Will Artificial Intelligence Change the Future of IVF?

"*Nothing is lost, nothing is created, everything changes*," says the famous chemist, Antoine Lavoisier. The same is true for Artificial intelligence (AI); everything touched by AI undergoes transformation. Therefore, this question arises whether AI is effective in assisted reproductive technologies (ART) as in other industries or not (1).

The global industry of IVF is predictable to grow by about 10% annually from $638 million in 2021 to $987 million in 2026. Increased age of first pregnancy, decline in fertility rates, prevalence of male infertility, obesity, alcohol consumption, public awareness of infertility, and development of several new treatment options are important factors in the growth of this market (2).

While most studies on humans and animals have been conducted with the aim of improving ART success, the rate remained almost constant at 30% with no noticeable change for a decade. AI as one of the greatest human discoveries of the present century can be used to improve IVF success rate. AI mimics human intelligence in medicine such as managing medical records and other data, performing repetitive tasks, designing treatments, providing digital counseling, virtual nursing, administration of medicine, designing drugs, utilizing precision medicine, and health monitoring and analysis of health care system. AI has the potential to overtake physicians and help them in prognosis and diagnosis of diseases more effectively, more accurately and more quickly (3, 4).

Artificial intelligence is the interface between humans and computers, while reproductive medicine is a combination of clinical medicine and embryology lab. The application of AI has the potential to create a distance between physicians and patients through computer algorithms. The term of Repro-AI is defined as the interdisciplinary technology between reproductive medicine and mathematical sciences to advance the applications of AI in the diagnosis and treatment of infertility.

In many areas of research, especially in the field of physics, a long time has elapsed before discovering the benefits of the new technologies and application of them in people's daily lives. However, the advantages of Repro-AI are perceptible in a shorter period of time. The efficiency of Repro-AI relies on continuous development and the use of powerful technologies such as automated time-lapse imaging, single-step culture, integrated digital and laboratory health data, and monitoring of environmental systems. Hopefully, some of these technologies are attainable in the near future, such as " laboratory on a chip" (IVF, ICSI, biopsy and freezing of embryo on fine chamber) and "DIY"(do-it-yourself) IVF cycles (1, 2).

The expansion of AI in reproductive sciences is so fast that it covers a wide range of procedures in IVF clinics, from assessment of couples' fertility to the success rate of IVF cycles. High-resolution image processing has been developed to interpret and analyze the quality of embryos for their correct grading and best selection. Therefore, the rate of implantation potential, ongoing pregnancy, and endometrial receptivity would be the highest for a synchronized dialogue between uterus and embryo (5).

In an IVF clinic, several obstacles should be overcome including managing large volumes of treatment data, tests, equipment and consumables used in various departments such as clinics, laboratories, operation rooms, consultation rooms, *etc*. AI and machine learning (ML) are much more effective in comparison to human power in intelligent management of all necessary information without the need for paper (1, 4).

Automation is one of the most important benefits of AI, which leads to increased productivity and efficacy. AI in embryology lab potentially helps to increase safety of gametes, embryos, patients, and staff. Moreover, infertility treatment can be standardized through automation and elimination of dreary, mental, manual, and time-consuming tasks such as embryo grading, semen analysis, embryo and oocyte cryopreservation, quality control, and quality assurance. The use of microfluidic systems and artificial intelligence-based robots can greatly contribute to embryo culture systems and the optimal use of culture media, chemicals, and plasticware (1, 2).

At present, embryologists spend a great deal of their time on the heavy and time-consuming work of the embryology lab, which prevents them from focusing on more important tasks such as intracytoplasmic sperm injection (ICSI), embryo biopsy, and training new embryologists and young staff. Unfortunately, there is a shortage of skilled and experienced embryologists worldwide, and their appropriate training requires a lot of time and effort under supervision of *seasoned senior embryologists or lab supervisors* (1, 2).

Despite significant advances in the IVF industry over the past 40 years, adoption of a common approach by inventers and users of Repro-AI technologies, universities, regulators, and professional groups will make incredible development in the infertility treatment industry. The Repro-AI will eventually provide quick and safe benefits to infertile patients (2, 4). Though the applications of AI in the embryology lab is more widespread in comparison to other areas, its use is likely to be expanded into other aspects of reproductive medicine in the near future. Extensive use of AI for correct assessment of infertile couples' characteristics such as their ovarian reserve, status of spermatogenesis and sperm parameters, age, endocrine status and diagnostic tests will undoubtedly increase the efficiency and speed of diagnosis and subsequent treatment of all reproductive disorders (5). Despite huge reports regarding the bright and growing future of AI in all aspects of human life, AI has opponents and critics, such as the leading physicist Stephen Hawking, who warned of AI: "*The development of full artificial intelligence could spell the end of the human race…. It would take off on its own, and redesign itself at an ever increasing rate. Humans, who are limited by slow biological evolution, couldn't compete, and would be superseded*" (1).

All in all, notwithstanding the entire benefits and criticisms of AI, there is great hope that AI can reform and improve all aspects of our life, including medicine and particularly IVF-related issues. The current challenge of AI is its different methods and algorithms on different platforms. Therefore, the generalizability of AI algorithms is currently limited to the population or clinic for which the platform is designed. In other words, the minimum necessary standards for its application have not yet been prepared to apply the technology to the whole community. Accordingly, despite the current satisfactory results of AI, it is necessary to be cautious about using the technology and wait for its development in the future. Perhaps the future will prove us that it was another creation of technology developers which is released ahead of time, and maybe it would be more advisable that human beings exert their best efforts to improve their intelligence instead of AI.

References

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