JMRO

Journal of Medical and Radiation Oncology

Journal homepage: www.jmedradonc.org

About Intelligence (Artificial or Not) – A Discussion with Marcel van Herk

Interview by Monica-Emilia Chirilă[1]

[1]*Journal of Medical and Radiation Oncology*

Corresponding author: Monica-Emilia Chirilă; **e-mail**: monica.emilia.chirila@gmail.com

Professor Marcel van Herk is the chair of radiotherapy physics at the University of Manchester. As a medical physics student, he started developing of a liquid ionization imaging device that later became the Varian PortalVision system for electronic portal imaging. During his Postdoctoral Fellowship at Harvard Medical School, in 1992, Dr. Van Herk started to incorporate 3D image processing in his work, first CT-MR image registration for treatment planning, and later measuring organ motion and other uncertainties in radiotherapy such as delineation variability. Much of this work has been integrated into the Elekta Synergy cone-beam CT image guidance system. For the past 10 years he has held a part-time teaching role as a Professor at the University of Amsterdam working, amongst others, at the integration of microscopic optical imaging into radiotherapy treatment planning. His goal is to conduct research that improves the clinical practice of radiotherapy.

MC: Could you please tell us a few words about your current activity and about your main accomplishments in the field of radiotherapy?

MvH: Well, I work on improving the precision of radiotherapy. I've been very active in image guided radiotherapy, quantifying organ motion, 4D, that kind of stuff, and I like to look for things that are unsolved. One thing that wasn't solved, was delineation. People are delineating tumors but do not agree, so I spent some time observing variation and teaching on that. Now, I think the big questions remaining are regarding tumor biology - what do we need to radiate? Where are the targets? Where's the microscopic disease? Currently, the focus of my work is big data - trying

https://doi.org/10.53011/JMRO.2021.02.10
2784 – 0131/Copyright 2021 The Author(s).

Interviews

to learn from the data of thousands of patients that were treated in the past. We try to see for instance, which parts of the patient are the most sensitive to radiation? What happens if you get a little bit more dose here and there? Do you see a difference in outcome? I think it's kind of a natural progression.

MC: Is it difficult to gather this amount of data that you need to analyze?

MvH: I started in Amsterdam, but I work in Manchester now, the biggest Cancer Center in Europe. But treatment data, outcome data is harder to get, so we've linked up with external databases, like the NHS (National Health System). So there is a lot of data. One thing that we can always find out is if the patient is dead or alive. So actually, a lot of the activities aim to predict the outcome. And sometimes you just find really surprising things. For example, we were looking at data from older 3D plans and correlated with the “dead or alive " status, and we found a little spot in the heart which got more dose and was correlated with a worse outcome. That was kind of an eye opener. And that gives us an opportunity, because it is not always possible to spare all the heart, so we can try to avoid the structures which are the most sensitive. It might be the electrical system, but we don't know. So we have to figure it out. We have to run prospective studies, looking at the effects of radiation - we're just finishing one. We looked at cardiac CT, before and after radiotherapy, and so we will hopefully report our findings in the near future.

MC: So you are not only searching for factors to predict the patient outcome, but also to identify toxicity-sensitive structures?

MvH: Yes, both. But it can be very complicated. If you want to compare data from different patients you have to put them together. The organs at risk can be mapped together, but the tumors are in different parts of the body, have different shapes and different sizes.

MC: How do you deal with the variability of the data? There are different devices, different types of scanners, and they produce images that are slightly different.

MvH: Actually, we do a lot of things with the planning data. And that's fairly well standardized. So that's not such a big deal. But obviously, statistics is actually quite complicated, making corrections for confounding factors.

MC: How did you identify these problems that need to be solved, and which later become your research focus? Do you find them by yourself? Or do you collaborate with clinicians and ask their opinions on what may be more difficult in their clinical work?

MvH**:** Of course, I am collaborating with great clinicians and their input is really important. But it's also just… listening. I’ve been around for so long now. I’m just picking up.

MC: How did you get to be involved in this field? Were you interested in that from the beginning of your career or was it something that started to interest you in time?

MvH**:** It's kind of funny story with that, because I studied physics. In school I was good at maths, but also physics. Computer science didn't exist yet. While I was in University I had a one year project. And so I went to the Cancer Institute in Amsterdam and there was a guy building his own computers and doing a lot of technology work. So that is how I got interested in this topic.

MC: What about image guided radiotherapy? Which was the main progress in the last years, in your opinion?

MvH: Well, obviously, we've got all sorts of new scanners, new reconstruction algorithms, MRI guidance, but the fundamental problem is the patient. And I think people often forget that, you know, you can get such beautiful equipments, but if the patient's organs are moving during the imaging, or during treatments, it's never going to be very good. So I think we need to find ways to deal with that. And it's funny, because the medical physicists want to measure stuff. They put a phantom on a scanner and they make measurements, but this does not say anything about the usability, because if you put a patient there, the things are totally different.

MC: Why do you think about image enhancement, in particular the use of the Cone Beam CT(CBCT) as a predictive tool?

MvH: Well, there is something in there, but the CBCT is not very good. And the main reason why it is not very good is because the patient is moving, the organs are moving. So, the best images actually, strangely, you get in the lung where you can do 4D CT. The contrast is very high. We've been looking at how these images change over time, but I don't think it's very predictive. But we're looking at those images to understand what is happening, for instance, to predict whether you need to adapt to treatment. So it's a workflow thing.

What we are now going to do with the cardiac substructures is doing what we call a rapid learning study. So we're treating one way and then at a certain point to kind of change it and we're treating another way and then what we hope to see is a jump in the output. We have to be really careful because if something else changes at the same time, obviously then that's what you measure is not true.

MC: In what fields of radiation oncology do you think artificial intelligence will be most helpful? Is it going to be autocontouring or decision making or something else?

MvH: I think it is contouring, but also this one I mentioned before - the biomarkers - I think that would be quite cool as well. The computer should say: I've measured densities in your body and looked at the picture and you're very weak. I do not like radiomics because it's garbage in and garbage out in a way, and then because the box is so big, you have so many variables. Yes, you can always find something but if you don't correct for the other variables…Actually it might be the same with genetics. Yeah, lots of zillions of people are working on them. But very few studies have found something that actually works.

MC: What's the story of the "van Herk formula"?

We were doing this project with three people (Peter Remeijer, Rasch and Lebesque). We were looking at organ motion and setup errors. And then we couldn't figure it out. Because the doctor says, I want to cover the margin and always treat my patients right. And that was the problem because that margin doesn't exist. So it was literally, I think, over a weekend or so that I thought: Well, shouldn't we do the probability? And then I wrote down most of the equations but Peter actually wrote down the linear equation. That's the margin recipe. The numbers don't mean anything, no doubt. The numbers gave the clinical answer at that time, given the errors basically. And we sold it really well. Because the way that we sold it was to make it really simple.

MC: Did you or do you work for the industry, for the companies which produce radiotherapy devices?

MvH: No, not for, but with the companies. My first project was the portal imaging device, so we created the Varian PortalVision. We worked for decades with Varian, and then we started

working with Elekta for the cone beam CT. I was out with a friend and he invited me to join him to write a grant. The deadline was in just a week. It was on image guided radiotherapy in prostate cancer. I did a little software things. And when Elekta started to build those machines, we were already in the circle, and we wrote the software from scratch and then we provided bug fixes. We were subcontractors. That was big.

I also work with Aquilab on training contouring system. I wrote some software there, but I will probably collaborate with other companies too, in the future. I also have some ideas, but if they are not translated into projects... Even if I give away the software for free, it's not going to be used clinically, it has to be in a company, and it has to be supported, FDA approved and stuff… But companies are difficult in the sense that they often change very quickly. So different people, new head of the group, different vision, priorities… I'm involved with MRI Linac, but only very little.

MC: What you say is very nice, because we need this human part, also.

MvH: And I know you were asking about the companies and that's often difficult because it really depends on a few people. And if they are not there, or they got a new boss, suddenly people don't understand what they have.

MC: About understanding – this raises another question: how do you make people understand what you're thinking about in case there's a gap between your training and their possibility of understanding the concept which you're explaining?

MvH: I just try to explain it very, very simply. But yeah, I think the main problem is people who don't want to listen, they don't understand. If people have a preset idea, then they really don't understand the issue, and you should have started at another level. To explain this, you go back to the basics.

MC: I was thinking that the studies on motion management are becoming even more important, because we are giving a higher dose in less fractions. So, the movement has more impact.

MvH: It is totally true. The amount of technology that you use depends on what you need it for. But if there is a simple solution, that is much better.

MC: Do you think that the MRI Linac will be the best solution for accurately delivering the radiotherapy ?

MvH: There are other tools for image guided radiotherapy, like fiducials and many more. If the MRI Linac could provide imaging in 3D in a fraction of a second, then it could pretty much solve all the problems, but that's not how it is. It's a complicated machine and workflows are really, really difficult. And it's tight, it's claustrophobic. And MRI is slow, and slower than the CT and slower than the CBCT. Because you can take a single slice very quickly, but if you want to take the volume, it takes much longer. Not all the organs move the same, and the longer the workflow is, the more is the chance that the target or the organs at risk would move.

MC: What are your plans for the future? Do you have anything in particular that you're working on that you would like to share with us?

MvH: Yes, no doubt… As I mentioned, one project is focused on measuring the electrical effects of radiotherapy on the heart. Another thing that we're starting up is to use routine imaging for biomarkers. For example – a change in the performance status can influence the change of the treatment, but evaluating the performance status can be subjective. But the images actually

have a lot of information because you can see how the muscles are developed. You can see the liver, you can see the heart (whether it has calcification or not), so there is a lot of information in routine data that we can exploit. It's already there; we just have to find out how to use it. But that's not the most important thing. The most important thing is that this amount of data exists in the past. So we can try out all sorts of algorithms on the old data to see whether that is predictive of what's happening to the patient. So, that is a cool thing. I like that a lot.

MC: Do you work on multiple projects at the same time?

MvH: Yes, lots of, because of the students.

MC: How do you manage to divide your time and energy?

MvH: Well, in normal times I was one of the supervisors, and other supervisors would do the majority of work and I would just walk in and see how it's going and if there is a particular problem and that was fairly efficient. But in lockdown, that doesn't work, so you actually really have to sit for an hour with students - sometimes more, to talk it through because the student is frustrated at home, and it's really difficult. So it's much tougher now, in lockdown, than it is normally. Normally it's only fun. Now it's also fun, but it takes double the amount of time. And double the amount of time to do that means almost no time to do anything.

MC: You mentioned the lockdown times with all the challenges, and I am wondering, how do you find ways to overcome challenges? What drives you? What motivates you to solve your research or work related problems and challenges? How do you manage not to give up?

MvH: Giving up isn't an option, because we can give up on a project, but that does not mean that we can give up on a student. You can give up on an idea, but you can't give up on the students. It is not an option, because you're responsible. And yes, I take that very seriously. One of the postdocs in our university said: I have two supervisors: a good supervisor (my colleague)- he tells me to go to bed early, read, etc; and I have a bad supervisor, who tells me to go to parties. That's me. And I was very, very proud to be the "bad" supervisor.

MC: I recently asked a young researcher in the field of artificial intelligence what he would ask you if he would meet you. His answer surprised me. He said that he would not ask anything, but would only thank you for all that you have done. So, I will do the same, and end by thanking you for your valuable contribution for delivering quality radiation treatments to cancer patients.