How will the role of physics in the fight against cancer develop over the next 10 years?

The application of physics in medicine has revolutionised our understanding and treatment of cancer. In the last 50 years innovations in cancer care means people are now twice as likely to survive for more than 10 years after diagnosis.

This progress is only expected to continue, meaning we are increasingly focused on living well after cancer, not simply survival. We are also facing a rapid increase in the number of people requiring cancer care, driven by increasing incidence and prevalence. Thus, demand on cancer services is only increasing at a time where global resources are being squeezed and scrutinised.

We also see a growing demand for more personalised care, earlier diagnosis, access to new treatments and techniques, as well as the need to address systematic inequalities. To discuss how the role of physics will change within this evolving cancer landscape, we need to consider what its role is now.

Physics is found at all stages of development in medicine; from concept, to research, to introduction of new equipment and techniques in the clinic, to maintenance and monitoring.

One key area of importance for physics in medicine is the use of radiation. This includes both ionising and non-ionising radiation and is used in both imaging and treatment. Physics is necessary for measurement, both of people themselves and equipment performance. This helps us diagnose problems, monitor safety and effectiveness, and manage risk.

Physics in medicine is also already highly multidisciplinary, with physicists involved in tasks from scientific problem solving, to radiobiology, to computing, as well as providing direct clinical support.

How will physics impact on cancer care in the next decade? Improving imaging means cancer can be diagnosed earlier, monitored better, and gives us more useful information. All these may enable more effective and targeted treatments. Within the next 10 years we are likely to see improvements in image quality driven by better equipment and software, as well as imaging systems that are faster and easier to use.

We also expect growing demand for safer imaging systems, with either lower radiation doses or increased use of non-ionising options such as MRI. This may enable imaging to happen more often and possibly expand the scope of screening. Finally, improvements in computing means we can get more information out of our images and automate more processes, such as using AI guided radiology reporting and contouring of anatomy.

Within cancer treatment, the diversity of treatment options is increasing, and many rely on fundamental physics concepts to deliver them safely and effectively. This includes the increased use of radiopharmaceuticals in therapies as well as developments in radiotherapy. There is likely to be increased use of proton and heavy ion therapy and development of the next generation of radiotherapy treatment machines, called LINACs.

Therapies are likely to become more accurate and precise, which will hopefully increase effectiveness and reduce side effects. However, in turn this also means we are likely to see increasing numbers of people returning for multiple treatments over the course of years. This requires careful analysis of risk and benefit due to the potential for harm from excess radiation, and new strategies to increase patients’ available treatment options in the future.

There is also an increasing demand to image during treatment, in order to provide the most accurate treatment possible. This will increasingly require physics staff to work across different traditional specialism boundaries.

More complex computing systems will also mean physicists must increasingly not only understand fundamental physics concepts, but also have a deep understanding of computers and how they model physical concepts. This ranges from automation in imaging and treatment planning using AI, to using machine learning and other “big data” tools to predict patient outcomes.

These tools have huge potential for speeding up treatment pathways, improving calculation accuracy and enabling increasingly personalised care based on better prediction of both risk and outcome from big data. However, they all need to be verified in the real world to check they are safe and accurate. Physics will therefore be necessary to decide on acceptable methods of verification and to problem solve where the results do not agree.

Innovation is also needed in the next 10 years to better meet diverse needs. With increased demand we need systems that can perform more efficiently, as we need to be able to increase and improve services whilst tackling long waiting lists. With climate change we need systems that minimise their impact on the environment. With improved survival we need techniques that allow for longer term monitoring and retreatment. We need to be able to diagnose people faster and allow for increasingly personalised care, using data to ensure people get the best possible care. And we need to ensure we minimise inequalities in healthcare; ensuring our systems are fair, effective and accessible to all.

This means recognising how our current systems need to change to meet the needs of marginalised groups; from ensuring software can reflect LGBTQ+ identities, to ensuring technologies are equally effective on different skin tones, to ensuring we are aware of how biases propagate in datasets.

Overall physics is pivotal in shaping the future of cancer care. Not only is understanding of fundamental physics a requirement in modern cancer care, but the role of the medical physicist also means that they’re well placed to support innovation, including advanced use of computers and new medical devices.

The role of physics is likely to become more important, with almost every cancer patient receiving some sort of scan or treatment that relies on physics, and physics will need to be used in increasingly multidisciplinary ways, at the interface of physics and biology, chemistry, and computing.

Without physics, it isn’t possible to provide modern cancer care, let alone improve it.

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