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Neutrosophic Approaches to Epidemic and Pandemic Response

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Abstract: This scientific paper focuses on the importance of health care during a pandemic or epidemic. The response to a pandemic involves the evaluation and treatment of affected patients, the implementation of preventive measures, and monitoring the evolution of the disease. In the field of nursing, the importance of nurses is highlighted in all stages of the response to a pandemic or epidemic. They play a crucial role in patient evaluation and triage, direct care of the infected, infection prevention, public education, interprofessional collaboration, resource management, and epidemiological surveillance. Furthermore, this article presents an approach based on neutrosophic sets in multi-criteria decision-making for triage selection in the nursing field during pandemics or epidemics. The COPRAS method is used to evaluate alternatives based on clinical nursing criteria. The results are used to determine the priority of the alternatives in terms of triage. The article emphasizes the importance of this methodology in decision-making in the field of nursing during pandemic or epidemic situations.

Keywords: Neutrosophic sets, COPRAS, pandemics, epidemics, nursing.

1. Introduction

The response to a pandemic or epidemic is a complex process that involves the collaboration of governments, health organizations, medical professionals, and the community in general. Health care during these types of events is crucial in containing and mitigating the spread of infectious diseases. In these situations, healthcare systems face significantly increased demand, highlighting the need for an efficient and coordinated response.

Health care not only involves the evaluation and treatment of affected patients but also the implementation of preventive measures. Added to this is monitoring the evolution of the disease and educating the community [1]. In addition, health professionals play a fundamental role in the early identification of cases. They excel in implementing isolation and quarantine measures, and managing critical resources and protective equipment [2]. Health care during a pandemic or epidemic not only saves individual lives but also contributes to controlling the spread of the disease. It protects society as a whole and reduces pressure on health systems.

One of the key elements of an effective response to a pandemic or epidemic is surveillance and early detection. This involves constant monitoring of public health indicators, identification of suspected cases, and confirmation through diagnostic tests. Furthermore, effective communication is essential to inform the public about the situation, preventive measures, and guidelines to follow. Education about the disease and proper hygiene practices also play an important role.[3]

To slow the spread of the disease, it is crucial to identify and isolate infected people. In the case of a severe pandemic, quarantines or movement restrictions may be necessary. Diagnostic testing and contact tracing help identify and isolate people who may have been exposed to the virus. This is essential to prevent the spread.

Healthcare workers and other essential professionals must have access to appropriate personal protective equipment (PPE) to protect themselves while caring for patients. Appropriate medical care should be provided to infected people, and effective treatments should be developed if available. In the case of a viral pandemic, the development and distribution of vaccines are essential for the immunization of the population. Collaboration between countries is essential to address a global pandemic. International organizations, such as the World Health Organization (WHO), play a central role in coordinating efforts globally.

Countries should have pandemic response plans in place and be prepared to implement them when necessary. This includes the storage of medical supplies and the training of health personnel. Pandemics can have a significant emotional and social impact on communities. It is important to provide psychological support and social services to address these issues.

The response to pandemics and epidemics in terms of nursing is essential for the effective management of public health and care for affected patients. Nursing professionals play a crucial role in all stages of the response to a pandemic or epidemic [4]. Here are some key areas in which nurses play an essential role:

1. Assessment and triage: Nurses are often the first to assess patients who arrive at healthcare facilities with symptoms suspected of a communicable disease. They perform triage to determine the severity of the illness and the need for isolation.
2. Patient care: Nurses provide direct care to infected patients, including administering medications, monitoring vital signs, and emotional support. They also help in managing complications and provide palliative care when necessary.
3. Infection prevention: Nurses are responsible for implementing infection prevention measures, such as proper use of personal protective equipment (PPE), hand hygiene, and surface disinfection. They also educate patients and their families about safe practices.
4. Public education: Nurses play a crucial role in public education about pandemics or epidemics, providing accurate and up-to-date information on how to prevent the spread of the disease and when to seek medical attention.
5. Interprofessional collaboration: Nurses work closely with physicians, epidemiologists, social workers, and other health professionals to plan and coordinate the response to the pandemic. They participate in team meetings and contribute their experience in nursing care.
6. Resource management: Nurses are often involved in resource management, such as allocating hospital beds, medical equipment, and supplies needed to treat infected patients.
7. Epidemiological surveillance: Nurses may be involved in collecting and analyzing epidemiological data to help track the spread of disease and make informed decisions about public health policies.
8. Emotional support: During a pandemic, nurses provide emotional support to patients and their families, who are often experiencing stress and anxiety due to illness and separation.

Nursing assessment and triage are essential processes in healthcare, especially during emergencies, such as epidemics or natural disasters. Assessment involves collecting clinical data and observing patients to determine their health status. Nurses play a critical role in this stage by taking vital signs, assessing symptoms, and gathering relevant information about the patient. This initial evaluation helps identify the severity of the patient's condition and make informed decisions about necessary medical care.

Triage, on the other hand, refers to the prioritization of patients based on the severity of their condition and the resources available. Nurses play a key role in the triage process by determining which patients require immediate attention and which can wait. This is done by evaluating the severity of symptoms, the stability of the patient, and the availability of medical resources. Triage is crucial in high-demand situations, ensuring that the most critical patients receive priority care. Thus, when faced with a triage system, nursing staff are constantly under pressure to make immediate decisions.

Decision-making is an essential aspect of human functioning, both personally and professionally. Decisions are often faced with predefined objectives, but in many situations, these objectives conflict. The need to simultaneously consider criteria and alternatives in decision problems is crucial, especially when dealing with uncertain data sets [5]. In recent years, research has focused on addressing the vagueness of initial information in solving complex practical problems, using multi-criteria decision-making (MCDM) methods. These methods allow decision-makers to address uncertainty and subjectivity in the decision-making process.

Fuzzy set theory was introduced to deal with uncertain and imprecise data. However, it has been observed that it cannot address all the uncertainties that arise in real problems in various fields of life. To address this limitation, neutrosophic set theory was proposed as a generalization of fuzzy and intuitionistic fuzzy sets. In neutrosophy, truth membership, indeterminacy membership, and false membership are independent and lie in a non-standard interval between 0 and 1. To make neutrosophic sets more practical, single-valued neutrosophic sets were defined (SVNS) and operations and properties of SVNS were proposed.

Experts in various disciplines have applied neutrosophic set theory in solving multi-criteria decision-making problems in fields such as investment, healthcare, and communication circuit design. In the field of medicine, where decision-making is complex and constant, neutrosophy has proven to be a valuable tool for addressing the indeterminacies of the real world and considering multiple factors in the decision-making process.

This research aims to make possible the possible situations of triage selection in the field of nursing in the face of pandemics or epidemics. The study will be carried out by applying single-value neutrosophic sets toward decision-making in the application of the COPRAS method.[6]

2 Preliminaries

2.1 The COPRAS method

This multicriteria decision-making technique was proposed by [7] and can be generally expressed as follows. Given a decision-making problem, which consists of m alternatives that must be evaluated considering n criteria and x_{ij} can be expressed as the value of the i^{th} alternative by the criterion. The main idea of the COPRAS technique consists of the steps described below:

Step1. Select the appropriate set of criteria that describes the chosen alternatives.

Step2. Prepare the decision matrix.

$$X = \begin{bmatrix} x_{11} & x_{12} \dots & x_{1n} \\ x_{22} & x_{22} \dots & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \quad (1)$$

Step 3. Determine the weights w_j of the criteria.

Step 4. Normalize decision matrix $\bar{X}$. The values of the normalized matrix are determined as

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}; i = 1,2, \dots, m; j = 1,2, \dots, n \quad (2)$$

Step 5. Compute weighted normalized decision matrix D, whose components are calculated as

$$d_{ij} = \bar{x}_{ij} \cdot w_j; i = 1,2, \dots, m; j = 1,2, \dots, n \quad (3)$$

Step 6. Calculate the summation of the criterion values with respect to the optimization direction for each alternative.

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij};\ P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (4)$$

where d_{+ij} values correspond to the criteria to be maximized and d_{-ij} values correspond to the criteria to be minimized.

Step 7. Determine the minimum component of P_{-i}:

$$P_{-min} = min_i P_{-i}; i = 1,2, \dots, L_{min} \quad (5)$$

Step 8. Determine the score value of each alternative Q_i:

$$Q_i = P_{+i} + \frac{P_{-min} \sum_{j=1}^{L_{min}} P_{-j}}{P_{-i} \sum_{j=1}^{L_{min}} \frac{P_{-min}}{P_{-j}}}; j = 1, \dots, L_{min} \quad (6)$$

Step 9. Determine optimality criterion K for the alternatives:

$$K = max_i Q_i\ ; i = 1,2, \dots, m \quad (7)$$

Step 10. Determine the priority of the alternatives. The greater Q_i score value for the alternative corresponds to the higher priority (rank) of the alternative.

2.2 Neutrosophic Sets

Definition 1. Let X be a space of the objects and $x \in X$. A neutrosophic set A in X is defined by three functions: truth-membership function $T_A(x)$, an indeterminacy- membership function $I_A(x)$ and falsity-membership function $F_A(x)$. These functions are defined on real standard or real non-standard subsets of $]0^-, 1^+[$. That is $T_A(x): X \to]0^-, 1^+[$, $I_A(x): X \to]0^-, 1^+[$ and $F_A(x): X \to]0^-, 1^+[$. There is no restriction on the sum of $T_A(x)$, $I_A(x)$ and $F_A(x)$, so $0^- \le supT_A(x) + supI_A(x) + supF_A(x) \le 3^+$.

2.3 Single Valued Neutrosophic Set.

A Single Valued Neutrosophic Set (SVNS) has been defined as described in [8].

Definition 2. Let X be a universal space of the objects and $x \in X$. A single valued neutrosophic set (SVNS) $\tilde{N} \subset X$ can be expressed as

$$\tilde{N} = \{\langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x) \rangle : x \in X\} \quad (8)$$

where $T_{\tilde{N}}(x): X \to][0,1]$, $I_{\tilde{N}}(x): X \to][0,1]$ and $F_{\tilde{N}}(x): X \to][0,1]$

with $0 \leq T_{\tilde{N}}(x) + I_{\tilde{N}}(x) + F_{\tilde{N}}(x) \leq 3$ or all $x \in X$. The values $T_{\tilde{N}}(x)$, $I_{\tilde{N}}(x)$ and $F_{\tilde{N}}(x)$ correspond to the truth-membership degree, the indeterminacy-membership degree, and the falsity-membership degree of x to Ñ, respectively. For the case when X consists of a single element, Ñ is called a single-valued neutrosophic number [9][10]. For the sake of simplicity, a single-valued neutrosophic number is expressed by $\tilde{N}_A = (t_A, i_A, f_A)$ where $t_A, i_A, f_A \in [0,1]$ and $0 \leq t_A + i_A + f_A \leq 3$.

Definition 3. Let $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ be two SVN numbers, then summation between $\tilde{N}_1$ and $\tilde{N}_2$ is defined as follows:

$$\tilde{N}_1 + \tilde{N}_2 = (t_1 + t_2 - t_1 t_2, i_1 i_2, f_1 f_2) \tag{9}$$

Definition 4. Let $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ be two SVN numbers, then multiplication between $\tilde{N}_1$ and $\tilde{N}_2$ is defined as follows:

$$\tilde{N}_1 * \tilde{N}_2 = (t_1 t_2, i_1 + i_2 - i_1 i_2, f_1 + f_2 - f_1 f_2) \tag{10}$$

Definition 5. Let $\tilde{N} = (t, i, f)$ be an SVN number and $\lambda \in \mathbb{R}$ an arbitrary positive real number, then:

$$\lambda\tilde{N} = \left(1 - (1 - \mathrm{t})^{\lambda}, i^{\lambda}, f^{\lambda}\right), \lambda > 0 \tag{11}$$

Definition 6. If A= $\{A_1, A_2, \dots, A_n\}$, and B= $\{B_1, B_2, \dots, B_n\}$ (i= 1, 2, …, m) are two single-valued neutrosophic sets, then the separation measure between *A* and *B* applying the normalized Euclidian distance can be expressed as follows:

$$q_n(A,B) = \sqrt{\frac{1}{3n}\sum_{j=1}^{n}\left(\left(t_A(x_i) - t_B(x_i)\right)\right)^2 + \left(\left(i_A(x_i) - i_B(x_i)\right)\right)^2 + \left(\left(f_A(x_i) - f_B(x_i)\right)\right)^2}$$

$$(i = 1,2, \dots, n) \tag{12}$$

Definition 7. **7**. Let A = (a, b, c) be a single-valued neutrosophic number, then a score function $\tilde{N}_A$ is mapped into the single crisp output $S(\tilde{N}_A)$ as follows

$$S(\tilde{N}_A) = \frac{3 + t_A - 2i_A - f_A}{4} \tag{13}$$

where $S(\tilde{N}_A) \in [0,1]$. This score function is the modification of the score function proposed by [11-12-13-14] and allows to have the results in the same interval while dealing with single-valued neutrosophic numbers.

The concept of a linguistic variable is very useful for solving decision-making problems with complex content. The value of a linguistic variable is expressed as an element of its term set. Such linguistic values can be represented using single-valued neutrosophic numbers.

In the method, there are k-decision makers, m-alternatives and n-criteria. k-decision makers evaluate the importance of the m-alternatives under n-criteria and rank the performance of the n-criteria with respect to linguistic statements converted into single valued neutrosophic numbers. The importance weights based on single-valued neutrosophic values of the linguistic terms are given in Table 1.

Table 1: Linguistic variable and Single Valued Neutrosophic Numbers (SVNNs). Source: [6]

Linguistic terms	SVNNs
Extremely Good (EG)/ 10 points	(1.00, 0.00, 0.00)
Very Very Good (VVG)/ 9 points	(0.90, 0.10, 0.10)
Very Good (VG)/ 8 points	(0.80, 0.15, 0.20)
Good (G) / 7 points	(0.70, 0.25, 0.30)
Medium Good (MG) / 6 points	(0.60, 0.35, 0.40)
Medium (M) / 5 points	(0.50, 0.50, 0.50)
Medium Bad (MB) / 4 points	(0.40, 0.65, 0.60)
Bad (B) / 3 points	(0.30, 0.75, 0.70)
Very Bad (VB) / 2 points	(0.20, 0.85, 0.80)
Very Very Bad (VVB) / 1 point	(0.10, 0.90, 0.90)
Extremely bad (EB) / 0 points	(0.00, 1.00, 1.00)

The performance of the group decision-making applying COPRAS-SVNS approach can be described by the following steps.

- Step 1. Determine the importance of the experts. In the case when the decision is made by a group of experts (decision makers), firstly the importance or share of the final decision of each expert is determined. If a vector $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_k)$ is the vector describing the importance of each expert, where $\lambda_k \geq 0$ and $\sum_{k=1}^{K} \lambda_k = 1$.
- Step 2. In the framework of this step, each decision maker performs his evaluations concerning the ratings of the alternatives with respect to the attributes and the attribute weights. If it is denoted by $x_{ij}^{k}, i = 1,2,\dots,m; j = 1,2,\dots,n$ the k^{th} expert's evaluation of the i^{th} alternative by the j^{th} criterion. This evaluation is expressed in linguistic terms presented in Table 1. So, the decision matrix for any particular expert can be constructed

$$X^k = \begin{bmatrix} x^k{}_{11} & x^k{}_{12} \cdots & x^k{}_{1n} \\ x^k{}_{22} & x^k{}_{22} \cdots & x^k{}_{2n} \\ \vdots & \vdots & \vdots \\ x^k{}_{m1} & x^k{}_{m2} \cdots & x^k{}_{mn} \end{bmatrix} \quad (14)$$

- Step 3. Calculate the weights of the criteria. The aggregated weights of the criteria are determined by

$$\mathrm{w}_j = \lambda_1 \mathrm{w}_j^{(1)} \cup \lambda_2 \mathrm{w}_j^{(2)} \cup \dots \cup \lambda_k \mathrm{w}_j^{(k)} = \left(1 - \prod_{k=1}^{K}\left(1 - t_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(i_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(f_j{}^{(w_k)}\right)^{\lambda_k}\right) \quad (15)$$

- Step 4. Construction of the aggregated weighted single-valued decision matrix

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} \cdots & \tilde{x}_{1n} \\ \tilde{x}_{22} & \tilde{x}_{22} \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} \cdots & \tilde{x}_{mn} \end{bmatrix} \quad (16)$$

where any particular element $\tilde{x}_{ij} = (\tilde{t}_{ij}, \tilde{i}_{ij}, \tilde{f}_{ij})$ represents the rating of the alternative A_i with respect to the j criterion and is determined as follows

$$\tilde{x}_{ij} = \lambda_1 \mathrm{x}_{ij}^{(1)} \cup \lambda_2 \mathrm{x}_{ij}^{(2)} \cup \dots \cup \lambda_k \mathrm{x}_{ij}^{(k)} = \left(1 - \prod_{k=1}^{K}\left(1 - t_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(i_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(f_j{}^{(x_k)}\right)^{\lambda_k}\right) \quad (17)$$

- Step 5. Determine the weighted decision matrix. Following Eq. (3), the weighted decision matrix can be expressed as $D = \lfloor d_{ij} \rfloor, d = 1,2,\dots,m; j = 1,2,\dots,n$, where $d_{ij} = \tilde{x}_{ij} * w_j$. Applying Eq. (10), a single element of the weighted decision matrix can be calculated.

$$d_{ij} = t_{ij}^{\tilde{x}} t_j^{w}, i_{ij}^{\tilde{x}} + i_j^{w} - i_{ij}^{\tilde{x}} i_j^{w}, f_{ij}^{\tilde{x}} + f_j^{w} - f_{ij}^{\tilde{x}} f_j^{w} \quad (18)$$

- Step 6. Perform a summation of the values for the benefit. Let $L_+ = \{1,2,\dots,L_{max}\}$ be a set of the criteria to be maximized. Then the index of the benefit for each alternative can be determined.

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \quad (19)$$

where this summation of the single value neutrosophic numbers is performed applying Eq.(9).

- Step 7. Calculate the summation of the values for cost. Let be $L_- = \{1,2,\dots,L_{min}\}$ a set of criteria to be minimized. Then the index of the cost of each alternative can be determined.

$$P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (20)$$

- Step 8. Determine the minimum value of P_{-i}.
- Step 9. Determine the score value of each alternative Q_i. At the beginning, the score values are calculated from the aggregated values for benefit and the cost $S(P_{+i})$ and $S(P_{-i})$ applying Eq.(13). The score values of the alternatives can be expressed as:

$$Q_i = S(P_{+i}) + \frac{S(P_{-min}) \sum_{i=1}^{L_{min}} S(P_{-i})}{S(P_{-min}) \sum_{i=1}^{L_{min}} \frac{S(P_{-min})}{S(P_{-i})}} \quad (21)$$

- Step 10. Determine optimality criterion *K* for the alternatives:

$$K = max_i Q_i; i = 1,2,\dots,m \quad (22)$$

Step 11. Determine the priority of the alternatives. The greater score value Q_i for the alternative corresponds to the highest priority (rank) of the alternative.

3 Results and Discussion

Patient assessment and triage during an epidemic or pandemic are critical processes for determining disease severity and allocating healthcare resources efficiently. For the development of the study, three alternatives are considered when evaluating the triage carried out by nursing staff when caring for patients in the face of a pandemic or epidemic:

1. Medical care capacity:

- Availability of hospital beds, ventilators, medical personnel, and medical supplies.
- Capacity of the health system to handle additional patients.

2. Prioritization of population groups:

- Determination of high-risk population groups that should receive priority attention.
- Consideration of the availability of specific vaccines or treatments.

3. Guides and protocols:

- Use of guidelines and protocols established by public health authorities and medical organizations for evaluation and triage.

Importantly, assessment and triage may vary depending on the severity of the epidemic or pandemic, as well as local conditions and available resources. These variables help healthcare professionals make informed decisions about care and resource allocation, prioritizing those patients who need it most.

Nursing clinical criteria in the care of pandemics or epidemics are essential to guarantee safe and effective care for patients. These criteria focus on the evaluation and care of patients, as well as preventing the spread of the disease. To confront the proposed variables, four evaluation criteria were established, which are codified in Table 2. The data were analyzed by 5 experts in the case, who analyzed the selection alternatives based on the analyzed criteria. Experts are considered to have an equal degree of importance.

Table 2: Evaluation criteria. Source: own elaboration.

Criteria	
C_1 Infection Control	- Proper use of personal protective equipment (PPE). - Rigorous cleaning and disinfection of surfaces and equipment. - Isolation and quarantine measures, as necessary. - Frequent and correct hand washing.
C_2 Prevention and Control of Transmission	- Safe handling of medical waste and contaminated materials. - Educate patients and staff about hygiene and prevention practices. - Monitor compliance with infection control measures in the healthcare unit. - Quickly identify and notify suspected or confirmed cases of the disease.
C_3 Resource Management and Logistics	- Manage available resources such as personal protective equipment (PPE), medical supplies, and equipment. - Collaborate on logistics to ensure critical resources are available when needed.
C_4 Personnel Safety	- Protect the health and safety of nursing staff through the proper use of personal protective equipment (PPE) and training on safety measures.

The weight vector of the criteria is obtained through the evaluations carried out by the experts considering the values provided in Table 1. In this way, Table 3 shows the weight vector obtained after applying equation (15).

Table 3: Vector of weights of the analyzed criteria. Source: own elaboration.

Weights vector	SVNN
C_1	(0.82671;0.17329;0.15157)
C_2	(0.83428;0.16572;0.15849)
C_3	(0.79186;0.20814;0.17411)
C_4	(0.82671;0.17329;0.15157)

The evaluation of the alternatives is carried out considering the values shown in Table 1. All the initial data are transformed into neutrosophic sets. The evaluations made by the experts are shown in Table 4.

Table 4: Evaluation carried out by experts of the decision alternatives with respect to the evaluation criteria. Source: own elaboration.

		Criterion 1			
Alternatives	X1	X2	X3	X4	X5
Healthcare capacity	(0.75,0.25,0.2)	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.75,0.25,0.2)
Prioritization of population groups	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)
Guides and Protocols	(0.9,0.1,0.1)	(0.9,0.1,0.1)	(0.75,0.25,0.2)	(0.9,0.1,0.1)	(0.9,0.1,0.1)
		Criterion 2			
Alternatives	X1	X2	X3	X4	X5
Healthcare capacity	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.9,0.1,0.1)
Prioritization of population groups	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)
Guides and Protocols	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)
		Criterion 3			
Alternatives	X1	X2	X3	X4	X5
Healthcare capacity	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)
Prioritization of population groups	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.35,0.75,0.8)
Guides and Protocols	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.5,0.5,0.5)
		Criterion 4			
Alternatives	X1	X2	X3	X4	X5
Healthcare capacity	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.5,0.5,0.5)	(0.75,0.25,0.2)	(0.9,0.1,0.1)
Prioritization of population groups	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)	(0.5,0.5,0.5)
Guides and Protocols	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)	(0.5,0.5,0.5)	(0.9,0.1,0.1)

Based on the evaluations carried out by the experts, the necessary transformations are carried out to obtain the decision matrix, using equation (17). Table 5 shows the results obtained after applying the indicated procedure.

Table 6: Weighted decision matrix. Source: own elaboration.

Alternatives	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Healthcare capacity	(0.67,0.33,0.289)	(0.725,0.275,0.251)	(0.35,0.75,0.8)	(0.725,0.275,0.251)
Prioritization of population groups	(0.81,0.19,0.19)	(0.5,0.5,0.5)	(0.35,0.75,0.8)	(0.5,0.5,0.5)
Guides and Protocols	(0.88,0.12,0.115)	(0.81,0.19,0.19)	(0.621,0.379,0.347)	(0.81,0.19,0.19)

Table 5: Initial decision matrix. Source: own elaboration.

The initial decision matrix allows for obtaining the weighted decision matrix, which is constructed by applying equation (19) and is presented in Table 6.

Alternatives	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Healthcare capacity	(0.554;0.446;0.397)	(0.605;0.395;0.37)	(0.277;0.802;0.835)	(0.599;0.401;0.365)
Prioritization of population groups	(0.67;0.33;0.313)	(0.417;0.583;0.579)	(0.277;0.802;0.835)	(0.413;0.587;0.576)
Guides and Protocols	(0.728;0.272;0.249)	(0.676;0.324;0.318)	(0.492;0.508;0.461)	(0.67;0.33;0.313)

At this point in the analysis, it is necessary to clarify that criteria 1 and 2 are considered benefit criteria, so their enhancement should be sought. Taking this into account, the coefficients proposed by the method are calculated and analyzed to select between the alternatives.

Table 7: Values of Pi, S(P), and Q score value for each alternative. Source: own elaboration.

Coefficients	Healthcare capacity	Prioritization of population groups	Guides and Protocols
Pi+	(0.824;0.176;0.147)	(0.808;0.192;0.181)	(0.912;0.088;0.079)
Pi-	(0.71;0.322;0.305)	(0.576;0.471;0.481)	(0.832;0.168;0.144)
S(P+)	0.831	0.81075	0.91425
S(P-)	0.69	0.53825	0.838
Q	**1,497**	**1,664**	**1,462**

When analyzing the results presented in Table 7, it can be seen that the analyzed method indicates that the most preferred alternative according to the experts is alternative 2, referring to the prioritization of population groups. The second most preferred alternative is the health care capacity, while the last place among the aspects analyzed is the use of guides and protocols. In this context, it can be concluded that the experts consider that prioritization of population groups, given the need to take action during pandemics or epidemics, should be a priority during the triage carried out by nursing staff.

Conclusions

Assessment and triage are two vital components of nursing care that allow for a rapid and effective response to emergencies and epidemics. Nurses play an essential role in collecting clinical information, prioritizing patients, and ensuring limited resources are allocated efficiently, which in turn helps save lives and reduce the spread of disease.

Research on the application of neutrosophic set theory in multi-criteria decision-making shows its usefulness in complex situations, such as triage selection in nursing during pandemics or epidemics.

The application of the COPRAS method together with the neutrosophic set theory allows for addressing uncertainty and subjectivity in triage decision-making in nursing, considering multiple criteria and alternatives. It was proven that the response to pandemics and epidemics requires effective planning and coordination, the active participation of health professionals, and the application of innovative approaches, such as neutrosophic set theory, for decision-making in highly complex situations.

Patient assessment and triage play a crucial role in public health care during these crises, and its effectiveness can make a difference in containing the disease and protecting society as a whole.

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