EUROPEAN UROLOGY 78 (2020) 775–776

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Platinum Opinion

The Emerging Role of Artificial Intelligence in the Fight Against COVID-19

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1. Introduction

According to Worldometer, a tool for algorithm-driven data analysis and real-time statistical visualisation, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) coronavirus disease 2019 (COVID-19) pandemic has led to more than 18 million cases and nearly 700 000 deaths in more than 200 countries as of August 5, 2020 (www.worldometers.info/coronavirus/). The impact on surgical specialities has been considerable [1]. There have been reductions in urological capacity of up to 80% and strict triage to limit procedures to only the most urgent emergency or cancer operations such as cystectomy, orchidectomy, radical nephrectomy, and radical prostatectomy for high-risk disease [2]. The COVID-19 pandemic has generated large volumes of clinical data that in anonymised form can be an invaluable resource towards answering a number of important questions for this and future pandemics. We summarise the role of artificial intelligence (AI) in analysing such large "data lakes" and focus on why this may be of interest to urologists.

2. Tracking and early warning signs

Using natural language processing, which helps computers to comprehend, analyse, and generate human language, King's College London in collaboration with Massachusetts General Hospital designed the COVID Symptom Tracker, an AI-based smart phone app that monitors viral transmission and symptoms [3]. This identified the importance of anosmia as an early warning symptom. The AI-powered NHSX contact tracing app warns users about viral exposure and so dramatically reduces transmission rates. Alerts are triggered when users self-report symptoms or test positive, while respecting anonymity. Widespread SARS-CoV-2 testing has been difficult owing to shortages of test kits and long waiting times for results. Seegene used its AI-based Big Data platform to create the Allplex assay, a real-time reverse transcription-polymerase chain reaction that detects N, E, and RdRP viral genes in a single reaction tube. It takes 4 h to test 94 patients, is accurate, and costs $20. Ten million kits have been exported to more than 60 countries.

3. Improving diagnosis and treatment

AI can help in improving the diagnosis of SARS-CoV-2 infection. For example, 4536 chest computed tomography images for 3222 patients spanning six hospitals formed the raw training and independent testing data sets for an AI algorithm designed by Infervision (Beijing, China) to tell the difference between COVID-19 (bilateral ground-glass opacities) and community-acquired pneumonia [4]. The sensitivity and specificity were 90% and 96%, respectively. New York University developed an AI predictive analytic model with 70–80% accuracy in quantifying the risk of acute respiratory distress syndrome; in this model, myalgia and elevated alanine aminotransferase and haemoglobin levels were highly predictive of clinical deterioration [5]. Cambridge University and NHS Digital have a COVID-19 capacity planning and analysis system that can predict demand for intensive care beds and ventilators using a machine learning algorithm. Such platforms can potentially reduce

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https://doi.org/10.1016/j.eururo.2020.09.031

mortality by flagging early warning signs and facilitating earlier intervention.

Cutting-edge metagenomic next-generation sequencing (mNGS) is an unbiased, high-throughput, massive parallel sequencing tool [6] that produces millions of nucleotide short reads. Using artificial neural networks with large data sets of raw transcriptomes as input and producing accurate genomes as output, NVIDIA Parabricks refined mNGS platforms to perform sequencing faster (~1 h) and at lower cost. Benevolent AI used deep learning to create biomedical knowledge graphs, networks defining inter-relationships between entities such as proteins and drugs. An example is baricitinib, which blocks viral entry by preventing endocytosis and is used to treat arthritis [7]. AI has thus led to some significant inroads into the discovery of potential treatments against our invisible enemy.

4. Why should this matter to urologists

The SARS-CoV-2 virus affects men more than women, but men on androgen deprivation therapy (ADT) seem to be relatively protected. Data for 9280 COVID-19 patients in 68 Italian hospitals including 4532 men showed that men had more severe disease, were hospitalised more frequently, and had worse clinical outcomes in comparison to women. However, prostate cancer patients receiving ADT had a significantly lower risk of COVID-19 infection compared to those who not receiving ADT [8]. This clearly needs further investigation at a time when there does not appear to be any definite benefit from repurposed agents against COVID-19 except perhaps dexamethasone and a potential role for bacillus Calmette-Guérin (BCG.) The hypothesis is that inhibition of transmembrane serine protease 2 (TMPRSS2) in the prostate by ADT or a 5α reductase inhibitor (5ARI) can block SARS-CoV-2 entry into nasal and bronchial epithelial cells, a process mediated by angiotensin-converting enzyme 2 (ACE-2) and TMPRSS2. ACE-2, the receptor for SARS-CoV-2, is found primarily in the lungs but also in the kidneys and prostate [9]. During SARS-CoV-2 entry into host cells, its spike protein is cleaved into S1 and S2 subunits. The S1 subunit contains a receptor-binding domain that docks with the peptidase domain of the ACE-2 receptor for cell entry. Cleavage of spike proteins by a protease such as trypsin/cathepsin G and/or ADAM17 (A Disintegrin and metalloproteinase domain 17) on the ectodomain and TMPRSS2 on the endodomain of the ACE-2 receptor facilitates viral entry into cells.

On the basis of the above findings, large-scale data analysis using AI of COVID-19 among men on TMPRSS-2 blocker, ADT, or 5ARI therapy is underway [3]. This involves adding questions about the use of these drugs to existing phone-based tracking apps [3], which have now gathered data on many millions of patients, to see if statistical modelling and AI algorithms can show a protective effect of these drugs against the virus via blocking of the ACE2-TMPRSS2 pathway. The anatomical location of ACE-2 may be a paradigm for future drug discovery pipelines.

AI is also important for urologists because it can identify populations at higher or lower risk of COVID-19–related urological pathologies in addition to epidemiological and clinical observations that suggest treatments such as ADT/5ARI/BCG. AI-driven data analytics are also likely to become embedded in safe clinical pathways and to help in restarting clinical services.

Conflicts of interest: The authors have nothing to disclose.

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