Annals of Medicine and Surgery 60 (2020) 702–703

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Limitations of health technology implementation: A commentary on "artificial intelligence, regenerative surgery, robotics? What is realistic for the future of surgery?"

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ARTICLE INFO

Keywords:
Health technology
Robotic technology
Augmented reality
Artificial intelligence
Costeffectiveness

Dear editor,

With great interest we have read the article: "Artificial intelligence, regenerative surgery, robotics? What is realistic for the future of surgery? By Sam P. Tarassoli published in Annals of Medicine and Surgery 41 (2019) 53–55 - https://doi.org/10.1016/j.amsu.2019.04.001 [1] which provides insight into anticipated surgical innovations for future decades. We would like to congratulate the author for this successful review article, and share our opinions.

Generally, within the current scope of our success in new medical technologies, at the core they are established in a cycle of conception, planning, execution and evaluation before being brought forward into the mainstream. Pragmatism works in tandem with the theorem behind scientific and medical communities with the aim to enhance the field and patient care. Hence, opportunities to further advance technological development ought to be balanced with servicing the greater population over self-interests. The article enthusiastically discusses potential of medical technologies, including challenges in implementation some technologies briefly due to limitations in scientific breakthrough such as "failure of getting cells to differentiate and proliferate into what is required, moving cells where we want which brings a challenge to printing a complex organ such as a kidney". We feel the article would benefit offering different perspectives on the challenges of implementing these future utilities on a large scale to benefit the population from other standpoints besides scientific limitations.

The author discusses use of robotic technology in healthcare, however the National Institute of Clinical Excellence (NICE) has only deemed robotic technologies use in prostatectomies as clinically effective and cost-effective based on Health Technology assessments (HTA) [2]. While it may be of used and be of benefit in other types of surgeries, the implementation of robotic technology has been limited as its use for non cost-effective interventions generates loss to out National Health Service (NHS). Furthermore, the uptake of robotic technology per region and use in robotic prostatectomies has been shown to be erratic in regions and it has been shown not to be meeting cost-effective thresholds nationally [3] which makes this technology challenging to use to benefit the population without disadvantaging the NHS.

Furthermore, the prospect of successful widespread applications of virtual (VR) and augmented reality (AR) is dependent on its accessibility in developed versus developing countries, available resources and costs to develop virtual applications for surgeons, and investing in their specialist training requirements. One example, the Microsoft HoloLens [www.microsoft.com/hololens] which first launched in 2016, has pioneered the way augmented reality can be pushed to its potential by incorporating holographic objects within its medium, as opposed to the traditional observational role we are accustomed with in VR [4]. It has already shown success in medical education with digital anatomy teaching becoming a curriculum staple for students at Case Western Reserve University and Cleveland Clinic, USA [4,5]. The elephant in the room, however, lies in the cost of a single device, which is listed at 3500 USD according to the HoloLens web page (as of June. 2020). Time will

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https://doi.org/10.1016/j.amsu.2020.11.041
Received 12 November 2020; Accepted 12 November 2020
Available online 25 November 2020

tell as to the extent the progress in this field reaches via the continuous collaboration between healthcare providers and technology giants, to eventually develop affordable devices for larger scale consumer use (i.e. Surgeons, medical students practicing anatomy, and access by doctors in less developed regions). This will set a precedent for how successful globalised future technologies can become over their lifespan to reach the highest number of users realistically possible.

In 2017, the Royal College of Surgeons of England established a commission operating independently to address the various surgical innovations anticipated over the coming years and decades with a report published in 2018, titled "Future of Surgery" [6]. The report goes into great detail on what we can expect to see in 20 years, ranging from robotics in surgical theatre, AI machine learning and nanotechnology, which have been eloquently covered in the original article. The report notably highlights several expected ethical concerns with example technologies and how this may shape public perception in accepting or rejecting these breakthroughs; with gene editing, how do we consider modifying the physical and cognitive features of a being that would be unable to consent to it? Access to organ printing capabilities and body enhancements to prolong life, eliminate multiple ailments [6] and replacement of extremities via prosthetics [7] may be subsequently implicated in healthcare and economic inequalities, depending on the affordability and ease of access to these innovations by wealthier communities as opposed to the impoverished with mitigating socio-economic factors.

Such technologies may be faced with conflicts of interest that may arise from governmental or private funding, and how legislatures such as the General Data Protection Regulation (GDPR) may influence data sharing and collection being utilised in a surgical capacity from country to country [6,8]. Artificial intelligence continues to be a remarkable advancement in the medical space but will undoubtedly raise further questions on who is ultimately responsible for the ownership and/or oversight of these intellectual properties.

Conclusively, we have discussed challenges implementing medical technology from a cost-effective, accessibility, healthcare inequalities, ethical and intellectual property standpoints respectively in addition to the author's view on limited scientific evidence for implementation of medical technologies.

Funding

No funding to declare.

Ethical approval

No ethical approval required.

Consent

No consent required.

Author contribution

Please specify the contribution of each author to the paper, e.g. study concept or design, data collection, data analysis or interpretation, writing the paper, others, who have contributed in other ways should be listed as contributors.

Jasmesh Sandhu and Yamen Jabr are joint-first authors with equal contribution in this manuscript.

Registration of research studies

NONE REQUIRED.

Guarantor

The Guarantor is the one or more people who accept full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Declaration of competing interest

No conflict of interest to declare.

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