Chapter 1
Basics of Artificial Intelligence for Assisted Reproductive Technologies

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ABSTRACT

In the field of assisted reproductive technologies (ART), each cycle brings high cost and long-term clinical and laboratory studies. In order to eliminate the negative effects of this process on families, the necessity of standardized ART protocols that can be applied to each individual with low cost and fast results is essential. Although artificial intelligence has the potential to respond strongly to this need, the integration of artificial intelligence into ART is slower compared to other branches of medicine. Increasing understanding of artificial intelligence by researchers will accelerate this integration. In order to understand and be able to use artificial intelligence, this chapter will first discuss the conceptual confusion in artificial neural networks, deep learning, machine learning, and artificial intelligence. Finally, gaps will be filled with artificial intelligence-related application areas and examples in ART.

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INTRODUCTION

Infertility is one of the chronic health problems that affects more than 50 million couples in the world and causes economic and social concerns at the global level (Boivin et al., 2007; Bushnik et al., 2012; Ombelet et al., 2008). Assisted reproductive technologies (ART) offer many couples a great opportunity to have children.

The ultimate goal in ART is the delivery of a healthy baby. In this process, oocytes are collected from the patient by induction of ovulation in female patients who are unable to obtain oocyte by natural means (OPU). Retrieved oocytes are subjected to morphological quality classification by the embryologist. The maturation of oocytes with a high probability of development is followed microscopically. At this stage, in vitro insemination (IVI) or intracytoplasmic sperm injection (ICSI) may be considered, or cryopreservation of oocytes may be planned for use at the appropriate time. On the other hand, the semen sample obtained from the male individual is examined microscopically and the sperms with the highest fertilizing capacity are selected. In eligible patients, ICSI is performed with the highest quality oocyte and sperm with the highest fertilization capacity. Embryo transfer (ET) is considered for those with the best development after ICSI. The process continues with pregnancy follow-up after implantation. In any of these stages, it is possible to cryopreserve sperm, oocyte or embryos until the date of use. Time-lapse video microscopes, one of the state-of-the-art products, have contributed greatly to the acceleration of microscopic follow-up stages (Gallego et al., 2019). The common point of all these is that there is a great effort is usually made to "choose the best" in ART. For this reason, it is an undeniable fact that the main purpose of establishing selection criteria is to choose the one closest to "perfect" (Gökhan et al., 2020)

Traditionally, IVF procedures have steps where embryologists identify and classify cells or tissues based on their own experience. It is desired that this process, in which the samples with the highest probability of producing viable and healthy babies are determined with great sensitivity, to be carried out in a standard, reproducible and rapid manner. Based on this need, AI, the leading product of today's developing technologies, has begun to be integrated into these processes. The goal of integrating AI into ART is to achieve results with high speed and great accuracy in human-dependent processes (Rosenwaks, 2020).

AI has the potential to provide a great time and economic gain by mimicking the traditional ART process objectively and rapidly, deriving from the medical knowledge possessed by embryologists. In this way, the decline in birth rates will be prevented and the psychological and economic difficulties experienced by families will be minimized in the process that operates in a self-contained and standardized manner. However, the integration of AI into ART is somewhat slower than in other branches of medicine, and this integration still needs improvement (Khosravi et al., 2019).

In order to understand and use AI, this section will first focus on the descriptions of AI and its components, artificial neural network (ANN), deep learning (DL), and machine learning (ML). Then, gaps will be filled with AI application examples in ART.

ARTIFICIAL NEURAL NETWORKS

Technology has become more and more important in our daily lives. As this makes life easier, demand by consumers is increasing, and thus the variety of services offered by companies is increasing (Kilic, 2023). Today, we experience examples of AI such as facial recognition, handwriting recognition, transcription of speech in a video, spam debugging in emails. In order to provide this diversity, computational systems