

Diagnosis and dilemmas: the intersection between brain death and bioethics

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Abstract

Brain death is a complex medical and bioethical concept that requires rigorous diagnostic criteria to ensure accuracy and safety. In Brazil, Federal Medical Council Resolution 2,173/2017 establishes a protocol that combines a detailed neurological clinical examination—absence of responsiveness, brainstem reflexes, and apnea—with complementary tests, such as transcranial doppler, angiotomography, and perfusion studies, especially in inconclusive cases. This literature review compares national and international guidelines and discusses the application of Beauchamp and Childress' bioethical principles – autonomy, beneficence, non-maleficence, and justice – in the doctor-patient relationship to respect dignity, values, and cultural context. The integration of medical science, diagnostic technology, and ethical principles favors safer, more humane, and legally supported decisions. Despite the limitations inherent in narrative reviews, the research reinforces the need for standardized protocols and suggests future investigations into diagnostic accuracy and the practical application of bioethical principles in determining brain death.

Keywords: Brain death. Death. Bioethics. Neurologic examination. Critical care. Philosophy.

Resumo

Diagnóstico e dilemas: a intersecção entre morte encefálica e bioética

Morte encefálica é um conceito médico e bioético complexo, que exige critérios diagnósticos rigorosos para garantir precisão e segurança. No Brasil, a Resolução do Conselho Federal de Medicina 2.173/2017 estabelece protocolo que combina exame clínico neurológico detalhado – ausência de responsividade, reflexos de tronco encefálico e apneia – com exames complementares, como doppler transcraniano, angiotomografia e estudos de perfusão, especialmente em casos inconclusivos. Esta revisão bibliográfica de literatura compara diretrizes nacionais e internacionais e discute a aplicação dos princípios bioéticos de Beauchamp e Childress – autonomia, beneficência, não maleficência e justiça – na relação médico-paciente, de modo a respeitar dignidade, valores e contexto cultural. A integração entre ciência médica, tecnologia diagnóstica e fundamentos éticos favorece decisões mais seguras, humanizadas e juridicamente respaldadas. Apesar das limitações inerentes à revisão narrativa, a pesquisa reforça a necessidade de protocolos padronizados e sugere investigações futuras sobre acurácia diagnóstica e aplicação prática dos princípios bioéticos na determinação da morte encefálica.

Palavras-chave: Morte encefálica. Morte. Bioética. Exame neurológico. Cuidados críticos. Filosofia.

Resumen

Diagnóstico y dilemas: la intersección entre muerte cerebral y bioética

La muerte cerebral es un concepto médico y bioético complejo, que exige criterios diagnósticos rigurosos para garantizar precisión y seguridad. En Brasil, la Resolución del Consejo Federal de Medicina 2.173/2017 establece un protocolo que combina un examen clínico neurológico detallado (ausencia de respuesta, reflejos del tronco encefálico y apnea) con exámenes complementarios, como doppler transcraneal, angiotomografía y estudios de perfusión, especialmente en casos inconclusivos. Esta revisión bibliográfica compara las directrices nacionales e internacionales y analiza la aplicación de los principios bioéticos de Beauchamp y Childress—autonomía, beneficencia, no maleficencia y justicia—en la relación médico-paciente, con el fin de respetar la dignidad, los valores y el contexto cultural. La integración entre la ciencia médica, la tecnología diagnóstica y los fundamentos éticos favorece decisiones más seguras, humanizadas y respaldadas jurídicamente. A pesar de las limitaciones inherentes a la revisión narrativa, la investigación refuerza la necesidad de protocolos estandarizados y sugiere futuras investigaciones sobre la precisión diagnóstica y la aplicación práctica de los principios bioéticos en la determinación de la muerte cerebral.

Palabras clave: Muerte encefálica. Muerte. Bioética. Examen neurológico. Cuidados críticos. Filosofía.

The authors declare no conflict of interest.

Brain death is a complex and multifaceted concept that requires rigorous, continually updated diagnostic criteria to ensure its accurate determination¹. In Brazil, Resolution 2,173/2017 of the Federal Council of Medicine¹ establishes clear guidelines for diagnosis that reflect a conservative approach, requiring clinical and complementary examinations to confirm the condition's irreversibility^{1,2}. Conversely, the international standardization of these criteria faces significant challenges stemming from diverse cultural, religious, and legal perspectives on death³.

Although the clinical neurological examination represents the cornerstone in determining brain death, some situations limit its full application or yield inconclusive results⁴. In these scenarios, complementary imaging or cerebral blood flow tests emerge as valuable diagnostic confirmation tools and provide greater reliability to the process of brain death determination⁴, highlighting transcranial Doppler (TCD), computed tomography angiography (CT angiography), and radionuclide perfusion imaging, each with its own technical particularities and clinical applications⁴⁻⁶.

From a bioethical point of view, brain death is a complex and delicate subject that raises profound ethical and moral questions. Thus, the bioethical principles of Beauchamp and Childress⁷—autonomy, beneficence, non-maleficence, and justice—play a fundamental role, as they offer a moral framework to guide physicians' decisions regarding patients with brain death, so that they are treated with respect, compassion, and dignity, even in post-mortem situations. The dignity of human life is an invaluable asset that must be preserved and respected until the end.

This study aims to link the main national and international diagnostic criteria for brain death and present the main complementary tests for its determination. Moreover, it seeks to highlight the importance of principles of biomedical ethics⁷ in the context of the physician-patient relationship, especially in the care related to patients with brain death. Each principle is fundamental in specific situations, while all complement each other without establishing hierarchies.

Method

This is a bibliographic literature review conducted between 2024 and 2025 using searches on Medline, PubMed, LILACS, and Virtual Health Library (VHL) databases. The Boolean term "OR" and the Health Sciences Descriptors (DeCS) in the LILACS database and Medical Subject Headings (MeSH) in the Medline database were used as follows: "brain death OR morte encefálica."

Articles in Portuguese and English, published between 2015 and 2025, bibliographic review studies, and available in full text, met the inclusion criteria. Duplicates and those that did not directly address the study proposal were excluded.

Results

The search identified 20,550 articles across the databases, which were subsequently screened based on the selection criteria. A total of 124 articles remained, which were subjected to meticulous reading for data collection. Fourteen articles were effectively used after data collection and analysis relevant to the research (Figure 1). In addition, CFM Resolution 2,173/2017¹ was used as a basis for the foundation of the Brazilian criteria for brain death, and the criteria for determining brain death from the American Academy of Neurology (AAN)⁸ and the *International guideline development for the determination of death*³ for some foundations of the international criteria.

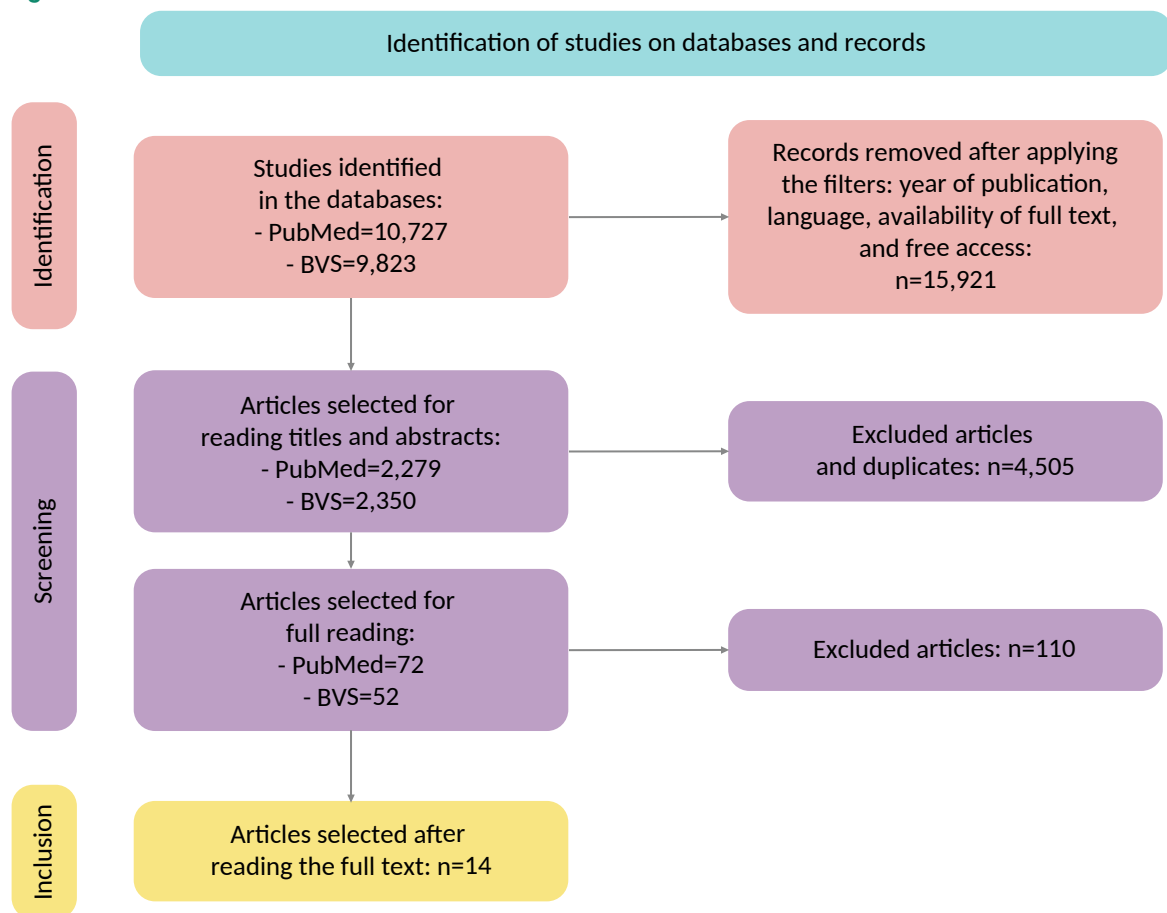
In addition to the aforementioned elements, to support this study, classic works in English, Portuguese, and Spanish in the field of bioethics were consulted, namely: *Principles of biomedical ethics*, by Beauchamp and Childress⁷; *Manual de bioética: fundamentos e ética biomédica*, by Elio Sgreccia⁹; and *Dignidad de la vida y manipulación genética*, by Francesc Torralba Roselló¹⁰. Furthermore, to deepen the argumentation of bioethical principles, works of a philosophical nature were incorporated, such as: *História da filosofia: Antiguidade e Idade Média*, by Dario Antiseri and Giovanni Reale¹¹; *Fundamentação da metafísica dos costumes*, by Immanuel Kant¹²;

Sobre a liberdade, by John Stuart Mill¹³; and *Uma teoria da justiça*, by John Rawls¹⁴.

These works provided a solid basis for analyzing and discussing bioethical principles and their relationship to brain death. Finally, for the necessary theoretical support, the websites *Eu Médico Residente*¹⁵ and the Brazilian Ministry of Health¹⁶; and the articles

“Clinical and ethical perspectives on brain death”¹⁷; “Death as the cessation of an organism and the moral status alternative”¹⁸; “Rethinking brain death: a physiological, philosophical and ethical approach”¹⁹; “The intractable problems with brain death and possible solutions”²⁰; “When is somebody just some body? Ethics as first philosophy and the brain death debate”²¹.

Figure 1. PRISMA Flowchart



Discussion

Clinical criteria

The process of determining brain death begins with a thorough neurological clinical examination, aiming at demonstrate the irreversible absence of neurological function and includes evaluation of brainstem reflexes and the apnea test²². This is a rigorous, standardized process that must be performed by two qualified physicians,

as recommended by CFM Resolution 2,173/2017¹. Before starting, it is essential to verify the prerequisites, which include identifying the cause of the brain injury, excluding reversible clinical conditions that may simulate brain death (such as hypothermia and drug intoxications), and ensuring the hemodynamic and metabolic stability of the patient^{2,22,23}.

The clinical neurological examination comprises the assessment of responsiveness and

consciousness, characterized by unresponsive coma and the absence of supraspinal motor response to nociceptive stimulation^{2,22,23}. Additionally, all brainstem reflexes must be absent, including the pupillary, corneal-palpebral, oculocephalic, vestibulo-ocular, pharyngeal, and tracheobronchial reflexes^{1,2}.

The lack of pupillary constriction verifies the absence of the pupillary reflex to light stimulation. In contrast, the corneal-palpebral reflex is considered absent when there is no eyelid closure to corneal stimulation^{2,24}. The oculocephalic and vestibulo-ocular reflexes assess the integrity of the neural pathways that control eye movements, and are considered absent when there is no eye movement during head rotation or irrigation of the external auditory canal with ice water²². The absence of the pharyngeal and tracheobronchial reflexes is verified by the lack of response to stimulation of the oropharynx and tracheal carina, respectively^{2,23,25}.

After confirming the absence of brainstem reflexes, an apnea test is performed to demonstrate the absence of spontaneous ventilation after hypercapnic carbon dioxide stimulation²⁶: the patient is pre-oxygenated with 100% oxygen for an adequate period, and mechanical ventilation is interrupted, maintaining oxygen delivery via tracheostomy catheter^{2,26}. The test is considered positive for apnea (and compatible with brain death) when, after a period, no respiratory movements are observed. Furthermore, the arterial carbon dioxide pressure (PaCO_2) reaches a value greater than or equal to 55 mmHg (or increases by 20 mmHg or more from baseline), confirming the absence of respiratory command by the brainstem^{1,2}. In patients undergoing extracorporeal membrane oxygenation (ECMO), the apnea test requires specific adaptations to ensure safety and correct interpretation of results, as detailed in systematic reviews dedicated to this clinical context^{23,26-28}.

Complementary examinations

In situations where the clinical neurological examination for determining brain death is

inconclusive or cannot be fully performed, complementary imaging or cerebral blood flow examinations may be used to assist in diagnostic confirmation⁴, such as transcranial Doppler, computed tomography angiography, and radionuclide perfusion studies⁴⁻⁶.

TCD is a non-invasive method that uses ultrasound to assess blood flow in intracranial arteries, and is useful for detecting the absence of flow, a strong indicator of brain death^{5,29}. CT angiography is another imaging modality that assesses cerebral blood flow and provides detailed images of intracranial arteries, allowing visualization of flow interruption in cases of brain death^{6,30}. Radionuclide perfusion studies, such as brain scintigraphy, use radiopharmaceuticals to assess cerebral blood perfusion, demonstrating the absence of radiopharmaceutical uptake by brain tissue in cases of brain death, which confirms the absence of blood flow and, consequently, brain death^{4,28,30}.

It is important to emphasize that complementary examinations are considered ancillary and should be interpreted in conjunction with the clinical examination to reinforce or confirm the absence of neurological function^{1,2,30}. The choice of complementary examination to be used depends on availability, the expertise of the medical team, and the particularities of each clinical case⁴. Physicians with experience in the field must interpret the results of complementary examinations to ensure proper application and interpretation of these important diagnostic resources in the determination of brain death^{1,2}.

To ensure the condition's irreversibility, the CFM Resolution requires repeating the clinical neurological examination after a minimum interval, which varies according to age and the etiology of the brain lesion. Only after confirmation of the persistence of the absence of neurological functions in two clinical examinations and, if applicable, with the support of complementary examinations, can brain death be declared^{1,2}. The entire process must be documented in detail in the patient's medical record, including the results of clinical and complementary examinations, the names of the responsible physicians, and the time of the

declaration of brain death, in accordance with the rigorous ethical-legal criteria established^{1,2,28}.

Bioethical discussion

There are different ways to conceptualize bioethics. According to Roselló¹⁰, there are two main approaches: fundamental bioethics and clinical bioethics. The first concerns finding solid foundations, from a philosophical point of view, to subsequently solve the multiple problems that arise for humankind. It develops on a plane of rational foundation and only descends in particular cases. In clinical bioethics, the thematic core lies in medical practice and the care relationship within institutions¹⁸.

The object of investigation in clinical bioethics is plural, presenting various thematic fields and diverse problematic cores. It can be stated that one of the main themes of clinical bioethics is the concept of brain death and its ethical implications. In recent years, this issue has been the subject of intense debate and the development of ideas, especially regarding monitoring, guidance, and dialogue with family members of patients affected by this condition^{17,19}. It is in this sense that the importance of the physician-patient relationship emerges, since it is through clear, empathetic, and respectful communication that mutual trust can be established, which is fundamental for ethical decision-making and for dealing with the complexities of brain death²¹.

In the context of brain death, the physician-patient relationship manifests itself in two distinct ways: on the one hand, the physician must emphasize informing and communicating the truth to the patient and family, the duty to avoid ineffective treatment and problems linked to high-risk interventions; on the other hand, respect for the patient presupposes their role as a moral agent, i.e., they recognize themselves as a subject of rights and claim them from the medical profession, due to the need to promote their greatest physical and mental well-being^{10,20,21}.

It is precisely within this context of the physician-patient relationship that the bioethical principles proposed by Beauchamp and Childress⁷ are inserted: autonomy, beneficence, non-maleficence, and justice, which do not

have different weights in themselves but can assume different relevance depending on the specific situation. In other words, the importance of each principle may vary depending on the context and circumstances.

For example, in a situation where a patient's life is at risk, the principle of beneficence may carry more weight than that of autonomy. Conversely, when a patient has the capacity to make decisions, the opposite occurs. In developing their thesis, Beauchamp and Childress⁷ relied on the theory of William David Ross, a Scottish ethicist and philosopher from the early 20th century, whose thinking argued about *prima facie* ethical duties, that is, initial and non-absolute moral obligations, which do not have a fixed hierarchy and can be weighed according to the specific case⁹.

Therefore, any objective hierarchy of principles is excluded, as evidenced by the *Belmont Report*³¹. Each principle, in a specific conflict and context, has a degree of supremacy over the others. Each situation has its own unique characteristics, so the distribution of each principle's value must take this basic assumption into account.

However, as Sgreccia points out⁹, the risk of falling into an ethics of the situation is very high, in addition to the explicit reference to intuitionism that the balance of values presents⁹. According to Ross, the *weight of principles in a conflict situation resembles the movement of someone going up and down a ladder, indicating variability across contexts*³². Thus, his thinking distinguishes between *prima facie* duties and real duties. The former correspond to obligations that are valid in general, unless they conflict with duties of equal or stronger nature in the concrete situation; the latter refer to the duties actually to be fulfilled, determined by the balance of the different weights they assume in that specific circumstance.

Indeed, the reference to the concept of person, in its entirety, helps to identify the choice in the applicability between the principles and, therefore, to harmonize them in case of conflict, insofar as it considers the integrality of the subject—their clinical conditions, values, autonomy, and concrete context—allowing us to weigh which principle should prevail without completely negating the others. From this

theoretical framework, we will now briefly analyze how each of these principles can be applied to the context of brain death. Initially, the principle of non-maleficence, presented by Beauchamp and Childress⁷, obliges healthcare professionals not to cause harm intentionally¹⁹.

In medical ethics, this principle is closely related to the Hippocratic maxim *primum non nocere*. The first philosophers and their schools did not limit themselves to giving medicine only the theoretical status of a science, but also managed to determine the ethical structure of the physician, the *éthos* or moral identity that should characterize them¹⁹. A physician should not, for example, prescribe any medication for healthy people. Furthermore, they must maintain confidentiality regarding whom they attend to, i.e., they must not transmit to anyone information they possess regarding their illness¹¹.

In the context of brain death, the requirements of the principle of non-maleficence have far-reaching implications, obligating physicians to possess both traditional and up-to-date theoretical and practical knowledge. The professionals must also seek new diagnostic and therapeutic procedures, as well as improve existing ones, in order to more adequately assess the patient's pain, advance treatments that minimize it, avoid so-called defensive medicine, and cultivate an attitude favorable to the appropriate relationship between health professional and patient¹⁹. In addition, the delicate process of disconnecting the machines involved in brain death must be carefully evaluated based on this principle^{17,18}.

Consequently, the principle of beneficence requires that the physician list positive aspects to promote well-being and establish a good relationship with patients and their families. According to Sgreccia⁹, there is a moral obligation for an individual A to promote the well-being of a subject B. In the context of brain death, this principle proves particularly relevant, guiding healthcare professionals to act in favor of the patient's well-being and dignity, even in the face of the irreversibility of the condition. Relief of pain and suffering, preservation of the patient's dignity,

and offering emotional support to the family are central points of this principle⁹.

Subsequently, in conjunction with the principles of beneficence and non-maleficence, autonomy has served as a defining landmark in bioethics since its beginnings. Two monuments of philosophical thought, one from the deontological perspective of reason and the other from the utilitarian school, vigorously argued over the moral importance of respecting individuals' autonomy. For Kant¹², autonomy—understood as self-government—is an essential condition for the individual to be recognized as a rational agent, constituting, moreover, the foundation of the dignity of human nature and of all rational nature¹². In turn, John Stuart Mill¹³ emphasized that respect for the autonomy of others is essential and must be ensured, further arguing that each individual develops their potential and conducts their way of being and acting according to their own convictions, provided that there is no violation of others' freedom¹³.

In line with these philosophical arguments, autonomy refers to a human being's capacity to develop from within, through the representation of the ends of their own life and the means to achieve them, thereby acting in accordance with this representation, free from external restrictions. In this way, human autonomy integrates the order of ethics and the order of being²¹.

It is real, not utopian, because it contains elements of heteronomy, known or unconsciously assimilated. Human beings, as members of a community and a culture, absorb a set of norms, criteria, concepts, traditions, myths, and symbols that extraordinarily condition the exercise of their own autonomy²¹.

In brain death, the patient's autonomy is exercised indirectly, since they can no longer express their own decisions or preferences. In this context, autonomy is respected through advance directives, legal representatives, or the healthcare team itself, which makes decisions based on the patient's best interests and their previously expressed values and wishes to family members^{15,18,21}.

Finally, the principle of justice refers to the moral obligation to treat people equitably and to

ensure that benefits, burdens, and resources are distributed fairly in the hospital environment. In accordance with Beauchamp and Childress's concept of justice⁷, John Rawls, when treating justice as fairness, states that:

*(...) those who engage in social cooperation choose together, in one joint act, the principles which are to assign basic rights and duties and to determine the division of social benefits (...). Just as each person must decide by rational reflection what constitutes his good, that is, the system of ends which it is rational for him to pursue, so a group of persons must decide once and for all what is to count among them as just and unjust. (...) Justice as fairness begins, as I have said, with one of the most general of all choices which persons might make together, namely, with the choice of the first principles of a conception of justice which is to regulate all subsequent criticism and reform of institutions*³³.

In the bioethical context, this principle addresses equity in access to healthcare, the allocation of medical resources, and protection against unfair discrimination. Distribution problems begin to arise when a given good is insufficient for everyone; that is, injustice occurs when a benefit to which a person is entitled is denied without reasonable cause or when a burden is unduly imposed, for example, in the distribution of organs for transplantation in cases of brain death, when inadequate criteria or inequalities in the system can compromise the fair allocation of these scarce resources.

In other words, the principle of justice proves fundamental in the context of brain death, as it involves the equitable distribution of resources and the guarantee that the rights of all those involved are duly respected. In this sense, distributive justice, related to the allocation of scarce resources, such as organs intended for transplantation, and commutative justice, which refers to the fair and equal treatment given to patients and families throughout the entire process, stand out. Furthermore, this principle is closely related to patient autonomy, as it requires consideration of their rights and respect for their previously expressed wishes,

contributing to a more coherent and integrated ethical approach¹⁶.

Final considerations

It was possible to summarize the main aspects of the brain death determination process, from the mandatory clinical and neurological criteria to the crucial role of complementary examinations. CFM Resolution 2,173/2017¹, aligned with international guidelines, establishes a rigorous protocol that prioritizes safety and diagnostic accuracy, in order to reflect the complexity and seriousness inherent in the determination of brain death².

Detailed clinical evaluation, with confirmation of the absence of responsiveness, brainstem reflexes, and apnea, constitutes the basis of the diagnosis, with complementary examinations being valuable tools to elucidate complex cases or confirm clinical findings²². Ultimately, adherence to a standardized and rigorous diagnostic process, such as that advocated by national and international guidelines, is imperative to ensure the determination of brain death in an ethical, legal, and safe manner for the patient and their family^{1,2}.

Within the bioethical landscape, brain death is a complex topic that raises discussions and reflections. Given the complexity of the human being, with their history, beliefs, values, religion, and customs, the bioethical principles of Beauchamp and Childress⁷ are essential tools for guiding healthcare professionals in each unique situation. In other words, they serve as a means for physicians to deliberate on the best approach to adopt for each patient¹⁷. For example, the principle of non-maleficence motivates professionals to avoid causing harm to patients.

In short, the integration of bioethical principles with medical-scientific knowledge and laboratory and computational tests aims to address the patient holistically, considering their human essence and seeking to understand them in their biopsychosocial complexity³⁴. This approach allows for the establishment of a more effective, respectful, and humanized physician-patient relationship.

This study, structured as a narrative literature review, offers a panoramic, interdisciplinary view of the diagnostic criteria and bioethical principles applicable to brain death. However, its qualitative nature limits its scope. First, the absence of an explicit methodology for critical appraisal or risk of bias in the 14 articles actually used reduces the degree of certainty of the conclusions drawn directly from the primary literature.

While the choice of the narrative format is justified by the need to combine national and international guidelines and by the emphasis on a humanized approach that integrates medical science and the principles of Beauchamp and Childress⁷, more robust reviews, such as systematic reviews, would ensure greater rigor in the selection and validation of studies.

Another point to be considered is the bioethical foundation in classic works, written in historical-philosophical contexts distant from contemporary clinical practice⁷⁻¹⁴. Despite the timelessness of

ethical principles, it is essential to recognize the evolution of diagnostic criteria for brain death and brain imaging and perfusion technologies, as well as to promote continuous dialogue between philosophical traditions and current scientific discoveries^{1,3}. This dialogue underscores the applicability of ethical values in decision-making across increasingly complex clinical scenarios.

For future work, the suggestion is to perform systematic reviews to answer specific questions about diagnostic accuracy, such as the sensitivity and specificity of complementary tests (such as transcranial Doppler or computed tomography angiography), or to empirically investigate the application of bioethical principles in clinical practices (whether in communication with family members or in the allocation of resources for transplants)^{4,5,21}. These studies, using search, selection, and critical quality assessment protocols, can reinforce the scientific and bioethical evidence for determining brain death, contributing to greater rigor and depth in the field.

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Contribution of the authors

Leandro Baptistella Casagrande was responsible for the conception and design of the study, research planning, selection of the co-author, identification and selection of bibliographic references related to bioethics, analysis and drafting of the text with a bioethical focus, and the conduct and development of the bioethical discussion. Victorio Souza Boff was responsible for drafting the title, writing the abstracts, writing the introduction and the methodology section, selecting and organizing the bibliographic references, writing and analyzing the discussion of clinical criteria and complementary tests related to the determination of brain death, writing the concluding remarks, editing the text, translating into foreign languages, submitting the article, and making the revisions requested during the editorial process.

Data availability: All data used or generated in this study are described and presented in full in the body of the article.

Editor in charge: Dilza Teresinha Ambrós Ribeiro

Received: 3.19.2025

Revised: 1.29.2026

Approved: 1.30.2026