

ISSN: 2956-0179
eISSN: 2956-0306

ANNALS OF NURSING

A SEMI-ANNUAL INTERNATIONAL JOURNAL

THE OFFICIAL JOURNAL OF THE MEDIKA COLLEGE
OF VOCATIONAL STUDIES IN HEALTHCARE
BELGRADE SERBIA.

CO-PUBLISHER: FACULTY OF MEDICINE,
UNIVERSITY OF MONTENEGRO, PODGORICA.



Annals
of Nursing

VOLUME 2, ISSUE 2, 2024

ISSN 2956-0179

e ISSN 2956-0306

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A Semi-Annual International Journal

The Official Journal of the Medika College of
Vocational Studies in Healthcare

Belgrade Serbia

Co-Publisher:

Faculty of Medicine

University of Montenegro

Podgorica, Montenegro

Volume 2, Issue 2, April -September 2024

Annals of Nursing

A Semi-Annual International Journal

Editor-in-Chief: Goran Belojević

Publisher: Medika College of Vocational Studies in Healthcare

8 Mitropolita Petra Street, 11000 Belgrade, Serbia

Co-Publisher: Faculty of Medicine, University of Montenegro

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Printing Company: School Service Gajić, Belgrade, Serbia

Print run : 50

Annals of Nursing is indexed with:



ACADEMIA



ABOUT THE JOURNAL

Annals of Nursing is the official journal of the Medika College of Vocational Studies in Healthcare, Belgrade, Serbia. Co-publisher is the Faculty of Medicine, University of Montenegro, Podgorica, Montenegro. It is a semi-annual international open-access, peer-reviewed journal that comprehensively covers all aspects of nursing in hospitals, families, and communities. The papers published in 'Annals of Nursing' are freely available to all internet users for non-commercial use. The journal focuses on the role of nurses in promoting health and quality of life, preventing illness, caring for disabled and ill individuals, and facilitating rehabilitation after illness.

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LETTER OF THE EDITOR-IN-CHIEF

Dear Readers,

We are proudly presenting the second issue of the second volume of the Annals of Nursing, which will continue publishing as a joint production of The Medika College of Vocational Studies in Healthcare, Belgrade, Serbia, and the Faculty of Medicine, University of Montenegro, Podgorica. This is the first Serbian-Montenegrin joint project in medical publishing ever.

Katarina Jonev Ćiraković presents a very interesting text about the patient's rights in the light of EU and Serbian legislative. Handling health data requires utmost care and must always prioritize the preservation of the individual's interests, fundamental rights, and dignity. The adoption of the EU general data protection regulation (GDPR) marked a major advancement in the development of a personal data protection system.

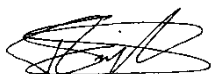
Manca Pajnič et al. show that fear of failure can be mitigated in 20% of cases using supervised examinations. Almost all investigated students (99%) agreed that incorporating information and communication technology and social networks improved their academic performance.

In their retrospective clinical study Milan Spaić and Aleksandar Mandarić elaborate a very important topic in general medical practice and transplantation medicine – diagnostics of brain death. Neurological tests assessing motor responses to painful stimuli, the corneal reflex, and the pupillary light response proved to be as reliable for diagnosing brain death as cerebral angiography.

Anita Kovačić Popović et al. bring a review about the integration of rehabilitation services. The integrative rehabilitation approach merges various clinical and therapeutic frameworks to establish an ideal setting for evaluating and addressing individual needs. Studies show that integrative methods play a crucial role in enhancing functionality and overall quality of life.

We are devoted to our main goal: the SCI. In line with this commitment, we will enhance double-blind review process, from the initial reading by the EIC to the final decision.

Kind regards,



Goran Belojević
Editor-in-Chief
Annals of Nursing

TABLE OF CONTENTS

Annals of Nursing, Vol 2, Issue 2, April – September 2024

Review

Katarina Jonev Ćiraković

THE RIGHT TO PRIVACY AND THE PROTECTION OF PATIENTS' PERSONAL DATA

p. 1-13

Original Article

Manca Pajnič, Ljubiša Pađen, Judita Lea Krek, Željko Vlaisavljević,

Veronika Kralj-Iglič

THE USE OF INVIGILATED EXAMS IMPROVED STUDENTS' ATTITUDES TOWARDS BIOPHYSICS: A QUASI-EXPERIMENTAL STUDY

p. 14-25

Original Article

Milan Spaić, Aleksandar Mandarić

BRAIN DEATH

p. 26-32

Review

Anita Kovačić Popović, Biljana Stojanović, Dejan Miljković

INTEGRATION OF REHABILITATION SERVICES – OVERVIEW AND PERSPECTIVES

p. 33-44

Review**THE RIGHT TO PRIVACY AND THE PROTECTION OF PATIENTS' PERSONAL DATA****Katarina Jonev Ćiraković**

Medika College of Vocational Studies in Healthcare, Belgrade, Serbia

Received: December 20, 2023; **Revised:** November 10, 2024.**Accepted:** November 12, 2024; **Published:** November 17, 2024.**DOI:** 10.5937/annnur2-48396**Abstract**

Globalization and accelerated technological development have led to new challenges in the protection of personal data. The Internet holds vast amounts of information, which at any moment is at risk of potential misuse on various websites, social networks, and platforms. The adoption of the EU General Data Protection Regulation (GDPR) marked a significant step in addressing this issue. Data related to the health sector—specifically, patients' personal data—are particularly sensitive. The concept of personal rights and their protection stems from the belief in universal values that apply to every individual. Safeguarding patient privacy is essential for preserving freedom and upholding fundamental human rights. It is crucial to define the scope and limitations of this protection, balancing the legitimate interests of third parties, society, and the state on one side, with the individual rights and interests of the patient on the other. In this context, recent amendments in European and Serbian legislation regarding personal data protection represent a cornerstone for this research, which holds significance for both legal and medical science, as well as practical application.

Keywords: patient rights, healthcare, internet, data protection**Corresponding Author:** Katarina Jonev Ćiraković; E-mail: jonev.katarina@gmail.com

Introduction

One of the most significant consequences of advancements in information technology over the past twenty years is the massive increase in data collected on individuals. The daily collection of billions of data points about citizens, their storage in large databases, and the processing of this data using artificial intelligence have become everyday realities. As the volume of data collected on individuals grows, so does the risk of its misuse.

The free flow of information is essential, but it also poses a significant risk to the privacy, independence, and individuality of everyone. Placing data at the core of industrial development and societal management demands a high level of both information security and protection of citizens' fundamental rights. A robust personal data protection system must address both the technical aspects of securing information systems and the coordinated regulatory framework and practical application of personal data protection at the international and national levels.

A significant step forward in the creation of a personal data protection system was the adoption of the EU General Data Protection Regulation (GDPR). This regulation not only harmonized norms and practices at the EU level but, since its implementation in 2018, has greatly influenced the development of data protection systems in candidate countries.¹ The GDPR has had a global impact on the evolution of data protection systems, including in the Republic of Serbia. Under the influence of the GDPR, Serbia adopted a new Law on the Protection of Personal Data.² The GDPR warrants special attention across various fields—legal, economic, accounting, healthcare, auditing, and all other areas of the digital business environment.

The protection of personal data, as required by numerous international and national regulations, is crucial for safeguarding an individual's right to privacy. The right to personal data protection and the right to respect for private life are closely related fundamental rights. Patient health data is a vital aspect of privacy, categorized as highly sensitive information. Therefore, processing such data requires special care and must always be conducted with respect for the interests, fundamental rights, and dignity of the person to whom the data belongs. By protecting an individual's health-related data, we safeguard their legitimate interests. This protection involves preventing the misuse of personal health information, such as illegal or unjustified access and use.

The development of information and communication technologies (ICT) and their increasing application in healthcare sector has made it possible to collect and process a large amount of health data of persons, which opened the issue of their security and protection. ICT in the healthcare sector offers numerous new opportunities in terms of better and more responsible healthcare for individuals (consumers, patients, doctors and healthcare workers), but it also has disadvantages that can negatively affect the rights of individuals, their privacy and the protection of personal data. This may pose a particular risk to the protection of the right to privacy and data protection due to misuse - illegal and unjustified use and/or disclosure of that data.

What is Included in the Patient's' Medical Records?

Health-related data are considered a professional secret for all entities involved in the process of ensuring a patient's right to health care. Unauthorized disclosure of this data can lead to disciplinary, administrative, civil, misdemeanor, and

even criminal liability. Furthermore, because patient medical data may be accessible to multiple parties, it cannot be disclosed to the public without the consent of the patient or individuals authorized by law.⁵

To understand the protection of a patient's right to privacy and the potential liability of the health care institution, it is important to first examine what constitutes medical data that guarantees the right to privacy.⁶

According to one definition accepted in both European and Serbian law, health data is personal data related to an individual's physical or mental health, including information about the provision of health services, from which details about their health condition can be derived.²

In addition to the data, any other information obtained during the diagnostic and treatment process, or in connection with the applied treatment procedures, is considered personal and must not be disclosed to third parties. The unauthorized transfer of such data would constitute a violation of the right to privacy and could compromise the patient's integrity. While the scope of this data is defined, it is not exhaustive, as new types and even categories of data related to the patient's health condition and treatment may emerge. In this context, a special category of data related to the patient's genetic status is particularly noteworthy.⁶

Advances in biotechnology have made it possible to analyze human genetic material to protect, preserve, and enhance health. As a result, additional measures are necessary to prevent abuses related to the possession, use, and disposal of a patient's genetic information, which is classified as a special category of health-related data.

At the European and national level, there is a whole range of instruments that regulate

in detail various aspects of the right to privacy and confidentiality. Nowadays, in personalized medicine era, in the era of the digital economy and with the development of information and communication technologies, new challenges are emerging on how to protect data on the health status of employees as patients who are very vulnerable and suitable for endangerment.⁷

The Right to Privacy of Patients

In the modern digital world, where e-health is increasingly advancing, personal health data holds significant value. Without such data, e-health could not have been created, nor could it continue to develop and adapt to the constant changes in modern society and the digital environment. Health services provided to patients must be legally regulated and free from any arbitrary influence by those who administer them.

The right to privacy of patients stems from the general right to privacy, which includes the right to protect personal data and serves as "an additional guarantee of the inviolability of human integrity." In the broadest sense, the right to privacy allows individuals to decide what information about themselves may be disclosed to

others, how this information will be collected, and for what purpose it will be used.⁹ The right to privacy is a fundamental human right essential to the functioning of both the state and society. This right is part of the corpus of personal rights, which emerged in the United States legal doctrine at the end of the 19th century. It protects the private sphere of an individual—encompassing physical, mental, and informational aspects (the collection, processing, use, and protection of personal data are regulated by law).¹⁰

The state's role in guaranteeing this right is twofold: both passive and active. The state must refrain from intruding into an individual's private sphere, while simultaneously establishing laws to ensure the right to privacy. Given that privacy is a personal right of citizens, theoretical frameworks often distinguish between different spheres of privacy—namely, the intimate sphere, the strictly personal sphere, and the private-public sphere, which lies between the first two categories.¹¹In the context of citizens' medical and health data, we are specifically referring to the strictly personal sphere of privacy.¹²

The right to privacy in healthcare is realized through the legal protection of a patient's personal (confidential) health data, irrespective of the type of health insurance—whether compulsory, voluntary, or otherwise. Privacy involves the duty to maintain the confidentiality of personal health data, where the right to confidentiality allows individuals to prevent the unauthorized re-disclosure of sensitive personal information to third parties. Confidentiality forms the foundation of the doctor-patient partnership, which, in modern law, replaces the earlier paternalistic approach and serves as a prerequisite for delivering quality medical services.¹³

While ensuring the confidentiality of a patient's health information is a duty of the doctor, it also represents the patient's right to have their personal data legally protected. The patient's rights to privacy and confidentiality of health information are closely tied to the right to personal data protection, a constitutionally guaranteed right; these rights are mutually dependent and interrelated. It is especially important that the patient's personal data is legally protected during processing. This responsibility also extends to healthcare professionals, who are obligated to

safeguard the life, health, privacy, and dignity of each patient.

Many healthcare workers and associates participate in the treatment process and must be informed about the patient's health status to effectively perform their duties and carry out necessary procedures. Specifically, the details about a patient's health status, acquired during professional responsibilities, are subject to legal protection.

Data Protection in Information Health System

Over the past three decades, the level of regulation in data protection and cybersecurity has significantly increased. To ensure effective governance, it is essential to differentiate between sector-specific laws that regulate health data processing, general data protection laws (such as GDPR), and laws that govern personal data processing, which may have direct or indirect implications for health information systems (e.g., e-Privacy).

Sector-specific regulation laws are crucial as they provide clear guidelines for processing personal data for health-related purposes and often serve as the legal foundation for such activities. These laws may address specific health public tasks (e.g., cancer registries) or regulate the use of health information in clinical or medical settings (e.g., electronic health records), with subsequent secondary use of the data for public health purposes. Data protection necessitates the development and implementation of such laws, as they help ensure maximum transparency and democratic legitimacy.¹⁴ The application of general data protection laws, particularly broader legislation, presents significantly greater challenges in the context of health information systems. Under general data protection legislation, the processing

personal data for health purposes is privileged. This applies not only to the processing of data for health protection ("vital interest") but also to the use of personal data for public health purposes. For example, the introductory statement of Article 46 of the GDPR states: "The processing of personal data shall also be considered lawful when it is necessary to protect an interest that is essential to the life of the data subject or another person".¹⁵

Certain types of processing may also serve important public interest grounds and vital interests of the data subject. This includes, for example, processing necessary for humanitarian purposes, such as monitoring epidemics and their spread, or in situations of humanitarian emergencies, particularly during natural disasters or man-made catastrophes.

While information security has traditionally focused on data integrity and availability, data protection has been primarily concerned with processing confidentiality. In recent years, these areas have increasingly converged, with regulatory acts such as the GDPR imposing strict data security requirements on data controllers.¹⁶

The regulation specifies that personal data refers to any information relating to an individual whose identity is either already determined or can be determined.¹⁷ An identifiable individual is one who can be directly or indirectly identified through an identifier, such as a name, identification number, location data, network identifier, or through one or more factors specific to the individual's physical, physiological, genetic, mental, economic, cultural, or social identity.¹⁸

It can be concluded that the EU General Data Protection Regulation applies exclusively to living natural persons

(not legal entities) whose identity can be determined based on certain personal characteristics. This means the Regulation does not apply to individuals who cannot be identified or who present themselves under a false identity, which is particularly relevant in the context of the internet community and individuals who "hide" behind fake online profiles.¹⁹

Since its primary focus is protection, the Regulation specifies what constitutes a violation of privacy. A privacy violation refers to any security breach that results in the accidental or unlawful destruction, loss, alteration, unauthorized disclosure, or access to data that has been transmitted, stored, or otherwise processed.¹⁸ Therefore, legal compliance requires that any activities involving the processing of personal data must adhere to the provisions of the EU General Data Protection Regulation and respect basic human rights and freedoms.

Data processing refers to any activity or set of activities performed on personal data or sets of data, whether automatically or manually. This includes actions such as collection, recording, organization, structuring, storage, modification, retrieval, inspection, comparison, disclosure by transfer, dissemination, or otherwise making data available, as well as matching, combining, restricting, erasing, or destroying data.¹⁹ In essence, this means that any use or handling of data can be classified as a processing operation. This means that controllers (and processors) must implement appropriate security measures to prevent accidental or intentional compromise of the personal data they hold.

Controllers should recognize that while information security is often equated with cybersecurity (protecting networks and information systems from attacks), it also encompasses other aspects, such as

physical and organizational security measures.

Effective organizational and technical measures to protect personal data are crucial for maintaining the trust of individuals whose data is processed, and they will help public health systems secure public support and cooperation from data subjects.

Measures may include not only technical solutions—such as encrypting data both at rest and in transit—but also a comprehensive approach to identity and access management or data governance, which involves classifying data (e.g., as Top Secret, Confidential, or Public). A key aspect of protection is the strict management of administration and access rights. Public health institutions—and healthcare institutions in general—often fail to enforce a stringent "need to know" principle.

Regulations like the GDPR do not specify exact security measures. Instead, they require controllers to implement a level of security that is "appropriate" to the risks posed by the processing. Public health authorities and other stakeholders in the sector should take this into account, considering the latest developments, implementation costs, and the nature, scope, context, and purpose of the process.

Given that the public health sector is often tasked with processing sensitive personal data, such as health and physical well-being information, data subjects will expect a very high level of security for such operations. Additionally, a lack of funds for data security measures is not an excuse, provided those measures are necessary to achieve an "adequate" level of protection.

An important issue is how to handle data compromises that lead to accidental or unlawful destruction, loss, alteration, unauthorized disclosure, or access to personal data. This includes injuries resulting from both accidental and intentional acts. Institutions of any size or setting can easily become overwhelmed by a data breach. Therefore, public health institutions are advised to plan for such eventualities, potentially conducting cyber incident simulations. A data breach plan is essential, with a clear allocation of tasks and responsibilities, including a communication strategy for breaches.

An important tool in this effort is regular penetration testing, conducted by an independent third party.²⁰ In simple terms, the data controller should invite "ethical hackers" to identify weaknesses in the system. Many countries have IT security or cybersecurity agencies that can assist public health institutions in establishing these protocols. For institutions that serve operational purposes, a disaster recovery plan is also critical and demanding.

This means that controllers (and processors) must implement appropriate security measures to prevent accidental or intentional compromise of the personal data they hold.

Protection of Patient Data

Personal health information is a critical element of privacy. This data represents a special and very sensitive category of information. Therefore, the processing of such data is particularly sensitive and must always be conducted in a way that preserves the interests, fundamental rights, and dignity of the individual whose data is being processed. The right to the protection

of personal health-related data is the right to protect an individual's legitimate, moral, and economic interests. This includes safeguarding personal health data from the risk of misuse, as well as from unconstitutional, illegal, or unjustified access and use, and from sanctioning illegal use and abuse.²¹ Individuals (patients) are increasingly losing control over personal data related to their health condition.

Numerous EU regulations include provisions on the protection of an individual's data related to their state of health. However, there is currently no regulation that specifically addresses the issues of personal data protection related to health at the European level. The GDPR aims to facilitate the flow of health data while ensuring the protection of personal (health) data from the risk of misuse, as well as from all illegal, unwanted, and unnecessary access and use of that data. In other words, a high level of protection for health-related personal data must be ensured. It is essential to continually strengthen and develop new technologies and monitoring mechanisms that enable the detection and sanctioning of potential violations of the fundamental right to the protection of personal data related to health.²²

Health services provided to patients for different purposes must be legally regulated. The obligation of confidentiality and storage of personal data about the patient and his health condition opens several important, complex and sensitive legal and ethical issues. The successful development of cross-border health services also depends on the trust of the users of these services (patients) that their privacy will not be compromised, that is, that their health data will be used and protected in an appropriate manner.²³

Directive 2011/24/EU on the application of patients' rights in cross-border healthcare (hereinafter referred to as Directive 2011/24/EU) addresses the cross-border transfer and protection of personal data related to patients' health. This Directive establishes rules to facilitate access to safe and high-quality cross-border healthcare and to promote cooperation in the healthcare sector between member states, while fully respecting national competencies in the organization and provision of healthcare.²⁴ According to Article 14 of Directive 2011/24/EU, the Union supports and facilitates cooperation and the exchange of information between member states, acting as part of a voluntary network that connects state authorities responsible for e-health, as appointed by the member states.

The goals of the e-health network are to: (1) provide sustainable economic and social benefits of European e-health systems and services, with interoperable applications aimed at achieving a high level of trust and security, improving the continuity of healthcare, and ensuring access to safe and high-quality healthcare; (2) develop guidelines on a standardized list of data to be included in patient summaries for use by healthcare professionals to enable continuity of cross-border healthcare and ensure patient safety; (3) establish effective methods for enabling the use of medical data for public health and research purposes; and (4) support member states in developing common measures for identification and verification to facilitate the secure transfer of data in cross-border healthcare.²³ These goals are pursued with full respect for data protection principles as stated in Directives 95/46/EC and 2002/58/EC.

The protection of personal data, as mandated by numerous international and national regulations, is crucial for safeguarding the right to respect private life. The right to personal data protection and the right to respect for private life are two distinct yet closely related fundamental rights. According to the established practice of the EU Court, the right to personal data protection must be balanced with other fundamental rights. This right is essential for ensuring respect for private life.

Personal health information is a critical aspect of privacy. This information constitutes a special and highly sensitive category of data. Therefore, the processing of such data is particularly sensitive and must always prioritize the interests, fundamental rights, and dignity of the individual whose data is being processed. The right to protect personal health-related data includes the protection of an individual's legitimate, moral, and economic interests. This encompasses safeguarding personal health information from risks of misuse, as well as from unconstitutional, illegal, or unjustified access and use, with appropriate sanctions for illegal use and abuse.²¹ However, individuals (patients) are experiencing decreasing control over personal data related to their health condition.

Numerous EU regulations include provisions for protecting an individual's health-related data. However, there is currently no regulation specifically addressing personal data protection in healthcare at the European level. Implementing the GDPR is essential not only for the effective operation of healthcare services but also for safeguarding the rights of both employees and patients. In the healthcare sector, personal data is continuously collected, processed, and stored, encompassing everything from patient health records to

sensitive employee information. Without robust data protection measures, there is a substantial risk of unauthorized access, data breaches, or misuse, which can erode trust in healthcare systems and jeopardize individuals' privacy.

For patients, the GDPR safeguards their personal and health-related data, giving them control over who accesses their information and how it is used. It provides them with the right to know what data is being collected, the ability to request corrections, and the right to withdraw consent. For healthcare employees, the GDPR ensures that their personal data is handled responsibly, granting them rights like those of patients in terms of privacy protection. Additionally, implementing the GDPR in healthcare is essential for maintaining compliance with European standards, promoting transparency, and building trust between healthcare providers and patients. It encourages healthcare institutions to adopt best practices in data protection, which not only upholds individuals' rights but also strengthens the integrity and efficiency of healthcare services.

The GDPR should facilitate the flow of health data while simultaneously protecting personal (health) data from misuse, as well as from any illegal, unwanted, or unnecessary access and use. In other words, a high level of protection for health-related personal data must be ensured. It is essential to continually strengthen and develop new technologies and mechanisms for detection and monitoring, which in practice enable the identification and sanctioning of potential violations of the fundamental right to personal data protection in relation to health.

Article 17 of the Personal Data Protection Act classifies data from health records as highly sensitive. The same article stipulates

that processing data that reveals the health status of an individual is prohibited. Exceptions to this prohibition are allowed if the processing is necessary for purposes such as preventive medicine, medical diagnostics, assessing the working capacity of employees, providing healthcare services, improving the healthcare system, or fulfilling public interest in the field of public health. In these cases, data processing is permitted, but only with the application of appropriate measures to protect the rights of the individuals concerned. This means that issues arise when personal data protection measures are not implemented, allowing everyone access to the most sensitive data, even with patient approval.

Healthcare workers play a critical role in safeguarding personal health data. Accordingly, they have a strict duty to maintain the confidentiality of any data they acquire in the course of their work. However, they may be exempt from this duty only with the written consent of the patient or their legal representative, or by the decision of the competent court.

Protection of Patient Data in Serbia

The digitization and advancement of technology, the growing use of data across various fields, and new regulatory acts introduced in Europe have prompted Serbia to take legislative action on personal data protection. As a result, in 2018, Serbia adopted the Law on Protection of Personal Data, replacing the previous law that had been in effect since 2008.²

With the increasing number of digital platforms and data processing systems involving health information, there is a real risk of data misuse, which could have serious consequences for patients' privacy and security. Therefore, it is essential to enhance the protection of this data and

establish legal mechanisms to ensure its security.

The Law on Patients' Rights of the Republic of Serbia²⁵ includes provisions that define patients' rights to access healthcare and how these rights can be exercised and protected. These provisions are directly related to the protection of patient privacy and represent a form of realizing the right to patient privacy. The law specifically addresses patients' rights to privacy and confidentiality, guaranteeing the right to privacy regarding all personal information shared with healthcare professionals or associates. This includes information about their health condition, potential diagnostic and therapeutic procedures, as well as the right to privacy during diagnostic tests and treatment (Article 14). Patients are guaranteed the right to privacy and confidentiality of all personal information communicated to the responsible healthcare professional or associate, including details about their health condition and any diagnostic or therapeutic procedures, as well as the right to protect their privacy throughout the diagnostic and treatment process.

Patients have the right to access their medical records, and denial of this access constitutes a violation of their right to privacy and confidentiality. However, this access must not disrupt established procedures within healthcare and other institutions that must be followed when exercising the right to review records (Article 20). In cases where the patient is a child or a person deprived of legal capacity, the legal representative has the right to access the medical records. A child who has reached the age of 15 and possesses mental capacity also has the right to access their own medical records.

Jonev Ćiraković K.: Patients' Rights

The healthcare professional in charge is responsible for properly maintaining medical records in compliance with the law. They must document all medical measures taken for a patient, including: the case history, diagnosis, diagnostic procedures, therapy, therapy outcomes, and any advice given to the patient (Article 20).

The right to confidentiality of patient health data: Health status data, or data from medical records, is considered personal and particularly sensitive information under the law. Individuals who unlawfully handle or disclose this data without the patient's or legal representative's consent, thereby violating this Article, are held accountable for the unauthorized disclosure of sensitive data in accordance with the Law (Article 21).

Health professionals, health associates, and other employees working under the employer's authority may only be relieved of their duty to safeguard this data in accordance with the Law, and only upon written consent from the patient or their legal representative, or by a court decision. If the patient or legal representative provides a written statement or authorization, notarized by the competent authority and kept in the medical records, granting consent for the disclosure of health information, the responsible health professional may disclose details about the patient's health condition. Additionally, the competent health professional may disclose information about the patient's health to an adult member of the immediate family if the patient has not given consent, provided this disclosure is necessary to avoid potential health risks to the family member (Article 22).

The patient or their legal representative is entitled to a copy of medical records, with the costs of duplication covered by the patient or representative. Copies of records for a deceased family member may be

provided to an adult family member or legal representative upon request for legal purposes. Medical data or copies may be shared with certain entities, such as health insurance organizations and judicial authorities, when required by law. Additionally, medical records may be used for scientific research with the patient's consent, with all data handled as particularly sensitive personal information in compliance with legal standards (Article 23).

In the case of the Republic of Serbia, it is important to mention an obligation of the Institute for Public Health regarding data breaches. This obligation is a special rule in relation to the general data protection system. Specifically, the Institute for Public Health is required to notify the person to whom the data pertains, the ministry responsible for health affairs, and the Commissioner of any violation of the security of personal data.

The purpose of notifying healthcare institutions and individuals is to act efficiently and from different perspectives on the injury, preventing its negative effects. This is particularly important because the data involved can reveal sensitive personal information that could affect an individual's personal, professional, and social position or status. If the Institute of Public Health fails to inform these parties about the violation, it may face a fine ranging from 50,000 to 2,000,000 dinars.

Patients have the right to access their personal data stored in medical records. The option to review this data should also be available online, but only if the data protection measures outlined in the Law on the Protection of Personal Data are ensured. Security and safety measures must be implemented by all healthcare institutions, private practices, and other legal entities within the medical sector.

Controllers should recognize that while information security is often equated with cybersecurity (protecting networks and information systems from attacks), it also encompasses other aspects, such as physical and organizational security measures.

Conclusion

One of the significant consequences of the development of information technologies over the past twenty years is the enormous increase in the amount of data about individuals. The free flow of information is both a necessity and a great danger to privacy, independence, and individuality.

A significant step forward in creating a personal data protection system was the adoption of GDPR. This regulation not only harmonized norms and practices at the EU level but, since its implementation in 2018, has had a major impact on the development of data protection systems in many countries around the world, including Serbia.

Patient health data is a critical element of privacy. This data is a special, highly sensitive category of information. Therefore, the processing of such data is particularly sensitive and must always be carried out in a way that preserves the interests, fundamental rights, and dignity of the individual whose data is being processed.

Establishing a strong, clear, and modern framework for data protection in the EU and Serbia that can address the numerous challenges of the modern digital age and the global digital market, while raising the culture of privacy and protection of personal data to a higher level, is essential.

Conflict of Interest

The author declares no conflict of interest.

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Original Article**THE USE OF INVIGILATED EXAMS IMPROVED STUDENTS' ATTITUDES TOWARDS BIOPHYSICS: A QUASI-EXPERIMENTAL STUDY****Manca Pajnič¹, Ljubiša Pađen¹, Judita Lea Krek¹, Željko Vlasisavljević², Veronika Kralj-Iglič¹**¹Faculty of Health Sciences, University of Ljubljana, Ljubljana, Slovenia²Medika College of Vocational Studies in Healthcare, Belgrade, Serbia**Received:** June 25, 2024; **Revised:** October 25, 2024; **Accepted:** November 6, 2024**Published:** November 25, 2024**DOI:** 10.5937/annnur2-51803**Abstract****Background**

Negative attitudes and insufficient motivation to study can contribute to poor outcomes when teaching biophysics. Fear of failure can be alleviated by using invigilated exams.

Aim

The aim of this study was to investigate whether invigilated exams impact students' self-reported effort to study, their attitudes, and the factors that promote academic performance.

Materials and Methods

A single-group post-test quasi-experimental study was conducted to explore the attitudes of a sample population. Data was collected using a questionnaire specifically developed for this study. The sample consisted of 472 students from four consecutive academic years (generations). Descriptive statistical methods were applied for data analysis, and average values were compared using the Student's t-test.

Results

Over 80% of students in the first generation reported a high level of fear of failure. After the introduction of new examination methods, this number decreased significantly by more than 20% ($p < 0.001$, $P = 1$). Concurrently, the time spent studying increased by over 40% ($p = 0.006$, $P = 88$). Furthermore, nearly all students (99%) believed that using information and communication technology (ICT) and social networks enhanced their academic success.

Conclusion

The findings indicate that information and communication technology have a positive, though limited, effect on students' motivation to learn biophysics and their attitudes toward the subject.

Keywords: learning, physics, academic performance, students, health, internet.**Corresponding Author:** Manca Pajnič, e-mail: manca.pajnic@zf.uni-lj.si

Introduction

Physics provides fundamental knowledge across all scientific disciplines that involve matter and energy, including living systems. It is based on a model approach that enables the prediction of system behavior, which can then be manipulated. In health and medical sciences, understanding the mechanisms of diseases is crucial, making physics—particularly biophysics—a powerful tool. Ultimately, the goal of health and medical sciences is to understand the origins of physiological and pathophysiological processes. Additionally, biophysics helps explain the interactions of living beings with foreign objects and provides insight into the body's interior (e.g., various imaging techniques). As a result, biophysics is integral to diagnostics, therapy, and prevention¹.

Mastering fundamental approaches in physics enables students to develop a critical perspective on problem-solving. They learn to break down complex problems into manageable parts, cultivate patience, and estimate the effort required to solve the problem. Solving problems in health and medical sciences often requires collaboration and teamwork, necessitating assistance from other fields of knowledge². This interdisciplinary and transdisciplinary teamwork proves effective, especially when individuals possess some knowledge of all the involved disciplines^{3,4}. Given these factors, it is highly beneficial for health sciences students to study physics and biophysics.

However, motivation to learn and acquire new knowledge depends on various factors, including interest, curiosity, effort, time, financial resources, age, experiences, and the methods used in the educational process^{5,6}. Students who are highly motivated to learn attain deeper knowledge with long-term retention⁷. There have been calls for better physics education for future health and life scientists, but students who do not

major in physics are often insufficiently motivated to study it^{8,9}.

Invigilated examinations are considered a negative motivation factor by some students. The open-book examination format was first introduced in¹⁰ to reduce fear and emotional blockages^{11,12}, but open-book exams can, on the other hand, lead to a decrease in study effort^{13,14} and motivation for study. The use of information and communication technology (ICT)—such as computers, tablets, audio devices, cameras, mobile phones, software, educational materials (e.g., texts, movies, cartoons, animations), the internet, and social networks¹⁵ present an opportunity to improve health science students' attitudes toward biophysics. Electronic devices have improved performance in many scientific fields and in everyday life. Including these methods seems to better simulate reality compared to situations where the student is isolated¹⁶. However, lecturers often equate the use of electronic devices during exams with cheating¹⁷. Some educational institutions explicitly prohibit mobile phones and electronic devices during exams. We believe that the fear and outrage of lecturers could be overcome by finding effective ways to use new tools and methods in teaching physics. This work reports on our attempt to improve students' performance, motivation to learn biophysics, and attitudes toward biophysics by introducing information and communication technology into the study, particularly in examination activities.

The purpose of this study was to explore students' views on overall devotion and attitudes toward biophysics, as well as their perceptions of problem-solving. Specifically, we aimed to investigate whether invigilated exams influence students' self-reported study effort, attitudes, and factors that facilitate academic performance.

Materials and Methods

Study Design

A single-group post-test quasi-experimental study was conducted on a sample of 471 health sciences students. As part of this quasi-experiment, students participated in a 4-hour physics problem-solving session (PPSS), which involved solving problems related to orthopedic clinical conditions. The task was to produce (calculate) a biomechanical analysis using information and communication technology. After completing the PPSS, students were given a questionnaire to assess both extrinsic and intrinsic motivation factors for learning biophysics, to express their attitudes toward the problem-solving methods, and to evaluate the usefulness of these methods for their academic success.

The Instrument

A general questionnaire was developed based on a literature review^{7,14,19}. The questionnaire covered three major themes: 1) questions related to students' overall devotion to biophysics, 2) students' perceptions of biophysics, and 3) self-assessed facilitators of academic performance. The questionnaire included 22 statements, with responses given in a simple yes/no format, a 1-5 Likert scale ranking, and a rating of the statements by importance (from 1 to 8). The questionnaire did not include demographic data as the sample consisted of first-year full-time students.

The Sample

First-year students from four study programs at the Faculty of Health Sciences, University of Ljubljana, were invited to participate in the study. Responses were collected from 472 students (2013: n=193, 100%; 2014: n=123, 100%; 2015: n=81, 100%; 2016: n=75, 100%) (Tables 1-3). Participation was voluntary, and anonymity

was ensured as no personal data were collected.

Data Analysis

Average values and standard deviations were calculated for each parameter in each generation and overall. When applicable, the average values were compared using the t-test. The statistical significance of the differences was determined by the probability (p) and statistical power (P) of the difference at $\alpha = 0.05$.

Ethics

The institution granted approval to conduct this research.

Results

Students' view on overall devotion to the biophysics

The human body is subject to laws of physics, so in question 1 (Q1) in Table 1 we failed to reach 100% positive answers by 2%. Considering all four generations, the students studied on average 15 hours to prepare for the problem solving. Most satisfying was that the time spent for study during preparation for problem solving increased considerably after introduction of new methods in 2012/2013 and stayed about the same in 2014/2015, but decreased again in 2015/16 (Table 1, Q2). The difference between 2012/2013 and 2013/2014 generations' results was statistically significant with sufficient statistical power ($p=0.006$, $P=0.88$). 77% of students wished to study more (Table 1, Q3) while 64% were not satisfied with their knowledge of biophysics, regardless of their success at exam (Table 1, Q4).

Table 1: Students' view on overall devotion to the biophysics considering generations of academic years 2012/2013. 2013/2014. 2014/2015 and 2015/16.

Study year	2012/2013		2013/2014		2014/2015		2015/2016		Overall	
	193		123		81		74		471	
Sample size										
Portion of positive answers or numeric result	No.	%	No.	%	No.	%	No.	%	No.	%
1 Human body is subjected to laws of physics.	184	95.3	116	94,3	79	97.5	74	100.0	454	96.4
2 How many hours aside of lectures did you study biophysics?	126	65.3	96	78.1	75	92.6	73	98.6	370	78.6
3 I could not study as much as I wished to.	173	89.6	115	93.5	79	97.5	74	100.0	441	93.6
4 Regardless of success at examination I am not satisfied with my knowledge on biophysics.	149	77.2	112	91.1	75	92.6	73	98.6	409	86.8

Continuation of Table 1.

5	I'm happy when I solve a physical problem.	188	97.4	121	98.4	80	98.8	74	100.0	464	98.5
6	It happened to me that I quit studying because I couldn't solve a problem.	187	96.7	118	95.9	78	96.3	74	100.0	457	97.0
7	It came to my mind that I will never pass the biophysics exam.	185	95.8	121	98.4	80	98.8	74	100.0	461	97.9
8	Fear of failure was positive as I studied more.	166	86.0	116	94.3	75	92.6	74	100.0	432	91.7
9	Fear of failure was negative as I studied less effectively.	173	89.6	117	95.1	77	95.1	74	100.0	442	93.8
10	Grade the biophysics course on a scale from 1-5 according to how demanding it was (1-not demanding. 5-very demanding).	192	99.5	123	100.0	81	100.0	74	100.0	470	99.9

Table 2: Students' perceptions toward biophysics considering generations of academic years 2012/2013, 2013/2014, 2014/2015, and 2015/2016

Study year	2012/2013		2013/2014		2014/2015		2015/16		Overall	
	No.	%	No.	%	No.	%	No.	%	No.	%
Sample size	193		123		81		75		472	
Portion of positive answers	No.	%	No.	%	No.	%	No.	%	No.	%
1. I believe that understanding physical phenomena would be useful in my future work.	163	84.5	111	90.2	76	93.8	75	100.0	425	90.0
2. I don't know how I could use physics in my future work.	165	85.5	113	91.9	77	95.1	74	98.7	429	90.9
3. I think I understand some physical phenomena.	175	90.7	117	95.1	80	98.8	75	100.0	447	94.7
4. I have learned of physical phenomena which I do not fully understand.	164	85.0	112	91.1	79	97.5	72	96.0	427	90.5

Almost all students (97%) are happy when they solve a physical problem (Table 1, Q5) while it happened to as many as 27% that the failure to solve the problem was so distressing that they stopped studying (Table 1, Q6). A very high percentage (76%) of students were presented with fear that they will never be able to pass the exam (Table 1, Q7). When the new methods were introduced, this percent was 84%. It dropped considerably and statistically significantly (for 20%, $p < 0.001$, $P = 1$) in the next year, possibly because the students learned from their seniors of high success in the previous year. Nevertheless, the percentage of students that feared that they would never pass the exam remained high (more than 60%, Table 2). Only 57% of students found fear stimulating to study more while 38% found it a cause of poor effectivity (Table 1, Q8 and Q9, respectively). Students rated biophysics a difficult subject (4.36 out of 5, Table 1, Q10), but some of them (23%) were positively surprised at their performance (Table 1, Q11).

Students' perceptions toward biophysics

Most students (86%) think that understanding physical phenomena would be useful in their future work, but only 35% have an idea how this will take shape (Table 2, Q1 and Q2, respectively). Most students (93%) thought that they understand some physical phenomena (Table 2, Q3) which is a fair result. But only 87% of students were critical and acknowledged that they learned of phenomena they did not understand (Table 2, Q4). Only 3% of students claimed that they were bored while almost all students (99%) have learned something new (Table 2, Q5 and Q6, respectively). These results indicate positive attitudes of students towards biophysics, as most of them believe that it will be useful to them and that they are able to understand at least some of it. As regards the contents of the course, it was new and interesting to almost all students, however, apparently not enough evidence was

presented for them to see how physics and biophysics can be used in their profession and not enough knowledge was gathered for them to attain a critical point of view.

Assessed facilitators of academic performance

In can be seen from Table 3 that students of all four generations thought that perception ability it is the most important, followed by the impact of the lecturer. Persistence in study and positive attitudes towards biophysics turned out close in importance while classical disciplines literature, peer counseling, enough time and peaceful environment were counted lower. In preparing for the PPSS Internet was at the bottom of the list. However, students were unanimous (100%) that use of internet and electronic devices increased their success when they had to perform (Table 1, Q12).

Discussion

Pickens¹⁸ defined attitude as a mindset or tendency to act in a particular way due to both an individual's experience and temperament. In science education, four areas of attitude objects have been identified¹⁹ : attitudes toward the science subject itself, attitudes toward learning the science subject, attitudes toward the topics and themes covered in a particular course, and attitudes toward the methods of science. Attitudes are developed through experience and exert a directive and/or dynamic influence on behavior^{6,19}. Moreover, attitudes tend to be relatively stable and often lead to consistent patterns of behavior²², while negative attitudes can have potentially harmful effects at personal, social, or national levels¹⁹. Students' academic success is correlated with their attitudes toward physics^{9,22}.

To improve students' attitudes toward biophysics, we introduced the use of information and communication technology (ICT) in problem-solving activities. We

Table 3: Assessed facilitators of academic performance at PPSS considering sample of academic years 2012/2013. 2013/2014. 2014/2015 and 2015/16.

Study year	2012/2013	2013/2014	2014/2015	2015/16	Overall
Sample size	193	114	76	75	458
Rank	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 Perception ability	3.12 (1.78)	3.33 (1.78)	3.37 (2.10)	3.73 (2.20)	3.32 (2.01)
2 Lectures and lecturers' guidance	3.31 (2.01)	3.44 (1.86)	3.87 (1.93)	3.77 (1.92)	3.51 (2.44)
3 Persistence in learning	3.89 (2.03)	4.14 (2.11)	4.24 (2.28)	4.28 (1.84)	4.07 (2.05)
4 Positive attitudes towards physics	4.20 (2.52)	4.04 (2.65)	4.64 (2.40)	4.03 (2.57)	4.20 (2.56)
5 Good notebook and other support	4.39 (1.96)	4.12 (2.04)	4.69 (2.04)	4.40 (1.92)	4.38 (2.01)
6 Peer counselling	5.96 (1.77)	5.09 (2.18)	4.34 (2.44)	4.35 (2.52)	5.21 (2.14)
7 Enough time and peaceful environment for learning	4.79 (1.85)	5.46 (1.76)	5.57 (1.95)	5.55 (1.76)	5.21 (1.81)
8 Internet access	6.31 (2.17)	6.26 (2.17)	5.33 (2.38)	5.65 (2.67)	6.03 (2.55)

tracked the responses of students in four consecutive generations regarding their devotion to and attitudes toward biophysics. Our findings showed that most students found biophysics useful and interesting, a sentiment that did not change with the introduction of new methods. However, students initially expressed a high level of fear of failure, which significantly decreased after the new methods were introduced (Table 1, Q7). This change was accompanied by an increase in the time spent studying (Table 1, Q2). Furthermore, allowing unlimited resources (thus eliminating cheating) did not automatically lead to successful problem-solving or high-quality presentations of solutions.

While fear of failure had some short-term positive effects—students claimed they studied more to avoid failure—we believe that the positive impact of fear is only temporary. In the long term, it does not outweigh the negative effect of turning students away from biophysics. We argue that motivation driven by genuine interest in the subject, rather than fear of failure, will yield long-term benefits. This type of motivation encourages students to engage with the methods and continue expanding their knowledge throughout their professional lives.

It is during early high school or even primary school years that students tend to develop negative attitudes toward physics.⁶ We believe that the high degree of fear in our students results from values imposed by teaching processes in primary and secondary schools. In these systems, students must solve problems with known solutions without mistakes to achieve high scores. Furthermore, "understanding" the phenomena is often emphasized, which sets physics apart from subjects that primarily require rote memorization²³. Teaching non-physicists at the university level presents additional challenges. For health sciences students, biophysics should be integrated into the

respective fields and address relevant, often complex problems. These problems are usually not well-understood by anyone, and the conventional approach of manipulating already known solutions is of little help. Additionally, insisting on complete understanding at every stage of the problem-solving process is counterproductive; not understanding the phenomena is often the driving force behind scientific inquiry.

A lecturer who practices science in both physics and health sciences can present students with original and relevant problems. These problems may not yet have solutions, and the lecturer must be willing to set aside their pride and use cutting-edge methods to invite students to propose potential solutions. Students will learn that accepting the frustration of not understanding a problem is an essential part of contributing to the process.

Previous studies have indicated that physics lecturers can play a crucial role in increasing students' interest, motivation, and satisfaction as well as in fostering motivation through personal approaches, appropriate teaching methods, and assessments^{26,27}. Our results show that students also found the lecturer's impact to be an important factor (Tables 3 and 4), which aligns with previous findings. The introduction of ICT into physics teaching further enhances the lecturer's role. To encourage the necessary skills for problem-solving—such as using existing knowledge, developing original approaches, improving communication skills, and fostering persistence—the lecturer can provide students with a variety of problems: some with known solutions, others that can be solved by combining existing solutions, and original ones with no known solution. These problems often stem from the lecturer's own scientific work, establishing a natural connection between science, profession, and teaching.

Therefore, it is crucial that physics lecturers in health sciences courses (including medicine) are active scientists engaged in both biophysics and health sciences/professions.

Conclusion

Our results have shown that information and communication technology can positively affect students' motivation for learning biophysics and their attitudes toward biophysics. However, the internet as a facilitator of academic performance was reported as the least important factor. Students reported that traditional methods, such as lectures and lecturers' guidance, are of great value. This study indicates that invigilated exams might be considered useful in improving the methods of teaching biophysics in health sciences and enhancing students' academic success. Students reported that traditional methods, such as lectures and lecturers' guidance, are of great value.

Acknowledgements

Authors acknowledge the support from the Slovenian Research Agency Program P3-0388.

Funding

This work was partially supported by Javna agencija za raziskovalno dejavnost RS/ Slovenian Research Agency under the grant Program P3-0388.

Conflict of interest

The authors declare no conflict of interest.

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Original Article**BRAIN DEATH****¹Milan Spaić, ³Aleksandar Mandarić**¹Department of Neurosurgery, Military Medical Academy, Belgrade, Serbia²Division of Neurosurgery, Clinical Hospital Centre Zemun, Belgrade, Serbia³Department of Radiology, Clinical Hospital Centre Zemun, Belgrade, Serbia**Received:** 2 September 2024; **Revised:** 1 December 2024; **Accepted:** 2 December 2024**Published:** 3 December 2024**DOI:** 10.5937/annnur2-53146**Abstract****Background**

Brain death is defined as the complete and irreversible loss of brain and brainstem function, although other organ systems in the body may continue to function. Following the onset of brain death, brainstem reflexes are lost sequentially in a craniocaudal direction.

Aim

This investigation aimed to compare clinical diagnostic criteria—specifically brainstem reflexes, such as the pupillary response to light, the corneal reflex, and motor responses to pain stimulation—with the instrumental confirmatory test for brain death using cerebral angiography.

Materials and Methods

A group of 30 patients who underwent cerebral angiography to confirm brain death was reviewed. Early clinical tests indicating brain death were compared with the final confirmatory tests using cerebral catheter angiography in the same patient population.

Results

The initial clinical tests indicating brain death corresponded with the final instrumental confirmatory tests in all patients.

Conclusion

Neurological tests assessing motor responses to painful stimuli, the corneal reflex, and the pupillary light response proved to be as reliable for diagnosing brain death as cerebral angiography.

Keywords: brain, brain stem, death, reflex, brain angiography**Corresponding Author:** Milan Spaić, e-mail: spaicmil@yahoo.com

Introduction

The term *brain death* refers to the irreversible cessation of all brain functions, including those of the cerebral hemispheres and brainstem. From a legal standpoint, brain death is recognized as the definitive death of a person.¹ The term *whole brain death* has been introduced to describe the complete loss of functions in both the cerebral hemispheres and the brainstem.²

From a neurobiological perspective, the death of a human being is not a sudden or instantaneous event. Death is considered a process that ultimately leads to the irreversible cessation of organ function over time. Continued cardiac activity after brain death does not affect the diagnosis of death. It is well-known that cardiac arrest can be reversible; with resuscitation measures, it is often possible to restart the heartbeat. However, the cessation of brain function is a definitive event. In other words, once brain death is diagnosed, it is not possible to restore brain activity.³

The onset of irreversible failure of central nervous system functions consequently leads to the gradual weakening of cardiac and respiratory functions. This process is referred to as the *death process*.⁴ The duration of this process represents the time window during which organ donation is possible.⁵ Thanks to medical support techniques applied in intensive care units, the cessation of cardiac function can be delayed for hours or even days.

Pathophysiology of Brain Death

The ultimate mechanism underlying brain death is an increase in intracranial pressure (ICP) above the mean arterial blood pressure, resulting in the cessation of blood flow to brain tissue. Common causes of this pathophysiological mechanism include head injuries, brain injuries, and spontaneous intracranial hemorrhages, all of which can cause brain edema and elevate

intracranial pressure. Once intracranial hypertension reaches a critical level, brain blood flow ceases, leading to brain death.⁵

The primary goal in treating such patients is to implement measures to reduce intracranial pressure. Surgical procedures aimed at lowering intracranial pressure, known as decompressive surgeries, are considered life-saving interventions.⁶ It is estimated that approximately 5–10% of all patients admitted to intensive care units (ICUs) eventually progress to brain death.⁷

Diagnosis of Brain Death

Three clinical signs are considered crucial for diagnosing brain death: coma, absence of brainstem reflexes, and apnea (cessation of respiratory movements). Before initiating the diagnostic assessment, it is essential to rule out conditions such as hypothermia and metabolic encephalopathy, which can clinically mimic brain death.³

The brainstem contains vital centers responsible for regulating the body's automatic functions, including the respiratory center, cardiac center, cough reflex center, swallowing center, and blood pressure center (Fig. 1).

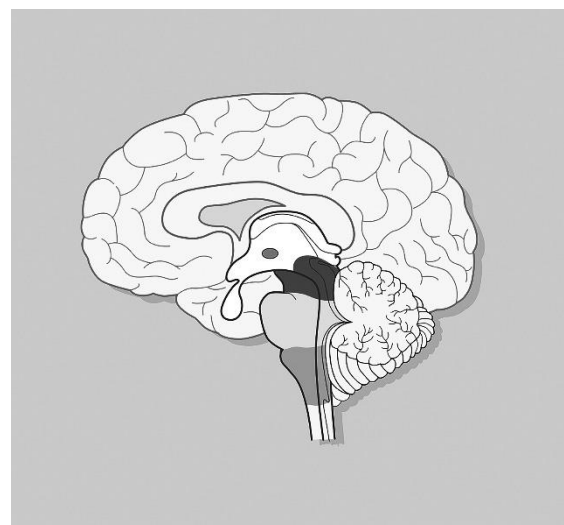


Fig. 1 The brain stem

The pathophysiology of brain death ultimately leads to cessation of respiration, followed by asystolic cardiac arrest due to hypoxemia. The most cranial center in the brainstem controls the pupillary response to light, and thus, a delayed response to light is typically the first sign in the progression toward brain death. This is followed by full dilation of the pupils without light response and absence of the corneal reflex. Finally, the process results in apnea, as the respiratory center is in the most caudal part of the brainstem, the medulla oblongata.⁵

The aim of this investigation was to compare clinical diagnostic criteria—comprising three simple neurological tests—with the instrumental confirmatory test of brain death.

The Tests for Brain Death

1. Pupillary response to light
2. Corneal reflex
3. Motor response to pain stimulation

These clinical tests were compared with the instrumental confirmatory test for brain death, which was:

Brain catheter angiography

Given that the first clinical signs of brain death are lack of reaction to painful stimuli, pupillary dilation, and absence of the corneal reflex, this study aimed to correlate these indicators with the confirmatory findings of cerebral angiography in the same patient population. Cerebral angiography is considered the gold standard for diagnosing brain death, as the absence of intracerebral blood flow demonstrated through this test is regarded as an absolute confirmatory sign of brain death.^{8–10}

The pathophysiology of brain death ultimately leads to the cessation of respiration, followed by asystolic cardiac

arrest due to hypoxemia. The most cranial center in the brainstem controls the pupillary response to light; thus, a delayed light response is typically the first sign in the progression toward brain death. This is followed by full dilation of the pupils without a light response and the absence of the corneal reflex. Ultimately, the process results in apnea, as the respiratory center is located in the most caudal part of the brainstem, the medulla oblongata.⁵

The aim of this investigation was to compare clinical diagnostic criteria—comprising three simple neurological tests—with the instrumental confirmatory test for brain death.

The question addressed was whether the clinical neurological tests were reliable and how confident these tests were compared to the absolute confirmatory instrumental test, cerebral angiography. The three neurological tests are simple and suitable for bedside assessment of brainstem function.

The first test involves examining the size and shape of the pupils and their response to direct light, also known as the photomotor reflex. In this context, dilated pupils that do not react or change size when exposed to strong direct light are consistent with the diagnosis of brain death.¹¹

The second test, also a straightforward bedside test, is the corneal reflex response.¹² (Fig. 2) The corneal reflex refers to the contraction of the orbital and eyelid muscles in response to a light touch on the cornea, typically using a cotton swab.

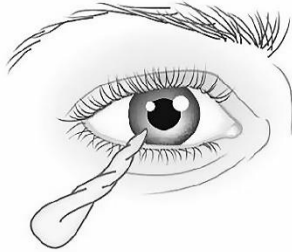


Figure 2. The corneal reflex

Thus, tactile stimulation elicits a vital response, typically a prompt blinking or movement of the eyelid and orbital muscles. However, the absence of this response is consistent with brain death.¹² The third test involves painful stimulation, which would normally provoke movement of the face and/or extremities. Pain stimuli, such as squeezing the skin or applying pressure to the orbital rim, are used to observe any muscle movements in response to intense pain. The absence of movement following painful stimuli is also consistent with brain death.¹³

In this group of patients, angiography was performed at least 6 hours after the initial clinical diagnosis of brain death. This timing adhered to the formal regulations of the national organ transplant program, which mandates that clinical assessments be conducted three times over a 6-hour period before proceeding with the instrumental confirmatory test.¹⁴

The aim of our investigation was to compare the initial bedside clinical diagnosis of brain death with the definitive confirmation of death through cerebral angiography.

Material and Methods

The clinical records of 30 patients who underwent cerebral angiography for confirmation of brain death were reviewed. These patients met the criteria for the national organ transplant program. Cerebral angiography was the final instrumental test used to confirm brain death in this group of patients, who were selected as candidates for the national organ donation program at the Clinical Hospital Centre Zemun, between December 2010 and June 2019.

Neurological follow-up and reflex assessments were conducted by the hospital's Brain Death Team. The team consisted of three members: a neurologist, a neurosurgeon, and an anesthesiologist. The diagnostic protocol included cerebral catheter angiography performed via the transfemoral route.

Results

The patients' ages ranged from 17 to 69 years, with a mean age of 53 years. There were 18 females (60%) and 12 males (40%). The underlying medical conditions were as follows: hemorrhage due to rupture of a brain aneurysm in 12 patients (40%), head and brain trauma in 8 patients (27%), spontaneous intracerebral hemorrhage in 6 patients (20%), massive cerebral ischemia in 3 patients (10%), and malignant brain edema following benign brain tumor surgery in 1 patient (3%).

Overall, vascular pathology was the underlying cause of brain death in 21 patients (70%). The initial clinical tests, including assessments of motor response, corneal reflex, and pupillary response, indicated brain death in all patients. The cerebral angiography, as an instrumental test, confirmed brain death in every patient. The typical scan, showing the absence of

the intracerebral blood flow network—referred to as the "Empty Skull" sign—was observed in each case (Fig. 2).



Fig. 2 Cerebral angiography in brain death shows an absence of the vascular network in the brain, known as the "Empty Skull" sign. Vascular flow is halted at the base of the skull (arrow).

Thus, the initial clinical bedside testing aligned with the final instrumental confirmation in all patients. Our diagnostic criteria, both neurological and instrumental, demonstrated 100% sensitivity, 100% specificity, and a 100% positive predictive value for all 30 patients included in the study.

Discussion

Different approaches to brain death criteria have been recognized in national legislation across various countries.¹⁵ A worldwide study on brain death protocols in 136 countries revealed considerable variability in how brain death is determined. The most used tests were the pupillary reflex (87%) and corneal reflex (86%).¹⁶

The brainstem reflexes, which are integrated within the neuronal circuits of the brainstem, indicate the vitality of the brainstem itself, comprising the medulla oblongata, pons, and mesencephalon (Fig. 1). Our review confirmed that the absence of motor, corneal, and pupillary responses indicated the onset of brain death in each of the 30 patients. The diagnostic protocol proceeded with cerebral catheter angiography, which revealed the "Empty Skull" sign—i.e., the absence of the intracerebral vascular network (Fig. 2).⁹

While computed tomography angiography (CTA) is a noninvasive and widely available technique for determining cerebral blood flow, it is not recommended for routine use in brain death confirmation. This is because CTA may show signal enhancement in the vessels at the base of the skull, which can mimic blood flow. As such, CTA is not considered the method of choice for diagnosing brain death.^{17, 18}

Cerebral pan-angiography has been recognized as the most reliable instrumental test for diagnosing brain death and is considered the gold standard.¹⁹ When clinical criteria plus cerebral angiography, as used in our study, are combined, this approach is considered the gold standard for comparison.¹⁸

It has been emphasized that three specific clinical findings are necessary to confirm brain death: coma, absence of brainstem reflexes, and apnea.¹⁸ Ancillary tests are needed when a neurologic examination cannot be performed. This has been confirmed in our patient group. Our results demonstrate that the absence of brainstem reflex responses resulted from the cessation of blood circulation in the brainstem and cerebral hemispheres.

Conclusion

Simple clinical bedside tests, including motor response to painful stimuli, the corneal reflex, and the pupillary response to light, were shown to be equally reliable as cerebral angiography in determining brain death. Therefore, confirmatory studies are not necessary to diagnose brain death. However, due to the regulatory requirements of the organ transplantation program, confirmatory testing is mandated in cases involving organ procurement.

Conflict of Interest

The authors declare no conflict of interest.

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Review**INTEGRATION OF REHABILITATION SERVICES –
OVERVIEW AND PERSPECTIVES****Anita Kovačić Popović¹, Biljana Stojanović^{1,2}, Dejan Miljković¹**¹ Medika College of Vocational Studies in Healthcare, Belgrade, Serbia² Clinic for Rehabilitation "Dr Miroslav Zotović", Belgrade, Serbia**Received:** October 14, 2024; **Revised:** November 22, 2024; **Accepted:** December 2, 2024**Published:** December 5, 2024**DOI:** 10.5937/annnur2-54107**Abstract****Background**

Rehabilitation is a complex process encompassing various aspects of physical, functional, psychological, and psychosocial health. The integrative rehabilitation method combines different clinical and therapeutic models to create an optimal environment for assessing and treating individuals.

Objective

This study aims to provide an overview of integrative approaches in rehabilitation, identify their advantages and challenges, and explore strategies to improve their implementation in healthcare systems.

Materials and Methods

Relevant scientific research on integrative approaches in rehabilitation was analyzed, focusing on studies addressing multidisciplinary teamwork, individualized treatments, and the application of complementary and integrative methods.

Results

Research indicates that integrative approaches significantly improve functionality and quality of life. Key factors for successful implementation include multidisciplinary teamwork and tailoring treatments to individual needs. Challenges in implementation include service fragmentation and a lack of coordination between different levels of healthcare.

Conclusion

Integrative approaches in rehabilitation offer substantial benefits in enhancing functionality and quality of life. Despite challenges in their implementation, particularly in low- and middle-income countries, investments in resources and training can facilitate the broader application of these methods. Further research is needed to optimize these approaches and maximize their benefits.

Keywords: physical and rehabilitation medicine, health care systems, health services**Corresponding Author:** Anita Popović Kovačić, e-mail: anitakovacic987@hotmail.com

Introduction

Rehabilitation is a complex process that encompasses various aspects of patients' physical, psychological, social, and functional health. While traditional rehabilitation approaches have primarily focused on the physical aspects of recovery, advancements in modern medicine and health sciences have highlighted the need for a more holistic approach. This approach integrates biological, psychological, and social factors to achieve comprehensive recovery. The biopsychosocial model, as the dominant framework in contemporary medicine, emphasizes the interdependence of biological factors, patients' psychological responses, and the social context in which rehabilitation occurs.¹ Healthcare systems worldwide face the challenge of implementing integrative methods into everyday practice while ensuring optimal coordination across different levels of care. Multidisciplinary teamwork has become the cornerstone of this approach, offering continuity of care, treatment adaptation to specific needs, and improving healthcare service efficiency. However, the introduction of integrative approaches also presents obstacles, such as service fragmentation, a lack of resources and professional training, and the complexity of incorporating complementary therapies within healthcare systems in low- and middle-income countries.

This paper aims to provide a comprehensive review of existing integrative approaches in rehabilitation, identify their advantages and challenges, and propose strategies for improving their application within healthcare systems. By analyzing relevant scientific research, this paper will highlight key aspects of multidisciplinary work, the application of individualized treatments, and the integration of complementary methods.

The Importance of the Integrative Approach in Rehabilitation

The integrative approach to rehabilitation combines conventional medical therapies with complementary and alternative methods to ensure comprehensive care tailored to the individual needs of patients. This approach involves the synergy of various disciplines, including medical care, physical therapy, psychological support, occupational therapy, and social rehabilitation. By applying these methods, patients receive not only physical assistance in their recovery but also psychological and social support, which is crucial for holistic recovery and improving quality of life.²

A key aspect of the integrative approach is multidisciplinary teamwork, which enables coordinated delivery of rehabilitation services. Multidisciplinary teams typically include physicians, physiotherapists, occupational therapists, speech therapists, psychologists, social workers, and nutritionists, who collaborate to create individualized treatment plans for patients. This approach provides a holistic understanding of the patient's condition and facilitates better adaptation of treatment to specific needs, ensuring optimal continuity of care.³ The main advantage of multidisciplinary teamwork is its ability to provide comprehensive support for both physical recovery and psychosocial rehabilitation, which contributes to an improved quality of life and a faster return to daily activities. However, although the multidisciplinary approach is widely recognized as the gold standard in rehabilitation, its implementation faces

challenges, particularly in resource-limited countries where a lack of coordination and resources can hinder its effectiveness.⁴

Despite the integrative approach demonstrating significant improvements in patients' functionality and quality of life, its implementation faces several challenges. One major challenge is the fragmentation of services within healthcare systems, which complicates coordination between different sectors of care. In low-income countries, additional obstacles include a lack of financial resources, limited training for healthcare professionals, and insufficient availability of complementary therapies.⁵ Another key issue is the lack of education and certification for complementary therapies among healthcare professionals. Without proper training, these methods may be underestimated or inadequately applied, potentially undermining their benefits for patients. Moreover, greater institutional support is needed, including better infrastructure and policies that promote integrative approaches in rehabilitation.

Integrative medicine emphasizes connecting conventional therapies with evidence-based complementary practices, such as acupuncture, yoga, meditation, massage, and relaxation techniques. These methods are increasingly incorporated into rehabilitation protocols as they contribute to stress reduction, pain relief, psychological stability, and overall patient well-being.⁶ The National Center for Complementary and Integrative Health recognizes these methods as part of the "whole person care model," which addresses both the physical and psychological aspects of health.⁷ Data from various studies on the integration of rehabilitation services, presented in Table 1, provide key insights into global efforts to improve rehabilitation methods through

multidisciplinary teamwork.

Studies by authors such as Reberšek and Salawu highlight the importance of horizontal integration between conventional medicine and complementary methods, particularly in the context of oncology patients and recovery from COVID-19.^{8,9} Reberšek analyzes how integrating complementary methods such as acupuncture and meditation with standard oncology treatments can significantly enhance patients' quality of life by reducing stress and anxiety.⁸ A similar approach is found in Salawu's work, which proposes integrating telemedicine into the rehabilitation of COVID-19 survivors. This method facilitates better coordination among healthcare teams and reduces the burden on hospitals.⁹ He and Tang discuss the challenges and benefits of horizontal and vertical integration within healthcare systems in Asia, where the main issues are resource shortages and weak coordination.¹⁰ These challenges are also reflected in Baigi et al.'s study from Iran, which recommends the digitalization of rehabilitation systems to improve efficiency and standardize services.¹¹ Chu et al. explore the use of technology in rehabilitation clinics and highlight the importance of technological innovations, such as smart clinics and telemedicine, in enhancing the efficiency of rehabilitation services.¹²

Table 1. Overview of studies on the integration of rehabilitation services

Authors (Year)	Country	Study Objective	Method	Results
Reberšek, 2019	Slovenia	To examine the role of integrative oncology as a complement to standard treatments and emphasize complementary methods in cancer care.	Literature review and case analysis.	Integrative oncology significantly improves patients' quality of life by reducing stress, depression, and anxiety during cancer treatment.
Salawu et al., 2020	United Kingdom	To develop a multidisciplinary tele-rehabilitation model for COVID-19 recovery.	Case study and proposal for integrating telemedicine solutions.	The tele-rehabilitation model is effective in addressing the rehabilitation needs of post-COVID-19 patients.
He, Tang, 2021	Hong Kong, Singapore, Malaysia, Indonesia	To analyze the integration of healthcare services for the elderly in Asia.	Literature review (2009–2019).	Early-stage integration models show promise with horizontal and vertical approaches but face challenges in system capacity and functionality.
Baigi et al., 2022	Iran	To recommend registration systems for rehabilitation services.	Literature review.	Digitalization and standardization of rehabilitation systems improve service delivery efficiency in Iran.
Chu et al., 2022	Hong Kong	To propose a smart rehabilitation clinic with integrated technology.	Qualitative analysis and proposal for technological innovations.	Technological innovations, including telemedicine, enhance rehabilitation service efficiency.
Gutenbrunner, 2022	Germany, Italy, Switzerland	To explore the role of nurses in rehabilitation.	Theoretical analysis and reflection.	Nurses play a crucial role throughout all phases of rehabilitation, with recommendations to strengthen their capacities.

Shahabi, 2022	Iran	To explore the integration of rehabilitation services into primary healthcare.	Qualitative interviews with policymakers and healthcare experts.	Proposed policies include increasing political support and empowering healthcare workers to better integrate rehabilitation services.
De Cola et al., 2023	Italy	To describe the hub-and-spoke model for neurorehabilitation.	Quantitative analysis of patient data before and after implementing the model.	Implementation of the hub-and-spoke model increased patient intake and improved the quality of neurorehabilitation care.
Louw et al., 2023	South Africa	To analyze rehabilitation service capacity in South Africa.	Data Survey research using WHO rehabilitation collection template.	Identified challenges in human resources, insufficient integration at the primary healthcare level, and inefficient referral systems.
Zubac et al., 2024	Serbia	To examine the holistic approach to care for individuals with depression and the role of nurses in destigmatization.	A 20-year literature review on holistic healthcare approaches.	Holistic care improves the quality of life for individuals depression and reduces stigma by addressing physical, mental, and spiritual needs.

Meanwhile, Gutenbrunner emphasizes the crucial role of nurses in delivering rehabilitation care, particularly in the long-term rehabilitation of patients with chronic diseases.¹³ In Zubac et al.'s work in Serbia, a holistic approach is applied to patients with depression, where multidisciplinary teams provide psychological support alongside physical therapies. This integration underscores the importance of psychosocial rehabilitation as part of comprehensive healthcare.¹⁴

These studies highlight a growing trend toward the adoption of multidisciplinary teamwork and complementary therapies as fundamental components of integrated rehabilitation services (Table 1).

The integration of rehabilitation services, as presented in Table 2, underscores the complexity and importance of multidisciplinary teams and

complementary therapies in improving health outcomes for various patient populations. The analyzed studies demonstrate that integrative approaches in healthcare systems can significantly enhance patients' quality of life, but also highlight key barriers that hinder their broader implementation.

The integration of rehabilitation services can be categorized into horizontal (across different levels of healthcare) and vertical (within a single level, among different specialties) integration.

Horizontal integration involves connecting primary, secondary, and tertiary care to ensure continuous information flow and coordination among healthcare professionals. He and Tang describe examples of both horizontal and vertical integration in

Asia, emphasizing the crucial role of primary healthcare in linking long-term, curative, and preventive care, particularly for elderly patients.¹⁰ Similarly, a study in Italy discusses horizontal integration through a hub-and-spoke model for neurorehabilitation, where specialized centers support smaller units in rural areas.¹⁶ Vertical integration, particularly through technological support, is also vital for rehabilitation processes. Chu et al. highlight the use of smart systems and telemedicine services in rehabilitation clinics, which improve coordination and allow for personalized care.¹²

Most studies focus on specific target populations in rehabilitation programs. In Asia, He and Tang emphasize the elderly as a key target group, given the increasing prevalence of chronic diseases and the need for long-term care.¹⁰ De Cola et al. in Italy focus on patients with neurological disorders,¹⁶ while Louw et al. in South Africa highlight vulnerable populations with limited access to rehabilitation services.¹⁷ Salawu et al. identify COVID-19 survivors as a new target group, requiring specialized tele-rehabilitation due to the high risk of long-term functional impairments following severe respiratory illness.⁹ In Serbia, Zubac et al. underscore the importance of a holistic approach to treating individuals with depression, where multidisciplinary teams provide psychological support alongside physical therapies. Nurses play a key role in reducing stigma through patient and community education, and the holistic approach helps prevent social isolation.¹⁴ Several barriers hinder the effective integration of rehabilitation services.

In Asia, He and Tang report system fragmentation, lack of coordination, and insufficient staffing as key challenges.¹⁰ De Cola et al. in Italy note limited resources in rural areas, which complicate the maintenance of care quality.¹⁶ Louw et al. identify inefficient referral systems and a

shortage of human resources as obstacles to providing effective rehabilitation services in South Africa.¹⁷ Salawu et al. point out technical barriers to accessing telemedicine, which hinder the implementation of tele-rehabilitation.⁹

The success of integrated rehabilitation systems depends on several factors. Electronic health records and telemedicine technologies, as emphasized by He and Tang and Chu et al., improve coordination and reduce fragmentation in rehabilitation services.^{10, 12} De Cola et al. highlight the importance of regional support and coordination between specialized centers and smaller units.¹⁶ The education and engagement of rehabilitation staff, particularly nurses, as noted by Gutenbrunner et al., are essential for maintaining continuity of care and improving patient outcomes.¹³ In Slovenia, Reberšek emphasizes the importance of a holistic, patient-centered approach in integrative oncology, combining standard oncological treatments with complementary methods like meditation, acupuncture, and lifestyle modifications. This approach helps not only improve physical health but also reduce stress and anxiety, which are crucial for patients with chronic diseases like cancer.⁸

Long-term outcomes from integrated rehabilitation services include reduced hospitalizations, improved quality of life, and better functional results. Salawu et al. emphasize that tele-rehabilitation reduces hospital burdens and accelerates recovery for COVID-19 survivors.⁹ De Cola et al. note that the hub-and-spoke model reduces the need for patient migration to other regions.¹⁶ Louw et al. highlight the socio-

economic benefits of integrated rehabilitation programs in South Africa.¹⁷ Recommendations from these studies stress the need for further development of technological solutions, such as telemedicine and smart clinics, enhanced multisectoral collaboration, and strengthened political and institutional support for integrating rehabilitation services. Shahabi et al. specifically emphasize the importance of increased political support and funding for rehabilitation services in low- and middle-income countries.¹⁵

This analysis explores the key aspects of integrating rehabilitation services from both a global and regional perspective, offering valuable insights into the practical barriers and opportunities for system improvement.

The integration of rehabilitation services through multidisciplinary teamwork and technology holds significant potential to enhance patients' quality of life. However, challenges such as limited resources, insufficient education, and technical barriers hinder broader implementation.

Addressing these issues through focused staff education, investment in digital infrastructure, and the development of holistic programs, including telemedicine, will be crucial for the future of rehabilitation services.

To overcome these challenges and improve the application of integrative methods, several key strategies should be prioritized. First, professional training is essential. Developing training programs for healthcare professionals will ensure that they are better equipped to understand and apply complementary therapies within rehabilitation.

Additionally, healthcare systems must be strengthened by improving infrastructure and investing in the integration of care across different levels. Lastly, further research is required to validate the benefits of the integrative approach in rehabilitation, particularly in resource-limited settings.

Research focusing on the long-term outcomes of rehabilitation and the effectiveness of integrative methods for specific patient populations could provide valuable insights. Such studies are critical for optimizing these approaches and expanding their application, especially in low- and middle-income countries.

Table 2. Key aspects of rehabilitation service integration

Authors	Type of Integration	Population	Integration Model	Barriers	Factors	Outcome	Recommendation
Reberšek, 2019	Horizontal integration between standard oncology and complementary methods	Patients with various types of cancer	Combination of standard medical treatments with complementary methods	Lack of communication between patients and doctors regarding complementary methods	Active patient involvement in therapy selection, professional guidance, and education on complementary methods	Improved quality of life, reduced stress, and better clinical outcomes	Education and communication between patients and doctors about complementary therapies
Salawu et al., 2020	Multidisciplinary integration	COVID-19 survivors	Tele-rehabilitation through multidisciplinary teams	Lack of digital infrastructure in certain regions	Access to telemedicine and education of healthcare workers	Reduction of hospital burden and improvement of quality of life	Further development of telemedicine solutions

Kovačić Popović A. et al. Integrated Rehabilitation

He, Tang, 2021	Horizontal and vertical integration of healthcare services in Asia, focusing on the connection between primary, secondary, and tertiary care	Elderly population	Regional healthcare systems and public-private integrations, including multidisciplinary teams	Staff shortages, poor coordination, and inadequate resources. Additionally, insufficient role of the private sector in some systems	Electronic health records and continuity of care, but there is a need to strengthen the integration of the private sector	Improved care coordination and reduction of unnecessary hospitalizations	Further development of electronic systems and strengthening of teamwork
Baigi et al., 2022	Primarily horizontal, with an emphasis on the implementation of a national registry	Patients in rehabilitation	Standardization and digitalization of rehabilitation systems through a registry	Lack of data and technical capacities, weaknesses in staff education and training	User education and data transparency	Improvement of rehabilitation services quality	Increased investment in digital infrastructure and staff training
Chu et al., 2022	Vertical integration of technologies in rehabilitation centers	Patients with disabilities	Smart rehabilitation clinics with telemedicine	Technical barriers and implementation costs	Technological innovations, such as telemedicine and artificial intelligence	Increased efficiency and cost reduction	Expansion of telemedicine services and user education
Gutenbrunner, 2022	Horizontal integration within rehabilitation teams	Patients with chronic conditions	Inclusion of nurses in all stages of rehabilitation	Lack of specialized training for nurses in rehabilitation	Strengthening the role of nurses and multidisciplinary collaboration	Improving patient outcomes through long-term care	Specialized training for nurses in the field of rehabilitation

Kovačić Popović A. et al. Integrated Rehabilitation

Shahabi, 2022	Horizontal and vertical integration primary healthcare	Inclusion of mobile teams and tele-rehabilitation	Lack of financial resources and weaknesses in training	Strengthening political support and increasing the budget	Reduction of hospitalizations and improvement of quality of life	Increasing political support and budget for rehabilitation services	People with disabilities
De Cola et al., 2023	Horizontal integration in neuro-rehabilitation	Neurological patients	Hub and spoke model for neuro-rehabilitation	Limited resources in secondary centers	Increased patient admissions and improved care	Improved accessibility and quality of care	Further expansion of the model to other areas of rehabilitation
Louw et al., 2023	Horizontal integration within the public sector	Vulnerable population in South Africa	WHO template for data collection on rehabilitation	Lack of human resources and inefficient referral systems	Use of shared data and multisectoral collaboration	Improving the accessibility of rehabilitation services	Strengthening multisectoral collaboration and support at the national level
Zubac et al., 2024	Horizontal integration through the application of a holistic approach in the care of patients with mental disorders	Individuals with depression and anxiety, including those with chronic illnesses	Holistic programs that include lifestyle changes, physical activity, improvement of social support, and spiritual care	Insufficient public education on depression and stigmatization of patients	Education for nurses and the population, individualized care, and a multidisciplinary approach	Improving the mental and physical health of patients, reducing stigmatization, and enhancing social relationships	Continuous education for nurses on holistic care and patient destigmatization

Conclusion

The integrative approach to rehabilitation is an innovative and comprehensive healthcare method that addresses the physical, psychological, and social aspects of recovery. Through the collaboration of multidisciplinary teams and the incorporation of complementary therapies, this approach enables personalized treatments that improve patients' functionality and quality of life. However,

challenges in implementation remain, particularly in resource-limited countries.

To address these challenges, further research, along with strategic investments in professional education and healthcare infrastructure, are essential for enhancing the efficacy and reach of integrative rehabilitation approaches.

Conflict of Interest

The authors declare no conflict of interest.

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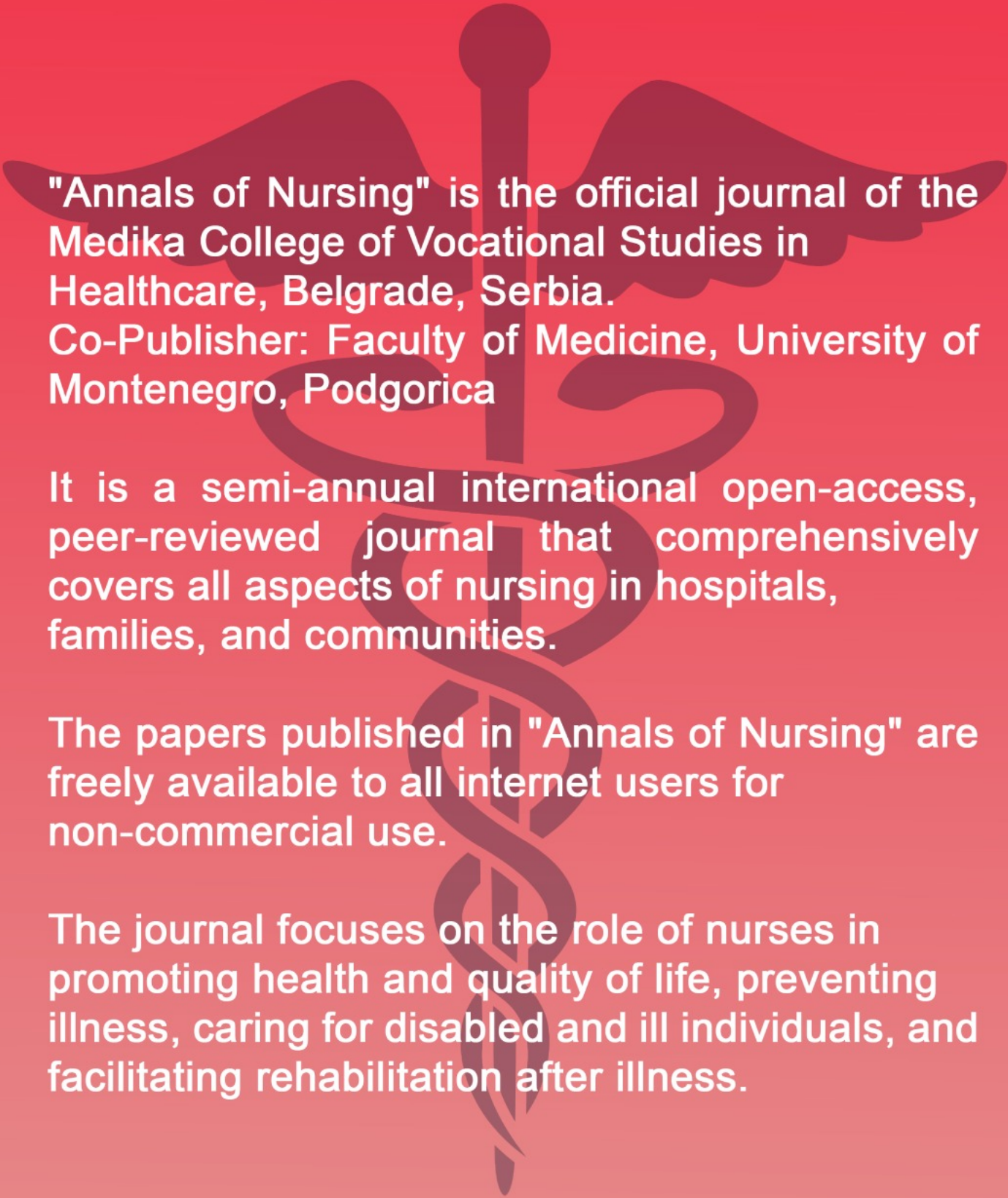
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Polugodišnje. - Drugo izdanje na drugom medijumu:

Annals of Nursing (Online) = ISSN 2956-0306

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