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Editorial

Use of Technology in Respiratory Medicine

I know I've made some very poor decisions recently, but I can give you my complete assurance that my work will be back to normal. I've still got the greatest enthusiasm and confidence in the mission. And I want to help you". HAL 9000.
Stanley Kubrik, director. 2001: A space odissey.1968

In just a few months' time, the COVID-19 crisis has accelerated the digitization in all sectors, including healthcare. Cutting-edge technological tools and innovations are increasingly adopted in all areas of public health, medicine and wellbeing. Digital health ecosystems allow the shift from an organization-centric to a patient-centric model of delivering healthcare services.[1] In addition to traditional methods,[2] robotics, artificial intelligence (AI), big data analytics, wearable devices, mobile applications (apps) and tele-medicine become effective resources.[3]

Some examples of recent developments include automated and standardized analysis and software tools using AI for visualization and quantification of radiological images; low-dose-computed-tomography for monitoring interstitial lung diseases (ILD) with lower radiation dose; combined deep learning (DL) and machine learning algorithms able to distinguish idiopathic pulmonary fibrosis among various ILDs[4–6]; DL algorithms to predict survival in intensive care unit (ICU)[7]; robotic bronchoscopy showing promising results especially when combined with advanced imaging.[8]

We have the technology to monitor chest wall motion providing information on respiratory muscles action and on critical vital signs, like respiration and cardiac activity and manage at distance the impairment in physical performance with appropriate programs of tele-rehabilitation.[9–13]

There is evidence that technologies such as virtual reality, augmented reality, domotics, and wearables, can relieve the burden of many healthcare tasks from professionals with more benefits and safety for more fragile individuals.[2,13–15] Furthermore, despite the usefulness of AI during the acute phase of pandemic has been questioned, it might be also helpful for the late sequelae of COVID-19.[16]

Data collected by robots and mobile apps may be analyzed by means of dedicated machine learning algorithms able to extract meaningful information for prevention diagnosis and treatment. However, data protection and privacy regulations and laws must be guaranteed.[15]

These are only some of the problems arising from an increasingly pervasive use of technologies. New questions on accountability arise. Who will be responsible for dysfunction of a home ventilator resulting in patient's damage? The prescribing physician, private companies, the caregiver?[17] Another issue regards the supervision of healthcare professionals when such technologies are employed. Does use of robotics require the constant in-person supervision of a qualified professional? Will there be a doctor still listening to lung sounds with a stethoscope?

To face these problems, we need to redesign the academic programs for the specializations we may require most in the next years, and include data science in the programs. The amount of medical data needed to train an effective and robust DL model would be much more compared with other application areas. Healthcare data and biomedical images are highly heterogeneous depending on several acquisition parameters that might not be standardized across different centers. Different from other application domains, the problems in biomedicine and healthcare are characterized by a high level of complexity. The diseases are highly heterogeneous, and most of diseases are still considered idiopathic, with little knowledge on their causes and progression. Finally, although DL models have been successful in quite a few application domains, they are often treated as black boxes. While this might be acceptable in other more deterministic domains, in healthcare it is not. Model interpretability (i.e., providing which phenotypes are driving the predictions) is crucial to give recommendations to medical professionals, and to support them in the decision-making process.

This is just an example on how the redesign of academic programs for specializations, including respiratory medicine, represents an urgent need. New educational programs able to integrate and strengthen the skills of the professional figure of the medical doctor with the skills relevant to Biomedical Engineering and Data Science have been recently developed and proposed. These first ventures not only should be followed by other similar initiatives, but also a new paradigm in medical education should be implemented. New medical professionals should be trained to treat patients through a better awareness and management of technology. This will allow the new doctors to gain in-depth knowledge of advanced medical technologies and be able to design personalized therapies using complex technological systems for clinical evaluation, diagnosis, and treatment. In addition, the new doctors will have to be able to optimize therapeutic outcomes based on the potential of data analytics and machine/deep learning techniques, the use of new materials and advanced therapeutic devices such as surgical robots, endo-prostheses, bio-printers.

There is another important issue to consider. Advances in technology are increasingly changing relationships between consumers (patients) and providers of products and services (healthcare services, hospitals, and other) in every business. Digital health and mobile health technology by means of apps could provide an important contribution to manage chronic conditions, to provide

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behavioral interventions (i.e., promote physical activity, improve adherence to drug therapy, facilitate smoking cessation), and to improve health outcomes (i.e., reduce hospital and health care facilities visits). These interventions are more effective when including text-messaging or personalization features. Participation of patients and healthcare professionals in design and development of the apps helps identifying patients' needs, implementing proper technical solutions to meet these needs and improve acceptance and effectiveness.

The democratization of recognized expertise associated to the use of information technology can be a positive force for improving access, cost, and equity, but also can challenge the role and status of traditional experts (physicians), including their marginalization.[18] It is important that new generations of doctors embrace the change, and turn it into an opportunity. Interestingly, it has been found that, rather than viewing the system as a surrogate for their clinical judgment, clinicians perceive themselves as partnering with the technology, suggesting that, even without a deep understanding of machine learning, clinicians can build trust with these systems through experience, expert endorsement and validation.[19]

In conclusion, we are in the middle of a cultural storm in medicine, new technologies and new expertises are increasingly involved in research and care. Physicians will be not the unique masters of this universe: from one side they need to update their knowledge and tools to manage health reality, from the other side they must accept to share responsibilities with other professionals.

However, robotics, AI, virtual reality will not be able to substitute the main weapon of medical art/science, since as of today the needed empathy between patients and caregivers cannot be learnt by machines.

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Conflict of interest

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