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How should Future Radiation Oncologists be Trained for a World Moving to Precision Medicine?

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PERSPECTIVE

"*If you know the enemy and know yourself, you need not fear the result of a hundred battles*." – Sun-Tzu – The Art of War [1]

The quote from Sun-Tzu rings true in many situations and is apt for what has lacked in training of radiation oncologists. With the transition from "intuitive"(past) to "empiric"(present day) and then onto "precision"(future) medicine, it is imperative for radiation oncologists of the future to understand their own ways of thinking, in order to effectively use the technology tools which are rapidly being developed to augment their ability as radiation oncologists to treat cancers (the 'enemy').

I use the terms "Intuitive", "Empiric" and "Precision" medicine in the way Clayton Christenson does so in "The innovators Prescription"[2]. Intuitive medicine refers to the type of medicine generally practiced until the mid-20th century. There was not a lot of data on many diseases, limited technology to make accurate diagnoses and limited therapeutic options. Often the doctor relied on their experience or "intuition" to make the diagnosis and treat accordingly. As data and technology evolved, medicine became more empiric rather than intuitive i.e. data is available for the best diagnoses and treatment outcomes, but there is still an inability to diagnose with 100% certainty or to treat with a therapeutic intervention which cures the disease with an almost 100% success rate. We enter the realm of precision medicine when diagnosis and treatment choice can be made with close to 100% certainty. As understanding of the human genome improves, precision diagnosis and treatment will allow more diseases to move into the realm of precision medicine, especially within oncology.

Unfortunately, much medical training is still rooted in an era of intuitive medicine where doctors often rely on intuition to diagnose and treat patients. This intuition is gained from seeing hundreds to thousands of patients and developing an intuition as to what problem exists, and the best possible treatment strategy. Therefore, medical students and interns are exposed to hundreds of patients in their training. This training was imperative in the past, as not a lot of tools existed to assist doctors in making diagnostic and treatment decisions. However, as technology evolved, innovations such as in imaging e.g. MRI and PET-CT scanners, pathologic tests, and best practice protocols allowed doctors to make their decisions with more confidence and did not need to rely

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on intuition alone. This is the world of medicine where doctors find themselves today, but training is still largely focused on seeing hundreds of patients in the clinic to intuitively know the correct treatment for a patient. And doctors relying on intuition rather than best practice and evidence are suboptimal, as they may focus less on technology which may assist and may be less inclined to stick to protocols and checklists designed to produce best outcomes. In his book "The Checklist Manifesto"[3], Atul Gawande describes how following a simple checklist improved treatment outcomes in patients who underwent surgical procedures, yet the enthusiasm to adopt this cheap and simple intervention was not high and was at times met with resistance from surgeons. This was despite the checklist showing bigger improvements in morbidity than many new surgical devices could offer, tools which the surgeons were much more keen to try. Perhaps one reason for this is because doctors trained to follow their intuition above a protocol or checklist, understandably are reticent to follow these, even if there is clear evidence that they improve outcomes.

Another possible consequence of current training methodology is the reinforcement of a decision-making bias which Nobel laureate Daniel Kahneman refers to in his book "Thinking, fast and slow"[4] as the 'Inside View'. The 'Inside View' is how we view our own situation, relying on our narrow experiences and intuition to make decisions. A patient's situation may not be unique compared to those studied in writing protocols, but their doctor may believe it their patients situation to be unique. This may prompt the doctor to ignore protocols, in the belief that based on their special situation and skills, the outcome will be different. Doctors accustomed to making intuitive judgments, are likely to look at patient information and then search for evidence from their own experience to support making a diagnosis or taking a treatment course without using the assistance of tests or protocols to assist this. This would not be surprising since due to a medical training system tuned for intuitive medicine, doctors are taught to look for evidence from their own experience and extrapolate. This may lead them to think that their own anecdotal knowledge is more informed than a protocol based on the statistics of an accumulation of thousands of similar patients. Extrapolating from your limited set of data does not take into account what former U.S defence secretary Donald Rumsfeld famously referred to as the "unknown unknowns" (i.e. that which we don't know we don't know), and it may better serve, on average, these doctors to rather follow the data than their anecdotal experience. This is because the doctor may not even be aware of the 'blind-spots' in their knowledge.

One way of protecting against these and many other biases is for doctors to gain more insight into their own decision making processes, or to "know themselves" as Sun-Tzu put it in his quote from "Art of War"[1] rather than concentrating on only knowing the enemy i.e. the 'cancer'. Little time is spent on this self-understanding in undergraduate or specialist medical training, which contrasts with the training received by business leaders. When doing an MBA in a top Business School, MBA students spend much time working with leadership coaches and reading personal personality analyses to understand themselves better, and how they make decisions. The idea is that if they know themselves, including strengths and weaknesses, they will make better decisions, and work better with others. Such training, which is standard in most top business schools, needs to become available in medical schools too. Game theory holds that we not only consider our moves, but the moves of our opponents, and then adjust our moves depending on what we anticipate our opponents to do – this is the standard battle between the oncologist and cancer, and in treating many cancers, oncologist become proficient at doing this. But it does neglect one important dimension - to analyze our own decision-making process. This is going to become key for radiation oncologists as they move away from intuitive judgments into an era of precision medicine. Specialist training programs should take a page from management and leadership programs and focus on this in addition to making registrars treat many cancer patients.

But isn't there something to be said for intuition. In his book "Blink"[5], Malcolm Gladwell argues that often ideas and solutions may occur as a result of intuitively knowing – or having a gut feel, without knowing the exact reasoning why or how the decision was made. He expresses that such intuition should be trusted, especially if it comes from an expert. This view does hold true in situations for which there is little data, such as a disease for which there is little diagnostic or treatment data. We should then defer to expert opinion. However, where evidence based diagnostic and treatment protocols exist, these should be used.

In his book, "Thinking, fast and slow" [4], Daniel Kahneman calls such 'intuitive' or 'gut-feel' thinking 'system 1' thinking - it is the instinctual answer given in response to a situation. In situations requiring more thought, we engage a more analytic system which he calls "system 2' thinking. The problem with 'system 1'thinking is that we may not be seeing the full picture, and we may be missing key data, leading to incorrect conclusions. It is better, in key or complex decisions, to logically think through a problem, making sure you are incorporating all available data. Hence, for radiation oncologists, it is imperative that they guard against this, and engage their 'system 2' thinking when dealing with patients' lives. At the very least, they should be aware of their decision-making process.

Currently in radiation oncology, diagnoses and treatment decisions often cannot be made with 100% certainty. Decisions may have too many variables or unknowns to give a definitive right answer. Here the registrars need to develop the ability to quickly see these situations and be able to apply their analysis of available data to give a best therapeutic option, and the current system of seeing many patients and attending tumor boards does well in developing this ability. However, if new data becomes available, radiation oncologists must be willing to possibly change their opinion. At times, doctors trained in the intuitive medicine system are unwilling to do this. A possible explanation is that they view themselves as the expert doctor who intuitively knows the problem and best solution. However, in the era of medicine we live in today, it is imperative for doctors to be willing to change their decisions. In the words of John Maynard Keynes "When the facts change, I change my opinion". This seems like an obvious statement, but far too often specialist doctors become attached to their decision, defending the position even when evidence points elsewhere.

For the registrars in an empiric moving onto precision medicine world, adaptability is key. Due to the changing environment, an oncology unit, and hence the radiation oncologists, cannot remain inert. They need to remain agile and have the ability to learn, unlearn and relearn in an ongoing process. This ability needs to be emphasized in radiation oncology programs and as new data and protocols become available, radiation oncologists must have the skills to quickly access this data, changing their practice accordingly, not sticking to the way things were done when they originally trained.

The era of empiric medicine still needs the expert radiation oncologist with the ability of weighing up all the data and making a best decision, especially in cases where the path is unclear. However, as we move into precision medicine, diagnoses and treatments which work with 100% certainty will become more commonplace. Artificial Intelligence (AI) machine learning technology is revolutionizing analysis in pathology to radiology, and this is only the beginning. Examples of this are seen in the ability of AI systems to do Gleason Grading in Prostate Cancer [6] and identify lymph node metastases on MRI scans [7]. Soon, it may not be inconceivable, for example, for a woman to go for a screening mammogram, have the image read by an AI algorithm which suggests a biopsy. The biopsy is then analyzed by an AI algorithm which diagnoses a specific molecular subtype of breast cancer and recommends the treatment course best for this patient. In this case, it is plausible that the patient may not need an oncologist to prescribe and oversee treatment, but will need a generalist who has a bit of experience in radiation oncology to oversee the treatment course which was prescribed by the AI algorithm. Although there may be initial reluctance from patients to be treated on the recommendations of a machine with no human input, as these algorithms prove themselves in clinical trials, getting consistently good results, the effect will be acceptance by the general public. In the early stages, these algorithms are only able to assist the generalist in knowing when to refer to a specialist, but as they improve, their accuracy will eventually get to that of a specialist, making obsolete the need for such a specialist doctor to intervene.

Knowing the shortcomings of the current training program, and the rationale to change it, what practical steps can we implement to assist with training the healthcare professionals we will need in the future to treat oncology patients? We still (for now) need expert radiation oncologists to make the judgment calls where the path is not clear. Registrars must be taught to always consider the data. One way to do this is to make sure they become emerged in the evidence-based medicine method. Every registrar must have (at least) one weekly research day, where they work on research with the intent of publication and deepening collective radiation oncology knowledge. In a busy radiation oncology unit where there are hundreds of patients to be seen, this may be met with some resistance, especially from clinical managers. A solution will be to ensure that interns and medical officers take on some of the load of treating radiation oncology patients. The exposure of general doctors in radiation oncology is currently woefully inadequate. As mentioned in the previous paragraph, generalists of the future may play a bigger role in the management of radiotherapy, so they should get exposure to this specialty. Rotating interns and medical officers through radiation oncology will provide this exposure.

Regarding the structure of clinical trials which the registrars are involved in, these too should be designed for precision medicine as described by Clayton Christenson in “The Innovators Prescription” [2]. These clinical trials should be structured not as a final test of a hypothesis to see if a treatment works or does not work, but should be seen as part of the treatment development process to rapidly refine and improve the treatment to get the best therapy developed quicker. An exhaustive look at the reforms needed in the management of clinical trials is beyond the scope of this commentary, but the recent COVID-19 pandemic has shown us how important restructuring clinical trials is to assist the quick development of clinical strategies.

The next important practical change is that registrars need to be able to use all the technology at their disposal to augment their abilities as radiation oncologists. A weak link is that, particularly in South Africa, the best technology is unavailable in the state hospitals, but there is an oversupply in private hospitals. Partnerships between teaching state hospitals and private hospitals need to be reached to enable registrars to rotate through private units as part of their training, learning to use the newest technologies. That process will make them more agile and prepared for work in the radiation units of the future. Another option is to use Public Private Partnerships (PPPs) to make the novel technology available in state facilities. As I discussed in my article “Novel life-saving radiotherapy technology and how it can be made available in the developing world” [8] in developing nations, research in radiation oncology often falls behind due to a lack of the newest equipment in academic, training, research institutions. There must be the right mix of policy and position (focus) to ensure that this happens. State units have previously been loath to have registrars receiving part of their training in private units. There may be a myriad of reasons for this, ranging from not being able to spare them to go for training even for short times from the busy public hospitals, to bruised egos in having to admit that there may be instances where the private sector is superior to the public academic hospitals. However, leaders in these academic units need to focus on the best training for their registrars and must realize that exposure to a diverse array of oncology units will enrich the training experience of registrars. But why would private units want to be part of registrar teaching circuits? The leverage or high ground that academic units hold over private units is that despite their lack of the best facilities, they are academic units with the prestige that this brings. If private units assist in teaching registrar's, they will get the prestige of being affiliated to an academic teaching unit, and not being seen as a solely profit-making business. Such an affiliation has worked well for all stakeholders in units such as the colorectal surgery unit at Wits University Donald Gordon Medical Centre (WDGMC). WDGMC is a private hospital, which forms part of the training circuit for the University of the Witwatersrand Medical school in certain specialties such as colorectal surgery. This ensures that registrars and fellows get exposure to using the cutting-edge treatment and expertise which may not be available in public hospitals. Such programs should be expanded to incorporate other specialties such as radiation oncology and to involve other private hospitals.

Another observation from the world of management is that in teams of people working together for a common goal, there is a lot of benefit to be gained from ensuring that there is diversity in the team [9]. This not only refers to ethnic diversity, which is important, but also to diversity in knowledge and background. Another possible reform is to introduce input from the schools of business and management into radiation oncology departments. Radiation units, which make large capital expenditures on machines such as linear accelerators, may benefit from the operational expertise which the school of management may bring, and this may also allow the radiation oncology registrars learn how to better manage units in the future – a skill which is vital but neglected in training. To get efficiently run oncology units, radiation oncology registrars must be exposed to best management practices. Another area where schools of management and leadership can assist the division of Radiation Oncology in medical schools is in leadership coaching. As mentioned earlier, methods in coaching business managers and leaders would be useful in getting radiation oncology registrars to better understand their decision-making processes and enable them to use the changing landscape of radiation oncology to augment their ability as clinicians.

As technologies within AI, machine learning and medical devices improve, the role of radiation oncologists within the treatment of an oncology patient will change, with these technologies slowly encroaching more onto their daily work. An example of this is AI algorithms which can automatically contour tumors and critical structures and work out optimal radiotherapy plans. Although this technology is still in its infancy, and currently far from being able to work autonomously, it is conceivable that this process could be fully automated in the future; doing the work that consumes a large portion of the radiation oncologists work day. This would free up the radiation oncologist of the future to focus on treatment aspects of radiation oncology which are more difficult to automate and are often neglected in their training, such as having empathetic discussions with patients regarding their treatment, side-effects and their future life. This is often learnt informally and on-the-job, but with the "human" aspect of their work likely to take on increased importance in the era of precision medicine, it is imperative that more attention is paid to it in training programs.

With the more empathetic human aspect of radiation oncology likely to become more central to the work of radiation oncologists of the future, it is also important to emphasize these aspects in the board exams for radiation oncologists. Too much emphasis is paid in the current examinations on testing knowledge that could easily be found in a simple Google search or looking at the recent National Comprehensive Cancer Network (NCCN) guidelines. Retaining such knowledge which can easily be found on the Radiation Oncologist's cell phone is becoming less important than them having the ability to properly connect with and guide their patients through their cancer journeys. Hence, in board exams in the past, candidates in the exam were asked to examine a patient, and later called to a separate room with an examiner to give their findings and answer questions relating to this. In the future, it will become more important for the examiner to watch the interaction of the exam candidate and the patient, rather than question them after regarding their findings.

Such a list of reforms to the training of radiation oncologists is far from exhaustive, but the aim of this short commentary is to shine the light on the need for reform in medical education today due to the changing landscape. These changes are the net result of a myriad of shifts and advances in technology. They create new opportunities for all stakeholders within Radiation Oncology and healthcare more broadly. These changes upset existing structures enabling new developing units to take up leadership positions if they can anticipate the changes needed quicker. Medical teaching especially within state hospital bureaucracies have traditionally suffered from inertia in making changes, but if they can make themselves more agile there will be improvement in their training programs. Academic units who can implement the needed reforms in registrar teaching will be able to harness the impetus created by the changing landscape to propel themselves to become the new academic centers of excellence.

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