Pressure Ulcers Attributes Image Mining to Support Therapeutic Process: A Research Proposal

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Abstract. The high number of clients suffering from pressure ulcers (PU) overloads hospital services, which are not equipped with the necessary human and technological resources. One needs to increase the productivity of this work, since health professionals, especially nurses use subjective and inaccurate assessments for PU diagnosis. This paper proposes a system for automatic interpretation of tissue and color to support the treatment of patients with PU.

1 Introduction

Pressure ulcers (PU) are circumscribed areas with loss of epidermis and dermis. They can reach the hypodermis and underlying tissues resulting from the combination of several factors, among which the application of a high pressure short or prolonged pressure [1], which causes collapse or thrombosis of the capillaries. It disturbs nutrition and oxygenation of the tissues involved, besides the accumulation of toxic byproducts of metabolism, which imply tissue anoxia and cell death [2].
The incidence of PU in France varies from 17% to 50% in patients admitted to long term care, and 34% to 46% in individuals with spinal cord injury [3]. Study in Portugal [4] followed 155 patients admitted during a year in the Intensive Care Unit (ICU) and found an incidence of 25.8% and 37.4% prevalence of PU. It happened that, on average, on the 7th day of hospitalization. More than two million PU occurred each year in the United States, with annual costs exceeding $ 1.3 billion and incidence of almost 15% in hospitalized patients aged 65 years or more, for a time equal to or greater than five days [3]. The incidence and prevalence of PU remain high, varying between 3% and 14% prevalence in hospitalized patients, according to the international literature [5]. A recent study [6] identified a prevalence of 57% and 37% incidence in adult ICU of a Public Health Service of Federal District (DF), Brazil.
The NPUAP (National Pressure Ulcer Advisory Panel) classifies PU into four stages, namely [7]:

de Souza Neves R., Guadagnin R., B. Gulhem D. and Aniceto Santana L..
Pressure Ulcers Attributes Image Mining to Support Therapeutic Process: A Research Proposal.
DOI: 10.5220/0004395801210126
In *Proceedings of the 4th International Workshop on Image Mining. Theory and Applications* (IMTA-4-2013), pages 121-126
ISBN: 978-989-8565-50-1

• Stage I –not whitish erythema in intact skin occurs, which precedes the ulceration;
• Stage II - partial skin lesion occurs, including epidermis or dermis;
• Stage III - total skin lesion occurs, causing damage or necrosis of the subcutaneous layer, which may deepen, but not reaching the fascia;
• Stage IV - full skin lesion occurs with extensive destruction, tissue necrosis or damage to muscle, bone or supporting structures.

The tissue and color of a PU identify the healing phase in a wound, since each phase presents differentiated tissues in accordance with the physiology of healing. The process of wound healing comprises three complex and coordinated phases: (1) inflammatory or exudative, (2) proliferative or fibroblastic, and (3) remodeling or maturation.

In the inflammatory phase performs vascular reactions take place. The wound is prepared for wound healing, cells residue and devitalized tissues are removed. Such vascular reactions include primarily transient vasoconstriction of lymphatic and blood vessels, and then vasodilatation which increases local blood flow.

The proliferative phase extends until complete epithelialization of the wound. It is characterized by the migration of endothelial cells from the periphery to the center of the lesion and by generation of granular and rosy tissue. It consists of a biological process known as angiogenesis or neovascularization.

In the remodeling phase, a reorganization of collagen fibers and their replacement occur. Insofar as remodeling progresses, the bright pink tissue coloration is replaced by a softer tone until achieving a whitish tone that characterizes a mature lesion [8].

An accurate evaluation of a PU provides relevant data to prognosis and best treatment. It includes number of ulcers, its location, stages, measurements (length, width and depth), tunnels existence, presence of necrotic tissue, exudate or odor, and surrounding skin aspect. Healing process can be evaluated by checking reduction of size, drainage, necrotic tissue and appearance of granulation tissue and the circumjacent skin [9].

Histologically differentiated PU tissues can be identified by different colors that show the status of the wound. Granulation tissue is the formation of a new tissue and appears in bright red tones. Fibrin exudate demonstrates cellular degradation that looks yellow or esfacelos that looks greenish-yellow [8]. The necrotic tissue represents a dead and dehydrated tissue, is usually black, but can also be yellow when the necrosis is infected [10] [11] or dark brown [8]. Epithelialization tissue represents the healthy healing and progresses from PU margin to PU center. It has pinkish-white appearance. Furthermore, a PU may have a green color, when there is bacterial growth [10] [11].

PU closing is directly influenced by tissue loss. Its percent values inform the development of the healing process. Tissue color and texture are classified in:

- devitalized tissue that looks pale, dark, brittle and susceptible to spontaneous bleeding, indicating ongoing infectious process;
- dehydrated necrotic tissue (gray-black crust), slough (soft tissue greenish-brown) and fibrotic whitish tissue;
- yellow fibrinous tissue with creamy consistency, which represents the amount of cellular degradation and may partially or totally cover the extent of the ulcer;
- granulation tissue with red, shiny, wet, highly vascularized aspect;

- epithelialization tissue with pinkish white appearance, which progresses from the margin to the center of the ulcer. [12].

The system RYB (red, yellow, black) is another classification technique for open injuries based on color. It categorizes the wound through observation of red, yellow or black and its variations. PU color indicate the factors that delays the healing process [13].

The research aims to develop a non-invasive system for automatic interpretation of color to support the treatment of patients with PU. Artificial Intelligence seeks solutions for various problems expressed by large data amounts through computational tools [14]. Its application to the present problem consists in generating diagnosis support information from PU tissues pictures processed by the software Weka (Waikato Environment for Knowledge Analysis).

The Weka software is a free open source software, for data mining, developed in Java, within specifications of the General Public License (GPL). This study will use Weka for PU images mining. Each PU case has a set of attributes, and one can derive relationships among them as well as infer the value of a certain attribute, based on knowledge of values of other attributes in a new PU case. [15] [16].

This sort of knowledge discovery is quite valuable to identify relationships between attributes. Image Mining identifies patterns in a collection of images in a specific area. The system memorizes the characteristics of a set of images. So it becomes able to classify each new image.

This project proposes a system to inform the stage of a PU on the basis of prior learning from a set of PU images.

2 Motivation

The high number of clients suffering from wounds overloads the outpatient and hospital services that are often not equipped with technological and human resources needed to treat them.

In DF (Brazil), there has been an increase in cases of clients suffering from PU, which somehow requires the services of State Department of Health of the Federal District (DF-SES). A prospective study in a public hospital in the DF-SES found that, among 217 interned patients, 51 patients developed PU. So the incidence was 23.5% and its prevalence 76.5% [17]. Nurses and other health professionals use imprecise and subjective evaluations for diagnosis of PU tissue and color during their routine care of patients with wounds. Thus, a system for interpretation of tissue (texture) and color of the PU in patients with wounds will be very useful.

3 Methods

The project will be developed in Brasilia Health Regional of Samambaia, of State Department of Health of the Federal District (DF-SES). It will be performed a survey of regional PU patients that satisfy inclusion criteria.

3.1 Sample

Males and females will be randomly selected. They should be aged from 18 to 80, be treated Regional Samambaia, have PU with stage I, II, III and IV, have signed the Statement of Consent concerning use of scientific pictures. The sample consists of 25 participants.

3.2 Data Collection

Data will be collected through a form as follows.

- identification data: name, gender, age, ethnicity, marital status, occupation, education level and medical diagnostics;
- general health data: additional illnesses, medication, smoking, alcohol consumption, thermoregulation, nutrition, urinary and bowel elimination, sleep and rest, self-care, self-esteem;
- PU evaluation data: number of ulcers, performed treatments, stage classification, etiology, thickness, measurement, location, appearance, border type, amount and type of exudate, odor and pain.

The data collection instrument included the necessary information for diagnosis that was tested on a group of 11 clients of Neurological Research Project "Validation tools for qualitative and quantitative evaluation," developed in the Neurosurgery Unit of Hospital de Base do Distrito Federal (HBDF). It was approved by the Research Ethics Committee (REC) of Foundation of Research and Education in Health Sciences (FEPECS) by Official Opinion number 235/2012.

3.3 Image Capturing

PU pictures will be the information source for image mining pictures with software Weka. The PU will be photographed for assessment of skin (texture) and color of the PU. Pictures will be taken with a camera with 18 megapixels resolution of recording images of 5184 by 3456 pixels in jpg format.

The camera will be used without flash, positioned at a right angle relative to the wound bed at a distance of 30cm to the PU. For metric reference a 3cm side square object will be set inside image field as close as possible to the wound. Furthermore, the customer PU will be positioned in favor of sunlight. Artificial light will be turned off.

3.4 Data Analysis

Research project will be performed by means of following steps:

Step 1. Definition of data of patients with PU (age, clinical data, overall condition, size, color red, black, yellow, etc.) that allow diagnosis of texture and color of tissue in addition with visual observation and other attributes. To load the data into Weka, files will be converted to the format file attribute-relation (ARFF).

Step 2. Definition of possible diagnoses of the tissue and color of the PU and the variables of each individual research participant. Diagnosis is a consequence of data from the patient, color and texture of the PU. This information set will be sent to a data mining procedure in order to detect relationships between these data and PU. Thus, one can infere new information to support diagnostic process inside therapeutic procedures.
Step 3. Construction of case base, with values for each attribute.
Step 4. Image pre-processing for noise suppression and enhancement of features of interest [18] [19] [20]. Analysis of the data by software Weka, which allows construction of a decision tree from training records. Different classification filters will be tested, in order to find the one that is more adequate for UP tissue and color analysis. The sample will be relevant to train the classification algorithm.
Step 5. Checking accuracy degree of the tree from test cases. By submitting data to a set of individuals with PU for training, the system informs the degree of accuracy of the tree.
Step 6. Evaluation of decision tree built as a tool for diagnosis support.
Step 7. Development of software in conjunction with software Weka for automated analysis and interpretation of tissue color PU, based on achieved results.

4 Expected Results

Once medical decisions concerning UP patients depends strongly from image analysis that can be computationally processed, it seems possible to develop an effective support for health assistance. UP wounds can however occur in a wide range of forms. First only planar UP should be studied because they allow better picture-based interpretation to follow a therapeutic process.
A computational tool for evaluating the tissue and color in patients with PU will be developed. System advances will enable support to PU treatment therapy, improving the quality of nursing care to patients with PU and reducing factors that increase the vulnerability of the individual to deterioration of his health problems that are also caused by presently used invasive therapy.

5 Final Remarks

The results to be achieved from this project will enable the development of similar initiatives in other areas of hospital care that also use medical images. The success of this technology is directly related to not requiring substantial resources for deployment. Health assistance needs to be substantially improved in Brazil and PU automatic analysis can be a contribution. A large-scale use of such instruments will be possible with low cost and also with the simplicity of its use by personnel without sophisticated professional qualification.

References

1. Kottke, F. J.; Lehman, J. F. Tratado de Medicina Física e Reabilitação de Krusen. 4. ed., v. 2, São Paulo: Manole Ltda, 1994.
2. Jorge, S. A. J.; Dantas, S. R. P. E. Abordagem multiprofissional do tratamento de feridas. São Paulo: Atheneu, p. 288-95, 2005.
3. Treuillet, S.; Albouy, B.; Lucas, Y. Three-dimensional assessment of skin wounds using a standard digital camera. IEEE TransMedImaging, v. 28, n.5, p.752-62, maio 2009.
4. Louro, M.; Ferreira, M.; Povoa, P. Avaliação de protocolo de prevenção e tratamento de úlceras de pressão. Rev. Bras. Ter. Intensiva, v.19, n.3, p. 337-41, jul/set 2007.
5. Menegon, D. B. et al. Implantação do protocolo assistencial de prevenção e tratamento de úlcera de pressão no Hospital de Clínicas de Porto Alegre. Rev. HCPA, v. 27, n. 2, p. 61-4, 2007.
6. Matos, L. S.; Duarte, N. L. V.; Minetto, R. C. Incidência e prevalência de úlcera por pressão no CTI de um Hospital Público do DF. Rev. Eletr. Enf. Goiânia, v. 12, n. 4, p. 719-26, 2010.
7. Bergstrom, N. et al. Treatment of pressure ulcers. Clinical Practice Guideline, n.15. Rockville: Public Health Service, Agency for Healt Care Policy and Reserch, 1004 (AHCPR publication, n.95-0653), 1994.
8. Silva, R. C. L.; Figueiredo, N. M.; Meireles, I. B. Feridas: fundamentos e atualizações em enfermagem. 2. ed. São Caetano do Sul: Yendis Editora, 2007.
9. Duthie, E. H.; Katz, P. R. Geriatria Prática. 3. ed. Rio de Janeiro: Revinter, p. 223-25, 2002.
10. Wild, T. et al. Digital measurement and analysis of wounds based on colour segmentation. European Surgery, v. 40, n. 1, p. 5-10, 2008.
11. Brasil. Ministério da Saúde. Secretaria de Políticas de Saúde. Departamento de Atenção Básica. Manual de condutas para úlceras neurotróficas e traumáticas / Brasília: Ministério da Saúde, 2002. 56 p.:il. - (Série J. Cadernos de Reabilitação em Hanseníase; n. 2). Disponível em: <http://bvsms.saude.gov.br/bvs/publicacoes/manual_feridas_final.pdf>. Acesso em: 3 nov. 2011.
12. Borges E. L. et al. Feridas: como tratar. 2. ed. Belo Horizonte: COOPMED, 2001.
13. Cuzzel, J. Z. The new RYB color code. AJN, v. 88, n. 10, p.1.342-6, 1988.
14. Russel, S., Norvig, P. Inteligência Artificial, Rio de Janeiro: Elsevier, 2004.
15. Hsu, W., Lee, M. L., Zhang, J. Image Mining: Trends and developments, in: Journal of Intelligent Information Systems, 19:1, 7-23, 2002.
16. Witten, I. H., Frank, E. Hall, M. A.. Data Mining: Practical Machine Learning Tools and Techniques, 3. Edition, USA: Morgan Kaufmann, 2011.
17. Lopes K. B. Incidência e prevalência de úlcera por pressão em pacientes internados no Hospital de Apoio de Brasília. [monografia]. Brasília (DF): Universidade Católica deBrasília, Brasília; 2007.
18. Gonzalez, R. C., Woods, R. E. Processamento digital de imagens, 3. ed., São Paulo: Pearson Prentice Hall, 2010.
19. Guadagnin, R. V., Batista, L. V. Poel, J. Processamento de imagens digitais e saúde, in BRASIL, L. M. (Org.) Informática em Saúde, Brasília: Universa, 2008.
20. Watt, A., Policarpo, A. The computer image, USA: Addison Wesley, 1998.