Doi: 10.11606/issn.2317-0190.v14i4a102863

ORIGINAL ARTICLE

Development of a protocol for the assessment of patients with pressure ulcers through telemedicine and digital images

Desenvolvimento de um protocolo para avaliação de pacientes com úlceras de pressão através da telemedicina e imagens digitais

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ABSTRACT

Introduction: Pressure ulcers are frequent complications in patients with spinal cord injuries. These ulcers need an early diagnosis and a strict follow-up to prevent a more severe evolution and delays in the rehabilitation process. Unfortunately, patients do not always have access to a center specialized in the treatment of wounds, and thus, telemedicine can be useful in such cases. Objective: To evaluate the effectiveness of a protocol for the assessment of pressure ulcers through digital images. Methods: 15 patients were selected, totaling 33 ulcers. The patients were separately assessed by 2 on-site physiatrists, who filled out the first part of the protocol (patients' clinical data) at the time of the consultation and took the photographs. These were sent to the physiatrists at-distance, who evaluated the wounds through the photographs and the data sent by the on-site physician. The similarities and differences between the two on-site physicians, between the on-site physicians and the physicians at-distance and between the two physicians at-distance were compared regarding the degree, necrosis, infection, fistula, secretion, wound border and depth aspect and conduct. The statistical analysis was based on Kappa calculations, a confidence interval and P value. Results: The highest Kappa values were observed when the on-site assessments were compared. For necrosis, degree and infection, the On-site Assessment (S) x Assessment at distance (D) Kappas were substantial and moderate. For the item conduct, the Kappa varied from weak to almost perfect. As for the evaluations of the borders, depth, secretion and fistula, there were divergences. Conclusion: The protocol is effective to assess wound necrosis, degree and infection. There is some difficulty in using the method to evaluate the border and depth aspect, secretion and fistula. The method showed to be more satisfactory for the assessment of pressure ulcers grade I and II.

KEYWORDS

spinal cord injuries, pressure ulcer, diagnostic imaging, telemedicine

RESUMO

Introdução: As úlceras de pressão são complicações freqüentes em pacientes com lesão medular. Estas precisam de um diagnóstico precoce e um acompanhamento rigoroso para que não evoluam para um quadro mais grave e para não retardar o processo de reabilitação. Infelizmente, não é sempre que o paciente consegue acesso a um centro especializado no tratamento de feridas e, por isso, a telemedicina pode ser útil nesses casos. Objetivo: Avaliar a eficácia de um protocolo de avaliação de úlceras de pressão através de fotografias digitais.

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Received on October 05, 2007; accepted on November 05, 2007.

Métodos: Selecionamos 15 pacientes, totalizando 33 úlceras. Os pacientes foram avaliados por 2 médicos fisiatras presenciais, separadamente, que no momento do exame, preencheram a primeira parte do protocolo (dados clínicos do paciente) e tiraram as fotografias. Estas foram encaminhadas aos médicos fisiatras à distância, que avaliaram as feridas através das fotos e dos dados enviados pelo médico presencial. Comparamos as semelhanças e diferenças das avaliações entre os dois médicos presenciais, entre presencial e a distancia e entre os dois médicos à distância nos quesitos grau, necrose, infecção, fístula, secreção, aspecto da borda e do fundo e conduta. A Análise estatística se baseou nos cálculos de Kappa, intervalo de confiança e P valor. Resultados: Encontramos os maiores valores de Kappa quando comparamos as avaliações presenciais. Para necrose, grau e infecção, os kappas Avaliação Presencial (P) x Avaliação à distância (D) foram substantial e moderate. No item conduta, o Kappa variou de fraco a quase perfeito. Nas avaliações das bordas, fundo, secreção e fístula foram encontradas divergências. Conclusão: O protocolo é eficaz para avaliar necrose, grau e infecção das úlceras. Existe dificuldade no uso do método para avaliar o aspecto de borda, fundo, secreção e fístula. Houve maior satisfação com o método para úlceras de pressão grau I e II.

PALAVRAS-CHAVE
traumatismos da medula espinal, úlcera de pressão, diagnóstico por imagem, telemedicina

INTRODUCTION

Pressure ulcers (also known as bed sores, decubitus ulcers or pressure sores) are skin lesions due to local tissue ischemia caused by the pain reflex alteration in patients with spinal cord injury or debilitated, elderly or chronically ill patients.[1]

Their prevalence is quite variable in the literature. In the last decade, a prevalence of 10-18%[2,3] has been reported in patients with acute disease, 2.3-28%[2,3] in chronic patients and 0-29%2,3 in patients under home care or rest/retirement homes.

In patients with spinal cord injuries, pressure ulcers occur in 25-40% of the patients.[2,3] The most common places for pressure ulcers are over bony prominences of the lower half of the body (95%): the ischium, sacrum, trochanter major of the femur and ankle.[3]

The lesion mechanism is multifactorial, i.e., it is caused by the direct effect of one or more extrinsic factors (pressure, shearing or friction) that are propitiated or modified by intrinsic factors, such as: local ischemia and fibrosis, decreased autonomic control, infection, age, loss of sensitivity, impaired mobility, fecal and/or urinary incontinence, anemia, hypoproteinemia, spasticity.[1]

In summary, what occurs is an alteration in the body's protection mechanisms (sensitivity, mobility or cognition), leading to a higher pressure load in some places, decreasing the capillary perfusion and forming, initially, a skin lesion, which can develop into several complications such as necrosis, abscess, fistula, osteomyelitis, cellulitis, sepsis and even death.

To classify the phases of the ulcers, they are normally divided in grades, as proposed by the National Data Center on Spinal Cord Injuries:1

- Grade I: the lesions are limited to the epidermis and superficial dermis;
- Grade II: the lesions involve full skin thickness and subcutaneous tissue;
- Grade III: the lesions extend to the muscle layer;
- Grade IV: destruction of all tissues and soft tissues, with bone and/or joint involvement.

The treatment is carried out with the removal of the causal factor, better distribution of pressure and greater care with transferences, hygiene and local care, debridement, local/systemic antibiotic therapy and plastic surgery, depending on the grade of the ulcer.

However, many times there are limitations when carrying out the adequate treatment and follow-up, due to the difficulties in patient transportation and locomotion, which can delay the diagnosis and decision-making procedure.

Therefore, we decided to develop a study to evaluate a method that could aid the diagnosis and follow-up of these patients using Telemedicine.

According to the World Health Organization (WHO), Telemedicine is the offer of healthcare services in cases where distance is a critical factor; such services are provided by healthcare area professionals, using information and communication technology for exchanging information that is valid for the diagnosis, prevention and treatment of diseases and the continuing education of healthcare providers, as well as performing research and assessments; all aiming at improving people's health and the health of their communities.

Miot, in 2001 stated in his study4 that the assessment of skin lesions through digital photographs in dermatology is a tool, of which the validity and reliability have already been established. Based on that, we proposed an exclusive protocol to be used for the assessment of pressure ulcers through digital photographs, so that the on-site evaluation could be compared to the at-distance one.

OBJECTIVES

To develop a protocol to evaluate pressure ulcers through digital photographs.

METHODS

Our sample contains 33 pressure ulcers (n=33) of 15 patients (2 women and 13 men) with spinal cord lesions, who are either inpatients or outpatients treated at the Outpatient Clinic of the Institute of Orthopedics of Hospital das Clínicas (IOT-HCFMUSP) or at the Division of Rehabilitation Medicine of Hospital das Clínicas (DMR-HCFMUSP).

The lesions were divided as follows:

By location:

- 1 in the ischium;
- 2 in the calcaneus;
- 12 in trochanteric region;
- 11 in the sacrum;
- 3 in the malleolus;

- 1 in the dorsum;
- 3 in the lower distal third of the lower limb.

By Grade:

- 2 Grade I
- 18 Grade II
- 4 Grade III
- 6 Grade IV
- 3 were not possible to answer.

The ulcers were assessed on-site (personally) by two physiatrists, separately, who filled out a specific protocol (see Appendix) at the moment of the evaluation. This protocol is divided in five parts:

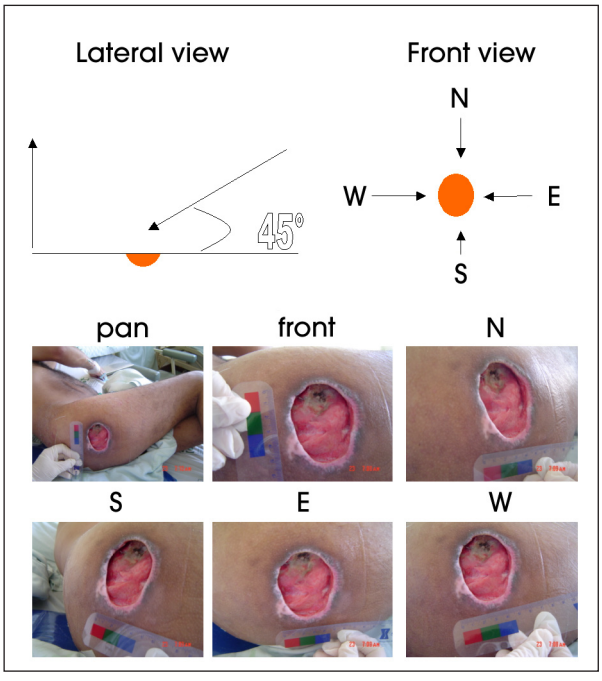
- A: Patient's data and ulcer measurements;
- B: Aspect of the lesion;
- C: Diagnosis;
- D: Conduct;
- E: Satisfaction with the method.

At the same moment, digital photographs were taken with a digital camera (Sony Cyber-shot, DSC-P72, 3.2 megapixels), at a resolution of 2048x1536, using a ruler with centimeters and color scale, seeking to follow the directives by Maglogiannis5 that proposes the use of high-resolution photographic cameras, fluorescent-light illumination with temperatures between 2900-3300K, rendering Index of 85 or more, light focus of 45° and light-ray collection at 0°.

Additionally, 6 photographs were taken for each ulcer, being one panoramic and the others focused on a certain region of the ulcer: front view, to analyze the background of the lesion and all the others with a mean inclination of 45°, focusing each one of the four borders of the ulcers (north, south, east and west), as illustrated in the model below:

These photographs were sent, together with part A of the protocol, to two physiatrists at-distance, who then answered, also in separate, the other parts of the protocol.

After that, the answers of the two on-site physicians were compared to those at-distance and between the on-site physicians and those at-distance. Statistical methods were then used to evaluate the concordance between the same methods and with different methods. The protocol can be seen at the Appendix.



Statistical analysis

Tables were constructed to compare the responses given by each examiner, as shown in Table 3. To verify the concordance, Kappa statistics was used. When the table was larger than 2x2, the weighted Kappa coefficient was used. Kappa coefficient varies from -1, when all examiners disagree in all evaluations to 1, when all of them agree in all evaluations.

However, it is only possible to calculate Kappa in quadrangular tables (nxn) and some tables acquired a rectangular format (nx n+x). In these cases, it was necessary to adapt them, so they would have the quadrangular format. In order to do that, we excluded the options in which only one physician chose a certain option.

We used the Kappa classification proposed by Landis & Koch,[6] which demonstrated:

Kappa	Strength of Agreement
<0,00	Poor
0-0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0,61-0.80	Substantial
0,81-1,00	Almost Perfect

To evaluate the significance of the Kappa coefficient (Kappa or weighted Kappa) , tests of hypotheses were performed, of which null hypothesis is that the coefficient is equal to zero.

The 95% confidence intervals were also calculated. P value shows whether Kappa is significantly different from 0 (when lower than 5%, it confirms it; when higher than 5%, it is not significantly different from zero).

Below are some tables constructed to calculate Kappa, confidence intervals and P value.

RESULTS

For a better analysis of the results, we tabulated the Kappa results, P value and confidence interval for all analyzed items, as follows.

DISCUSSION

The highest Kappa values, as expected, were found between the on-site assessments.

For the necrosis, grade and infection assessments, the proposed method seems to be safe, as the SxD Kappas in these items were substantial and moderate.

Regarding the item conduct, discrepancies were observed, as the SxS Kappa was substantial and SXD Kappa varied from weak to

Table 1
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physicians 1 and 2.

(On-site 1)	(On-site 2)		
	Yes	No	Total
Yes	11	1	12
No	4	17	21
Total	15	18	33

Kappa	0.6893
P-value	<.0001
95% Lower Limit	0.4430
95% Upper Limit	0.9355

Table 2
Distribution of frequencies (n) of the evaluations of necrosis performed by the physicians at-distance 1 and 2, for all combinations found.

(At distance 1)	(At distance 2)			
	Yes	No	NPA	Total
Yes	9	1	1	11
No	1	15	1	17
NPA	1	4	0	5
Total	11	20	2	33

Kappa	0.5194
P-value	0.0001
95% Lower Limit	0.2844
95% Upper Limit	0.7544

Table 3
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 1 and at-distance 1.

(On-site 1)	(At distance 1)		
	Yes	No	Total
Yes	8	2	10
No	3	15	18
Total	11	17	28

Kappa	0.6196
P-value	0.0010
95% Lower Limit	0.3198
95% Upper Limit	0.9193

Table 4
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 1 and at-distance 1, for all combinations found in the sample.

(On-site 1)	(At-distance 1)			
	Yes	No	NPA	Total
Yes	8	2	2	12
No	3	15	3	21
Total	11	17	5	33

Table 5
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 1 and at-distance physician 2.

(On-site 1)	(At-distance 2)		
	Yes	No	Total
Yes	9	2	11
No	2	18	20
Total	11	20	31

Kappa	0.7182
P-value	<.0001
95% Lower Limit	0.4614
95% Upper Limit	0.9749

Table 6
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 1 and at-distance physician 2, for all combinations found in the sample.

(On-site 1)	(At-distance 2)			
	Yes	No	NPA	Total
Yes	8	2	2	12
No	3	15	3	21
Total	11	17	5	33

Table 7
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 2 and at-distance physician 1.

(On-site 2)	(At-distance 1)		
	Yes	No	Total
Yes	8	4	12
No	3	13	16
Total	11	17	28

Kappa	0.4842
P-value	0.0102
95% Lower Limit	0.1560
95% Upper Limit	0.8124

Table 8
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 2 and at-distance physician 1, for all combinations found in the sample.

(On-site 2)	(At-distance 1)			
	Yes	No	NPA	Total
Yes	8	4	3	15
No	3	13	2	18
Total	11	17	5	33

Table 9
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 2 and at-distance physician 2.

(On-site 2)	(At-distance 2)		
	Yes	No	Total
Yes	9	4	13
No	2	16	18
Total	11	20	31

Kappa	0.5939
P-value	0.0008
95% Lower Limit	0.3060
95% Upper Limit	0.8818

Table 10
Distribution of frequencies (n) of the evaluations of necrosis performed by the on-site physician 2 and at-distance physician 2, for all combinations found in the sample.

(On-site 2)	(At distance 2)			
	Yes	No	NPA	Total
Yes	9	4	200	15
No	2	16	0	18
Total	11	20	2	33

COMPARISONS	KAPPA	CI	P VALUE
NECROSIS			
S1XS2	0.68	0.44-0.93	<0.0001
D1XD2	0.51	0.28-0.75	0.0001
S1XD1	0.61	0.31-0.91	0.001
S1XD2	0.71	0.46-0.97	<0.0001
S2XD1	0.48	0.15-0.81	0.0102
S2XD2	0.59	0.30-0.88	0.0008
DEGREE			
S1XS2	0.74	0.53-0.95	<0.0001
D1XD2	0.46	0.24-0.67	<0.0001
S1XD1	0.53	0.32-0.74	<0.0001
S1XD2	0.49	0.28-0.71	<0.0001
S2XD1	0.48	0.29-0.68	<0.0001
S2XD2	0.45	0.22-0.67	<0.0001
INFECTION			
S1XS2	0.6	0.28-0.91	0.0007
D1XD2	0.49	0.20-0.77	0.0017
S1XD1	0.65	0.39-0.91	<0.0001
S1XD2	0.81	0.57-1.00	<0.0001
S2XD1	0.48	0.18-0.78	0.004
S2XD2	0.9	0.71-1.00	<0.0001
FISTULA			
S1XS2	#		
D1XD2	0.09	0.07-0.26	0.0416
S1XD1	0.29	0.01-0.56	0.0083
S1XD2	0.09	0.23-0.05	0.1151
S2XD1	#		
S2XD2	#		
CONDUCT			
S1XP2	0.8	0.59-1.00	<0.0001
D1XD2	0.5	0.22-0.78	<0.0001
S1XD1	0.28	0.31-0.88	0.2546
S1XD2	1	1.00-1.00	<0.0001
S2XD1	0.24	0.02-0.46	0.0512
S2XD2	0.55	0.29-0.82	0.0003
BACKGROUND			
S1XS2	0.58	0.37-0.78	<0.0001
D1XD2	0.42	0.15-0.69	0.0008
S1XD1	0.23	*0.03-0.50	0.0516
S1XD2	0.25	0.00-0.49	0.0297
S2XD1	0.14	*0.15-0.43	0.36
S2XD2	0.51	0.24-0.78	0.0003
SECRETION			
S1XS2	0.66	0.38-0.94	<0.0001
D1XD2	0.38	0.18-0.58	0.3832
S1XD1	0.23	0.02-0.44	0.0091
S1XD2	0.55	0.30-0.81	<0.0001
S2XD1	0.17	0.04-0.31	0.0673
S2XD2	0.47	0.26-0.69	0.0002
BORDER			
S1XS2	0.11	*0.13-0.37	0.3562
D1XD2	0.06	*0.18-0.31	0.6274
S1XD1		#	
S1XD2	0.06	*0.21-0.33	0.6951
S2XD1		#	
S2XD2	0.07	*0.22-0.36	0.622

= not possible to calculate Kappa * = negative value

almost perfect. This fact suggests that perhaps the way the answers were constructed needs to be modified, as they encompass wide-ranging conducts.

Regarding the assessment of borders, background, secretion and fistula, discrepancies were also found, with the S1XS2 Kappa being much better than the SXD Kappa, showing that there is still difficulty in analyzing these items with the proposed method. For the two first items, the justification for the low Kappa values is the existence of 2 or more answers, simultaneously (for instance, the background can present, at the same time, granulation tissue and fibrin, crust and necrosis). That makes the calculation difficult, and many times, prevents it, making it necessary to use adaptations that decrease the sample number.

For the items secretion and fistula, the reason for discrepancy was that the quality of the image obtained with the camera could not detail enough the tissue brightness and consistency, as well as the absence of 3-D images and the lack of patient assessment.

The final question of the protocol asked the examiner at-distance about the satisfaction with the method for that specific ulcer. The examiners said they were satisfied with on average 48% of the assessments, being the latter divided in:

- 83% in ulcers Grade I
- 69% in ulcers Grade II
- 27% in ulcers Grade III
- 0% in ulcers Grade IV

It is necessary to remember that our protocol was carried out at only one moment, with no return visits. Probably for this reason, the examiners at-distance required an on-site evaluation of all Grade IV ulcers, as this is a more severe lesion, which needs at least one on-site assessment before proceeding with the evolution follow-up at-distance.

Based on these data, it is possible to affirm that this protocol was effective to assess necrosis, Grade and infection of pressure ulcers. It was not effective to assess borders, background, secretion and fistula.

The sample size could be increased, which would give further support to the observed figures. The patients could be followed regarding their evolution, which would generate a new study (evolutive).

Finally, we believe this protocol can be used safely in the evolution follow-up of non-fistulous ulcers, intercalated with on-site examinations.

CONCLUSION

This protocol was effective to assess necrosis, Grade and infection of pressure ulcers. It was not effective to assess border, background, secretion and fistula. The physicians were more satisfied with the method for Grade I and II ulcers.

We suggest further studies of evolution follow-up to assess pressure ulcers through digital photographs.

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PROTOCOL

Date:_____

Examiner:_____

PART A: Patient's data and ulcer dimensions and characteristics

1- Number of Identification/Patient's initials: _____

2- Age: _____

3- Sex: □ Female □ Male

4- General Status: □ GGS □ RGS □ BGS

5- Fever at the moment: □ Yes □ No

6- History of Fever: □ Yes _____ days ago, _____episodes □ No

7- Ulcer location: □ Ischium □ Sacrum □ Trochanter major □ Calcaneus □ Other
□ Right □ Left

8- Elevation of local temperature? □ Yes □ No

9- Fetid odor? □ Yes □ No

10- Relevant information: (other infectious focus, secretion drainage orifice):

_____

_____

_____

11-Height of lesion: _____cm. (longest longitudinal axis)

12- Lesion length: _____cm. (longest transversal axis)

13- Lesion depth: _____cm. (Distance from the ulcer border to the deepest point, at any angle)

Part B: Aspect of the lesion

1- Is there any secretion? □ Yes □ No

What is the aspect of the ulcer? □ serous □ serous-sanguinolent □ yellowish □ pus □ sanguinolent □ Other:_____

2- Is there necrosis? □ Yes □ No □ Not possible to answer

3- Lesion border:

□ Hyperemiated □ Atrophic □ Fibrotic □ Necrotic □ Others:_____

4- Lesion background:

□ TGranulation tissue □ Necrosis □ Fibrin

□ Others:_____

Parte C: Diagnosis

1- Grade: :

□ I □ II □ III □ IV □ Not possible to answer

. Grade I: lesions are limited to the epidermis and superficial dermis;

. Grade II: lesions involve full skin thickness and subcutaneous tissue;

. Grade III: lesions extend to the muscle layer;

. Grade IV: destruction of all tissues and soft tissues, with bone and/or joint involvement.

2- Infection:

□ Absent □ Local infection □ infection

. Absent: clean ulcer, with evident granulation tissue, absence of yellowish or purulent secretion, little odor, with little or no alteration of local temperature and absence of necrosis or only dry necrosis.

. Local infection: ulcer with increased local temperature, hyperemiated borders, yellowish or purulent secretion, strong odor, presence of fibrin and wet necrosis.

. Systemic infection: patient with poor general status, possibly febrile or with a history of fever and ulcer with the characteristics of local infection.

3- Is the presence of fistula suspected? □ Yes □ No □ Not possible to answer

Part D: Conduct

(The choosing of one alternative does not exclude another)

1- Local pressure relief and general guidelines

2- Local treatment and dressings

3- Systemic antibiotic therapy (Orally, IM, IV)

4- Referral to the ER for debridement and/or complementary examinations and/or hospital admission for the treatment of the infection.

5- Referral to plastic surgery to program the surgical closing of the ulcer and follow-up.

Part E: Satisfaction with the method

1 – Do you consider it necessary to have an on-site consultation at the moment?

□ Yes □ No