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Research Article

Artificial intelligence: Can help Minimize Poor Outcomes and Challenges in Gynecology and Obstetrics?

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Abstract:

Background: Artificial intelligence (AI) and Machine Learning (ML) have been the subject of discussion among many professionals, researchers, and managers working in the fields of gynecology and obstetrics.

Objective: This work aims to review the role of Artificial intelligence in minimizing poor outcomes and challenges in gynecology and obstetrics.

Results: Recently, the use of AI has gained traction in its ability to predict clinical outcomes using routinely obtained information, such as patient attributes, medical images, and blood test results. However, AI in healthcare systems requires collaboration and training among the partners for successful implementation. In conclusion, AI has become one of the significant components of life today and so is its requirement in medicine, especially in digital medicine. We conclude that AI has an important future in improving IVF success.

Keywords: artificial intelligence; gynecology and obstetrics; Fetal Echocardiography; poor outcomes

Introduction

Artificial intelligence (AI) is a branch of computer science that aims to create machines or systems that can perform tasks that normally require human intelligence, such as learning, reasoning, perception, decision-making, or natural language processing **(Figure 1).** AI has been widely applied in various fields of medicine and healthcare, such as disease diagnosis, drug discovery, patient risk assessment, and personalized treatment **(Rajpurkar et al., 2022)**. AI has been revolutionizing discovery, diagnosis, and treatment designs in various fields of medicine, including gynecology **(Brandão et al., 2024)**. AI can aid in the detection of gynecological disorders, therapy design, and identification of new therapeutic targets by accelerating drug discovery, and improving treatment outcomes **(Li et al., 2021)**. Artificial Intelligence, machine learning, deep learning, and neural networks are some of the terms often used to describe the use of advanced computational methods to analyze large and complex data sets, such as those generated by clinical research, **(Gupta et al. 2021)**. This technology has been actively used in gynecology and obstetrics (GYN/OB) and is now merged into daily medical practice. Various problems can arise during the diagnosis of a disease and AI helps to overcome those problems. AI can be a promising tool to resolve many challenges **(Prabha, 2024)**.

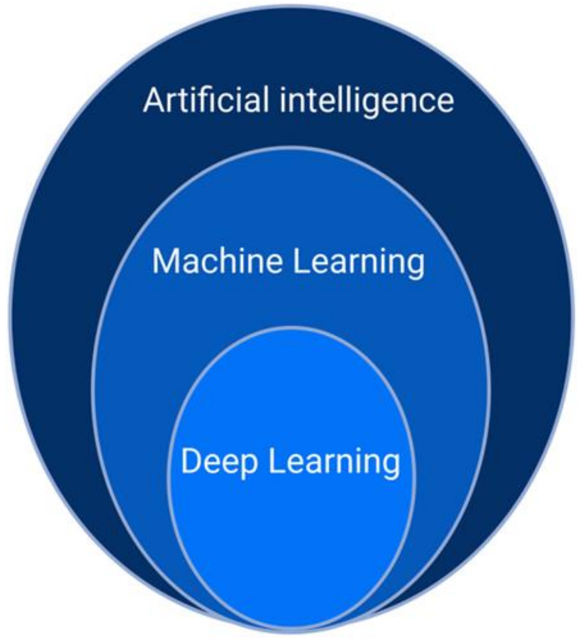


Figure 1. Hierachy of information processing theories in the computer science field. Artificial intelligence (AI) is an umbrella term attributed to the primary objective within the field of computer science to develop machines with intelligence. Machine learning describes approaches to achieve AI that learns from experience without explicit programming. Deep learning is a form of machine learning that utilizes artificial neural networks to extract, process, and predict information by learning from examples. It is commonly applied in the scientific field in image classification.

The need for the nexus of AI in obstetrics and gynecology

Obstetrics and gynecology are the debatable specialties that account for indemnity payments due to negligence claims. Besides litigation costs, socioeconomic consequences on a long-term basis due to medical errors have become detrimental **(Vickers and Jha, 2020)**. Hypoxia-induced encephalopathy has become the most common confrontational event due to intrapartum fetal misinterpretation, which can be partially preventable. In addition, numerous poor outcomes and challenges have been recounted in gynecology, which is witnessed in gynecological oncology, where failed detection and prognosis of malignancy have been a major concern **(Williams et al., 2019; Dillon et al., 2022)**. The conventional methodologies are considered inadequate in proffering treatment stratification on an individualized basis with various limitations. Infertility treatment has remained a major concern with traditional approaches. Thus, AI-assisted IVFs are instances of surging demands of AI in obstetrics and gynecology for enhanced success rates in treatment **(Liu et al., 2020; Mapari et al., 2024)**.

In addition, the rapid markup of advancements in genetic engineering in IVF practice raised the need for AI to enhance precision. Traditional methods have always been the most important tool in addressing healthcare issues among women through evidence synthesis, clinical trials, etc. Nevertheless, the gray areas present within the traditional approaches have been the reason for failure in providing appropriate solutions in clinical practices. Thus, AI has become one of the significant components of life today and so is its requirement in medicine, especially in digital medicine **(Ahmad et al., 2021)**. This lies in the fact that the progression of precision techniques has enabled accurate predictions in the healthcare domain as AI-based algorithms assist in meeting diagnostic challenges such as performance and efficiency in clinical services **(Kalra et al., 2024)**. These algorithms also improve clinical attentiveness in monitoring and treating complex diseases, controlling infections, etc. This shows that there is a clear need for the intervention of AI in obstetrics and gynecology **(Malani et al., 2023)**.

Evolution and progress of AI in medicine

In the recent decade, there have been copious discussions about the AI position in the medicinal field, particularly focusing on big data management, assessment of algorithms, and medicolegal problems. The US Food and Drug Administration (FDA) has already endorsed various AI algorithms for the benefit of physicians and patients, and different organizations worldwide have followed the initiatives of the FDA **(Bhattad and Jain, 2020)**. The applications of AI have assisted medical professionals and doctors in different domains, such as health information systems, syndromic and epidemic surveillance, geocoding of healthcare data, medical imaging, predictive models, and decision support systems **(Jain et al., 2024)**. The AI system can provide health professionals with medical information with consistent and continuous real-time updates sourced from different textbooks, journals, clinical patients, and practices, which enables sophisticated and enhanced patient care and assists necessary inference for health outcomes prediction and health-risk assessment, specifically contributing to the field of gynecology and obstetrics **(Drukker et al., 2020)**. The evolution of big data as an input to AI in the field of obstetrics and gynecology is shown in **Figure** 2.

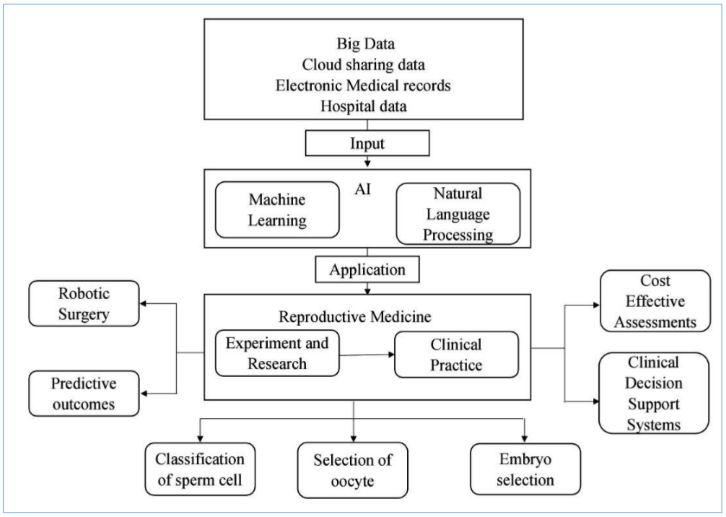


Figure 2. Role of AI in reproductive medicine **(Malani et al., 2023)**.

Applications of artificial intelligence in obstetrics

1- Diagnostic imaging and interpretation

AI is no longer a temporary social phenomenon or a topic only for specific scientific fields. Instead, it is a technical field that can help in improving diagnosis, treatment strategy, and clinical outcomes and overcoming various problems related to diagnosis even in the obstetric field. AI systems currently used for obstetric diagnostic purposes, such as fetal cardiotocography, ultrasonography, and magnetic resonance imaging, and demonstrates how these methods have been developed and clinically applied **(Sarno et al., 2023)**.

Fetal Cardiotocography

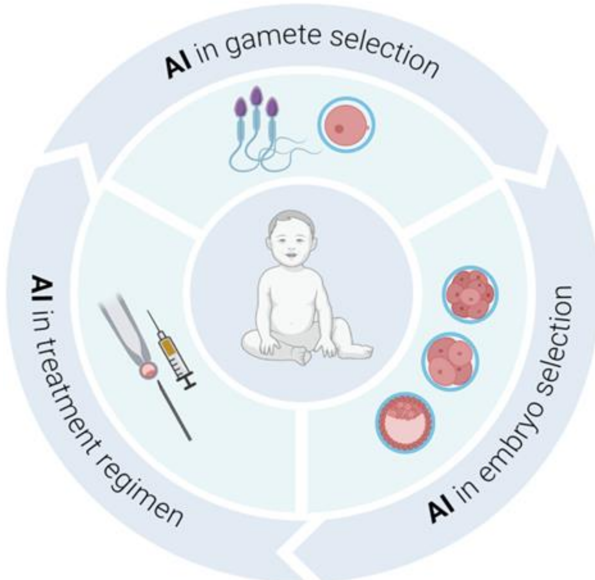
Cardiotocography (CTG) was an early development in the field of obstetrics. CTG is the most important device for evaluating fetal well-being through measurements of the fetal heart rate and uterine contractions **(Ahmed et al., 2024)**. The fetal heart rate pattern reflects fetal cardiac and central nervous system responses to hemodynamic changes. To overcome limitations in the interpretation of CTG by humans, AI using modern computer systems has been applied to CTG interpretation, and many experiments are underway **(Salini et al., 2024)**. A recent systematic review concluded that machine learning interpretation of CTG during labor did not improve neonatal outcomes in terms of neonatal acidosis, cord blood pH <7.15–7.20, 5-minute Apgar score <7, mode of delivery, neonatal intensive care unit admission, neonatal seizures, or perinatal death, and had limited reliability compared to experts **(Balayla and Shrem, 2019)**. A plausible reason for the limited efficacy is that the training for ML models of CTG was based on human interpretation. Therefore, an alternative approach that does not include human interpretation or guidelines in system development has been investigated in the context of feature engineering theory **(Kim et al., 2022)**.

Ultrasonography

One safe, noninvasive technique for diagnosing pregnancies is US. Yet, despite its broad application, it can be challenging to obtain accurate readings in particular situations, including motion distortions, hazy borders, acoustic shadows, low signal-to-noise ratio, maternal obesity, and speckle noise, which make precise readings challenging **(Benacerraf et al., 2018)**. ML has been used for several years to help with the automatic recognition and distinction of different fetal body parts through algorithms on US images of fetuses. Algorithms for obtaining and measuring biometric data and fetal features from US pictures have been developed in several research studies **(Yousefpour et al., 2023; Fiorentino et al., 2023)**. For the time being, there is a semi-automated application for interpreting fetal ultrasonography; if a sonographer or doctor chooses the right pictures of each body component, the program employs an AI algorithm to automatically generate body measurements. Many businesses are getting ready to offer services relating to this technology, which is already in use. For example, automated standard scan planes have been established for quantifying fetal biparietal diameter and head circumference using three-dimensional transthalamic plane US pictures and two-dimensional transventricular US images of the fetal brain **(Grandjean et al., 2018; Han et al., 2024)**. Further studies have demonstrated the efficacy of ML in recognizing embryonic organs and structures, which helps diagnose congenital anomalies **(Burgos-Artizzu et al., 2019; Burgos-Artizzu et al., 2020)**.

Fetal Echocardiography

Fetal echocardiography (ECG) has only been used for 15 years; nonetheless, this imaging modality is essential for perinatal care in that it is very useful for diagnosing and monitoring intrauterine growth restriction, twin-to-twin transfusion syndrome, and congenital heart anomalies **(Edwards and Arya, 2024)**. Monitoring fetal cardiac function with US is challenging due to involuntary movements of the fetus, the small fetal heart, the fast fetal heart rate, limited access to the fetus, and the lack of experts in fetal echocardiography. Automatic calculation of the fetal heartbeat has been carried out in many studies that have extracted the fetal heart rate from CTG using dimensionality reduction or measured fetal QRS complexes from maternal ECG recordings using ANN and pulse-wave Doppler envelope signals extracted from B-mode videos **(Sulas et al., 2021; Mertes et al., 2022)**. For cases with congenital heart anomalies, an intelligent navigation method referred to as "fetal intelligent navigation echocardiography (FINE)" was developed and this can detect four types of abnormalities **(Weichert et al., 2023)**. Arnaout et al. demonstrated a deep learning method identifying the five most essential views of the fetal heart and segmentation of cardiac structures. They found that hypoplastic left heart syndrome was the most frequently distinguished anomaly compared to normal structures and tetralogy of Fallot at the gestational age of 18 to 24 weeks (**Arnaout et al., 2021)**.



MRI Interpretation

AI aids in interpreting MRI scans for conditions like endometriosis, fibroids, and ovarian tumors. AI-driven image analysis helps differentiate between benign and malignant masses, thereby aiding in early and accurate diagnosis. In obstetrics, MRI is a subject of active research alongside US. MRI is frequently used to distinguish various fetal brain conditions and evaluate the severity of placenta previa **(Patel et al., 2019)**. For example, a particular study involved the automated extraction and analysis of fetal brain structures from MRI scans of 45 pregnant women, including automated volume measurements **(Khalili et al., 2019)**. Another study utilized various AI techniques to analyze 59 MRI scans of fetuses with ventriculomegaly, predicting the need for postnatal interventions like cerebrospinal fluid diversion with 91% accuracy. This demonstrates AI's potential in diagnosing conditions using MRI and predicting necessary treatments **(Pisapia et al., 2018; Ghaffar et al., 2023)**.

Role of AI in the IVF clinic

AI will likely demonstrate utility in several facets of the IVF procedure. Below, we discuss some of the more recent literature on the use of AI in gamete and embryo selection as well as the development of a treatment regimen **(figure 3).** Adopting AI within the fertility clinic could lead to a major increase in IVF success. For example, AI could potentially aid the embryologist in providing rapid, objective, and accurate assessment of gamete and embryo health **(Chow et al. 2021).** AI may also aid physicians in formulating an optimal, personalized fertility treatment plan based on patient characteristics. AI, using routinely generated images or time-lapse videos, may objectively and accurately grade and rank embryos, thus assisting in transferring or freezing them **(Fernandez et al. 2020).**

Figure 3. Emerging role of artificial intelligence (AI) in the *in vitro* fertilisation (IVF) clinic. AI represents an opportunity for technological advancement to improve IVF success. It is multifaceted in its capability. For example, AI may aid in selecting the best oocyte and sperm combination as well as predicting embryo quality. Furthermore, AI may assist the clinician in developing an optimal patient-specific treatment regimen to improve IVF success.

Further, AI may have a role in analyzing data from non-invasive metabolomic and secretory profiles from the embryo during culture. Consequently, this may lead to improved culture media formulations and regimens. In the IVF clinic, decision-making for an IVF cycle regimen is guided by patient age, gamete quality, medical history, and many more **(Wang et al. 2019).** This process intends to maximize the chances of pregnancy and birth of a healthy baby. From patient to patient, an IVF cycle might thus differ in stimulation protocol and mode of fertilization (IVF vs intracytoplasmic sperm injection) as well as the potential for other procedures including assisted hatching and preimplantation genetic testing, amongst others **(Vollset et al. 2020).** Despite the challenges, it is undeniable that AI has a future role in the IVF field. However, AI must overcome hurdles before its utilization. AI requires extensive simulation studies, publication in peer-reviewed journals, and rigorous validation in numerous clinics and different patient populations **(Benjamens et al. 2020).**

Others

Estimating gestational age and predicting preterm birth, aneuploidy, and asymptomatic short cervical length have been investigated using machine learning algorithms **(Safiullina et al., 2023)**. An effective system was developed for predicting fetal brain abnormality. A recent systematic review demonstrated that a model for the prediction of prematurity using the support vector machine technique performed best among 31 studies analyzed, with an accuracy of 95.7% **(Bertini et al., 2022)**. Deep learning-based automatic measurement programs for parameters indicating the progression of labor (e.g., the angle of progression) are currently applied **(Lu et al., 2022)**. AI-based programs have advantages in terms of obtaining more objective results and may be helpful for parameters that are clinically important but may have errors between measures. For example, measurements of amniotic fluid are susceptible to errors between measurements, which can affect treatment decisions, and AI-based programs that can automatically measure these items are being developed **(**Figure 2**)**, **(Kim et al., 2022)**. A recently published paper reported that an automated method based on deep learning was very useful for measuring amniotic fluid **(Cho et al., 2021)**. In addition, AI-based programs can be helpful for measurements that require evaluators to be fully trained and experienced, such as nuchal translucency, and these techniques may be combined with a robot arm that performs the scanning to automatically extract standardized fetal imaging views **(Nie et al., 2017)**.

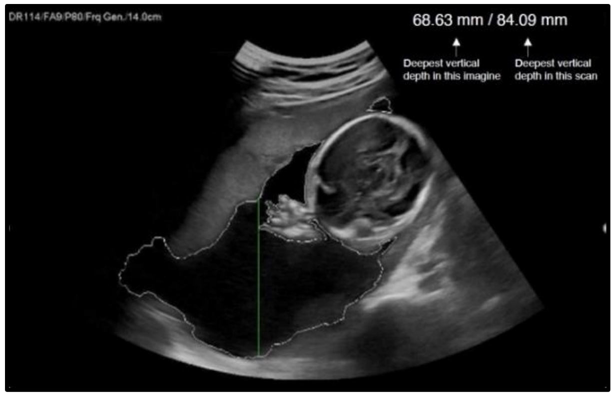


Figure 2: Artificial intelligence–based automatic amniotic fluid measurement program using deep learning. The amniotic fluid part is automatically extracted from the given image and the deepest vertical depth of the amniotic fluid part; that is, the amniotic fluid index is automatically calculated **(Kim et al., 2022)**.

Predictive analytics and risk assessment

Preterm Birth Prediction

AI is emerging as a promising tool to tackle this complex issue by enabling early prediction, personalized risk assessment, and improved management strategies **(Ganesh and Kalpana, 2022)**. By integrating multiple variables, AI models can predict the likelihood of preterm birth more accurately than traditional methods, aiding in the early identification of high-risk pregnancies. AI-powered analysis of biological markers (e.g., cytokines and cervical length) and imaging techniques (e.g., US and MRI) enhance the assessment of maternal-fetal health. Algorithms interpret subtle changes in biomarkers and imaging data to detect early signs of preterm labor or complications such as cervical insufficiency, providing clinicians with actionable insights for proactive management **(Lee and Ahn, 2020)**. AI-driven fetal monitoring systems analyze real-time data from sensors and monitors to assess fetal well-being. These systems detect deviations from normal fetal patterns, such as heart rate variability or uterine contractions, prompting timely interventions to prevent preterm labor or optimize neonatal outcomes. Models analyze various factors, including maternal age, medical history, and biomarkers, to predict the risk of preterm birth. Early identification allows for timely interventions to prevent or manage preterm labor **(Patel et al., 2024)**. AI models, such as those developed using neural networks and random forest algorithms, have demonstrated superior accuracy in predicting preterm birth by analyzing data from EHRs, including maternal demographics, medical history, and prenatal test results. These models can identify subtle patterns and interactions between variables that are often missed by conventional methods **(Figure 3), (Vaidya et al., 2024)**.

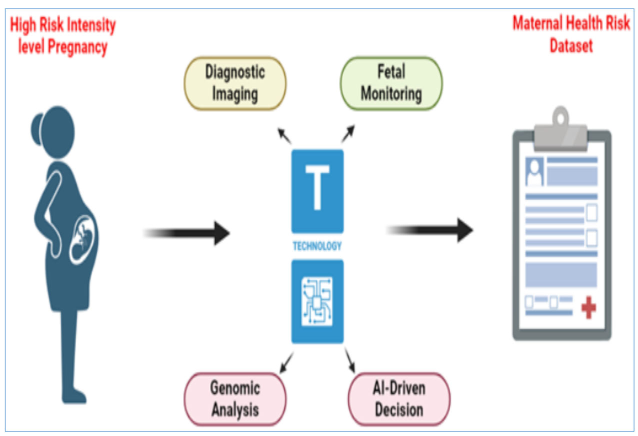


Figure 3: AI method to predict maternal health during pregnancy and health risk prediction **(Vaidya et al., 2024)**.

Preeclampsia

AI algorithms utilize maternal health data to identify women at high risk of developing preeclampsia, facilitating closer monitoring and early detection **(Mapari et al., 2024)**. AI-enhanced imaging techniques aid in assessing placental health and blood flow, which are critical in managing preeclampsia and ensuring optimal fetal growth **(Jost et al., 2023)**. AI algorithms analyze extensive datasets, incorporating maternal demographics, medical history, biochemical markers (e.g., serum levels of angiogenic factors like sFlt-1 and PlGF), and imaging data (e.g., Doppler US of uterine arteries). These models identify patterns and factors associated with preeclampsia risk, enabling the early identification of high-risk pregnancies **(Aljameel et al., 2023)**.

Gestational Diabetes

AI technologies are being explored and implemented to enhance the detection, monitoring, and management of gestational diabetes mellitus (GDM), offering promising avenues for improving outcomes for both mothers and babies **(Khan and Khare, 2024)**. Large patient data sets can be analyzed by ML algorithms to find risk factors linked to the development of GDM. To estimate the chance of GDM starting, these algorithms can incorporate clinical information such as the mother's age, BMI, prior obstetric history, and glucose levels **(Belsti et al., 2023)**. By identifying high-risk pregnancies earlier, healthcare providers can intervene promptly with preventive measures and personalized management plans. AI also plays a crucial role in continuous glucose monitoring and management. Advanced AI algorithms can analyze real-time data from continuous glucose monitors worn by pregnant women with GDM. These algorithms can detect patterns and trends in glucose levels, providing timely insights to both patients and healthcare providers **(Daley et al., 2022)**.

Applications of AI in Gynecological Disorders

Gynecological Oncology

AI in gynecological oncology is the use of artificial intelligence (AI) to perform tasks that are related to the diagnosis, treatment, and prognosis of gynecological cancers, such as cervical, uterine, and ovarian cancers **(Gandotra et al., 2024)**. AI can help improve the efficiency, accuracy, and quality of various processes and outcomes in the gynecological oncology field. AI can help with screening and diagnosis, such as analyzing medical images, detecting lesions, recommending biopsies, and classifying tumors **(Hunter et al., 2022)**. AI can also help with risk assessment, such as predicting the likelihood of developing or having gynecological cancers based on genetic, environmental, and lifestyle factors. This can enhance the early detection and prevention of gynecological cancers. AI in recent times has revolutionized treatment and prognosis, such as creating personalized treatment plans, recommending drugs, optimizing dosages, and monitoring responses **(Rajkomar et al., 2019)**.

1- Ovarian Cancer

AI is a powerful technology that can help in the diagnosis of ovarian cancer, which is a challenging and deadly disease. AI can analyze various types of data, such as blood tests, patient background, imaging tests, and genomic sequencing, to identify the features, subtypes, and complications of ovarian cancer. AI can also provide interactive and tailored information to patients and clinicians through chatbots or virtual assistants. Here are some examples of the role of AI in the diagnosis of ovarian cancer. AI can predict the pathological diagnosis of ovarian tumors using patient information and data from preoperative examinations **(Akazawa et al., 2020; Xu et al., 2022)**. AI can enhance ovarian cancer diagnostics by integrating multiple data sources and using deep learning methods **(Hatamikia et al., 2023)**. A recent study revealed how AI can aid in the diagnosis of ovarian cancer to improve patient outcomes. The study used a deep learning framework to analyze data from clinical records, pathology reports, immunohistochemistry results, gene expression profiles, and copy number profiles of 768 ovarian cancer patients. The framework was able to classify the patients into four subtypes of ovarian cancer with high accuracy and consistency **(Farahani et al., 2022)**.

AI can discover new biomarkers for ovarian cancer using image analysis techniques. A study applied AI methods to ovarian cancer, pancreatic cancer, and image biomarker discovery **(Boehm et al., 2022)**. One of the applications of AI in biomarker discovery is for ovarian cancer, which is a rare but lethal disease that often lacks early symptoms and detection **(Li et al., 2021)**. Ovarian cancer has a high mortality rate, with only about 47% of patients surviving 5 years after diagnosis. Biomarkers can help improve the diagnosis, prognosis, and treatment of ovarian cancer by providing information about the molecular characteristics of the tumor, the response to therapy, and the risk of recurrence **(Kawakami et al., 2019; Laios et al., 2021)**.

AI can also improve the prognosis and treatment of ovarian cancer by using genomic analysis or natural language processing to detect the molecular subtypes or biomarkers of ovarian cancer from endometrial samples or electronic health records **(Bahado-Singh et al., 2022)**. AI can also optimize the treatment of ovarian cancer by using reinforcement learning or decision support systems to recommend the best drug regimen or alternative therapy for each patient based on their molecular profile and clinical characteristics **(Asante et al., 2020)**. Reinforcement learning is a subfield of AI that involves creating algorithms that can learn from their own actions and rewards in an environment and optimize their behavior to achieve a goal **(Beer et al., 2021)**.

2- Cervical Cancer

Artificial intelligence (AI) has improved cervical cancer diagnosis and treatment in several ways. AI can help automate the evaluation of dual-stain tests, which measure the presence of two proteins (p16 and Ki-67) in cervical samples to predict the risk of precancer **(Boon et al., 2022; Ouh et al., 2024)**. This can reduce the time and cost of screening, as well as increase the accuracy and efficiency of diagnosis. AI can also help analyze images of cervical cells or tissues, such as Pap cytology or histopathology, using complex algorithms that can automatically recognize, extract, and classify features **(Li et al., 2020)**. This can improve the sensitivity and specificity of detecting precancerous or cancerous changes and reduce the variability and subjectivity of human interpretation **(Yang et al., 2023)**. Artificial intelligence (AI) is a powerful tool that can help in the discovery of novel biomarkers for cervical cancer. Biomarkers are biological indicators that can be used for the diagnosis, treatment, and prognosis of cervical cancer **(Aswathy et al., 2024)**. AI can analyze large and complex data sets generated by high-throughput omics technologies, such as genomics, transcriptomics, proteomics, and metabolomics, and identify patterns and associations that are relevant for cervical cancer **(Zhang et al., 2024)**. AI can also assist in screening and diagnosis by analyzing digital images of the cervix and detecting precancerous changes that require medical attention **(Dellino et al., 2024)**.

A machine learning model based on support vector machines (SVMs) was able to identify several microRNAs (miRNAs) as a biomarker for cervical cancer **(Ding et al., 2021)**. The model used gene expression data from The Cancer Genome Atlas (TCGA) and achieved an accuracy of 93.3% and an AUC of 0.98 **(Balakittnen et al., 2024)**. AI can use natural language processing (NLP) to extract relevant information from clinical records and literature to identify potential biomarkers for cervical cancer **(Gholipour et al., 2023)**. Deep learning and machine learning can help create personalized treatment plans for cervical cancer patients by analyzing their genetic information, such as gene expression, mutation, or methylation. These data can be used to identify biomarkers that can indicate the prognosis, response, or resistance to certain drugs or therapies **(Alharbi and Vakanski, 2023)**. AI and deep learning technology have been extensively used in analyzing genomic data for targeted therapy in cervical cancer. Genomic data can help in cervical cancer treatment by identifying the molecular profiles of different tumors and finding potential targets for therapy **(Ma et al., 2022)**.

Gynecological Hormonal Disorder

AI can help diagnose, treat, and prevent various diseases, including gynecological hormonal disorders **(Agrawal et al., 2022)**. Gynecological hormonal disorders are conditions that affect the female reproductive system and are caused by an imbalance of hormones. Some examples of gynecological hormonal disorders are polycystic ovary syndrome (PCOS), endometriosis, uterine fibroids, and menopause **(Bulun et al., 2019)**.

1- Endometriosis

Endometriosis is characterized by the presence of endometrial-like tissue outside the uterus, which can cause inflammation, adhesions, scarring, and infertility **(Rathod et al., 2024)**. AI has the potential to improve the diagnosis and treatment of endometriosis by analyzing different types of data, such as biomarkers, clinical variables, genetic factors, imaging data, and lesion characteristics. AI can also help to understand the underlying mechanisms and risk factors of endometriosis, as well as to predict the outcomes and responses to different therapies **(Giudice et al., 2023, Avery et al., 2024, (Bendifallah et al., 2022)**. By integrating AI, three-dimensional cultures and organ-on-chip models, it is possible to achieve better understanding of physiopathological features and better tailored effective treatments, thereby helping to overcome some of the limitations of current animal models and cell lines in mimicking the complexity and heterogeneity of endometriosis **(Deng et al., 2024)**. Machine learning techniques can be used to predict endometriosis based on previous records as well as genetics and epigenetics. A previous study used machine learning classifiers such as decision tree, partial least squares discriminant analysis, support vector machine, and random forest to analyze transcriptomics and methylomics data from endometriosis and control samples. The study identified several candidate biomarker genes such as NOTCH3, SNAPC2, B4GALNT1, SMAP2, DDB2, GTF3C5, PTOV1, TRPM6, RASSF2, TNIP2, RP3-522J7.6, FGD3, and MFSD14B1 **(Akter et al., 2019)**. AI can potentially help in various aspects of diagnosis, treatment, and management of endometriosis and its associated symptoms **(Kiser et al., 2024)**. AI can use various types of data, such as clinical, imaging, genetic, or molecular, to create predictive models that can help clinicians tailor the best treatment option for each patient. AI has a high accuracy and performance in predicting the response to treatment of endometriosis, especially when using multiple data sources or multimodal datasets **(Qi et al., 2024)**.

2- Polycystic Ovarian Syndrome (PCOS)

Polycystic ovary syndrome (PCOS) is a hormonal disorder that affects millions of women around the world. It causes various physical and psychological symptoms, such as excessive body hair growth, irregular menstrual cycles, acne, obesity, infertility, and insulin resistance **(Zeng et al., 2022)**. One of the main applications of AI in PCOS is the detection and diagnosis of the syndrome using various methods, such as machine learning, deep learning, fuzzy logic, and computer vision **(Khanna et al., 2023)**. These methods can analyze different types of data, such as clinical features, hormonal levels, ultrasound images, scleral images, and genetic markers, to identify PCOS patients and classify them into different phenotypes. AI can also help in predicting the risk of PCOS and its associated outcomes, such as metabolic syndrome, depression, anxiety, and quality of life **(Verma et al., 2024)**. AI can help personalize the treatment of PCOS by considering the patient's characteristics, preferences, and goals. For example, a study used reinforcement learning to optimize the dosage of metformin, a common drug for PCOS, based on the patient's weight, insulin sensitivity, and ovulation status **(Guixue et al., 2023)**. AI can help provide emotional support and guidance for women with PCOS who may experience psychological distress, such as depression, anxiety, and low self-esteem **(Wang et al., 2023)**. For example, a study by used natural language processing to create a chatbot that can deliver cognitive behavioral therapy (CBT) for women with PCOS **(Gbagbo et al., 2024)**. Another study used machine learning to design a mobile app that can provide psychoeducation and relaxation techniques for women with PCOS **(Prapty and Shitu, 2020)**.

Gynecological surgery

In surgery, the application of physical AI has been utilized more than virtual AI. Virtual AI uses established patient factors, repetitive patterns, and treatment algorithms to predict the outcome, as opposed to the surgical field, which has many independent variables. Some of these variables are the consistency of different tissues, the skills of each surgeon, the changes that are done in the surgical field while operating, and unique differences between patients and their pathology; ultimately, these unique factors make it challenging to create an algorithm **(Moawad et al., 2019)**. Areas in which AI has assisted gynecological surgery include those related to imaging and spatial awareness. AI can aid the surgeon by providing better imaging before and during surgery **(Gumbs et al., 2021)**. The creation of three-dimensional printing (3DP) that replicates the surgical site is far superior to its two-dimensional (2D) counterpart, as it represents a more precise version of the actual model **(Meyer-Szary et al., 2022)**. This allows a more accurate preoperative plan, hence diminishing errors in the operating room. 3DP can also provide different materials that can resemble the tissues that would be encountered, thus providing realistic practice for trainees and unprecedented preoperative planning **(Iftikhar et al., 2020, Kannaiyan et al., 2024, Iftikhar et al., 2020)**.

AI has also helped decrease operative time and accuracy, which subsequently decreases operative complications **(Iftikhar et al., 2024)**. This has been done via the utilization of augmented reality. Augmented reality consists of a computer that can reconstruct objects taken from the real-world and enhance them virtually to create a more informative visual image **(Vávra et al., 2017)**. One review of augmented reality in surgery summarizes some of the shortcomings of this technology, such as increased cost, concern for a latency of the system, and that the head-mounted display is heavy and impractical for long surgeries **(Dirie et al., 2018)**. Furthermore, augmented reality might cause nausea and vomiting due to "simulator sickness," which would be less than ideal during surgery. Augmented reality might also demonstrate too much information and increase clutter, thus distracting the surgeon from the task on hand, and would be most helpful in an immobile structure so mobile organs (like the uterus) are not ideal for this technology. Despite certain disadvantages, it was concluded that there are positive benefits to augmented reality, such as increased precision, safety, and a time reduction in performing procedures **(Iftikhar et al., 2020)**.

Conclusion

There is still a very long way to go until AI-based technologies become perfectly integrated into everyday clinical decisions. AI has been developed as the most significant area in various industries, resulting in incredible potential. The streamlined efficiency and predictive performance related to disease diagnosis using AI, chiefly in clinical imaging errands, are equivalence with or even exceed that of doctors, and they are capable of the benefits of being determined and ensuring stable characteristics. AI has attained equivalent performance with that of medical experts in a particular medical sector, and obstetrics and gynecology are among them. Thus, with technological development and interdisciplinary incorporation, AI could propose much more in obstetrics and gynecology. However, more research studies are needed to attest to the usefulness of this technology in real life. The developments until this moment have been tremendous, and even more are expected over the next few years.

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