Cancer Biotechnology

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Can Artificial Intelligence Push the Limit in Cancer Diagnostics?

Artificial intelligence (AI) is the technology that is used for understanding the data and objects which usually requires human intelligence but with more accuracy and speed. Explosion of data and need for accurate analysis in a short duration, led to the development of AI, which can help learn and process the object or data under consideration. AI is being used for several advanced technology and security purposes such as data analysis, image processing, data security, fraud detection, speech recognition, chatbots and for algorithm trading [1]. Lately, the use of AI in healthcare has become imperative due to large amount of data in the healthcare sector and for effective diagnosis and prognosis of complex diseases such as cancer and diabetes. Cancer is one such menace to human health and one of the leading causes of death among both men and women globally. According to the World Health Organization 'WHO', approximately 9.6 million deaths occurred due to cancer in 2018. As Figure 1 suggests, low and middle income countries are worst affected by cancer with about 70% of cancer deaths reported in the developing countries [2].

Artificial Intelligence for Analyzing Data and Image Analysis for Cancer Diagnostics at an Early Stage

Complexity of cancer arises from various factors such as constantly varying mutational landscape of cancer cells, complex and dynamics tumor microenvironment, and difference in genetic background of each cancer patient. All these aspects make diagnosis and treatment of cancer very difficult. This is due to the fact that not only one cancer type varies from other cancer type in mutations but it also varies within a patient when progressed to later stage such as metastasized stage. Advanced stage diagnosis and/or misdiagnosis of cancer are two such factors which is needed to be addressed for effective therapy. Current technologies use different means that are being employed for diagnosis of cancer such as imaging (Pap smear and mammography), molecular profiling (Proteomics, Genomics, Transcriptomics and Metabolomics; tissue based biomarker), and cell free DNA analysis

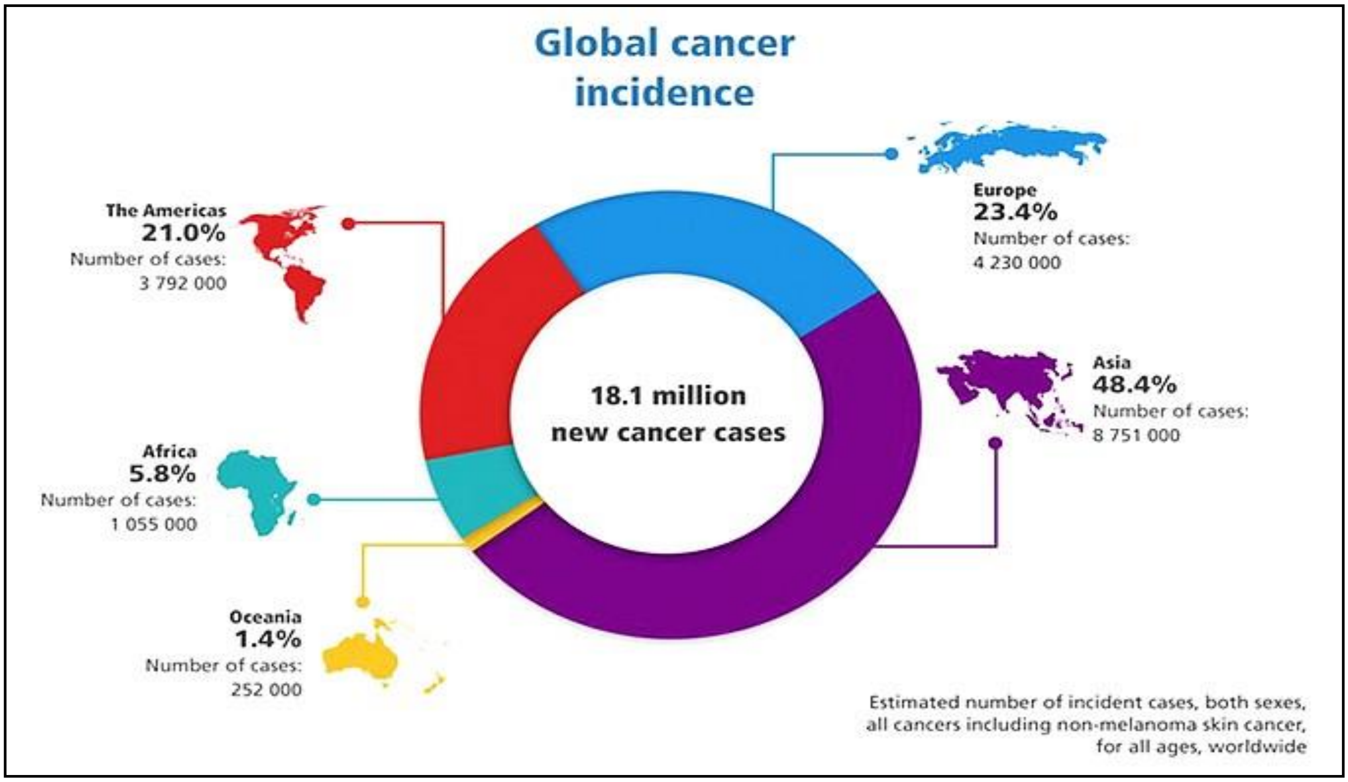

*Figure 1 Global cancer incidence [**Source:** WHO http://gco.iarc.fr/].*

(cfDNA; circulating biomarker). While, microscopic examination by pathologist can help in determining the prognosis and the treatment to some extent, it remains very challenging for effective therapy of cancer that has metastasized to different sites in the body [3]. There is no dearth of data but understanding data in meaningful and unbiased manner with accuracy is one of the time taking and labor intensive process for human intelligence. AI offers hope in analyzing these data that can go beyond human intelligence level to gain a better insight into the critically important diagnosis of cancer at its early stage. AI can be used for understanding data and image analysis in a meaningful manner with the aid of more affordable and cheap devices (democratization of technology). To this end, several computer models have been developed for cancer diagnosis that mostly focuses on image analysis, to identify the abnormalities specified by pathologist [4]. Especially, cognitive computing has been developed for dealing complex cancer data. These algorithms are created to read, memorize and advise physicians for decision making on the ever evolving medical literature. They help physicians in taking decision on relevance of data for determining appropriate cancer treatment [5]. AI can also help in determining pre-symptom cancer risk by using predictive models trained on large dataset. To explore the potential of AI technology more, let us take a look into few of the following examples.

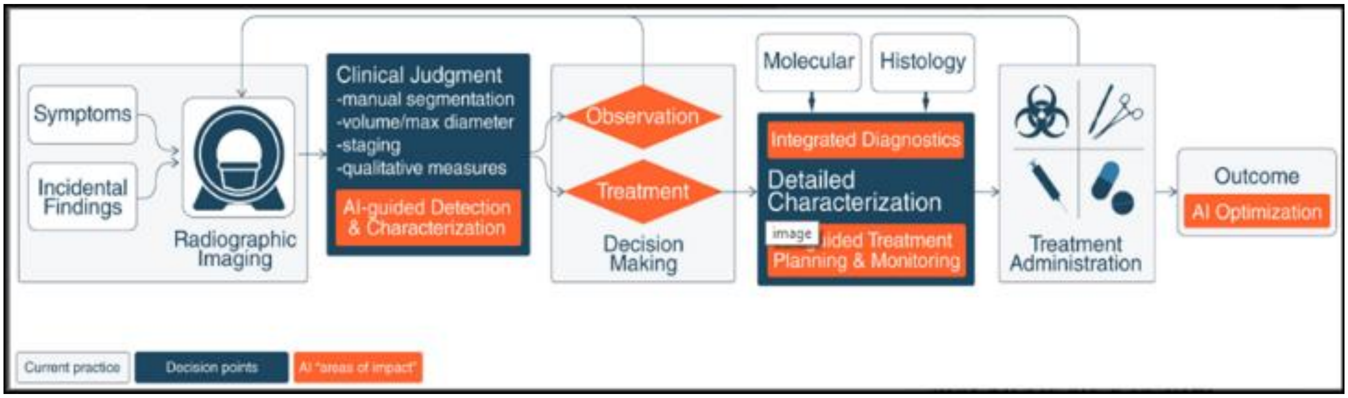

*Figure 2: Potential Enhanced Clinical Workflow With Artificial Intelligence (AI) Interventions. [**Source:** CA Cancer J Clin. 2019].*

Lunit, an AI company, which has analyzed 1,700,000 images, working in the field of breast and lung cancer, has developed INSIGHT algorithm for analyzing chest X-rays and mammography images. Lunit INSIGHT algorithm can analyze mammography for diagnostic purpose with 97% accuracy. It is a self-learning algorithm for finding nodules in specific region with fewer false negative results (Table 1) [6].

Table 1: AI based company in cancer diagnosis.

Company	Function
Google AI https://ai.google/healthcare/	Working in the field of digital pathology. Assisting pathologist for detecting breast cancer in lymph node biopsy.
IBEX Medical Analytics https://ibex-ai.com/	Work on the data from digitized glass slide and electronic medical records to reveal underlying pattern and clinical insights for personalized treatment and diagnosis.
logy.AI https://logy.ai/	AI based company working on diagnosis of cancer and malaria
Philips https://www.usa.philips.com/healthcare/innovation/artificial-intelligence	Philips teamed up with PathAI for improving breast cancer diagnosis.
Paige.AI https://paige.ai/	Creating large scale machine learning algorithm on digital slides for cancer diagnosis and therapy.
Lunit https://www.lunit.io/	AI based medical company. Developing powerful data driven imaging biomarkers

Google has also developed the deep learning-based approach to improve diagnostic accuracy for detecting nodal metastasis (LYmph Node Assistant or LYNA) (Table 1). In breast cancer, nodal metastasis affects the treatment decisions such as radiation therapy, chemotherapy and surgical removal of additional lymph node. Convolutional neural network (CNN) architecture was used in this AI system which gave excellent results with 8 false positive and 92.4% tumor detection (Camelyon 16 dataset). Human pathologist on the other hand achieved only 73.2% sensitivity for tumor detection [3, 7]. In another study, deep convolutional neural network is used for skin lesions. CNN was trained on 129,450 clinical images and its performance was tested against 21 board-certified dermatologists on biopsy proven clinical samples. Keratinocyte carcinomas versus benign seborrheic keratoses (common cancers) and malignant melanomas versus benign nevi (deadly skin cancer) were used as two critical binary classifications. Here, AI system proved to be as excellent as experts in classifying skin cancers [8].

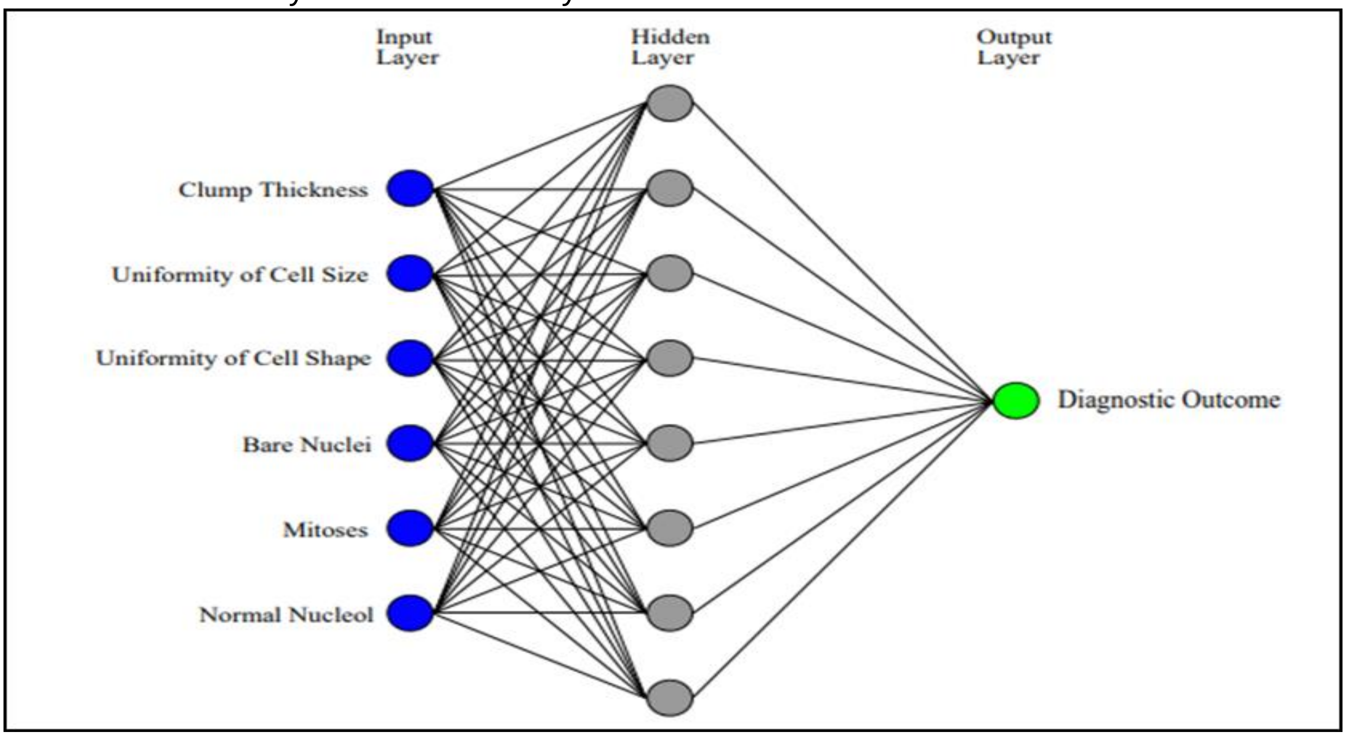

*Figure 3: A simple example of how Artificial Neural Network (ANN) is trained to predict the diagnostic outcome from six inputs and one hidden layer with 8 neurons [**Source:** Designs 2018]*

Quantgene, on the other hand provides precision technology and looks into the cell free DNA (cfDNA) for determining genetic predisposition to cancer. cfDNAs expelled by cells and are found in the circulating blood. Cancer cells also expel cfDNA which can act as circulating biomarker. Qunatgene looks at each copy of cfDNA present in blood sample [9]. CanSAR is another AI system developed to look into molecular profile (proteins) that can be targeted by drugs. MD Anderson and Memorial Sloan Kettering launched Oncology Expert Advisor (OEA) which can be used for incorporating all information of more than 1 million patients for generating support system for research and patient care [5]. Table 2 summarizes the important research and developments in cancer diagnosis using AI.

Table 2: Recent AI based research and developments in the field of cancer diagnosis.

Research	Type of Cancer	Comments	Reference
Cancer diagnosis with AI and spectroscopy	Breast Cancer	Biopsy data were analyzed by supervised and unsupervised algorithm to identify changes associated with lipids, collagen and nucleic acid content. Specificity accuracy were found for luminal A (70%), B (100%), HER2 (90%) and TNBC (90.7%).	[10]
Lesion-based Convolutional Neural Network	Early Gastric Cancer	Visual geometry group (VGG)-16 model was employed to classify endoscopic images as EGC or non-EGC. Evaluation of diagnostic performance and factors affecting AI diagnosis. 90.1% sensitivity is observed in this study.	[11]
Image based deep learning framework for individualizing radiotherapy dose	Cancer in lung	Image (CT) distinct subpopulations were identified that have differential sensitivity to radiotherapy. Use of medical image for individualization of radiotherapy dose.	[12]
MR based AI model for therapy assessment	Locally advanced Rectal Cancer	AI model analyzes texture of high-resolution T2 weighted MR images for identifying patients who will show complete response and no response at an early stage of treatment.	[13]
Radiomics MRI phenotyping with Machine learning for predicting lower grade glioma (LGG)	Glioma	For predicting LGG, machine learning classifiers were trained on radiomics features of glioma where best classifier assessed by area under the curve (AUC).	[14]
Machine learning analyzing immune-histochemistry of suspected thyroid nodules	Thyroid cancer	This model can be used for identifying benign and malignant thyroid nodules which is noninvasive prediction based on the CT images.	[15]

Conclusion

Considering the extraordinary challenges in cancer diagnosis at an early stage, it is important to outline how AI system can be developed for future healthcare. One viable path could be that instead of developing separate AI based system by different group, an integrated AI system could be developed for better data sharing. Further, healthcare data should be shared freely among different AI system with fewer hurdles although security of data is one of the concerns. Instead of using only cancer patient data for training algorithm, it is also important to train AI system on healthy individual data for predictive analysis. For detecting predisposition, it is imperative to explore more individual's data related to food habit, substance abuse such as tobacco or alcohol intake and family history. Researchers also need to generate data more responsibly, minimizing human error and faster the hospitals will adopt AI technology more lives will be saved.

Author's Biography:

Peeyush Prasad is a biomedical scientist with research experience in multiple areas. Currently, he is a scientific consultant at Kolabtree. He had completed his M.Sc. in Biomedical Sciences from Dr. B.R. Ambedker Center for Biomedical Research (ACBR), University of Delhi. He has explored LC-MS based proteomics approach for neuro-infectious diseases at Institute of Bioinformatics and worked on various bioinformatics tools. Further, he joined Shiv Nadar University where worked on signaling pathways in breast cancer and colon cancer. He has published 6 papers and 5 conference proceedings. His papers are published in highly reputed journals such as ACS Applied Material and Interfaces and Oxford Carcinogenesis. He is an avid reader of technological development in healthcare and likes to ideate on future of healthcare sciences".

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