

Criminal Liability of Robots in Surgical Operations

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Abstract

The objective of this study is to determine the extent of criminal liability for medical errors resulting from the use of artificial intelligence applications (robots) in surgical operations. These constitute some of the latest technologies introduced into the field of surgery through the employment of artificial intelligence applications in surgical procedures, whose operating principle entails a fundamental change in the conduct of surgeries by enabling remote control by the surgeon. They have had a positive role in providing high precision and greater flexibility of movements compared to conventional surgery. Nevertheless, they may give rise to errors or harms that necessarily entail criminal liability for damages caused by artificial intelligence, manifested in errors attributable to the robot's manufacturer.

The researchers divided this study into two sections. The first section provides the theoretical foundation of artificial intelligence crimes in surgical operations in terms of the concept of artificial intelligence and the concept of the robot; in the second subsection the researchers addressed the advantages and risks of using robots in surgical operations. The second section discusses the criminal liability of robots in surgical operations with respect to the liability of the manufacturers of robots and clarifies the penalties prescribed for crimes of artificial intelligence and the errors resulting therefrom, including robotic errors. The researchers followed the descriptive and analytical methodology, as it is the most

appropriate for the nature of this study, given that this methodology contains rules of induction and interpretation of legal norms.

The researcher reached a set of findings, most notably the insufficiency of current legal provisions to impose criminal liability on artificial intelligence technologies. The researcher recommended the regulation of legal rules governing artificial intelligence technologies in terms of their use and the determination of the party responsible for crimes emanating from them.

Keywords: Artificial intelligence; Criminal liability; Robot.

Introduction

In light of the developments the world has witnessed in recent decades, including rapid advancements in the field of technology, artificial intelligence has taken a substantial share of this progress. Artificial intelligence is no longer confined to programming or industry; rather, it has become an active component of everyday human life and has begun to assert its presence in delicate and sensitive fields such as medicine, education, the judiciary, security, and others. The medical field is among the most prominent sectors directly affected by developments in artificial intelligence, as its applications have entered the stages of diagnosis, care, and treatment, and have even extended to include precise and complex surgeries.

It has become commonplace today to use advanced surgical systems that rely on artificial intelligence, such as surgical robots, which enable physicians to perform operations with levels of efficiency and precision that are difficult to achieve by traditional means. However, this use raises a set of legal issues, particularly in the event of errors or unforeseen outcomes that harm the patient. Hence the need arises to question the adequacy of traditional legal rules in keeping pace with these transformations, and the capacity of the legal system to apportion liability should harm occur due to artificial intelligence.

In this context, the issue of criminal liability is raised, as it constitutes a fundamental instrument for protecting society from acts that cause harm to others or affect public order. Yet its application to artificial intelligence faces significant challenges, foremost among them the difficulty of identifying the acting party when an error occurs. Is the liable party

the operating surgeon who used the system? Or the manufacturer of the system? Or the entity that programmed or maintained it? Moreover, can artificial intelligence be considered a "legal actor" subject to criminal prosecution in its own right?

Although Jordanian laws, foremost the Penal Code No. (16) of 1960 and the Medical and Health Liability Law No. (25) of 2018, contain provisions related to medical error and the liability arising therefrom, they do not address directly or explicitly the criminal liability resulting from the use of artificial intelligence technologies in the surgical field. This creates a legislative lacuna that may lead to the loss of patients' rights or to the imposition of liability unfairly upon one of the parties.

Research Problem:

The research problem centers on analyzing the legal dilemma concerning criminal liability for the use of artificial intelligence applications in surgical operations under Jordanian law, by analyzing the legal elements of criminal liability and determining the scope of their application to this type of cases. This gives rise to the following question:

To what extent do the provisions of criminal liability in Jordanian law apply to damages resulting from the use of artificial intelligence in surgical operations, and who bears such liability in the event of an error?

Research Questions:

Several subsidiary questions arise from this main problem, including:

1. Can artificial intelligence be considered a legal actor capable of being held criminally liable?
2. What criteria can be relied upon to determine the liability of the physician, the institution, or the manufacturer?
3. Are the current Jordanian laws sufficient to address such incidents, or is there a need for legislative development?

Objectives of the Research:

- Analyze the extent to which rules of criminal liability apply to errors resulting from the use of artificial intelligence in surgery.
- Clarify the position of Jordanian law on these issues.
- Highlight the deficiencies or shortcomings in Jordanian legislation in this regard.
- Provide legal proposals to develop the legislative framework in line with recent developments.

Significance of the Research:

Theoretical significance: The theoretical importance of this study lies in the fact that errors and harms resulting from the use of robots in surgical operations are serious matters that cannot tolerate legislative gaps or deficiencies; therefore they require continuous study given the renewal and development of the means by which they are perpetrated. Consequently, it is necessary to keep penal provisions abreast of these means, since there is no crime nor punishment except by statute (*nullum crimen, nulla poena sine lege*).

Practical significance: The practical importance of this study lies in shedding light on who bears criminal liability for the use of artificial intelligence applications in the medical field, particularly surgical operations, and in assisting the competent authorities in taking the necessary measures in that regard.

Previous Studies:

- Ahmed Al-Sayed Abdelrazek (2023) The Extent of Criminal Liability of the Medical Robot as One of the Applications of Artificial Intelligence (An Analytical Foundational Study). This study reviewed the general rules and provisions of liability and demonstrated the extent of their applicability to some criminal manifestations of the medical robot, and set out the legal framework for that liability. The subjects that constitute an addition and difference from this study are the study of the manufacturer's liability and the sanctions prescribed for it.

- Istabraq Asaad Al-Khazraji (2023) Criminal Liability for Crimes Committed via Artificial Intelligence in Jordanian Legislation (Comparative Study). This study addressed the nature of artificial intelligence and its types, and touched upon the basis of criminal liability for acts of artificial intelligence. The subjects that constitute an addition and difference from this study are the clarification of the manufacturer's liability for robots in surgical operations and the sanctions prescribed for it.

Section One: Theoretical Foundation of Artificial Intelligence Techniques in Surgical Operations

The medical sector has witnessed over the past two decades a radical transformation as a result of the tremendous development in artificial intelligence techniques, particularly in the field of medicine which fundamentally relies on diagnostic accuracy, clarity of results, and the anticipation of risks before they occur. Intelligent systems, including machine learning algorithms and deep learning techniques, have become the cornerstone in the analysis of medical data and the planning of surgical operations, and the use of these tools has contributed to improving the quality of medical decision-making.

They have become an effective tool to support medical decision-making, data analysis, and the planning of surgical operations with high precision. This development has contributed to raising diagnostic accuracy, reducing the risks associated with surgery, and improving patient outcomes. However, the introduction of artificial intelligence into the medical field has raised legal questions related to the criminal liability of the physician, especially in cases where a medical error occurs while relying on these intelligent systems, or when system failure leads to adverse results for the patient.

Artificial intelligence techniques are used in surgical operations, insofar as surgical robots and data-analysis systems enter at the core of precision surgical procedures; these systems analyze live images, assess tissue perfusion, and provide precise recommendations to the surgeon during the operation. (Fournier & Langlois, 2018)

Artificial intelligence constitutes a qualitative addition to surgical medicine, yet it imposes upon the legislature and the judiciary the duty to develop a legal framework that keeps pace

with this development, defines the criminal liability for these technologies, and at the same time ensures the protection of patients from the potential risks of this type of technology.

Accordingly, the researcher divided this chapter into two requirements: the first addressed the essence of artificial intelligence, and the second dealt with the advantages and risks of using robots in surgical operations.

First Subsection: The Nature of Artificial Intelligence

Artificial intelligence represents one of the most prominent technological innovations that has transformed the shape of contemporary medical sciences. It is defined as the capacity of computer systems to perform tasks that would ordinarily require human intellect, such as analysis, decision-making, learning from data, and predicting future behaviors.

Artificial intelligence is regarded as a system capable of making semi-autonomous decisions based on data, which differentiates it from traditional instruments that are used in a purely mechanical manner.

Accordingly, the researchers divided this requirement into two branches: in the first branch they addressed the concept of artificial intelligence, and in the second branch they discussed the concept of the robot.

First Branch: The Concept of Artificial Intelligence

The term "artificial intelligence" is composed of two words: "intelligence," which denotes the human capacity for comprehension, inference, analysis, and discrimination; and "artificial," which is an adjectival derivative of "artifice," meaning that which is manufactured, i.e., non-natural.

It is defined as the capacity of computer systems to perform tasks that emulate human mental processes, such as learning, planning, problem-solving, decision-making, and data analysis.

Artificial intelligence is also defined as "the superior general mental capacity that entails engaging in thinking, planning, problem-solving, abstract reasoning, understanding complex ideas, and learning rapidly from experience."

Artificial intelligence has been defined as "a set of techniques that enable computers and machines to simulate human learning, solve problems and make decisions. Applications and devices operating with artificial intelligence can see objects and identify them, thereby understanding and responding to human language."

Researchers hold that artificial intelligence may be defined as a set of novel methods used in programming computer systems which are employed to simulate the human mind and the mental and motor processes of humans, thereby enabling the deduction of facts and outcomes that are stored in the computer's memory to address numerous problems.

Branch Two: Concept of the Robot

Larousse Dictionary defined "the electronic robot" as "an automatic device that has the capability to handle objects or perform operations, according to an adjustable program" ([http:// www. Larousse. Fr/encyclopedia](http://www.Larousse.Fr/encyclopedia))

Qamus al-Tiknuluji al-Kabir defined it as "an automated machine put into service, having multiple uses and capable of being programmed."

The American Robot Institute defined the robot as "a multifunctional manual manipulator that is reprogrammable and is designed to transfer specialized materials through a variety of programmed motions in performance." A robot is known as a machine manufactured by humans that performs a set of functions and tasks automatically without human intervention; it has become part of our daily life in executing tasks and has entered the field of medicine and now performs surgical operations.

The Japanese Federation defined it as "an all-purpose machine equipped with limbs and memory devices to perform a predetermined sequence of movements; it is capable of rotation and of replacing the human worker."

The Committee for the Analysis and Processing of Information of the French Language defined it as "a device that performs a specific task through an ultra-micro automatic

guidance system." Robotic surgery has been defined as "a surgical procedure on the human body carried out by an automated device programmed by the physician, relying on advanced technological techniques."

Researchers contend that the robot may be defined as a machine having the capacity to perform multiple functions, to move and navigate, and to make decisions and execute other functions for which it has been programmed.

Branch Two: Benefits and Risks of Using Robots in Surgical Procedures

The technological development that has occurred has impacted all spheres of life, and consequently has necessitated the use of artificial intelligence in the medical field through a set of general regulatory frameworks governing it. Artificial intelligence is used in the diagnosis of all diseases by means of magnetic imaging; surgical robots have likewise been employed to assist physicians in performing delicate surgeries; AI applications in the medical field also manifest in the analysis of prevention and treatment through the use of artificial intelligence algorithms applied to patients' medical records and medical diagnoses.

Surgical robots represent a qualitative leap in contemporary medicine, as they help improve surgical outcomes and reduce risks. For this reason, we will first discuss the advantages and uses of the robot, and the risks associated with this use.

Section One: Advantages of Using Robots in Surgical Operations

A medical robot is an advanced technological system used by surgeons to perform surgical operations with high precision. It typically consists of a robotic arm equipped with precise surgical instruments and is controlled by the surgeon via a control unit. It has numerous advantages that facilitate medical work, particularly in the field of surgical operations, including:

- Assistance in the accurate diagnosis of disease.
- Saving time and material resources.
- Reducing medical strain by means of accurate diagnosis.

It is used in many daily tasks, including: management of patient records; continuous monitoring of hospitals; performing radiological and medical imaging for patients; transporting medical supplies and patients; continuous follow-up of patients' treatment plans; therapeutic and surgical training; sample analysis; assistance in performing surgical operations; and therapeutic medical research.

It should be noted that it is founded upon the governing principles of artificial intelligence in the medical field.

- Responsibility: namely, the manufacturer of the robots bears liability for all errors emanating from them due to manufacturing defects.
- Safety: high accuracy and high quality in use, together with achieving a high degree of privacy and robust security.
- Justice: the fairness of artificial intelligence systems.
- Transparency: through understanding all governing decisions, which should exhibit a high degree of transparency and a high quality of explanation for decisions and procedures.
- Privacy: protection of data privacy, particularly in the training of artificial intelligence systems.

Subsection Two: Risks of Using Robots in Surgical Operations

- The use of robots in surgical operations is more costly than conventional surgery.
- The surgeon is required to be well trained in the methodology and operation of the robot.
- Surgical complications may occur.
- Violation of data privacy, hacking of the robot, and tampering with it.

Chapter Two: Criminal Liability of the Robot in Surgical Operations

Criminal liability in the medical field constitutes one of the most important forms of legal accountability aimed at protecting patient safety and ensuring that medical personnel comply with the professional standards imposed by law and medical ethics. Recent developments in the medical field, such as the use of artificial intelligence and digital

technologies, affect the determination of the legal responsibility of medical personnel. These technologies may produce fundamental changes in the manner of performing surgical operations and monitoring their outcomes, and consequently require a precise understanding of the legal standards for assessing liability in cases of errors resulting from their use. Therefore, the criminal culpability of medical personnel is established only where an unlawful act constituting an offense is present.

Criminal liability is founded on traditional elements (the physical element — the conduct, the result, and the causal link; the mental element — intent or negligence according to the statutory definition of the offense), and these are the same elements applied by the judiciary when examining the establishment of accountability for medical practitioners whenever their conduct causes harm that exceeds acceptable professional risks.

Within the Jordanian legislative framework, the provisions of the Penal Code, health charters, and sometimes specific provisions such as the regulatory rules governing the practice of medical professions and the Medical Association define procedural and substantive elements for the establishment of the material and mental elements of liability. For example, the penal characterization concentrates on cases of gross negligence or conduct associated with evident danger (such as performing medical procedures without qualifications or without explicit and informed consent), whereas other errors may remain subject to civil or disciplinary liability without reaching the level of a criminal offense unless the conditions of the mental element or the required degree of seriousness are met. Recent studies confirm that the practical tendency of the Jordanian judiciary is to exercise caution when converting medical errors into criminal offenses, except where clear evidence of a material breach of professional rules emerges.

Medical and Health Liability Law No. (25) of 2018 defined medical error as "any act, omission, or negligence committed by the service provider that does not conform to the prevailing professional standards within the available work environment and results in harm" (Article 2). The law also made recourse to technical expertise and verification committees a central mechanism for determining the existence of error, and prescribed special provisions concerning complaint procedures, conciliation, and the doubling of penalties in certain cases. This legislative provision constitutes a focal point for any

judicial reasoning that seeks to determine the nature of error and distinguish it from multiplicity.

The researchers divided this chapter into two sections; in the first section they addressed the liability of the robot manufacturer, and in the second section

First Section: Liability of the Manufacturer of Robots, the Programmer and the Physician

The legal basis of criminal liability is the freedom of choice and the consciousness of the living human being, but the robot is not a living human being to which criminal liability can be ascribed. It is accepted that a programming error may occur, by virtue of which a crime is committed by the robot, and the question that arises is the extent of the robot's liability for medical errors.

Jurists are divided on this matter. One school of thought holds the manufacturer criminally liable, because the manufacturer bears responsibility for ensuring the safety of its products and testing them prior to use; consequently, the basis of liability is established against the manufacturer. In other words, full criminal liability is attributed to the robot operator based on the element of volition and freedom of choice, insofar as the manufacturer is able to control the surgical robot.

Another school of thought accepts the attribution of joint criminal liability, i.e., liability should be shared between the programmer and the manufacturer in addition to any other party that may have a role in the development or use of artificial intelligence.

A further school of thought attributes criminal liability to the surgical robot itself, i.e., holding the artificial intelligence itself criminally liable; however, this idea faces significant legal and criminal challenges.

It may be said that the prevailing view is that criminal liability should be combined between the manufacturer and the treating physician, because the robot is merely a machine used by the perpetrator to execute his crimes.

Criminal liability of the manufacturer is founded on defects in the manufacture of the surgical robot, which necessitates holding the manufacturer accountable.

It is necessary here to distinguish between offenses: an offense may be intentional or unintentional. In intentional offenses, the manufacturer's liability may arise from programming the robot to commit specific, defined offenses, in which case the manufacturer constitutes a legal person as perpetrator of the offense and the robot functions merely as an instrument or device used by the manufacturer. In the case of unintentional offenses, the fault is attributable to the programming by the manufacturer, and the manufacturer is criminally liable for that fault.

The Jordanian Court of Cassation affirmed in multiple rulings the necessity of conducting technical expertise to determine whether the occurrence constitutes a breach of professional obligations or was the result of an expected medical complication, and it warned against imposing criminal liability on a physician merely because an adverse outcome occurred without evidence of negligence, ignorance, or gross recklessness.

Requirement Two: Penalties Prescribed for the Manufacturer of Robots, the Programmer and the Physician

Pursuant to the principle of legality (no crime nor punishment except by statute), and given that AI-related offenses presuppose the commission of the offense by the manufacturer or the programmer or through a malfunction of the robots themselves, and moreover that the majority of legislations do not directly criminalize liability for the acts of robots, traditional laws focus principally on individual liability, whether that of the physician or the programmer.

Branch One: Penalties on the Robot User

The error may be committed by the programmer himself or through a malfunction of the robot device itself. In this case, the basis of criminal liability of the treating physician is a technical error of the artificial intelligence, and the person responsible for the unintentional error is punished; this is manifested in the form of failure to observe safety and security precautions.

Branch Two: Penalties on the Robot Manufacturer

If the error resulted from the manufacturer or the programmer themselves, the manufacturer bears criminal and civil liability for the resulting medical error. The legislator also presumes the existence of a technical system founded on the presumed fault of the programmer or the manufacturer themselves, according to the gravity of the committed offense, such that the penalty may reach life imprisonment, a term of imprisonment, or a fine.

Conclusion

In conclusion, and after studying the thesis "Criminal Liability for the Use of Robots in Surgical Operations", it became evident that there is a significant need for a clear legal framework governing the uses of artificial intelligence applications and the allocation of responsibilities, and for regulating the use of modern technologies such as artificial intelligence in the medical field, particularly in surgical operations, in order to ensure the protection of patients and to achieve criminal justice effectively.

Results

The researchers reached the following results:-

1. The current legal texts are insufficient to impose criminal liability on artificial intelligence technologies.
2. The robot is a machine used by the physician, and the manufacturer, the programmer, and the treating physician are the subjects of inquiry in criminal liability.

Recommendations

The researchers recommended the following:

1. To establish legal rules governing artificial intelligence technologies with respect to their use and to determine the party responsible for crimes arising from them.

2. To introduce compulsory insurance for the use of robots in the medical field to cover errors of the robots.

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