

Human Rights and Legal Regulation of AI-Assisted Reproduction



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ABSTRACT

The growing application of artificial intelligence in assisted reproductive technologies raises significant legal and ethical concerns regarding embryo selection, reproductive data protection, medical responsibility, and patient rights. Rapid technological development has challenged existing legal frameworks because conventional health regulations do not fully address the distinctive risks created by algorithmic decision making in reproductive medicine. This study examines the legal implications of using artificial intelligence in artificial insemination and assesses the capacity of existing regulations to protect patients while accommodating medical innovation. The study applies comparative legal research by examining regulatory approaches in the European Union, the United Kingdom, and Japan. The findings show that existing regulations do not provide comprehensive standards for algorithmic transparency, system validation, genetic and reproductive data protection, human supervision, and medical liability when artificial intelligence contributes to clinical decisions or patient harm. The comparison also identifies substantial differences in regulatory supervision, approval mechanisms, accountability standards, and patient safeguards across the selected jurisdictions. These regulatory differences create legal uncertainty for healthcare professionals, technology developers, and patients who rely on artificial intelligence in reproductive treatment.



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Introduction

The rapid integration of artificial intelligence (AI) into healthcare has transformed medical decision-making, diagnosis, and treatment planning.¹ One of the most significant developments has occurred in assisted reproductive technologies (ARTs), particularly in vitro fertilization (IVF), where AI systems are increasingly used to evaluate embryos, predict implantation success, analyze

¹ Shannon Glick, 'Ethical Need for a Fertility Decision-Aid for Transgender Adults of Reproductive Age', *Voices in Bioethics*, 9 (2023), 1-9. <https://doi.org/10.52214/vib.v9i.10309>

genetic information, and support clinical decision-making.² While these technologies promise improved accuracy and higher success rates, they also generate complex legal questions concerning liability, transparency, privacy, and the protection of fundamental rights.³

From a legal perspective, AI-assisted embryo selection challenges several established principles of medical law.⁴ Traditional legal frameworks governing reproductive medicine were designed on the assumption that medical decisions are primarily made by physicians exercising professional judgment.⁵ The growing reliance on algorithmic systems in embryo assessment raises questions regarding the allocation of legal responsibility when an AI-generated recommendation results in medical harm, discrimination, or an incorrect embryo selection.⁶ Furthermore, the processing of highly sensitive genetic information creates additional concerns regarding privacy rights, data protection, and informed consent.⁷

The legal significance of these issues extends beyond medical regulation. AI-assisted reproductive technologies intersect with broader questions of human rights law, including the right to privacy, reproductive autonomy, equality, non-discrimination, and the protection of human dignity.⁸ The increasing use of predictive algorithms in reproductive decision-making has also generated concerns regarding algorithmic bias, explainability, and the possibility of selecting embryos based on non-medical characteristics. Consequently, the absence of clear legal

² T Tarasevych, 'Legal Regulation of Artificial Intelligence in the Sphere of Human Reproductive Functions: Cur-Rent Challenges and Implementation Prospects', *Uzhhorod National University Herald. Series: Law*, 1.75 (2023), 123–130. <https://doi.org/10.24144/2307-3322.2022.75.1.20>

³ Yemane Hailu Gebre, Gebrehiwot Weldegebrail Gebre, and Kahsa Tadel Gebre, 'Adoption of Artificial Insemination Technology and Its Intensity of Use in Eastern Tigray National Regional State of Ethiopia', *Agriculture and Food Security*, 11.1 (2022), 1-14. <https://doi.org/10.1186/s40066-022-00384-3>

⁴ Ammar Zafar, 'Balancing the Scale: Navigating Ethical and Practical Challenges of Artificial Intelligence (AI) Integration in Legal Practices', *Discover Artificial Intelligence*, 4.1 (2024), 1-18. <https://doi.org/10.1007/s44163-024-00121-8>

⁵ E D Kusumawati, 'A Brief Review on Advanced Renewable Materials for Supporting Artificial Insemination Technology', *IOP Conference Series: Materials Science and Engineering*, 1098.6 (2021), 1-6. <https://doi.org/10.1088/1757-899x/1098/6/062036>

⁶ Nishtiman Othman Mohammed, 'Ethical and Legal Challenges of Ai in Healthcare: A Global Perspective', *International Journal of Law, Justice and Jurisprudence*, 5.1 (2025), 29–35. <https://doi.org/10.22271/2790-0673.2025.v5.i1a.160>

⁷ Choi Yongjeon and Wook Jang, 'Regulatory Trends and Legal Challenges in the AI-Based Medical Industry', *National Public Law Review*, 21.1 (2025), 87–120. <https://doi.org/10.46751/nplak.2025.21.1.87>

⁸ Anil Balan, 'Examining the Ethical and Sustainability Challenges of Legal Education's AI Revolution', *International Journal of the Legal Profession*, 31.3 (2024), 323–348. <https://doi.org/10.1080/09695958.2024.2421179>

standards may undermine both legal certainty and public trust in emerging reproductive technologies.⁹

Existing legal scholarship has examined AI governance in healthcare, medical liability arising from automated decision-making, and the protection of personal and genetic data.¹⁰ Other studies have focused on the ethical implications of assisted reproductive technologies and embryo selection.¹¹ However, the existing literature largely addresses these issues separately and provides limited analysis of how different legal systems regulate the combined challenges arising from AI-assisted reproductive technologies.¹² Moreover, comparative legal studies examining the relationship between AI liability, embryo protection, and genetic data governance remain relatively limited.¹³ This gap is particularly significant because legal responses vary considerably across jurisdictions. In the United Kingdom, reproductive technologies are governed through a specialized regulatory framework that provides extensive oversight of fertility practices. Within the European Union, legal protection primarily focuses on personal and genetic data, while recent initiatives concerning artificial intelligence seek to regulate high-risk AI systems. Japan has adopted sector-specific approaches to medical AI governance, whereas many Arab jurisdictions continue to rely on general medical liability rules, health regulations, and ethical principles without establishing comprehensive legislation specifically addressing AI-assisted reproductive technologies. These differences provide an important opportunity for comparative legal analysis.

The urgency of the issue is evident in the rapid commercialization and adoption of AI-based reproductive technologies, which have developed faster than the legal frameworks intended to regulate them.¹⁴ As algorithmic systems become increasingly influential in embryo evaluation and reproductive decision-making,

⁹ Hari Sutra Disemadi, Lu Sudirman, and B. Method, 'REASSESSING LEGAL RECOGNITION OF AI: HUMAN DIGNITY AND THE CHALLENGE OF AI AS A LEGAL SUBJECT IN INDONESIA', *Masalah-Masalah Hukum*, 54.1 (2025), 1–12. <https://doi.org/10.14710/mmh.54.1.2025.1-12>

¹⁰ Yatama Zahra, 'Regulating AI in Legal Practice: Challenges and Opportunities', *Journal of Computer Science Application and Engineering (JOSAPEN)*, 3.1 (2025), 10–15. <https://doi.org/10.70356/josapen.v3i1.47>

¹¹ Yue Wang, and Zhuo Ma, 'Ethical and Legal Challenges of Medical AI on Informed Consent: China as an Example', *Developing World Bioethics*, 25.1 (2025), 46–54. <https://doi.org/10.1111/dewb.12442>

¹² Rowena Rodrigues, 'Legal and Human Rights Issues of AI: Gaps, Challenges and Vulnerabilities', *Journal of Responsible Technology*, 4 (2020), 1–12. <https://doi.org/10.1016/j.jrt.2020.100005>

¹³ Pamela Samuelson, 'Legal Challenges to Generative AI, Part I.', *Communications of the ACM*, 66.7 (2023), .20–23. <https://doi.org/10.1145/3597151>

¹⁴ S. S., E. S. Sagalaeva Shevchuk, E. N. Volodkova, I. N. Kashurin, and P. V. Razumov, 'Legal and Ethical Problems of Regulating Relations Regarding the Use of Assisted Reproductive Technologies', *Journal of Pharmaceutical Sciences and Research*, 10.7 (2018), 1716–1722. <https://www.pharmainfo.in/jpsr/Documents/Volumes/vol10Issue07/jpsr10071820.pdf>

unresolved legal questions concerning accountability, transparency, genetic privacy, and embryo protection become more pressing. The lack of harmonized legal standards may expose patients, medical professionals, and healthcare institutions to significant legal uncertainty while potentially affecting the protection of fundamental rights.¹⁵

This study addresses the central legal problem arising from the absence of clear and coherent legal rules governing the use of artificial intelligence in assisted reproductive technologies. In particular, it examines the inadequacy of existing legal frameworks in regulating algorithmic decision-making, allocating legal responsibility among physicians, clinics, and AI developers, protecting genetic data, and safeguarding embryo-related interests. This study adopts a comparative legal methodology to analyze and compare regulatory approaches in the European Union, the United Kingdom,¹⁶ Japan, and selected Arab jurisdictions. Through this comparative perspective, the research seeks to identify legislative strengths and weaknesses, evaluate the effectiveness of existing legal solutions, and propose principles that may contribute to the development of a coherent legal framework for AI-assisted reproductive technologies. The study aims to develop a comparative legal framework capable of addressing the unique challenges associated with AI-assisted reproductive technologies. Its contribution lies in integrating three interconnected dimensions medical liability, genetic data protection, and embryo rights within a single comparative legal analysis. By doing so, the study seeks to contribute to contemporary debates on AI governance, reproductive rights, and legal accountability while providing practical recommendations for legislators and policymakers.

Research Method

This study adopts a doctrinal and comparative legal research methodology to examine the regulatory challenges arising from the use of artificial intelligence in assisted reproductive technologies.¹⁷ The research focuses on the legal implications of AI-assisted embryo assessment and selection, particularly in relation to legal liability, genetic data protection, reproductive rights, and embryo-related interests.¹⁸ The doctrinal component of the study is based on the analysis of primary legal sources, including national legislation, regulatory instruments,

¹⁵ Patrick C. Aloamaka, and Moses O. Omozue, 'AI and Human Rights: Navigating Ethical and Legal Challenges in Developing Nations', *Khazanah Hukum*, 6.2 (2024), 189–201. <https://doi.org/10.15575/kh.v6i2.37801>

¹⁶ The United Kingdom, Human Fertilization and Embryology Act" of 1990, which was amended in 2008 <https://www.legislation.gov.uk/ukpga/2008/22/contents>

¹⁷ Recommendation on the Ethics of Artificial Intelligence, UNESCO, 2022. <https://www.unesco.org/en/articles/unesco-adopts-first-global-standard-ethics-artificial-intelligence>

¹⁸ Aneesh V. Pillai, and Anatoliy Kostruba, 'WOMEN'S REPRODUCTIVE RIGHTS AND THEIR SCOPE UNDER INTERNATIONAL LEGAL FRAMEWORKS', *Entrepreneurship, Economy and Law*, 8 (2021), 18–28. <https://doi.org/10.32849/2663-5313/2021.8.03>

judicial decisions, and international legal standards relevant to artificial intelligence, medical law, and reproductive technologies. Particular attention is given to legal rules governing medical liability, informed consent, privacy rights, genetic data protection, and the regulation of high-risk AI systems.¹⁹

The comparative legal method is employed to examine and compare the approaches adopted in the European Union, the United Kingdom, Japan, and selected Arab jurisdictions. These legal systems were selected because they represent different regulatory models concerning reproductive medicine, data governance, and artificial intelligence regulation. The comparative analysis seeks to identify similarities, divergences, regulatory gaps, and best practices that may contribute to the development of a coherent legal framework for AI-assisted reproductive technologies.²⁰ The study relies on both primary and secondary legal materials. Primary sources include legislation, regulatory guidelines, and judicial decisions, while secondary sources consist of academic books, peer-reviewed journal articles, policy reports, and legal commentaries. These materials are examined through qualitative legal analysis to evaluate the adequacy of existing legal frameworks and to assess their capacity to address emerging challenges associated with algorithmic decision-making in reproductive healthcare.

Results and Discussion

The Legal Challenges of Artificial Intelligence in Artificial Insemination

Artificial insemination is considered one of the most important modern medical techniques that emerged in the late twentieth century with the aim of treating infertility in couples who face difficulties in natural conception.²¹ It practically means "fertilizing the egg outside the body in a controlled laboratory environment, then reintroducing the resulting embryo into the woman's uterus to continue its development."²² Despite the simplicity of the definition, the process involves a complex series of medical and physiological procedures that require high expertise and precise equipment, starting from stimulating the ovaries to produce multiple eggs, thru egg retrieval and fertilization, and ending with selecting the most

¹⁹ O. M Reznik, and A. E. Ishchukova, 'Legal Regulation of Surrogacy in Ukraine and the United States of America', *Legal Horizons*, 18 (2019), 34–38. <https://doi.org/10.21272/legalhorizons.2019.i18.p34>

²⁰ Leysan Minnurovna Fayzrakhmanova, Almaz Albertovich Nigmatzyanov, Georgy Borisovich Romanovsky, and OLGA Valentinovna Romanovskaya, 'Legal Bases of Preimplantation Diagnostics in Russia and Abroad (A New Look At The Human Rights System)', *BiLD Law Journal*, 7.2 (2022), 184–189. <https://elib.pnzgu.ru/library/1698418208>

²¹ Shifa Shahina Nijamudeen, and V. Dekal, 'A Study of Awareness on Artificial Insemination among Medical College Students', *Indian Journal of Forensic Medicine and Toxicology*, 14.3 (2020), 88–93. <https://doi.org/10.37506/ijfmt.v14i3.10332>

²² Souvik Dhara, Swati Thakur, S.M.S. Anwar, M.D. Gupta, and S. Sinha, 'ARTIFICIAL INSEMINATION IN GOAT: A NEW PROSPECT FOR SCIENTIFIC GOAT BREEDING', *Animal Reproduction Update*, 3.2 (2023), 1–5. <https://doi.org/10.48165/aru.2023.3.2.1>

suitable embryos for implantation.²³ The selection and evaluation of embryos is one of the most important and sensitive stages, as it determines the final success rate. It is also a major focus for the application of artificial intelligence in this field.

The process of artificial insemination goes thru five main stages; the first stage is hormonal stimulation of the ovaries, where most treatment protocols resort to giving the woman hormonal medications to stimulate the ovaries and increase the number of fertilizable eggs.²⁴ This stage carries a lot of complexity due to the varying hormonal responses among women and requires careful monitoring to avoid ovarian hyperstimulation.²⁵ As for the second stage, it involves egg retrieval, which is performed under anesthesia using a vaginal ultrasound-guided needle.²⁶ This stage is legally sensitive, as any mistake can cause significant harm to the patient or result in the loss of precious eggs.²⁷ The third stage is in vitro fertilization, where eggs are combined with sperm in a controlled laboratory environment, and intracytoplasmic sperm injection may be used in more difficult cases.²⁸ In the fourth stage, the embryos are evaluated, and this stage is considered one of the most sensitive as the embryos are photographed and assessed according to morphological and structural criteria, selecting the embryo with the highest likelihood of success.²⁹ With the advent of artificial intelligence, algorithms now contribute to scoring embryos based on thousands of images and analyzing multiple factors.³⁰ The fifth stage, the embryo is returned to the uterus, which is the

²³ Nizamullah FNU, Muhammad Fahad, Nasrullah Abbasi, Muhammad Umer Qayyum, and Shah Zeb, 'Ethical and Legal Challenges in AI-Driven Healthcare: Patient Privacy, Data', *International Journal of Innovative Research in Science Engineering and Technology*, 13.8 (2024), 15216–15223. https://www.researchgate.net/publication/384868121_Ethical_and_Legal_Challenges_in_AI-Driven_Healthcare_Patient_Privacy_Data_Security_Legal_Framework_and_Compliance

²⁴ Min Jung Park, 'Comparative Analysis of Medical, Legal, and Ethical Considerations for Establishing a Standard Operating Protocol for Artificial Insemination by Donor', *Journal of the Korean Medical Association*, 61.7 (2018), 383–391. <https://doi.org/10.5124/jkma.2018.61.7.383>

²⁵ Tharakesavulu Vangalapat, 'Ethical and Legal Challenges in Generative AI: A Multidisciplinary Investigation', *International Journal of Science and Research (IJSR)*, 12.12 (2025), 2274–2280. <https://doi.org/10.21275/sr231228092245>

²⁶ Yanling Xing, Wei Wang, Na Wan, Dongmei Zhang, Mei Shan, and Guan Wang, 'The Influence of Vaginal Microbiota on the Pregnancy Outcome of Artificial Insemination with Husband's Sperm Based on Microscope Images Combined with PCR Fluorescence Method', *SLAS Technology*, 30.2 (2025), 1-6 <https://doi.org/10.1016/j.slast.2024.100242>

²⁷ Sara Gerke, Timo Minssen, and Glenn Cohen, 'Ethical and Legal Challenges of Artificial Intelligence-Driven Healthcare', In *Artificial Intelligence in Healthcare*, (2020), 295–336. Elsevier. <https://doi.org/10.1016/B978-0-12-818438-7.00012-5>

²⁸ Irina G. Polyakova, 'Informal Sperm Donation in Russia', *Changing Societies and Personalities*, 5.3 (2021), 481–495. <https://doi.org/10.15826/csp.2021.5.3.146>

²⁹ Nora Arvai, Bertalan Meskó and Gellért Katonai, 'Generative AI's Impact on the Mental Health of Medical Students: Scenario Analysis', *JMIR Medical Education*, 12 (2026) <https://www.sciencedirect.com/org/science/article/pii/S2369376226001054>

³⁰ Miao Tian, Zepeng Shen, Xingnan Wu, Kuo Wei, and Yuxiang Liu, 'The Application of Artificial Intelligence in Medical Diagnostics: A New Frontier', *Academic Journal of Science and Technology*, 8.2 (2023), 57–61. <https://doi.org/10.54097/ajst.v8i2.14945>

final stage where the carefully selected embryo is reintroduced into the woman's uterus using a thin catheter. After that, the medical monitoring phase of the pregnancy begins.³¹

Artificial intelligence and its applications in artificial insemination represent the scientific and technical foundation for understanding how artificial intelligence operates within the artificial insemination system, along with the fundamental transformations in the performance of fertility centers and the decision-making ability of doctors.³² Therefore, artificial intelligence is defined as the ability of digital systems to perform tasks that typically require human intelligence, such as analysis, learning, interpretation, and decision-making.³³ In the medical field, artificial intelligence relies on analyzing vast amounts of clinical data and laboratory images to predict outcomes and provide accurate treatment recommendations.³⁴

Thus, artificial intelligence in artificial insemination relies on techniques such as deep learning, artificial neural networks, predictive algorithms, and biometric image analysis.³⁵ These techniques work on analyzing images of embryos and videos of their development inside the incubator to determine their suitability for implantation.³⁶ In fact, there are several components of artificial intelligence used in in vitro fertilization, including data.³⁷ IVF centers collect vast amounts of data, including images of embryos, the chronological development of each embryo,

³¹ Majed Ahmed Saleh Al-Adwan, and Enas Mohamed Ali Qutieshat, 'Artificial Intelligence in Medicine: Legal Pathways to Sustainable Development Goals (SDGs)', *Journal of Lifestyle and SDGs Review*, 5.2 (2025), 1-28. <https://doi.org/10.47172/2965-730x.sdgsreview.v5.n02.pe04475>

³² Tareq Al-Billeh, Ruba Hmaidan, Ali Al-Hammouri, and Mohammed AL Makhmari, 'The Risks of Using Artificial Intelligence on Privacy and Human Rights: Unifying Global Standards', *Jurnal Media Hukum*, 31.2 (2024), 333–350 <https://doi.org/10.18196/jmh.v31i2.23480>

³³ Tareq Al-Billeh, Ali Al-Hammouri, Tawfiq Khashashneh, Mohammed AL Makhmari, and Hamad Al Kalbani, 'Digital Evidence in Human Rights Violations and International Criminal Justice', *Journal of Human Rights Culture and Legal System*, 4.3 (2024), 842–871 <https://doi.org/10.53955/jhcls.v4i3.446>

³⁴ Nehaluddin Ahmad, Aqilah Walin Ali, and Mohammad Hilmy Baihaqy bin Yussof, 'THE CHALLENGES OF HUMAN RIGHTS IN THE ERA OF ARTIFICIAL INTELLIGENCE', *UUM Journal of Legal Studies*, 16.1 (2025), 150–169. <https://doi.org/10.32890/uumjls2025.16.1.9>

³⁵ Joao G.N. Moraes, Tamara Gull, Aaron C. Ericsson, Scott E. Poock, Monica O. Caldeira, and Matthew C. Lucy, 'Establishment of the Uterine Microbiome Following Artificial Insemination in Virgin Heifers', *Frontiers in Microbiology*, 15 (2024), 1-22 <https://doi.org/10.3389/fmicb.2024.1385505>

³⁶ Sunam Jassar, Scott J. Adams, Amy Zarzeczny, and Brent E. Burbridge, 'The Future of Artificial Intelligence in Medicine: Medical-Legal Considerations for Health Leaders', *Healthcare Management Forum*, 35.3 (2022), 185–189. <https://doi.org/10.1177/08404704221082069>

³⁷ Sonia Tanwar, Khushi Mishra, Bhumika Soni, and Akshat Sharma 'Artificial Insemination: A Review', *International Journal of Recent Research and Review XVI*, 4 (2023), 48–54 <https://doi.org/10.62233/ijrrr6>

division rates, genetic data, maternal health data, and hormonal data. Data is considered the primary fuel for algorithms.³⁸

There are algorithms that are trained on previous data from thousands of successful and unsuccessful pregnancies to identify patterns that increase the likelihood of success.³⁹ And also the predictive ability thru algorithms assigning a score to each embryo based on indicators invisible to the human eye.⁴⁰ Finally, clinical decision support systems that provide recommendations on the timing of implantation, the number of embryos, medication protocols, and success probabilities.⁴¹ Therefore, embryo evaluation represents the cornerstone of IVF success, and artificial intelligence has brought profound changes to the traditional methods used by embryologists.⁴² Continuous time-lapse imaging techniques allow for continuous capture of embryo images without removing them from the incubator.⁴³ The algorithm monitors the timing of divisions, development speeds, minute deformations, and the transition time from one stage to another. Analyzing these changes gives the algorithm the ability to predict with much higher effectiveness than traditional human evaluation.⁴⁴

Embryo classification algorithms are among the first direct applications of artificial intelligence in in vitro fertilization.⁴⁵ They rely on evaluating the external

³⁸ Daiju Ueda, Taichi Kakinuma, Shohei Fujita, Koji Kamagata, Yasutaka Fushimi, Rintaro Ito, Yusuke Matsui, et al., 'Fairness of Artificial Intelligence in Healthcare: Review and Recommendations', *Japanese Journal of Radiology*, 42 (2024), 3-15. <https://doi.org/10.1007/s11604-023-01474-3>

³⁹ Hamzeh Abu Issa, and Mekhled Ibrahim Al Zobi, 'Internet Protocol Spoofing Crime in Jordanian Law', *In Advances in Science, Technology and Innovation*, (2025), 193–195. https://doi.org/10.1007/978-3-031-90558-2_24

⁴⁰ Frets Paulus Rahakbauw, and Moh Jufri Ahmad, 'Kedudukan Hukum Dan Hak Waris Anak Hasil Inseminasi Buatan Di Indonesia', *Journal Evidence Of Law*, 3.3 (2024), 292–301. <https://doi.org/10.59066/jel.v3i3.771>

⁴¹ Ihda Shofiyatun Nisa, Isniyatin Faizah, Bisri Mashuri, and Muizzatul Khasanah, 'Penerapan Konsep Ijtihad Dalam Mengatur Teknologi Reproduksi Modern Di Indonesia', *Al-Faruq: Jurnal Hukum Ekonomi Syariah Dan Hukum Islam*, 4.1 (2025), 42–56. <https://ejournal.iai-tabah.ac.id/alfaruq/article/view/3394>

⁴² Sophia Fantus, Jinxu Li, Tianci Wang and Lu Tang, 'Ethical Knowledge, Challenges, and Institutional Strategies Among Medical AI Developers and Researchers: Focus Group Study', *Journal of Medical Internet Research*, 28 (2026) <https://www.sciencedirect.com/org/science/article/pii/S143888712600083X>

⁴³ Rumiana Tenchov, and Qiongqiong Angela Zhou, 'Assisted Reproductive Technology: A Ray of Hope for Infertility', *ACS Omega*, 10.22 (2025), 22347–22365. <https://doi.org/10.1021/acsomega.5c01643>

⁴⁴ Yong Sun, Yipeng Wang, Junyu Shi, Zhiyuan Zhang, Yanmei Xiao, Lei Zhu, Manxi Jiang, and Qiang Nie. 'Time-Lapse Video-Based Embryo Grading via Complementary Spatial-Temporal Pattern Mining', *arXiv.org*, (2025), 1-11. <https://arxiv.org/abs/2506.04950>

⁴⁵ Aditya Gaur, Joecelyn Kirani Tan, Medha Sridhar Rao, Muhtasim Fuad, Taha Bhatti, Hareesha Rishab Bharadwaj and Khabab Abbasher Hussien Mohamed Ahmed, 'AI in UK Medical Education: A Framework for Curriculum Reform', *JMIR Medical Education*, 12 (2026) <https://www.sciencedirect.com/org/science/article/pii/S2369376226001285>

morphology and the dynamics of cell division. Studies show that some algorithms achieve prediction accuracies of 70-80%, which surpasses most human evaluations.⁴⁶ The algorithms use probabilistic models based on the woman's age, uterine health, embryo quality, ovarian response, and data from thousands of previous cases, providing the patient with an approximate percentage of success chances.⁴⁷ From this standpoint, artificial intelligence systems work on determining the appropriate type of medication, setting hormonal doses, predicting ovarian hyperstimulation, and suggesting the optimal timing for egg retrieval. These solutions reduce errors and help standardize treatment protocols.⁴⁸

Artificial intelligence assists in analyzing PGT genetic data, detecting genetic mutations, classifying genetic diseases, and predicting future disease risks in the fetus, raising ethical questions about the legitimacy of genetic selection.⁴⁹ Some systems adjust oxygen levels, temperature, acidity levels, and air circulation rates based on data related to the growth efficiency of each embryo, leading to an improved laboratory environment.⁵⁰ As for the impact of artificial intelligence on the role of the doctor and IVF centers, the role of the doctor has shifted from a decision-maker to an observer. The introduction of artificial intelligence has fundamentally changed the role of the doctor, as the doctor is no longer the sole chooser of the embryo.⁵¹ Algorithms now suggest the most successful decision, and the doctor has become an auditor of the system's decisions.⁵² This raises an

⁴⁶ Mohammad A.Z. Khan, and Justin C. Konje, 'Ethical and Religious Dilemmas of Modern Reproductive Choices and the Islamic Perspective', *European Journal of Obstetrics and Gynecology and Reproductive Biology*, 332 (2019), 5-9. <https://doi.org/10.1016/j.ejogrb.2018.10.052>

⁴⁷ Aurelija Blaževičienė, Irayda Jakušovaite, and Alina Vaškelyte, 'Attitudes of Fertile and Infertile Woman towards New Reproductive Technologies: A Case Study of Lithuania', *Reproductive Health*, 11.1 (2014), 1-7. <https://doi.org/10.1186/1742-4755-11-26>

⁴⁸ Myroslava Bielova, and Oleg Byelov, 'Reproductive Choice Rights in the System of New Bioethical Human Rights', *Visegrad Journal on Human Rights*, 1 (2025), 18-24. <https://doi.org/10.61345/1339-7915.2025.1.2>

⁴⁹ Yael Liebes-Peer, Shlomo Czeisler, Rachel Broderick, Manuela Vecsler, Yair Heller, Chaim Linhart, Joseph Mossel and Jochen K. Lennerz, 'Regulatory science for AI-based software as a medical device in computational pathology and oncology biomarker and drug development', *Journal of Pathology Informatics*, (2026) <https://www.sciencedirect.com/science/article/pii/S2153353926001409>

⁵⁰ Yaling Hew, Duygu Kutuk, Tuba Duzcu, Yagmur Ergun, and Murat Basar, 'Artificial Intelligence in IVF Laboratories: Elevating Outcomes through Precision and Efficiency', *Biology*, 13.12 (2024), 1-23. <https://doi.org/10.3390/biology13120988>

⁵¹ Léa Lomba, 'Reproductive Justice and Inequalities', *Civitas: Revista de Ciências Sociais*, 25.1 (2025), 1-12. <https://doi.org/10.15448/1984-7289.2025.1.47436>

⁵² Ion Nemteanu, Adir Mancebo, Leslie Joe, Ryan Lopez, Patricia Lopez and Warren Woodrich Pettine, 'Scalable Agile Framework for Execution in AI for Medical AI Ethics Policy Design in Small- and Medium-Sized Enterprises', *Journal of Medical Internet Research*, 28 (2026) <https://www.sciencedirect.com/org/science/article/pii/S1438887126001718>

important legal question: "Who is responsible if the doctor relies on a faulty algorithm?"⁵³

On the other hand, algorithms allow for reducing errors, improving success rates, standardizing practices, minimizing personal bias, and enhancing the patient experience, thereby increasing the efficiency of medical centers.⁵⁴ However, one of the main challenges of adopting artificial intelligence in clinics is the difficulty in interpreting algorithmic decisions, the need for high expertise to read the results, the lack of legal regulations, the risks of algorithmic bias, and the fear of losing medical control.⁵⁵ Therefore, integrating artificial intelligence into IVF processes represents a qualitative leap at the medical level.⁵⁶ However, it simultaneously raises a number of complex legal issues due to the nature of the decisions made by the intelligent system and their direct impact on health outcomes and the fate of embryos.⁵⁷ Hence, there is a need to review the most prominent legal challenges, including legal liability, genetic data protection, algorithmic transparency, digital discrimination of embryos, and the rights of patients and embryos.⁵⁸

From this standpoint, the legal liability resulting from artificial intelligence errors represents one of the most significant issues raised by the use of artificial intelligence in in vitro fertilization.⁵⁹ The algorithms' primary role in evaluating embryos creates difficulty in determining who is responsible for the error. So, is it

⁵³ Lvova O. L., and Ivaniv I. R., 'The Moral and Legal Foundations of Bioethics in the Context of Human Rights: Legal Theory and International Practice', *Al'manah Prava*, 11.11 (2020), 327–233. <https://doi.org/10.33663/2524-017x-2020-11-55>

⁵⁴ F, Y Ma Bai, and Z Li., 'O-123 Trends and Challenges in the Practice of ART in China', *Human Reproduction*, 39.Supplement_1. (2024), <https://doi.org/10.1093/humrep/deae108.138>

⁵⁵ Haniyah, and Uji Santoso, 'Status Hukum Bayi Tabung (Kajian Hukum Dan Status Keperdataanya)', *Jurnal Legisia (Jurnal Hukum Universitas Sunan Giri Surabaya)*, 14.1 (2022), 1–12. <https://journal.unsuri.ac.id/index.php/legisia/article/view/141>

⁵⁶ Hina Sardar, Adnan Azam, Mehreen Azam and Muhammad Ramzan, 'Adoption of AI chatbots among medical students: integration of AI literacy and information literacy within the theory of planned behavior', *The Electronic Library*, 44.3 (2026), 679-701. <https://www.sciencedirect.com/org/science/article/abs/pii/S0264047326000093>

⁵⁷ H'oriya Souiki, 'Third-Party Artificial Insemination and the Problem of Donating Sperm and Eggs - A Comparative Study between the Algerian Law, Islamic Law, French Law and European Laws in General', *Technium Social Sciences Journal*, 36 (2022), 236–243. <https://doi.org/10.47577/tssj.v36i1.7368>

⁵⁸ Noor Al-Khawajah, Tareq Al-Billeh, and Majd Manasra, 'Digital Forensic Challenges in Jordanian Cybercrime Law', *Pakistan Journal of Criminology*, 15.3 (2023), 29-44. <https://www.pjcriminology.com/publications/digital-forensic-challenges-in-jordanian-cybercrime-law/>

⁵⁹ Jouni Aljoudeh, Abdulrahman Al Balkhi, Yahia Ranjous, Abdulrahman Shbani, Danial Takieddin, Mohammad Bashar Izzat, Experiences and Perceptions of Clinical and Graduate Medical Students 'Regarding AI in Syria: Cross-Sectional Study', *JMIR Medical Education*, 12 (2026) <https://www.sciencedirect.com/org/science/article/pii/S2369376226000966>

the doctor, the medical center, the developing company, or the algorithmic system itself?⁶⁰

In traditional medicine, medical errors are based on negligence, omission, or failure to adhere to scientific principles.⁶¹ However, in the context of using artificial intelligence, a medical error could be a programming error, an error resulting from insufficient training data, an error in interpreting the algorithm's results, or a malfunction in the device or storage system.⁶² This diversity makes it more challenging to determine responsibility compared to traditional medical systems.⁶³ In most legislations, the doctor remains responsible if they rely on the algorithm without verifying its accuracy, fail to properly interpret the system's results, or choose to fully depend on artificial intelligence despite the presence of error indicators.⁶⁴ But the important legal question is, "Is reliance on artificial intelligence considered a breach of the duty of care?" The answer varies depending on the country and the level of professional reliance.⁶⁵

As for the responsibility of artificial insemination centers, they usually bear the responsibility for maintaining the equipment, training the medical staff, selecting the approved smart systems, and reviewing algorithm updates.⁶⁶ They may also bear joint responsibility with the doctor.⁶⁷ As for the responsibility of the algorithm developer, this point raises new questions in law, such as: "Is the program subject to tort liability?" And is he held accountable for a design flaw? And is he asked

⁶⁰ Gordana Kovaček Stanić, 'Assisted Reproductive Technologies: Impact on Parenthood Law', *European Integration Studies*, 21.1 (2025), 141–162. <https://doi.org/10.46941/2025.1.6>

⁶¹ Michael P. Cary Jr., Jing Wang and Jennie C. De Gagne, 'Preparing the nursing workforce for the health AI era: Insights from the Macy Foundation Conference on AI in Medical Education', *Journal of Professional Nursing*, 65 (2026), 164-172. <https://www.sciencedirect.com/science/article/pii/S875572232600061X>

⁶² Sherrie L Kelly, Melissa Forgie and Mark C Walker, 'Bridging the Implementation Gap in Medical AI Education: 3-Lever Framework for Concurrent Reform', *JMIR Medical Education*, 12 (2026). <https://www.sciencedirect.com/org/science/article/pii/S236937622600084X>

⁶³ Min Jung Park, 'Comparative Analysis of Medical, Legal, and Ethical Considerations for Establishing a Standard Operating Protocol for Artificial Insemination by Donor', *Journal of the Korean Medical Association*, 61.7 (2018), 383–391. <https://doi.org/10.5124/jkma.2018.61.7.383>

⁶⁴ Tariq Kamal Alhasan, 'Satellite navigation spoofing, bodily injury, and emotional distress under the Montreal Convention', *Journal of Air Transport Management*, 137 (2026) <https://doi.org/10.1016/j.jairtraman.2026.103083>

⁶⁵ Ioanna Malandraki, 'TRANSCENDING DEATH: BIOETHICAL CONSIDERATIONS ON POST-MORTEM ARTIFICIAL INSEMINATION', *Journal of Philosophy ARHE. University of Novi Sad*, 21.42 (2024), 97-110. <https://doi.org/10.19090/arhe.2024.42.97-110>

⁶⁶ A, N Ahmad Masum, and N H M Dahlan, 'Legitimacy Of Children Born By Artificial Insemination In Malaysia: A Legal Analysis Of Section 112 Of The Evidence Act 1950', *LNS (A) Cxiii Legal Network ... academia.edu*, (2021), 1-18 https://www.academia.edu/download/77280812/2021_LNS_Legitimacy_Of_Children_Born_By_Artificial_Insemination_In_Malaysia.pdf

⁶⁷ Hamzeh Abu Issa, and Ma'En Juwaihian, 'The Extent of the Need for Teaching Forensic Sciences for Law Students in Jordanian Universities', *Indian Journal of Forensic Medicine and Toxicology*, 15.1 (2021), 1097–1100. <https://doi.org/10.37506/ijfmt.v15i1.13563>

about the system's failure predictions? In many countries, new rules are beginning to take shape to hold developers of medical artificial intelligence accountable according to the concept of product liability, where the intelligent system is treated as a product with a defect.⁶⁸

Regarding the possibility of recognizing the algorithmic system as a responsible legal entity, some legal scholars in Europe propose the idea of electronic personhood for the intelligent system, but the majority of studies reject attributing independent legal personality to artificial intelligence because it lacks human will. Therefore, legal liability in medical artificial intelligence is a multi-party responsibility, necessitating a comprehensive framework that defines the role of each party.⁶⁹ The protection of genetic data in artificial insemination is considered one of the most dangerous types of data because it reveals highly sensitive information about the individual, such as genetic predisposition to diseases, biological characteristics, and family origin. When this data is published or breached, the family may suffer social or economic harm.⁷⁰ The sensitive nature of genetic data represents a unique biological fingerprint that can predict disease behavior and requires double protection compared to regular medical data. Artificial intelligence uses this data to assess the risk of genetic diseases before embryo implantation.⁷¹

As for the risks of genetic data leakage, they include commercial manipulation, selling data to insurance companies, use in genetic enhancement, exposing the family to genetic stigma, and hacking into medical center databases. These risks make data protection regulation mandatory rather than optional.⁷² International regulations governing genetic data privacy, most notably the European GDPR, which is the strictest,⁷³ and the American GINA Act, prohibit genetic

⁶⁸ Andreas Nikolaos Koukoulis, 'Medical Involvement in Procreation in Greek Law', *BioLaw Journal*, 3 (2022), 129–137. <https://doi.org/10.15168/2284-4503-2387>

⁶⁹ M. V. Bielova, and O. M. Byelov, 'Reproductive Rights as a Component of Fourth-Generation Rights: Theoretical and Legal Analysis', *Uzhhorod National University Herald. Series: Law*, 1, 88 (2025), 115–121. <https://doi.org/10.24144/2307-3322.2025.88.1.15>

⁷⁰ Tetyana Vilchyk, and Alla K. Sokolova, 'Areas for Further Improvement of Legislative Regulation of Patients' Rights in Ukraine', *Wiadomosci Lekarskie (Warsaw, Poland : 1960)*, 72.7 (2019), 1324–1330. <https://doi.org/10.36740/wlek201907118>

⁷¹ Ivo Smrž, 'Assisted Reproduction in the Case Law of the European Court of Human Rights', *Casopis Zdravotnického Práva a Bioetiky*, 15.1 (2025), 1–20. https://www.digitalniknihovna.cz/knav/view/uuid:fd2a63af-9e7e-453a-89a0-9e8663f3a69b?article=uuid:0d116142-402b-416d-a639-7a969e4a6bb1&page=uuid:fd2a63af-9e7e-453a-89a0-9e8663f3a69b_2

⁷² Muhammad Azwar Kamaruddin, Airah Amir, and Abd Rahim Razaq, 'The 'Iddah in Artificial Insemination: A Study between Medical and Shariah Point of View', *Malaysian Journal of Syariah and Law*, 8.1 (2020), 34–49. <https://doi.org/10.33102/mjssl.v8i1.177>

⁷³ The Regulation (EU) 2016/679 (General Data Protection Regulation) in the current version of the OJ L 119, 04.05.2016; cor. OJ L 127, 23.5.2018. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679>

discrimination.⁷⁴ Additionally, the Canadian Medical Research Act⁷⁵ and Australia's⁷⁶ and Brazil's genetic data regulations exist.⁷⁷ However, Arab countries suffer from the absence of detailed laws for genetic data, and the existence of general data protection regulations is insufficient. There is also a lack of effective oversight mechanisms and technical expertise in data security investigations, necessitating the need for specialized Arab legislation.⁷⁸

On the other hand, most artificial intelligence algorithms, especially those based on deep learning, suffer from the problem of algorithmic transparency and the black box issue, as neither the doctor nor the patient can understand the precise method by which the decision was made.⁷⁹ The black box is a system where the user cannot understand how it works from the inside. In the case of in vitro fertilization, the problem lies in the algorithm, which may assign a score to an embryo without explanation.⁸⁰ The doctor does not know why the system chose this embryo over others, and the patient cannot object or understand the decision.⁸¹

The impact of lack of transparency on legal responsibility, if the decision cannot be explained, it is difficult to determine whether the doctor made a mistake. Is the algorithm biased? Are the data insufficient? This results in difficulties in filing lawsuits, determining compensation, and reconstructing medical events. Transparency requirements include the ability to review the algorithm, record every step taken by the algorithm, and provide understandable reports for the

⁷⁴ The United States, Genetic Information Nondiscrimination Act of 2008, <https://www.eeoc.gov/statutes/genetic-information-nondiscrimination-act-2008>

⁷⁵ Canadian Institutes of Health Research Act, S.C. 2000, c. 6, Assented to 2000-04-13, <https://laws.justice.gc.ca/eng/acts/c-18.1/page-1.html>

⁷⁶ Minna Paltiel, Mark Taylor, and Ainsley Newson, 'Protection of Genomic Data and the Australian Privacy Act: When Are Genomic Data 'Personal Information'?', *International Data Privacy Law*, 13.1(2023), 47–62. <https://doi.org/10.1093/idpl/ipad002>

⁷⁷ Nicolau B. da Cunha, Jaim J.da Silva Junior, Amanda M.M. Araújo, Ludmila R. de Souza, Michel L. Leite, Gabriel da S. Medina, Gustavo R. Rodriguez, et al., 'Updates on the Regulatory Framework of Edited Organisms in Brazil: A Molecular Revolution in Brazilian Agribusiness', *Genes. Multidisciplinary Digital Publishing Institute (MDPI)*, 16.5 (2025), 1-21. <https://doi.org/10.3390/genes16050553>

⁷⁸ Mohammad AlTaei, and Subhi Hamadi Hamdoon, 'Multi-Agent Intelligent System Design for Telemedicine Applications to Develop Health Care Systems of Developing Countries', *International Journal of Emerging Multidisciplinaries: Computer Science & Artificial Intelligence*, 2.1 (2023), 1-9. <https://doi.org/10.54938/ijemdcsl.2023.02.1.234>

⁷⁹ Yuping Song, Zhenwei Li, Jing Han, and Xiaochen Wang, 'RESEARCH ON THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN FUND MANAGER IDENTIFICATION', *Singapore Economic Review*, 70.4 (2025), 973–1007. <https://doi.org/10.1142/S0217590820480033>

⁸⁰ Tareq Nicola Al-Billeh, 'The Role of Forensic Dentistry in Detecting Crimes in Jordanian Law and Judiciary', *Journal of Forensic Medicine Science and Law*, (2023) <https://doi.org/10.59988/jfmsl.vol.32issue2.14>

⁸¹ Victoria S. Jiang, and Charles L. Bormann, 'Artificial Intelligence in the in Vitro Fertilization Laboratory: A Review of Advancements over the Last Decade', *Fertility and Sterility*, 120.1 (2023), 17-23. <https://doi.org/10.1016/j.fertnstert.2023.05.149>

doctor and patient.⁸² There must also be regulations to standardize the quality of algorithms. Therefore, algorithmic discrimination of embryos and bias are among the most dangerous challenges because they may lead to the creation of illegal selection of embryos that prefer certain traits without medical justification.⁸³

However, sources of algorithmic bias may result from non-diverse training data, algorithm designs that do not account for genetic differences, gender or racial biases in the samples, and human errors in data entry.⁸⁴ Bias can lead to the creation of genetic social disparities, the promotion of the phenomenon of designer babies, harm to human diversity, and an ethical deviation akin to silent genetic engineering. Therefore, legitimate medical use aims to avoid genetic diseases, while illegitimate medical use leads to the selection of traits, enhancement of abilities, and modification of esthetic features.⁸⁵ As for the rights of patients and embryos in the context of artificial intelligence, they include the right to informed consent, meaning that the patient must understand the nature of the algorithm, its role in decision-making, its accuracy, error rate, and the entities involved in their genetic data.⁸⁶ However, the rights of embryos in facing algorithmic decisions, there is a legal discussion about protecting embryos from discrimination, ensuring that viable embryos are not excluded, and preventing selection based on esthetic traits. Finally, the right to access data: patients should be able to know the details of embryo evaluations, obtain understandable reports, and contest the algorithmic decision.⁸⁷

International Experiences in Regulating Artificial Intelligence in Artificial Insemination

The legal regulation of artificial intelligence in the field of artificial insemination represents a global challenge due to the nature of sensitive medical decisions that the algorithmic system intervenes in, directly related to reproduction, the rights of

⁸² Abigail Maguire, 'An Examination into the Embryo Disposal Practices of Human Fertilization and Embryology Authority Licenced Fertility Centers in the United Kingdom', *Cambridge Quarterly of Healthcare Ethics*, 30.1 (2021), 161–74. <https://doi.org/10.1017/S096318012000064X>

⁸³ Yong Sun, Yipeng Wang, Junyu Shi, Zhiyuan Zhang, Yanmei Xiao, Lei Zhu, Manxi Jiang, and Qiang Nie. 'Time-Lapse Video-Based Embryo Grading via Complementary Spatial-Temporal Pattern Mining', *arXiv.org*, (2025), 1-11. <https://arxiv.org/abs/2506.04950>

⁸⁴ Perrine Ginod, and Michael H. Dahan, 'Preimplantation Genetic Testing for Polygenetic Conditions: A Legal, Ethical, and Scientific Challenge', *Seminars in Reproductive Medicine*, 14.2 (2024), 60-68.. <https://doi.org/10.1055/s-0044-1782618>

⁸⁵ Giovanna Pedroche Miranda, and Cleide Aparecida Gomes Rodrigues Fermentão, 'Genetic Rights and the Principle of Human Dignity as a Form of Learning', *Revista de Gestão Social e Ambiental*, 19.4 (2025), 1-16. <https://doi.org/10.24857/rgsa.v19n4-112>

⁸⁶ Jacob Theilgaard Lassen, Mikkel Fly Kragh, Jens Rimestad, Martin Nygård Johansen, and Jørgen Berntsen, 'Development and Validation of Deep Learning Based Embryo Selection across Multiple Days of Transfer', *Scientific Reports*, 13.1 (2023), 1-9. <https://doi.org/10.1038/s41598-023-31136-3>

⁸⁷ Mónica Correia, Guilhermina Rego, and Rui Nunes, 'THE RIGHT TO BE FORGOTTEN REGARDING GENETIC DATA: A LEGAL AND ETHICAL ANALYSIS', *Acta Bioethica*, 30.2 (2024), 231–43. <https://doi.org/10.4067/S1726-569X2024000200231>

embryos, and the patient.⁸⁸ Based on this, international experiences vary in their legislative maturity, as some countries have clear regulations for organizing genetic data, while others rely on judicial precedents or general principles without specific legislation.⁸⁹

In fact, the United Kingdom is one of the most advanced countries in regulating artificial insemination, possessing one of the most comprehensive legislations globally, overseen by an independent body known as the Human Fertilization and Embryology Authority (HFEA).⁹⁰ Regarding the legislative framework of the HFEA Act, the Human Fertilization and Embryology Act was enacted in 1990 and amended in 2008. This law clearly regulates the creation of embryos, the use of modern technologies, the storage of embryos, scientific research on embryos, the rights of couples and medical entities, and the licensing standards for medical centers. Although the law was not specifically created for artificial intelligence, its principles serve as a foundation for regulating algorithms.⁹¹

The regulation of artificial intelligence in the context of IVF, the HFEA has issued several guidelines regarding the evaluation of embryos using digital systems.⁹² These guidelines stipulate that algorithmic tools must be approved after clinical trials, require the recording of algorithmic data, and prohibit the use of any algorithm that relies on non-medical traits such as height or skin color. The authority also emphasizes the necessity for doctors to understand how algorithmic decisions are made, which is an important condition that international experiments are criticized for lacking.⁹³

⁸⁸ Mariana Nicolielo, Catherine Kuhn Jacobs, Bruna Lourenço, Murilo Costa Maffei, Dóris Spinosa Chéles, Matheus Búbola Duarte, Bruno Araújo Mendes, et al., 'MAIA Platform for Routine Clinical Testing: An Artificial Intelligence Embryo Selection Tool Developed to Assist Embryologists', *Scientific Reports*, 15.1 (2025), <https://doi.org/10.1038/s41598-025-17755-y>

⁸⁹ Małgorzata Madej, Paweł Karpiński, Hayane Akopyan, Michał Witt, and Maria M. Sasiadek, 'Genetic Data Protection as an Indispensable Element of Genomic Medicine Development', *Polish Archives of Internal Medicine*, 133.2 (2023), 1-11. <https://doi.org/10.20452/pamw.16425>

⁹⁰ Abigail Maguire, 'An Examination into the Embryo Disposal Practices of Human Fertilization and Embryology Authority Licenced Fertility Centers in the United Kingdom', *Cambridge Quarterly of Healthcare Ethics*, 30.1 (2021), 161-74. <https://doi.org/10.1017/S096318012000064X>

⁹¹ The United Kingdom, Human Fertilization and Embryology Act" of 1990, which was amended in 2008 <https://www.legislation.gov.uk/ukpga/2008/22/contents>

⁹² Tawfiq Khashashneh, Tareq Al-Billeh, Ali Al-Hammouri, and Roua Belghit, 'The Importance of Digital Technology in Extracting Electronic Evidence: How Can Digital Technology be used at Crime Scenes?', *Pakistan Journal of Criminology*, 15.4 (2023), 69-85 <https://www.pjcriminology.com/publications/the-importance-of-digital-technology-in-extracting-electronic-evidence-how-can-digital-technology-be-used-at-crime-scenes/>

⁹³ Mariana Nicolielo, Catherine Kuhn Jacobs, Bruna Lourenço, Murilo Costa Maffei, Dóris Spinosa Chéles, Matheus Búbola Duarte, Bruno Araújo Mendes, et al., 'MAIA Platform for Routine Clinical Testing: An Artificial Intelligence Embryo Selection Tool Developed to Assist Embryologists', *Scientific Reports*, 15.1 (2025), <https://doi.org/10.1038/s41598-025-17755-y>

It is noted from the British experience the presence of an independent body with extensive powers, regulations that prohibit genetic manipulation or non-medical selection, and the requirement for doctors to be transparent when using algorithms, as well as precise standards for storing genetic data.⁹⁴ On the other hand, there are no specific texts directly addressing artificial intelligence, relying instead on guidelines rather than explicit laws, and the adoption of some technologies has been delayed due to complex procedures.⁹⁵ As for the European Union, it is considered one of the most legally advanced systems in terms of protecting personal data, especially genetic data, which falls under the highly sensitive category. By referring to the General Data Protection Regulation (GDPR), it is considered one of the strongest laws in the world.⁹⁶ It includes prohibiting the processing of genetic data without clear consent, imposing significant penalties on artificial insemination centers for data breaches, requiring companies to conduct algorithmic impact assessments, and granting patients the right to object to fully automated decisions.⁹⁷

However, the European Union issued the AI Act 2024, which is the world's first comprehensive law on artificial intelligence. It stipulates that medical algorithms are considered high-risk systems and must be clinically evaluated before use. Algorithms with non-medical selective purposes are prohibited, and the results of the algorithm must be interpretable.⁹⁸ It is noted from the European experience that there is a clear and separate law for artificial intelligence, strong protection for genetic data, strict procedures for the approval of medical systems, and the consideration of embryo evaluation as a high-risk sector.⁹⁹ On the other hand, the laws are very complex and may delay innovation, the high cost of complying with

⁹⁴ Kristi Harbord, 'Genetic Data Privacy Solutions in the GDPR', *Texas A&M Law Review*, 7.1 (2019), 269–97. <https://doi.org/10.37419/lr.v7.i1.6>

⁹⁵ D. Gilboa, Akhil Garg, M. Shapiro, M. Meseguer, Y. Amar, N. Lustgarten, N. Desai, et al., 'Application of a Methodological Framework for the Development and Multicenter Validation of Reliable Artificial Intelligence in Embryo Evaluation', *Reproductive Biology and Endocrinology*, 23.1 (2025), 1–12. <https://doi.org/10.1186/s12958-025-01351-w>

⁹⁶ Petro Sukhorolskyi, and Valeriia Hutsaliuk, 'Processing of Genetic Data under GDPR: Unresolved Conflict of Interests', *Masaryk University Journal of Law and Technology*, 14.2 (2020), 151–176. <https://doi.org/10.5817/MUJLT2020-2-1>

⁹⁷ The Regulation (EU) 2016/679 (General Data Protection Regulation) in the current version of the OJ L 119, 04.05.2016; cor. OJ L 127, 23.5.2018. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679>

⁹⁸ EU AI Act: first regulation on artificial intelligence, 2023, <https://www.europarl.europa.eu/topics/en/article/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence>

⁹⁹ L.E. Lubis, H.D.R. Raharja, G.M. Fajri, W.E. Wibowo, S.A. Pawiro and F. Haryanto, 'Beyond hype: Adoption and attitudes toward generative AI among Indonesian medical physicists', *Physica Medica*, 144 (2026) <https://www.sciencedirect.com/science/article/pii/S1120179726000463>

European standards, and the difficulty of standardizing regulations among member states.¹⁰⁰

The United States is characterized by its numerous states and the absence of a comprehensive federal law for artificial intelligence or artificial insemination. Despite the tremendous medical advancements, America relies on state laws, judicial precedents, and professional regulations from medical associations, resulting in the absence of a unified national framework.¹⁰¹ The Genetic Information Nondiscrimination Act (GINA) prohibits the use of genetic data by insurance companies and discrimination in employment based on genetic information, but it does not regulate the use of artificial intelligence in embryo selection. Judicial cases in the field of IVF errors include cases of embryo mix-ups, carrying embryos for other families, and laboratory evaluation errors. Courts have begun to impose significant civil liability on centers and laboratories.¹⁰²

It is noted from the American experience a great flexibility in medical innovation, and the presence of large tech companies developing advanced algorithms.¹⁰³ Conversely, there is a lack of clear regulation for artificial intelligence and weak protection of genetic data compared to Europe.¹⁰⁴ As for Canada, the Assisted Human Reproduction Act (AHRA) prohibits the sale of embryos, regulates cell donation, and sets laboratory standards, but artificial intelligence is not explicitly mentioned.¹⁰⁵ As for genetic data protection, Canada is one of the few countries that has a clear law for genetic data protection, considering it among the highly sensitive data.¹⁰⁶

Brazil is considered one of the first countries to allow the use of artificial intelligence in embryo selection, such as the MAIA algorithm. Brazil has a system that allows the official approval of the algorithm after clinical reviews to determine

¹⁰⁰ Gordana Kovacek-Stanic, 'European Accomplishments in Regulation of the Family Status of the Child Conceived by Artificial Reproduction Technologies', *Stanovništvo*, 53.2 (2015), 1–19. <https://doi.org/10.2298/stnv1502001k>

¹⁰¹ Mónica Correia, Guilhermina Rego, and Rui Nunes, 'THE RIGHT TO BE FORGOTTEN REGARDING GENETIC DATA: A LEGAL AND ETHICAL ANALYSIS', *Acta Bioethica*, 30.2 (2024), 231–43. <https://doi.org/10.4067/S1726-569X2024000200231>

¹⁰² The United States, Genetic Information Nondiscrimination Act of 2008, <https://www.eeoc.gov/statutes/genetic-information-nondiscrimination-act-2008>

¹⁰³ Ying Hu and Ying Ding, 'AI appreciation effect: how contagious diseases influence medical AI adoption', *International Journal of Research in Marketing*, (2026) <https://www.sciencedirect.com/science/article/pii/S0167811626000200>

¹⁰⁴ Małgorzata Madej, Paweł Karpiński, Hayane Akopyan, Michał Witt, and Maria M. Sasiadek, 'Genetic Data Protection as an Indispensable Element of Genomic Medicine Development', *Polish Archives of Internal Medicine*, 133.2 (2023), 1–11. <https://doi.org/10.20452/pamw.16425>

¹⁰⁵ Canadian Institutes of Health Research Act, S.C. 2000, c. 6, Assented to 2000-04-13, <https://laws.justice.gc.ca/eng/acts/c-18.1/page-1.html>

¹⁰⁶ Canada, Assisted Human Reproduction Act (S.C. 2004, c. 2). <https://laws-lois.justice.gc.ca/eng/acts/A-13.4/>

its success criteria, and mandates that centers use only licensed systems.¹⁰⁷ It is one of the fastest countries in integrating artificial intelligence into IVF, in addition to having advanced local companies developing embryo evaluation algorithms. However, there is a weakness in genetic data protection compared to the European Union, and there is widespread reliance on companies without detailed oversight.¹⁰⁸

Japan relies on a strict system for evaluating medical systems, requiring high transparency for algorithms, and it has one of the largest embryo image databases in the world.¹⁰⁹ In contrast, Singapore has a national artificial intelligence policy (AI Singapore) and relies on clear ethical principles in medicine, along with a framework for responsible AI.¹¹⁰ As for South Korea, it has heavily invested in medical artificial intelligence and has advanced IVF centers that use very precise algorithms.¹¹¹ Based on the above, previous experiences offer a set of lessons that can be utilized thru the necessity of having an independent body like the British HFEA to regulate algorithms, laboratories, and the use of genetic data, and issuing a specific law for medical AI similar to the European AI Act, which includes defining high-risk systems, requiring transparency, setting accreditation conditions, and determining legal liability. Additionally, adopting only approved algorithms as in Brazil, protecting genetic data according to the European GDPR model,¹¹² enhancing the principle of informed consent according to the Japanese and Singaporean models,¹¹³ and avoiding the American model due to the absence of a unified national regulation.

¹⁰⁷ Nicolau B. da Cunha, Jaim J.da Silva Junior, Amanda M.M. Araújo, Ludmila R. de Souza, Michel L. Leite, Gabriel da S. Medina, Gustavo R. Rodriguez, et al., 'Updates on the Regulatory Framework of Edited Organisms in Brazil: A Molecular Revolution in Brazilian Agribusiness', *Genes. Multidisciplinary Digital Publishing Institute (MDPI)*, 16.5 (2025), 1-21. <https://doi.org/10.3390/genes16050553>

¹⁰⁸ Mariana Nicolielo, Catherine Kuhn Jacobs, Bruna Lourenço, Murilo Costa Maffei, Dóris Spinoza Chéles, Matheus Búbola Duarte, Bruno Araújo Mendes, et al., 'MAIA Platform for Routine Clinical Testing: An Artificial Intelligence Embryo Selection Tool Developed to Assist Embryologists', *Scientific Reports*, 15.1 (2025), <https://doi.org/10.1038/s41598-025-17755-y>

¹⁰⁹ Shinya Matsuda, 'Health Policy in Japan – Current Situation and Future Challenges', *JMA Journal*, 2.1 (2019), 1–10. <https://doi.org/10.31662/jmaj.2018-0016>

¹¹⁰ Singapore National AI Strategy 2.0, National AI Strategy Learn how Singapore is leveraging AI and driving its adoption. (2023) <https://file.go.gov.sg/nais2023.pdf>

¹¹¹ South Korea invests in AI health care options, August 1, 2023, <https://wedc.org/market-intelligence/posts/south-korea-invests-in-ai-health-care-options/>

¹¹² The Regulation (EU) 2016/679 (General Data Protection Regulation) in the current version of the OJ L 119, 04.05.2016; cor. OJ L 127, 23.5.2018. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679>

¹¹³ Sachi Spaulding, 'Surrogacy and Japan: A Case for Regulation', *UCLA Pacific Basin Law Journal*, 38.1 (2021), 61-83. <https://doi.org/10.5070/p838153632>

The Proposed Legal Framework for Regulating Artificial Intelligence in Artificial Insemination

After reviewing the scientific concepts of artificial insemination, the technical challenges associated with artificial intelligence, analyzing legal issues, and studying international experiences, it becomes necessary to present a clear and comprehensive legal framework that countries can adopt to ensure the safe and responsible use of artificial intelligence technologies in the field of assisted reproduction.¹¹⁴ There are several general principles governing the use of artificial intelligence in artificial insemination, so any legal regulation should be based on a set of fundamental principles that guide and shape the overall framework upon which detailed rules are built.¹¹⁵ Among these principles is the principle of algorithmic transparency, which states that the algorithms used in embryo evaluation must be interpretable, subject to medical and legal scrutiny, classified according to clear standards, provide understandable reports to the doctor, and allow the patient to receive a simplified explanation of the decisions. Without transparency, it is impossible to ensure fairness or hold the doctor or center accountable.¹¹⁶

There is also the principle of embryo protection and preventing algorithmic discrimination, which stipulates in the proposed framework the prohibition of using algorithms to select non-medical traits,¹¹⁷ the prohibition of selecting embryos based on gender unless for medical necessity, and the affirmation that artificial intelligence cannot be used as a tool for human selection, while respecting the value of the embryo and protecting it from unscientific exclusion.¹¹⁸ There is the principle of genetic data protection, whereby genetic data is treated as highly protected, subject to special licensing, and its transfer or sale to any third party is

¹¹⁴ Barbara J. Stone, Kendra H. Steele, and Angelika Fath-Goodin, 'A Rapid and Effective Nonsurgical Artificial Insemination Protocol Using the NSETTM Device for Sperm Transfer in Mice without Anesthesia', *Transgenic Research*, 24.4 (2015), 775–781. <https://doi.org/10.1007/s11248-015-9887-3>

¹¹⁵ Riccardo Rescinito, Matteo Ratti, and Massimiliano Panella, 'Prediction Models for Intrauterine Growth Restriction Using Artificial Intelligence and Machine Learning: A Systematic Review and Meta-Analysis', *Population Medicine*, 5.Supplement. (2023). <https://doi.org/10.18332/popmed/165587>

¹¹⁶ Giovanna Pedroche Miranda, and Cleide Aparecida Gomes Rodrigues Fermentão, 'Genetic Rights and the Principle of Human Dignity as a Form of Learning', *Revista de Gestão Social e Ambiental*, 19.4 (2025), 1-16. <https://doi.org/10.24857/rgsa.v19n4-112>

¹¹⁷ Tariq. K, Alhasan, 'Governing the black box in adjudication: Policy frameworks for algorithmic transparency in international arbitration', *Social Sciences & Humanities Open*, 14 (2026) <https://doi.org/10.1016/j.ssaho.2026.103109>

¹¹⁸ Nejc Kozar, Vilma Kovač, and Milan Reljič, 'Can Methods of Artificial Intelligence Aid in Optimizing Patient Selection in Patients Undergoing Intrauterine Inseminations?', *Journal of Assisted Reproduction and Genetics*, 38.7 (2021), 1665–1673. <https://doi.org/10.1007/s10815-021-02224-y>

prohibited.¹¹⁹ It must be encrypted, fragmented, and not linked to direct identity.¹²⁰ Finally, the principle of oversight on high-risk algorithms, whereby systems involved in embryo selection are classified as high-risk systems and are subject to several regulations, including prior approval from a governmental authority, independent clinical evaluation, annual audits, and documentation of decision-making stages.¹²¹

Therefore, we propose drafting a specialized law to regulate the use of artificial intelligence in artificial insemination. This law should include clear definitions for medical artificial intelligence, high-risk systems, genetic data, embryo freezing, embryo evaluation algorithms, and shared responsibility.¹²² This law shall apply to IVF centers, algorithm development companies, doctors, specialists, embryo storage centers, and cloud service providers, and it shall specify the conditions for the accreditation of medical algorithms. No algorithm shall be allowed for use in embryo evaluation unless it has undergone a rigorous clinical trial, received accreditation from an independent national authority, had its source code reviewed upon request, proven not to exhibit genetic bias, and been registered in a national medical algorithm registry.¹²³

It is required that IVF centers use only licensed systems, train medical staff to interpret AI results, document every algorithmic decision, inform the patient of the type of system used, and create a secure digital medical record.¹²⁴ In order to protect genetic data, it is necessary to prohibit the transfer of embryo data to any entity outside the country, require explicit consent for processing, encrypt the data

¹¹⁹ Michael Constantin Kirchberger and med habil, 'Public Perceptions of AI in Medicine and Implications for Future Medical Education: Cross-Sectional Survey', *JMIR Formative Research*, 10 (2026) <https://www.sciencedirect.com/org/science/article/pii/S2561326X26002647>

¹²⁰ Azadeh Akbari Sene, Zahra Zandieh, Mojgan Soflaei, Hamid Mokhtari Torshizi, and Kourosh Sheibani, 'Using Artificial Intelligence to Predict the Intrauterine Insemination Success Rate among Infertile Couples', *Middle East Fertility Society Journal*, 26.1 (2021), 1-7. <https://doi.org/10.1186/s43043-021-00091-2>

¹²¹ Olga A. Yavor, Viktoriia V. Nadon, and Olena O. Ruban, 'Transformation of Legal Regulation of Family Relations under the Impact of Scientific Progress', *Astra Salvensis*, (2019), 523-537. https://dspace.nlu.edu.ua/bitstream/123456789/17903/1/Yavor_Nadon_Ruban_523-537.pdf

¹²² Yehezkel Margalit, and Beck Fruchter R, '[AI (ARTIFICIAL INTELLIGENCE) IN AI (ARTIFICIAL INSEMINATION)]', *Harefuah*, 163.6 (2024), 348-353. <https://pubmed.ncbi.nlm.nih.gov/38884286/>

¹²³ Nikica Zaninovic, and Zev Rosenwaks, 'Artificial Intelligence in Human in Vitro Fertilization and Embryology', *Fertility and Sterility*, 114.5 (2020), 914-920. <https://doi.org/10.1016/j.fertnstert.2020.09.157>

¹²⁴ David Appiah, and John K. Ganle, 'Ethical Constraints and Dilemmas in the Provision of In-Vitro Fertilization Treatment in Ghana: From the Perspectives of Experts', *BMC Medical Ethics*, 25.1 (2024), 1-11. <https://doi.org/10.1186/s12910-024-01113-0>

in an irreversible format,¹²⁵ not retain the data for longer than the medically necessary period, and subject security breaches to criminal penalties.¹²⁶

It is necessary to establish a national authority for medical artificial intelligence that will undertake periodic monitoring, technical auditing of algorithms, bias detection, data storage oversight, and issue public transparency reports.¹²⁷ It should also immediately halt any non-compliant systems.¹²⁸ Penalties for violators should include substantial financial fines, revocation of the center's license, and prohibition of algorithm developers from practice, in addition to criminal liability for genetic data breaches and civil compensation for patients and embryos.¹²⁹ Legal responsibility between the doctor, the center, and the program must be organized by adopting a shared responsibility system based on three levels: the doctor's responsibility when relying on the algorithm without verification, misinterpreting the data, and not explaining to the patient how the decision was made; the center's responsibility for maintaining the equipment, training the staff, selecting the algorithms, managing the data, and conducting periodic oversight; and the developer company's responsibility for software defects, algorithmic bias, errors resulting from system design, and failure to update security.¹³⁰

There should also be joint responsibility between the doctor and the center for medical errors, the producer's responsibility on the developer company, criminal liability in case of genetic data leakage, and independent responsibility for

¹²⁵ Jacob Theilgaard Lassen, Mikkel Fly Kragh, Jens Rimestad, Martin Nygård Johansen, and Jørgen Berntsen, 'Development and Validation of Deep Learning Based Embryo Selection across Multiple Days of Transfer', *Scientific Reports*, 13.1 (2023), 1-9. <https://doi.org/10.1038/s41598-023-31136-3>

¹²⁶ Abdullah Alkhseilat, Tareq Al Billeh, Mohammed Albazi, and Naser Al Ali, 'The Authenticity of Digital Evidence in Criminal Courts: A Comparative Study', *International Journal of Electronic Security and Digital Forensics*, 16.6 (2024), 720–738 <https://doi.org/10.1504/ijesdf.2024.142010>

¹²⁷ Athanasios Samaras, Alexandra Bekiaridou, Andreas S. Papazoglou, Dimitrios V. Moysidis, Grigorios Tsoumakas, Panagiotis Bamidis, Grigorios Tsigkas, et al., 'Artificial Intelligence-Based Mining of Electronic Health Record Data to Accelerate the Digital Transformation of the National Cardiovascular Ecosystem: Design Protocol of the CardioMining Study', *BMJ Open*, 13.4 (2023), 1-7. <https://doi.org/10.1136/bmjopen-2022-068698>

¹²⁸ Xiaokang Shi, Zewu Jiang, Li Xiong, Ka-Chun Siu and Zhen Chen, 'Utilization of AI Among Medical Students and Development of AI Education Platforms in Medical Institutions: Cross-Sectional Study', *JMIR Human Factors*, 13 (2026) <https://www.sciencedirect.com/org/science/article/pii/S2292949526000039>

¹²⁹ Tareq Al-Billeh, Abdullah Alkhseilat, and Lana AL-Khalaileh, 'Scope of Penalties of Offences in Jordanian Public Office', *Pakistan Journal of Criminology*, 15.2 (2023), 341-356 <https://www.pjcriminology.com/publications/scope-of-penalties-of-offences-in-jordanian-public-office/>

¹³⁰ Florindo Gomes, and RA Tuty Kuswardhani, 'Legal Responsibility Form against Doctors for Violations of the Code of Ethics between Colleagues', *International Journal of Judicial Law*, 3.2 (2024), 01–04. <https://doi.org/10.54660/ijjl.2024.3.2.01-04>

algorithmic bias.¹³¹ The necessity of protecting the rights of patients and embryos, as the rights of patients include the right to informed consent, the right to reject the algorithmic decision, the right to know the error rate, the right to access a copy of the embryo evaluation, and the right to use a traditional evaluation instead of the algorithmic one.¹³² As for the rights of embryos, they include preventing the exclusion of embryos for non-medical reasons, protecting embryos from genetic discrimination, ensuring the safety of the storage process,¹³³ criminalizing the sale of genetic data of embryos, and protecting remaining embryos from waste or tampering.¹³⁴

Conclusion

The study showed that artificial intelligence can improve embryo assessment and increase success rates, but it raises ethical and legal challenges related to embryo rights, genetic data protection, and avoiding discrimination. There are no clear regulations governing artificial intelligence in IVF, leaving the field open to medical errors and genetic data exploitation. The study revealed that British, European, and Japanese experiments provide best practices, especially in independent oversight of algorithms, genetic data protection, transparency in interpreting algorithmic decisions, and preventing the selection of embryos for non-medical reasons. Therefore, it is clear from this research paper that artificial intelligence offers tremendous benefits to the field of IVF, but on the other hand, it raises a significant number of legal and ethical issues that cannot be ignored. Without a strong legal framework, these technologies could become a source of risks that affect patients' rights and open the door to unaccountable medical decisions. Therefore, there must be a swift legislative move that balances technological advancement with legal protection while enhancing transparency, justice, interpretation, and accountability. Finally, it is necessary to issue a specialized law for artificial intelligence in industrial fertilization that includes a clear definition of medical artificial intelligence and high-risk systems, algorithm accreditation standards, regulation of fertilization centers, genetic data protection, and shared legal liability. Thus, the establishment of an independent national authority in every country in the world to oversee, approve regulations, monitor

¹³¹ Mohammed Al Makhmari, Ali Al-Hammouri, Tareq Al-Billeh and Abdulaziz Almamari, 'Criminal Liability for Misuse of Social Media in Omani and UAE Legislation', *International Journal of Cyber Criminology*, 18.2 (2024) 92-106 <https://cybercrimejournal.com/menuscript/index.php/cybercrimejournal/article/view/420/121>

¹³² Evangelina Mollar, and Mariano Sorrentino, 'Bioethics and Artificial Intelligence in Medicine: A Critical-Argumentative Approach', *The Journal of Healthcare Ethics & Administration*, 11.4. (2025), 38–47. <https://doi.org/10.22461/jhea.1.71653>

¹³³ Hamzeh Abu Issa, Mohammad Khater, Majd Almanasra, and Naji Al Wreikat, 'Common Belief vs. Science: Scientific Fallacies in Proving the Victim's Consent and Lies in Sexual Crimes', *Social Sciences and Humanities Open*, (2025). <https://doi.org/10.1016/j.ssaho.2025.102124>

¹³⁴ Perrine Ginod, and Michael H. Dahan, 'Preimplantation Genetic Testing for Polygenetic Conditions: A Legal, Ethical, and Scientific Challenge', *Seminars in Reproductive Medicine*, 14.2 (2024), 60-68.. <https://doi.org/10.1055/s-0044-1782618>

centers, and audit any complaints or violations. Activating the principle of transparency and rights so that patients can understand how algorithms work, providing options for evaluating embryos using traditional methods, and protecting embryos from discrimination based on non-medical traits.

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