



Review article

Integrative and complementary practices in Intensive Care Units: An integrative review

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ABSTRACT

Objective: To synthesize the knowledge published in the literature on the use of Integrative and Complementary Health Practices in Adult Intensive Care Units.

Design: An integrative literature review based on Ganong's theoretical-methodological framework.

Setting: Data collection was carried out in January 2023 using the descriptors Intensive Care Units and Complementary Therapies, crossed using the Boolean operator "AND". Twenty-five studies were selected and uploaded to Endnote Web. QDA Miner Lite software was used to assist in the analysis of the results.

Main outcome measures: The inclusion criteria were: complete original articles, available online and detailing Integrative and Complementary Health Practices applied in the setting of Adult Intensive Care Units. Excluded works included: publications in conference and event annals; literature review articles; editorials; and study protocols.

Results: The studies date back to 1994, mostly constituted by quantitative clinical trials. Music therapy was prevalent, presented fewer difficulties in application and greater acceptance by participants. The combination of complementary practices also proved to be effective.

Conclusions: There is a growing interest in the application of Integrative and Complementary Health Practices (ICHPs) in the Intensive Care Unit (ICU) setting. However, more research is needed to understand the impact of each practice. Moreover, nursing is essential for the effective implementation of ICHPs.

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1. Introduction

The biomedical model was born based on biological thinking under the influence of Descartes [1]. In this case, fragmenting the body to provide care dehumanizes the patient who the health professional needs to intervene on [2]. This model focuses on the disease, individual, curative, specialist, and hospital-centric treatment [3].

With the aim of breaking with predominantly curative practices in the current Brazilian scenario, discussions have been taking place around health promotion with a view to meeting the demands proposed by the unified health system (*Sistema Unico de Saúde - SUS*). In this scenario, there is the acceptance and insertion of integrative and complementary healthcare practices [4].

These practices have theoretical-philosophical bases that oppose the conventional model, as they propose a holistic view of the human being which integrates the physical, psychological and social systems [5]. Integrative and Complementary Practices (ICPs), also known as Traditional, Complementary, and Integrative Medicine (TCIM), are therapies based on the traditional knowledge of multiple cultures [6]. ICPs explore environmental, behavioral, and health and disease process dimensions. Their focus is on ensuring holistic health, emphasizing disease prevention and physical, mental, and emotional well-being [6,7].

Given the growing recognition of Integrative and Complementary Practices, the Brazilian Ministry of Health implemented the National Policy on Integrative and Complementary Practices (PNPIC) in 2006, acknowledging the inclusion of these practices in the Unified Health System (SUS). As a result, Brazil has become a leading country in the Americas in the utilization of ICHPs within its official health system [8].

Despite the growing search for complementary care methods, inserting ICHPs in the hospital environment is still a challenge, mainly due to the fact that it opposes the biomedical model predominant in this context. Thus, the question arises: how are ICHPs applied to adult and Elderly patients admitted to the Intensive Care Unit (ICU)?

The relevance of this study lies in its potential to provide support for the use of complementary therapies in the ICU setting and expand the nurses' scope of action through adjuvant therapeutic action to pharmacological treatment. From this perspective, the objective of this review is to synthesize the knowledge published in the literature on the application of ICHPs in adult and Elderly patients admitted to the ICU.

2. Material and methods

2.1. Design

This is an integrative literature review for which Ganong's theoretical-methodological framework was used, which guided completing the following steps: identifying the theme and selecting the research question; establishing the inclusion and exclusion criteria; identifying pre-selected studies; categorizing the selected studies; analyzing and interpreting the results; and presenting the review/knowledge synthesis [9].

A review protocol was validated (APPENDIX A) to operationalize the study, which was registered at OSF Registries through the link: <https://doi.org/10.17605/OSF.IO/ZBMCG>.

Data collection took place in January 2023 in the Virtual Health Library (VHL/BIREME), Medical Literature Analysis and Retrieval System online (Medline) from the PubMed platform, and in the Cumulative Index of Nursing Literature and Allied Health (CINAHL)

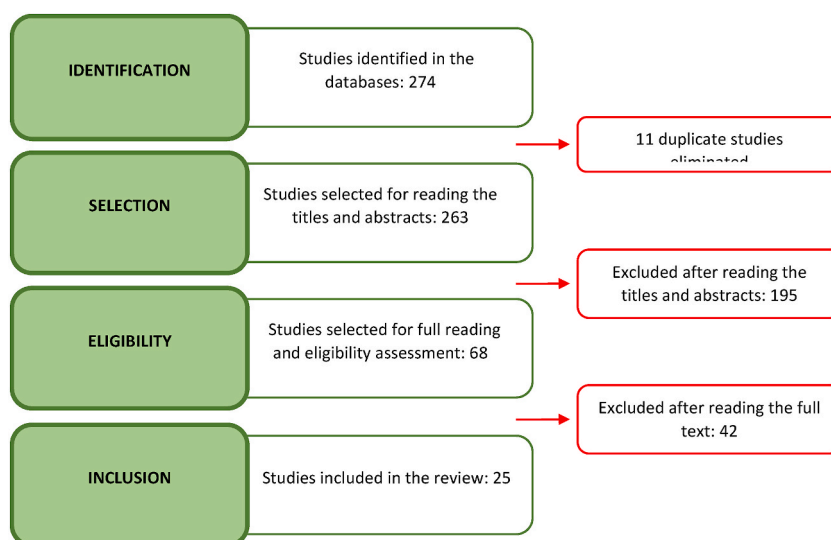


Fig. 1. Steps for the selection of the study corpus.

Source: Adapted from the article: Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA Statement" [10].

Table 1
Quality assessment based on MMAT.

Articles	Design	S1	S2	1	2	3	4	5
Green (1994) [13]	Qualitative	Y	Y	Y	Y	Y	Y	Y
Almerud; Petersson. (2003) [14]	Mixed methods	Y	Y	Y	Y	Y	Y	Y
Wilkins; Moore. (2004) [15]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Gunnarsdottir; Jansdotti. (2006) [16]	Mixed methods	Y	Y	Y	Y	Y	Y	Y
Lee et al. (2010) [17]	Quantitative non-randomized	Y	Y	Y	N	Y	Y	Y
Riveros (2012) [18]	Qualitative	Y	Y	Y	Y	Y	Y	Y
Nascimento et al. (2012) [19]	Quantitative non-randomized	Y	Y	Y	Y	Y	Y	Y
Chlan et al. (2013) [20]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Karadag et al. (2015) [21]	Quantitative descriptive	N	N	N	N	N	N	N
Arslan; Ozer. (2016) [22]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Beming et al. (2016) [23]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Jacq et al. (2018) [24]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
AminiSaman et al. (2018) [25]	Mixed methods	Y	Y	Y	N	N	N	N
Nicola et al. (2019) [26]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Xing et al. (2019) [27]	Quantitative descriptive	Y	N	N	N	N	N	N
Chlan et al. (2019) [28]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Babamohamadi et al. (2020) [29]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Momeni et al. (2020) [30]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Momeni et al. (2021) [31]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Oshvandi et al. (2020) [32]	Quantitative descriptive	Y	Y	Y	Y	Y	Y	Y
Aomatsu et al. (2021) [33]	Quantitative descriptive	Y	Y	Y	N	Y	Y	Y
Karimzadeh et al. (2021) [34]	Mixed methods	Y	Y	Y	Y	Y	Y	Y
Takacs et al. (2021) [35]	Qualitative	Y	Y	Y	Y	Y	Y	Y
Kurd et al. (2021) [36]	Qualitative	Y	Y	Y	Y	Y	Y	Y
Rousseaux et al. (2022) [37]	Mixed methods	Y	Y	Y	Y	Y	Y	Y

Legend: Y – Yes/N - No.

from the EBSCOhost platform. For reference management and the creation of a library with the selected articles, the EndNote Web software was utilized.

The following descriptors extracted from the Medical Subject Headings (MeSH) were used: “Intensive Care Units”; and “Complementary Therapies”. Furthermore, the Boolean operator “AND” was used to generate the cross between the descriptors and the following filters were applied: full text available and Portuguese, English and Spanish languages. No time restrictions were included in order to provide the widest possible coverage of the topic in the literature.

The inclusion criteria were complete original articles, available online and detailing Integrative and Complementary Health Practices applied in the ICU setting. Excluded works included: publications in conference and event annals; literature review articles; editorials; and study protocols.

2.2. Search results

The captured articles were sent to Endnote Web, which indicated 11 duplicates, with repetitions being eliminated. The title and summary of the articles were subsequently read, selecting 25 studies coded by the letter X of the alphabet and Arabic numerals. To illustrate the treatment of the collected material, an adaptation of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [10] flowchart was used. This resulted in the selection of 25 articles that met the inclusion criteria defined in the study (Fig. 1).

2.3. Data abstraction

A bibliometric profile was designed to characterize the articles using an instrument created by the authors in Microsoft Excel to capture information: title, year, country, publication journal, type of study, design, and level of evidence [11].

2.4. Quality assessment

The type of study was identified, and the level of evidence was assigned [11] for the selected articles, as described in Table 1. To assess the methodological quality of the studies included in this review, we employed the Mixed Methods Appraisal Tool (MMAT) [12]. This tool allows for the evaluation of the consistency, scope, and relevance of the results as scientific evidence, contributing to the reliability of our findings.

The analysis encompassed a set of 25 articles, which, although presenting different levels of evidence, adhered to the MMAT quality criteria. This methodological tool served to assess the quality of the studies but was not used as an exclusion criterion, as the 5 articles that did not meet all MMAT criteria were considered in the analysis, given that they contributed to a more comprehensive and expanded view of the results.

Title	Year/Country	Journal	Study type	Design	Level of evidence	Code
Touch and visualization to facilitate a therapeutic relationship in an intensive care unit - A personal experience	1994, United Kingdom	Intensive & critical Care Nursing	Qualitative	Case report	4	X24
Music therapy - A complementary treatment for mechanically ventilated intensive care patients	2003, Sweden	Intensive & critical Care Nursing	Mixed	Case-control study	3B	X8
Music intervention in the intensive care unit: A complementary therapy to improve patient outcomes	2004, United States	Evidence - Based Nursing	Quantitative	Pilot Study	2B	X12
Does the experimental design capture the effects of complementary therapy? A study using reflexology for patients undergoing coronary artery bypass graft surgery	2006, Iceland	Journal of Clinical Nursing	Mixed	Randomized clinical trial	2B	X14
A pilot study in acute subarachnoid hemorrhagic patients after aneurysm clipping with complementary therapies of Chinese medicine	2010, Taiwan	Complementary Therapies in Medicine	Quantitative	Randomized controlled study	1B	X6

Chart 1. Characterization of the selected articles, 2023.
Source: Elaborated by the author, UFRN. Natal, 2023.

<i>Efecto de la oración de intercesión sobre la evolución de pacientes críticamente enfermos</i>	2012, Colombia	Revista Salud Bosque	Qualitative	Double-blind randomized controlled trial	1B	X4
Integrative and complementary therapy in nursing: Therapeutic touch in intensive care unit	2012, Brazil	Revista de Enfermagem UFPE on-line.	Quantitative	Observational cross-sectional study	2C	X13
Effects of Patient-Directed Music Intervention on Anxiety and Sedative Exposure in Critically Ill Patients Receiving Mechanical Ventilatory Support A Randomized Clinical Trial	2013, United States	Journal of the American Medical Association	Quantitative	Randomized clinical trial	1B	X9
Effects of aromatherapy on sleep quality and anxiety of patients	2015, Turkey	British Association of Critical Care Nurses	Quantitative	Case-control study	3B	X2
Touching, Music Therapy and Aromatherapy's Effect on the Physiological Situation of the Patients in Intensive Care Unit	2016, Turkey	International Journal of Caring Sciences	Quantitative	Case-control study	3B	X23
A Novel Picture Guide to Improve Spiritual Care and Reduce Anxiety in Mechanically	2016, United States	Annals of the American Thoracic Society	Quantitative	Cohort study	2B	X5

Chart 1. (continued).

Ventilated Adults in the Intensive Care Unit						
Music for pain relief during bed bathing of Mechanically ventilated patients: A pilot study	2018, France	Plos One	Quantitative	Non-randomized controlled study	2B	X11
Transcutaneous Electrical Nerve Stimulation at The Acupuncture Pints to Relieve Pain of Patients Under Mechanical Ventilation: A Randomized Controlled Study	2018, Iran	Journal of Acupuncture and Meridian Studies	Quantitative	Randomized, double-blind clinical study	1B	X1
Promoting righttime sleep in the intensive care unit: Alternative strategies in nursing	2019, Italy	Intensive & critical Care Nursing	Quantitative	Uncontrolled pre-post clinical trial	2B	X22
Traditional Chinese medicine bundle therapy for septic acute gastrointestinal injury: A multicenter randomized controlled trial	2019, China	Complementary Therapies in Medicine	Quantitative	Single-blind randomized controlled trial	1B	X21
Economic evaluation of a patient-directed music intervention for ICU patients receiving mechanical ventilatory support	2019, United States	Critical Care Medicine	Quantitative	Case-control study	3B	X10

Chart 1. (continued).

Patients in Intensive Care Units: A Parallel Randomized Placebo-Controlled Trial						
Adjunctive homeopathic treatment of hospitalized COVID-19 patients (COVIHOM): A retrospective case series	2021, Austria	Complementary Therapies in Clinical Practice	Qualitative	Case report	4	X16
Homeopathic Treatment for COVID-19-Related Symptoms: A Case Series	2021, Israel	Complementary Medicine Research	Qualitative	Case report	4	X15
Virtual reality and hypnosis for anxiety and pain management in intensive care units	2022, Belgium	European Journal of Anaesthesiology	Mixed	Randomized clinical trial	1B	X25

Chart 1. (continued).

3. Theory

The Intensive Care Unit (ICU) consists of high technology and is responsible for providing care to critical patients. Furthermore, it is one of the scenarios in which the biomedical model is strongly inserted [38].

The usual dynamics of this sector can cause discomfort to the user due to excessive noise and lighting, lack of privacy and separation from family, and can also trigger stress and insecurity [39]. Thus, it is believed that inserting ICHPs is a useful strategy for this care and is therefore our theoretical framework.

4. Results

4.1. Characterization of the selected studies

Studies that deal with the use of ICHPs in the ICU date back to 1994 and are mostly quantitative clinical trial studies. The Intensive and Critical Care Nursing journal stands out with the publication of 3 of the selected articles.

It is noteworthy that 11 studies present level of evidence 1B, which classifies randomized clinical trials with a narrow confidence interval and includes cohort studies (Chart 1).

4.2. Use of ICHPs in the ICU

The selected articles revealed two broad classes of experiments: isolated therapies and combined therapies. Music therapy stood out among the studies using isolated therapy, while studies with combined therapies have aromatherapy/musical therapy/therapeutic touch as the most prevalent (Chart 2 and Chart 3).

5. Discussion

There is currently a need for new approaches in health when it comes to the promotion, prevention, and recovery of patients, therefore the use of Integrative and Complementary Health Practices is consolidated as an assertive tool for this objective [38]. There is an integration between ICHPs and conventional treatment in this area, holding a therapeutic and holistic relationship [39].

TYPES OF ISOLATED THERAPIES	ARTICLES	MAIN FINDINGS
Acupuncture	(X1)	Used to promote transcutaneous electrical nerve stimulation, resulting in reduced pain and reduced use of analgesics and sedatives in patients in the intervention group ⁽¹⁰⁾ .
Aromatherapy	(X2)	Improvement in scores on the Pittsburgh Sleep Quality Index scale and the Beck Anxiety Inventory scale. It is presented as a nursing intervention, non-invasive, cheap, and easy to apply to critically ill patients ⁽¹¹⁾ .
	(X3)	Use of lavender and <i>Citrus aurantium</i> essential oils alone in conscious patients, and there was no significant difference between the two groups. However, both groups had lower anxiety levels than the placebo group, revealing efficacy in reducing anxiety in ICUs ⁽¹²⁾ .
Spiritual care	(X4)	Attributed intercessory prayer remotely as a strategy for caring and comforting patients. It evaluated the variables of multiple organ dysfunction, days spent in the ICU and mortality, with a positive result in the control group ⁽¹³⁾ .
	(X5)	Pain and anxiety were verified after the intervention, and a reduction in anxiety, stress and better coping with hospitalization were identified ⁽¹⁴⁾ .
Phytotherapy	(X6)	Herbal medicine has been used to treat acute subarachnoid hemorrhage surgical patients. There was an increase in the participants' level of consciousness on the
	(X7)	Glasgow scale and a decrease in the number of days spent in the ICU ⁽¹⁵⁾ . Herbal medicine was used to treat patients admitted to the ICU with COVID-19. The results showed a reduction in the time of Invasive Mechanical Ventilation, ICU stay and hospitalization ⁽¹⁶⁾ .

Chart 2. Isolated therapies, articles, and codes.

Source: Elaborated by the authors, UFRN. Natal, 2023.

Music therapy	(X8)	Demonstrated a significant decrease in patients' systolic and diastolic blood pressure ⁽¹⁷⁾ .
	(X9)	The study conducted in X9 and X10 used a self-starting audio device to play music or promote cancellation of external noise according to the intervention group, thus achieving a reduction in sedatives and anxiety levels, in addition to proving a reduction in hospitalization costs for patients ⁽¹⁸⁻¹⁹⁾ .
	(X10)	
	(X11)	Music therapy was offered during the bed bath, which resulted in a reduction in pain during the intervention ⁽²⁰⁾ .
	(X12)	Achieved improvements in all standards assessed in the subjects of its pilot study, with satisfaction not only reported by patients, but also by family members ⁽²¹⁾ .
Therapeutic Touch	(X13)	Identifies touch used as a technique to improve patient comfort conditions ⁽²²⁾ .
Reflexology	(X14)	The level of anxiety and physiological variables were measured in the control and intervention groups. A decrease in anxiety and systolic blood pressure was observed ⁽²³⁾ .
Homeopathy	(X15)	Assigned homeopathy to 5 patients with moderate to severe COVID-19 infection. Patients showed physical and mental improvements in a short treatment period ⁽²⁴⁾ .
	(X16)	13 patients with COVID-19 underwent homeopathy treatment. One patient with septic shock died, the others showed improvement in their clinical condition and were discharged within a short period of time ⁽²⁵⁾ .

Chart 2. (continued).

Massage therapy	(X17)	Used massage therapy through Swedish massage on patients' feet. The results were positive for pain reduction ⁽²⁶⁾ .
	(X18)	Assigned massage therapy to patients' feet to determine the effects on consciousness level and delirium. There was no significant change ⁽²⁷⁾ .
	(X19)	The study used foot massage on unconscious traumatized patients. As a result, there was a reduction in the pain intensity related to changing positions ⁽²⁸⁾ .
Distraction therapy	(X20)	Rhythmic breathing was used in patients undergoing coronary artery bypass graft surgery. The group undergoing intervention achieved a significant reduction in pain intensity ⁽²⁹⁾ .

Chart 2. (continued).

The results found point to a recent increase in publications on this topic. This pattern in recent years can be attributed to the publication by the World Health Organization (WHO) of the document "WHO Strategy on Traditional Medicine 2002–2005" [40,41].

However, there are still difficulties in accepting the use of ICHPs in hospitals, mainly by the medical team, which has not been a sufficient reason to avoid the application of complementary practices [41].

The results show that some studies apply therapies in isolation, while others use them in combination. Music therapy was the most prevalent isolated practice, and is believed to be related to its broad and diverse influence on the individual. There are reports that music is good for health since the period before Christ, and that it reduced pain, stress and anxiety in war veterans during the Second World War. These results gave rise to the professionalization of music therapy [42].

Articles X15 and X16 obtained positive results with homeopathy to help treat COVID-19 [27,28]. Furthermore, X19 mentions that massage therapy promoted analgesia in unconscious clients admitted to the ICU, however it was necessary to combine it with analgesics for better clinical evidence [31].

The X20 study demonstrated the effectiveness of rhythmic breathing as a distraction strategy to reduce pain in patients undergoing coronary artery bypass graft surgery, proving to be a safe and inexpensive therapy that can be used in conjunction with other therapies [32].

Despite the satisfactory results presented with isolated therapies, studies used combined practices. In this context, it is necessary to consider the fragility of research in not identifying the benefits that each of the therapies offers to achieve the result. On the other hand, it was observed there was no significant difference between two treatments when used in isolation in a study with combined therapies using reiki and reflexology applied to patients with endocrinopathies; however, when used in combination, there was a tendency greater improvement in symptoms such as insomnia, edema, stress, anxiety, and body pain [43].

In this context, it is worth highlighting the X21 study conducted in the province of Zhejiang/China, and the X23 study carried out in Turkey, which were based on the traditional practice of oriental medicine [33,35]. The first applied acupuncture and herbal medicine to patients with gastrointestinal injuries and sepsis in the ICU, obtaining an increase in patient survival; while the second study used Aromatherapy, Music Therapy and Therapeutic Touch, obtaining a decrease in heart rate and an increase in hemoglobin levels in patients hospitalized in the ICU.

Finally, an aspect identified in the studies concerns the importance of nursing in applying integrative practices in health services. However, there is a need to qualify these professionals so that they have the knowledge to prescribe and refer patients to these therapies. In this sense, the importance of including content that deals with ICHPs in nursing care in the curricular structure of nursing training is highlighted [44].

COMBINED THERAPY TYPES	ARTICLES	MAIN FINDINGS
Acupuncture and Phytotherapy	(X21)	Electroacupuncture combined with phytotherapy was used in patients with gastrointestinal injuries and sepsis in the ICU. The study achieved satisfactory results, increasing patient survival and markers ⁽³⁰⁾ .
Aromatherapy, Music therapy and Therapeutic touch	(X22)	It was found that complementary techniques using musical sounds and massage with scented oils improved the quality of sleep in patients hospitalized in the ICU. Furthermore, a finding was made regarding the thirst reported by patients, a stress factor which impacts their sleep; therefore, it was a challenge in addition to the therapeutic approaches used ⁽³¹⁾ .
	(X23)	The patients' vital signs and hemoglobin levels were evaluated before and after the therapy applications, achieving a decrease in heart rate and an increase in hemoglobin levels as results ⁽³²⁾ .
Guided relaxation and Therapeutic touch	(X24)	Therapeutic touch and guided imagery relaxation were used to calm a palliative care patient admitted to the ICU. It reduced the patient's heart rate and blood pressure during and after therapy ⁽¹⁰⁾ .
Virtual reality and Hypnosis	(X25)	Use of hypnosis and virtual reality to reduce pain in patients undergoing cardiac surgery. The results did not show significant differences between the groups for the variables analyzed ⁽³⁴⁾ .

Chart 3. Combined therapies, articles, and codes.

Source: Elaborated by the authors, UFRN. Natal, 2023.

5.1. Study limitations

Although the number of articles included in the review is a representative quantity, it is still considered limited when there is an increase in adherence to complementary health practices. Furthermore, many studies cannot be accessed because they are not open access.

5.2. Contributions to the nursing, health or public policy areas

The results found are relevant, as they point to theoretical-scientific contributions of using ICHPs in the ICU, in addition to their potential use throughout the healthcare network. Regarding nursing, it reinforces the importance of nurses in practicing ICHPs in their daily lives and points out new opportunities for action and entrepreneurship.

6. Conclusions

This integrative review demonstrated a growing interest in the use of Integrative and Complementary Health Practices (ICHPs) in the Intensive Care Unit (ICU) setting. Music therapy, aromatherapy, therapeutic touch, and homeopathy were the most frequently identified therapies in the research, with music therapy standing out as the most commonly used practice in isolation.

The results obtained in the research indicated that these practices could help reduce pain, anxiety, and stress, and in some cases, even improve physiological indicators such as heart rate and hemoglobin levels.

The studies also revealed that the combination of different therapies can potentiate the benefits, but also highlighted the need for more research to identify the individual contribution of each practice. Furthermore, the fundamental role of nursing in the implementation of ICHPs is highlighted, demonstrating the importance of professional qualification to ensure both the safety and effectiveness of these interventions.

Thus, the incorporation of ICHPs into clinical practice represents an advance in the search for more humanized and integral care, which considers the bio-psychosocial needs of patients.

CRedit authorship contribution statement

Louise Constância de Melo Alves Silva: Writing – review & editing, Methodology, Investigation, Conceptualization. **Laísia Ludmyla Sousa de Farias:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Vanuza Raquel de Lima:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Samantha Guerrero Soares:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Fernanda Mirelly dos Santos Paiva:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Luan Thallyson Dantas de Assis:** Writing – original draft, Methodology, Investigation. **Kátia Regina Barros Ribeiro:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Késsya Dantas Diniz:** Writing – review & editing, Validation, Supervision. **Viviane Euzebia Pereira Santos:** Writing – review & editing, Visualization, Validation, Supervision. **Hylarina Maria Montenegro Diniz Silva:** Writing – review & editing, Visualization, Validation, Supervision. **Rodrigo Assis Neves Dantas:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

Data availability statement

Data will be made available on request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e40333>.

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