within the very constitution of the dressing, there is no release of silver in the bed. This dressing is also a barrier to bacterial penetration, in addition to retaining the bacteria in its own weave, decreasing odor and reducing the level of endotoxins. It is effective against more than 150 pathogens, including: *Staphylococcus Aureus, VRE, MRSA,* and *P. aeruginosa*. This dressing's ability for bacterial adsorption on the charcoal surface stands out, providing action of silver against these adsorbed bacteria[18].

Actcoat® is an antimicrobial barrier coating with controlled release of nanocrystalline silver. The smaller particles enable a greater area of contact with the wound surface. It inhibits more than 150 types of microorganisms, including multidrug-resistant bacteria and fungi[19].

However, in clinical practice, wounds which do not show improvement in healing, do not respond to antimicrobial agents or standard treatment for wound healing are considered a potential shelter for biofilms[20]. Biofilms are known as a structured community of bacterial cells enclosed in a matrix of self-produced extracellular polymeric substance, consisting of one or more species of microorganisms attached to a living or inert surface[21]. They present cohabitation of different microbial species that cooperate with each other in order to promote their own survival and the chronic nature of wound inflammation and infection.[22].

It is estimated that the prevalence of bacterial biofilms in human chronic wounds is approximately 78.2%. However, this data should be considered cautiously, considering that the presence of these microorganisms in human chronic wounds is underrepresented, since studies on this topic report very small samples with methodological, ethical and economic biases[23]. In the study of biofilms in wounds, some authors[24] mainly refer to chronic lesions resulting from diabetes mellitus, venous stasis and pressure injuries, with few studies addressing biofilms in infections or wounds of other etiologies such as SCD.

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Biofilms are still capable of creating a persistent, low-grade inflammatory response that impairs epithelialization and granulation tissue formation[25], preventing healing. They act as a reservoir of pathogenic bacteria that release large amounts of endotoxins, causing tissue damage caused by the excessive reaction of immune system components. They serve as an ecological niche for the evolution of antimicrobial-resistant organisms[21,26].

Spatial distribution occurs irregularly in wounds; it is believed that it may be adhered to the surface of the wounds, suspended in the exudate, contained in the tangle or adhered to the slough and deeper necrotic tissue[21]. Another possibility is that the biofilm is associated with the dressings used in the treatment of wounds[26].

Some *in vitro* and *in vivo* studies in an animal model have detected the presence of biofilm on the edges of epidermal wounds[27] and in the wound bed[28]. On the other hand, some of these studies do not describe the ultrastructural identification of the biofilm, focusing only on the positive culture of wounds by counting the number of bacteria in the tissue corresponding to the wound area[27-28]. This fact demonstrates weaknesses in the conduct of studies and the complexity involved in the structural identification of biofilms in skin lesions.

Despite controversies about the identification conditions of biofilms in skin wounds, it is known that biofilms are microscopic in nature, and when they are left to thrive, they can show clinical signs at a macroscopic level, such as oral plaque; however, this image is less clear when it comes to chronic wounds[29]. There is strong agreement among experts on the subject that it is not possible to visualize the biofilm macroscopically "with the naked eye". It is also argued that the desquamation, debris and exudate present in the wound bed can be visually confused with biofilm by health professionals[21].

Calcium alginate, charcoal and hydrofiber with silver, as well as Acticoat with Nanocrystalline Silver® as predictive factors for non-healing of the ulcer may be related to the presence of biofilm in ulcers, which was not investigated because it was not the objective of this study. Some professionals have been using identifiers in clinical practice which suggest the presence of biofilm in wounds, without consensus or strong scientific evidence about them. The chronicity of the lesions[30], recalcitrance to treatment with antibiotics or antiseptics[21], the presence of a shiny, translucent and viscous film on the surface of the wound, and alternating periods of latent infection with episodes of acute infection[20] are cited as indicators of the presence of biofilm, along with no improvement in clinical signs of infection with systemic antibiotic treatment[31] and rapid slough and gelatinous material reinstallation after removal from the wound bed[30].

Despite advances, the clinical management of biofilms is still quite limited and there is no consensus on the evidence related to the recognition, diagnosis and treatment of these microorganisms[32].

Diagnostic techniques considered as the gold standard in biofilm detection are electron and confocal microscopy[25], which makes it impossible for nurses to routinely identify it. The main algorithms for treating wounds with suspected biofilm propose the rupture and removal of the biofilm through combination therapy. These algorithms consider the association of cleaning solutions for wounds and dressings with antimicrobial agents (silver, iodine, iodine carboxomer and PHMB), antibiofilm agents (honey, lactoferrin, Gallium, Xylitol and dispersin B), and debridement of necrotic tissue (autolytic, enzymatic, mechanical, surgical or biological)[25,32,33].

These studies consider that the use of these therapies in isolation is ineffective in treating chronic wounds with the presence of already formed (mature) biofilm. This may be a justification for calcium alginate, charcoal and hydrofiber dressings with silver, as well as Acticoat with Nanocrystalline Silver®, having behaved as predictive factors for non-healing of the ulcer. They were used alone in ulcers with suspected biofilm due to the state of deterioration or stagnation of the injured area.

It is inferred that these interactive dressings were used when the ulcers were under the deleterious effects caused by the biofilm action. Thus, careful evaluation is necessary for adopting a set of measures that help in the fight against biofilm and enhance the action of dressings.

Study limitations

One of the limitations of this study refers to obtaining data from a secondary source, not always adequately filled in, in addition to a sample that may not represent patients with ulcers resulting from SCD in Brazil. This fact makes the results needing to be carefully evaluated in relation to their generalization. The small number of ulcers in the sample is justified by the low prevalence of the event studied.

CONCLUSION

The healing rate of SCD leg ulcer was high. The predictive factors for healing were ulcers with no history of recurrence and with an area of less than 7.25 cm^2. Although occlusive dressings are recommended as a topical therapy

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for treating ulcers, calcium alginate, charcoal with silver, hydrofiber and Actcoat® were factors that contributed to non-healing of ulcers.

The data from this study will enable health and nursing professionals to support clinical reasoning and guide therapeutic decision-making, and consequently improve care for patients with SCD and leg ulcers. The study's contribution to the clinical practice of nurses in relation to implementing care processes is noteworthy.

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