ACTA SCIENTIFIC CANCER BIOLOGY

Volume 3 Issue 8 August 2019

Editorial

Multidisciplinary Approaches in Cancer Diagnosis and Treatment: Towards Patient-Specific Predictive Oncology

Natalya Kizilova*

Warsaw University of Technology, Institute of Aeronautics and Applied Mechanics, Warsaw, Poland

***Corresponding Author:** Natalya Kizilova, Warsaw University of Technology, Institute of Aeronautics and Applied Mechanics, Warsaw, Poland.

Received: June 25, 2019; **Published:** July 01, 2019

Novel technologies developed in physics, chemistry, material and computer sciences significantly change our everyday life. During the last decades new revolutionary approaches to medical diagnostics, surgery planning based on computer-assisted systems (*in silico*) have changed the quality of medical care and allowed development of personal medicine using complex patient-specific models, automated medical data analysis, vast omic (i.e. genomic, proteomic) studies, and decision making using artificial intelligence (AI) [1-4]. Digital technologies help in shape and material optimization of bone implants, orthodontic procedures, teeth restoration based on the *in silico* mechanical analysis of the corresponding 3D patient-specific models. Blood flow simulations with computational fluid dynamics (CFD) in the CT- based patient-specific vasculatures allow estimation of the stenosis severity and decision making on the stenting procedure [5]. Moreover, electromagnetic, acoustic, optical and other physical properties of tissues carry valuable diagnostic information [6]; some physical properties of blood can be used in cancer diagnostics and estimation of the treatment quality [7]. Nanoparticles and nanofluids were shown to be good candidates for medical applications [8]. It means, contemporary medicine is based on different sciences and needs interdisciplinary collaboration.

Another dimension in the healthcare as interdisciplinary field is formulated in the new health policy framework of the 21st Century called One Health (OH). The One Health concept considers human health in the tight connection to the health of animals (zoonotic diseases) and the environment (food and water quality, contamination), economy, livelihood, and even political regime [9,10]. It is well recognized, cancer diseases are significantly determined by environmental, economic and other factors included into the OH concept. Deeper understanding of cancer biology, gender and geographic distributions of the cancer types [11] needs interdisciplinary collaborative work of doctors, biologists, ecologists, mathematicians, physicists and engineers.

During the last decade a breakthrough in cancer diagnostics has been demonstrated by high-precision and high-fidelity cancer recognition on medical images using the AI or machine intelligence [1,2,12]. For a long time machine learning has been used for medical data analysis and classification in different clinical domains. Recently considerable success of AI in the identification and classification of skin lesions [13], lung cancers [14], metastases in women with breast cancer [15], and prediction of oncogenes and tumor suppressors [16] has been achieved. AI methods can be based on different mathematical algorithms [17], and the most successful ones may be selected in randomized case studies.

For instance, the AI system based on convolutional neural network (CNN) [4,18] better detected skin cancer than a team of experienced dermatologists [19]. The system was trained on >100,000 images of malignant melanomas and benign moles, and then its diagnostic ability has been compared with that of 58 dermatologists from 17 countries around the world. It was revealed, the CNN correctly diagnosed 95% of cancer while experts did only 86,6% cases.

AI algorithms also work in the case of insufficient (incomplete) medical data. The transfer learning (TL) methods can recognize and classify the objects based on the knowledge gained while solving a different but related recognition problem. A TL-system based on CNN and pre-trained on >1000000 of images representing >1000 generic image classes [13] allowed automated classification of skin cancers. Similar TL approach based on Google Net Inception CNN demonstrated better abilities in recognition of lung cancer on the whole-slide images in comparison to that recognized by pathologists [14]. Such systems also serve for integrated analysis of different types of omics data (proteomics, transcriptomics) [20] providing important instruments for precision oncology, pre-clinical and clinical oncology research [12,21,22]. Recently cancer sub-typing based on the patterns recognition across point mutation, copy number, methylation, and RNA expression datasets [23], prediction of glioblastoma progression based on the integrated analysis of DNA methylation [24] have been reported. Reinforcement Learning (RL) algorithms can be trained for predicting optimal dosing regimens to reduce brain tumor size in clinical trials [25].

Therefore, AI demonstrated promising perspectives in analysis, recognition and classification patterns on medical images, integrated arrays of different omic data, including the incomplete data cases, as well as interpret and explain them. The experts could guide the learning process of the TL- or RL-based systems, change the set of the databases, estimate the learning quality and other actions within the expert-in-the-loop system [3]. Information technologies and multidisciplinary approaches in cancer diagnosis and treatment are the main compounds for patient-specific predictive oncology.

Bibliography

1. Yu K., *et al*. "Artificial intelligence in healthcare". *Nature Biomedical Engineering* 2 (2018): 719-731.
2. Lynch CJ and C Liston. "New machine-learning technologies for computer-aided diagnosis". *Nature Medicine* 24.9 (2018): 1304-1305.
3. Girardi D., *et al*. "Interactive knowledge discovery with the doctor-in-the-loop: a practical example of cerebral aneurysms research". *Brain Informatics* 3.3 (2016): 133-143.
4. LeCun Y., *et al*. "Deep learning". *Nature* 521 (2015): 436-444.
5. Kizilova N. "Diagnostics of Coronary Stenosis: Analysis of Arterial Blood Pressure and Mathematical Modeling". In: Biomedical Engineering Systems and Technologies. Springer Series on Communications in Computer and Information Science. Plantier, G., Schulz, T., Fred, A., Gamboa, H. (Eds.) (2015):299-312.
6. Kizilova N. "Electromagnetic properties of blood and its interaction with electromagnetic fields". In: Advances in Medicine and Biology. L.V. Berhardt (ed.) NOVA Sci. Publ. 137 (2019): 1-74.
7. Batyuk L and N Kizilova. "Dielectric properties of red blood cells for cancer diagnostics and treatment". *Acta Scientific Cancer Biology* 2.10 (2018): 55-60.
8. Batyuk L., *et al*. "Investigation of antiradiation and anticancer efficiency of nanodiamonds on rat erythrocytes". In: Nanomaterials: Application and Properties (2017): 04NB23.
9. Kingsley P and EM Taylor. "One Health: competing perspectives in an emerging field". *Parasitology* 144.1 (2017): 7-14.
10. Zinnstag J., *et al*. "One Health: the theory and practice of integrated health approaches". (2015).
11. World Cancer Report. World Health Organization. Chapter 1.1. ISBN 978-92-832-0429-9. (2014).
12. Azuaje F. "Artificial intelligence for precision oncology: beyond patient stratification". *Nature Precision Oncology* 3 (2019): ID6.
13. Esteva A., *et al*. "Dermatologist-level classification of skin cancer with deep neural networks". *Nature* 542 (2017): 115-118.
14. Coudray N., *et al*. "Classification and mutation prediction from non-small cell lung cancer histopathology images using deep learning". *Nature Medicine* 24 (2018): 1559-1567.
15. Ehteshami Bejnordi B., *et al*. "Diagnostic assessment of deep learning algorithms for detection of lymph node metastases in women with breast cancer". *Journal of the American Medical Association* 318.22 (2017): 2199-2210.
16. Bailey MH., *et al*. "Comprehensive characterization of cancer driver genes and mutations". *Cell* 173.2 (2018): 371-385.
17. Li Y., *et al*. "A review on machine learning principles for multi-view biological data integration". *Briefings in Bioinformatics* 19.2 (2018): 325-340.
18. Rawat W and Z Wang. "Deep convolutional neural networks for image classification: a comprehensive review". *Neural Computation* 29 (2017): 2352-2449.
19. Forschner A., *et al*. "Diagnostic accuracy of dermatofluoroscopy in cutaneous melanoma detection: results of a prospective multicentre clinical study in 476 pigmented lesions". *British Journal of Dermatology* 179.2 (2018): 478-485.
20. Karczewski KJ and MP Snyder. "Integrative omics for health and disease". *Nature Reviews Genetics* 19 (2018): 229-310.
21. Wong D and S Yip. "Machine learning classifies cancer". *Nature* 555.7697 (2018) 446-447.
22. Zhang W., *et al*. "Network-based machine learning and graph theory algorithms for precision oncology". *Nature Precision Oncology* 1 (2017): 25.
23. Ramazzotti D. "Multi-omic tumor data reveal diversity of molecular mechanisms that correlate with survival". *Nature Communications* 9 (2018): 4453.
24. Klughammer J., *et al*. "The DNA methylation landscape of glioblastoma disease progression shows extensive heterogeneity in time and space". *Nature Medicine* 24 (2018): 1611-1624.
25. Yauney G and P Shah. "Reinforcement learning with action-derived rewards for chemotherapy and clinical trial dosing regimen selection". *Proceedings of Machine Learning Research* 85 (2018): 161-226.

Volume 3 Issue 8 August 2019