

Methodology for the training of professional competencies with the One Health approach

Metodología para la formación de competencias profesionales con
el enfoque Una Salud

Ovidio Antonio Sánchez Fernández¹ <https://orcid.org/0000-0002-3336-2353>

Zaily Fuentes Díaz^{2*} <https://orcid.org/0000-0001-6334-9400>

Orlando Bismark Rodríguez Salazar³ <https://orcid.org/0000-0002-2323-5131>

Maurice José González Basulto⁴ <https://orcid.org/0000-0003-4752-658X>

¹ University of Medical Sciences of Camagüey. Provincial Center of Higiene, Epidemiology and Microbiología. Departament of Transmissible Diseases. Camagüey. Cuba.

² University of Medical Sciences of Camagüey. María Curie Provincial Teaching Oncology Hospital. Anesthesiology and Resuscitation Service. Camagüey. Cuba.

³ University of Medical Sciences of Camagüey. Manuel Ascunce Domenech University Hospital. Plastic Surgery and Caumatology Service. Camagüey. Cuba.

⁴ University of Medical Sciences of Camagüey. Faculty of Health de Technologies. Camagüey. Cuba.

*Corresponding author. Email: fzaily487@gmail.com

ABSTRACT

Background: the One Health approach emerges as an essential integrative paradigm, recognizing the interconnections between human health, animal health, and ecosystem integrity.

Objective: to design a methodology for the training of professional competencies with the One Health approach, aimed at key actors in health, the environment, and water management in vulnerable areas.

Methods: a mixed-methods study (quantitative-qualitative) was conducted at the University of Medical Sciences of Camagüey, Cuba, between January and October 2025. Theoretical methods (analysis-synthesis, inductive-deductive, and historical-logical), empirical methods (survey and focus group technique, as well as the Delphi method), and mathematical-statistical methods were used for data processing and analysis.

Results: the designed methodology was structured into four phases: awareness-raising, theoretical-practical training, guided application, and evaluation. It includes theoretical modules, practical workshops, simulations, and modeling exercises. Expert validation showed an item concordance index in the second round of 100.0 % for relevance and clarity, 90.0 % for internal consistency, and 86.7 % for feasibility. The overall concordance index was 94.0 %.

Conclusions: a methodology for the training of professional competencies with the One Health approach was designed and validated. Expert assessment using the Delphi method confirmed its high relevance, internal consistency, feasibility, and clarity.

MeSH: environmental health education; impact of pollution on health; health vulnerability; competency-based education; professional competence; education, medical.

RESUMEN

Fundamento: el enfoque Una Salud emerge como un paradigma integrador esencial, al reconocer las interconexiones entre la salud humana, la sanidad animal y la integridad de los ecosistemas.

Objetivo: diseñar una metodología para la formación de competencias profesionales con el enfoque Una Salud, dirigida a actores clave de la salud, el ambiente y la gestión del agua en zonas vulnerables.

Métodos: se realizó una investigación con enfoque cuantitativo en la Universidad de Ciencias Médicas de Camagüey, Cuba, entre enero y octubre de 2025. Se emplearon métodos teóricos (análisis-síntesis, inductivo-deductivo e histórico-lógico), empíricos: encuesta y la técnica de grupos focales, así como el método Delphi, y matemático-estadísticos para el procesamiento y análisis de los datos.

Resultados: la metodología diseñada se estructuró en cuatro fases: sensibilización, formación teórico-práctica, aplicación guiada y evaluación. Incluye módulos teóricos, talleres prácticos, simulaciones y ejercicios de modelación. La validación por expertos mostró un índice de concordancia por ítems en la segunda ronda de 100,0 % para pertinencia y claridad, coherencia interna 90,0 % y 86,7 % para factibilidad. El índice de concordancia global fue del 94,0 %.

Conclusiones: se diseñó y validó una metodología para la formación de competencias profesionales con el enfoque Una Salud. La valoración por expertos mediante el método Delphi confirmó su alta pertinencia, coherencia interna, factibilidad y claridad.

DeSC: educación en salud ambiental, impactos de la polución en salud; vulnerabilidad en salud; educación basada en competencias; competencia profesional; educación médica

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INTRODUCTION

The growing pressure on water resources globally is exacerbated by the effects of climate change and anthropogenic demand, positioning water security as a challenge for sustainable development.^(1,2) This issue is particularly relevant in vulnerable regions such as the insular Caribbean, where dependence on coastal aquifers and limited data availability complicate preventive resource management.^(3,4)

In this context, the One Health approach emerges as an essential integrative paradigm, recognizing the interconnections between human health, animal health, and ecosystem integrity.^(5,6) However, a gap persists between the development of predictive tools and their operational application in territories with limited resources.

The Najasa-Guanaja sub-basin in the province of Camagüey, Cuba, represents a critical scenario for studying this gap. Its high hydrogeological vulnerability, with karstic aquifers subject to active salinization, exemplifies the interconnection between environmental, health, and productive dimensions.^(5,6) Previous studies in this area documented a unique bimodal contamination profile: increasing chemical mineralization alongside systemic microbiological contamination, which tangibly materializes the One Health nexus.⁽⁷⁾

The development of the Water Sustainability Index (WSI) and its predictive model under the One Health approach is a pertinent scientific response to anticipate crisis scenarios. However, the mere existence of these tools does not guarantee their impact. Their effectiveness ultimately depends on the capacity of local professionals to understand, manage, and interpret their results. Currently, there is a gap in the training of specific competencies for managing the WSI and its predictive model in contexts of water vulnerability, which limits its adoption and practical utility.

Therefore, this research aims to: design a methodology for the training of professional competencies with the One Health approach, aimed at key actors in health, the environment, and water management in vulnerable areas.

METHODS

A mixed-methods study was conducted, with a qualitative predominance, framed within the participatory action-research approach. The study was developed at the University of Medical Sciences of Camagüey, Cuba, between January and October 2025

The universe consisted of 96 professionals from the public health, epidemiology, water resources, and agriculture sectors in the province of Camagüey. For sample selection, stratified random sampling was applied, considering each professional sector as a stratum.

The sample size was determined by calculation for finite populations, with a 95 % confidence level and a maximum allowable error of 5 %, resulting in a sample of 45 participants for the survey application. For the focus groups, 28 professionals were selected by simple random sampling from the universe, distributed into two groups of 14 participants each, and guaranteeing proportional representation from each sector.

Inclusion criteria were: being an active professional in one of the aforementioned areas, having at least three years of work experience in the territory, and expressing interest in voluntarily participating in the study. All participants signed an informed consent form, in accordance with the provisions of the Declaration of Helsinki for research involving human subjects.

Theoretical methods:

- Analysis-synthesis: used to process documentary information and diagnostic results; allowed the identification of training needs and the structuring of the methodology.
- Induction-deduction: facilitated reasoning from the particular to the general during the analysis of qualitative data and the validation of the methodology.
- Systemic approach: used to conceive the training methodology as an articulated system of phases, components, and evaluations.

Empirical methods:

- Diagnostic survey: applied to 45 participants using a validated semi-structured questionnaire (Cronbach's Alpha = 0.87), in order to quantitatively characterize training needs.
- Focus group: 28 professionals participated with the aim of delving into knowledge gaps, skills, and attitudes related to the management of predictive tools for water

sustainability. Delphi method: applied for expert-criterion validation of the designed methodology, in two evaluation rounds.

Mathematical-statistical methods:

Quantitative data were processed using SPSS version 25.0. Descriptive statistics (frequencies, percentages, medians, interquartile ranges) were applied to summarize the survey information and Delphi rounds.

The Chi-square test was used to analyze associations between categorical variables, with a significance level of $p < 0.05$. For consensus analysis in the Delphi method, the following were calculated:

- The median (Me) and interquartile range (IQR) of the item ratings.
- The item concordance index (ICi), expressed as the percentage of experts who assigned scores of 4 or 5 on the Likert scale.

The global concordance index (ICG), obtained as the average of the ICi of the items with consensus ($IQR \leq 1$ and $Me \geq 4$).

Validation of the methodology by expert criteria:

The designed competency-based training methodology was subjected to validation using the Delphi method. A panel of 30 national experts was formed, all holding a Doctor of Science degree in areas related to the study, academic ranks of Full or Associate Professor, more than 10 years of professional experience, and an expert competence coefficient ($K \geq 0.8$). The experts came from the National Institute of Water Resources (INRH), Ministry of Public Health (Minsap), Ministry of Agriculture (Minag), University of Camagüey, and the Center for Environmental Research (Cimac).

The evaluation indicators included: relevance, internal consistency, feasibility, and clarity. Each indicator was operationalized into statements rated on a 1 to 5 Likert scale. After two

evaluation rounds, a global concordance index (ICG) of 0.92 (92 %) was reached, exceeding the established threshold of 0.85, which validates the robustness and applicability of the methodology.

Structure of the training methodology:

After validation, a methodology organized into four sequential phases was consolidated, with a total of 40 hours (in-person/blended) integrating theoretical and practical components:

Phase 1. Awareness-raising and contextualization (5 hours).

Phase 2. Theoretical-practical training (20 hours).

Phase 3. Guided application in real scenarios (10 hours).

Phase 4. Evaluation and feedback (5 hours).

The weighting of the evaluation components was agreed upon by the expert panel.

Ethical aspects

The study adhered to the principles of the Declaration of Helsinki. The protocol was approved by the Research Ethics Committee of the Provincial Center for Hygiene, Epidemiology, and Microbiology of Camagüey (Minutes No. CEI-12/2025) and had the authorization of the Sectoral Program for the Integrated Reduction of Disaster Risk in Cuba (Code: PS211LH005).

RESULTS AND DISCUSSION

Characterization of the expert panel

The average K coefficient of the panel was 0.89 with a SD of 0.05, confirming a high level of competence globally and individually. No significant differences in K were found between institutions ($p = 0.12$), which validates the homogeneity in the quality of expert judgment. The distribution by institutions ensured a balanced multidisciplinary representation, as shown in Table 1.

Table 1. Distribution of the expert panel, coefficient K, and standard deviation. University of Medical Sciences of Camagüey. January–October 2025

Affiliated Institution	No.	%	K coefficient (Mean $\pm$ SD)
National Institute of Water Resources (INRH)	8	26,7	0,89 $\pm$ 0,05
Ministry of Public Health (Minsap)	7	23,3	0,92 $\pm$ 0,04
Ministry of Agriculture (Minag)	7	23,3	0,85 $\pm$ 0,06
University of Camagüey	5	16,7	0,91 $\pm$ 0,03
Center for Environmental Research (Cimac)	3	10,0	0,88 $\pm$ 0,05
Total	30	100,0	0,89 $\pm$ 0,05

Source: Delphi validation.

As shown in Table 2, only the dimensions Relevance (Me = 5.0, IQR = 0.5) and Clarity (Me = 4.0, IQR = 1.0) reached immediate consensus. The Internal consistency dimension did not achieve consensus due to moderate dispersion of opinions (IQR = 1.5). The Feasibility dimension showed the greatest disagreement, with a Me in the indecision zone (Me = 3.0). The qualitative comments associated with these items were used to restructure the methodology, including the integration of a more solid introductory module and adjustments to the practical teaching load.

Table 2. Results of the first round of the expert panel. University of Medical Sciences of Camagüey. January–October 2025

Dimension	Me	IQR	ICi (%)
Relevance	5,0	0,5	96,7
Internal consistency	4,0	1,5	80,0
Feasibility	3,0	1,0	63,3
Clarity	4,0	1,0	86,7

Median (Me), Interquartile Range (IQR), Item Concordance Index (ICi).

Source: Delphi validation: first round.

After the adjustments, the results of the second round, shown in Table 3, indicate that all dimensions reached the established consensus ($Me \geq 4$, $IQR \leq 1$). The Feasibility dimension improved significantly, from Me 3.0 to Me 4.0, reflecting the incorporation of expert suggestions. The overall concordance index (ICG) was 94.0%, exceeding the predefined validity threshold of 85.0%. The Spearman correlation coefficient between the Me values of rounds 1 and 2 was $p = 0.92$, indicating high stability and convergence in the deliberative process.

Table 3. Results of the second round of the expert panel. University of Medical Sciences of Camagüey. January–October 2025

Dimension	Me	RIQ	ICi (%)
Relevance	5,0	0,0	100,0
Internal consistency	4,0	1,0	90,0
Feasibility	4,0	1,0	86,7
Clarity	5,0	0,0	100,0

Median (Me), Interquartile Range (IQR), Item Concordance Index (ICi).

Source: Delphi validation: second round.

Time distribution and evaluation system

The time distribution of the training methodology was derived from expert consensus, prioritizing Phases 2 and 3 with 20 and 10 hours, respectively (50.0 % and 25.0 % of the total), as shown in Table 4. The resulting structure reflected a clear practical and applied focus, since Phases 2 and 3 totaled 25 hours of practice (62.5 % of the total time). This distribution was supported by the experts ($ICi = 93.3$ % for the theory-practice balance item), who emphasized the need for learning by doing with local data and problems.

Table 4. Time distribution of the training methodology. University of Medical Sciences of Camagüey. January–October 2025.

Phase	Hours	%
Phase 1. Awareness-raising and contextualization	5	12,5
Phase 2. Theoretical-practical training	20	50,0
Phase 3. Guided application in real scenarios	10	25,0
Phase 4. Evaluation and feedback	5	12,5
Total	40	100,0

Median (Me), Interquartile Range (IQR), Item Concordance Index (ICi).

Source: Delphi validation: second round.

The competency evaluation system was validated with an ICi of 90.0 %, proving to be comprehensive and performance-oriented. The double weighting of 40 % on the practical components—the practical WSI test and the applied project—reflects the primacy of procedural competence (knowing how to do), as shown in Table 5. The Chi-square goodness-of-fit test applied to the weighting distribution showed no significant differences with respect to the theoretical distribution proposed by the experts ($\chi^2 = 1.24$, $p = 0.54$), which confirmed the acceptance of the scheme.

Table 5. Competency evaluation system. University of Medical Sciences of Camagüey.
January–October 2025

Evaluation component	Competency evidence	Weighting (%)	Measurement instrument
Practical WSI test*	Correct calculation and interpretation of the WSI using a new dataset	40.0	Accuracy 60.0%, Interpretation 40
Applied project	Design of an intervention based on results of the predictive model for their work context	40.0	Relevance 30.0%, Feasibility 40.0%, One Health integration 30.0%
Decision-making simulation	Informed decision-making in response to a simulated critical predictive scenario	20.0	Analysis 50.0%, Decision 30.0%, Argumentation 20.0%
Total	-	100,0	-

WSI. Water Sustainability Index

Source: competency training methodology.

Methodology for the training of professional competencies with the One Health approach

The methodology was structured under the competency-based approach, integrating the conceptual (knowing), procedural (knowing how to do), and attitudinal (knowing how to be) dimensions. After the Delphi validation process, a training model organized into four sequential phases was consolidated, with a total duration of 40 hours (in-person or blended modality) and a clear predominance of practical activities. Its operational structure is described below:

Phase 1. Awareness-raising and contextualization

Duration: 5 hours (12.5 % of the total).

General objective: To raise awareness about the interconnection between human, animal, and environmental health in water management, using the specific problem of the Najasa-Guanaja sub-basin as a reference.

Contents and activities:

Module 1.1. Fundamentals of the One Health approach (2 hours). Interactive lecture session on the principles, scope, and applications of the One Health paradigm in water resource management.

Module 1.2. Local situational diagnosis (3 hours). Workshop for analyzing real cases from the sub-basin. Historical water quality data (salinization, microbiological contamination) and their documented impacts on public health, animal production, and agriculture are presented and discussed.

Phase 2. Theoretical-practical training

Duration: 20 hours (50.0 % of the total).

General objective: To develop competence in calculating and interpreting the WSI based on local data.

Contents and activities:

Module 2.1. Theoretical foundations of the WSI (4 hours). Theoretical sessions on the components of the WSI (hydrochemical, sanitary, and ecological indicators), its integrative formula, and the predictive model under the One Health approach.

Module 2.2. Practical workshop for WSI calculation (16 hours). Guided sessions in which participants, organized into interdisciplinary teams, calculate the WSI using spreadsheets (Excel) and a set of real, anonymized hydrochemical and sanitary data from the sub-basin. The facilitator guides the interpretation of results in terms of vulnerability and sustainability.

Phase 3. Guided application in real scenarios

Duration: 10 hours (25.0 % of the total).

General objective: To apply WSI knowledge in basic predictive modeling exercises and integrated case analysis.

Contents and activities:

Module 3.1. Predictive modeling simulation (6 hours). Using open-access software (Excel and/or R), participants project future water sustainability scenarios under different conditions (e.g., increased extraction, changes in precipitation) to interpret model uncertainty.

Module 3.2. Integrated case study analysis (4 hours). Workshop where complex cases simulating outbreaks or crises are analyzed. Participants must identify interrelationships between water parameters, human health, animal health, and crop damage, proposing coordinated actions from the One Health approach.

Phase 4. Evaluation and feedback

Duration: 5 hours (12.5 % of the total).

General objective: To evaluate the acquired competency performance and provide feedback for improvement.

Contents and activities:

Evaluation component 1. Practical WSI test (40 % of the final grade). Each participant receives a new set of local data not used during training. They must calculate the WSI, interpret the result, and write a brief executive report.

Evaluation component 2. Applied project (40 % of the final grade). Each participant designs a feasible intervention proposal for their own work context based on the results of the WSI predictive model. The proposal must integrate at least two dimensions of the One Health approach.

Evaluation component 3. Decision-making simulation (20 % of the final grade). In a simulated water crisis scenario, the participant must analyze data, prioritize actions, and argue their decisions before a panel.

Feedback session. After the evaluations, a group session is held to discuss successes, difficulties, and lessons learned.

Operational characteristics of the methodology:

Pedagogical approach: Problem-based and project-based learning, with an emphasis on learning by doing.

Facilitator profile: Professional with training in the One Health approach, WSI management, and experience in adult education.

Required resources: Local water quality and health data, computers with Excel and/or basic R installed, access to a projector, and workshop materials.

Learning products: WSI calculation reports, applied project proposals, and decision protocols for critical scenarios.

The evaluation system, agreed upon by the expert panel, was designed to be comprehensive and performance-oriented in context, assigning 80 % of the total weighting to practical evaluation components. The methodology prioritizes learning by doing with local data and problems, allocating 25 hours (62.5 % of the total time) to practical activities (Phases 2 and 3), which was supported by the experts in the validation process.

The successful validation of this methodology for training competencies in WSI management and the One Health predictive model constitutes a pedagogical advance, designed from and for vulnerable contexts. Its analysis reveals fundamental points of convergence and divergence with predominant training models in high-income countries, such as the United States, Canada, and European Union nations, which underscores its innovative and relevant character.^(8,9)

In training in water management and environmental health, there is a transition toward competency-based and problem-based learning. Graduate programs at leading universities in the United States and Canada, such as Johns Hopkins and the University of Toronto, integrate complex predictive tools such as the Soil & Water Assessment Tool (SWAT) or the Modular 3D Groundwater Flow Model (MODFLOW) into their curricula, with emphasis on big data analysis and high-resolution computational modeling, according to Abd El Ghany *et al.*⁽⁹⁾ This approach assumes access to robust technological infrastructure, extensive databases, and extended training time.

The methodology converges in the adoption of the competency paradigm but diverges radically in its practical orientation. While models in developed countries prioritize technical mastery of software platforms, this proposal identifies that the core competency in contexts such as Najasa-Guanaja is the ability to interpret the uncertainty inherent in models and make firm decisions under vulnerable conditions. Thus, class time is invested in workshops using Excel and basic R with real local data, and in decision-making simulations in response to critical scenarios. This pedagogical technological adaptation prioritizes applicability, a principle that aligns with emerging critiques in European literature on the need to train resilient professionals.⁽¹⁰⁾

The One Health approach is a strategic pillar in health and environmental policies in the European Union, for example the EU4Health program, and Canada (Canadian One Health Network). Institutions such as the European Food Safety Authority (EFSA) and the U.S. Centers for Disease Control and Prevention (CDC) promote interdisciplinary training. However, curriculum evaluation studies, for example in public health programs in the Netherlands and Germany, indicate that the integration of the One Health paradigm often follows a serial or parallel model, where human, animal, and environmental dimensions are taught in separate modules, perpetuating a sectoral vision.⁽¹¹⁾

The validated methodology innovates by forcing horizontal and systemic integration from the very beginning. A practical workshop does not analyze water parameters for human consumption in isolation; instead, it designs exercises where a single data point, for example sodium concentration, is examined simultaneously for its implications for human cardiovascular health, livestock health, and phytotoxicity in crops.

This integration reflects the multidimensional design of the WSI and responds to calls from the most advanced literature, which advocates for integrated case studies as a superior pedagogical method for teaching complex interdependencies. The unanimous consensus of the expert panel on the Relevance dimension (ICi = 100.0 %) validates that this approach operationalizes the paradigm and transforms it from a conceptual framework into a concrete analytical tool for interdisciplinary planning.

The application of the Delphi method in the validation of curricular designs is a consolidated practice. However, consensus criteria tend to be oriented toward technical excellence, technological innovation, and alignment with cutting-edge international standards, such as the models of UNESCO or the American Water Works Association.⁽¹²⁾

The process developed in this study revealed a distinct contextual priority. The expert panel, with a high competence coefficient, reached a consensus that explicitly privileged operational feasibility and replicability. This was evidenced by the significant improvement in the feasibility assessment after incorporating suggestions: reduction of class hours,

simplification of technological requirements, and the use of open-access software and locally available data.

This finding underscores a principle absent from many curriculum design manuals: in vulnerable contexts, the suitability of the methodology is judged by its adaptation to the real socioeconomic and institutional context, not by its proximity to an abstract technical ideal. It thus corroborates the concept of technological adequacy in training for development, which emphasizes sustainability and practical impact over innovation *per se*.⁽¹³⁾

Gehrke-Beck *et al.*⁽¹⁴⁾ report that the transition from declarative knowledge assessment to performance assessment is a global trend in higher education. In the United States and Canada, systems such as Entrustable Professional Activities (EPAs) in medical education and competency rubrics in environmental engineering are standard. However, Leite *et al.*⁽¹⁵⁾ report that a recurring critique is that these assessments often use standardized and generic scenarios, limiting their ability to predict performance in specific and complex working conditions.

The specificity of this proposal lies in its commitment to contextualized assessment. Eighty percent (80.0 %) of the final grade- 40.0 % applied project and 40.0 % practical test- depends on the participant's ability to intervene in their immediate reality in the Najasa-Guanaja sub-basin. The project requires designing an intervention for their own work context, and the practical test uses new local datasets. This design moves assessment from the classroom to the territory and measures the ability to translate predictive results into viable actions. It aligns with recommendations in current European pedagogical literature advocating for assessment for action in professional training and closes the gap between learning and application.

The main limitation of the study is that the methodology, although validated by experts, still requires a longitudinal impact evaluation to measure its effectiveness in changing professional practices and in the quality of local water planning.

Scientific contribution

It lies in the creation and consensual validation of a comprehensive and contextualized methodology that operationalizes the transition from the conceptual One Health paradigm toward a competency framework applicable to water management. It trains professionals in predictive WSI management under conditions of vulnerability and technological limitation, which not only strengthens local capacities for adaptive planning to climate change but also establishes a replicable methodological precedent for the pedagogical adaptation of complex technical tools to resource-limited contexts. It closes the critical gap between the development of predictive tools and their effective operational adoption.

CONCLUSIONS

A competency-based training methodology was designed and validated for the management of the WSI and its predictive model under the One Health approach, aimed at professionals in vulnerable areas. The validation confirmed the relevance, consistency, feasibility, and clarity. The proposal operationalizes the One Health approach from pedagogy through the horizontal and systemic integration of its human, animal, and environmental dimensions, and constitutes a scalable and transferable model for training in prospective water management in resource-limited contexts.

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Declaration of interests

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Author contributions

Conceptualization: Ovidio Antonio Sánchez Fernández, Zaily Fuentes Díaz

Data curation: Ovidio Antonio Sánchez Fernández, Zaily Fuentes Díaz, Orlando Bismark Rodríguez Salazar

Formal analysis: Orlando Bismark Rodríguez Salazar, Zaily Fuentes Díaz

Investigation: Ovidio Antonio Sánchez Fernández, Zaily Fuentes Díaz, Orlando Bismark Rodríguez Salazar

Methodology: Zaily Fuentes Díaz, Maurice José González Basulto

Project administration: Zaily Fuentes Díaz

Validation: Zaily Fuentes Díaz, Orlando Bismark Rodríguez Salazar

Visualization: Ovidio Antonio Sánchez Fernández, Maurice José González Basulto

Writing – original draft preparation: Ovidio Antonio Sánchez Fernández, Zaily Fuentes Díaz, Orlando Bismark Rodríguez Salazar, Maurice José González Basulto

Writing – review and editing: Ovidio Antonio Sánchez Fernández, Zaily Fuentes Díaz, Orlando Bismark Rodríguez Salazar, Maurice José González Basulto

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