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Interview

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"The person who influenced me most was the person who disagreed most strongly with me": an interview with Professor Robert Anderson

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Dunbar Ivy: Introduction

It is a great pleasure to again welcome Professor Robert Anderson to the University of Colorado School of Medicine and the Children's Hospital of Colorado. Most paediatric cardiology training programmes do not have dedicated faculty in cardiac anatomy. At many institutions in the United States, Europe, and other countries, Professor Anderson has filled the gap in teaching first-hand the anatomy of the normal heart and of congenital cardiac malformations. His interactive style is popular with trainees and faculty and allows him to engage the audience in understanding the complexities of cardiac anatomy. We have been fortunate to have Professor Anderson teach to our faculty and fellows many times over the last two decades and look forward to future teaching sessions. The following interview was recorded by Dr Sebastian Goreczny, visiting Fulbright scholar and Assistant Professor of Pediatric Cardiology at the Polish Mother's Memorial Hospital, Research Institute, Lodz, Poland (Fig 1).

Figure 1. Professor Robert Anderson with the faculty and trainees of the Department of Cardiology, Colorado Children's Hospital. Top row, from the left: Jenny Zablah, James Monaco, Joe Zakhar, Jess McPhaul, Jess Persson, Dana Irrher, Erin Lueth, Caitlin Haxel, Amanda McIntosh, Dan Errhman; Bottom row, from the left: Dunbar Ivy, Gareth Morgan, Robert Anderson

Sebastian Goreczny: What brings you to Colorado Children's Hospital?

Prof. Robert Anderson: I'm here to teach the Fellows in paediatric cardiology the essence of cardiac anatomy as it relates to the congenitally malformed heart.

From teacher's perspective, what is the best way for a student or young doctor to learn cardiac anatomy?

Good question. Ideally to go into the dissecting room, the autopsy suite, to look at the normal heart first to gain a total command of the anatomy of the normal heart, and then to have access of an archive of specimens of the various types of congenital cardiac malformations. Obviously for that, you need a good archive, an archive that has been well catalogued, an archive which demonstrates the salient features of the malformations.

That sound like an ideal plan but having in mind limited time and sometimes resources, on the other hand internet as a vast resource, if you were to give a few tips how to learn cardiac anatomy, what would they be?

The point you make about the internet is a very important one, because there is a project that is being developed at the moment that is going to be called the Pediatric Cardiology Learning Center. The initial idea for it came from a paediatric cardiologist, Lindsey Rodgers, who trained at Children's Hospital of Philadelphia and then became an attending at Cincinnati Children's Hospital. She sent a questionnaire out to the Fellows in North America studying paediatric cardiology and established from this questionnaire that the teaching in cardiac anatomy, particularly in cardiac development, is very poor and non-uniform. She came up with a notion that, ideally, if you established what she christened the Pediatric Cardiology Learning Center, then you could create the type of material that you need to appreciate the nuances of cardiac anatomy, and you could keep it in the Cloud. If the resource existed as she envisaged it, then Fellows in paediatric cardiology could then enter the Pediatric Cardiology Learning Center website, and could take the information there, and could access it in their own time and as they require it. Obviously, that means first of all we have to create the material to be placed on the Pediatric Cardiology Learning Center website, but that is happening at the moment. If things go according to plan, and it is being funded at the moment and supported from Cincinnati Children's Hospital, that would be the ideal way of bringing cardiac anatomy, and the anatomy of the congenitally malformed heart, to everybody's fingertips.

How would you describe the importance of learning cardiac embryology to better understand cardiac anatomy?

It is always been recognised that an understanding of cardiac embryology is the basis for appreciating the morphogenesis of the different lesions. The problems that we have had thus far is that notions of cardiac embryology have been very different. Different authorities, such as myself, have different views as to how the heart does develop. It has been very difficult to gain solid information regarding cardiac development. I think now, however, we are in the situation where that is at our fingertips. So, how easy is it to make that available? You know full well that the problem in cardiac development is that the structure of the heart is changing all the time. To build up in your own mind the three-dimensional changes that take place is very difficult. The ideal situation would be to take what we know about the different stages in development and animate between them. So, make models as accurate as we can of the different stages, but then animate between them so you can appreciate the morphological changes.

What would be the most challenging to explain stages of cardiac development?

For example, with ventricular looping so if you could create an animation going from the so-called straight tube to the looping of the ventricle, and then the formation, the ballooning, as we now describe it, of the atrial chambers, the ventricular chambers, then that would make things so much easier to understand. Atrial septation would be another perfect example where you could animate the growth of the primary atrial septum, the closure of the primary foramen, the growth of the vestibular spine that we now know is the key to separation of the atrial ventricular junctions. At the moment we are doing all this bit by bit. We have to put together in our mind two-dimensional pictures, although now we do get a degree of three dimensionality, but to build the whole thing up and to animate it would make thing so much easier. If it was done in that fashion, I think then the time, which you say is at a premium, would be so far better spent, because everything would be amenable and available for more rapid digestion.

You have mentioned building models and three-dimensional reconstructions, actually with current technologies we can print hearts, but do you think it will replace work with the heart specimen?

In the ideal world I do, but I don't necessarily think that you need to print models. My own view is that if you create the three-dimensional dataset, and then you have the ability to virtually dissect that three-dimensional dataset, you get a far better idea of what's going on than trying to build the model. Of necessity, if you build the model of the entire heart, and there are malformations within the heart, you cannot see the malformations because of the walls. It is the same as when I have the heart in my hands. To demonstrate holes in the heart, I have to pull the heart open. In doing so, I distort the anatomy to a certain extent. The best models would be those in which the heart has been sectioned. Then you could print the sectioned parts, directly corresponding to echocardiographic planes in which you are familiar. But then, for each heart, you would need perhaps four, five, or six models. These are very expensive to produce. In contrast, if you create one virtual dataset, a three-dimensional dataset of a given heart, which you can have on your computer, then you can rotate the dataset on your computer. You can cut it with the various software packages that are already available. To me, that is the way to do what is currently being aspired to by many people, namely printing models. As I said, I don't think we necessarily need to print the models. It is virtual dissection of the three-dimensional dataset that is the key to understanding.

We could appreciate the virtual dissections during your lectures at Colorado Children's Hospital. With that, and other tools available, do young doctors better understand cardiac anatomy than their predecessors 20–30 years ago?

That is another very good question. For myself, I certainly understand anatomy far better, even within the last 3 years, than I did 10 years ago. That has been exclusively through the availability to do virtual dissections. As you pointed out, I've shown virtual dissections in my lectures, I've been very fortunate in this respect to work with a young Japanese cardiologist called

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Shumpei Mori. Shampei is a master at virtual dissection. Having made his virtual dissections, you can see all the salient features.

Shumpei came 3 years ago, in 2015, wanting to work with me in London. Sadly, I could no longer offer him a position, because since allegedly I am retired, I no longer have a laboratory. He and I have corresponded, nonetheless, and shared our information. The work he has done by means of virtual dissection has revolutionised my own understanding of the heart. Areas that were difficult to understand, such as the inferior pyramidal space, the location of the triangle of Koch, the fact that the atrial wall is separated by an extension of the atrial ventricular groove, have suddenly become clear when you are able to do perform virtual dissection. The sub-pulmonary infundibulum, the extent of the infundibular sleeve, the fact there is not an outlet septum in the normal heart, itis all revealed in these virtual dissections. My own opinion and knowledge have changed so much over the last 3 years. I would hope that now this information is available, and at the moment it is largely available in the form of the printed paper, it would be so much better if we could make it available in the form of three-dimensional datasets that the student or interested person could manipulate in his or her own time. That would make it so much more amenable, and then the understanding would be totally revolutionised.

With all the resources that are available now, how significantly has understanding of cardiac anatomy changed over the last years?

I am sure things are moving forward. Over the last 15–20 years, the emphasis has been on the so-called evidence-based medicine. We now teach, and we hope to teach, on the basis of evidence. I would have hoped that has always been the case, but many of the controversies that are confronting us at the moment with regard to the understanding of cardiac anatomy are based on opinion rather than evidence. Now that we have the available three-dimensional data, there is no way you can fool anybody. It is immediately amenable to everybody. If the datasets are available to everybody, you cannot pull the wool over their eyes. They can see what you can see, and you have to tell the truth. Eventually, my belief is that the truth will come out. The controversies that exist at the moment reflect false facts. We hear all about false facts at the present time, false news all the time, and false news also exists in cardiac anatomy. The evidence will remove those false facts and give us the real thing.

With respect to all advanced technologies available now, why do we still have controversies regarding cardiac anatomy? What are the main controversies?

The major reason is that we have come back to the fact that many of our concepts of cardiac anatomy have been based on cardiac development. The cardiac development in many instances was speculation. It was not based on evidence. If you are basing a concept of cardiac anatomy on a concept of cardiac development that is flawed, the anatomy is going to be flawed. You will know that during my time here in Denver, one of the lectures that I gave was on ventricular septal defects. These are the commonest congenital lesions, and yet still a source of major controversy. The reason for the controversy is because there are different ways to approach the ventricular septum, and to base the knowledge of the defects within the septum. Yet some of the concepts of septal anatomy are totally wrong. An example is the notion that there is a septum of the atrioventricular canal. We now know that there is no septum of the atrioventricular canal within the ventricles. There is a septum of the atrioventricular canal, but it is an atrial septum. But there is no septum of the atrioventricular canal in the ventricle. Also, there is no outlet septum in the normal heart. So, when concepts of ventricular septal defects are based on the existence of these alleged components of the septum that do not really exist, then how can the concepts be correct?

What are the major misunderstandings of cardiac anatomy nowadays?

I think a lot because of the fact that when we formulate new concepts, we do not necessarily understand the concepts that have already been put forward, which are themselves crucially important, but which we are trying to improve. When we try to improve a concept that has been formulated by someone else, the person that has formulated that concept will obviously be a little bit irritated. He, or she, will likely think that their initial concept was itself perfect. When people, such as myself, came along and tried to improve some of the initial concepts, we did not fully understand the principles on which they were based. There is a very well-known British philosopher called AJ Ayer. He commented, when he wrote a book on “Language, Truth and Logic” that the person who influenced him most was the person who disagreed most strongly with him. That has been the case for myself. It is well-known that, in the field of CHD, Richard Van Praagh, the major expert when I started, established the basis of how we now analyse congenital malformed hearts. He and I do not always see eye-to-eye. Yet, it has been the criticisms of the work that I have done, and concepts that I have put forward, by Richard Van Praagh that have permitted me to correct them, and to make them much better. His criticisms have improved and helped formulate what I now think is a very good system. But that remains a little bit different from the way he still thinks about these things. I would hope we could come even a little closer together. But then, the people who followed his teachings will need to look at what we are doing and appreciate the facts on which we have based our suggested modifications. Hopefully then we can come together, and remove the controversies.

Do you think we are getting closer to getting rid of controversies and exploring the facts without any doubts?

I certainly hope so. You probably know we have an International Nomenclature Committee. It was set up in the late 1990s to resolve the controversies. Since the 2000s, the committee has met many times, and has formulated a coding system for the categorisation of the congenitally malformed heart. The good news is that coding system is now accepted by the International Classification of Disease. So, in International Classification of Disease-11, the codes and the definitions of the International Nomenclature Committee will now be adopted by the WHO. In the work done by the International Nomenclature Committee since 2000, we have cross-mapped the various terms used to describe the different entities. We have tried to bring consensus into the way we describe ventricular septal defects. We have

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tried to cross-map the different terms so that we can give them a number. So, whichever nomenclature you might prefer, if you find the phenotype, then we are talking about the same phenotype. That will now appear in International Classification of Disease-11, since we have defined all of the phenotypes. We are in the process of setting up a virtual website that will illustrate the anatomy of these phenotypes. It is my belief that, when this eventually becomes onsite, it will resolve a large part of the controversies. We will begin to speak the same language. You cannot, however, do that by edict. You can only do it by persuasion. That means, in turn, that we have to be sure that we are promoting the real thing.

What were your milestones in learning and exploring cardiac anatomy?

Van Praagh had already seen the need to bring a logical approach to complex congenital malformations. Probably the real innovator, however, and the person who set the scene for the analysis of congenital malformations overall, was Jessie Edwards, the pathologist initially from the Mayo Clinic and then from United Hospitals in the Twin Cities. The knowledge that Edwards brought with his textbook was absolutely superb. Anton Becker, the pathologist I worked most closely, had trained with Edwards in Minneapolis-Saint Paul. I worked very closely with Anton from 1975 to 1990. It was the influence that Edwards had had on Becker, and that Becker was able to bring to me, that moulded our thinking. Many people think that I am a pathologist. That is not true, I am a medically qualified anatomist. So, the interaction with Becker, who is the consummate cardiac pathologist, the best I have ever worked with, was key to my success. He had himself learned from Jessie Edwards, so he brought the sequence forward. The combination of Becker as a pathologist, and myself as an anatomist, made it possible for us to interact, to discuss and move things forward based very much on the teachings of Edwards. The essence was description. When the heart is malformed, it is far better to describe what you see, rather than try to fit the lesions that you think you see into pre-existing pigeon holes. Often times, the pigeon holes are just not there. The essence of what Edwards taught, through Becker coming to me, was to describe what you see. If it does not fit into a pigeon hole, we should not try to create a pigeon hole to put it into. We should simply describe what we see, hopefully in a way that others can understand.

Nowadays, where should we expect new innovations in that field?

The techniques we now have to visualise the heart, in other words the ability now to see the anatomy of the congenitally malformed heart, is mind-blowing. The ability to take computer tomographic datasets, to reconstruct them, to virtually dissect them, means that you now see the anatomy of the congenitally malformed heart far better in life than when we have the heart in our hand. This is because we distort the anatomy when we open the hearts to see what is inside them. I firmly believe now that the availability of this new material, the availability to virtually dissect, to come back and to look at it again, because, of course, with the three-dimensional dataset, you can take it apart, put it back together, cut it in any plane you want, which is simply not possible when you have the heart in your hand. The success of the anatomist or pathologist depends on his manual ability to dissect and demonstrate many parts. With virtual dissection that is so much easier.

Have you noticed that hearts have changed over the years?

The lesions that we see, I've spoken about pigeon holes and I don't particularly like putting them in pigeon holes, but we do recognise that there are certain entities. We recognise their phenotypes, which is what the International Committee has done. We have defined at the moment 300, I think 320 different phenotypes. I think those phenotypes cover all the lesions. There will be some things that do not quite fit one or another of those phenotypes, but what the clinical cardiologist sees as a new patient comes forward, I think virtually all those lesions are going to fit within the phenotypes that we recognise. I think that now we are able to recognise them. To answer your question, therefore, the hearts have not changed over the years.

Can then one say, "I've learned cardiac anatomy I don't need to go back to it."?

We are all learning all the time and one of the features of patients with CHD, we can recognise each of those individual lesions but the combination of lesions is what produces the complexity. It is very possible the next patient seen by anyone will never been seen before. If the anatomy is described in sequential segmental fashion, however, and all the lesions are listed, then everyone should be able to understand the new entity even though it may be unique.

Thank you!

Thank you!

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