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Neutrosophic Perspectives in Healthcare Decision-Making: Navigating Complexity with Ethics, Information, and Collaboration

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Abstract. Decision-making in healthcare is a multifaceted process that involves multiple actors and factors. It is a crucial process that directly influences the quality of care provided to patients. To make appropriate clinical decisions, it is essential to have accurate clinical information, including medical histories and test results, in addition to considering ethical principles. Interdisciplinary consultation, proper documentation, and institutional policies play a vital role in ethical and clinical decision-making, especially in complex situations. Research utilizes methods such as COPRAS and neutrosophic correlation coefficients to guide decision-making in complex situations, but it is emphasized that results may vary depending on the method used and the subjectivity of experts. The results highlight the importance of ethical principles in clinical decision-making, including doing good, avoiding harm, treating all patients fairly, and respecting patient autonomy. The combination of clinical information, ethical principles, and active participation of patients and their families is essential for making informed and ethical decisions that promote the health and well-being of patients.

Keywords: Neutrosophic correlation coefficients, COPRAS method, medical care, clinical decisions, ethics.

1. Introduction

Decision-making in healthcare is a fundamental process that directly influences the quality of care provided to patients. To make appropriate clinical decisions, healthcare professionals must have complete and accurate clinical information about the patient, including their medical history, test results, and current health status. This information is essential for evaluating treatment options and weighing the possible risks and benefits associated with each decision.

In addition to clinical information, it is fundamental to consider the ethical principles that guide decision-making in patient care. The principles of beneficence (doing good) and non-maleficence (avoiding harm) are essential and should be at the core of any medical choice. Patient autonomy must also be respected by involving them in the decision-making process and respecting their preferences and personal values. Ethical decision-making is based on a delicate balance between these ethical principles, adapted to the clinical situation and the patient's needs.[1]

Interdisciplinary consultation plays a significant role in complex situations, allowing multiple experts to contribute their perspectives and knowledge to make informed decisions. Additionally, institutional policies and ethical committees can provide additional guidance in ethical and clinical decision-making. Proper documentation of decisions is essential to ensure transparency and accountability in healthcare and can be crucial in case of disputes or subsequent evaluations.

Decision-making in healthcare is a continuous and adaptable process, as the patient's circumstances may change over time. Formal ethical review through hospital ethics committees or ethical consultants may be necessary in particularly complex or controversial cases. Ultimately, decision-making in healthcare is a key aspect of medical practice that requires training and ethical education, as well as constant reflection on how to balance clinical imperatives with ethical values and patient autonomy [2].

It is also a complex process that involves patients, their families, healthcare providers, and sometimes healthcare systems. All involved parties need to understand their roles and responsibilities in this process to ensure that decisions are made in an informed and ethical manner.

Patients should be informed about their medical condition, available treatment options, and the risks and benefits of each option. They should have the opportunity to discuss these options with their healthcare providers and make a decision that is consistent with their values and preferences. [3]

Healthcare providers have the responsibility to provide information and guidance to patients. They should have a thorough knowledge of available treatment options and be able to communicate this information clearly and concisely. They should respond to patients' questions honestly and completely. Additionally, they should respect patients' decisions, even if they disagree with them.

Families can play a significant role in healthcare decision-making. They can provide emotional and practical support to patients and help them understand medical information to make informed decisions. However, families need to respect the autonomy of the patient and not make decisions on their behalf unless the patient is unable to do so [4].

Healthcare systems can facilitate the decision-making process by providing information and resources to patients and their families. They can also assist in coordinating care among different healthcare providers [5].

Some factors that can hinder healthcare decision-making include:

- The complexity of medical information.
- Emotional stress from illness or injury.
- Uncertainty about the prognosis.
- Healthcare costs.

To make informed decisions about their healthcare, patients can take the following steps:

- Ask their healthcare provider about their medical condition and available treatment options.
- Inquire about the risks and benefits of each option.
- Discuss their situation with family and friends.
- Research treatment options on their own.
- Take the necessary time to make a decision.

Decision-making in healthcare is an important process that can have a significant impact on the health and well-being of patients. By understanding their rights and responsibilities, patients can make decisions that are in the best interest of their health.

Taking into account the previous reasoning, this research will carry out an evaluation of clinical and ethical decisions in patient care. For its development, the expansion of the COPRAS-SVNS method approach is carried out, in addition to using neutrosophic correlation coefficients and carrying out a comparison between these coefficients.

2 Preliminaries

Definition 1. Consider X as a collection of points or objects, with a representative element denoted as x. A neutrosophic set A within X is defined by three key functions: the truth-membership function $T_A(x)$, the indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. These functions, $T_A(x)$, $I_A(x)$ and $F_A(x)$ represent real standard or nonstandard subsets within the interval $]0^-, 1^+[$, meaning that, $T_A\ (x): X \rightarrow]0^-, 1^+[$, $I_A\ (x): X \rightarrow]0^-, 1^+[$ and $F_A\ (x): X \rightarrow]0^-, 1^+[$. There are no constraints on the sum of $T_A\ (x)\ I_A\ (x)$ and $F_A\ (x)$, so $0^- \leq supT_A(x) + supI_A(x) + supF_A(x) \leq 3^+$. Applying neutrosophic sets to practical problems can be challenging. Therefore, the concept of a single-valued neutrosophic set (SVNS) was introduced to facilitate its use in real-world scientific and engineering applications. Below, we present the definition of an SVNS [6].

Definition 2. Let X be a space of points or objects with each point denoted as 'x.' An SVNS A within X is defined by three membership functions: the truth-membership function $T_A(x)$, the indeterminacy-membership function $I_A(x)$, and the falsity-membership function $F_A(x)$, each of which ranges from 0 to 1. Consequently, an SVNS A can be described as $A = \{x, T_A(x), I_A(x), F_A(x)\ |x\ \in\ X\}$, then, the sum of $T_A\ (x)$, $I_A\ (x)$ and $F_A\ (x)$, satisfies the condition $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

Definition 3. The complement of an SVNS A is denoted by Ac and is defined as $Ac = \{x, F_A(x), 1 - I_A(x), T_A(x)\ |x\ \in\ X\}$

Definition 4. An SVNS A is contained in the other SVNS $B, A\ \subseteq\ B$ if and only if $T_A(x)\ \leq\ T_B(x), I_A(x)\ \geq\ I_B(x)$, and $F_A(x)\ \geq\ F_B(x)$ for every x in X.

Definition 5. Two SVNSs A and B are equal, written as A = B, if and only if $A\ \subseteq\ B$ and $B\ \subseteq\ A$

Definition 6. For any two SVNSs A and B in the universe of discourse $X\ =\ \{x_1, x_2, ..., x_n\}$, the correlation coefficient between two SVNSs A and B is defined as follows: [7]

$$M(A, B) = \frac{1}{3n}\sum_{i=1}^{n}[\phi_i(1 - \Delta T_i) + \varphi_i(1 - \Delta I_i) + \psi_i(1 - \Delta F_i)] \quad (1)$$

Where

$$\phi_i = \frac{3 - \Delta T_i - \Delta T_{max}}{3 - \Delta T_{min} - \Delta T_{max}},$$

$$\varphi_i = \frac{3 - \Delta I_i - \Delta I_{max}}{3 - \Delta I_{min} - \Delta I_{max}},$$

$$\psi_i = \frac{3 - \Delta F_i - \Delta F_{max}}{3 - \Delta F_{min} - \Delta F_{max}},$$

$$\Delta T_i = |T_A(x_i) - T_B(x_i)|,$$

$$\Delta I_i = |I_A(x_i) - I_B(x_i)|,$$

$$\Delta T_i = |T_A(x_i) - T_B(x_i)|,$$

$$\Delta T_{min} = min_i|T_A(x_i) - T_B(x_i)|,$$

$$\Delta I_{min} = min_i|I_A(x_i) - I_B(x_i)|,$$

$$\Delta F_{min} = min_i|F_A(x_i) - F_B(x_i)|,$$

$$\Delta T_{max} = max_i|T_A(x_i) - T_B(x_i)|,$$

$$\Delta I_{max} = max_i|I_A(x_i) - I_B(x_i)|,$$

$$\Delta F_{max} = max_i|F_A(x_i) - F_B(x_i)|,$$

for any $x_i \in X$ and i = 1, 2, . . ., n

Nonetheless, significant variances are taken into account when considering the elements within the universe. As a result, it is essential to factor in the weight of element x_i (where i = 1, 2, ..., n). In the subsequent discussion, we present a correlation coefficient that is weighted for SVNSs.

Definition 7. Let w_i be the weight for each element x_i $(i = 1,2,\ldots,n), w_i \in [0,1]$, and $\sum_{i=1}^{n} w_i = 1$, then we have the following weighted correlation coefficient between the SVNSs A and B:

$$M_w(A,B) = \frac{1}{3}\sum_{i=1}^{n} w_i[\phi_i(1-\Delta T_i) + \varphi_i(1-\Delta I_i) + \psi_i(1-\Delta F_i)] \quad (2)$$

Definition 8. Let $A = (T_A, I_A, F_A)$ and $B = (T_B, I_B, F_B)$ be two SVN numbers, then the sum between A and B is defined as follows:

$$A + B = (T_A + T_B - T_A t_B, I_A I_B, F_A F_B) \quad (3)$$

Definition 9. Let $A = (T_A, I_A, F_A)$ and $B = (T_B, I_B, F_B)$ be two SVN numbers, then multiplication of A by B is defined as follows:

$$A * B = (T_A T_B, I_A + I_B - I_A I_B, F_A + F_B - F_A F_B) \quad (4)$$

Definition 10. Let $A = (T_A, I_A, F_A)$ be a SVN number and $\lambda \in \mathbb{R}$ an arbitrary positive real number, then:

$$\lambda A = \left(1 - (1 - T_A)^{\lambda}, I_A{}^{\lambda}, F_A{}^{\lambda}\right), \lambda > 0 \quad (5)$$

Definition 11. If A= $\{A_1, A_2, \ldots, A_n\}$, and B= $\{B_1, B_2, \ldots, B_n\}$ (i= 1,2,…,m) are two single-valued neutrosophic sets, the measure of separation between A and B using the normalized Euclidean distance can be articulated in the following manner:

$$q_n(A,B) = \sqrt{\frac{1}{3n}\sum_{j=1}^{n}\left(\left(T_A(x_i) - T_B(x_i)\right)\right)^2 + \left(\left(I_A(x_i) - I_B(x_i)\right)\right)^2 + \left(\left(F_A(x_i) - F_B(x_i)\right)\right)^2}$$

$(i = 1,2,\ldots,n)$ (6)

Definition 12. Let $A = (T_A, I_A, F_A)$ be a single-valued neutrosophic number, a score function is mapped $\tilde{N}_A$ into the single crisp output $S(\tilde{N}_A)$ as follows

$$S(\tilde{N}_A) = \frac{3 + T_A - 2I_A - F_A}{4} \quad (7)$$

where $S(\tilde{N}_A) \in [0,1]$. The score function has been adapted to yield results within the same range as we work with single-valued neutrosophic numbers.

2.1 Decision-making method using the correlation coefficient of SVNSs

In the multiple-attribute decision-making problem with single-valued neutrosophic information, the characteristic of an alternative A_i $(i = 1,2,\ldots,m)$ on an attribute C_j $(j = 1,2,\ldots,n)$ is represented by the following SVNS [7]:

$$A_i = \{C_j, T_{Ai}(C_j), I_{Ai}(C_j), F_{Ai}(C_j) | Cj \in C, j = 1,2,\ldots,n\}$$

Where $T_{Ai}(C_j)$, $I_{Ai}(C_j)$, $F_{Ai}(C_j)) \in [0,1]$ and $0 \leq T_{Ai}(C_j)$, $I_{Ai}(C_j)$, $F_{Ai}(C_j) \leq 3$ for $Cj \in C, j = 1,2,\ldots,n, and\ i = 1,2,\ldots,m$.

For the sake of simplicity, the values associated with the three functions $T_{Ai}(C_j)$, $I_{Ai}(C_j)$, $F_{Ai}(C_j)$ are represented by a single-valued neutrosophic value (SVNV) denoted as $d_{ij} = < t_{ij}, i_{ij}, f_{ij} >$ $(i = 1,2,\ldots,m;\ j = 1,2,\ldots,n)$. Typically, these SVNVs are determined through the evaluation of an alternative A_i in relation to a criterion C_j by an expert or decision-maker. As a result, we can construct a single-valued neutrosophic decision matrix $D = (d_{ij})_{mxn}$.

In the context of solving problems involving multiple attributes for decision-making, the notion of an ideal point has been employed to assist in determining the optimal choice within the set of decisions. While it's important to note that there is no actual ideal alternative in the real world, this concept serves as a valuable theoretical framework for assessing available alternatives [8-14-16-17].

In the decision-making method, an ideal SVNV can be defined by $d_j^* =< t_j^*, i_j^*, f_j^* >=< 1,0,0 > (j = 1,2,\ldots,n)$ in the ideal alternative A^*. Hence, by applying Equation (2) the weighted correlation coefficient between an alternative A_i $(i = 1,2,\ldots,m)$ and the ideal alternative A^* is given by [9-18]:

$$M_w(A_i, A^*) = \frac{1}{3}\sum_{j=1}^{n} w_j\left[\phi_{ij}\left(1-\Delta t_{ij}\right)+\varphi_{ij}\left(1-\Delta i_{ij}\right)+\psi_{ij}\left(1-\Delta f_{ij}\right)\right] \tag{8}$$

Where

$$\phi_{ij} = \frac{3-\Delta t_{ij}-\Delta t_{i\,max}}{3-\Delta t_{i\,min}-\Delta t_{i\,max}},$$

$$\varphi_i = \frac{3-\Delta i_{ij}-\Delta i_{i\,max}}{3-\Delta i_{i\,min}-\Delta i_{i\,max}},$$

$$\psi_i = \frac{3-\Delta f_{ij}-\Delta f_{i\,max}}{3-\Delta f_{i\,min}-\Delta f_{i\,max}},$$

$$\Delta t_{ij} = \left|t_{ij}-t_j^*)\right|,$$

$$\Delta i_{ij} = \left|i_{ij}-i_j^*)\right|,$$

$$\Delta f_{ij} = \left|f_{ij}-f_j^*)\right|,$$

$$\Delta t_{i\,min} = min_j\left|t_{ij}-t_j^*\right|,$$

$$\Delta i_{i\,min} = min_j\left|i_{ij}-i_j^*\right|,$$

$$\Delta f_{i\,min} = min_j\left|f_{ij}-f_j^*\right|,$$

$$\Delta t_{i\,max} = max_j\left|t_{ij}-t_j^*\right|,$$

$$\Delta i_{i\,max} = max_j\left|i_{ij}-i_j^*\right|,$$

$$\Delta f_{i\,max} = max_j\left|f_{ij}-f_j^*\right|,$$

for $i = 1,2,\ldots,m$ and $j = 1,2,\ldots,n$. By the correlation coefficient $M_w\ (A_i, A^*)$ $(i = 1,2,\ldots,m)$, the ranking order of all alternatives and the best one(s) can be obtained.

2.2 COPRAS-SVNS

The notion of a linguistic variable proves to be highly advantageous when addressing decision-making challenges with intricate content. A linguistic variable's value is articulated as a member of its term collection. These linguistic values can be depicted using single-valued neutrosophic numbers [10-15].

Within the COPRAS-SVNS approach, there are k-decision makers, m-options, and n-criteria. The k-decision makers assess the significance of the m-options under the n-criteria and establish a ranking for the n-criteria in relation to linguistic statements transformed into single-valued neutrosophic numbers. The significance weights, determined by the single-valued neutrosophic values of the linguistic terms, are presented in Table 1.

Table 1: Linguistic variable and SVNSs. Source: [11]

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 the COPRAS-SVNS approach can be described by the following steps [12], [13]:

- 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 sharing 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 we denote 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

$$X^k = \begin{bmatrix} x^k{}_{11} & x^k{}_{12} \cdots & x^k{}_{1n} \\ x^k{}_{22} & x^k{}_{22} \cdots & x^k{}_{2n} \\ \vdots & \vdots & \vdots \\ x^k{}_{m1} & x^k{}_{m2} \cdots & x^k{}_{mn} \end{bmatrix} \quad (9)$$

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

$$\mathrm{w}_j = \lambda_1 \mathrm{w}_j^{(1)} \cup \lambda_2 \mathrm{w}_j^{(2)} \cup \dots \cup \lambda_k \mathrm{w}_j^{(k)} = \left(1 - \prod_{k=1}^{K} \left(1 - T_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(I_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(F_j{}^{(w_k)}\right)^{\lambda_k}\right) \quad (10)$$

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

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

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

$$\tilde{x}_{ij} = \lambda_1 \mathrm{x}_{ij}^{(1)} \cup \lambda_2 \mathrm{x}_{ij}^{(2)} \cup \dots \cup \lambda_k \mathrm{x}_{ij}^{(k)} = \left(1 - \prod_{k=1}^{K} \left(1 - T_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(I_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(F_j{}^{(x_k)}\right)^{\lambda_k}\right) \quad (12)$$

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

$$d_{ij} = T_{ij}^{\tilde{x}} T_j^{w}, I_{ij}^{\tilde{x}} + I_j^{w} - I_{ij}^{\tilde{x}} I_j^{w}, F_{ij}^{\tilde{x}} + F_j^{w} - F_{ij}^{\tilde{x}} F_j^{w} \quad (13)$$

- Step 6. Calculate the sum 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

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \quad (14)$$

- Step 7. Calculate the sum 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

$$P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (15)$$

- Step 8. Determine the minimal value of the P_{-i}.
- Step 9. Determine the score value of each alternative Q_i. In the beginning, the score values are calculated from the aggregated values for benefit and cost $S(P_{+i})$ and $S(P_{-i})$ by using equation (7). The score values of the alternatives can be expressed as

$$Q_i = S(P_{+i}) + \frac{S(P_{-min}) \sum_{i=1}^{L_{min}} S(P_{-i})}{S(P_{-min}) \sum_{i=1}^{L_{min}} \frac{S(P_{-min})}{S(P_{-i})}} \quad (16)$$

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

$$K = max_i Q_i; i = 1,2, \dots, m \quad (17)$$

- 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 Methodology

To carry out this research, the working group selected, through document review and brainstorming, the set of components that would be analyzed. In this context, eight elements were identified that, according to expert opinion, are fundamental for proper healthcare management regarding clinical and ethical decisions. These elements were subjected to evaluation using three decision criteria and tested using the proposed initial methods.

To assess the elements to be evaluated in relation to the established criteria, the five experts forming part of the working group were asked to complete a brief form that included the most accurate possible assessment of the issues in question. Additionally, they were asked to assign an importance level to each of the evaluated criteria. In this process, the assessments were supposed to indicate to what extent the expert considered the alternative Ai to be beneficial (Tx), harmful (Fx), or if they were not entirely sure (Ix) regarding criterion Cj, using Table 1 as a guide. The experts involved in the study reached a consensus on the level of importance assigned.

The evaluation and subsequent comparison of the results obtained represent an effective way to validate the selection or efficient screening process of the elements that experts consider of particular importance.

4 Results and Discussion

For the analysis of the alternatives, three selection criteria were considered, focusing on the quality of medical care. These were C1- Effectiveness of the treatment, C2- Benefit for the patient, and C3- Quality of life of the patient.

Based on the evaluations conducted by specialists and following the COPRAS-SVNS method approach, necessary modifications were made to obtain all the elements required to facilitate the creation of the decision-making matrix. Subsequently, using equation (12), the weighted decision matrix for this analysis was calculated. Table 2 succinctly presents the results obtained in this context.

Table 2: Weighted decision matrix. Source: own elaboration.

Alternatives	Treatment effectiveness	Benefit for the patient	Patient quality of life
Complete clinical information	(0.531;0.469;0.433)	(0.497;0.503;0.466)	(0.277;0.802;0.835)
Risk and benefit assessment	(0.531;0.469;0.433)	(0.4;0.6;0.591)	(0.303;0.756;0.775)
Patient autonomy	(0.753;0.247;0.232)	(0.618;0.382;0.361)	(0.531;0.469;0.413)
Ethical principles	(0.573;0.427;0.383)	(0.581;0.419;0.387)	(0.542;0.458;0.424)
Interdisciplinary consultation	(0.586;0.414;0.394)	(0.495;0.514;0.508)	(0.542;0.458;0.424)
Ethical framework and institutional policies	(0.531;0.469;0.433)	(0.481;0.528;0.494)	(0.428;0.582;0.552)
Adequate documentation	(0.61;0.39;0.34)	(0.537;0.463;0.418)	(0.476;0.534;0.489)
Ethical review	(0.573;0.427;0.383)	(0.497;0.503;0.466)	(0.428;0.582;0.552)

After collecting this data, the next step was to calculate the values suggested by the method to decide between the available options. It is important to note that Criteria 2 and 3 were considered as factors that contribute benefits, so maximizing their values is sought. On the other hand, Criterion 1 was considered a cost factor, so reducing its value is considered more beneficial. The results obtained after analyzing and calculating the data are presented in Table 3.

Table 3: Values of Pi, S(P), and Q score value for each alternative. Source: own elaboration.

Alternatives	Pi+	Pi-	S(P+)	S(P-)	Q
Complete clinical information	(0.636; 0.403; 0.389)	(0.531; 0.469; 0.433)	0.61	0.5400	1.26
Risk and benefit assessment	(0.582; 0.454; 0.458)	(0.531; 0.469; 0.433)	0.55	0.5400	1.2
Patient autonomy	(0.821; 0.179; 0.149)	(0.753; 0.247; 0.232)	0.83	0.7570	1.29
Ethical principles	(0.808; 0.192; 0.164)	(0.573; 0.427; 0.383)	0.82	0.5840	1.41
Interdisciplinary consultation	(0.769; 0.235; 0.215)	(0.586; 0.414; 0.394)	0.77	0.5910	1.36
Ethical framework and institutional policies	(0.703; 0.307; 0.273)	(0.531; 0.469; 0.433)	0.7	0.5400	1.35
Adequate documentation	(0.757; 0.247; 0.204)	(0.61; 0.39; 0.34)	0.76	0.6230	1.33
Ethical review	(0.712; 0.293; 0.257)	(0.573; 0.427; 0.383)	0.72	0.5840	1.32

In this case, it can be observed that Option 4 received the highest rating, making it the primary choice of the experts. In this situation, multiple preferred alternatives were evaluated for application in healthcare, rather than selecting only the highest-scoring one. Table 3 presents the top three alternatives that received the highest ratings in the decision index, which were Alternatives 4, 5, and 6, according to expert opinion.

On the other hand, when using the approach based on neutrosophic correlation indices for evaluation, the values of the operators φ, μ, and ψ were calculated to determine the correlation coefficients, following the logic of the method. Obtaining these elements allowed for the calculation and determination of the correlation coefficients, as detailed in Table 4.

Table 4: Values of φ, μ, and ψ and Mw for each selection alternative. Source: own elaboration.

	φij			μij			ψij			
	C1	C2	C3	C1	C2	C3	C1	C2	C3	Mw
Complete clinical information	0.84	1	0.89	0.87	1	0.96	0.96	1	1	0.599
Risk and benefit assessment	0.94	1	0.89	0.91	1	1	1	0.96	0.9	0.558
Patient autonomy	0.9	0.95	1	1	0.96	1	1	0.96	1	0.697
Ethical principles	1	0.9	0.86	1	1	0.96	0.96	1	1	0.704
Interdisciplinary consultation	1	0.95	0.95	0.96	1	0.96	1	1	1	0.612
Ethical framework and institutional policies	1	0.95	0.9	1	0.96	1	1	0.96	1	0.697
Adequate documentation	0.95	1	0.95	1	1	0.96	1	0.96	1	0.697
Ethical review	0.84	1	0.84	1	0.96	0.92	0.96	1	1	0.633

In this situation, the most relevant correlation coefficient was found in relation to the fourth option. However, Options 3, 6, and 7 demonstrated a very similar level of evaluation, making them equally viable for consideration by the evaluators. When comparing the results of both methods, similarities were observed in the outcomes in both cases. Both the COPRAS method and the use of correlation coefficients showed a clear preference for Option 4 in relation to ethical principles. Additionally, in both methods, Option 5 was chosen as one of the most preferred by the experts.

However, while in the COPRAS method, Options 3 and 7 did not have significant relevance, their inclusion in the second method allows considering them as favorites for implementation. On the other hand, Options 1 and 2 did not turn out to be significant in either of the two methods, suggesting that they might have a lower priority.

The results obtained allow for establishing whether there is coherence between the methods used in relation to the chosen decision options. In essence, it was found that the most important option for the experts was the same in both methods, as well as the less desirable or lower-scoring options. Other options experienced some variation in terms of their importance or score depending on the method. However, these differences could be due to the apparent disparities in the calculation methods used or even external factors such as the subjectivity of the experts.

It is suggested that, for more accurate results, each method could be performed separately, as done in this study. Then, only select the common and relevant elements for both methods as of interest.

Certainly, in the interest of this research, it becomes evident the correctness of assertions about the importance of ethical principles. These are fundamental in clinical decision-making, as they include beneficence (doing good), non-maleficence (avoiding harm), justice (treating all patients fairly), and respecting the patient's autonomy. Therefore, it is evident that ethical principles are comprehensive enough to provide other guarantees for satisfactory patient care.

Conclusions

Decision-making in healthcare is a critical process that directly influences the quality of patient care. The importance of having complete and accurate clinical information has been emphasized, along with considering fundamental ethical principles such as beneficence, non-maleficence, and respect for patient autonomy in the decision-making process. Interdisciplinary consultation, proper documentation, and institutional policies play an essential role in ethical and clinical decision-making. Formal ethical review through ethical committees may be necessary in complex or controversial cases.

Active participation from patients, their families, and healthcare providers is crucial in the decision-making process. Patients should be informed about their medical condition and treatment options, with the opportunity to express their preferences and personal values. The use of methods such as COPRAS and neutrosophic correlation coefficients has been shown to provide valuable guidance in complex situations. However, it is essential to consider that results may vary depending on the method used and the subjectivity of the experts.

Research results suggest that the most important option for experts was the consideration of ethical principles in clinical decision-making. This underscores the relevance of these principles in healthcare, encompassing aspects such as doing good, avoiding harm, treating all patients fairly, and respecting patient autonomy. Decision-making in healthcare is a multifaceted process involving multiple stakeholders and considering a variety of factors. The combination of clinical information, ethical principles, and active participation of patients and their families is essential for making informed and ethical decisions that promote the health and well-being of patients.

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