

Proposal for recognition of the comfort pattern in clients with pemphigus vulgaris using Fuzzy Logic*

PROPOSTA DE RECONHECIMENTO DE PADRÃO DE CONFORTO EM CLIENTES COM PÊNFIGO VULGAR UTILIZANDO A LÓGICA FUZZY

PROPUESTA DE RECONOCIMIENTO DEL ESTÁNDAR DE COMODIDAD EN CLIENTES CON PÉNFIGO VULGAR UTILIZANDO LA LÓGICA FUZZY

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ABSTRACT

The objective was to propose the use of Fuzzy Logic for recognition of comfort patterns in people undergoing a technology of nursing care because of pemphigus vulgaris, a rare mucocutaneous disease that affects mainly adults. The proposal applied experimental methods, with subjects undergoing a qualitative-quantitative comparison (taxonomy/relevance) of the comfort patterns before and after the intervention. A record of a chromatic scale corresponding to the intensity of each attribute was required: pain, mobility and impaired self-image. The Fuzzy rules established by an inference engine set the standard for comfort in maximum, median and minimum discomfort, reflecting the effectiveness of nursing care. Although rarely used in the area of nursing, this logic enabled viable research without a priori scaling of the number of subjects depending on the estimation of population parameters. It is expected to evaluate the pattern of comfort in the client with pemphigus, before the applied technology, in a personalized way, leading to a comprehensive evaluation.

DESCRIPTORS

Nursing care
Dermatology
Pemphigus
Fuzzy Logic

RESUMO

O objetivo é propor a Lógica Fuzzy para reconhecimento de padrões de conforto de pessoas submetidas a uma tecnologia de cuidar em Enfermagem por apresentarem pênfigo vulgar, uma doença cutâneo-mucosa rara que acomete principalmente adultos. A proposta aplicável em métodos experimentais com sujeitos submetidos à comparação quali-quantitativa (taxonomia/pertinência) do padrão de conforto antes e depois da intervenção. Requer o registro em escala cromática correspondente à intensidade de cada atributo: dor; mobilidade e comprometimento da autoimagem. As regras Fuzzy estabelecidas pela máquina de inferência definem o padrão de conforto em desconforto máximo, mediano e mínimo, traduzindo a eficácia dos cuidados de Enfermagem. Apesar de pouco utilizada na área de Enfermagem, essa lógica viabiliza pesquisas sem dimensionamento *a priori* do número de sujeitos em função da estimação de parâmetros populacionais. Espera-se avaliação do padrão de conforto do cliente com pênfigo diante da tecnologia aplicada de forma personalizada, conduzindo a avaliação global.

DESCRIPTORIOS

Cuidados de enfermagem
Dermatologia
Pênfigo
Lógica Fuzzy

RESUMEN

El objetivo es proponer la lógica Fuzzy para reconocer estándares de comodidad en personas con pênfigo vulgar, una enfermedad muco-cutánea rara que afecta principalmente a los adultos. La propuesta es aplicable en métodos experimentales con sujetos sometidos a la comparación cualitativa y cuantitativa (taxonomía/ pertinencia) del estándar de comodidad antes y después de la intervención. Se requiere el registro en una escala cromática de la correspondiente intensidad de cada atributo: dolor, movilidad y compromiso de la autoimagen. Las reglas Fuzzy establecidas por la máquina de inferencia, definen el estándar de comodidad del cliente en condiciones máximas, regular y mínimo de incomodidad traduciendo la eficacia de los cuidados de enfermería. Sin embargo, a pesar que la lógica Fuzzy que es poco utilizada en el área de enfermería, podrá contribuir para viabilizar investigaciones sin el cálculo *a priori* del número de sujetos en función de la estimación de los parámetros poblacionales. Se espera la evaluación del estándar de comodidad del cliente con pênfigo utilizando tecnologías aplicadas de forma personalizada y con miras a una evaluación integral.

DESCRIPTORIOS

Atención de Enfermería
Dermatología
Pênfigo
Lógica difusa

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INTRODUCTION

Pemphigus vulgaris is a chronic mucocutaneous, autoimmune disease, with unlimited evolution, which has intraepidermal blistering as a principle characteristic, with a severe prognosis⁽¹⁾.

Although the affected person may present areas of apparently healthy skin, the entire epidermis may be vulnerable to the appearance of new lesions, mainly due to small pressures, friction or traumas⁽²⁾. This sensitivity occurs due to acantholysis, that is characterized by the separation of epidermal cells (keratinocytes). This separation results from the destruction of intercellular cement, which becomes an antigen for an unknown reason, stimulating the production of antibodies, which promote the separation of the places of adhesion (desmosomes) and the filaments of union between the keratinocytes⁽¹⁾.

The bubbles arise from acantholysis, that in the case of pemphigus vulgaris occur in the basal layer, the deepest layer of the epidermis, which is considered the most severe form⁽³⁾. When they are broken, bullous lesions give rise to eroded disseminated lesions, with painful and fetid characteristics, causing physical and emotional discomfort, in addition to leaving the person predisposed to infections and infestations, particularly in the hospital environment. The vulnerability to infection is aggravated by the use of corticosteroids and immunosuppressives commonly used in the treatment of the disease⁽¹⁻³⁾.

Oral and genital mucosal lesions may be present. Swallowing food can become difficult, predisposing the client to weight loss and even to malnutrition. Genitalia lesions cause a burning sensation when urinating, especially in women.

The picture presented usually causes discomfort and vulnerability to risks, and the care of people with this disease represents a challenge for nursing staff⁽²⁾, not only in its complexity, but also due to the reality of many services, which often do not have the adequate physical structure and specialized nursing staff.

The complexity of nursing care for these clients is characterized not only by the physical, emotional and social repercussions, but also by the need for specialized and specific expertise, for the promotion of comfort and the prevention of injuries⁽⁴⁾.

The lack of theoretical frameworks directed to nursing care for these patients was observed during the performance of an integrative literature review, published in 2011⁽⁵⁾, which aimed to identify recommended nursing care for patients with pemphigus. The search was conducted in the Scientific Electronic Library Online (SciELO), in the databases: Latin American and Caribbean Health Sciences

(LILACS); Database of Nursing (BDENF); and, United States National Library of Medicine (PubMed). The keywords *enfermagem e pênfigo/nursing* and *pemphigus* were used.

Of the 31 articles encountered, only six met the inclusion criteria. These were authored predominantly by medical professionals, consequently being related to medication therapy, without considering the details required for nursing care, a fact that indicates the need to investigate evidence specifically directed to nursing care for these clients⁽⁵⁾.

With the awareness of this reality, a nursing care protocol for clients with pemphigus was published⁽²⁾; however, to date no recognized methodology has been used to reveal the effects of recommended nursing interventions, including the evaluation of comfort/well-being of the hospitalized client with pemphigus vulgaris.

It is questioned, then, how to show the effectiveness of the application of technology-specific nursing care to promote comfort and well-being of clients with pemphigus vulgaris. Based on this question, we developed the following objective: to propose Fuzzy Logic for the recognition of patterns of comfort of people with pemphigus vulgaris subjected to a technology of care in nursing.

It is believed that the proposal contributes to a personalized assessment of the pattern of comfort of hospitalized clients with pemphigus vulgaris, evaluating them before, during and after implementation of a specific nursing care protocol.

The vulnerability to infection is aggravated by the use of corticosteroids and immunosuppressives commonly used in the treatment of the disease.

THEORETICAL FRAMEWORK

A brief history of Fuzzy Logic is described, also known as Nebulous Logic, which emerged in the 1960s, more precisely in 1964, launched by Lotfi A. Zadeh, professor in the Department of Electrical Engineering and Computer Science at the University of California, who at that time was researching the problems of classification of sets that did not present well-defined boundaries⁽⁶⁻⁸⁾.

Zadeh objected to the assumptions imposed by rigid formal binary logic, considering that many human experiences cannot simply be classified as true or false, positive or negative, being inadvisable to define if the element belongs or does not belong to a particular set. He proposed the flexibility of relevance to the sets of elements, suggesting the use of the degree of relevance, given that one element can partly belong to one or another set with different relevance values⁽⁶⁻⁸⁾.

Despite initial resistance from the scientific community, especially by North American statisticians, several studies emerged worldwide. In 1972, in Japan, the first research group about Fuzzy systems was coordinated by Professor Toshiro Terano. That same year, in the United Kingdom, the

presentation of the first Fuzzy controller occurred, created by E. Mandani⁽⁸⁾.

Since then, several engineering researchers started to apply the theory to systems control. In 1985, Masaki Togai and Hiroyuke Watanabe created in Bell Laboratory, situated in the United States, the first Fuzzy chip. In 1987, the first train controlled by Fuzzy Logic was established in Japan, a country where the appliances are based on Fuzzy control, developed by companies with research laboratories in Fuzzy Logic for product development⁽⁸⁾.

The interest in Fuzzy Logic has been growing on the part of professionals and researchers from different areas, aiming to explore language skills and reasoning development that is closer to human, with great diversity of operations and a large capacity for application. Such logic helps researchers to produce models according to their need and reality, especially in the areas of knowledge that is necessary to work with imprecision and subjectivity, including engineering, chemistry, biology, medicine, economics, psychology, social sciences, education and public health⁽⁸⁾.

Daily problems are usually described with the use of vague linguistic terms, often involving qualitative variables, representing difficulties in the use of quantitative methods. Thus, Fuzzy Logic can be considered a useful tool in addressing problems in the health area, making it possible to deal with imprecisions and uncertainties in a more critical and realistic manner, facilitating interpretations. This logic has demonstrated its usefulness in the improvement and development of equipment and models in various activities in the hospital and research environments⁽⁸⁾.

It is worth noting many contributions of this theory to nursing research. Fuzzy Logic shares the epistemological and philosophical vision of the profession, allowing an understanding of how nurses deal with complex, ambiguous and imprecise phenomena.

An integrative review published in 2011, with the objective of presenting how Fuzzy Logic had been used in research with nurses, revealed that its use as a methodological resource was still new and unexplored by these professionals. Nor was the inherent issue in question observed in the article. Despite the absence of a time limit, only 49 articles were found in the databases, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica database (EMBASE), Sciverse Scopus and United States National Library of Medicine (PubMed)⁽⁹⁾.

Of the articles found, 21 were selected, of which 16 were written by nurses and five had nurses as collaborators, assisting in data collection. For article selection, the following criteria were considered: publications in Portuguese, English and Spanish languages, themes related to nursing and/or Fuzzy Logic, and nurse authorship or collaboration⁽⁹⁾.

The first article in this review was published in 1993 in Spain. The nurse appears as a collaborator, completing

data collection. In 1995, there were two articles written by nurses in the United States, both related to the intensive care area. Later publications having nurses as authors or collaborators in other countries, such as United Kingdom, New Zealand, Brazil, Greece, Taiwan and Northern Ireland, have emerged⁽⁹⁾. The presence of another two articles occurred, published by Brazilian nurses, the first in 2005 and the most recent in 2009. The 21 articles analyzed in this review revealed the use of Fuzzy Logic in the process of decision-making and development of models⁽⁹⁾.

Many daily situations in nursing practice are permeated by ambiguous or imprecise information. Therefore, in these cases, Fuzzy Logic provides a relatively easy approach to modeling the decision-making process⁽¹⁰⁾. The use of Fuzzy Logic may be a path for the development of methods to generate an accurate diagnosis, by supporting the expert in establishing his decision and even to attribute weight to each rule that uses this process⁽¹¹⁾.

Concepts and sets of Fuzzy theory

The concept of *Fuzzy* measure, introduced by Sugeno in 1974, is a form used to assess the levels of uncertainty, especially when the values are dependent on the subjectivity of the person who is performing the measurement. An example of a subjective measure is the assessment of pain, discomfort or well-being. Despite the subjectivity involved in the evaluation, certain features may be unanimous⁽⁸⁾.

Fuzzy sets do not have well-defined borders that enable dealing with problems in which transitions from one class to another occur smoothly. The basic operations of the classic sets are the union, intersection and complement. To obtain the *Fuzzy* sets and their operations, it is necessary to generalize the characteristic function of Classical Logic for the interval [0,1], which implies the consideration of a continuum of values of relevance, and not just dichotomous variables (belongs or does not belong). It should be considered a function of relevance that provides the degree of relevance of the different numbers considered as a whole, permitting the classification and grouping of the elements in a different manner from Classical Logic, favoring the reinterpretation of old concepts.

Thus, *Fuzzy* Logic differs from conventional logic, working with the concept of partial truth, or that is, with truth values ranging between completely true and completely false of Boolean logic, enabling work with linguistic variables⁽⁸⁾.

An element will belong to a subset between two sets with one degree of relevance in the interval [0,1]. So, a *Fuzzy* set is characterized by a function of pertinence which measures a level that can be considered as a measure which expresses the possibility that a given data element is a member of the *Fuzzy* set⁽⁸⁾.

Fuzzy logic enables the establishment of different degrees of relevance of attributes, expressed in a geometric form (*Fuzzy* sets) on a support constructed for one of the

Cartesian axes, which can be represented, for example, by a chromatic scale. It is a tool that can capture vague information, described in natural language, converting it into easily understandable relevance values on a scale of zero to one (fuzzification)⁽¹²⁾.

Fuzzy linguistic variables

The use of the linguistic term, common in our daily life to express concepts and knowledge during communication between people, can be considered the most important manner in the use of information. In the case of the purpose of this article, for example, the nurse specialist in dermatology nursing has a role in the selection of Fuzzy sets, because he defines this domain and performs its Fuzzy partition. Numerical variables are very useful in the exact sciences, but the symbolic variables show their importance in the development of areas of artificial intelligence and decision-making processes⁽⁸⁾.

Fuzzy linguistic variables qualitatively express a linguistic term that grants a concept (attribute), that is quantitatively evaluated by a pertinence function⁽⁸⁾. The following attributes were considered to recognize the pattern of comfort presented by clients with pemphigus vulgaris: pain, impaired self image/body exposure, and injuries and mobility.

METHOD

The need to work with imprecise data during research about the pattern, comfort and well-being, presented by patients with pemphigus vulgaris before and after implementation of a protocol of nursing care led to interest in Fuzzy Logic, given its significant contribution for understanding phenomena that involve inaccuracy, as in the cited study.

Considering that to respond to the formulated and precise question, it is necessary to deal with imprecise data that translate the subjectivity of the patient affected by an unusual pathology about his comfort and well-being, it was decided to use Fuzzy Logic. This theory helps in the comprehension of the concepts that extrapolate the barriers of formal logic, given its significant contribution to the comprehension of phenomena that involve imprecision⁽⁶⁾. It also enables the recognition of patterns of comfort of people with pemphigus vulgaris before and after the application of a specific technology to care for that clientele.

It is important to emphasize the inadequacy of using as a method for data analysis the proposals that use a dichotomous concept (yes/no, true/false), typically used in quantitative studies, since the search for information in the proposed study breaks the boundaries and limitations imposed by this binary quantification.

To facilitate the assessment of the comfort pattern of each patient in the three moments (before, during and after nursing interventions), they were asked to mark the color on the chromatic scale corresponding to the intensity of each attribute that expressed discomfort caused by the

illness. The strips (chromatic scale) were marked by the clients for each attribute and subsequently placed on the support (abscissa) of the graph to evaluate the corresponding relevance. In the case of intersection of two Fuzzy sets, we used the minimum relevance value that identified the classification of the attribute. This procedure allowed the qualitative-quantitative evaluation of the individual by attribute and, later, his state of comfort, which was translated by the Fuzzy Inference engine with the rules, "if... then" with maximum relevance concerning the pertinence of two attributes in an interactive manner.

Regarding the attributes of pain and impaired self-image/body exposure and the lesions, the client orientation was conducted as follows: cold colors corresponded to low intensity; intermediate shades, to average intensity; and, warm colors, to high intensity, as shown in the graphic below (Figure 1).

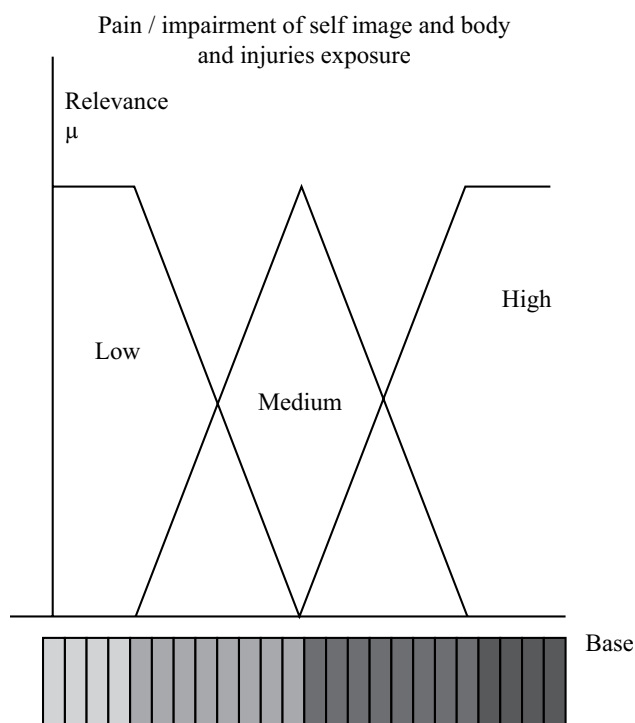


Figure 1 – Evaluation of the relevance corresponding to pain and impaired self image/body exposure and injuries - Rio de Janeiro, 2012.

Expressing the characteristics of the established attributes

Pain: while some authors cite that pain *can* be present⁽¹⁾, the practice of caring for these clients has shown that this is inevitable, according to the picture usually presented.

Impairment of self image / body exposure and injuries: due to characteristics of the lesions, pemphigus vulgaris has a disfiguring character, causing serious repercussions on the social and emotional life of the affected person⁽²⁾.

We emphasize not only the exposure of the body, but the body with lesions, increasing the discomfort caused by the physical pain.

In the case of the mobility attribute, the evaluation happens in an inverse manner, because the cold colors represent low mobility, intermediate colors, average mobility and warm colors, high mobility, as shown in the graphic in Figure 2.

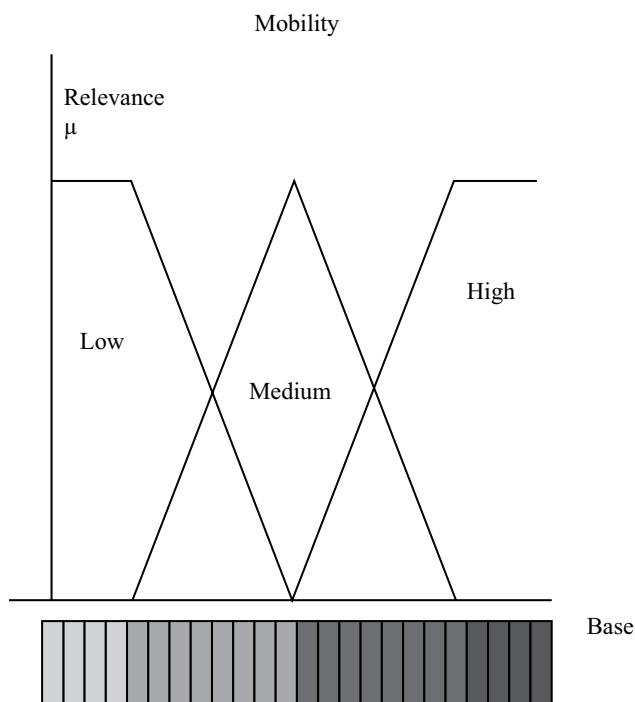


Figure 2 – Evaluation of the relevance corresponding to mobility - Rio de Janeiro, 2012.

Mobility: due to the lesions often being disseminated and the fragility of the skin, the patient normally has limited mobility⁽²⁾. This limitation may be related to extension of the limbs, walking and changing positions, also resulting in the development of pressure ulcers.

Fuzzy rules

The traditional logic does not allow interactive assessment of the change in condition of a person with antecedent and consequent assumptions, restricting itself to two sets: comfort and discomfort. The antecedents of a Fuzzy rule describe an elastic, non-rigid condition, which can be partially satisfied. A Fuzzy region is defined and entered into the system. Thus, the preparation of the antecedents frequently are characterized by a classification of work, while the preparation of consequences requires knowledge about the dynamics of the system.

After construction of the Fuzzy rule set, it is necessary to use an *inference engine* in order to extract the final answer⁽⁸⁾ which describes situations where specific inference leads to a desired result. This is to capture specific knowledge. A set of rules is able to describe a system in its various possibilities. Each rule is composed of an antecedent part (If), that describes a condition (Premise) and a consequent part (Then)⁽¹²⁾. Rules are processed in parallel, that is, considering all simultaneously, as shown in Chart 1. Finally, one can obtain a qualitative-quantitative result.

The rules are detailed below:

Rule 1: If pain and/or *high* exposure and/or *low* mobility, then: *maximum discomfort*

Rule 2: If pain and/or *medium* exposure and/or *medium* mobility, then: *medium discomfort*

Rule 3: If pain and/or *low* exposure and/or *high* mobility, then: *minimal discomfort*

Applied to the research in progress, which had as subjects patients with pemphigus vulgaris hospitalized in the dermatology clinic of the *Hospitais Universitários do Rio de Janeiro*, the proposal was approved by the Committee on Ethics and Research of the *Universidade do Estado do Rio de Janeiro*, receiving protocol number 0258.0.228.000-11.

Chart 1 – Fuzzy Interface Engine Rules - Rio de Janeiro, 2012

Pain <i>If</i>	Mobility “If”	Self-image impairment, and body exhibition and injuries <i>If</i>		
		High	Medium	Low
High	High	Maximum discomfort	Maximum discomfort	
	Medium			
	Low			
Medium	High		Medium discomfort	
	Medium			
	Low		Maximum discomfort	
Low	High		Medium discomfort	Minimal discomfort
	Medium			Maximum discomfort
	Low		Maximum discomfort	

DISCUSSION

Caring guided by Technology of Nursing Care for the comfort and well-being of the client with pemphigus vulgaris (TCECPV) was implemented according to the evaluation of the specialist and/or nurse trained to apply it, using sensitive listening in relation to the human needs identified, that is, in a judicious, sensitive and personalized manner⁽⁴⁾. All study subjects were cared for using the TCECPV, assessing their comfort/well-being before, during and after the nursing interventions.

The performed interventions followed the recommendations described in TCECPV that aimed to: relieve the discomfort caused by skin and mucosal lesions; heal existing lesions; prevent the onset of new lesions; prevent infections and infestations; maintain fluid and electrolyte balance; control possible side effects of treatment; and, evaluate the social and emotional influences of pemphigus vulgaris in the life of the client and family; to guide the client and his family, in an attempt to reduce anxiety and increase the ability to deal with the problem⁽²⁾.

The evaluation of the established attributes was conducted by the client before, during and after the application of the TCECPV. The person who classified a given attribute such as pain, for example in a *high* condition, with a 1.0 degree of relevance at the time of initial evaluation, that is, before interventions, and *medium* 24 hours after the application of TCECPV with relevance 0.8 and the same classification after a week of interventions proposed in TCECPV, will have moved from *maximum* discomfort to *medium* discomfort, which was maintained, characterizing a positive development.

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Reapplying the rules for other attributes, it was verified if the proposed care in TCECPV modified the comfort pattern of the person, monitoring the evolution of the comfort pattern of the client. The classifications of the pattern of comfort, maximum, medium and minimum discomfort, in the three moments of evaluation, permitted the translation of the effectiveness of the technology for the proposed care.

Once the clients were evaluated in a personalized manner, according to the dimensions of pain, mobility, impaired self-image, leading to a global evaluation of comfort and well-being, systems based on Fuzzy Logic do not have a priori requirement of scaling the number of study participants. Some authors⁽¹³⁾, for example, used it to evaluate the scale of the nursing service with only officially employed nurses, without the concern of scaling the number of subjects participating in the study.

CONCLUSION

Fuzzy Logic was an alternative that enabled the study in question, not only because it was a relatively rare disease, but also because it involved the very subjective topic of comfort/well-being of the person.

Based on the foregoing, this article guides the recognition of patterns of comfort for people with pemphigus vulgaris in a qualitative-quantitative manner, as the clients will be evaluated in a personalized and comprehensive way, aiming at the implementation of care that promotes comfort and well-being in the physical, emotional and spiritual spheres.

It is also considered that, despite being a method not yet well explored by nurses, it can help to guide/facilitate further studies in the area of nursing.

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