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AI AND HEALTHCARE ETHICS

ISLAMIC PERSPECTIVES ON MEDICAL ACCOUNTABILITY

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FOREWORD

The swift advance of artificial intelligence (AI) technologies heralds both unprecedented opportunities and significant challenges within the realm of medicine. As AI becomes increasingly integrated into healthcare systems, we are confronted with novel ethical quandaries that necessitate a sophisticated understanding of contemporary technological capabilities and their potential to question or disrupt long-established moral frameworks. This study endeavors to address these pressing challenges through the lens of Islamic bioethics, offering a thorough examination of AI's impact on the concept of medical accountability.

Islamic bioethics is anchored in a dual framework of medical accountability, which transcends mere legal obligations to also encompass a profound religious-moral duty towards God, the ultimate Creator of the human body. This dual accountability embodies the Islamic principle of trust (*amāna*) and highlights the imperative of integrating new technologies in a manner that honors religious precepts and professional standards.

In this context, our study revisits the concept of medical accountability by examining the roles and responsibilities of three key stakeholders – God, the patient, and the physician. By scrutinizing these roles through pre-AI and contemporary lenses, we seek to elucidate the ethical ramifications of AI technologies on the concept of medical accountability. This inquiry bears significance for Islamic bioethics, and also enriches the broader discourse on the intersection of technology and morality within global healthcare.

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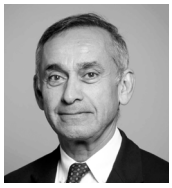

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EXECUTIVE SUMMARY

This study provides a detailed examination of the ethical implications of artificial intelligence (AI) technologies, with a special focus on the context of the Gulf Region and the broad Arab-Muslim world where Islamic values are an integral part of the moral world of these societies. For an in-depth and systematic analysis of the Islamic bioethical deliberations on AI, mainly focusing on the concept of medical accountability, this study is divided into three main Sections:

- **Section 1. AI in healthcare** explores the integration of AI technologies into medical practice. It assesses how AI can enhance diagnostic accuracy, treatment efficacy, and overall patient care. This section provides a comprehensive analysis of how AI technologies are transforming traditional healthcare paradigms and the implications for medical practice, while also addressing the challenges and limitations associated with its adoption.
- **Section 2. Bioethical perspectives** delves into the ethical implications of AI, as examined in the Western, dominantly secular, bioethical literature. It explores the ethical challenges posed by AI in healthcare, particularly in relation to medical accountability. The traditional physician-patient relationship, where the physician is the primary decision-maker, is disrupted by AI technologies. This section analyzes key ethical issues, focusing on the accountability of developers, clinicians, and healthcare systems. It highlights how the complexity of AI, its 'black box' nature (we cannot see how AI makes decisions or learns), and biases in algorithms complicate responsibility and decision-making. Other concerns include the digital divide, data security, patient privacy, and the impact of AI on doctor-patient relationships, all of which demand a reevaluation of ethical standards in healthcare.
- **Section 3. Islamic ethical perspectives** offers a comprehensive analysis of the concept of medical accountability, reexamining the roles of the three key stakeholders – God, the patient, and the physician – that have always been central to the Islamic moral tradition. Pre-AI insights are revisited in light of the profound ethical changes introduced by the AI revolution, as following:

1. Divine creator of the human body (God)

In Islamic belief, God is the sole creator and genuine owner of the human body, with humans regarded as trustees of their bodies. The Qur'an emphasizes God's authority and the sanctity of the human body, with medical procedures permitted as part of divine wisdom. Medicine, whose efficacy is linked to understanding and employing the consistent natural laws established by God, is considered a legitimate and religiously sanctioned practice.

While AI-enhanced medicine does not challenge the religious permissibility of medical practices, it cannot alter the core principles of accountability. Among all beings in our visible world, only humans are deemed religiously accountable. AI may influence medical decision-making processes, but it cannot assume the divinely endowed mental capacity granted to humans, which is necessary for moral responsibility.

2. Custodian of the human body (patient)

In Islamic ethics, patients are trustees of their bodies, authorized to make medical decisions. Physicians must obtain informed consent before interventions, barring exceptional cases such as emergencies or public health risks. The physician-patient relationship is contractual, requiring clear communication and agreement. Scholars debate physician liability for procedures consented to by patients but not sanctioned by God.

With AI in healthcare, these principles persist. Physicians are still required to obtain patient consent, and they may need to inform patients about the use of AI, as it is considered an emerging technology. The concept of charitable giving (*ṣadaqa*) might apply to using patient data for AI training, allowing 'data donation' by patients, while setting conditions to ensure that divine authority over their bodies – and, by extension, the data derived from examining those bodies – will not be violated.

3. Professional intervener in the human body (physician)

Physicians are obligated to uphold ethical integrity and professional competence in their practice. The use of AI tools should aim to enhance the quality of medical care and must not be exploited for unethical purposes. This study explores the implications of AI on physician competence, particularly the potential shift in liability toward new and non-clinical stakeholders. It also examines the ethical challenges posed by the 'black box' nature of some AI-operated technologies, emphasizing the need to strike a balance between transparency and the efficiency and precision of medical interventions.

In conclusion, in the era of AI-enabled medicine, we explore whether the collective liability shared by involved stakeholders, or the corporate liability of institutions will offer a more appropriate framework for addressing the risks and potential injuries associated with AI-driven healthcare. As AI technologies continue to evolve, new stakeholders – such as data scientists, AI developers, and institutions responsible for licensing AI-enabled tools – may also assume a share of the responsibility for medical accountability.

SECTION 1. ARTIFICIAL INTELLIGENCE IN HEALTHCARE

1.1 INTRODUCTION: BACKGROUND AND STUDY SCOPE

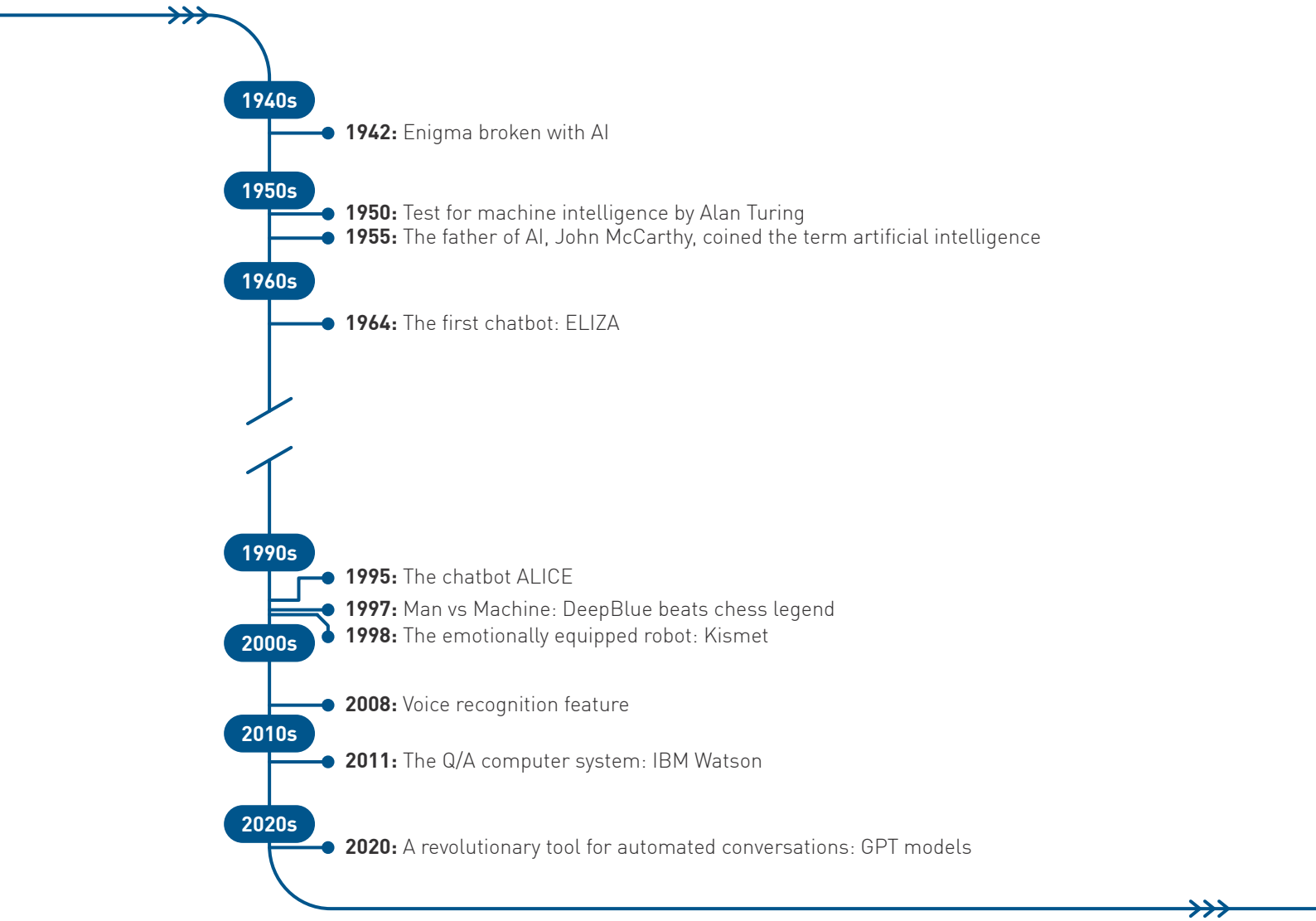
In its current manifestation, Artificial intelligence (AI) refers to the capacity of technology-driven algorithms to learn from data, thereby allowing for the execution of automated tasks without the need for humans to manually program each step.[1] AI systems are machine-based systems that can make predictions, decisions or recommendations that influence real and virtual environments and are designed to operate at different levels of autonomy.

Artificial intelligence has significant potential to enhance healthcare delivery and contribute to achieving universal health coverage.

AI has significant potential to enhance healthcare delivery and contribute to achieving universal health coverage (UHC). It has the potential to provide diagnostic support, aid in clinical care, advance health research and drug development, and support various public health initiatives, such as disease prediction and surveillance, outbreak management, and health system administration.[2]

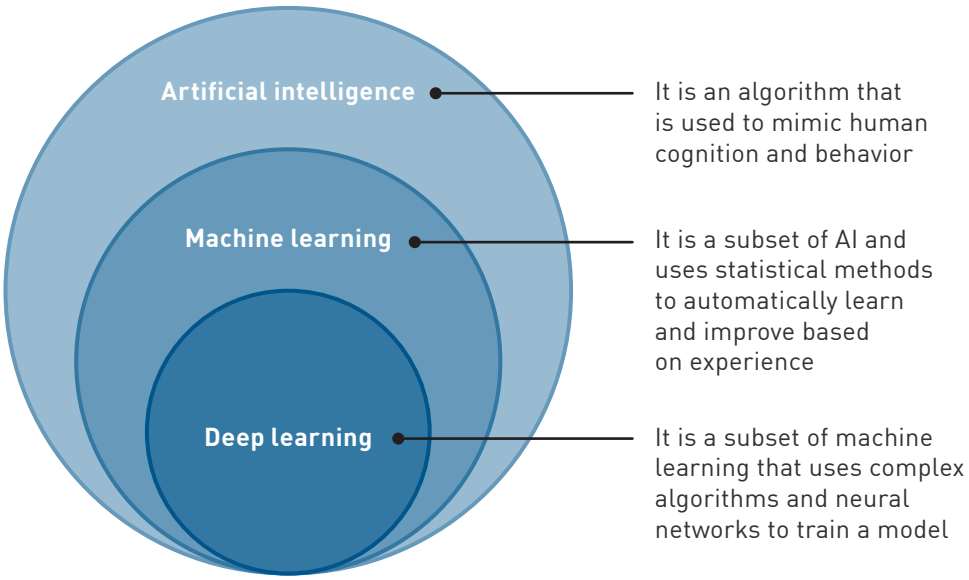
The first AI program was developed in 1951, and in 1956, the term 'artificial intelligence' was coined at the Dartmouth Conference by computer and cognitive scientist, John McCarthy and his colleagues. This marked the beginning of the AI era during the 1960s and 1970s when research on AI focused on rule-based and expert systems.[3] In the 1980s and 1990s, the focus of research in AI shifted to machine learning (ML) and neural networks. In the 2000s, AI research continued to evolve, leading to the development of virtual assistants which could understand language and respond to user requests in real time.[4,5] Most recent state-of-the art AI systems are of a generative nature as they can sample (generate) meaningful content (text, image, audio) given an appropriate context. The figure on the following page explores the historical journey of artificial intelligence.

There are a number of subsets of AI technologies – for example, ML applications including pattern recognition, signal processing, natural language processing, and expert systems. ML is a process that includes training a computing system to solve a given problem using past experience. The application of ML across different fields has gained significant interest over recent years due to the decreased costs of computing power and memory.[6] And ML has recently become the most popular approach of current AI-based healthcare applications. This is different from traditional computing where programs are written to implement rule-based specifications. A subset of ML, deep learning (DL), uses multilayered artificial neural networks to identify patterns in large data sets.[7] While it is a subset of ML, DL employs a more advanced approach that enables computing systems to extract, analyze and comprehend information that is useful from raw data through the imitation of human learning and thinking.[8] The key pioneers of DL (Geoffrey Hinton and John Hopfield) were awarded the 2024 Noble Prize in Physics attesting to the fundamental nature of their invention.



Source: Alowais et al. (2023)[9]

There are two key intrinsic properties of systems learned from data (including AI systems) that are relevant to the discussion on AI for healthcare. The first is the concept of 'generalization' and the second is 'robustness'. Generalization is the ability of an AI system to work accurately in data domains outside the span of its training data. For example, if an AI-enabled x-ray machine (as shown above) is developed in Europe on 'European data', then will it have the ability to work as well in the Middle East as it does in Europe? Robustness is the ability of AI systems to perform accurately when data is subject to small human imperceptible perturbations. For example, will an AI-driven x-ray machine work accurately when there are small changes in the lighting conditions? It is important to note that, with the current state of AI systems, there is a trade-off between generalization and robustness. For example, increased robustness is often achieved by sacrificing generalization and vice-versa.



Source: Khan et al. (2021)[10]

1.2 SCOPE OF THE REPORT

This is one of the early studies that the World Innovation Summit for Health (WISH) has conducted on the interplay of AI and healthcare ethics. It is the first study to focus on pertinent Islamic bioethical perspectives. We started this study by highlighting the most pressing scientific advance of AI in the health field to put the related ethical considerations in their proper scientific context. The report aims to provide a systematic overview of the critical ethical considerations associated with the spread and implementation of these technologies. As per the standard practice followed in previous reports on Islamic bioethics, we try to engage with perspectives from outside the Islamic moral tradition, especially the widely discussed secular Western perspectives. This is so readers have a balanced background of the ethical deliberations on the use of AI in healthcare from inside and outside the Islamic tradition. To do justice to the complexity and diversity of relevant ethical issues, the report covers a wide range of issues, including transparency, privacy and security, and bias and fairness. It highlights how these issues relate to medical accountability. Section 3 on Islamic ethical perspectives focuses on medical accountability because there is a scarcity of research that examines this issue from an Islamic perspective. This is particularly relevant to healthcare professionals and policymakers. The report concludes by proposing actionable policy recommendations for policymakers and industry stakeholders in Qatar and the surrounding region to consider for the ethical management of AI in health.

1.3 OVERVIEW OF THE USE OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Health systems continue to face exponential healthcare cost development, far outpacing gross domestic product (GDP) growth rates, to effectively support health system sustainability.[11] An aging population, rising prevalence of chronic diseases, and limited finances have placed an increased strain on health systems worldwide. Healthcare services continue to struggle with the demand for accessibility and availability. As health systems continue to struggle to meet the demands for care and financial sustainability, populations are placing growing expectations on health systems for increased personalization of care that focuses on health and wellness.

AI is already changing the way in which health services are being delivered in several high-income countries. AI has the potential to improve healthcare delivery at each stage, including prevention, diagnosis and treatment of disease.[12] The potential applications for AI in health and medicine are expanding rapidly, although its use remains mainly limited to high-income countries due to the lack of adequate infrastructure in other parts of the world.[13] AI applications can be defined based on their specific goals and the methodology used to achieve them. Data sources have proliferated in the healthcare field due to the collection of data from wearable technologies, electronic health records, genetic information generated from genome sequencing, radiological imaging, and hospital rooms.

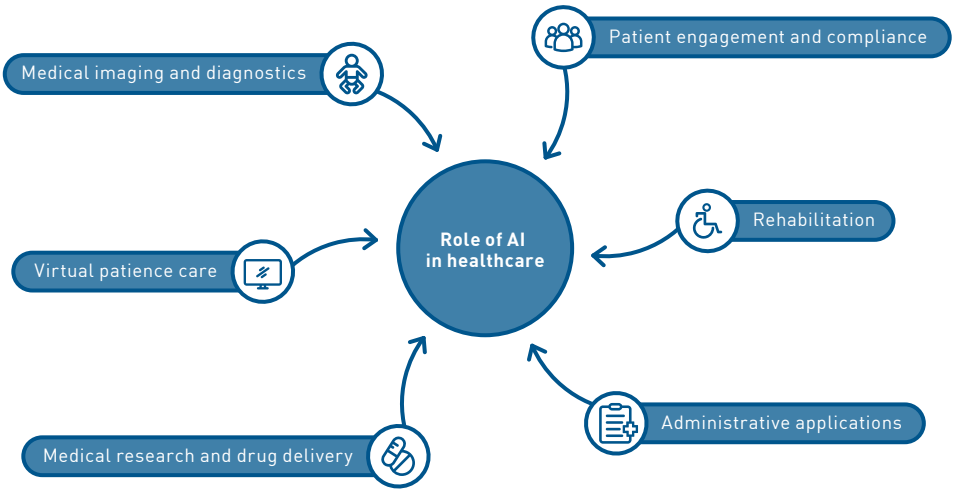
1.4 ARTIFICIAL INTELLIGENCE APPLICATIONS IN HEALTHCARE

While some AI applications in the healthcare setting are more advanced than others, current technologies show overall promise. An increasing number of academic studies and published reports stress that AI has an increasingly positive role to play in the overall improvement of diagnostics and clinical care.[14–16] These positive aspects have an important moral value to be considered in the overall assessment of AI applications in the healthcare sector and their benefit to society. The table on the following page outlines some of the most promising AI applications currently used in healthcare.

Artificial intelligence applications used in healthcare

Medical imaging and diagnosis	AI is increasingly used by radiology departments for the early diagnosis of a number of diseases, and for reducing the rate of diagnostic errors. Machine learning (ML) algorithms in medical image analysis have been expanded widely to most medical departments that use images for fields such as pathology, dermatology, cardiology, gastroenterology, oncology and ophthalmology. For instance, AI has been used as a tool for analyzing electrocardiogram (ECG) and echocardiography (echo or ultrasound) charts, which have been shown to support cardiologists in clinical decision-making. Encouraging results from the use of AI in the early detection of several diseases have been noted, including eye disease, breast and skin cancer and pneumonia, using body imaging technologies.[17–19] Other examples include the use of AI to analyze speech patterns that predict psychotic occurrences and recognize features of a number of neurological conditions such as Parkinson's disease.[20] ML models have been used to predict the onset of diseases such as diabetes[21,22] and tuberculosis.[23] Another notable use of AI in imaging is the use of computer vision in the assessment of the healing process. For example, computer vision is used to assess the quality of wound healing and to predict the risk of infection. Similarly, AI is being used to detect issues in the healing process, and monitor the healing of broken bones.	**Robot-assisted surgeries**	AI modeling has allowed surgeons to advance their intraoperative metrics, including force and tactile measurements. AI has also allowed for increased precision in the detection of positive surgical margins and is now facilitating the complete automation of specific steps in surgical procedures.[24,25] AI is expected to revolutionize surgery by facilitating preoperative planning and simulation, enhancing precision, improving decision-making, optimizing outcomes, and possibly enabling new forms of procedures. In the preoperative phase, AI models may be able to customize incision and dissection planes, plan osteotomy patterns, fabricate cutting jigs, three-dimensionally pre-bend fixation plates, and predict surgical outcomes. Within the intraoperative phase, AI may offer real-time surgical guidance/navigation and decision-making support (with or without augmented reality technology), and take on and automate procedures robotically.[26] To date, the most commonly used robotic surgical system is the da Vinci System, where a 'master-slave' relationship is used and a human surgeon performs surgical gestures within a console setting.[27,28] The gestures are transmitted to robotic arms that are anchored in the patient's surgical site.
Hospital administration systems	AI applications are being used to optimize healthcare administration systems, including resource allocation, staff scheduling, and billing processes, leading to improved efficiency and cost savings. AI has the potential to reduce administrative burdens through the automated population of structured data inputs such as retrieving patient data from medical records, and collating documentation about patient appointments.[29]	**Genomics and precision medicine**	In the case of genomic medicine, AI uses advanced computation and inference to offer insights, allowing systems to learn and reason and improve physician decision-making.[30] Numerous cellular features, such as gene activation, protein-nucleic acid interactions, and splicing, can be quantified efficiently and serve as targets for predictive models. With enhanced access to diverse data sets and contemporary computational tools such as ML, the potential exists for researchers to pioneer a new era in genomic medicine.

Clinical care	AI can be used by clinicians during consultations to integrate patient records, identify at-risk patients and vulnerable groups, aid in clinical decision-making and, potentially, catch medical errors. For example, in low- and middle-income countries, AI has been used in the management of antiretroviral therapy. AI can predict HIV drug resistance and disease progression, allowing physicians to optimize treatment plans.[31] However, clinical experience related to patient care remains essential and, for the foreseeable future, AI cannot become a substitute for clinical due diligence. As the use of AI in clinical practice increases, healthcare workers will be pushed to adapt their clinical practice. AI could provide support in automating tasks, allowing physicians more time to listen to patients and address their concerns.	**Virtual patient care**	The use of AI technologies has largely facilitated the shift from hospital-based to home-based care. Remote monitoring systems, such as virtual assistants and video-observed therapies, are being increasingly used to support patient care. Chatbots for health are more commonly used, as well as wearable sensors and health apps.[32] The pairing of telehealth services with AI-powered remote patient monitoring signifies a significant leap in healthcare delivery. AI has the potential to take over routine documentation throughout these interactions. Algorithms can then relay important updates and critical information, and co-ordinate care activities in a way that enhances patient care and reduces the likelihood of medical errors or delays.[33] This can significantly reduce the administrative burden on physicians, and redirect their focus towards direct patient interaction, further enhancing the quality of care and patient outcomes.[34]
Research and drug delivery	AI has the capacity to analyze large, complex data sets that are typically used in medical research.[35] It can also be used to hunt for specific scientific research works, integrate different types of data, and support drug innovation and discovery.[36] Pharmaceutical companies are using AI to streamline the drug development process. Scientists can use predictive analytics to recognize appropriate candidates for clinical trials and to develop models of biological processes.[37] In the pre-trial phase of clinical trials, AI (particularly ML) helps select cohorts, enhance participant engagement, and streamline data collection and analysis. This paves the way for true personalized medicine by leveraging computational power to tailor treatments to individual patients.		



Source: Al Kuwaiti A et al. (2023)[38]

Alongside the above positive aspects, the use of AI in health and medicine raises several ethical concerns. These concerns include the replacement of healthcare professionals and human decision-making.

1.5 EMERGING TRENDS

It is clear that the widespread adoption of AI technologies will impose wide-ranging changes to how we practice and deliver clinical care. Each of the emerging AI trends has associated ethical implications, which we address in the following sections.

1.5.1 The growing role of the patient

AI has the potential to revolutionize how patients manage their own medical concerns, particularly related to chronic illnesses such as diabetes, cardiovascular diseases, and mental health disorders.[39] AI-enabled conversation agents (chatbots), health monitoring and risk prediction tools, and assistive technologies designed to help those with disabilities, all play a vital role in empowering patients and assisting in their self-care.[40] Such a shift includes the ethics governing the physician-patient relationship – it changes the conventional idea of a patients' 'vulnerability' that entitles them to more protection, and the 'knowledge power' of the physician that assigns medical responsibility and liability. However, some patients may find this shift to patient-based care increasingly stressful – rather than being empowering and beneficial, it may limit access to traditional healthcare services. The increased adoption of self-management tools also raises wider questions around regulation, particularly when the applications are distributed by entities outside of the formal healthcare system.

1.5.2 The shift towards home-based care

AI applications in telemedicine can facilitate the shift from hospital care to home-based care. This includes remote health monitoring systems such as virtual assistants that support home-based patient care, and video-observed therapies for

patients with tuberculosis.[41] In 2020, COVID-19 significantly expanded and accelerated the use of telemedicine, and the expectation is that this trend is likely to continue to grow. In China alone, the number of telemedicine providers increased almost fourfold during the pandemic.[42]

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The prevalence of search engines that rely on algorithms to provide medical information, and the increased number of speech or text chatbots for health have also further facilitated the shift to home-based care.[43] The growth in the use of wearable sensors has the potential to increase the effectiveness of 'just-in-time adaptive interventions' (interventions that provide support by adapting to an individual's internal state). However, the vast amounts of data collected through these wearables also raise concern about how this data is used and who owns it.[44] When it comes to medical accountability, those responsible for the process of collecting, selecting and using data to develop smart healthcare tools can also be considered. Where possible, mistakes involving stakeholders should be examined with the clinician.

1.5.3 The extension of clinical care beyond the healthcare system

Health-related AI applications are increasingly being used by entities outside the health system. For example, AI applications for mental health can be provided through the workplace, the education system and social media. AI can also be linked to financial services in some cases.[45] These extended uses of health applications are potentially beneficial and effective at compensating for increased demand.[46] However, they raise new questions and concerns about issues related to governance and the stakeholders that could be held accountable for medical errors.

1.5.4 Using AI for prioritization and resource allocation

The potential of AI to help with decision-making regarding the prioritization and allocation of limited resources is currently being evaluated.[47] This use of AI has become more attractive following the COVID-19 pandemic when many providers lacked bed capacity due to the shortage of equipment such as ventilators. Clinics and hospitals in countries worldwide were overwhelmed and overstretched. There is a potential for ML algorithms to be trained to assist in clinical decision-making and ration supplies. These technologies can help identify which patients receive critical care. They can also help inform when certain interventions such as ventilator support can be discontinued.[48] Other applications include resource allocation of scarce health resources, such as the distribution of newly approved COVID-19 vaccines when the initial supply is insufficient.[49]

Resource allocation guided by the use of computerized decision-support programs has long raised several ethical concerns about accountability. Challenges arise when managing conflicts between machine and human predictions, and when a decision for a patient is influenced by a machine's interpretation of other patients' outcomes.[50]

SECTION 2. BIOETHICAL PERSPECTIVES

Various ethical challenges are emerging with the increased adoption of AI technologies in healthcare. As outlined in the previous section, the conventional perception of the physician-patient relationship is where the physician is the more powerful stakeholder and almost the sole decision-maker, and the patient is the more vulnerable party. This perception is seriously challenged by the integration of AI technologies in the healthcare sector. In this section, we provide an analytical overview of the ethical questions and challenges posed by these new developments. We highlight their relevance to the issue of medical accountability, which is the focus of Section 3 on Islamic ethical perspectives.

2.1 ETHICAL ISSUES AND ARTIFICIAL INTELLIGENCE: RESPONSIBLE DECISION-MAKING AND MEDICAL ACCOUNTABILITY

2.1.1 Accountability and its stakeholders

The integration of AI technologies into healthcare, primarily as decision-making aids, raises complex questions of accountability. While legal frameworks generally recognize liability for clinicians, healthcare institutions and AI developers, establishing developer liability remains challenging due to the evolving nature of these frameworks. Although errors in the AI's code can contribute to harm, the legal responsibility of developers is still being clarified. Recent research highlights ongoing efforts to define accountability within this complex landscape.

The main challenge to assigning responsibility in the context of AI-powered technologies is the problem of 'control'. AI-operated systems function independently of their designers or developers. This implies that the designers or developers cannot easily be held responsible.[51] This gap in responsibility could potentially add to undue burden experienced by the harmed patient or the healthcare worker who used the technology but who were not involved in the design of the AI product.[52,53] Assigning responsibility to the developer may add an incentive to ensure that all necessary steps are taken to minimize patient harm. Similar expectations have already been established for the developers of other medical technologies such as drug and vaccine manufacturers, and producers of medical equipment.[54] For this reason, the liability regime in the European Union (EU) is being advanced, with the Artificial Intelligence Act (AI Act), the Artificial Intelligence Liability Directive, and the revised Product Liability Directive, all potentially creating new obligations for designers and developers.[55]

The 'traceability' of harm is another added challenge in healthcare decision-making systems. The development of AI involves contributions from many agents. Therefore, legally and morally it becomes ever more difficult to assign responsibility, which (in theory) is shared among all contributors.[56] The participation of a machine in the decision-making process may discourage assigning responsibility to designers and developers, and those involved in the selection and use of the technology.[57] This could mean that the victim of harm may not be compensated for the harm they suffer,

because the cause cannot be fully detected. Societal trust in these technologies may also be compromised if it appears that the designers and developers behind the AI products cannot be held responsible.[58]

Another challenge is the joint or separate issuance of ethical guidance by technology companies.[59] Companies voluntarily and publicly commit themselves to comply with the norms and standards highlighted in these guides. However, these ethical standards are non-legally binding, not authoritative and too loosely formulated to form the basis of legal charges. To bridge this gap, independent audits and oversight authorities should be created to examine practices to judge if unethical standards or legal violations were responsible for the resulting medical errors or injuries, and to implement corrective measures where issues are identified.[60]

2.1.2 Accountability of the physician

Given that AI technologies are used to assist in, rather than replace, decision-making, it is arguable that clinicians are accountable for any harm that results from the use of these technologies in the healthcare setting. However, this can oversimplify the reasons for harm and the associated accountability. If the clinician were to make a mistake while using the AI technology, they could be held accountable if they had been trained to use it.[61] Clinicians should also have the responsibility to ask for proper validation of the technology before adopting into practice. However, if an error exists in the algorithm or data that is used to train the AI technology, then accountability is better placed with the developers of the technology, not the clinician.[62]

Other reasons in favor of not holding clinicians solely accountable for the harm caused by AI technologies apply to the existing principles of accountability in the use of non-AI-operated health technologies. Clinicians do not have control over AI-guided technologies, which often operate using 'black box' algorithms. This means that clinicians are unsure of how the AI system converts data into recommendations or decisions.[63]

By holding physicians fully accountable for any harm caused by AI technologies, companies and developers could completely avoid accountability.

By holding physicians fully accountable for any harm caused by AI technologies, companies and developers could completely avoid accountability. This makes human users the scapegoats for all faults, while they have little to no control over the decisions that are being made by AI.[64]

However, clinicians should not be fully exempt from accountability for medical errors. This would avoid issues surrounding 'automation bias', where clinicians potentially overlook whether an automated technology meets patients' needs.[65] Physicians should not be encouraged to ignore their own expertise, training and judgment in favor of a machine-made recommendation.[66] Where AI technologies issue a set of options for recommendations that a clinician must select from (rather than a single decision), there is a case that the physician be held accountable if they make the wrong choice.

The preceding examples assume that the physician is using AI as approved by their healthcare institution. Some physicians have experimented with AI systems in providing care (such as ChatGPT) which have not been approved. In those cases, accountability falls squarely on the physicians for their legally and ethically questionable use of AI.[67]

2.1.3 Accountability of system developers

The situation is made more complex when a decision is taken to use a particular AI-driven technology throughout an entire healthcare system. In this case, the developer, the institution and the clinician may all have contributed to the occurrence of medical harm, yet no single entity is fully accountable.[68] Here, there is a case to be made for the responsibility to be assigned to the government agency or institution that selected the AI technology, validated it and deployed it.[69] Leaders of organizations or institutions should appraise the application of AI vendors carefully and critically, and consider establishing internal policies and guidelines that govern their use.[70]

2.2 THE DIGITAL DIVIDE AND BIAS IN ALGORITHMS

2.2.1 The digital divide

The digital divide refers to: "the uneven distribution of access to, use of or effect of information and communication technologies among any number of distinct groups."[71] While the overall cost of digital technologies continues to fall, access remains inequitable. Depending on context, disparities can be linked to gender, culture, geography, religion and language.[72]

In 2024, available statistics show that about 66 percent of the global population – 5.35 billion people out of nearly 8 billion – have access to the internet. Despite the widespread connectivity, over 30 percent of the world's population remains without internet access.[73] Without an internet connection, these individuals have no online presence or digital footprint. Consequently, their data is excluded from the data sets that inform AI-driven healthcare tools.

Paradoxically, those most in need of these tools – particularly people in poorer countries where there is often a shortage of trained physicians – are the least represented in these data sets. This disparity raises the risk of medical accountability issues, as AI-driven healthcare solutions may rely on data that does not reflect the unique needs or backgrounds of these populations.

Also, AI technologies require electricity, information technology infrastructure, internet connectivity, and wireless and mobile networks and devices. If the climate is agreeable, there is great potential for solar energy to provide a way forward for many countries worldwide. For this reason, investment in solar energy has increased considerably over the past decade.[74] However, about 860 million people currently have limited access to electricity, including 600 million people living in sub-Saharan Africa.[75] Even in high-income countries with abundant resources that boast near-universal electrification, the digital divide still exists. In the US, millions of people living in rural areas and in cities have limited to no access to high-speed broadband services. Also, about 60 percent of healthcare facilities located outside metropolitan areas lack broadband.[76]

To address this, in 2019, the United Nations Secretary-General's High-level Panel on Digital Cooperation recommended:

> "By 2030, every adult should have affordable access to digital networks, as well as digitally enabled financial health services, as a means to make a substantial contribution to achieving the Sustainable Development Goals".[77]

2.2.2 Bias and fairness in AI algorithms

This accessibility also affects how data for AI is collected, which means that the data sets used to train AI models are predominantly biased. Most AI models are trained on homogeneous data sets that are not representative of population diversity.[78–80] For example, many data sets lack representation of women and girls, elderly people, ethnic minorities, disadvantaged groups and rural communities.[81] Therefore, AI is generally biased towards the populations that we have more data about. This places minority populations at a severe disadvantage. These systematic biases can become normative biases which, if not addressed, can exacerbate the already existing disparities in healthcare.[82]

If biased data is used to inform AI models in drug development, identified biomarkers that are responsive to specific therapies may only be accurate for the gender or race of the data set that was used, and not for the general population. An approved drug may not be effective for the excluded or unrepresented population, and may even prove harmful to their health.[83]

Data biases exist for several reasons. Due to the digital divide, women in low- and middle-income countries are less likely than men to have mobile phones or access to the internet,[84] and are therefore generally less represented. Another cause is the imbalance in data collection. For instance, genetic data is disproportionately collected from individuals of European descent.[85,86] Also, many clinical and experimental studies tend to include male experimental models or subjects, which reinforces the neglect of biological differences that are sex-specific.[87]

Biases also occur when communities or individuals choose not to provide information, making data collection increasingly difficult. In some instances, data collection requires the use of expensive devices such as wearable sensors and monitors, which can be inaccessible.[88]

Biases can also be related to the AI developer and their country of origin. Biases can be influenced by who is funding and designing a specific AI technology. AI technologies that are designed and trained in one country and then used in a different country could potentially be ineffective. They could provide an incorrect prediction for a population of different origin, race or ethnicity. Biases can also be introduced during the implementation phase – for example, if the diversity of communities and populations that need the AI system has not been considered (due to differences in age, co-morbidities, socioeconomic status or disabilities), then the technology can be ineffective, or even harmful for these neglected populations.[89] Such harms are not the result of an unqualified or unskilled clinician, but have been caused by problems that happened in the phases preceding the use of the AI-enabled tools by the physician. This would challenge the conventional assumption of physician's liability when medical errors occur.

2.3 PATIENT PRIVACY AND DATA SECURITY

Due to the large public repositories of digital data that have emerged in the era of AI, data privacy – particularly in healthcare – has become a matter of increasing concern.[90–92] Often the main concerns are about: data ownership and protection; the commercialization of patient data; confidentially of information; and patient privacy.[93] Data can be misused if traced back to patients and used to determine their identity. This brings many concerns and possibilities. Currently, most countries lack centralized protocols for data encryption and sharing for AI-driven healthcare. Instead, protocols are generally decided on a case-by-case basis, based on the approval of the related institutional ethics committee.[94] These points are relevant to the issue of medical accountability because malpractices involving violations of patient privacy and confidentiality can result in medical injuries or psychological harm. In such cases, the treating physician is not held accountable; instead, the accountability falls on those responsible for these violations, such as developers who failed to adhere to standard data ethics during the data collection process.

Most countries lack centralized protocols for data encryption and sharing for AI-driven healthcare. Instead, protocols are generally decided on a case-by-case basis.

Several data privacy and security issues, including the issue of medical accountability, should be considered when designing new AI-based technologies, or when deciding which products to use. The collection and use of patient health information could potentially implicate the US Health Insurance Portability and Accountability Act, the EU General Data Protection Regulation, and various other privacy and security laws. It is crucial that AI companies and institutions using these products determine the applicability of the Act and other country-specific regulations to the data. These regulations can be circumvented by making data anonymous before uploading to an AI database.[95]

There is also a responsibility on the user to perform sufficient vendor due diligence before entrusting third-party organizations with patient data. Healthcare entities should critically consider whether direct access to patient data is the only way the AI product can perform or provide value. They should examine alternative methods, such as creating separate databases of information within the main system.[96]

Appropriate security safeguards should be adopted to maintain privacy. Access controls should remain strict, and personnel and vendors must be educated on security obligations, which data sets have available and limited access, and the restrictions related to data use.[97–99]

2.4 THE 'BLACK BOX' PROBLEM AND LACK OF TRANSPARENCY

One of the major challenges of using the full potential of AI in medicine is the reluctance of clinicians to trust and adopt a product or technology that they do not fully understand – this is known in the AI context as the 'black box' problem.[100] Although modern ML relies on powerful models, these models remain unclear. When applied to the healthcare field, they fail to meet the widely accepted pre-AI standards of transparency, which are essential for obtaining informed consent.[101] Adaptation of AI tools, particularly in healthcare, has been relatively slow. Patients also tend

to lack confidence in using AI technologies, which can further hamper development. Concerns around trust become more urgent as more decision-making is delegated to rely on AI.[102] While generally human error can be accepted, machine error tends to be much less tolerated.

The 'black box' ethical dilemma is about balancing the need for the highest possible AI accuracy and efficiency while providing patients with enough information to ensure truly informed consent. While not an absolute rule, it is widely accepted that the accuracy of data science models often comes at the expense of clarity. The trade-off may be that patient understanding needs to be sacrificed to achieve high accuracy in complex AI systems. To maintain informed patient consent with the greatest transparency, AI-enabled medical tools should ideally prioritize accuracy and clarity. However, if these factors cannot be equally ensured, important questions arise about how the physician can deliver the best possible care. What would 'best care' mean in an age of AI, when AI-enabled systems may not fully disclose their reasoning processes to the physicians tasked with interpreting their outputs?

2.5 IMPACT ON HEALTHCARE PROFESSIONALS AND PHYSICIAN-PATIENT RELATIONSHIPS

The overall impact of AI technologies on doctor-patient relationships is the subject of greater focus by scholars.[103] Although AI systems have the potential to be more efficient than human-provided care, they can also provide lower-quality care. They are also associated with fewer face-to-face interactions, further dehumanizing clinical practice.[104,105] As outlined above, many factors and ethical challenges associated with the implementation of AI technologies in healthcare contribute directly to the overarching concerns around accountability. To date, it remains unclear whether AI system service providers will be bound by the same professional standards as healthcare professionals (for example, such as the Oviedo Convention).[106] A reduction in the quality of clinical care or oversight by healthcare professionals caused by the roll-out of AI systems could potentially be viewed as a violation of these professional standards.[107] Care models that incorporate artificial agents that are designed to provide care directly to patients are of particular concern when it comes to medical accountability.

While discussing the 'new' stakeholders introduced by AI technologies who may share in medical accountability, (as further detailed in Section 3), it is also crucial to address the broader social concerns linked to the increasing automation and mechanization of healthcare services. Socially assistive robots are increasingly employed to care for patients with demanding needs, particularly at the emotional level, such as those with dementia, neurological disorders, or terminal illnesses. While companies might aim to cut costs and avoid accountability issues by integrating more machines, this approach risks undermining essential human-to-human interaction and disrupting the established framework of medical accountability. Ultimately, accountability should rest with a human being, not a machine.

SECTION 3. ISLAMIC ETHICAL PERSPECTIVES

The information outlined in the previous sections of this study aligns with published academic literature, which mainly concludes that AI has the potential to tackle critical challenges in medicine and significantly enhance healthcare by converting raw data into meaningful insights. This capability is expected to drive advances in drug discovery, disease diagnosis, prognosis, treatment optimization, and outcome prediction. However, there is a parallel agreement that AI applications also raise serious concerns for existing ethical and legal frameworks. The available literature on AI applications in medicine and healthcare predominantly reflects Western, secular perspectives, often overlooking the influence of religious values in other contexts, such as Islam, Christianity, and Judaism.[108–115]

The available literature on AI applications in medicine and healthcare predominantly reflects Western, secular perspectives, often overlooking the influence of religious values in other contexts.

To address this gap, this study focuses on examining the intersection of AI and medicine through the lens of Islamic bioethics. Given the broad range of bioethical issues raised by the AI revolution and its applications in medicine and healthcare, (as outlined in Section 2), this section focuses on the ethical implications of accountability for medical errors, particularly as they pertain to physicians and healthcare professionals.[i] Two central questions are explored:

1. What ethical framework governs medical accountability and defines physician responsibility for medical errors?
2. How will the integration of AI impact this ethical framework and the conditions of accountability?

Given the novelty of researching this topic from an Islamic perspective, this study is premised on an extensive review of pre-modern Islamic literature and contemporary bioethical discourse. The research draws primarily from key sources in the study of Islamic jurisprudence (*fiqh*), including classical *fiqh* texts and modern discussions facilitated by prominent transnational institutions such as the Islamic Organization for Medical Sciences and the International Islamic Fiqh Academy (IIFA). These sources are foundational, as they frequently inform legislation and judicial decisions in Muslim-majority countries.

Beyond *fiqh*, the study considers Islamic theology, philosophy, and related genres, such as public morality and professional ethics, to provide a comprehensive analysis of *fiqh*-related discussions. To offer a broader perspective, secular bioethical studies are also reviewed, although a detailed comparative analysis between secular and Islamic viewpoints is beyond the scope of this research.

i For further insights into the concept of medical accountability from a perspective tailored to specialists in religious and legal studies, refer to Ghaly M. Islamic ethico-legal perspectives on medical accountability in the age of artificial intelligence. In *Research Handbook on Health, AI and the Law*. Edward Elgar Publishing. 2024.

3.1 ACCOUNTABILITY AND KEY STAKEHOLDERS

In the context of Islamic medical ethics, 'accountability' refers to a dual responsibility: a religio-moral responsibility towards the One who created the body, namely God; and a legal responsibility towards the respective professional or legal authorities. This dual accountability reflects the moral concept of trust (*amāna*) inherent in the medical profession.[116–118] While legal regulations aim to hold physicians liable for their actions, accountability before God is considered a higher, more comprehensive form of responsibility.

As outlined in Section 2, the integration of AI technologies in the modern healthcare sector has challenged the conventional perception that only the physician would always be the presumed accountable stakeholder for any medical errors or resulting injuries. The above secular discourse typically sidelines or simply ignores the religious aspects of a moral tradition such as Islam. Considering these new scientific, but morally significant, changes, and the gaps in available secular literature, we explore the impact of AI technologies on medical accountability by analyzing the roles of three key stakeholders in relation to the human body: God, the sole creator of the body; the patient, as the human custodian of the body; and the physician, as the professional who intervenes with the body. We begin by delineating each stakeholder's role as outlined in pre-AI Islamic scholarship, and then examine the implications of these roles within the context of AI-empowered medicine.

3.2 DIVINE CREATOR OF THE HUMAN BODY (GOD)

In Islamic belief, God is the sole creator of the universe and all beings, including humans.[119–122] The Qur'an affirms that God is the only entity worthy of worship due to His role as the Creator (eg, 2:21;[i] 45:04[ii]) and highlights human dependence on God for sensory and bodily functions (eg, 30:54;[iii] 23:78;[iv] 09:8-9;[v] 67:2[vi]). Also, the Qur'an acknowledges the perfection with which God has created humans (eg, 95:04;[vii] 23:12-14;[viii] 15:28-29[ix]). Islamic jurisprudence reflects these theological principles with several key concepts:

i "People, worship your Lord, who created you and those before you, so that you may be mindful [of Him]."

ii "In the creation of you, in the creatures God scattered on earth, there are signs for people of sure faith."

iii "It is Allah Who creates you in a state of weakness, then gives you strength, then weakness after strength, together with old age."

iv "It is God who endowed you with hearing, sight, and heart."

v "Have We not given him [men] two eyes. And a tongue, and two lips."

vi "Indeed, We [alone] created man from a drop of mixed fluids, to test them, so We made them hearing and seeing."

vii "Indeed, We created humans in the best form."

viii "And indeed, We created man from an extract of clay. Then We placed them as a drop of fluid in a safe place. And then We made that drop into a clinging form, and We made that form into a lump of flesh, and We made that lump into bones, and We clothed those bones with flesh, and later We made them into another creation – glory be to God, the best of creators."

ix "And recall when your Lord said to the angels, 'I am creating a human out of dried clay, of fermented mud. When I have fashioned him and breathed from My spirit into him, all down to him, fall down to him, prostrating.'"

1. **God's authority:** God's authority over human bodies surpasses individual control, as God is the ultimate creator and owner, while humans are seen as trustees of their bodies.

2. **The body's sanctity and inviolability:** Human bodies are regarded as having sanctity (*ḥurma*) and inviolability (*ma'ṣūmiyya*) granted by God. Any harm or aggression, even if consented to by the individual, is deemed a sin.[123–128]

In reference to the second point above, medical procedures causing injury are not automatically considered religious violations. Procedures such as limb excision or tooth extraction are deemed permissible and part of a divinely sanctioned medical practice. Prophetic traditions, including "The One who sent down the disease sent down the cure" and "For every disease, there is a cure," support the legitimacy of medicine.[129–133] Medicine was introduced by physicians as an art based on principles and natural laws that God has made consistent, discoverable, and accessible to the human intellect. This consistency allows medical experts to rely on these principles and develop their practice accordingly.[134] Medicine is considered a field of knowledge endorsed by religious principles, with medical and religious knowledge viewed as stemming from divine wisdom.[135,136] Some scholars recognize medicine's religious merit due to its divine origin, with God referred to as the Sublime Physician (*al-ṭabīb al-a'ẓam*).[137]

3.2.1 AI's impact on ethical considerations

The integration of AI technologies and advanced tools into the medical field does not inherently challenge the long-standing religious permissibility of AI-enhanced medicine. Concerns expressed in secular discussions about artificial superintelligence (ASI) posing an existential threat, while not exclusive to the medical field, are deemed theologically untenable by Muslim scholars.[138–141] However, techno-optimists underscore the potential benefits of AI, such as increased efficiency and affordability, though many remain promises.[142,143]

AI is unlikely to radically transform the practice of medicine so that it would be deemed religiously impermissible.

The more realistic view suggests that AI is unlikely to cause radical changes in the medical profession that would result in its judgment as religiously prohibited, instead of its pre-AI image of being praiseworthy. AI is unlikely to radically transform the practice of medicine so that it would be deemed religiously impermissible. Instead, the fundamental religious permissibility of medical practice will remain intact, with prohibitions continuing to apply to specific interventions, such as euthanasia and human cloning.

Another critical aspect of AI-empowered medicine is that human accountability in medical practice cannot be transferred to smart machines or AI-driven tools. According to mainstream Muslim scholars, with some asserting a consensus on the matter, only humans, jinn (supernatural spirits), and angels fall under the category

of religiously accountable (*mukallaf*) beings. Other creatures – such as animals, plants, and inanimate objects – are not considered accountable, even if they exhibit certain levels of rational behavior akin to human cognition.[144–148] The 14th century Islamic scholar Al-Zarkashī (d. 1392) observed that the mental capacity underlying religious accountability is a divine endowment rather than an acquired skill.[149] While AI can replicate certain human functions, it cannot emulate the divinely endowed mental capacity that defines accountability. Therefore, it cannot be held accountable for medical errors. However, AI-empowered medicine may still influence the nature and scope of human medical accountability, a topic we explore further when discussing the roles of other stakeholders below.

3.3 CUSTODIAN OF THE HUMAN BODY (PATIENT)

In the study of Islamic law, the human body is subject to two primary types of rights (*ḥuqūq*): those pertaining to God; and those related to individuals.[150, 151]

a. **God's rights:** In the capacity of their sole creator and true owner, God holds supreme authority over human bodies. Muslim scholars unanimously agree that physicians are accountable to God in the hereafter for any actions that contravene divine permissions and prohibitions, rendering such actions morally wrong and constituting religious sin (*ithm*).

b. **Individuals' rights:** While God holds ultimate authority, humans are entrusted with stewardship over their bodies, and are therefore entitled to a set of rights, grounded in two key principles:

   - **Divine trust:** Humans are authorized to make decisions regarding their bodies as God's trustees. This authority applies as long as the patient has decisional capacity and is considered religiously accountable (*mukallaf*). Therefore, barring emergencies or public health risks such as pandemics, most Muslim scholars require physicians to obtain the patient's consent prior to any medical intervention.[152–156] A minority of Muslim jurists argue that competent physicians could treat a disease without the patient's permission. Their reasoning is based on the notion that a physician's voluntary act of treatment falls within the category of religiously noble deeds, motivated by the altruistic purpose of helping vulnerable individuals regain their health. This enables patients to continue performing religious rituals and securing worldly benefits (*maṣāliḥ*).[157–160]

   - **Contractual commitment:** The physician-patient relationship is fundamentally contractual, necessitating informed consent based on mutual agreement and clarity. The patient, as the more vulnerable party, must be provided with sufficient information about the medical intervention. Therefore, the agreed benefit or service (*manfa'a*), including those provided by a physician, must be clear and devoid of uncertainty (*gharar*) or unknowability (*jahāla*). The presence of these elements could potentially render the contract between the physician and the patient invalid.[161–165]

A physician is generally liable (*ḍāmin*) toward the patient in this world for breaching the patient's rights, except when the patient consents to a procedure not permitted by God, such as those leading to death or unnecessary organ loss. While this act remains morally wrong under God's rights, holding physicians accountable in the hereafter, jurists differ on whether the physician should also be held liable as well:

- **Minority position:** Physicians should be held liable since the intervention lacked God's permission.
- **Majority position:** Physicians are not liable as long as the patient consents.
- **Intermediate position:** Differentiates between life-terminating procedures and organ excision, with liability exempted only in the latter case.[166–176]

3.3.1 AI's impact on ethical considerations

The use of AI-empowered tools in medicine and healthcare does not diminish the essential requirement of obtaining patient consent for medical interventions. Scholars maintain that this obligation stems from the principle that individuals hold authority over their bodies. It pertains to the nature of the intervention, irrespective of the methods used to execute it.

Another important consideration is whether physicians are required to inform patients about the use of AI-driven tools in their treatment. Given that AI applications in healthcare are still considered 'emerging' or 'novel' technologies outside standard practice, patients might not anticipate their use. Therefore, in line with the right to receive adequate information and clarity (*bayyina*) to make informed decisions, it is reasonable to mandate that patients be notified about the use of AI tools, especially if these tools could affect the expected outcomes of their treatment.

Another important consideration is whether the patient's permission would absolve the physician of liability, even if the use of AI-driven tools would potentially result in the termination of the patient's life or the impairment of organ functions. The disagreement among Muslim jurists outlined in the previous section shows that the patient's permission in such cases influences jurists to consider the physician not liable for the resulting injury.

Another point to address is the use of patient data for training and ML, stressing the religious aspects that are usually missing in secular bioethical deliberations. Given the principle of human authority over parts of one's body, (or 'personal assets'),[177] the Islamic concept of charity (*ṣadaqa*) is relevant. According to this concept, individuals may voluntarily donate valuable possessions for the benefit of others, seeking God's reward. In the context of modern AI-enabled healthcare, where data holds significant value, data sets could also be considered to be valuable assets that can be donated for charitable purposes. However, patients are entitled to set specific conditions to ensure that this new form of 'data donation' does not ultimately infringe on God's supreme authority over the human body and the associated divine rights.

3.4 PROFESSIONAL INTERVENER IN THE HUMAN BODY (PHYSICIAN)

In addition to securing permission from God and the patient, physicians must adhere to specific conditions for medical interventions. Failure to meet these conditions would result in different forms and levels of accountability. These conditions can be categorized into two main themes:

a. **Good intentions and noble goals:** Muslim jurists generally agree that the primary objective of medical practice should be to provide medical care (*taṭbīb*). Some scholars extend this principle to include non-curative interventions, such as cosmetic surgeries, within the broader concept of providing a religiously permitted benefit (*maṣlaḥa mashrūʿa*).[178] Actions that deviate from the primary goal of medical care or a religiously permissible benefit – such as prescribing unnecessary medications, ordering unnecessary x-rays for financial gain, or performing organ removals to help individuals evade mandatory military service – are deemed violations. These actions undermine the intended purpose of *taṭbīb* and may result in the physician being considered religiously sinful and/or legally liable.

b. **Professional competence:** Muslim scholars emphasize that medical practice must be grounded in sufficient theoretical knowledge, deep understanding, and professional excellence, including the proficient use of medical tools and devices.[179–190] Muslim scholars and transnational Islamic institutions have endorsed the standardization of medicine, recognizing that a medical degree and a state-issued license to practice are essential credentials from an Islamic perspective.[191] Physicians are also expected to adhere to established medical standards, except in cases where their perspective is recognized as part of a 'respectable minority doctrine'.[192–194]

Controversy arises when a physician, despite lacking competence, is authorized by the patient to perform a specific intervention. The majority position among Muslim jurists asserts that an incompetent physician is automatically liable for any resulting injuries. However, some jurists adopt a more lenient stance, arguing that if the patient is fully aware of the physician's lack of expertise and still consents to the intervention, the physician may not be held liable. This leniency is based on the principle that liability stems from deceiving the patient, which is not the case when the patient is informed and consents knowingly.[195–197]

Muslim scholars emphasize that medical practice must be grounded in sufficient theoretical knowledge, deep understanding, and professional excellence, including the proficient use of medical tools and devices.

Considering modern developments in medicine and the increasing complexity of healthcare, contemporary Islamic bioethical deliberations addressed new scenarios and touched on the concept of corporate liability. For instance, in a collaborative medical intervention, each team member is held accountable for their own mistakes. If the team leader errs in guiding or supervising the team, the leader shares joint liability with the other team members.[198]

3.4.1 AI's impact on ethical considerations

The integration of AI-empowered tools in healthcare must align with the goal of providing high-quality medical care. However, there is a risk that AI technology could be exploited for unethical purposes, such as misleading patients about the benefits of AI-enhanced care to justify exorbitant fees, a practice reminiscent of historical quackery.[199]

The more critical concern with AI in medicine is the requirement for physicians to have adequate theoretical knowledge and professional excellence. Many AI applications are still classified as 'emerging' or 'novel' technologies, which means that physicians may have limited experience with these tools. This raises the question of whether the novelty of AI tools categorizes physicians who use them as 'ignorant', a topic with no definitive answer. Factors such as the approval status of the AI device by licensing authorities, such as the US Food and Drug Administration, play a crucial role.[200] If the device is licensed and an injury occurs, liability may fall on the licensing authority rather than the physician. This aligns with the concept of corporate liability endorsed by the IIFA.

Another critical factor is whether the patient was adequately informed about the use of the AI device and the physician's level of expertise. If the patient was not properly informed and the device was unlicensed, the physician should be liable for the resulting injuries. Conversely, if the patient gave informed consent and was aware of the physician's lack of expertise, the traditional juristic disagreement regarding the liability of 'ignorant' physicians would apply. An intermediate position might hold that the physician would not be liable if the decision was made in consultation with a team and met the minimum threshold of the respected minority doctrine.

Ethical implications of the 'black box' effect also need to be considered. There is a principle that high accuracy often comes at the cost of interpretability. This suggests that preference should be given to AI tools that balance both accuracy and transparency. If a physician cannot understand an AI system due to its inherent opacity, this should not be regarded as ignorance, since the information remains inaccessible to humans in general. However, physicians are still required to assess the system's effectiveness and provide patients with information about its potential benefits, risks, and inherent limitations.

The liability for injuries caused by AI devices should also account for whether the injury resulted from a design defect, or other issues related to the AI device itself. Traditional views hold physicians accountable for using potentially faulty tools. But the degree of autonomy in AI devices may shift liability toward the device's designers if a design error is identified. Liability could also be directed to data scientists if there is unjustified data bias.

SECTION 4. CONCLUSION AND POLICY RECOMMENDATIONS

The rapid advances in AI technologies are transforming the field of medicine, bringing exciting possibilities and new challenges for healthcare professionals. As the global healthcare community adapts to these changes, it is essential to uphold the value systems embedded in world religions, such as Islam, to ensure religio-culturally competent healthcare in the age of AI. Also, these emerging perspectives, along with other related topics, should be a focal point for research in Islamic and global bioethics.

This report focuses on the intersection of AI-driven medicine and Islamic bioethics, and highlights the importance of a comprehensive understanding of the ethical frameworks outlined in classical and contemporary sources. It provides a practical example of applying these frameworks by examining the concept of medical accountability.

We emphasize adherence to three long-established requirements in Islamic tradition: obtaining God's permission; securing the patient's consent; and ensuring the physician's professional competence when integrating AI into medical practice. While AI tools cannot bear medical accountability, which remains a human responsibility, the traditional model of individual physician accountability may shift. In the age of AI-enabled medicine, collective liability shared by medical teams or the corporate liability of institutions will likely be the more fitting framework for AI-enabled healthcare. As AI technologies evolve, new stakeholders, such as data scientists and AI developers, may also bear some responsibility for medical accountability.

RECOMMENDATIONS FOR POLICYMAKERS AND INDUSTRY STAKEHOLDERS

1. Support research on AI-enabled healthcare and Islamic ethics

Invest in and promote research focused on the intersection of AI-enabled healthcare and Islamic ethics. There is limited literature in this area and the religio-cultural sensitivity of secular ethical approaches is often inadequate. Therefore, it is crucial to encourage studies that address the ethical challenges faced by individuals and institutions in Muslim countries from an Islamic perspective. It is also imperative to 'educate' computer scientists (by giving lectures, incorporating modules in the curriculum, and so on) on Islamic ethics in AI for healthcare.

The centuries-old Islamic moral tradition provides valuable insights into the ethical challenges of AI in healthcare. Such research helps Muslims address these issues and also enriches the global ethical discourse. However, conducting research that integrates Islamic perspectives with global discussions is resource intensive. It requires a significant investment of time, expertise and financial support to ensure respect for religio-cultural sensitivities and to develop inclusive solutions.

2. Mandate informed consent with disclosure of AI use

Enforce regulations requiring healthcare professionals to obtain explicit informed consent from patients. This includes clear disclosure of AI tools and technologies used in diagnosis and treatment. The physicians should also clearly state how reliant they were on the AI decision when making their final decision.

Patients should be fully informed about the involvement of AI technologies in their care. This could be initially addressed through increasing AI literacy in general, thus ensuring that patients can make well-informed decisions, and maintains transparency in the physician-patient relationship. This aligns with the ethical and legal standards of informed consent.

3. Implement standards for transparency in AI systems

Develop and enforce standards for transparency in AI systems used in healthcare. These standards should require disclosure of whether the AI-driven tool is an emerging technology or has been established as a standard practice with proven efficacy and safety. Information available on the functioning and decision-making processes of AI tools should be disclosed whenever feasible.

The 'black box' nature of some AI-based technologies presents challenges to transparency and accountability. We can address ethical concerns and ensure that AI technologies are used responsibly and effectively within medical practice by setting clear standards for the disclosure of AI tools' status and operational details. At a minimum, AI technology should be validated prior to adoption in healthcare facilities.

4. Establish a legal framework for collective liability in AI-enhanced healthcare

Develop and implement a legal framework that includes collective liability shared by medical teams, institutions and technology developers involved in AI-enabled healthcare.

The integration of AI in healthcare necessitates a re-evaluation of liability structures. Given the complexity and collaborative nature of AI technologies, traditional individual liability may not suffice. A collective liability framework will ensure that all parties involved – medical professionals, AI developers, and institutions – are held accountable for AI-related risks and injuries. This would provide a more comprehensive and balanced approach to medical accountability. Ongoing review and revision of these standards will ensure that they remain relevant and effective in managing the ethical and legal implications of AI in healthcare.

5. Integrate ethical training for AI developers and data scientists

Incorporate ethical training programs for AI developers, data scientists and related professionals, focusing on the implications of their work within healthcare settings.

AI technologies impact medical practice significantly; therefore, those who develop and manage these technologies should understand the ethical dimensions of their work. Ethical training will help these professionals make decisions that align with legal standards and ethical principles. The training would also ensure that AI technologies are used in ways that respect patients' rights and wellbeing.

6. Promote data donation frameworks with ethical oversight

Establish ethical guidelines and oversight mechanisms for the use of patient data in training AI systems. Guidance should ensure that 'data donation' practices are grounded in the broad concept of charity (*ṣadaqa*), and respect patient autonomy and related religious obligations.

Patient data is a valuable asset in AI development. While data donation can benefit research and healthcare, it must be managed in accordance with ethical standards. Guidelines should ensure that data use does not infringe on patients' rights and that it aligns with the principles of Islamic ethics.

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ABBREVIATIONS

AI	artificial intelligence
ASI	artificial superintelligence
CILE	Research Center for Islamic Legislation and Ethics
DL	deep learning
ECG	electrocardiogram
EU	European Union
GDP	gross domestic product
HBKU	Hamad bin Khalifa University
IIFA	International Islamic Fiqh Academy
ML	machine learning
UHC	universal health coverage

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