The Role of Artificial Intelligence in the Diagnosis and Treatment of Gynecological Malignancies

Mahshad Ashrafpour *[1], Arezo Bahramiakbari[2]

1,2. School of Health Sciences, University of Georgia, Tbilisi, Georgia.

*Correspondence to:** Mahshad Ashrafpour, School of Health Sciences, University of Georgia, Tbilisi, Georgia

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Abstract

Introduction: *Gynecological malignancies are among the top ten most common cancers in the female population. There are multiple screening tests for some gynecological cancers but still, the diagnosis and treatment of some of them would be problematic. In recent years, the use of Artificial Intelligence (AI) has upgraded the diagnosis and treatment methods of gynecological cancers. AI-powered systems and algorithms can analyze medical images precisely and diagnose malignant lesions that may stay unnoticed. Multiple samples from patients would be presented to an AI-powered system, then it analyzes precisely all those samples and specifies the abnormalities that a be seen may not see. Also, AI can suggest diverse treatment options based on the patient's condition, analyze a patient's genetic profile, and tumor characteristics, and based on them suggest a personalized treatment option.*

Methods: *We searched two online databases- PubMed, and Cochrane Library- for papers dated between 2015-2024. We used "Artificial intelligence", "Ovarian cancer", "Cervical cancer" and "Gynecologic oncology" as our keywords which gave us a large number of articles. Then we filtered them by their type of study and free full text. In total 57 relevant articles were found among them we chose 10 articles which were reviews and, cohort studies. We chose the ones that were conducted in different geographical areas so the results would be reliable.*

Results: *The results of this study demonstrate that AI-powered systems can diagnose gynecologic cancer earlier than physicians and even can correct errors. The accuracy of AI in the diagnosis of ovarian cancer is 97.2% and in cervical cancer is 90%, it also makes a distinction between cancerous and normal Pap smears with 80–100% accuracy which makes it a reliable source of data analysis.*

Conclusion: *This review highlights that AI helps physicians with the detection and treatment of gynecologic cancers and even pre-cancerous lesions. AI could be used as a helpful tool for interpretation of smears and images. It would suggest personalized treatment protocols according to the data that is presented to the system. In general, AI has a great future in gynecologic oncology.*

Keywords: *Artificial intelligence, Machine learning, Gynecologic oncology.*

Introduction

Gynecological malignancies are among the top ten most common cancers in the female population. Endometrial cancer is now the most common cancer among gynecological malignancies. Current studies suggest that endometrial cancer diagnoses could increase dramatically by 2035 [1]. Cervical cancer is the 4th most common cancer among women and the 7th most common cancer overall [2]. Ovarian cancer is the 8th most common cancer among the female population and the 18th most common cancer overall [3]. Among all gynecological cancers, only cervical cancer has a specific screening test which is "pap smear". Due to the lack of appropriate screening tests, the diagnosis of most gynecologic cancers is often delayed. The 5-year survival of these cancers widely depends on the stage of diagnosis [4].

In recent years, AI has been used for the diagnosis of numerous diseases including gynecological cancers [5], retinal disease [6], and skin malignancies [7]. AI-powered systems and algorithms can analyze medical images and data precisely and differentiate benign and malignant lesions [8],[9]. Data from patients must be introduced to the AI algorithm in a structured manner so that the algorithm will be able to recognize it [10]. Machine learning (ML) algorithm is a subfield of AI and it is based on neural networks (NNs) that are being used in various fields of healthcare including disease diagnosis and prognosis, disease treatment, drug development, and personalized treatment approaches. AI would design personalized treatment approaches based on the patient's symptoms and history which were introduced to it [11]. Watson was able to suggest therapeutic approaches for cancers with the use of AI [12]. It seems if we provide enough data for AI-powered systems, they will be able to outperform human physicians in diagnosis and treatment plans. The main problem for human physicians is that when the amount of data is large, they won't be able to sum up all the data and use it for proper diagnosis, in contrast, AI has the ability to deliver this task and this is the point that AI would outperform human physicians [11].

Despite the small number of published articles using AI models for diagnosis and treatment of gynecological malignancies, those available offer important information. The available review papers do not give information about all gynecological cancers at the same time and they mostly focus on the prediction and diagnosis of cancers but not treatment options. All these reasons made us choose this topic. We tried to gather data not only about the prediction and diagnosis of gynecological malignancies but also about the personalized treatment options that AI could offer.

The goal of this research paper is to find out if AI-powered systems are worth using in healthcare specifically in gynecology oncology.

Methods

For writing this review paper, we searched two online databases- PubMed and Cochrane Library for papers dated between 2015-2024. We used multiple keywords, the ones that gave us the most related results were "Artificial intelligence", "Ovarian Cancer", " Machine learning", "Cervical Cancer" and "Gynecologic Oncology". The number of articles which were found on PubMed and Cochrane Library was large, so we decided to apply more filters. We filtered them by the type of study, Clinical trials, Reviews, and Cohort studies were the types we wanted to use. In addition, we only selected free full texts. In total 57 relevant articles were found, among them, we chose 10 articles that were Review and Cohort. We selected those 10 according to their abstract. We were curious about data from different parts of the world so we chose the studies which were conducted in various geographical areas. The articles which were chosen were also cited the most compared to other articles with similar topics. We applied all these filters so our results would be reliable, and physicians would be able to use data from this data for clinical use.

Results

A study was performed by Markis et al. 2017, in which they tried to develop an automatic diagnostic system to analyze liquid endometrial cytology images of 416 patients using deep learning (DL) and the accuracy of this model was found to be 90% [13]. In addition, it was shown that the overall accuracy of using deep learning CNN for endometrial cancer diagnosis is 80.8% [14].

According to the study which was conducted in Uganda by Mirugwe et al. 2023, deep learning convolutional neural networks (CNN) can be effectively used for screening and diagnosis of cervical cancer [14]. A study was performed by Markis et al. 2017, in which they tried to develop an automatic diagnostic system to analyze liquid endometrial cytology images of 416 patients using deep learning (DL) and the accuracy of this model was found to be 90% [15]. Based on the data which was reported by Allahqoli et al. 2022, the accuracy of AI in predicting cervical cancer varied between 70-100% [16]. In addition, AI is able to distinguish cancerous from non-cancerous pap smear with 80-100% accuracy [16]. In several published studies, the sensitivity and specificity of AI algorithms in colposcopy have been reported at 71.9-98.22% and 51.8-96.2%, respectively [17],[18],[19].

According to Jung et al. 2022, the accuracy of the CNN model in the diagnosis of ovarian cancer is 97.2% [20]. In the cohort study which was conducted by Cai et al. 2024, AI would help with early diagnosis of ovarian cancer [4]. On the other hand, the prevalence of ovarian cancer is low compared to other gynecological cancers, and not much data is available about it, this cancer is usually diagnosed at the advanced stages these

are the reasons that data regarding the role of AI in ovarian cancer diagnosis is limited compared to other gynecological malignancies [21].

AI is not only being used for the screening or diagnosis of gynecological malignancies but also for enhancing treatment options. One of the initial steps in cancer treatment is surgery. AI would help in operations by recognizing patterns and determining the exact site of the tumor. Furthermore, radiotherapy is one of the treatment modalities among oncology patients. AI can help with contouring accuracy and speed which would help oncologists in generating treatment plans. In addition, AI can aid in optimizing radiation dose according to an individual's condition which can result in minimizing toxicity to healthy tissues [22]. The other therapeutic approach that is being used for cancers is chemotherapy and AI would aid in this field as well. The CNN-based model proved to be effective in distinguishing patients with various responses to platinum-based chemotherapy agents with a sensitivity of 73% and specificity of 91% [23]. AI would integrate all personal data and the history of one patient can offer the best personalized treatment plan to clinicians which would decrease any unnecessary treatments [22]. Table.1 describes the steps through which AI works in the gynecology oncology field.

Step	Description
Data Collection	Gather patient data including clinical history, imaging results, lab tests, etc.
Data Preprocessing	Organize collected data. Standardize data format.
Feature Extraction	Identify relevant features from the data (e.g., tumor size, shape, stage, exact site).
Model Training	Train AI models using machine learning algorithms on labeled datasets.
Diagnosis	Analyze patient data using trained models to make preliminary diagnoses.
Treatment Recommendation	Incorporate treatment guidelines and patient preferences into AI-driven decision support systems. Suggest personalized treatment regimen for the patient.
Monitoring and Follow-up	Monitor treatment response and disease progression. Adjust treatment plans as necessary.
Research and Development	Continuously improve AI algorithms and models through feedback and research.
Clinical Integration	Integrate AI systems into clinical workflows. Ensure compliance and ethics.
Outcome Evaluation	Evaluate the impact of AI interventions on patient outcomes.

Table.1

Discussion

According to the studies that were used for this review, AI-powered machines have high accuracy, sensitivity, and specificity to be used in screening, diagnosis, and offering personalized treatment regimens for individuals who are suffering from different gynecological cancers. AI-powered machines are able to differentiate malignant and non-malignant lesions, especially in the case of cervical lesions. Based on the study which was conducted by Mirugwe et al. 2023, the development of automated cervical screening algorithms has the potential to revolutionize cervical cancer detection and help with early diagnosis which would be beneficial, especially in resource-limited situations [15]. According to Makris et al. 2017, the use of CNN can be used as a diagnostic reference for gynecologists. CNN-based systems would also be helpful for the classification of endometrial lesion images [13]. AI algorithms are also very useful for the diagnosis of ovarian cancer through analyzing medical images [24]. Application of ML, CNN, and generally AI would be recommended in all oncology settings as well as gynecological malignancies since these systems would positively affect the accuracy in different fields. However, it is important to compare the results with an oncologist/gynecologist's opinion to avoid any unwanted errors since experts are still working on these systems [9].

This study has certain strengths. We tried to use the recently published papers as a result, the data that is being represented by this review is reliable and up-to-date. In addition, we tried to recruit the studies that were conducted in different geographical areas so the result of this paper would be useful for our colleagues who are working in different areas.

There are some limitations to this review paper that I would like to mention. First, only publications which were published in English were used, there may be other articles and research which were conducted in other languages [25]. Additionally, we were not able to find many original articles that were free as well. According to Breen et al. 2023, most of the published articles have an unclear risk of bias due to limited data analysis [25].

Since 2020, more researchers started to work on different aspects of AI use in medicine and we would recommend researchers and healthcare workers to continue working and improving AI systems and recruit these systems in medical fields, especially oncology. Medical students would also benefit from learning more about the AI role in medicine. As was mentioned earlier in this paper, there is no screening method for ovarian cancer, we would like to recommend researchers and scientists who are specifically working in the AI field, to focus on this field since ovarian cancer is a life-threatening disease among female population and it is usually being diagnosed at advanced stages.

Conclusion

In this review paper, we discussed the roles of AI and its subsets in gynecological malignancies. These systems have high accuracy, sensitivity, and specificity in the diagnosis of these cancers and in offering treatment regimens. In addition, AI has a promising future in improving treatment modalities, personalized treatment regimens, and screening in gynecology. But still, further studies are required to reduce the bias of these systems. Also, specialists cannot rely on these systems yet and more research must be performed and systems must be improved.

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