

The Application of Artificial Intelligence Technology for the Diagnosis of Malignant Tumors: A Review

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ABSTRACT

Background: The digital technology has revolutionized many fields including the healthcare. The advancement in digital technology in the form of artificial intelligence is going to revamp the patient care in near future. The application of convolutional neural network in the computer aided diagnostic system has revealed very promising results.

Material and methods: The research papers were collected after searching the databases by using the specific key words such as convolutional network (CNN), ResNet34, ResNet50, ResNet101, ResNet152, EfficientNet B3 and VGG-19. The search period was five years from 2020 to 2024.

Results: A total of 33 research article have been selected for this review paper on the basis of inclusion and exclusion criteria. The significant majority of the studies revealed that diagnostic accuracy of artificial intelligence technology regarding the histopathological diagnosis of malignant tumors ranged from 85% to 100%.

Discussion: The computer aided diagnostic system based on artificial intelligence technology has emerged as excellent technique for the histopathological examination of the tissue specimens. In some conditions, it has surpassed the pathologist in the speedy evaluation of lesions with more diagnostic accuracy.

Conclusion: The application of artificial intelligence for the diagnosis of the malignant tumors could provide a very valuable assistance to the pathologist. It would provide more speedy results with high accuracy which could be very important in the patient care.

Keywords: Global warming, Green house gases, Climate change, Sustainability, IPCC

1. INTRODUCTION

There is a rising trend in the number of cases of malignant tumors in the various countries of the world. Approximately 20 million new cases of malignant tumors diagnosed around the globe in 2022 (1). The lungs, female breast, colorectum, prostate, stomach, liver, thyroid, cervix- uteri and urinary bladder are among the common sites of cancers [1].

The malignant tumors are characterized by uncontrolled growth of abnormal cells. The normal human cells grow and divide at predetermined set rate while the malignant cells do not follow the normal pattern of growth. Invasion and metastasis are another feature of malignant cells which play important role in the morbidity and mortality in the human beings. The first step in the development of malignant tumor is the permanent change in the cellular DNA which could occur due the DNA damage. The mutations in the DNA are the result of effects of radiations, chemicals or infections of certain viruses. The

occurrence of DNA mutation in some genes initiate the process of development of malignancies. In certain cases of tumors, the mutations are inherited from the affected parents while in some cases there are acquired mutations which could be attributed to exposure to ultraviolet radiations, tobacco smoke and or chemicals.

The management of cancers requires the correct diagnosis and staging of the malignant tumors. If left untreated, the cancer advances in the stage due to their features of invasion and metastasis. The treatment is relatively easy in the early stage as compared to the advance stage of cancers. For the diagnosis of malignancies, assessment of clinical features, radiological evaluations and laboratory tests play a very important role but the gold standard for the diagnosis of cancers is a microscopic examination of the cells from the morbid site by the histopathologists.

Since, cancer cases are rising in number and the increased number of malignant tumors could be attributed to the increase in the population and aging. With the advancement in the age, the risk of development of DNA mutations increases which is a contributing factor in the development of cancer. The cigarette smoking contributes significantly in the high number of cancers. The smokers are at increased risk to develop cancers of lungs, oral cavity, esophagus, larynx and urinary bladder. Approximately 0.94 to 1.47 billion persons from all over the world are smokers [2].

There is rising number of obese people in the many countries of the world [3]. The obesity is also linked with many types of cancers such as malignant tumors of breast, colorectum, esophagus, kidney, gall bladder, endometrium, pancreas and liver [4]. The alcohol drinking is associated with increased risk of cancers of esophagus, colon, larynx, breast, stomach, liver and pancreas [5]. Another important factor which contributes in the development of cancer is unhealthy diet. Intake of less fiber diet is associated with increased risk of colorectal cancers [6]. The air pollution is also linked with the increased number of cancers. Air pollution increases the risk of lung carcinoma [7].

The rising number of malignant tumors is increasing the challenges for the histopathologists as it increases the workload and stress on them. Due to workload, the burn out among the pathologist is not uncommon [8].

In this regard, the search for the advancement in the diagnosis of cancer by applying smart digital technology becomes the need of the day. The digital technology has revealed many beneficial effects in various area which provide the efficient services to the humanity. Among these areas, the health care and education are of vital importance. The emerging branch of digital technology is artificial intelligence which has been employed in the many fields including the patient care [9]. The artificial intelligence technology has made to computers to perform a task like human beings. This software has developed the ability to work with a cognitive function quite similar to human brain.

For the diagnosis of malignant tumor, the histopathologist performs the microscopic examination of the tissue sections and applies his cognitive knowledge to judge the tissue samples for the evidence of malignancy. In this regard, the use of digital technology may be quite helpful to the histopathologist in their work. The application of artificial intelligence could be a good tool for the diagnosis of cancers [10-12].

The objective of the present review is to find out the role of application of artificial intelligent technology for the histopathological diagnosis of malignant tumors.

2. MATERIALS AND METHODS

1. **Study design:** The present study is a narrative review of the research papers having the qualitative and quantitative evidence regarding the role of artificial intelligence in the diagnosis of malignant tumors.
2. **Research question:** does the application of artificial intelligence play a significant role in the diagnosis of cancers.
3. **Key words used:** The literature was searched by using these key words. Artificial intelligence, malignant tumors, cancers, deep machine learning, convolutional network (CNN), ResNet18, ResNet34, ResNet50, ResNet101, ResNet152, EfficientNet B3, VGG-19
4. **Research time period:** January 2000 to December 2024
5. **Data sources:** Google scholar, Scopus, web of science, PubMed

Inclusion criteria:

1. Studies performed on human cancers
2. Research papers published in peer review journals
3. Published in English language

Exclusion criteria:

1. Research papers published before January 2000.
2. Unavailability of research paper in English language

3. Studies conducted on animals
4. Studies published in non-peer review journals

Data extraction

Each study was evaluated with respect to following parameters

- Year of publication
- Design of study
- Study population
- Histopathological examination
- Application of AI technology
- Deep machine Models
- Findings

Data analysis:

After removing the duplications of the collected research papers, the data is evaluated for the key findings.

3. RESULTS

Base on inclusion and exclusion criteria, a total of thirty-three research papers has been collected and analyzed. These studies have been carried out to check the performance of machine learning models regarding the classifications of malignant tumor on the histopathological images. The common tumors of the human being were evaluated which included breast cancer, colorectal malignant tumors, lung carcinomas, prostatic carcinoma and lymphoproliferative disorders. The commonly employed artificial intelligence models include VGG-16, Dense Net – 121, ResNet-152 V2, ResNet-18, ResNet-34, ResNet-50, MobileNetV2, EfficientNet- B3. The results are summarized in table 1.

Table 1: The Diagnostic Accuracy of AI Models Regarding the Diagnosis of Malignant Tumors

Author	Site / type of Tumor	AI Models	Results
Arshad W [13]	Breast cancer	• Inception V 3 • ResNet-152 V2 • Mobile Net V2 • VGG-16 • DenseNet- 121	Accuracy : 94% Accuracy : 95% Accuracy : 97% Accuracy : 98% Accuracy : 99%
Ibrahim DM [14]	Colorectal cancer	• DenseNet-121 • VGG-16, • GoogLeNet • ResNet-18 • ResNet-50 • ResNet-50 with SN images	Accuracy: 94.7% Accuracy: 92.4% Accuracy: 91.4% Accuracy: 86.9% Accuracy: 99.7% Accuracy: 99.94%
Bukhari SUK [15]	Prostatic adenocarcinoma	• ResNet-18 • ResNet-34 • ResNet-50	Accuracy:97.1% Accuracy:98.0% Accuracy:99.5%
Bukhari SUK [16]	Brain cancer	• ResNet-18 • VGG-19	Accuracy: 97% Accuracy: 92%
Perry C [17]	Nodal and extra nodal Non-Hodgkin	DHL – Classifier	92%

	lymphoma		
Raciti P [18]	Prostatic cancer	PaPR	Sensitivity : 97.4% Specificity : 94.8%
Steinbuss G [19]	Lymph node: small lymphocytic lymphoma/chronic lymphocytic leukemia & nodal diffuse large B-cell lymphoma	EfficientNet	Accuracy: 95.56%
Miyoshi H [20]	Lymph Node: Non Hodgkin lymphoma	Deep neural network classifier	Accuracy: 97.0 %
Syrykh C [21]	Lymph Node: Follicular lymphoma	Bayesian neural networks (BNN)	accuracy : 91.0 %
Li D [22]	Lymph Node: Diffuse large cell lymphoma	- AlexNet - GoogleNet - Vgg16 - ResNet18 - SqueezeNet - MobileNetv2 - Inceptionv3 - DenseNet201 - Xception - Vgg19 - Places365GoogleNet - InceptionResNetv2 - ResNet50 - ResNet101 - NASNetMobile - NASNetLarge - ShuffleNet - GOTDP-MP-CNNs (with combined 17 CNNs)	Model A Accuracy:92.08 % Accuracy:95.05 % Accuracy:95.05 % Accuracy:92.08% Accuracy:92.08 % Accuracy:90.10 % Accuracy:90.10 % Accuracy:90.10 % Accuracy:98.02 % Accuracy:87.13 % Accuracy:96.04 % Accuracy:94.06 % Accuracy:86.14 % Accuracy:89.11 % Accuracy:95.05 % Accuracy:95.05 % Accuracy:87.13 % Accuracy:100.00 %
Zhang X [23]	Lymph Node: CLL, FL, and MCL lymphoma	- BP - GA- BP - ResNet-50	Accuracy:96.0% Accuracy:97.7% Accuracy:98.63%
Yu WH [24]	Instetinal T cell Lymphoma	- XGB-1 - XGB-2 - CNN	AUC : 0.966 AUC : 0.955 AUC : 0.822
Hamdi M [25]	Lymph Node: CLL, FL, and MCL	MobileNet- XGBoost	Ave. Accuracy: 96.7%

	lymphoma	- VGG16 -XGBoost - AlexNet -XGBoost	Ave. Accuracy: 96.4% Ave. Accuracy: 95.8%
Wang,J [26]	lymph node metastasis in breast cancer	- EfficientNet B3 - ResNet-50 - DenseNet121	Accuracy: 97.96% Accuracy: 95.90% Accuracy: 96.35%
Sarwinda D [27]	Colorectal cancer	- ResNet-18 - ResNet-50	Accuracy :85% Accuracy :88%
Balasubramanian AA [28]	Breast cancer	- VGG-16 - ResNet-50	Accuracy: 98.72% Accuracy :99.05%

4. DISCUSSION

The significant number of studies revealed that the diagnostic accuracy of Artificial Intelligence – Machine learning models has achieved excellent results for the diagnosis of malignancies. The conclusive diagnosis of malignant tumor requires a thorough microscopic examination of the tissue specimens which is a very tedious, laborious and time-consuming task. The machine learning models of artificial intelligence technology has achieved the diagnostic accuracy from 85% to 100% regarding the histopathological diagnosis of malignant tumors on the images of the stained section of the tissue samples. The figures are very encouraging for the histopathologists as the application of artificial intelligence technology could assist the pathologist in the histopathological examinations of the tissue samples.

Approximately twenty million new cases of malignant tumor were diagnosed in 2022 and among these the five most common malignant tumors include lung cancer (12.4%), breast carcinoma in women (11.6%), Colorectal carcinoma (9.6%), prostatic malignant tumors (7.3%) and the gastric cancers (4.9%) [29].

The rising number of malignant tumors also adds the workload and stress on the pathologists. In this regard, the useful application of artificial intelligence technology in the field of histopathology could reduce the burden on the pathologists. The histopathological diagnosis of the malignant tumors is a vision-based assessment of the microscopic details such as pleomorphism of cells and nuclei, hyperchromasia of the nuclei, abnormal mitosis, high nucleus to cytoplasmic ratio and necrosis on the stained-glass slides made from the tissue blocks. The development of virtual slides made it possible to evaluate these by the computer vision-based technology. The digitalization of whole glass made it possible for the introduction of image tissue-based diagnosis [30].

The artificial intelligence deals with training of machines such as computers through algorithms so that these could perform the functions like the human brain. A subset of artificial intelligence is machine learning which make the computers capable to have self-learning from the experiences. A subgroup of machine learning is deep learning which employ the application of neural networks. The deep learning technique revealed better results in the process of automatic image classifications. The deep learning is remarkably accurate regarding the evaluation of histopathological image classification [31].

The application of artificial intelligence in histopathology to assist the pathologists revealed improvement in the detection of neoplastic lesions [32]. A study published by Miyoshi H et al revealed that the deep learning model performed better than the human [20]. In the study, the diagnostic accuracy of neural network classifier was 97% while pathologist's accuracy was 76% on the hematoxylin and eosin-stained sections [20]. The employment of digital pathology is going to provide more accurate and rapid diagnosis of the lesions [33].

5. CONCLUSION

The application of computer aided diagnosis for the malignant tumors would be very valuable adjunct techniques which could reduce the stress on the pathologists and improve the diagnostic accuracy with more swiftness.

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