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Possible role of artificial intelligence in radioprotection

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Acute radiation syndrome: A multifactorial and complex challenge

Exposure to ionizing radiation (like X- and gamma rays), depending upon the absorbed dose, leads to a variety of biological manifestations which are classically referred to as acute and chronic effects [1]. A number of signs which appear, at different time points post whole body exposure, are the resultant of a complex (when more than one or few factors determine the outcome and may not be manageable with single agent) biological response involving a number of molecular mediators, pathways, inter cellular and tissue interactions resulting from systemic response [2]. Unlike the bacterial infection or a metabolic disorder (like type 1 diabetes), the target is not singular and soon after the radiation exposure the number of mediators which appear on the landscape of tissues become very large and the response becomes multifactorial [3,4]. A number of human pathologies like cancer, neurodegenerative disorders and normal ageing have also been recognised to be multi-factorial and complex [5,6]. Unlike these pathologies, the pace with which the complexity increases with time makes acute radiation syndrome difficult to manage and hence lethal [7]. In fact a large number of molecules of natural, synthetic origin and complex natural products have been tested for radioprotection but due to variety of reasons including toxicity at effective doses and bioavailability, as of now no agent is available which is safe and effective for human applications [8]. The temporally changing cellular and tissue landscapes, poses a major hurdle in developing protective strategies and does not fall into the realm of one pill therapy.

Artificial intelligence in biology

Use of computational methods (both chemo- and bio-informatics) for analysing large data sets is nothing new and the large number of softwares available commercially and in public domain serve the purpose of screening small molecules, analysing large data obtained from genomic, proteomic and metabolomics studies etc. [9]. Many of the programmes which analyse large data sets use supervised learning methods (use of training data sets) [10,11]. However, with the advancements made in the field of machine and deep learning techniques, now it is possible to use these methods in conjunction with approaches like neural networks (a series of algorithms structured in a layered fashion which mimics the functioning of human brain and improve its decision making capacity by changing its input without the need of additional algorithms) to devise what is popularly known as artificial intelligence (AI). In fact AI has been proposed to help in better decision making in diverse fields including detection of malignant from benign tumor [12]. Similarly a number of researchers have proposed that using machine and deep learning methods, it is possible to come out with an algorithm which can detect cancer from medical and non-medical data sets.

The need of artificial intelligence for understanding the complexity of radiation biology and developing countermeasures

However, the point that is being envisaged here is a step forward in developing AI to an extent that it would reliably mimic the normal as well as pathophysiology of radiation syndrome and be able to assess different molecular pathways, cellular, tissue-tissue interactions and systemic responses which appear and disappear temporally on the landscape of the biological tissues. In fact, given to the complexity that a mammalian system exhibits at delayed time points, it is very difficult to achieve ideal radioprotection without understanding the temporal changes in the biology after IR exposure. It is conceivable that when a large number of factors which are interacting in a complex way determine the outcome then the only way to understand the complexity is to use a computational device capable of processing and predicting a large number of probabilities and provide the best possible solution. The unprecedented optimism associated with AI is that it works on itself and improves without any supervision thereby improving decision making capability. This view may sound optimistic, that AI would be able to predict the complexity and be able to suggest possible targets for countermeasures, but if the answer lies in understanding the complexity and when large number of mediators add to that complexity then resorting to AI should be an interesting option if not the only option.

AI platforms for radiation syndrome and other complex diseases: The possibility

Living organisms exhibit a staggering complexity and a large number of molecular and cellular networks function simultaneously and influence each other in a manner which is neither continuous nor periodic with an ultimate goal to restore the homeostasis [13]. The future of all endeavours including biology, medicine, and environment belongs to efforts involving teaming up of man and machine. It is worth noting that whether living or non-living, all the matter is made up of atoms and it can be anticipated that by utilizing a combination of supervised, unsupervised machine and deep learning techniques it is

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possible to make a system (*may or may not be consciousness*) [14,15] intelligent enough to work and improve its performance on its own. The computing industry is amongst the fastest growing industries and AI is undoubtedly the future. In spite of all the apprehensions that are associated with AI like the possibility of building AI without losing control over it and will machine ever take over the human race etc., in today's world, the power of intelligence and automation is comprehensible. Keeping in view the gains we are making with AI, AI can be expected to be improved upon in a direction which makes the machines more and more intelligent. Considering the pace with which the field of AI is progressing, it is undoubtedly a matter of a decade or two before we would be having a device with machine and deep learning methods equipped with quantum computing capabilities (In quantum computing, unlike the binary bit which can be realized with a two state system, qubit is the simplest two state quantum mechanical system displaying quantum features like coherent superposition which makes it more efficient in terms of computing) This device would be capable enough to understand the human biology (from the complexity point of view and understanding the foundations which forms the basis for this complexity) in health and pathological scenarios which may reliably predict solutions for multifactorial pathologies like radiation induced lethality and other complex diseases like cancer.

Is there a chance that AI will accurately predict?

The higher life forms exhibit extreme complexity and pose a real challenge to any efforts trying to understand it. Unlike a machine, human brain (for simplicity sake a comparison of the decision making that works in peripheral tissues is being made here with the brain) probably does not process all aspects of a problem in parallel, at least consciously before arriving at a solution. Imagine a situation if an AI has to recognise a cat, it needs an image of a cat which it will process for shape, size, texture etc. and matching with all the animals that possibly could match and finally figure out that it's a cat. However, we humans probably don't do information processing in this manner but we have memories stored and as soon as we see a cat with our eye we recognize it as a cat. As our intelligence is the outcome of a combination of a number of senses (olfaction, hearing, vison, sense of touch etc.) and of course the brain. The way a human brain solves a problem is more or less not well understood but what is conceivable is that we just end up in connecting two or more relevant information together resulting in either a solution or making sense of an issue. The processing or the computational aspect which leads to connecting of two different sets of information is not well understood. If it involves more than just a computational aspect and processing of information then probably AI without human consciousness and of course without that 'unknown ability' to just bring relevant pieces of information together may fall short in completely understanding the biology and predicting solutions. It is interesting to witness whether just by increasing the computational capability along with machine and deep learning methods it is possible to understand the complexity of life and predict solutions. However, even though different organisms and humans are evolved and shaped the way they are by nature, working through billions of years without abeyance and our intelligence which makes us a dominant species (in terms of the apparent control we have over the existence of other living organisms and of course our own and the biosphere) depends to a little extent on our ability to process the information from computational point of view and to a larger extent on our ability to recognize and use the right things for right purpose (like use of calculator, flights for large distance travel, computers for processing large data sets). In a situation where this aspect becomes a major factor, there AI with mere computational ability (ability to do many calculations per second) may not be able to understand and predict the outcome of the biological events. Nevertheless, it is interesting to contemplate if AI would help in complete understanding of human biology and guide us in devising strategies for complex diseases including radiation syndrome.

References

1. Hall EJ, Giaccia AJ (2019) Radiobiology for radiologists. 8th Edition. Wolters Kluwer, Philadelphia, USA.
2. Prem Kumar I, Gupta D, Bhatt AN, Dwarakanath BS (2011) Models for the development of radiation countermeasures. *Def Sci J* 61:146-156.
3. Uozaki H, Fukayama M, Nakagawa K, Ishikawa I, Misawa S, et al. (2014) The pathology of multi-organ involvement: two autopsy cases from the Tokaimura criticality accident. *The British Institute of Radiology* 78: 27.
4. Berger ME, Christensen DM, Lowry PC, Jones OW, Wiley AL (2006) Medical management of radiation injuries: current approaches. *Occu Med* 56: 162-172.
5. Kirkwood TB (2005) Understanding the odd science of aging. *Cell* 120: 437-447. [Crossref]
6. Mitchell KJ1 (2012) What is complex about complex disorders? *Genome Biol* 13: 237. [Crossref]
7. Williams JP and McBride WH (2011) After the bomb drops: A new look at radiation-induced multiple organ dysfunction syndrome (MODS). *Int J Radiat Biol* 87: 851-868. [Crossref]
8. Singh VK, Newman VL, Romaine PLP, Wise SY, Seed TM (2014) Radiation countermeasure agents: an update (2011 -- 2014). *Expert Opin Ther Patents* 24: 1229-1255. [Crossref]
9. Spicer R, Salek RM, Moreno P, Cañueto D, Steinbeck C, et al. (2017) Navigating freely-available software tools for metabolomics analysis. *Metabolomics* 13: 106. [Crossref]
10. Heinemann J (2019) Machine learning in untargeted metabolomics experiments. In: Baidoo E. (eds) Microbial metabolomics. Methods in molecular biology, vol 1859. Humana Press, New York, USA.
11. Cuperlovic-Culf M (2018) Machine learning methods for analysis of metabolic data and metabolic pathway modeling. *Metabolites* 8: 4. [Crossref]
12. Bi WL, Hosny A, Schabath MB, Giger ML, Birkbak NJ, et al. (2019) Artificial intelligence in cancer imaging: Clinical challenges and applications. *CA Cancer J Clin* 69: 127-157. [Crossref]
13. Cannon WB (1932) The wisdom of the body. WW Norton & company, Inc. New York.
14. Dehaene S, Lau H, Kouider S (2017) What is consciousness, and could machines have it? *Science* 358: 486-492. [Crossref]
15. Hildt E (2019) Artificial intelligence: Does consciousness matter? *Front Psychol* 10: 1535. [Crossref]