Civil Liability Arising from Medical Error in Disease Diagnosis in Light of the Development of Artificial Intelligence Technologies

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Abstract: The use of artificial intelligence technologies in the medical field is rapidly growing, especially in the realm of diagnosis, which is increasingly favored to mitigate the risks of human error. However, the use of these technologies in this context is not immune from error itself.

This necessitates the search for civil liability arising from diagnostic errors in the context of the development of artificial intelligence technologies. We find inadequacy in traditional liability rules in this framework, where, concerning personal liability for errors, it is difficult to determine responsibility among a large number of individuals contributing to the existence of these systems. Additionally, the complex composition of these technologies, especially regarding their independent, unpredictable, and uncontrollable actions, absolves them of personal responsibility for actions not initiated by them. Thus, the concept of human error, without which the damage would not have occurred, including liability for the actions of others, whether regarding the supervisor or the consequential actions of their subordinates, becomes inconceivable.

Furthermore, the application of liability rules for things and the associated theory of supervision has become untenable, especially with the emergence of advanced generations characterized by autonomy in decision-making and self-learning capabilities without any guidance. This hinders their control and direction, besides the inability to predict their behaviors or decisions. Similarly, concerning product liability, it is challenging to determine the product within the complex structure of these technologies, which require the involvement of multiple individuals in their development. Additionally, the multiplicity of defects and the difficulty of detecting them further complicates matters.

Thus, it appears that no existing liability system based on current rules can fully align and adapt to intelligent diagnostic systems. Therefore, it is necessary to consider new concepts and principles of liability to ensure appropriate compensation for victims of harm resulting from diagnostic errors in the context of artificial intelligence. However, in the absence of recognition of the independent legal personality of these systems, one solution advocated by some aspects of French jurisprudence is to establish a completely new system of liability for the actions of artificial intelligence, not only in healthcare but in all fields that may be affected by it. Nonetheless, at present, we believe it is more appropriate and suitable to establish a specialized liability system solely for compensating damages resulting from medical artificial intelligence, particularly those arising from diagnostic errors.

Keywords: Civil liability - Error - Medical diagnosis - Artificial intelligence.

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Introduction:

Artificial intelligence is that branch of computer science through which programs can be created and designed to simulate human intelligence, enabling computers to perform tasks that require thinking, understanding, hearing, and movement instead of humans[1]. It holds significant importance in the healthcare system and caregiving field for most countries worldwide, as recent years have witnessed an increase in the use of artificial intelligence technologies in the medical field.

The rapid spread of artificial intelligence technologies in this field can be attributed to their success in quickly and accurately performing tasks, even in challenging conditions beyond human capabilities. They are no longer limited to merely storing data and preserving files but have expanded to include data analysis, reaching accurate conclusions, diagnosing conditions in record time, detecting many diseases, providing medical treatment, and performing highly complex surgical procedures through intelligent systems and robots.

The reliance on artificial intelligence technologies in diagnosis, which involves identifying the disease afflicting the patient, pinpointing its causes, characteristics, and symptoms, has become increasingly prevalent. It represents the first step in medical treatment where a doctor demonstrates their scientific capabilities, and thus, they must exercise the necessary care in diagnosing the illness and allocate the required time for it. Hence, the importance of this stage and the severity of errors within it become apparent. If a diagnosis is made based on intelligent diagnostic systems and an error occurs as a result, it raises the question of the most appropriate civil liability system to compensate for the damages arising from this diagnostic error?

To elucidate the various aspects of the research topic and address the problematic issues it raises, we adopted a descriptive approach to highlight the concepts related to the study subject. Additionally, we utilized an analytical method by reviewing various legal texts governing the subject and analyzing them. This was achieved by dividing the topic into two sections: the first section encompasses the concept of diagnostic error in light of the development of artificial intelligence technologies, while the second section focuses on the nature of civil liability arising from errors in the context of these technologies' advancement.

TITLE 1:The Concept of Diagnostic Error in Light of the Development of Artificial Intelligence Technologies

To clarify the concept of diagnostic error in light of the development of artificial intelligence technologies, we will first discuss the evolution of these technologies in the field of medical diagnosis. Then, we will elucidate diagnostic errors in the context of these advancements.

[1] Mohammed Ali Al-Sharqawi, Artificial Intelligence and Neural Networks, Al-Kitab Publishing Center, Cairo, 1998, p. 23.

First Subtitle: The Evolution of Artificial Intelligence Technologies in the Field of Medical Diagnosis

In the following part, we will elucidate the artificial intelligence technologies in the medical field, then precisely in the medical diagnosis.

I. Artificial Intelligence Technologies in the Medical Field

Artificial intelligence technologies can manifest in various forms, including: Medical Robotics, Expert Systems, Neural Networks and Genetic Algorithms and Electronic Health Records (EHR).

a- Medical Robotics: robots or androids are distinguished fields within artificial intelligence that focus on simulating the motor functions performed by humans or animals in general. They aim to perform repetitive and dangerous tasks or tasks that humans are unable to perform.

As for medical robotics, it is defined as a machine that resembles a human in its activity, operating through an electromechanical system containing a database. There are two types:

- Non-autonomous: This type receives commands and executes them, as is the case when a doctor sends a small robot to navigate inside a patient's channels and intestines to capture the necessary images for diagnosis.

- Fully autonomous: This type has complete independence, capable of making decisions on its own without the need for human intervention. This is evident in some robotic surgeries and robotic nursing[2].

Medical robots vary in their applications,There are assistive technology robots aimed at improving the quality of life for individuals with disabilities and the elderly. Additionally, there are rehabilitation robots that support the human motor nervous system and motor sensory functions, such as arms, hands, and legs, aiding in therapeutic training for individuals with mobility impairments, helping them regain movement and mobility faster.

Moreover, surgical robots have achieved significant success, assisting doctors in performing complex and precise surgical procedures with high levels of accuracy and efficiency. They have also contributed to simulating surgeons' movements in remote surgeries[3]. The first use of surgical robots was recorded in 1984 at the University of British Columbia Hospital in Vancouver. In 1997, a new robotic surgery technique emerged, temporarily replacing the conventional endoscope. This technique greatly facilitated surgeries

[2] Ahmed El-Sayed Abdel-Razzaq Batoor, The Criminal Liability of Medical Robots as One of the Applications of Artificial Intelligence (An Analytical and Foundational Study), Legal Magazine (aspecialized journal in legal studies and research), Cairo University, Egypt, vol. 16, issue 1, 2023, p. 206.

[3] Talal Hussein Ali Al-Ra'ud, Civil Liability for Damages Caused by Artificial Intelligence Technology Operators, A Comparative Study, PhD Thesis, Faculty of Law, Mansoura University, Egypt, 2022, p. 65.

by using robotic hands capable of moving within the patient's body with extreme precision, without any errors[4].

In 2004, the Da Vinci robot was successfully used for the first time at King Khalid University Hospital in Saudi Arabia. It performed a rare surgery on a child suffering from severe obesity, allowing her to move naturally again[5]. In 2022, the Hussein Cancer Center introduced the first-of-its-kind robotic surgery system in Jordan, aiming to perform major surgical operations. The medical team at the center conducted the first successful surgery to remove a cancerous tumor using the robot[6].

Additionally, there are robots used for remote diagnosis as a means for doctors and nurses to communicate with patients remotely and access their medical data and condition through electronic medical records. These robots have enabled healthcare professionals to provide assistance in diagnosing chronic diseases by efficiently analyzing medical tests and radiological images. This allows doctors to detect subtle abnormalities or those difficult to see with the naked eye, with much lower margins of error[7].

b- Expert Systems: are one of the most important fields and branches of artificial intelligence. They are software programs that mimic the performance of human experts in a specific area of expertise by collecting and utilizing information and expertise from one or more experts in a particular field[8].

In the medical field, expert systems can perform various tasks such as issuing alerts for changes in a patient's health status, assisting in disease diagnosis, suggesting treatments, and interpreting medical images. Some of the most well-known examples of expert systems used in the medical field include the "Dxplain" system, which aids in disease diagnosis; the "Puff" system, used for interpreting lung function tests; and the "Peirs" system, used for diagnosing and interpreting thyroid function tests[9].

c- Neural Networks and Genetic Algorithms: Artificial neural networks are extensively used in diagnosing many diseases, especially respiratory diseases such as asthma and tuberculosis, as well as heart diseases, liver inflammation, and others. Genetic algorithms are

[4] Mohammed Ahmed Al-Adawi Abdel-Rabeh Mujahid, Civil Liability for Artificial Intelligence Robots "A Comparative Study", Legal Magazine, Cairo University, Egypt, vol. 6, issue 2, 2021, p. 314.
[5]Kawthar Mansal, Wafa Shanatlia, Proof of Medical Error in the Field of Robotic Surgery - Da Vinci System as a Model - Intervention within the activities of the National Symposium entitled "The Burden of Proof of Medical Error Attached to Public Health Institutions and ItsJudicial Applications in Jurisdictions", 08 May 1945 University, Guelma, Algeria, June 3, 2021, p. 07.
[6]Nasri Ali Falah Al-Dweikat, The Tort Liability for Damages Caused by Artificial Intelligence Robots in Jordanian Civil Law, Journal of Al-Zaytoonah University of Legal Studies, Al-Zaytoonah University, Jordan, vol. 3, issue 2, 2022, p. 236.
[7]Reda Mahmoud Al-Abd, Medical Civil Liability in the Face of the Development of Artificial Intelligence Technologies, Journal of Legal and Economic Studies, City of Sadat University, Egypt, vol. 8, special issue for the International Conference, 2022, pp. 06-07.
[8] Lakhdar Othman, Lamar Ridwan, Activating Knowledge Management through Expert Systems, Journal of New Economics, University of Khemis Miliana, Algeria, vol. 4, issue 1, 2013, p. 81.
[9] Al-Ritimi Mohammed Abu Qasim, Artificial Intelligence Applications, Research Paper, Libyan Association for Artificial Intelligence, University of 7th of April, Libya, 2012, p. 06.

also used in the field of medical imaging, including magnetic resonance imaging (MRI) of the brain, as well as segmenting the affected area from medical images.

d- Electronic Health Records (EHR): There are numerous computer applications in the medical field that have crystallized within a new concept called Electronic Health Records (EHR). EHR refers to the dual use of electronic communications and information technology in the healthcare sector. It involves the use of digitally transmitted and stored data that can be electronically retrieved for medical, educational, and administrative purposes locally or remotely in both public and private sectors.

The computer applications in the medical and healthcare fields include several prominent uses, such as computer-based patient records, electronic decision support systems, automatic reminder and alert systems, computer-assisted medical education and research, and others[10].

II. Artificial Intelligence Technologies in the Context of Medical Diagnosis

The use of artificial intelligence is rapidly growing in the medical field, particularly in the context of diagnosis. Diagnosing diseases requires a high level of accuracy to provide effective treatment and ensure patient well-being. Artificial intelligence encompasses a broad range of data, algorithms, analyses, neural networks, and insights that continually expand and adapt to the healthcare needs and patients' conditions. Its use in healthcare, especially in medical diagnosis, is essential. In recent times, artificial intelligence has made significant progress in the early detection of diseases.

As medical knowledge advances, doctors nowadays face a vast amount of information when diagnosing patients. Artificial intelligence, capable of analyzing vast numbers of medical images, and it is able to quickly and consistently identify patterns, including differences that humans may not discern[11]. This enables healthcare specialists to accelerate and enhance diagnostic capabilities by extracting clinically closest opinions from the wealth of available information. Today, computers employ human-like intelligence to perform precise tasks in detecting many life-threatening diseases such as infectious diseases and cancer. Medical images are analyzed for disease diagnosis using deep learning algorithms, an advanced form of machine learning technology. This involves studying and analyzing sets of medical images accompanied by information and learning how to classify them and discover distinguishing features, thereby enabling later understanding of similar images and providing appropriate diagnoses for medical conditions[12].

[10] Abu Bakr Khalid, Kheir Eddine Bouzrabe, Effectiveness of Using Modern Artificial Intelligence Applications in Confronting the Coronavirus (COVID-19) Pandemic: The Case of South Korea, Journal of Management and Economic Research, Ziane Achour University, Djelfa, Algeria, vol. 2, issue 2 (special), 2020, pp. 39-40.
[11] WebTeb(2022), The use of Artificial Intelligence in Medical Diagnosis, https://www.webteb.com/articles/%D8%A7, 03-11-2022
[12] Ahmed Shoukry Omar Abu Khattouh, Criminal Law and Modern Medicine - A Comparative Analytical Study - Legitimacy of Organ Transplantation, Dar Al-Nahda Al-Arabiya, Cairo, 2007, p. 144.

The diagnosis of diseases and the ability to examine large numbers of patients in a short time are among the most prominent uses of artificial intelligence. This field has made significant progress in early diagnosis and disease detection in its earliest stages, perhaps even before their occurrence, spread, or exacerbation, through the analysis of radiological images. The ability to predict diseases and their spread through the use of artificial intelligence analytics relies on data analysis and disease prediction, especially cancer[13]. With computers and neural networks now capable of reading magnetic resonance imaging (MRI) scans to detect tumors and malignant growths at a much faster pace than radiologists, with significantly less margin for error[14].

Although the use of these algorithms in healthcare is among the most important ways to assist doctors in diagnosing medical conditions with extreme precision through vast amounts of data based on data correlations, as well as the ability to learn to recognize patterns similarly to doctors and quickly draw conclusions. They are most commonly used in diagnosing diseases such as lung cancer, heart diseases, and skin conditions through the analysis of medical images. However, this does not mean they will replace doctors; rather, they will transfer the expertise of skilled physicians to novice doctors, allowing physicians to focus on topics directly related to the diagnosed disease. These technologies aid in early disease diagnosis and are among the most important elements utilized by healthcare systems to support appropriate decision-making and potentially reduce treatment costs[15].

A scientific paper published last year mentioned that a deep learning system was able to diagnose esophageal cancer with an accuracy rate of 98%, despite the relative difficulty in diagnosing this type of cancer, which often occurs in advanced stages when the opportunity for effective treatment is missed. Many applications and wearable devices utilize artificial intelligence techniques to monitor vital signs and can predict the likelihood of a health crisis before it occurs. The American platform Care Predict has developed a wearable tool that tracks even minor changes in behavioral patterns of the elderly, which precede falls, malnutrition, and depression, and it can quickly send distress signals when needed.

Furthermore, medical robots can be used to move among people to measure human disease symptoms and identify healthy individuals from patients. We find that there are two types of medical robots: the first type can measure human vital signs without identifying the disease, while the second type is for diagnosing and identifying the disease itself. These operations, which often require doctor intervention, can be performed using cameras and suitable algorithms to do so automatically, faster, and more accurately, especially with the analytical power of artificial intelligence algorithms that can be utilized. This technology can also be used in hospitals, linked with facial recognition databases to alert and warn patients

[13] Mohammed Jabril Ibrahim Hassan, Criminal Liability Arisingfrom Harms of Using Artificial Intelligence in the Medical Field, Analytical Study, Journal of Legal and Economic Studies, City of Sadat University, Egypt, vol. 8, special issue for the International Conference, 2022, p. 16.

[14] Khaled Mamdouh Ibrahim, Legal Regulation of Artificial Intelligence, Dar Al-Fikr Al-Jamee, Egypt, 2022, p. 82.

[15] Boufateh Toureya, Use of Computer Algorithms to Support Medical Decision-Making and Initial Diagnosis to Reduce Medical Costs - An Applied Study on Measles Disease -, Dafater Bouadex Journal, Ibn Badis University of Mostaganem, Algeria, vol. 10, issue 2, 2021, pp. 239-240.

and add any necessary information that may benefit their health and help reduce the spread of diseases in the future[16].

Based on the above, we find that the use of artificial intelligence in diagnosis makes high-quality healthcare accessible to everyone at reasonable prices by assisting doctors in making faster decisions about the most appropriate treatment for their patients. It also helps enable early disease detection while enhancing workflow by speeding up data reading times and automatically prioritizing urgent cases[17].

Second Subtitle: Diagnostic Error in Light of the Development of Artificial Intelligence Technologies

In the following part, we will address the definition of diagnostic error and its legal nature, followed by the specificity of diagnostic error in the context of the advancement of artificial intelligence technologies.

I. The Definition of Diagnostic Error and Its Legal Nature

Diagnosis is considered one of the most important obligations imposed by the medical contract on the physician. Based on it, the appropriate and required treatment for the condition presented to the physician is determined. The first thing the doctor does is listen to the patient's or their family's complaint and observe the symptoms they are experiencing. Then, the initial examination process begins by palpating painful areas, measuring heart rate, blood pressure, and other factors that assist in the examination and diagnosis process. Therefore, diagnostic error inevitably leads to error in identifying the medical condition and subsequently in determining the appropriate treatment for it. In other words, diagnostic error may lead to errors in the entire treatment process, which can have serious consequences on the patient's health and may result in missed opportunities for recovery[18].

Diagnostic error manifests itself in one of its forms as a result of failure, lack of skill, and inadequate care in the practice of medicine. This error may occur either due to negligence, such as ignorance of agreed-upon basic principles[19], or diagnostic shortcomings

[16] Khaled Younis, Revolution in Surgical Techniques and Symptom Monitoring and Diagnosis..Medical Robots Compete with Doctors in Operating Rooms, https://arabicpost.net/%D8, 16-10-2022.
[17] "ChatGPT AI Tool Successfully Diagnoses Rare Disease Afflicting Child, Baffling 17 Doctors"
The ChatGPTartificial intelligence tool succeeded in diagnosing a rare disease that affected a child, leaving symptoms puzzled 17 doctors. The disease, known as "Tethered Cord," manifested in a four-year-old child experiencing tooth pain and unusual growth retardation, leading to reliance on painkillers for comfort. After consulting with 17 doctors over three years without obtaining a diagnosis, recourse was made to the ChatGPTartificial intelligence tool, which ultimately identified the condition responsible for the child'ssuffering. Mervat Rashad, "Artificial Intelligence Succeeds in Diagnosing Rare DiseasePuzzling 17 Doctors.. The Afflicted Child Suffered from Mysterious Pain and Doctors Suspected COVID-19.. The Mother Turned to ChatGPT Tool to Discover It Was a Rare Neurological Condition Called Tethered Cord Syndrome."
https://www.youm7.com/story/2023/9/13/%, 13-09-2023.
[18] Hadi Shafiq, Civil Liability for Medical Diagnostic Errors - A Comparative Study -, PhD Thesis, Faculty of Law and Political Science, Djilali Liabes University, Sidi Bel Abbes, Algeria, 2017-2018, p. 138.
[19]Talal Al-Ajaj, Civil Liability of the Physician - A Comparative Jurisprudential and JudicialStudy -, Modern Book World, Jordan, 2011, p. 198.

due to haste and speed resulting from the high number of patients. It may also result from scientific error, such as a physician favoring one scientific opinion over another due to the similarity of symptoms, leading to misdiagnosis due to ignorance or disregard of medical theories despite their universal recognition[20]. Moreover, errors can occur due to the improper or insufficient use of scientific means, as physicians often require medical equipment for disease diagnosis, such as radiology and laboratory tests. Rushing to form an opinion, neglecting to ensure that findings are surrounded by the guarantees provided by scientific means, misusing these means, or failing to take precautions can lead to diagnostic errors[21]. Additionally, failure to seek assistance from other experts and specialists when encountering a medical condition that falls outside one's expertise or is complex and requires the intervention of other specialists can also lead to diagnostic errors[22].

Since diagnosis is considered one of the obligations imposed on the physician in the medical treatment contract, and a physician's diagnostic error in the presence of a medical contract is considered a contractual error, it imposes contractual liability on the treating physician. In this case, the physician is not only obligated to provide a diagnosis but also must fulfill this obligation according to the required standard of care. Moreover, the physician may be obligated to achieve a result when using medical devices. This constitutes a contractual error in diagnosis[23].

However, sometimes a physician may diagnose a patient's medical condition without establishing a medical contract between them. This occurs in cases where the patient does not choose their physician or does not have complete freedom of will in doing so. Therefore, the physician's diagnostic error in such cases is considered a negligence error, imposing liability for negligence on the physician with the presentation of the elements of harm and causation. This is based on the legal relationship established between the diagnosing physician on one hand and the patient on the other, such as when the patient undergoes treatment in a hospital or at their employer-provided workplace, or when the physician initiates treatment for a patient found in a public place due to a medical emergency, or other situations where a contractual relationship does not exist between the parties[24].

II. The Specificity of Diagnostic Error in Light of the Development of Artificial Intelligence Technologies

Attention is drawn to the increasing trend towards self-diagnosis using artificial intelligence to mitigate the risks of human error and improve quality of life. However, the use of artificial intelligence in this context is not without error. AI algorithms heavily rely on large and diverse datasets for learning and making predictions. Nevertheless, the quality and representativeness of these datasets can vary from person to person, leading to biases and

[20] Hadi Shafiq, Forms of Medical Error in Diagnosis, Journal of Law and Political Science, University Center of Naâma, Algeria, vol. 1, issue 2, 2015, p. 390.
[21] Talal Al-Ajaj, Op.cit, p. 200.
[22] Hadi Shafiq, Forms of Medical Error in Diagnosis, Op.cit, pp. 390-391.
[23] Hadi Shafiq, Civil Liability for Medical Diagnostic Errors - A Comparative Study -, Previous Reference, p. 139.
[24] Ibid, pp. 140-143.

inaccuracies in AI systems, resulting in biased outcomes, incorrect diagnoses, or inappropriate treatment recommendations[25].

Artificial intelligence now works on collecting patient data and generating reports to assist doctors in diagnosing their health conditions and making treatment decisions. However, the data used to create algorithms that generate results on which patient health decisions are based can be susceptible to distortion. They may be misused depending on who develops them and on the motives of the programmers, companies, or healthcare systems that design them[26].

Although artificial intelligence algorithms evolve based on patterns and correlations found in training data, they may not always take into account all factors or consider new or rare cases that differ from the set of cases they were trained on. This increases the risk of error and uncertainty in decision-making. Additionally, these algorithms also carry the risk of errors or incorrect interpretation of complex medical information. If an AI system provides inaccurate diagnoses or recommendations for inappropriate treatments, it can have harmful effects on patients' health, leading to delayed or ineffective interventions if AI systems fail to account for individual differences or unique medical conditions.

Despite the significant contribution of artificial intelligence algorithms in diagnosing tumors and malignant diseases through the use of advanced medical imaging techniques, some recent studies have shown otherwise. They have emphasized that total reliance on these algorithms in radiological imaging may lead to catastrophic errors in medical diagnosis that could end a patient's life. This occurs in cases where the algorithm generates an image showing a mass that was not previously present or removes a mass that was actually present. These circumstances can lead to catastrophic diagnostic errors, where doctors may mistakenly consider a patient to have a malignant tumor when they do not, known as false negatives, or mistakenly consider a patient not to have a malignant tumor when they do, known as false positives.

TITLE 2 :The Nature of Civil Liability Arising from Diagnostic Errors in Light of the Development of Artificial Intelligence Technologies

To clarify the nature of civil liability arising from error in the context of the advancement of artificial intelligence technologies, we will address the appropriateness of traditional liability rules in light of the development of these technologies, and then discuss the establishment of a new liability within this framework[27].

[25] Dangers of Artificial Intelligence in the Medical Field and Patient Health, https://www.annajah.net/%D8%A7%D8, 09-06-2023.
[26] Basem Mohamed Fadl, Alternative Means for Compensating for Artificial Intelligence Damages, Dar Al-Fikr Al-Jamee, 2023, p. 47.
[27] Artificial Intelligence May Lead to Catastrophic Errors in Radiological Medical Diagnosis, https://lc.ac.ae/lu-review/%d8%a7%, 06-09-2021.

First Subtitle: The Appropriateness of Traditional Liability Rules in Light of the Development of Intelligent Diagnostic Systems

Within this issue, we will address personal liability based on fault, then objective liability, then liability for defective products as a basis for accountability of intelligent diagnostic systems.

I. Personal Liability Based on Error as a Basis for accountability of Intelligent Diagnostic Systems

The individual is asked about the errors committed by oneself, which entail liability for compensation according to Article 124 of the Algerian Civil Code[28], as well as the errors committed by others in cases where the liable party is under their supervision as stipulated in Article 134 of the Civil Code, or is under their control as stipulated in Article 136 of the Civil Code.

However, this liability for personal actions and liability for the actions of others alike raise the issue of the connection between personality and liability. The Algerian legislator, similar to other comparative legislations, has recognized only two categories of persons: natural and legal persons. Each is granted legal personality based on specific criteria. A natural person is a human being capable of being a positive or negative party to obligations, thus enjoying a set of rights while bearing corresponding obligations. The law acknowledges the beginning of legal personality at birth and its end at death. As for legal persons, they consist of a group of natural persons and assets pooled or earmarked to achieve a common purpose or goal through acquiring legal personality[29]. The legislator grants them independent legal personality separate from the individuals comprising them, in line with their purpose, allowing them to enjoy a range of rights except those inherently tied to human status, within limits set by the law.

Although the conceptual nature of legal personality suggests its proximity to artificial intelligence due to its immaterial nature, this alone is insufficient to consider it a legal person. Legal personality has been granted legal recognition, and as a result, its provisions have been regulated and its forms defined, albeit exhaustively. In contrast, artificial intelligence has not yet been recognized by the legislator. Therefore, the inability to determine the category of persons to which it belongs makes it difficult to recognize it as possessing independent legal personality separate from the personalities of its users. Consequently, holding it personally accountable is not feasible[30].

[28] Algerian Civil Code, Law No. 75-58, dated September 26, 1975, published in the Official Gazette on September 30, 1975, as amended by Law No. 05-10, datedJune 20, 2005, published in the Official Gazette on June 26, 2005.

[29] Mohammed Al-Saghir Bali, Introduction to Legal Sciences (Theory of Rights and Law), Dar Al-Ilm for Publishing and Distribution, Algeria, 2006, p. 160.

[30]Rafaf Lakhder, Mouwash Firouz, The Specificity of Civil Liability for Damages Caused by Artificial Intelligence Systems in Algerian Law, Tabna Journal of Academic Scientific Studies, University Center of Brika, Algeria, vol. 6, issue 1, 2023, p. 581.

This necessitates the search for the party responsible for the errors of intelligent diagnostic systems. However, this creates another difficulty in identifying the responsible party among a large number of individuals contributing to the existence of these systems, including the manufacturer, programmer, operator, and user, given the multiplicity and specificity of their actions, making it challenging to distinguish between their errors. Additionally, significant difficulty arises in this type of liability due to the presence of some technologies characterized by deep learning and autonomous decision-making, as they mimic the human mind. This restricts the role of individuals in controlling this type of artificial intelligence technology[31]. The complex nature of the latter, especially concerning its independent and unpredictable actions, negates their personal responsibility for actions not initiated by them. Thus, the concept of human error, without which the harm would not have occurred[32], including liability for the actions of others, whether regarding the supervisor or the consequences of the actions of subordinates, is not conceivable.

II. Objective Liability as a Basis for accountability of Intelligent Diagnostic Systems

According to Article 138 of the Algerian Civil Code, it is evident that a person is not only responsible for their personal errors but also for things under their custody when they cause harm to others. However, the provisions of this article cannot be applied to artificial intelligence unless it is considered a thing and that thing is under custody.

Since artificial intelligence does not possess legal personality, everything that is not a person falls within the scope of things according to the law[33]. Although the legislator has not explicitly defined things within the framework of this liability, it appears from Article 138 of the Algerian Civil Code that they encompass any non-living material thing regardless of its nature or type, except for things governed by special provisions. While this may not pose an issue for holders of artificial intelligence, considering it as a tangible thing and its actions as material, it deviates from this scope due to the technical intricacies of artificial intelligence.

However, under the responsibility of the guardian of things, things also take on the description of living nature as stated in Article 139 of the Algerian Civil Code. This aligns with artificial intelligence because its holder, such as robots, transcends mere inertness to motion. Moreover, in its technical sense, it is in constant motion within its virtual world. However, it does not align with animals as living beings capable of sensation despite lacking discernment and perception, unlike artificial intelligence, which, despite its movement, does not possess the attribute of life. Although animals, despite their independence in taking stances, cannot make appropriate decisions due to the major point of contention, intelligence. However, despite the difficulty of predicting their actions, they can be controlled through

[31] Mohammed Fathi Mohammed Ibrahim, The Legal Framework for Liability for the Use of Modern Technology in the Medical Field, Journal of Legal and Economic Studies, City of Sadat University, Egypt, vol. 8, special issue for the International Conference, 2022, p. 17.
[32] Rafaf Lakhder, Mouwash Firouz, Op.cit, p. 581.
[33] Youssef Islam, Civil Liability and Artificial Intelligence: Any Solution?, Annals of the University of Algiers 1, Special Issue for the International Conference entitled "Artificial Intelligence: A New Challenge for Law?", University of Algiers 1 Ben Youcef Ben Khedda, Algeria, 2018, p. 237.

confinement and restriction because they are material beings, unlike artificial intelligence with its moral character. Consequently, the characteristics of things under this liability are not present in artificial intelligence in both its non-living or living nature[34].

This liability also faces difficulty in determining the guardian for artificial intelligence technologies, as Article 138 of the Algerian Civil Code defines the guardian as the person who has the ability to use, manage, and supervise. This concept of guardianship of things considers actual control over the thing. However, intelligent diagnostic technologies possess a significant degree of self-learning and autonomy, and their actions are not predetermined but are instead determined by electronic programs. This restricts user control over them and thus excludes the idea of guardianship because this intelligence is not subject to human control. Consequently, reconciling the necessity of fulfilling the requirements of the concept of guardianship on one hand, and the independence of artificial intelligence and its ability for self-learning on the other hand, becomes difficult[35].

Therefore, applying the rules of liability for the actions of things and the theory of guardianship derived from it to intelligent diagnostic applications has become untenable, especially with the emergence of advanced generations characterized by independence in decision-making and the ability for self-learning without any guidance. This hinders their subjection to control and guidance, as well as the inability to predict their behaviors or decisions, making them resistant to traditional rules[36].

III. Liability for defective products as a basis for accountability of intelligent diagnostic systems

By virtue of Law 05-10 amending and supplementing the Algerian Civil Code, the legislator introduced a new form of civil liability within Article 140 thereof, which is the liability of the producer for defective products. This is considered a form of objective liability without fault, based on the condition of the defect in the product due to its lack of safety margin and safety concept in terms of industrial or technical defect. Thus, the producer becomes liable for damages caused by the defective product.

It can be said that the tremendous advancement in artificial intelligence technologies was among the reasons that prompted the introduction of the system of liability for defective products. Therefore, there is not a significant difficulty in applying this liability. However, it requires expanding the definition of the concept of the product, as defined by the legislator within Article 140 repeated of the Algerian Civil Code. It is worth mentioning that artificial intelligence may take on a material form, thus being considered tangible property and inevitably falling within the scope of the application of the rules of liability for defective products. However, it may not take on any tangible nature, as is the case with diagnostic

[34]Rafaf Lakhder, Mouwash Firouz, Op.cit, pp. 583-584.
[35] Laurent Archambault, Léa Zimmermann, Repairing Damages Caused by Artificial Intelligence: French Law Must Evolve, Gazette du Palais: Bi-monthly Collection, Vol. 138, No. 02, 2018, p. 752.
[36]Emad Abdel Rahim Al-Dahiyat, Towards Legal Regulation of Artificial Intelligence in Our Lives: The Problem of the Relationship Between Humans and Machines, Al-Ijtihad Journal of Legal and Economic Studies, University of Tamanrasset, Algeria, vol. 8, issue 5, 2019, p. 21.

assistance programs, which raises questions about the possibility of applying these rules to them. In this regard, the legislator has included electrical energy within this article, considering it as a product, despite it being non-material goods, which can be explicitly compared to non-material artificial intelligence systems[37]. This is confirmed by referring to paragraph 10 of Article 03 of Algerian Law No. 03-09 concerning consumer protection and the suppression of fraud[38], which defines the product as: "any goods or services that may be subject to transfer for consideration or free of charge," and diagnostic AI programs provide diagnostic services and thus are considered products.

However, there is difficulty in defining the product within the framework of intelligent diagnostic technologies due to their complex composition, which requires the involvement of several individuals in their formation. Each part of artificial intelligence technology is handled by a specific person, such as the manufacturer, programmer, and developer. Especially since the Algerian legislator has not defined the product within the Civil Code but has instead defined it with other terms in many other laws, notably Law No. 03-09 mentioned above, which introduced the term "intervener" in paragraph 07 of Article 03, stating that: "every natural or legal person involved in the process of offering products for consumption." The meaning of offering products for consumption includes all stages of production, importation, storage, transportation, wholesale, and retail distribution[39]. Consequently, it can be said that the characteristic of the product applies to every natural or legal person who, in the course of their usual activities, produces intelligent diagnostic systems.

We find that the process of identifying defects in artificial intelligence firstly leads us to identify the multitude of its flaws. Some may stem from design flaws, while others may arise from manufacturing defects. Additionally, there may be what is known as marketing defects, such as inadequate instructions or warnings. However, the difficulty lies in detecting these defects, as any flaw in the physical carrier does not necessarily hinder the application of product liability.

Looking at the intelligent system as a set of algorithms, and considering all possibilities from the perspective of the producer, it becomes challenging to apply product liability, especially to systems capable of deep learning and making independent decisions. This poses difficulties in proving the existence of a defect in the product. Even if these flaws exist in the system at the time of its release from the manufacturer or developer, it is difficult to draw a clear line between damages resulting from artificial intelligence's autonomous decisions and damages resulting from the defective product[40]. Moreover, the involvement of multiple parties

[37]Reda Mahmoud Al-Abd, Op.cit, pp. 40-41.
[38] Consumer Protection and Combating Fraud, Law No. 03-09, dated February 25, 2009, published in Official Gazette No. 15 on March 8, 2009, as amended and supplemented by Law No. 18-09, dated June 10, 2018, published in Official Gazette No. 35 on June 13, 2018.
[39]Mukhtar Rahmani, Civil Liability for Defective Products, PhDThesis, Faculty of Law, University of Algiers 1, Algeria, 2015, p. 102.
[40] Amel Belabbas, The Suitability of Civil Liability Rules for Compensating Damages Caused by Smart Systems, Journal of Legal and Economic Research, University Center of Aflou, Algeria, vol. 6, issue 1, 2023, p. 473.

in the development of artificial intelligence complicates the precise determination of the responsible party.

In this context, it can be said that intelligent diagnostic systems capable of executing tasks independently, yet still under the control of the user or designer, bear the responsibility for the structural risks related to the design of the assistance system in the product, following the rules of liability for defective products. As for the responsibility for behavioral risks related to the use of the item, it falls on the owner, such as the hospital or the doctor using the system to diagnose the patient.

Despite these challenges, this does not preclude the adaptation of certain types of civil liability, especially liability for acts and defective products, as an initial solution and a temporary judicial remedy until a new form of liability is established in the future.

Second Subtitle: Establishing a New Liability for Diagnostic Errors in Light of the Development of Artificial Intelligence Technologies

It seems that no existing liability system can fully align and adapt to intelligent diagnostic systems and their unique characteristics. Therefore, it is necessary to consider new concepts and principles of liability to ensure adequate compensation for victims of harm resulting from diagnostic errors in the context of artificial intelligence.

However, in the absence of recognition of the independent legal personality within artificial intelligence systems, one solution advocated by some aspects of French jurisprudence is the creation of an entirely new system of liability for the actions of artificial intelligence. This would apply to all areas potentially affected by artificial intelligence, not just healthcare. Nevertheless, at present, we believe it is more appropriate and suitable to establish a specific liability system solely for compensating damages arising from medical artificial intelligence, especially those resulting from diagnostic errors.

I. Adopting an Operator Liability System for Artificial Intelligence Systems

The European legislator has innovated the operator liability system as a basis for holding independent artificial intelligence systems accountable. The European Parliament recommended adopting this liability on October 20, 2020, to facilitate compensation for those harmed by the operation of artificial intelligence systems and technologies[41]. This is achieved by directly and automatically referring to the responsible intelligence operator, who is assumed to have digital control over this intelligence, such that it cannot be released or escaped from. The European Parliament assumed that the operator is nothing but a digital custodian, essentially the main driver or person in control of artificial intelligence systems. This custodian is envisaged to be the manufacturer, programmer, or developer as they are responsible for the manufacturing and operational aspects of intelligence in reality. It is also envisaged that the user or owner, due to their digital control rights over independent artificial

[41]Resolution of the European Parliament of October 20, 2020 containing recommendations to the Commission on a Civil Liability Regime for Artificial Intelligence (2020/2014(INL)), Brussels, October 20, 2020.

intelligence systems, has the right to claim compensation for damages caused by intelligence under their digital guardianship[42], without requiring them to have actual control and full guidance over artificial intelligence, as is the case with traditional guardianship.

This applies whether those systems are highly dangerous or not, where highly dangerous systems are those whose independent operations entail a high probability of causing harm to one or more individuals randomly and beyond what can reasonably be expected. The severity of the danger is measured by calculating the degree of impact and influence between the severity of the harm, the degree of decision-making independence, the probability of risk occurrence, and the system's method and context of use, as specifically determined by the legislator without including medical artificial intelligence, including intelligent diagnostic systems, unless an exception is allowed for the inclusion of systems other than those mentioned if they cause repeated accidents resulting in injury or serious harm. The liability of the operator arising from specifically identified highly dangerous systems on the list is deemed objective liability, unlike systems added to that list as highly dangerous systems, for which liability for presumed fault on the operator's side can be mitigated if they prove that they have exercised due care, or demonstrated effective and regular examination of the artificial intelligence system during operation, or installed all available updates provided by the artificial intelligence manufacturer, or notified the manufacturing company of potential problems and damages that may occur during the operation of the intelligence. As for non-dangerous intelligence systems, which are anything contrary to highly dangerous systems, the operator's liability is based on proof of negligence[43].

II. Establishing New Liability Rules Specific to Artificial Intelligence

The system of successive or consecutive civil liability is more suitable for the characteristics of medical artificial intelligence at present. According to this system, the person responsible for the damage is determined based on their contribution to the operation of intelligent diagnostic technology. Therefore, responsibility initially lies with the user of this technology, as they are the one interacting with it and have the ability to operate it. Subsequently, responsibility is shifted to the producer or manufacturer of the physical entity if it is proven that the damage resulted from a defect in the physical entity, with the manufacturer of the physical entity being exempted if it is determined that the damage occurred due to the independent technology that lacks a physical entity, in which case designers or programmers of these systems are referred to.

However, regarding intelligent diagnostic technology, which has the ability of self-learning and evolves according to the data inputted into it, individual liability cannot be applied on the basis of a single responsible party, as the damage can be attributed to multiple

[42] Jessica Eynard, Identifying Actors in the Life Cycle of Artificial Intelligence Systems, Dalloz IP/IT, France, 2022, p. 71.

[43] Mahmoud Hassan Al-Sahli, The Basis of Civil Accountability for Independent Artificial Intelligence "Traditional Templates or New Vision?", Journal of Rights for Legal and Economic Research, Faculty of Law, Alexandria University, Egypt, vol. 1, issue 2, 2022, pp. 143-150.

reasons that are difficult to determine. This could be a flaw or error in program design, programming, algorithm updates, or in usage. Therefore, it is difficult to assign the damage to only one of these parties. Hence, it is necessary to give the victim the option to have the greatest possible chance of compensation. Accordingly, the victim should be given the opportunity to establish liability either on the party most capable of providing compensation, which typically includes the designer, manufacturer, or hospital owning the artificial intelligence, or on the party easiest to identify, such as the doctor who used this intelligence for diagnosis or the hospital employing the doctor.

However, the complex nature of artificial intelligence calls for the establishment of a system of successive solidarity liability among all parties involved in any way in the design, production, purchase, or use of medical artificial intelligence. This liability system consists of two levels. The first level involves providing the victim with the opportunity to establish the liability of the doctor who used it for diagnosis, as they would be the primary interactor with the patient. At the second level, the doctor would be able to file a claim against another actor in the liability chain if it becomes apparent that the latter may have been obligated to or could have been responsible for the damage caused by their involvement.

This proposed liability system will allow the doctor to avoid automatically and inevitably bearing ultimate responsibility for the actions of artificial intelligence. As a result, they will be able to practice their profession using the best technological tools for accurate disease diagnosis without constantly being at risk of being held liable, which could hinder them from performing their duties.

Conclusion:

Through our study, the significant and prominent role of artificial intelligence technologies in the medical field, especially in diagnosis, becomes evident. These technologies have become one of the most important modern technological means in medical activities. However, despite the continuous development of these technologies, especially in this field, the legal framework governing them is progressing slowly, particularly concerning civil liability. Current legal texts face several challenges in framing the liability of this intelligence due to its unique characteristics on one hand and its lack of legal personality on the other hand. This pushes for the necessity of introducing new liability in light of the evolution of these intelligence technologies.

Based on the foregoing, there are several recommendations to be noted, among the most important:

- The Algerian legislature needs to introduce new liability specifically for medical artificial intelligence by establishing rules that are suitable for the characteristics and nature of these technologies, striking a balance between expanding the use of these technologies in medical diagnosis and protecting humans from the harm resulting from errors in these diagnostic technologies.

- While awaiting the introduction of new liability, the legislature should strive to reform and develop the existing legal system, making its texts more flexible to address the developments in artificial intelligence.

- Utilize foreign expertise that has made significant progress in the field of artificial intelligence usage, particularly relying on advanced European Parliament legislation that introduced operator liability for artificial intelligence systems.

- Finally, medical artificial intelligence technologies should be designed and programmed to be safe, serving humanity and fulfilling their intended purpose, especially concerning intelligent diagnostic systems due to the risks associated with errors they may cause.