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ABOUT COVER

Editor-in-Chief of *Artificial Intelligence in Cancer*, Dr. Mujib Ullah is an expert in the field of regenerative medicine and a United States trained investigator in artificial intelligence (AI) and in cancer. Dr. Ullah conducts preclinical and clinical studies to determine how turning off oncogenes (cancer genes) can cause tumor regression. His work is based upon a learned appreciation of AI techniques and deep learning, and their potential to develop predictive models for personalized treatments with engineered stem cells, immune cells and regenerative tissue. He is currently expanding his translational research to include early diagnostics, therapeutic monitoring, and prediction of response to therapeutics in solid tumors, such as kidney cancer and lung cancer, helping to make personalized medicine possible. The ultimate goal of this research is to achieve accurate diagnoses of aggressive cancers as well as to provide new insights about metastatic spread and the development of resistance against therapies. (L-Editor: Filipodia)

AIMS AND SCOPE

The primary aim of *Artificial Intelligence in Cancer* (*AIC*, *Artif Intell Cancer*) is to provide scholars and readers from various fields of artificial intelligence in cancer with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

AIC mainly publishes articles reporting research results obtained in the field of artificial intelligence in cancer and covering a wide range of topics, including artificial intelligence in bone oncology, breast cancer, gastrointestinal cancer, genitourinary cancer, gynecological cancer, head and neck cancer, hematologic malignancy, lung cancer, lymphoma and myeloma, pediatric oncology, and urologic oncology.

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EVIDENCE REVIEW

Applications of artificial intelligence in, early detection of cancer, clinical diagnosis and personalized medicine

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Abstract

Artificial intelligence (AI) refers to the simulation of human intelligence in machines programmed to convert raw input data into decision-making actions, like humans. AI programs are designed to make decisions, often using deep learning and computer-guided programs that analyze and process raw data into clinical decision making for effective treatment. New techniques for predicting cancer at an early stage are needed as conventional methods have poor accuracy and are not applicable to personalized medicine. AI has the potential to use smart, intelligent computer systems for image interpretation and early diagnosis of cancer. AI has been changing almost all the areas of the medical field by integrating with new emerging technologies. AI has revolutionized the entire health care system through innovative digital diagnostics with greater precision and accuracy. AI is capable of detecting cancer at an early stage with accurate diagnosis and improved survival outcomes. AI is an innovative technology of the future that can be used for early prediction, diagnosis and treatment of cancer.

Key Words: Artificial intelligence; Cancer; Clinical tumor prediction; Early detection of cancer; Clinical diagnosis; Personalized medicine manuscript

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Core Tip: Early detection of cancer potentially enhances the chances for successful treatment and patient survival outcome. Artificial intelligence (AI), a field of computer science, aims to develop algorithms or computer programs with advanced analytical or predictive capabilities. The development of highly accurate AI algorithms for the early recognition of the disease is crucial not only for the rapid identification and diagnosis of cancer patients, but also for the treatment. Many AI platforms are being developed and approved by the US Food and Drug Administration for use in some areas of cancer, such as identifying suspicious lesions in cancer and interpretation of magnetic resonance imaging or computed tomography. Similarly, the Big Data to Knowledge initiative was launched by National Institute of Health to support the research and development of tools to integrate big data and data science into biomedical research. AI-guided clinical care has the potential to play an essential role in the screening, diagnosis and treatment of cancer.

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INTRODUCTION

Cancer is a major public health problem and remains the second leading cause of death in the United States[1,2]. Early detection of cancer potentially enhances the chances for successful treatment and patient survival outcomes[1-3]. Prediction of early cancer and treatment response is a crucial issue in personalized treatment for cancer patients[4]. Artificial intelligence (AI), a field of computer science, aims to develop algorithms or computer programs with advanced analytical or predictive capabilities (Figure 1)[1,3,5]. Integration of AI technology into early detection of cancer could improve precision diagnosis, improve the clinical decision-making process, and lead to revolutionize the future of diagnostics and treatment[5,6].

AI innovation has the potential to affect several parameters of cancer therapy[5,6]. These include prediction, screening, analysis and interpretation of huge data sets, decoding tumor-imaging data, drug discovery and drug validation in a clinical setting[6,7]. Screening of tumor targets in both healthy and high-risk populations offers the opportunity to detect cancer early and with an improved recovery chance for treatment and cure (Figure 2)[7-9]. Advances in AI with machine learning and deep learning are rapidly evolving, and will soon change the science of cancer screening and detection[8,10]. There is a need to train cutting-edge AI technologies to predict early cancer in patients[5]. Although AI applications are still limited, the potential role of AI for early detection of cancer is huge to extract information on diagnosis, prognosis, and therapy responsiveness[5,11,12].

AI IN EARLY DETECTION OF CANCER

The precision algorithms of AI can be used to improve precision medicine to target the right patient for the right therapy at the right time[5,12,13]. The scoring of proliferation marker Ki-67 is highly relevant for early-stage breast cancer diagnosis, classification, prognosis, and treatment[2,4,7]. Automated brain tumor segmentation methods are computational algorithms that yield tumor delineation and have become an important diagnostic tool in planning precision medicine[4,7,14]. Accurate identification and detection of lymph node metastasis are critical for planning treatments for colon cancer[2,4,15]. Given the complexities and heterogeneity within the cancer data, AI-based algorithms can be used for digitalized identification of histopathologic tumor specimens and image analysis (Figure 1)[4,10]. Gene mutation prediction and validation using raw input digitized histopathology give promising results for six different genetic mutations (STK11, EGFR, FAT1, SETBP1, KRAS, and TP53) in lung cancer[2,4,7,10]. Mutations in KRAS, tumor protein P53 and predictive accuracy of these markers can be used for early diagnosis of cancer[1,2,4]. Clinicians have utilized AI to establish an early signature (Programmed death-ligand 1), which could predict the

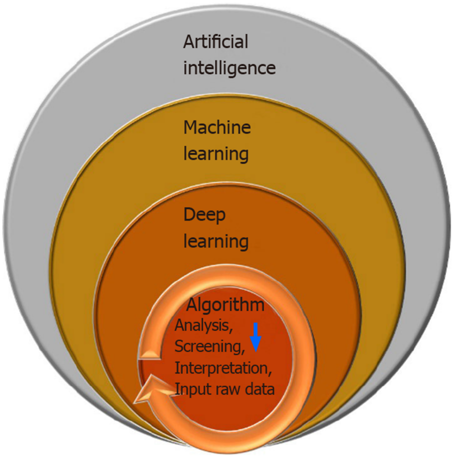

Figure 1 Artificial intelligence (vehicle with innovative technology), machine learning (the engine that drives artificial intelligence) deep learning (the wave comes to healthcare), and raw data (feeding materials of the artificial intelligence engine).

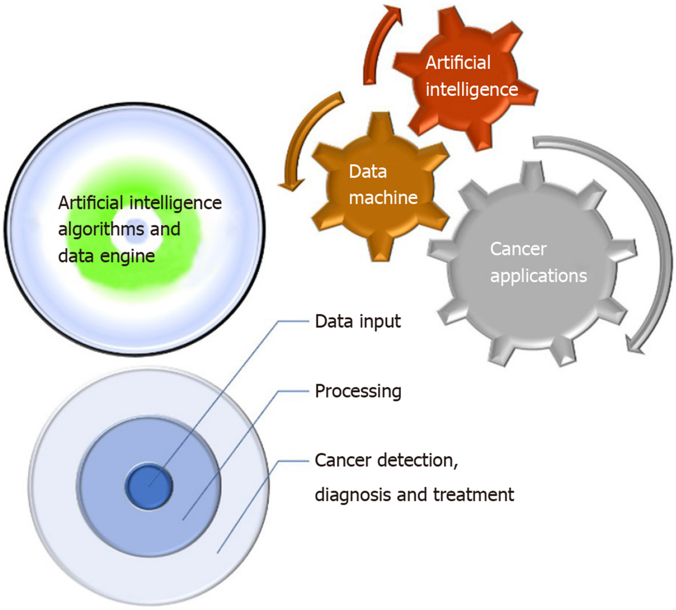

Figure 2 Applications of artificial intelligence in tumor detection, diagnosis and treatment.

effectiveness of cancer immunotherapy[1,13].

Data analytics capabilities of AI have made a leap forward in recent years to predict cancer at its starting point[5,16,17]. Screening algorithms for cancer targets and processing data via AI will allow increased early detection and intervention[5,13,18]. Conventional cancer detection and treatment methods are expensive, time-consuming and often result in poor treatment outcomes[1,5,19]. To tackle this issue, the development of machine learning techniques is central to discovering novel biomarkers for early diagnostics[1,2,19]. Precise and early cancer diagnosis is fundamental for clinical management of cancer[2]. AI can accelerate drug discovery, harness biomarkers to accurately match patients to clinical trials, and truly personalize cancer therapy using only a patient's own data[2,5,20]. These advances are indicators that practice-changing cancer therapy empowered by AI may be on the horizon.

AI IN CLINICAL DIAGNOSTICS

The development of highly accurate AI algorithms for the early recognition of the disease is crucial not only for the rapid identification and diagnosis of cancer patients, but also for the treatment[6,21]. AI can be helpful in clinical diagnostics to ensure adequate patient care[6]. Useful screening tools to precisely diagnose cancer, such as mammography, radiology and image processing would improve the efficacy of clinical diagnostics[22]. The AI algorithms are already developed with large data sets that show improved diagnostics than clinicians[22]. AI-aided diagnostics for detecting cancer at heterogeneous and complex stage, showed effectiveness in various clinical datasets[22].

Many AI platforms are being developed and approved by the US Food and Drug Administration for use in some areas of cancer, such as for the identification of suspicious lesions in cancer and interpretation of magnetic resonance imaging or computed tomography[23,24]. There are several AI algorithms for the screening of cancer, for the identification of flagged areas in tumors, or treatment trends, and for the evaluation of big data sets[23]. For instance, there is an AI algorithm to visualize lung nodules in lung cancer patients and another AI algorithm to detect breast abnormalities[25-27].

AI AND NEW EMERGING TECHNOLOGIES

Cutting-edge technologies such as AI are diffusing throughout the health-care system and reshaping patient care[15,28]. The volume of available data has grown exponentially, which can be used for early diagnosis and clinical decision-making process[5,15,28]. The revolution of AI in biomedical science is crucial to develop the concept of precision medicine[7,15]. Concurrent with the development of the field of precision medicine is an even larger revolution in understanding the events of early detection of cancer using digital technology[5,7]. AI in cancer has focused on risk prediction in the hopes of using risk information to influence health behaviors and treatment outcomes[4,7,15]. Understanding the science of early perdition in cancer offers tools and insights to help how to translate AI information into effective treatment (Figure 2)[4,18]. To date, AI has been used in many examples of clinical medicine[12,14]. For example, a smartphone app called DiagnosUs developed by AI technology for analyzing and annotating medical images and videos based on tight linkages between cancer prediction and patient treatment response[12,14,28].

AI could fuel everything from drug development to innovative design to new, better therapies[3,5,28]. Advanced analysis of big data with AI can make predictive modeling of biological processes transform research into development, and increase the accuracy to choose the right medication and dosage for complex diseases[5,28]. For example, the Google-backed company DeepMind has built a device that can diagnose different diseases in real-time[11,28]. It can be used for quick scan, diagnosis, and can detect early conditions such as diabetic retinopathy, age-related degeneration and cancer[11,28]. Similarly, the Big Data to Knowledge initiative was launched by National Institute of Health to support the research and development of tools to integrate big data and data science into biomedical research[11,29].

AI-guided clinical care has the potential to play an important role in screening, diagnosis and treatment of cancer[5,28]. The integration of AI technology into cancer care could further improve the accuracy and speed of diagnosis for better health outcomes[7,11,29]. Scientists trained computer algorithms to analyze patient images of prostate, breast and brain tumors[1,5,7,29]. It can be used at clinics as a tool to help with diagnosis, clinical decision-making and for the prediction of patient outcomes[1,29]. AI can predict commonly mutated genes, identify biomarkers, interpret complex images, and diagnose solutions for challenging types of cancer (Figure 2)[2].

CONCLUSION

AI has improved diagnosis and treatment outcomes in cancer patients[15]. AI can recognize patterns that can easily be missed by clinicians[10,15]. Cancer is an aggressive disease with a low survival rate, and the treatment process is lengthy and very costly[10]. Furthermore, the lack of large publicly available data sets, concerns over interpretation, lack of well-annotated databases, reproducibility and validation-issues have been significant barriers for AI practice and algorithm development[7]. There is a need to establish a central platform for sharing standardized cancer datasets to drive AI innovation[7]. In the near future AI can be integrated into a multitude of innovative emerging mobile health interfaces, such as digital technologies, smartphone apps and wearable devices, to develop real-time trackers for digital biomarkers that can explain, influence, and predict clinical outcomes[10,15,28].

REFERENCES

1 **Bi WL**, Hosny A, Schabath MB, Giger ML, Birkbak NJ, Mehrtash A, Allison T, Arnaout O, Abbosh C, Dunn IF, Mak RH, Tamimi RM, Tempany CM, Swanton C, Hoffmann U, Schwartz LH, Gillies RJ, Huang RY, Aerts HJWL. Artificial intelligence in cancer imaging: Clinical challenges and applications. *CA Cancer J Clin* 2019; **69**: 127-157 [PMID: 30720861 DOI: 10.3322/caac.21552]

2 **Coudray N**, Ocampo PS, Sakellaropoulos T, Narula N, Snuderl M, Fenyö D, Moreira AL, Razavian N, Tsirigos A. Classification and mutation prediction from non-small cell lung cancer histopathology images using deep learning. *Nat Med* 2018; **24**: 1559-1567 [PMID: 30224757 DOI: 10.1038/s41591-018-0177-5]

3 **Hirasawa T**, Aoyama K, Tanimoto T, Ishihara S, Shichijo S, Ozawa T, Ohnishi T, Fujishiro M, Matsuo K, Fujisaki J, Tada T. Application of artificial intelligence using a convolutional neural network for detecting gastric cancer in endoscopic images. *Gastric Cancer* 2018; **21**: 653-660 [PMID: 29335825 DOI: 10.1007/s10120-018-0793-2]

4 **Mojarad S**, Venturini B, Fulgenzi P, Papaleo R, Brisigotti M, Monti F, Canuti D, Ravaioli A, Woo L, Dlay S, Sherbet GV. Prediction of nodal metastasis and prognosis of breast cancer by ANN-based assessment of tumour size and p53, Ki-67 and steroid receptor expression. *Anticancer Res* 2013; **33**: 3925-3933 [PMID: 24023330]

5 **Topol EJ**. High-performance medicine: the convergence of human and artificial intelligence. *Nat Med* 2019; **25**: 44-56 [PMID: 30617339 DOI: 10.1038/s41591-018-0300-7]

6 **Houssami N**, Kirkpatrick-Jones G, Noguchi N, Lee CI. Artificial Intelligence (AI) for the early detection of breast cancer: a scoping review to assess AI's potential in breast screening practice. *Expert Rev Med Devices* 2019; **16**: 351-362 [PMID: 30999781 DOI: 10.1080/17434440.2019.1610387]

7 **Liang Y**, Kelemen A. Big Data Science and Its Applications in Health and Medical Research: Challenges and Opportunities. *J Biom Biostat* 2016; **7**: 307 [DOI: 10.4172/2155-6180.1000307]

8 **Sadoughi F**, Kazemy Z, Hamedan F, Owji L, Rahmanikatigari M, Azadboni TT. Artificial intelligence methods for the diagnosis of breast cancer by image processing: a review. *Breast Cancer (Dove Med Press)* 2018; **10**: 219-230 [PMID: 30555254 DOI: 10.2147/BCTT.S175311]

9 **Ullah M**. Need For Specialized Therapeutic Stem Cells Banks Equipped With Tumor Regression Enzymes And Anti-Tumor Genes. *J Biomed Allied Res* 2020; **2**: 1-6 [DOI: 10.37191/Mapsci-2582-4937-2(1)-013]

10 **Robertson S**, Azizpour H, Smith K, Hartman J. Digital image analysis in breast pathology-from image processing techniques to artificial intelligence. *Transl Res* 2018; **194**: 19-35 [PMID: 29175265 DOI: 10.1016/j.trsl.2017.10.010]

11 **Krumholz HM**. Big data and new knowledge in medicine: the thinking, training, and tools needed for a learning health system. *Health Aff (Millwood)* 2014; **33**: 1163-1170 [PMID: 25006142 DOI: 10.1377/hlthaff.2014.0053]

12 **Divya S**, Indumathi V, Ishwarya S, Priyasankari M, Devi SK. A self-diagnosis medical chatbot using artificial intelligence. *J Web Development Web Designing* 2018; **3**

13 **Acs B**, Rantalainen M, Hartman J. Artificial intelligence as the next step towards precision pathology. *J Intern Med* 2020; **288**: 62-81 [PMID: 32128929 DOI: 10.1111/joim.13030]

14 **Pearce G**, Wong J, Mirtskhulava L, Al-Majeed S, Bakuria K, Gulua N, editors. Artificial Neural Network and Mobile Applications in Medical diagnosis. 2015 17th UKSim-AMSS International Conference on Modelling and Simulation (UKSim); 2015 Mar 25-27; Cambridge, UK. IEEE, 2016 [DOI: 10.1109/UKSim.2015.34]

15 **Jiang Y**, Yang M, Wang S, Li X, Sun Y. Emerging role of deep learning-based artificial intelligence in tumor pathology. *Cancer Commun (Lond)* 2020; **40**: 154-166 [PMID: 32277744 DOI: 10.1002/cac2.12012]

16 **Ullah M**, Qiao Y, Concepcion W, Thakor AS. Stem cell-derived extracellular vesicles: role in oncogenic processes, bioengineering potential, and technical challenges. *Stem Cell Res Ther* 2019; **10**: 347 [PMID: 31771657 DOI: 10.1186/s13287-019-1468-6]

17 **Ullah M**, Ng NN, Concepcion W, Thakor AS. Emerging role of stem cell-derived extracellular microRNAs in age-associated human diseases and in different therapies of longevity. *Ageing Res Rev* 2020; **57**: 100979 [PMID: 31704472 DOI: 10.1016/j.arr.2019.100979]

18 **Ullah M**, Akbar A. Clinical Relevance of RNA Editing to Early Detection of Cancer in Human. *Int J Stem Cell Res Ther* 2020 [DOI: 10.23937/2469-570X/1410066]

19 **Ullah M**, Akbar A, Thakor AS. An emerging role of CD9 in stemness and chemoresistance. *Oncotarget* 2019; **10**: 4000-4001 [PMID: 31258843 DOI: 10.18632/oncotarget.27021]

20 **Ullah M**. The Pandemic of Novel Coronavirus Disease 2019 (COVID-19): Need for an Immediate Action. *J Biomed Sci* 2020 [DOI: 10.38125/oajbs.000168]

21 **Bhatia A**, Mago VK, Singh R. Use of soft computing techniques in medical decision making: A survey. 2014 International Conference on Advances in Computing, Communications and Informatics (ICACCI); 2014 Sep 24-27; New Delhi, India. IEEE, 2014: 1131 [DOI: 10.1109/ICACCI.2014.6968460]

22 **McKinney SM**, Sieniek M, Godbole V, Godwin J, Antropova N, Ashrafian H, Back T, Chesus M, Corrado GC, Darzi A, Etemadi M, Garcia-Vicente F, Gilbert FJ, Halling-Brown M, Hassabis D, Jansen S, Karthikesalingam A, Kelly CJ, King D, Ledsam JR, Melnick D, Mostofi H, Peng L, Reicher JJ, Romera-Paredes B, Sidebottom R, Suleyman M, Tse D, Young KC, De Fauw J, Shetty S. International evaluation of an AI system for breast cancer screening. *Nature* 2020; **577**: 89-94 [PMID: 31894144 DOI: 10.1038/s41586-019-1799-6]

23 **Weisberg EM**, Chu LC, Fishman EK. The first use of artificial intelligence (AI) in the ER: triage not diagnosis. *Emerg Radiol* 2020; **27**: 361-366 [PMID: 32643069 DOI: 10.1007/s10140-020-01773-6]

24 **Ratner M**. FDA backs clinician-free AI imaging diagnostic tools. *Nat Biotechnol* 2018; **36**: 673-674 [DOI: 10.1038/nbt0818-673a]

25 **Yu KH**, Beam AL, Kohane IS. Artificial intelligence in healthcare. *Nat Biomed Eng* 2018; **2**: 719-731 [PMID: 31015651 DOI: 10.1038/s41551-018-0305-z]

26 **Liu Y**. Application of artificial intelligence in clinical non-small cell lung cancer. *Artif Intell Cancer* 2020; **1**: 19-30 [DOI: 10.35713/aic.v1.i1.19]

27 **Alcantud JCR**, Varela G, Santos-Buitrago B, Santos-García G, Jiménez MF. Analysis of survival for lung cancer resections cases with fuzzy and soft set theory in surgical decision making. *PLoS One* 2019; **14**: e0218283 [PMID: 31216304 DOI: 10.1371/journal.pone.0218283]

28 **Powles J**, Hodson H. Google DeepMind and healthcare in an age of algorithms. *Health Technol (Berl)* 2017; **7**: 351-367 [PMID: 29308344 DOI: 10.1007/s12553-017-0179-1]

29 **Balthazar P**, Harri P, Prater A, Safdar NM. Protecting Your Patients' Interests in the Era of Big Data, Artificial Intelligence, and Predictive Analytics. *J Am Coll Radiol* 2018; **15**: 580-586 [PMID: 29402532 DOI: 10.1016/j.jacr.2017.11.035]

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