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Editorial

Ethical Problems and Possible Limitations from the Use of AI in Medicine

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Artificial Intelligence (AI) is rapidly transforming the field of medicine, providing groundbreaking innovations in diagnosing, treating, and caring for patients. Despite its benefits, the incorporation of AI in healthcare raises ethical issues and constraints that must be carefully addressed. The major ethical concerns include bias and fairness, transparency and explainability, privacy and confidentiality, accountability, informed consent, autonomy and human oversight, economic and accessibility challenges, and other issues related to AI algorithms.

Bias and Fairness. The incorporation of Artificial Intelligence (AI) into medical practice holds great potential for advancing diagnostics, treatment planning, and patient care. Yet, the ethical dilemma of bias and fairness poses a significant challenge that must be tackled to guarantee equal healthcare outcomes. The effectiveness of AI systems relies heavily on the quality of the data used for training. Should the training data exhibit bias, the AI is likely to generate prejudiced results. For example, if an AI system is predominantly trained on data from one specific demographic, it may struggle to provide accurate outcomes for other groups, thereby perpetuating healthcare disparities. Such concerns highlight the importance of promoting fairness and equity in medical treatment.

Bias in AI emerges when the algorithms utilized in training exhibit the prejudices present in the data. In the healthcare arena, biased AI could result in unequal healthcare provision, wherein certain patient groups may receive inferior treatment compared to others. This issue is particularly concerning in a field where accuracy and impartiality are vital for patient welfare.

Sources of bias in AI systems can stem from various origins. Medical data used for training often comes from historical records, which may carry biases due to past healthcare inequalities. For instance, if a dataset primarily consists of data from a specific demographic, the AI system trained on this data may not perform effectively for other groups, such as women, children, or minorities.

Collecting and sampling data can lead to sampling bias, which can skew the performance of AI systems if the data used for training is not representative of the whole patient population. Labeling data for AI training can also introduce bias, especially if it is done subjectively or inconsistently, causing the AI to learn incorrect associations and affecting its decision-making abilities.

The negative impact of bias in medical AI systems can be significant, affecting the accuracy of diagnoses, the effectiveness of treatments, and ultimately patient outcomes. An AI system that is biased toward a particular demographic may result in misdiagnoses in marginalized groups. For example, women may experience heart attack symptoms differently than men, but if an AI system is primarily trained on male data, it may not correctly identify these distinctions, leading to potential errors in diagnosing female patients. Biased AI systems may also suggest different treatment approaches based on demographic factors that should not play a role in clinical decision-making, which can perpetuate healthcare disparities and worsen health outcomes for underserved populations. When patients perceive AI systems as biased, it can erode their trust in these technologies and the healthcare providers who use them, ultimately hindering the adoption of helpful AI tools and diminishing patient engagement and satisfaction.

Addressing bias and ensuring fairness in AI systems used in medicine is a complex task that requires a multifaceted approach. It is imperative to incorporate diverse and representative datasets that accurately reflect the entire patient population. This involves collecting data from a

variety of demographic groups and ensuring proper representation in the training data. Implementing techniques to identify and mitigate bias during the development and training of AI systems is essential. This includes the use of fairness-aware algorithms, conducting regular audits of AI systems, and continuously monitoring their performance across different patient demographics. Transparency in the development and deployment of AI systems is crucial for building trust. This includes clearly documenting data sources, algorithms used, and steps taken to address bias. Establishing accountability mechanisms for errors and biases in AI decisions is also critical. Involving a diverse group of stakeholders, such as ethicists and sociologists, can further enhance the fairness and effectiveness of AI systems in medicine.

Addressing bias and fairness in AI is crucial for realizing the full potential of AI in the field of medicine. By acknowledging and reducing bias, utilizing diverse and inclusive data, and promoting transparency and accountability, we can create AI systems that enhance healthcare for all patients. Proactively facing these challenges will help establish confidence in AI technologies and ensure that their advantages are enjoyed by all patient demographics.

Transparency and Explain ability. The incorporation of Artificial Intelligence (AI) in medical settings shows potential in boosting diagnostic accuracy, fine-tuning treatment strategies, and enhancing overall patient care. However, the ethical hurdles of transparency and explainability must be tackled to guarantee the ethical and efficient deployment of AI in healthcare.

Many AI systems, notably those utilizing deep learning, function as "black boxes" – they analyze extensive data sets and generate decisions without offering explicit justifications for their conclusions. This lack of transparency proves problematic in the realm of medicine, where comprehending the reasoning behind a diagnosis or treatment suggestion is vital for both healthcare providers and patients. In the medical field, transparency is crucial for AI systems and their decision-making processes to be clearly communicated and understood. Healthcare providers must have insight into how AI systems reach conclusions in order to make informed decisions about patient care. Without transparency, it can be difficult for clinicians to trust and effectively utilize AI recommendations. Patients are more likely to trust and follow AI-driven recommendations if they comprehend the decision-making process. Transparent AI systems help to demystify AI and increase patient comfort with its use in their treatment. Additionally, transparency enables accountability by allowing for the tracing and understanding of decision-making pathways, which is essential for addressing any errors or biases and implementing necessary corrective actions.

The degree to which the internal workings of an AI system can be understood and interpreted by humans is known as explainability. In the field of medicine, explainability is crucial for ethical reasons. Healthcare providers must be able to verify AI-driven recommendations against established medical knowledge and clinical guidelines. Explainable AI systems allow clinicians to double-check AI outputs, ensuring they are medically sound and appropriate. Patients require clear explanations of how AI influences their diagnosis and treatment to make informed choices about their healthcare. Explainability promotes patient autonomy by providing them with the knowledge to understand and consent to AI-driven decisions. It also enables the identification and correction of errors in AI systems. If an AI system's decisions can be interpreted, healthcare providers can identify inaccuracies and take necessary steps to prevent harm to patients.

While the advantages of being transparent and explainable are evident, achieving this in AI systems used in medicine presents a challenge. The complexity of many AI models, particularly deep learning networks, makes it difficult to provide clear explanations of their decision-making processes. Simplifying these models to improve explainability can sometimes impact their accuracy and efficiency. Often developed by private companies who may keep their algorithms

confidential, the lack of openness can impede transparency and hinder healthcare providers' understanding of these systems. There is typically a trade-off between the simplicity and accuracy of an AI model. More accurate models may be less interpretable, while simpler models that are easier to explain may sacrifice performance.

In response to these ethical challenges, there are several strategies that can be implemented. Researchers and developers are working on developing AI models that are inherently more easy to understand while still maintaining accuracy. Techniques such as decision trees, rule-based systems, and model-agnostic methods can improve explainability. Implementing regulatory frameworks that require transparency and explainability for AI systems used in healthcare can ensure that ethical considerations are given priority. This includes guidelines for documenting, auditing, and reporting AI decision-making processes. Providing education to healthcare providers on the capabilities and limitations of AI systems can help them effectively utilize these technologies. Training programs can focus on interpreting AI results and integrating them into clinical practice efficiently. Fostering trust and acceptance among patients regarding the use of AI in their care involves engaging them in discussions and providing clear, easily understandable information about how AI systems function. This requires effective communication strategies that demystify AI technologies.

Transparency and explainability are key ethical factors to consider in the implementation of AI in medicine. It is crucial to address these issues to ensure responsible and effective use of AI systems, building trust between healthcare providers and patients. By emphasizing transparency and explainability, the medical community can leverage the advantages of AI while upholding ethical standards that support top-notch patient care.

Privacy and Confidentiality. The use of Artificial Intelligence (AI) in medicine brings great potential for advancements in diagnostics, personalized treatment, and patient care. Yet, it also brings ethical concerns regarding privacy and confidentiality. Safeguarding patient information and upholding trust in the healthcare system necessitates a thoughtful approach to the ethical implications of AI integration. Violations of medical data can result in serious repercussions for individuals, such as identity theft and discrimination.

Privacy concerns regarding Data Collection and Storage are critical in the realm of AI systems. These systems heavily depend on vast amounts of data, including sensitive personal health information (PHI), to operate effectively. Improper handling of this data could result in severe privacy breaches. The sheer volume of data required by AI systems heightens the risk of privacy violations, as it may contain highly sensitive information such as medical histories and genetic data. It is imperative to ensure the secure storage of PHI, especially as AI systems often utilize cloud storage which carries risks of unauthorized access and data breaches. Implementing secure storage solutions and robust encryption protocols is crucial to protect this information. Collaboration between healthcare providers and institutions is essential for the effectiveness of AI in medicine, but it also presents significant privacy challenges in terms of data sharing.

Effective access controls are crucial to guarantee that only approved individuals can access confidential health information. Inadequate controls pose a threat of unauthorized access, which can result in data misuse. A significant number of AI systems are outsourced to third-party vendors. It is imperative to enforce stringent privacy regulations on these vendors to avoid potential data exploitation or mishandling. To address privacy issues, health data is commonly de-identified before integration into AI systems. Nevertheless, there are inherent risks associated with the de-identification process. Data analytics advancements may sometimes lead to the re-identification of de-identified data, which can put patient privacy at risk. It is vital to have strong de-identification processes in place to prevent this. Finding the right balance between data utility for AI and privacy protection is key to effectively safeguarding patient privacy while making the

most of AI technology.

Confidentiality is fundamental to the doctor-patient relationship, and the integration of AI technology can potentially disrupt this foundation. If patients perceive that their private information is at risk or being mishandled, it can undermine their faith in the healthcare system. Preserving confidentiality is crucial in upholding this trust. Patients must be educated on how their data will be utilized, particularly in relation to AI systems. Openness regarding data practices is key in maintaining trust and ensuring patients understand how their information is being managed.

Healthcare providers are bound by both legal and ethical responsibilities to protect patient confidentiality. It is crucial to follow regulations like HIPAA in the US and GDPR in Europe to maintain data protection standards when incorporating AI in healthcare practices. In addition to legal obligations, ethical considerations should also be prioritized, such as respecting patient autonomy and using data in a manner that benefits patients while safeguarding their privacy.

Establishing strong data governance frameworks is crucial in addressing the ethical dilemmas surrounding AI in healthcare. This involves setting up solid rules regarding data handling, storage, sharing, and access control, and making sure all parties comply with these guidelines. Employing advanced security measures like encryption, multi-factor authentication, and secure cloud services can safeguard sensitive health information from unauthorized breaches. Regular audits and ongoing monitoring of AI systems and data usage can help preemptively detect and resolve privacy concerns. This proactive strategy is vital in upholding data accuracy and preserving patient confidence. Informing patients about the utilization of their data and including them in decisions regarding data sharing can improve transparency and build trust. Patients should be educated on the advantages and potential drawbacks of AI in their treatment, and their consent should be obtained prior to the utilization of their data.

Privacy and confidentiality are essential ethical considerations when utilizing AI in healthcare. To tackle these concerns, a comprehensive strategy involving strong data management, enhanced security protocols, consistent evaluations, and patient awareness is necessary. By giving importance to these ethical principles, the healthcare sector can leverage AI advantages while safeguarding patient data and upholding trust in the medical field.

Accountability. The incorporation of Artificial Intelligence (AI) into medicine has the potential to revolutionize the field by improving diagnostic precision, tailoring treatment strategies, and streamlining healthcare services. Yet, this advancement also presents ethical dilemmas, particularly in the realm of accountability. The question of who should be held responsible for decisions and results influenced by AI in medical settings is intricate but essential for upholding ethical and legal standards in healthcare.

Accountability entails the duty for individuals or entities to be answerable for their actions, take ownership of them, and communicate the outcomes openly. In the context of AI in medicine, accountability becomes intricate due to the involvement of multiple stakeholders, including AI developers, healthcare providers, and medical institutions. Identifying responsibility in cases where AI influences medical decisions poses a key ethical dilemma. AI can aid in diagnosing conditions and recommending treatments, but errors can happen. When an AI system makes a mistake, who should be held accountable - the developers, healthcare providers, or the institution that utilized it? Clear guidelines are necessary to assign blame accurately. Moreover, determining accountability becomes even more complex when AI-generated treatment plans result in negative outcomes. Clinicians must navigate this challenge by balancing AI suggestions with their own expertise. AI systems, especially those utilizing deep learning techniques, are often seen as "black boxes," making it challenging to comprehend the rationale behind their conclusions. This lack of clarity raises ethical concerns, particularly in the healthcare sector. Patients deserve to know the reasoning behind the

decisions made about their treatment. Failure to explain AI-generated recommendations undermines the concept of informed consent, leaving patients unaware of critical aspects of their care. Without transparency, assessing the effectiveness and dependability of AI systems becomes a complex task.

Medical professionals must have confidence in and comprehend the outputs of artificial intelligence in order to make well-informed decisions. However, the lack of transparency in algorithms complicates this trust-building process. It is vital, yet intricate, to establish legal and ethical responsibility for the use of AI in medicine. It is essential for AI systems to adhere to medical regulations and ethical guidelines. Nonetheless, there is a growing uncertainty in accountability as regulations struggle to keep up with the rapid advancements in AI. While AI can offer valuable support, it cannot replace the intricate ethical decision-making that is essential in medicine. Balancing AI recommendations with ethical principles such as beneficence, non-maleficence, and justice presents a significant challenge.

Establishing clear guidelines and standards for the use of AI in medicine is crucial in defining accountability. This involves outlining the roles and responsibilities of AI developers, healthcare providers, and institutions when deploying and utilizing AI systems. Enhancing transparency and explainability of AI systems is key. It is important for AI developers to create algorithms that are easily understood and provide explicit reasoning for their recommendations. This transparency helps clinicians trust AI outputs and allows patients to make informed decisions. Developing strong regulatory frameworks is vital to ensure AI systems meet rigorous standards of safety, effectiveness, and ethical conduct. Regulatory bodies must update regulations to address the unique challenges presented by AI and offer precise accountability guidelines. Continuously monitoring and evaluating AI systems in medical practice is essential for finding and addressing potential issues in a proactive manner. This involves conducting regular audits, performance evaluations, and creating feedback mechanisms to ensure that AI systems are operating correctly and ethically. By promoting shared decision-making models, where AI supplements rather than replaces human judgment, we can strike a balance between the benefits of AI and the necessity of human oversight. Clinicians should view AI as a tool to improve their decision-making processes while maintaining full responsibility for patient care. Providing healthcare providers with education on the ethical considerations of AI and offering training on its utilization can empower them to effectively handle accountability concerns. It's crucial for clinicians to comprehend the limitations of AI, utilize it appropriately in clinical settings, and explain its role to patients.

Ensuring accountability in the ethical use of AI in medicine is essential. This can be achieved through the establishment of clear guidelines, increased transparency, strong regulatory frameworks, ongoing monitoring, collaborative decision-making processes, and ethical education. By prioritizing these aspects, the healthcare sector can uphold responsible and ethical AI usage, preserving trust and credibility in medical care while leveraging the advantages of cutting-edge technology.

Informed Consent. The incorporation of Artificial Intelligence (AI) into the field of medicine provides numerous advantages such as improved diagnostic precision, personalized treatment strategies, and enhanced patient outcomes. However, the utilization of AI also brings about intricate ethical dilemmas, particularly concerning the issue of informed consent. It is crucial for patients to comprehend and consent to the use of AI in their healthcare in order to uphold ethical medical standards, yet the intricate nature of AI systems complicates this process.

Informed consent is a fundamental aspect of medical ethics and legal protocols, necessitating that patients have a comprehensive understanding of the nature, advantages, risks, and alternatives of medical procedures. Patients must willingly agree to undergo such procedures after being fully informed about relevant details. The integration of AI within medicine poses a number of challenges in

obtaining informed consent properly.

Artificial intelligence systems, particularly those utilizing advanced machine learning and deep learning algorithms, are complex in nature and often operate as opaque "black boxes." This complexity can hinder patients and healthcare professionals from fully comprehending the inner workings of AI systems and their impact on medical decisions. The technical jargon used in describing AI systems may be unintelligible to the average patient, posing a challenge in understanding the implications of AI-driven diagnostics and treatments.

The reasoning behind recommendations made by AI systems can be difficult to explain, which makes the informed consent process more complicated. In order for informed consent to be considered valid, patients need to be educated about the use of AI in their treatment. However, there are obstacles to achieving this level of transparency. Healthcare professionals may not have the knowledge or expertise to effectively communicate how AI systems work to patients. As a result, there is a concern that the role of AI may not be fully disclosed to patients, either unintentionally or because it is seen as insignificant.

Establishing patients' confidence in AI systems and the information disseminated by healthcare providers is vital for obtaining informed consent. Certain patients might harbor doubts or apprehensions about AI technologies due to negative perceptions or a lack of comprehension, which can impede their ability to make truly informed decisions. Conversely, other patients may blindly trust AI recommendations without grasping the potential risks and limitations involved.

Healthcare professionals need to communicate information about AI technologies in a manner that is easily understandable without compromising accuracy. This involves utilizing simple, jargon-free language and creating analogies to simplify complex concepts. Producing patient-friendly educational resources like brochures, videos, and interactive tools can assist patients in comprehending how AI will be utilized in their treatment.

It is crucial for healthcare providers to effectively communicate with patients about AI technology. Providers must be trained to understand AI systems and be able to explain their functions to patients clearly. Ongoing education and training programs can help ensure that healthcare providers are equipped to have discussions with patients about AI technologies. By encouraging open dialogue and questions, patients can feel comfortable discussing any concerns they may have and gain a better understanding of how AI is being used in their healthcare.

Transparency about the use of AI in medical care is essential. Patients should be clearly informed about the use of AI in their diagnosis or treatment and the role it will play. It is important to provide a balanced view of the potential benefits and risks associated with AI, including any uncertainties or limitations.

It is crucial to adhere to ethical and legal standards when obtaining informed consent. This includes ensuring that the processes align with regulations like HIPAA and GDPR, which require specific disclosures and protections for patient data. It is also important to follow ethical guidelines that prioritize patient autonomy, beneficence, and non-maleficence in the use of AI.

Empowering patients to take an active role in their healthcare decisions can improve the informed consent process. Including patients in discussions about their care options, including AI usage, and respecting their preferences and values is essential. It is also important to create feedback mechanisms for patients to share their experiences and concerns about AI technologies.

Obtaining informed consent is a vital ethical consideration when utilizing AI in the medical field. To overcome the difficulties caused by the intricate nature and unpredictability of AI systems, it is essential to streamline explanations, improve communication, promote transparency, and abide by ethical and legal guidelines. By giving precedence to these factors, healthcare professionals can guarantee that patients are well-informed and able to independently make decisions about their treatment, ultimately fostering trust and upholding the integrity of the

healthcare system.

Autonomy and Human Oversight. The incorporation of Artificial Intelligence (AI) into the field of medicine shows immense potential in increasing the precision of diagnoses, fine-tuning treatment strategies, and elevating the quality of patient care. Yet, the adoption of AI in the healthcare industry brings forth important ethical concerns regarding individual autonomy and the necessity of human supervision. Striking a balance between the advantages of AI and the importance of upholding human oversight and patient autonomy is essential for ethical healthcare delivery. Patient autonomy, a key principle in medical ethics, highlights the importance of patients having the right to make informed decisions about their healthcare. The introduction of AI in medicine can complicate this principle in various ways. In order for patients to make autonomous decisions, they must have a clear understanding of how AI is involved in their treatment. However, the complexity of AI systems can make it challenging for healthcare providers to fully explain their workings and impact on medical decisions. This can hinder the process of obtaining informed consent, as patients may not fully comprehend the implications of AI-driven recommendations. Patients may also feel uneasy about AI influencing their care, particularly if they perceive these systems as detached or overly technical. It is crucial to ensure that patients feel in control of their healthcare decisions to maintain trust and uphold their autonomy.

The autonomy of healthcare providers is a key concern when considering the use of AI systems in clinical decision-making. While AI can provide valuable insights and recommendations, it also has the potential to challenge the traditional role of clinicians. Relying too heavily on AI may diminish the authority of healthcare providers, as there may be pressure to follow AI recommendations even when a clinician's expertise suggests a different course of action. This could undermine the ability of healthcare providers to personalize care for their patients, as the nuanced judgment of experienced clinicians is essential in delivering effective healthcare. AI systems, while advanced, may not account for the complexities of patient interactions, leading to conflicts between AI recommendations and clinical judgment.

Ensuring the safety and reliability of AI systems in medicine requires human oversight. Although AI can rapidly analyze large amounts of data, it is not immune to errors. These errors can stem from biased data, flawed algorithms, or unexpected anomalies in patient information. Therefore, ongoing human supervision is essential to identify and rectify these mistakes, safeguarding patient well-being. It is vital for human experts to regularly validate and monitor AI systems, updating algorithms as medical knowledge evolves and adjusting systems to align with updated clinical guidelines.

Establishing accountability for the use of AI in medicine is vital yet intricate. When AI is utilized in patient treatment, it can be difficult to determine who should be held responsible for the results. It is crucial to have clear guidelines outlining the duties and obligations of AI developers, healthcare professionals, and institutions in instances of errors or negative outcomes related to AI. Ethical dilemmas frequently emerge in the field of medicine, necessitating a thorough examination of multiple factors and the weighing of conflicting interests. Human supervision ensures that ethical values like doing good, avoiding harm, and fairness are upheld in decision-making processes involving AI.

Various strategies can be utilized to address the ethical concerns surrounding autonomy and human oversight in the deployment of AI in medicine. It is essential to provide clear and comprehensible information on the functionality, limitations, and impact of AI systems on patient care. This level of transparency is vital in enabling patients and healthcare providers to make informed decisions and develop trust in AI technology. Introducing human oversight within the design of AI systems can help strike a balance between the benefits of AI and the necessity of human intervention. By incorporating human-in-the-loop systems, clinicians have the ability to override AI recommendations when required,

ensuring that final decisions are made with human judgement. Educating healthcare professionals on the capabilities, constraints, and ethical considerations of AI can empower them to effectively utilize these tools while upholding their professional autonomy. Similarly, educating patients on the role of AI in healthcare can help enhance their understanding and acceptance of its implementation. Developing comprehensive ethical guidelines and regulations for the use of AI in healthcare is crucial to ensuring autonomy and oversight. Collaboration among stakeholders, including clinicians, patients, ethicists, and AI developers, is necessary to establish clear standards for the ethical deployment of AI in medicine.

Addressing concerns related to autonomy and human oversight is paramount in integrating AI into healthcare. Transparency, education, and adherence to ethical guidelines are essential to maximizing the benefits of AI while upholding ethical medical practices.

Economic and Accessibility Issues. The introduction of Artificial Intelligence (AI) in the field of medicine holds promise for enhancing patient care, diagnostics, and treatment planning. However, navigating the ethical challenges stemming from economic and accessibility issues is crucial to ensuring that the benefits of AI are accessible to all individuals. The costs associated with developing, implementing, and sustaining AI systems in healthcare are substantial, requiring investments in hardware, software, and skilled professionals. This financial barrier can result in disparities, where only financially stable healthcare institutions are able to adopt AI technologies, leaving under-resourced hospitals and clinics behind. Addressing these disparities is essential for achieving fair distribution of technological advancements in healthcare.

Unequal AI adoption in healthcare can worsen existing disparities, with wealthier institutions benefiting more than poorer areas. This can lead to a widening gap in healthcare outcomes, making it crucial to ensure that all patients, regardless of economic status, can access AI benefits. The use of AI in medicine may streamline tasks, but also poses ethical concerns about job displacement and the future of the healthcare workforce. It is important to find a balance between utilizing AI for efficiency while also preserving job opportunities for healthcare professionals. Access to AI-driven healthcare services is frequently dependent on the presence of digital infrastructure. Areas lacking high-speed internet, advanced medical technologies, and other essential tools may face difficulties in incorporating AI solutions. This disparity in digital resources can hinder the adoption of AI advancements, particularly affecting populations in rural or underdeveloped regions and widening existing healthcare inequities. Additionally, many AI systems are developed with specific language and literacy requirements in mind. Patients who do not speak the dominant language or have limited health literacy may encounter challenges when using AI-driven healthcare tools, furthering disparities in access to information and services.

AI systems are often created using data and assumptions from certain demographics, which can lead to a lack of consideration for cultural, social, and medical differences in diverse patient populations. Ethical AI in medicine should prioritize customization and sensitivity to the needs of various cultural and demographic groups to promote equitable care.

Governments and regulatory bodies have a vital role to play in promoting equal access to AI in healthcare. It is crucial to implement policies that support funding for AI infrastructure in areas that are underserved, offer subsidies for low-income healthcare providers, and establish guidelines for fair AI usage in order to lessen economic inequalities. Public-private partnerships are also important in closing the gap in AI accessibility. By fostering collaborations between technology firms, healthcare institutions, and government bodies, we can facilitate the sharing of resources, information, and technologies to ensure that AI-driven healthcare services are more widely available.

It is essential to invest in educating both healthcare professionals and the general public

about AI technologies. This includes providing training for healthcare workers on how to effectively utilize AI tools, as well as educating patients on the advantages and limitations of AI in their treatment. Empowering patients with this knowledge can help reduce accessibility barriers. In addition, AI developers should focus on creating inclusive designs that can accommodate different languages, cultural backgrounds, and literacy levels. Ensuring that AI tools are user-friendly and accessible to a diverse range of people is crucial for ensuring equitable healthcare delivery.

The use of AI in medicine raises important ethical issues related to economics and accessibility. Solving these challenges will require a united effort from policymakers, healthcare professionals, technology experts, and the public. By promoting inclusivity, fairness, and collaboration, the healthcare industry can strive towards ensuring that the advantages of AI are distributed equitably, leading to improved healthcare results for all patients, regardless of their financial or social status.

The implementation of Artificial Intelligence (AI) in the field of medicine offers great potential for advancements in diagnostics, personalized treatment, and overall healthcare efficiency. Despite the numerous benefits that AI brings, there exist limitations that raise ethical concerns within the medical community. Recognizing and overcoming these limitations is crucial in order to ensure the responsible and ethical use of AI in healthcare.

AI systems rely on top-notch, thorough datasets for optimal operation. Flawed, outdated, or incomplete data can impede AI effectiveness, resulting in unreliable results. Medical scenarios are intricate and multifaceted, posing challenges for AI in accurately capturing the nuances of human health. Integrating AI into healthcare systems faces hurdles such as compatibility issues, infrastructure changes, and staff retraining. Establishing solid regulatory frameworks for AI in medicine is an ongoing process. It is crucial to ensure that AI technologies in medicine meet rigorous ethical and clinical standards, but this task remains complex. The successful implementation of AI in healthcare relies on trust and acceptance from both providers and patients, which can be achieved by demonstrating the reliability, accuracy, and benefits of AI systems while addressing ethical concerns.

The potential of AI in improving patient care and healthcare efficiency is significant. However, it is essential to address ethical issues and limitations associated with AI to ensure responsible and equitable use. Continuous dialogue among technologists, ethicists, healthcare providers, and patients is necessary to navigate the ethical challenges of AI in medicine and maximize its benefits for everyone.

Historical vignette

The Medicine of the semi-god healer Chiron and the divine origin of the Medical art

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Abstract

The mythological creature Centaur Chiron, lived in the mountain Pelion in ancient Thessaly in Greece. Chiron was considered as the teacher of medicine for all ancient physicians, even for the god patron of medicine Asclepius. As a creature of the land, half horse, half man, knew about herbs, elixirs, knifes (surgery) and music. Chiron as the son of Cronus had a divine origin and the perception of such a teacher supported the glorious origin of medical art.

Key words: ancient Greek mythology, Mount Dikte of Crete, Asclepius, religion.

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According to Homeric tradition, the semi-god empiric healer Centaur Chiron, the just among the Centaurs, as described by Homer, was the son of Cronus and Philyra, the daughter of Apollo (1-8). Chiron was credited with introducing the first organized and renowned Medical School in Greece, situated in some enchanting location in Mount Pelion (9-12). He had married the nymph Naiad or Chariclo and had two daughters, Euippe, who was initiated into her father's art, and Ocyrhoe, who, as Ovid mentioned, besides practicing medicine, also engaged in Divination. Clement of Alexandria mentioned another daughter as well, Hippe, who had married Aeolus and taught him the "ancestral science" and natural theory (4, 13-17).

As known from Hellenic mythology, Zeus's father, Cronus, had severed the genital organs of his own father, Uranus, and had dethroned him. Fearing a similar fate from his own children, as soon as he became a father, he would swallow his offspring, as Hesiod recounted, “And one after the other, the great Cronus would swallow them, as soon as each one descended from the sacred womb of their mother (Rhea) to her knees” (Greek: καὶ τοὺς μὲν κατέπινε μέγας Κρόνος, ὥς τις ἕκαστος νηδύος ἐξ ἱερῆς μητρὸς πρὸς γούναθ’ ἵκοιτο). Continuously, Rhea pleaded with her husband, trying unsuccessfully to convince him not to believe the prophecy, and was attempting in vain to persuade him to cease this original infanticide (18). Thus, when Rhea, the wife and sister of Cronus, was about to give birth to Zeus, she sought refuge in a cave on Mount Dikte of Crete. There, in secret, she gave birth to the future god of gods and humans. To deceive Cronus, who demanded to devour the newborn, Rhea swaddled a stone instead of Zeus and offered it to him. Without suspecting a thing, Cronus ate the stone instead of his child (7). Later, Rhea entrusted the infant Zeus to Themis, who, in turn, handed him to the nurturer Amalthea, or the Curetes, the guards of "Idaean Dactyls" (Greek: τοῖς Ἰδαίοις Δακτύλοις) who pounded their shields to drown out the cries of the infant Zeus so that Cronus would not hear them. There, Zeus enjoyed the care of the Meliae or Meliades Nymphs (1, 6-7, 10, 19-23). The goat Amalthea also nursed him. The Nymphs nurtured the newborn god, using Amalthea's horn as a nursing bottle, which thereafter became a symbol of abundance and of every desirable thing, receiving from Zeus the power and blessing of fruitful creation. The Nymphs Adrasteia and Ida would lull him to sleep until Zeus grew into manhood (10-11, 22, 24-30).

Once Zeus reached adulthood, Metis, daughter of Oceanus and Tethys and the first wife of Zeus, who knew more than all the gods and mortal humans prepared a nauseating potion, and unsuspecting, Cronus drank it. The effect of the potion proved miraculous and effective, as Cronus first regurgitated the stone and then all his children, those he had given birth to and swallowed before Zeus, meaning Pluto, Poseidon, Hecate, Hestia, Demeter, Hades and Hera. Impressed by the effectiveness of the potion,

Cronus decided to elevate one of his sons to the role of a physician (7, 18, 22, 31).

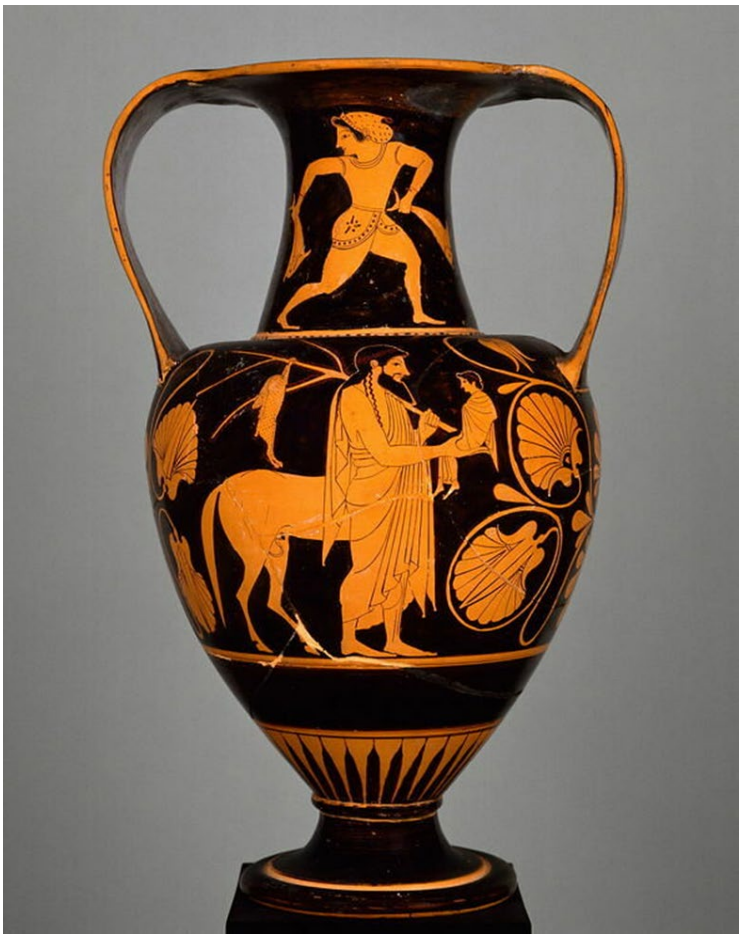

Figure 1. *Chiron and Achilles, amphora, ca 525-515 BC, Louvre Museum.*

When he encountered the remarkably beautiful nymph Philyra, he fell in love with her. To conceal his identity, Cronus transformed into a horse and fathered a son with her, Chiron. In the year which followed, Chiron became the first physician (11, 16, 32).

Chiron was a bright healer and his medical knowledge was mentioned by both Homer and Pindar. Pindar had described Chiron as a creature who "had gentle hands in the art of a physician" (Greek: Φαρμάκων μαλακόχειρα νόμον). This wise seer, Chiron, possessed medicine and cultivated the first therapeutic plants. Chiron discovered numerous surgical techniques and therapeutic herbs (centaurion and chironion) (9-10, 13, 33-44), which he taught in his School along with Philosophy, Ethics, Astronomy, Divination, Magic, Music, Hunting and the Art of War, as a tutor of men destined to rule or become leaders. His pupils included figures like Jason, Achilles, Peleus, and Hercules, while Xenophon had added Cephalus, Asclepius, Melanion, Nestor, Amphiaraos, Peleus, Telamon, Meleagros, Theseus, Hippolytus, Palamedes, Menestheus, Odysseus, Diomedes, Castor, Polydeuces, Machaon, Podaleirius, Antilochus, Aeneas and Achilles [Figure 1] (1, 4, 7, 10, 18, 42, 44-45). Above all he was mentioned as the first teacher of god Asclepius, the patron of medicine [Figure 2] (22, 46). It was said that Chiron had also trained some female healers, such as Circe and Medea (18, 47). Apollodorus noted that Chiron apart from botany he had been performing various surgical operations, as this when he operated Phoinix, who was suffering from a refractory eye disease (7).

Figure 2. *Apollo entrusting Chiron with the education of Asclepius, engraving by Hendrick Goltzius 1558-1617*

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According to Pindar's testimony, Chiron was healing his patients with Music (soft tunes), complete sweetness, and gentleness, "he relieved each one of his sufferings, some with soothing incantations, caring for them softly, and others with calming elixirs, or by anointing their limbs with healing ointments. And some, with a single cut, he set upright (Greek: …λύσαις ἄλλον ἀλλοίων ἀχέων ἔξαγεν, τοὺς μὲν μαλακαῖς ἐπαοιδαῖς ἀμφέπων, τοὺς δὲ προσανέα πίνοντας, ἢ γυίοις περάπτων πάντοθεν φάρμακα, τοὺς δὲ τομαῖς ἔστασεν ὀρθούς). The lyre and the surgical knife were wedded to him. Indeed, he was a distinguished surgeon, according to Pindar's testimony (7, 13, 16).

For a physician to connect with a lineage from centaur Chiron was considered as the most significant factor to enter history as a majestic figure in Hellenic Mythology [48]. Chiron was nominated as the father-teacher of "all" ancient physicians. This myth, associated with the divine birth of the first healer, signifies nothing more than the noble, divine, godly origin of the art of medicine.

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Review Article

Anatomical variations of the dorsal motor nucleus of the vagus (DMN)

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Abstract

The aim of our review is the description of possible anatomical variations of the dorsal motor nucleus of the vagus nerve (DMN). However, due to the insufficient literature, only a short summary of these sources was achieved. The topic of our project focuses on the anatomical variations of the dorsal motor nucleus of the vagus nerve. Data base Pub Med was the source of our search. We inserted in advanced search of Pub Med the block chain; "anatom*" AND ("variat*" OR "categor*" OR "type*" OR "difference*" OR "version*") AND ("human*" OR "man*") AND ("dorsal motor nucleus" OR "DMN" OR "DMNX"[MeSH]) AND ("vagus" OR "X"). Initially, 19 articles arose. From 19, 7 of them were related to the topic of our paper and 1 article was not accessible. Consequently, for the composition of our paper 6 articles were utilized.Hence, the DMN exhibits distinct differences between infants and adults, with a potential pathogenic mechanism for Sudden Infant Death Syndrome (SIDS) involving abnormal or delayed neurogenesis in the DMN nucleus. Additionally, the distribution of substance-P neurons and tyrosine hydroxylase neurons is unique in the DMN. The overall variations in the dorsal motor nucleus of the vagus nerve are minimal, and the significance of this study lies in its potential for informing future research.

KeyWords: DMN, SIDS, Substance-P, Tyrosine Hydroxylase, variations

Introduction

The DMN, the largest parasympathetic nucleus in the brainstem, is a diverse collection of approximately 16,826 neurons on each side of the brain. These neurons can be classified into two groups: vagal motor neurons and interneurons. There are five types of vagal motor neurons, with Type I being the largest and Type IV being the smallest. Type V neurons are pigmented. Type I neurons have a mean diameter of 31 μm and are the largest in the DMN, while Type II neurons are medium-sized with differences in soma size. The percentage of Type II neurons is estimated approximately in 27%. Additionally, Type III neurons in the DMN are characterized by a fusiform shape and medium size in transverse sections, with an estimated total number of 1.643, making up 13% of the motoneuronal population.[(1)] On the other hand, Type IV neurons are small and ovoid, with a total estimated count of 3.653, comprising 29% of the motoneuronal population. Type V neurons, which contain black pigment, are described as ovoid and medium-sized, with a total estimated count of 1.392 pigmented neurons. In contrast, the presumed interneurons are significantly smaller, measuring three to five times smaller than the average size of the other neuron types in the X. The interneurons in the nucleus are observed to have various shapes, including oval, fusiform, or round, with an estimated total of 3,024. These neurons are not evenly distributed throughout the nucleus. The DMN is subdivided into three major subnuclei: the rostral, intermediate, and caudal.[(2)]

The DMN functions by projecting parasympathetic preganglionic cholinergic efferent fibers to the viscera. It is commonly observed that the rostral part of the DMN represents abdominal organs, while the cardiac representation is located in an intermediate region between the rostral and caudal parts. However, most organs are not exclusively represented in only one division of the nucleus. Additionally, the DMN communicates with the

NTS, which sends vagal information to the DMNV and integrates sensory vagal afferent stimuli.

Our work aims to explore anatomical variations in the DMN in humans. Limited literature and a lack of studies on this topic have restricted our ability to provide in-depth analysis, but we can discuss certain anatomical features based on immunoreactivity and histological observation.

Materials and Methods

The topic of our project focuses on the anatomical variations of the dorsal motor nucleus of the vagus (DMN). Data base Pub Med was the source of our search. We inserted in advanced search of Pub Med the block chain; "anatom*" AND ("variat*" OR "categor*" OR "type*" OR "difference*" OR "version*") AND ("human*" OR "man*") AND ("dorsal motor nucleus" OR "DMN" OR "DMNX"[MeSH]) AND ("vagus" OR "X"). Initially, 19 articles arose. From 19, 7 of them were related to the topic of our paper and 1 article was not accessible. Consequently, for the composition of our paper 6 articles were utilized.

Discussion

The comparison of the DMN in adults and infants reveals interesting things. Although the number of neurons in the DMN remains consistent between adults and infants, adults have a higher nuclear volume and lower neuronal density in this medullary nucleus compared to infants.[3,4] Additionally, apoptosis levels in DMN neurons are higher in adults than in infants, with no significant statistical difference in glial cells. The differences in neuronal volume and density between adults and infants may be due to variations in microvascularization and distribution of neuropil. Microvascularization also plays a role in the progression of apoptosis.[5]

The DMN seems to possess and important role in Sudden Infant Death Syndrome (SIDS). Sudden Infant Death Syndrome (SIDS) is the leading cause of death in infants between the ages of one month and one year.[6] It is believed that abnormal or delayed neurogenesis in the DMN may be linked to SIDS.

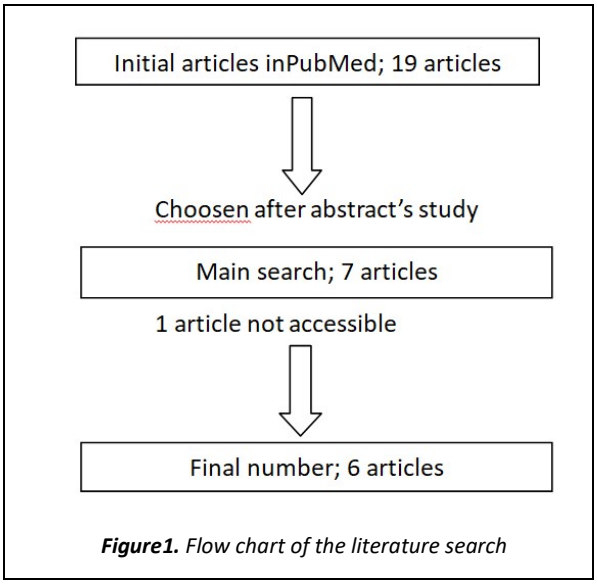

Figure1. *Flow chart of the literature search*

In control infants, neurogenesis in the DMN nucleus is complete at birth, with exponential postnatal growth as infants develop. However, in SIDS victims, there is a lack of development and dendritic arborization, leading to a deficiency in neuron size in the DMN. Differences have been observed in the growth of DMN neurons in SIDS infants compared to age-matched infants, with a delay in the expected loss of dendritic spines.6 Reduced neuronal density has also been observed in SIDS infants compared to normal infants.4

Immunoreactivity of the DMN. Some neurons in the DMN contain special substances such as substance-P, an undecapeptide, and tyrosine hydroxylase, a cell enzyme. Substance-P is found in both somata and fibers of approximately 16% of the total number of neurons in the DMN, totaling around 2040 neurons. The distribution of substance P positive neurons is higher in the intermediate division compared to the caudal division, with a lower presence in the rostral division. These Substance-P neurons in the DMN can appear either round or fusiform.[2] Regarding tyrosine hydroxylase; neurons that are positive for this enzyme can be round, oval, or fusiform in shape. The distribution of tyrosine hydroxylase is higher in the intermediate subdivision, while in the caudal subdivision, these neurons are only located ventrally and in the rostral subdivision, they are found medially. Notably, substance P

positive neurons are primarily located in the center of the DMN, whereas tyrosine hydroxylase positive neurons are more commonly found in the periphery. Additionally, there is a difference observed in Parkinson's disease, where substance P positive neurons are decreased in the DMN compared to non-Parkinson individuals.[(2)]

Conclusion

The DMN, the brainstem's largest nucleus, is divided into sub nuclei based on functional and anatomical specialization. Despite its significance, there have been limited studies on the anatomical variations of the DMN. However, we emphasize specific anatomical differences between adults and infants, the growth pattern of neurons in SIDS infants, and the distribution of specific neuron types in the DMN sub regions. Therefore, understanding the cyto-architecture of the DMN could be essential for explaining clinical conditions and guiding future research.

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Review Article

Nikolaos K. Louros (1898-1986): the Greek Gynecologist and Medical Philosopher

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Abstract

Nikolaos K. Louros (1898-1986) was a prominent Greek gynecologist and obstetrician. He was the son of Konstantinos Louros (1864-1957), a professor of obstetrics and gynecology at the University of Athens and a member of parliament. Louros, beginning in Athens, pursued his medical education in Switzerland and completed his specialization in Germany under the guidance of renowned professors, where he conducted remarkable medical research. Upon returning to Greece, Louros played a pivotal role in revitalizing obstetrics and gynecology and held key academic positions. During the German occupation of Greece, he actively contributed to the country's resistance efforts, frequently clashing with the occupiers and their supporters. His scientific contributions earned him international acclaim, positioning him among the world's leading gynecologists. In addition to his medical achievements, Louros also engaged in literary and philosophical pursuits. He additionally addressed the most significant social issues of his time through public discourse.

KeyWords: Obstetrics, Gynecology, 20th century, History of Medicine

Introduction

Greece upholds a longstanding tradition dating back to antiquity, characterized by the cultivation of exceptional physicians who not only demonstrate medical proficiency but also exhibit profound spiritual insight and humanitarian culture. One of the most distinct recent continuators of this tradition is Nikolaos K. Louros (1898-1986) *(Figure 1).* Louros' name is connected with prominent professors of medicine of Europe, especially of Germany and Switzerland, as well as with the renewal of obstetrics and gynecology in Greece. His medical expertise was combined with a sense of duty which allowed him to not only produce breakthrough scientific work, but to also maintain an irreproachable position during the German occupation of Greece (1941-1944), during which his actions constitute an example of bravery and freedom. The same sense of duty and humanism characterized his actions both as a political figure as well as an author and thinker. The present study mainly originates from his extensive autobiography, written by the pen of a belletrist physician, "Yesterday" (1980) [1].

Figure 1*. Nikolaos K. Louros (1864-1986) (From: https://iasis.med.uoa.gr/stin-ipiresia-tou-asthenous/frontizontas-ti-gynaika/)*

Early years and medical studies

Nikolaos Louros was born on March 6th, 1898, in Athens, as the only son of Konstantinos Louros (1864-1957), a professor of obstetrics and

gynecology at the University of Athens and a politician. Growing up in Athens, he was exposed to the world of theatre and art from an early age, fostering a lifelong passion for them. In fact, he initially aspired to pursue a career as an actor. Interestingly, his father envisioned a future for him as a journalist, recognizing the importance of the profession. However, Louros' innate inclination towards medicine prevailed, leading him to enroll at the Medical School of the University of Athens. After completing two years of medical studies, Louros' father encouraged him to further his education in Switzerland. It was during his time abroad that he formed a close friendship with Petros Kokkalis (1896-1962), a fellow Greek medical student who would later become a prominent physician and professor in Greece. Their friendship endured until Kokkalis' active involvement with the Communist Party in Greece. During his studies abroad, Louros balanced academic pursuits alongside exposure to world-class physicians and a vibrant nightlife, while also nurturing his enduring interest in the arts.

One of the first surgeons whose figure deeply influenced and whose abilities captured the admiration of young Louros was Emil Theodor Kocher (1841-1917), an important personality in medicine's evolvement, recipient of the Nobel Prize in 1909, student and assistant of the infamous surgeon Theodor Billroth (1829-1894) [2]. He dedicated a special place for his life and work in his autobiography. Upon completing his medical studies, Louros pursued further education in Vienna, where he studied under the tutelage of the esteemed gynecologist Ernst Wertheim (1864-1920). Wertheim, a colleague of Louros' father in Vienna, unfortunately passed away in 1920, before Louros could commence his specialization under his guidance. Nevertheless, Louros' interest in Wertheim's medical pursuits led him to Ernst Bumm (1858-1924), whom Louros acknowledges as his true mentor. After brief stints in Munich and Leipzig, where he encountered renowned physicians, Louros made the decision to continue his career in Berlin. It was there that he encountered the esteemed professor Bumm, a world-renowned gynecologist who was widely regarded as one of the best in Germany. Fortunately, professor Bumm accepted Louros as his assistant. Louros held immense admiration and respect for Bumm, both for his exceptional medical skills and for his seminal work "Obstetrics", which Louros described as "immortal" and the "Gospel" of gynecology, complete with captivating drawings.

Bumm assessed Louros' research on vaginal microorganisms as suitable for a thesis for the position of assistant professor at the Medical School of Berlin. However, Bumm passed away a few months later, prompting Louros to seek another professor to endorse his candidacy, which ultimately proved successful. Following his mentor's demise, Louros followed his close friend and Bumm's assistant Kurt Warnekros (1882-1949) to Dresden, where assumed the roles of attending physician and head of scientific projects. In 1928, after years of hard work and prolific scientific output, Louros became adjunct professor at the Medical School of Berlin's University. Despite his success in Germany, Louros harbored a desire to return to Greece. An opportunity arose, when the renowned Prime Minister of Greece Eleftherios Venizelos (1864-1936) was hospitalized at the "Evangelismos" hospital in Athens and became acquainted about the talented young physician Louros. The director of the gynecological clinic at "Evangelismos" was due to retire, prompting Venizelos to propose Louros as his successor. Louros swiftly prepared the necessary paperwork for his return to Greece. However, negotiations with the hospital's council faltered as Louros found some of their terms unacceptable. Eventually, Konstantinos Logothetopoulos (1878-1961), a distinguished Greek gynecologist who would later serve as Minister and Prime Minister during the German occupation of Greece, assumed the position [3]. Disappointed by this turn of events, Louros returned to Dresden.

Return to Greece and German occupation

The following summer, Louros returned to Greece, prepared to work in the clinic his father had envisioned for him. With the financial assistance of Elena Venizelou (1873-1959), the

"Marika Iliadi" clinic was heralded as the most advanced in Greece at the time. Louros made a notable innovation by introducing colored walls, departing from the traditional white color scheme previously employed. Thanks to a bill proposed by the Minister, future Prime Minister, Georgios Papandreou (1888-1968), who Louros had come to know, the University of Athens was able to appoint adjunct professors. Consequently, Louros was appointed as an adjunct professor of obstetrics and gynecology at the University in 1933. By 1938, he had ascended to the position of professor and director of the 2nd University Clinic of Obstetrics and Gynecology at the "Areteio" University Hospital, a role he held until his resignation in 1942.

In 1939, Professor Warnekros, Louros' close friend, arrived in Athens to attend to Princess Frederica's pregnancy. Initially, Konstantinos Louros, Nikolaos' father, served as the royal physician. However, due to his advanced age, Warnekros was called upon and collaborated with Nikolaos Louros for the birth of Princess Sofia (1938-), who later became Queen of Spain. When Princess Frederica was pregnant with the heir and future King, Konstantinos II of Greece (1940-2023), Warnekros entrusted Louros with the entire birthing procedure. As a result of his exceptional service, Louros was honored with some of the highest awards bestowed by the Greek State, awarded by King George II of Greece (1890-1947).

When the German occupation began, General Georgios Tsolakoglou (1886-1948), the first Prime Minister of occupied Greece, offered Louros the position of Prime Minister of Education and Hygiene. Louros promptly declined the offer. A few days later, he discovered that his colleague, professor Konstantinos Logothetopoulos, who he would later clash with on numerous occasions, had accepted the position. During the first days of the martyrial German occupation of Greece, Louros connected with the philosopher and Greece's future Prime Minister Panagiotis Kanellopoulos (1902-1986), who was the organizer of multiple revolutionary acts at the time. Kanellopoulos wrote respectively: "During this time of struggle I was brotherly connected with the professor at the Medical School Nikolaos Louros who was willing to take on any dangerous mission" [4]. Kanellopoulos also mentions the "beautifully written" book of Louros "Retrospections" in his monumental "History of the European Spirit", when talking about famous xylographies [5].

In 1942, Louros declined Minister Logothetopoulos' proposal to assist in the establishment of a new Medical School in Thessaloniki, citing that the timing was not appropriate as many other pressing issues needed resolution first. Tensions between them heightened when Logothetopoulos demanded Kokkalis to take actions against his conscience. Despite his opposition to Kokkalis' Communist activities, Louros encouraged him to maintain his stance, and when Logothetopoulos discharged Kokkalis, Louros and Konstantinos Choremis (1898-1966), a prominent figure in the rejuvenation of pediatrics in Greece, fulfilled their promise and resigned alongside Kokkalis. This incident illustrates Louros' ethos of standing by his unjustly treated colleague, even when they did not see eye to eye politically.

During the tumultuous days of the occupation, when Greece endured harsh conditions alongside its people, Louros, unable to teach or practice medicine, embarked on an endeavor to establish a scientific corpus. He recalls that this effort constituted: "precious solace during the endless days of the occupation". He finally presented his two books "Obstetrics" and "Gynecology", in the vernacular, that later merged into one massive volume. In a night in July 1944, Louros was abducted and taken to the camp in Haidari, where he and Choremis, among many others, were imprisoned. There, he endured humiliation and violence at the hands of German soldiers. The appalling conditions and inhumane treatment are detailed in his autobiography. Despite the hardships, Louros endeavored to apply his medical knowledge to assist the severely wounded. After enduring a month of atrocities, he was finally released. Louros later learned from friends that Logothetopoulos was the one who had betrayed him, but he chose not to testify during Logothetopoulos' multiple trials, so as not to further burden the ex-Prime Minister, who had

already been sentenced to life imprisonment. On the other hand, Logothetopoulos claimed that it was through his own intervention that Louros and Choremis were ultimately freed by the German authorities [6].

Later years

After the liberation of Greece, Louros resumed his position as director at the 2nd University Clinic of Obstetrics and Gynecology, where he served until 1951. During this time, he also assumed the role of dean of the Medical School. Subsequently, he transitioned to the 1st University Clinic, that was finally housed at the "Alexandra" University Maternity Hospital, where he continued his dedicated service until his retirement from professorial duties in 1968 *(Figure 2).* "Alexandra's" foundation stone was laid by Logothetopoulos during his tenure as Rector of the University in 1933 and flourished under the stewardship of Nikolaos Louros. From 1945 onwards, Louros held the reins of the obstetrics and gynecology specialty [7]. His students recall that: "He was the ultimate authority of the time regarding the specialty. With a single word, he could either pave the path to progress or relegate one to obscurity." [8].

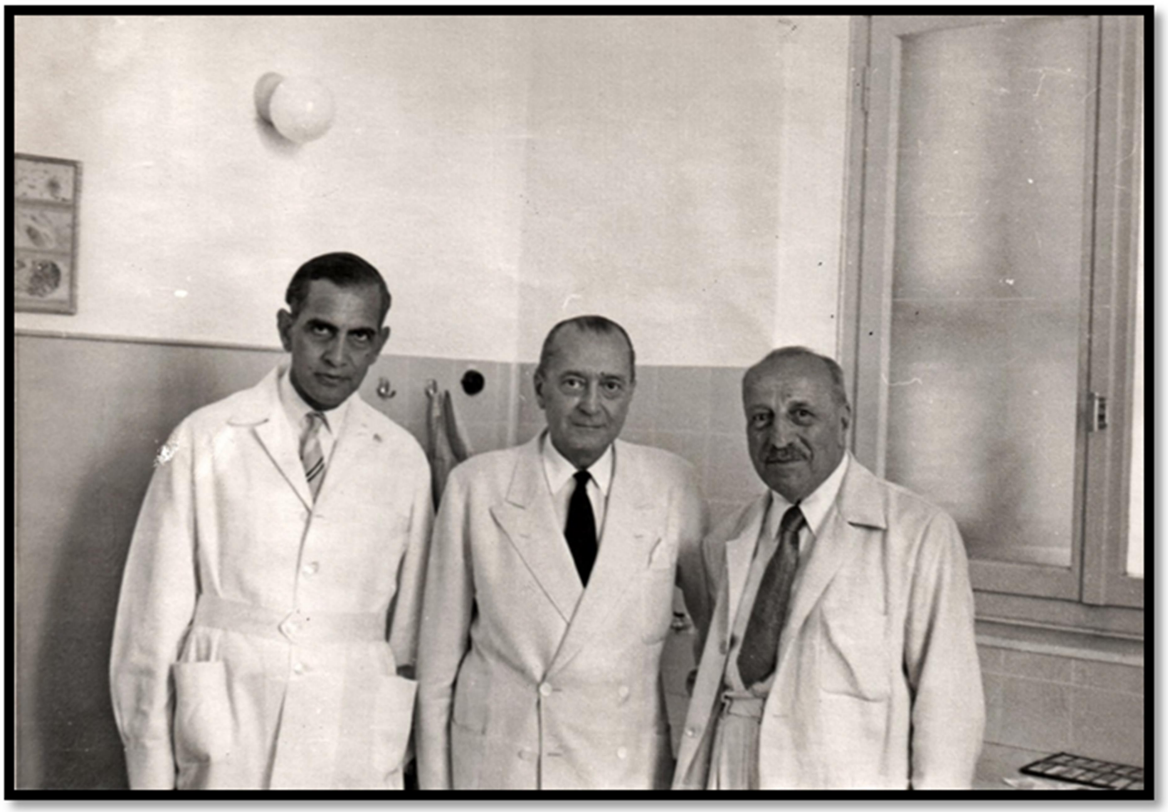

Figure 2. *Nikolaos K. Louros in the middle, Georgios Papanikolaou (1883-1962) on the right, during his visit to the "Alexandra" hospital in the 1950s. (From: https://estories.uoa.gr/en/human_portraits_nkua_studies)*

In 1966 he became member of the Academy of Athens [9]. He also served as President and Vice-President of the International College of Surgeons. By the time the dictatorship of the colonels (1967-1974) in Greece was over, Louros was appointed as the first Minister of Education, under which title he served for four months. In his speech to the youth on the national anniversary of

the 28th of October, he stated: "Our back is fraught by the centuries of the constant struggle of a tortured race that lived and will live with the sense of freedom rooted inside us. Without it, there is no breath" *(Figure 3).*

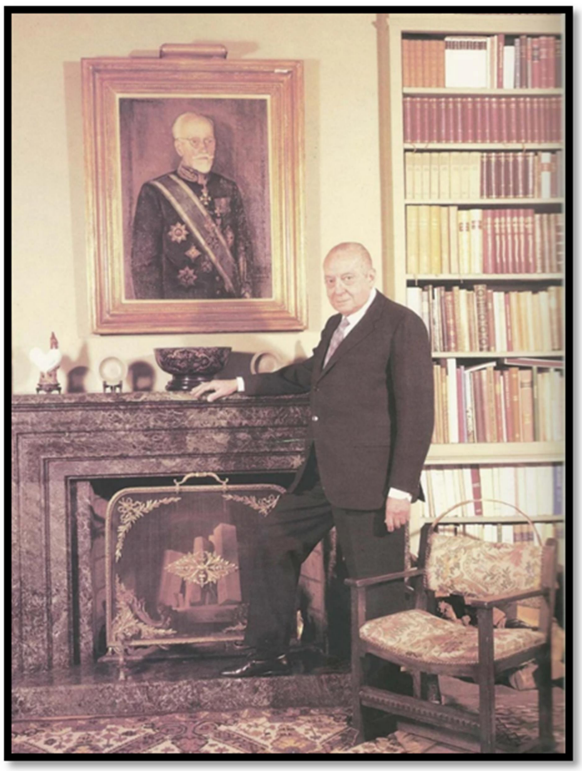

Figure 3*. Nikolaos K. Louros under the portrait of his father Konstantinos Louros (1864-1957) (From: https://www.louros-foundation.gr/portal/n-k-louros)*

Scientific and literature work

Louros' scientific work is massive and breakthrough. During his years as a young researcher he was interested in infections. He therefore occupied himself with Streptococci and their attributes as well as with the importance of the reticuloendothelial system in infections. Septicemia in pregnant women was also a topic of his multiple works, as he contributed with the immunization of the pregnant women via the anti-streptococcic serum. In the realm of clinical practice, Louros made notable strides in advancing techniques for facilitating shorter and less painful childbirth experiences. Furthermore, he played a pivotal role in developing surgical approaches to the treatment of cervical cancer. Louros also invented a "conservative surgical" therapy method for managing fibromyomas in young women. His contributions extended to refining techniques such as ligamentopexy of the uterus and the creation of an artificial vagina. Through these innovations, Louros left an enduring surgical legacy in the field of gynecological operations.

A significant aspect of Louros' contributions to medicine lies in his pivotal role in training multiple generations of gynecologists, imparting upon them the scientific approach he acquired from European professors and refined through his diligent work. Louros' influence on the progress of obstetrics and gynecology in Greece is profound and undeniable. Whether in his capacity as a professor or Minister, he advocated for the rejuvenation and establishment of hospitals and universities, many of which stemmed from his commitment to social service. His scientific excellence transcended the borders of Greece, resonating across Europe, America, and beyond. Through his lectures delivered in numerous countries worldwide, Louros not only showcased his medical prowess but also seized the opportunity to honor Greece, perpetuating its legacy on the global stage.

In addition to his invaluable scientific contributions, Louros demonstrated a deep interest in literature, philosophy, and theoretical thought. His body of work encompasses a diverse range of texts, including articles on social issues, novels, and philosophical inquiries. Louros tackled a wide array of topics, from discussions on the cultivated individual to addressing demographic concerns, social insurance, and various socio-medical subjects. Louros' multidisciplinary approach reflects his broad intellectual curiosity and commitment to exploring diverse facets of human knowledge and experience. He wrote regarding surgery: "Surgery is not a science, but art that services science. Therefore, it is not an aim rather than a means" [10]. He also stated about the modern physician: "The physician, especially the Greek, with his heavy spiritual heritage, in order to shape his personality, it is not accepted, as the old professor and medical

philosopher [Theodoros] Afentoulis (1824-1893) claimed, to be unphilosophical. Despite the evolvement of science and the therapeutic outcomes of the medical specialties, we are nostalgic, from the perspective of his personality, the humanitarian family physician, often also medical philosopher, who … benefited his patients to a greater extent than the thermometer and the poor medical tools of his era permitted" [10].

Louros' main philosophical interest rotated around the concept of "need". He suggests regarding it that: "1. The need is an outcome of the deprivation or the insufficiency and 2. That the subjective prevalence depends on the weakness of ignorance. When the need responds and fulfills the pursuits of the weakness, then something useful for human emerges (Christ, Buddha, Muhammad). When, however, the subjective prevalence depends on the subjective exploitation of human weakness, the outcome becomes harmful [11]. "The Power of Weakness" (1974) is a captivating novel by Louros, in which he explores the timeless themes of the pursuit of knowledge, dreams, the influence of conscience and fortune on personal lives, and their impact on the course of humanity. Through multiple historical scenes, Louros delves into these profound aspects of the human experience, offering insightful reflections on the interconnectedness of individual destinies and the broader trajectory of human history. This novel represents just one of his many contributions to thought, showcasing his talent for weaving together intricate narratives that resonate with readers and provoke contemplation on the complexities of existence [12].

Conclusions

Nikolaos K. Louros died on April 7th, 1986. He stands as a significant figure in modern Greek medicine. His work ethic, expansive knowledge, philosophical outlook on life, and, notably, his acts of bravery during challenging times make him an exemplary figure for physicians and humanity at large. Louros' life underscores the notion that excellence in medicine requires more than just scientific prowess; it necessitates the ability to apply medical knowledge with a steadfast commitment to alleviating human suffering.

For the modern physician, the study of literature and philosophy holds paramount importance. It serves as a reminder not to be overwhelmed by medicine's rapid advancements but to always remember the human aspect—the individuals seeking help and the pain accompanying their illnesses. A good physician becomes a great one only when they recognize that patients require not only medical expertise but also someone to provide support during their times of struggle. Louros' legacy serves as a guiding light, inspiring physicians to embody compassion, empathy, and resilience in their practice.

Conflicts of interest

All authors of this study have not any personal conflicts of interest or any financial conflicts of interest.

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Historical Review

The Andalusian surgeon al-Zahrawi (936-1013) and his method of treatment for infantile hydrocephalus in Muslim Spain

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Abstract

Hydrocephalus is a condition in which excess cerebrospinal fluid builds up within the fluid-containing cavities or ventricles of the brain, with its name deriving from the Greek words "hydro" (ύδρο), meaning water, and "cephalus" (κέφαλος), meaning the head. Cases of hydrocephalus have been known to humankind since the era of Hippocrates, Galen and the medieval Arabian physicians. During the 10th century, Abul-Qasim Al-Zehrawi was the first physician to write detailed notes about hydrocephalus and the instruments he had used during treatment through trepanation. His contributions to medicine made him a pioneer in the field of operative surgery, while he is considered to be among the greatest surgeons of the Middle Ages.

Keywords: Abulcasis, Caliphate of Cordoba, Middle Ages, cerebrospinal fluid, cranium surgery.

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Introduction

Medieval Arab physicians undoubtedly played a significant role in the progress of medicine not only by helping maintain and safeguard the knowledge of antiquity during the relative stagnation of Europe in that period, but also by making their own notable additions, discoveries and corrections. One of the most prominent Arab figures was Abu al-Qasim al-Zahrawi, a gifted polymath physician and surgeon, who made some remarkable contributions in the development of neurosurgery and is credited as the first to describe a detailed surgical operation for the treatment of infantile hydrocephalus. This condition had a long history of being referenced in the medical and historical literature around the world, ever since the time of Hippocrates and Galen, who attributed its existence to an extracerebral accumulation of water [1]. Hippocrates first described hydrocephalus as "water over the head", while Rhazes, the Persian physician stated that the cause of this condition was "water enclosed without exit, exiting upon death" [2]. It is believed that physicians were interested in hydrocephaly due to its odd appearance, while Hippocrates suggested decompression through trepanation as a treatment [3]. While hydrocephalus was first described in 5th century B.C., it wasn't until the 10th century A.D. that Abu al-Qasim Khalaf ibn al-Abbas Al-Zahrawi made a description for the treatment of hydrocephalic children with the surgical evacuation of superficial intracranial fluid for the first time [4].

This historical vignette presents al-Zahrawi's most important live and medical moments to enlighten a part of his bequest on the field of surgery.

Biography

Abu al-Qasim Khalaf ibn Abbas al-Zahrawi, more commonly known in Western literature as Abulcasis [5] (Latin and later English transliteration of his name, which will be used for the rest of the article for reasons of simplicity) lived between 936 and 1013 A.D. in the Caliphate of Cordoba, the Islamic state occupying most of the Iberian Peninsula during the Middle Ages. He was born in Al-Zahra, a royal city near Cordova, as indicated by his name ("al-Zahrawi" meaning the one from Al-Zahra), the destruction of which later in history, during the Christian-Muslim conflicts of the Reconquista period [6], means that few details regarding his life aside from his published works have reached us to this day. It is known that he lived mostly in Cordoba, where he studied,

practiced and taught medicine and surgery [7]. He served as the personal court physician of Caliph Al-Hakam II, a renowned patron of arts and sciences whose position of power gave Abulcasis access to almost all of the medical knowledge available in that time, and dedicated his life in the advancing and improvement of medicine and surgery as scientific fields, as well as the practices and knowledge level of individual doctors. He wrote several pioneering and revolutionary works for a variety of medical topics, he was the first to describe or explain a number of diseases, however his defining and most important contribution was in surgery (neurosurgery in particular) through the development or improvement of techniques to deal with multiple diseases and injuries including infantile hydrocephalus. While Abulcasis was undoubtedly a bright physician, devoted to medicine, he was also a firm believer of the importance of child education and behavior and advised students to study medicine but have knowledge on grammar, language, mathematics, astronomy and philosophy as well [8].

Works and legacy

Not all of Abulcasis' extensive work has survived to this day. Perhaps the most important one though, his medical encyclopedia "Kitab al-Tasrif li-man Ajaza an al-Talif" or roughly translated as "The book [that] elucidates [medical problems] for him who cannot write [about the subject]", has and trough it the incredible genius of him is known to us. Consisting of thirty books covering a particularly wide spectrum of his era's medical knowledge and with the last one completely dedicated to surgery, primarily neurosurgery, this encyclopedia was indicative of its writers' perceptions regarding medicine (according to him a doctor interested in practicing surgery had to acquire an expert knowledge of every aspect of medicine in general and of the conditions he could possibly encounter, before progressing into surgery proper) [9]. Abulcasis made his entrance into western European sources thanks to Gerardo of Cremona [10], who during his travel to Toledo (early 11th century) in search for translations of ancient Greek scrolls came into contact with the works of various Muslim scholars (Abulcasis included) that have been transferred there after the pillaging of the libraries of Cordoba by the Castilian monarch Alfonso the VI (ca 1040-1109). He translated in Latin many of these books, one of which was the thirtieth book of Abulcasis "Kitab al-Tasrif", the one dedicated to surgery and the one where the surgical treatment of infantile hydrocephalus was described. Thanks to this translation, that was followed by many others, his work influenced several of the first pioneer surgeons of western Europe with the Italian surgeon Guilliermo di Saliceto (1210-1277) being most likely the first to be influenced by Abulcasis and Guy de Chauliac (ca 1300-1368) being the first of several great French surgeons that were influenced by him and utilized his work to further progress medicine.

Surgical method for infantile hydrocephalus

Infantile hydrocephalus is a medical condition characterized by the dramatic swelling of the infants' brain because of excess cerebrospinal fluid retention. It can be caused by a multitude of factors ranging from Aqueductal stenosis, a condition when the passageway that connects parts of the brains' ventricles, narrows down, thus preventing the free-flow of cerebrospinal fluid, to head injuries or infections of the central nervous system. Abulcasis described it on the first chapter of his thirtieth book as a condition in which the head of the infant was swollen by liquid the quantity of which increased daily and could be located either between the skin and cranial bones or between the latter and the meningeal coverings. Based on this, it appears that he used the term hydrocephalus both for subdural and subgaleal effusion. According to his writings the condition occurred more frequently on infants during birth due to either the violent application of pressure at the infant's head by the midwife or other unknown to him factors, which would appear to be the unknown during that time causes of congenital hydrocephalus [4, 11-12].

For surgically treating this condition Abulcasis [Figure 1] provided the following instructions: for

a concentration of liquid between the skin and the bones resulting in a small-sized tumor, a small transverse incision on the center of the head was performed and the liquid was allowed to flow freely towards outside. Should the quantity of the liquid be particularly great a similar procedure but with two cross-bodied incisions was advised. As for a concentration between bones and meningeal coverings, according to Abulcasis this would be indicated by the cranial sutures which would be open towards every direction, three incisions on the center of the head were made. Following the incisions on either case, all the liquid should be removed. He also specifically stated on both cases that during the making of the incisions the surgeon should be cautious not to traumatize an artery for it would result in uncontrollable bleeding and potentially to the death of the patient. The tool that was used in treating infantile hydrocephalus, which resembled what is now known as a surgical scalpel, is described in detail in his textbook al-Tasreed, along with about 200 more drawings of surgical instruments [4, 11-12].

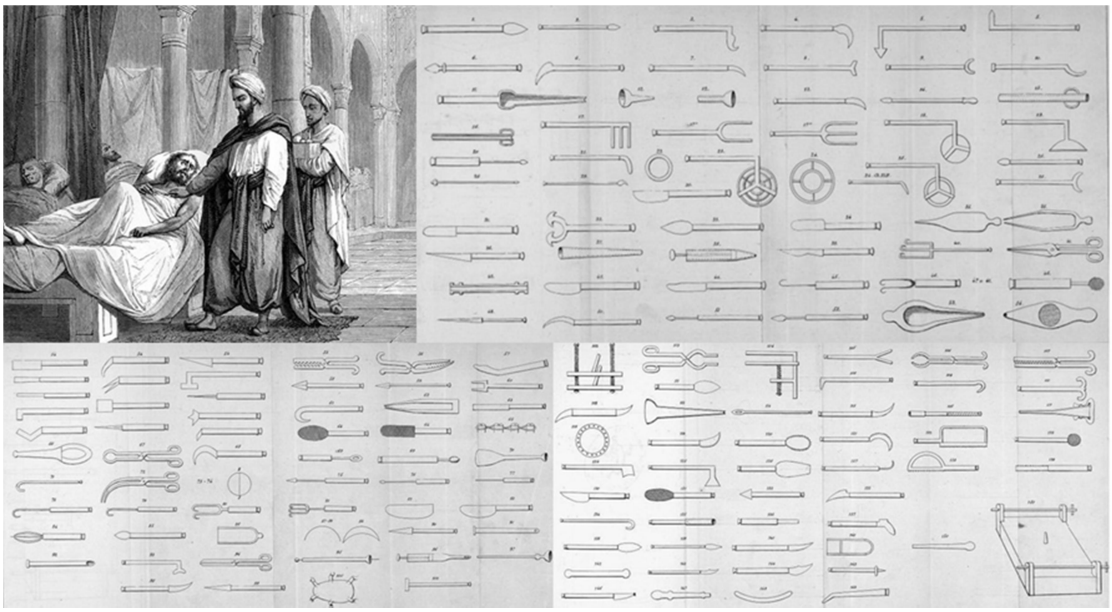

Figure 1. *Abulcasis in the Bimaristan (hospital) at Cordoba attending to a patient, while an assistant carries a box of medicines, engraving from the 1883 edition of Vies des Savants Illustres (top left) & Surgical instruments of Abulcasis as printed in La Chirurgie d'Abulcasis (trans. Lucien Leclerc), 1861.*

Postoperatively he advised for the wounds to be covered with bandages and ointments for the next five days. These first bandages would then be removed and the process would be repeated until a full healing. The instructions also stated that the patient should be sustained by foods with limited moisture for that time span [4-11-12].

Discussion

Taking all the above into consideration it is easy to understand why Abulcasis was considered such a remarkable pioneer. Not only did he describe a technique for dealing with a fairly important and relatively frequent neurological condition without any of modern day's knowledge regarding the nervous system or advanced tools and machinery designed for such procedures, but he also did this in such detail that despite the lack of definitive proof regarding the conducting of such operations in historical archives, his technique is generally considered to have been truly utilized. The interest he took on ensuring a suitable postoperatively care for the patient as well as providing the future doctor reading his

work with all the necessary advices and information shows that he was not motivated by a simple lust for knowledge or the will to be remembered but by true dedication in improving medicine. This is further supported by the many reports of him personally conducting all kinds of trivial medical procedures, such as removal of teeth, wishing both to enhance his personal skills through experience, as well as to help people in need, and his repeated statements regarding the value of observation and its' superiority when compared to exclusively theoretical one, meaning he encouraged criticizing and questioning existing knowledge, including his own writings. He highlighted the significance of a good relationship between physicians and patients, which should be built on trust and not take into account the social status [4].

The work of Abulcasis on hydrocephalus continued to avail physicians throughout the world for centuries. The Turkish surgeon Serefeddin Sabuncuoglu (1385-1468 AD), who was a pioneer of pediatric neurosurgery, seems to have no important differences with Abulcasis in his textbook, since he described treatment by surgical incision for water accumulation in patients' intracranial cavity [8]. Modern-day research emphases the difference between hydrocephalus in children and hydrocephalus that develops later in life. It appears to be related to the restriction of the flow of cerebrospinal fluid (CSF) and most of the infants are treated with a ventricular shunt, after the full growth of the brain, with the time of the first intervention for treatment to be of great importance [13].

Epilogue

Hydrocephalus is a condition that has been known to the ancients since the time of Hippocrates and Galen, with Abulcasis being the first person to give specific details about the medical instruments used in decompression-trepanation as a treatment. In the centuries to follow a number of aspiring physicians were engaged in discovering further information regarding hydrocephalus, in an attempt to understand the causes and to provide a treatment. It was in the 20th century that Harvey Cushing, the founder of modern neurosurgery, noted for the first time that the main source of the excess cerebrospinal fluid was the choroid plexus [14]. The significance of Abulcasis contribution to the understanding of hydrocephalus is undisputed. He was capable to provide detailed information from such an early era and be of help for many medical generations to come, in regards to a condition that might currently be routinely treated with great success, but used to have high mortality in the recent past. His innovations and clinical observation shaped European surgical practice, making Abulcasis one of the most influential physicians.

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