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"Use of medical imaging to determine cause and mechanism of death"

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DR HOWLETT: Members and guests, the medical specialty of radiology has come a long way since the era of plain x-rays, the only imaging modality available for many decades, after the discovery of x-rays in 1895 by a Professor of Physics at the University of Würzburg, Wilhelm Röentgen. Computerised tomography or CAT scans and magnetic resonance imaging amongst other modalities have produced nothing short of a revolution in the way medicine is being practiced since the latter part of the last century. Nor have advances in radiology been confined to the realms of investigation and diagnosis. Interventional radiology now offers treatment for diseases such as aneurisms and tumours previously treatable only following the application of a surgeon's knife, if treatable at all.

Tonight, we will hear about a comparatively new application for the radiologist's skills. The investigation not of the living but of the dead and the Society has the privilege of hearing from one of the pioneers in this emerging sub-specialty, Dr Chris O'Donnell. Dr O'Donnell graduated from the University of Melbourne and undertook post-graduate training at Hammersmith Hospital in London as well as back in Australia. He became a Fellow of the Royal Australian & New Zealand College of Radiologists in 1986. Dr O'Donnell has been a consultant forensic radiologist at the Victorian Institute of Forensic Medicine since 2002 and holds a university appointment as senior lecturer in the Department of Forensic Medicine at Monash University. Please welcome Dr O'Donnell.

DR O'DONNELL: Thank you, Dr Howlett, I am very honoured and

privileged to have been invited to speak to you all today. What I am going to talk about is a very new area of medical imaging. Many doctors here probably use medical imaging in their every day clinical practice. This is a new application as Dr Howlett suggested in medico-legal death investigation. This is where I work. The Victorian Institute of Forensic Medicine in Southbank just behind the ABC. This is what I do. This is the use of CT scanning in particular for the investigation of the deceased. Before I start, you may have seen what I call myself. That is a necro-radiologist. Some in this audience in fact think that is a relatively frivolous name and what it is meant to portray is that I am a radiologist looking at the deceased.

I have a colleague overseas, she is actually Greek who has written in the literature because she does not agree with that word of necro-radiologist. Necros meaning "dead". So a necro-radiologist is a dead radiologist. Perhaps after tonight I will be. I might live up to that. So she has in this article decided to look at this from its origins. There is a Greek word "tomy" and the verb temnein meaning "to cut". So a necrotomy is "dissecting the dead". So what she says I should be called is a not a necro-radiologist but a necroto-radiologist, a radiologist who is dissecting the deceased using imaging techniques. Now I do not think necroto-radiologist is a really nice term so I have been looking a little myself and there is another Greek word called thanatos. Thanatos means "death" so a new name I am going to call myself is a thanato-radiologist, a radiologist of death, professor.

I show this picture and again you might think this

is frivolous but everything I am talking to you tonight is as a result of The Beatles. Believe it or not. The Beatles earned huge amounts of money for a company called EMI and they were with that money looking at diversifying away from the record industry into electronics and they gave that money to this very uninspiring looking man, Sir Godfrey Hounsfield, and told him to go and live his dream and his dream was to determine what was in a box by taking readings at all angles through it. He was an engineer who just came up with this idea.

After some work and many, many millions of dollars this is what he came up with. It is not very impressive but in fact this was a huge revolution in medical imaging and within a very few years he was given the Nobel Prize for medicine. Such an incredible achievement. This is what it looks like now with the sophistication of computers and so forth. It has completely changed the way we do business in the medical world. This is the CAT scan. How does it work? It is very easy. It is an x-ray tube and a ring of detectors that rotates around a patient. Now I understand there will be some medical people in this audience, there are also non-medical people so I will try and explain to you how this actually works.

There are two ways it can done. One is like cutting a piece of salami. We actually just make rotational cuts through the body and make slices as if it was a piece of salami. Modern CT scanners actually make a continuous spiral but I like to think of it as a slinky. People probably know about slinkies. You pull out a slinky, each individual leaf of the slinky is a slice but we have the potential to put them all back together to make a three-

dimensional object. Analogy, I always try and do this with my children to try and get them to understand things, let us look at a watermelon.

Let us look at an x-ray of a watermelon. This is the traditional way of looking at things. So for example, Röentgen in 1895 when he first did his x-rays, this is how a watermelon would have looked. It has not changed much since them. You see some detail of what is going on inside the watermelon but not a lot of detail. Let us stick it on our CT scanner and make one of those salami cuts or actually one of those slinky cuts that I was talking about and immediately you can see the internal structure of the watermelon far better than you could with the normal x-ray.

The best thing out of this is that you do not have to just look in the slice as if it was a piece of salami or a slinky. One is able to put this into cyberspace and cut it in any direction one chooses. So for example here, we have physically cut the watermelon in this direction and we can now do that electronically. You can cut the watermelon in this direction. This is what it looks like when it is physically cut. This is what it looks like electronically. We can do this on our workstation. We can colourise it. There is digital data now. It does not have to be black and white. It can be any colour. We can colourise it. We can make it as bizarre as you choose. But more importantly, we can take those individual slices of the slinky and put it together and make a three-dimension model of the watermelon.

If you look very, very carefully here you can see those individual slices put together so we now have a

three-dimension model of the watermelon. We can colourise that watermelon but now we can actually take big chucks out of the watermelon as if it is a watermelon. So this can now be applied in the medical field and has been done so for 30 or 40 years. This is the sort of image we can now produce on a routine basis in clinical practice.

When I started at the Institute of Forensic Medicine it did not look as bad as this but it was not much better. We did not have a CT scan, we had equipment that Röentgen in 1895 would have been pretty happy with I think. It was very, very basic. This is the sort of images we could produce. Nothing to what we could do in that clinical case that I just showed you. Very, very basic radiography. It was okay but it was not giving us much information.

This is a condition known as pneumothorax where there is air in the lung. Very, very difficult to see because of all the overlying tissues. When I joined the Institute of Forensic Medicine in 2002 I had a dream. It was not as ambitious as this man's dream but it was a dream that I would like to try and introduce what I was used to in my clinical practice into the forensic world. The CT had had such a huge impact on clinical practice I felt that this could be of value in the forensic world.

I did not just get the idea. Many, many other people have also had this idea taking it from the clinical, from patients into other areas. So for example, animals, industrial uses. This is a gearbox using that same technique to look inside a gearbox. There is micro-CT looking at electronics. Building equipment so these are concrete blocks and trees looking for internal

structure of the tree. Mummies. We do quite a lot of work with Mummies either outside the sarcophagus or indeed inside the sarcophagus. We can get very interesting information.

There is even now people have taken this - the Gen Ys of the world have taken this and actually created art. This is the CT of a Barbie doll. This is a CT of a Big Mac. You can even see what a Sikh gentleman wears under his turban by using CT. So there is fantastic advances and information that is available to CT. So what if we could take that case. This is that case from when I first started with the pneumothorax. We could use a CT scan to look at exactly the same condition. This is the pneumothorax so obviously seen and like the watermelon we cannot just see it in black and white. We can make it in colour, three-dimensions. So the ability to see pathology is just incredibly open.

In April 2005 through good fortune, we were able to get one of these CT scanners to be installed into the mortuary at the Institute of Forensic Medicine and since that time in April 2005 all deceased persons that have come through our institute have been scanned. Up to 25,000 in number now. In 2005, this was completely revolutionary. We were self taught, there were no text books.

The doctors I work with, the pathologists had never really looked at CT and they had very little experience in radiology. I am a radiologist with no experience in pathology. So it was basically the blind leading the blind. However after - well this is still July 2010 when we had done over 20,000 cases, we have done close to

25,000. I think we now have a very, very good understanding of this technology.

We now know what it is good at detecting. It detects gas and blood and bone and teeth and metal. It just so happens that in a forensic environment, a lot of these things are very, very important. Gas, for example, this is a gentleman who has died after scuba diving and has what is known as arterial gas embolism, with the whole cerebral circulation replaced by air. A very, very difficult diagnosis for pathologists to make because as soon as they incise the skull, the air disappears. We have a CT scan before that happens to show that there is air embolism present.

We see air in a very, very decomposed body here. You can see that there is air in every structure of the body. This is a common finding that we have to get used to, as we are seeing the deceased. We are used to seeing clinical patients, we have to move into the deceased.

Blood, this is a common problem in not only clinical practice but in forensic practice it is preeminent, a trauma, spontaneous bleeding, this is a large haemorrhage in the abdomen.

Haemorrhage in the brain and I am only going to show one pathology image but it think it is important that we do see the difference between what things look like in the autopsy room and what things look like in the CT so this is a CT scan of haemorrhage and this is the brain showing the haemorrhage. You can see they look very, very different but you do get the same information.

This is a person who has multiple fractures and we can see these fractures beautifully. We can demonstrate

them beautifully. Skull fractures, very, very complex injuries, can be very, very readily detected on CT.

Teeth. If we have forensic odontologists here and we do a lot of work with teeth for identification but this is a very interesting case. The tooth in a deceased person is actually in the bronchus, in the right main bronchus. So all this tooth, we went looking for what it looked like, so we took everything away using a workstation. There is the tooth. We found where the tooth was from, we told the pathologists and they went and found the tooth. The central incisor.

Metal in a forensic world, we see lots of metal, whether it be a knife. This person unfortunately fell and was impaled on a metal bar. This sort of material, we can see readily on the CT images and demonstrate it very, very well.

Now, that is not to say, I called this talk virtual autopsy and it is not true virtual autopsy, there are blind areas on the CT and there is some tissues in the body for example that we cannot see very well on CT and importantly in a forensic environment, the skin and muscle with, especially in relation to trauma, CT has a blind area.

So not all the injury that occurs can CT be useful for. It is only some injury. Some of those other areas have to be addressed at autopsy.

A policy from when we started this CT scan it was to scan all deceased persons as they came through. It is a big task. It takes a lot of time and effort but we decided that that was the appropriate thing to do on all deceased persons so we have a permanent digital record of

every single person that has come through our institute. Scanned from head to toe.

They are also scanned in the condition in which they arrive so we have this permanent record of how they looked when they came so before anyone has touched them. All that data is stored electronically forever so it is accessible for us or anyone else who wants to see that data at any time.

Prior to 2009, we were learning how this all worked and I think over time we have now realised and the pathologists have now realised that this is a very useful technique in assisting them and determining cause and mechanism of death, whether an autopsy is done or not. It is also very useful for identification but I am not going to talk about that tonight.

Just to show you some of the things that CT can be very useful for in natural disease, issues of forensic pathology, unsuspected pathology. Remember we scan every single deceased person, so we find things that we did not necessarily think we were going to see. We see hazards that the staff may be exposed to. We can forewarn them of that, of course the metal. But this is natural death. This is a person who has died from a ruptured aneurysm, a blood vessel in the abdomen. Shows the bleeding into the retroperitoneum. Very easy diagnosis for cause of death in this case.

This is a more difficult case of an older gentleman who died and we can see here a hernia. It is obstructed and has caused the bowel to be obstructed so a much more difficult diagnosis but sometimes for the pathologists, can be difficult as well.

This is a forensic case of drowning and there are patterns that we can see on CT that are typical of drowning. Overdose of tablets for example. Here is an individual who has taken a large number of tablets and we can see those tablets inside the stomach and we can look at the toxicology and make the diagnosis of overdose.

This is a hospital case and this is also increasingly being of value in hospitals, I think because autopsies are not being done in hospitals, in routine quality practice so CT can be very helpful. This is a person who has had a biopsy of their kidney and has passed away after the biopsy with a large haemorrhage in the retroperitoneum. Seen very readily on the CT.

We scan everybody and sometimes we find amazing things, that just turned up. How it got there we do not know but my legal friends here I am sure would be very interested. We scan everybody and it is amazing what turns up.

This is an individual who jumped off a building and has got very severe injuries. He left a note, talking about his difficulties in life because he had problem he believed with his prostate gland and he could not control. He was passing so much urine and life was not worth living so he decided to take his own life. Normally a case like this you would think it is such an easy diagnosis but while we were doing the CT scan, we found in the brain, this tumour of the pineal gland, which was confirmed at autopsy. This can cause a condition that causes people to pass too much urine, so he thought he had a condition that was incurable, he could not do anything about, we were actually able to find and tell the family that there was

in fact a brain tumour that was responsible for his urinary problem. Completely incidental find.

This is a case of Sudden Infant Death Syndrome, so a child has died and the family did not want an autopsy but we were able to see that there is haemorrhage in the brain so this child has sustained trauma. It was unrecognised from the outside, no bruising, but very, very important finding by the pathologist.

Hazards, so the pathologists are going to do an autopsy. This is quite useful. We can scan the body and find for example this is a piece of metallic material. This is what is called an IVC filter. It has little barbs on it so the pathologists when they are about to do their autopsy want to know about these things so they do not prick their fingers. We can tell them that there is going to be a metallic device that they need to be careful about.

This interesting case and someone who has had prostate cancer who has had radioactive rods inserted into their prostate gland which is still active, so if the pathologist was to put a hand down into the pelvis, they would be exposed to radiation. We can warn them about that before they do the autopsy.

Tuberculosis, no pathologist really wants to do an autopsy on someone with tuberculosis unless they have taken preventative measures. But this is a person who has tuberculosis, cavitating tuberculosis, we can forewarn the pathologists about that so they can take the precautions before they do their autopsy.

It is also great for forensic cases. For example here we can show the injury, with the knife still in and

the effect it has had on the heart. This is very useful information for the pathologists before they do their autopsy they know what they are going to find or a deceased person who has had a bullet to the head, we can actually show the injuries, as if it was an autopsy, by looking at the skull, looking at the passage of the bullet through the brain, then producing three dimensional models that the pathologist can use to work out the direction of the bullet as it has passed through the brain.

People in the rest of the world are starting to take notice of the work that we have done and this is a - I have recently visited Kuala Lumpur, we have had pathologists from Kuala Lumpur come into work with us and they have set up an institute of forensic medicine with exactly the same scanner as we have with all our protocols because of the work they did in Melbourne so it is starting to spread from Melbourne to other places including in this area in Asia.

This is our fantastic technique. It is really taking off. How does it work in everyday practice? This is the legal bit, I guess, where it fits into the legal framework. I work for the coroner. The coroner's role is - I do not need to tell the legal people here but preamble to the current Victorian Coroner's Act is that the coroner is responsible for the independent investigation of deaths and fires for the purposes of finding the causes of death in fires and to contribute to the reduction of the number of preventable deaths in fires and the promotion of public health and safety and the administration of justice so these are all of things that are going on in the background in the Institute while we are doing medico-

legal death investigation. Coroners Act, it was an act that came into effect on 1 November 2009 and has completely changed our practice recently. As I said up until 2009 we were just using CT as an adjunct to our every day work but from 2009, November 2009 CT has actually become part of the Act. It is actually included in the Act. It is the first place in the world where CT is specifically mentioned as part of the process of medico-legal death investigation and s.23 talks about "A coroner may provide a body to a medical investigator to enable a preliminary investigation to be performed on the body. As every deceased person comes to our institution they have a preliminary examination. There is no specific order of the coroner, it is a routine procedure and that preliminary examination includes a whole raft of scientific examination including CT scans so CT scanning is now part of this routine process.

The medical investigator is not me it is the pathologist at our institute, the so called duty pathologist. And why they are doing this is because the Act in s.17 says that a medical investigator conducts a medical examination on the deceased person and provides a report to the coroner that includes an opinion that the death was due to natural causes and the coroner is not required to continue the investigation. So part of this preliminary examination is to see whether this is a natural death or whether it needs further investigation.

Our process at the Institute every morning is the process of preliminary examination. The pathologist sits down, looks at all the information that is available, the circumstances, the toxicology, external examination of the

deceased and the CT scan and the CT scan is an integral part of this because they get to see what is inside the body not just what is on the outside.

They look to see whether there are any positive findings that helps them make a diagnosis or importantly if there are any relevant negatives, no obvious indications of trauma or bullets or whatever. That helps them form an opinion. They have a form that they fill out every day and based on that they form an opinion about the need for autopsy or a reasonable medical cause of death which they then present to the coroner each morning.

What has that done to our work practice. How successful has that been. These are the relative number of or the relative portion of cases admitted to our Institute since 2001 to 2010-11 and you can see that the number of autopsies or the percentage of autopsies done over that time was already falling before our CT scanner was installed and this really reflected community standards. There was a big concern in the community and families about autopsies so these rates were dropping well before the CT scanner was installed and if you look here the rates did not change for the first four years up until 2009, the rates of autopsy did not change but when the duty pathologist came in and this preliminary examination process was instituted immediately it reduced the autopsy rate about 50 per cent because the coroner was confident on the basis of the opinion of the pathologist that there was natural death.

The numbers have climbed a little in that time but they are still less than they had been over the previous years. I think this has been a successful process and the

CT scan has been an integral part of that.

The reason it has been successful is because the pathologist and the coroners were confident and comfortable in the CT scan. They had this four and a half years of experience of using it in every day practice so as the pathologist and the radiologist we learnt how to do CT of the deceased.

The coroners and pathologists became comfortable with the technology, what it was good at, what it was bad at. The legislation was framed around the CT scanner because of this confidence and now I believe it is the cornerstone of the success of the duty pathologist is because the CT scanner is now available.

How is this going in the rest of the world. There are other jurisdictions that do use CT. In particular in Switzerland, Germany and Japan but the difference is in our system we have a coroner. Most medico-legal systems in the world use criminal justice systems so it is a different process. They have much less broad indications for referral. It is mainly looking at criminal death, less natural death. So CT has not taken off to such a degree as in Australia.

There are very few jurisdictions in the world including Australia at this time where CT is a routine procedure prior to autopsy. In most jurisdictions in the world CT is an adjunct to autopsy.

Now, I have tried to show how it fits in with our process. What about using this as evidence because I am now increasingly being called to give evidence on the CT scan. How should we represent it, do we show it like the water melon. It is a very interesting way that we have to

now think about how we are going to show in court what is really quite complex medical information.

You could present it as a written report and that is what I do do, a written report. But I do not think it gives you the full flavour of what we are doing. I think these pictures have hopefully shown you that there is a lot more information than just a written report. Black and white images are fine but there are colour. We can produce things in great colour. We can label them but we can also do three dimensional models. How should we present it? For example in this case this is what is called hemopericardium, blood around the heart, I could write a report that says the CT scan shows a large body in the hemopericardium. I could produce an image like this showing it or I could colourise it and put labels on it or I could produce something like this, a three dimensional model. Which is the best way to present this data to the court? This is a laceration of a kidney. I can say, laceration of the kidney. I can produce an image like this or I can produce a colour coded labelled image, a three dimensional model and we could take it even one step further and actually produce a physical three dimensional plastic model and that has actually been done in places where you can actually hold it in your hand, a model of what the CT data looks like. So there are lots of possibilities here of how we could present this information.

Head injury, talk about a head injury. We could show the image, we could colourise it, we can do a three dimensional model, we can actually do a physical model that someone could hold. There are lots of possibilities.

Now this has not been tested in the literature, certainly not in our literature, the medical literature, apart from in Switzerland where they asked a whole lot of prosecutors what they would prefer. Which of those options would they prefer if they were to be giving evidence. And you can see here the text comes out the worst, this is from a scale of one to five where one is bad and five is good. And you can see as we work up the scale from text, the CT with text, the colour coded text, to three dimensional models, this is what the prosecutors would prefer to be given.

What would they like to present in court? They want the 3D images. They want the colour 3D images. This is not yet published. That same Greek pathologist who does not like necro-radiology gave me this information so it is to be published but I think this just shows where at least the prosecutors in Switzerland feel the value of this is in three dimensional colourised information. But how are we going to present it in court. Do we do a paper copy of that or do we do a presentation like I am giving you tonight, trying to show you the complexity of what we are doing.

What about access to others. I work at the Institute of Forensic Medicine and I am working mainly for the police or for the Institute. What if other people want access to it, how do we give them access. Do I just give them the data and let them go off and play with it. Do we give them the images that I have been working on. Do we give them access to another radiologist for them to work it on. This is all part of the interesting complexity of this because there is a set of raw data that

anyone can have but there is a lot of work that goes into actually making those final images, it takes a lot of time and effort, and necessarily could be seen to compromising the data. Because I cut stuff out and I put stuff in.

The last thing I want to talk about is the fact that this data is permanent. It is permanently stored and it is available at any time for anyone who wants to have access and there is a concept now that we talk about digital exhumations. Instead of having to physically exhume a body if at any stage someone wants to get some information about a deceased person that digital data is there and present at the click of a button. We can actually access that information at any time and decide if there is an issue in a case sometimes it shows, well, may be we do need to physically exhume the body, or there is nothing on the CT scan, there is probably no value in exhuming the body so this is a very valuable set of data that it is accessible for the future and this is one such case, a very decomposed body. Had been through an autopsy process and then some information came, it was an identity case trying to find out who this person was. That this person who was suspected to be on the CT scan had had some coronary artery intervention. They had had coronary artery disease and some cardiologist had put a stent in. I was asked to look at the case. The deceased person was somewhere else. I could physically get those images up and if you look very, very carefully here you can see - I did not pick this up at the time, this is sometime later, you can see very subtlety something here. Playing around and doing some three-dimensional re-constructions we can see there are in fact two stents in the coronary

artery one 12mm in length and one 16mm in length and the medical records on this person showed two stents one 12mm in length and one 16mm in length so we were able to positively identify this person on the basis of the CT data without needing to go and get the body from where it had been placed.

CT scanning is moving as it is in clinical practice and there are some really great advances that we can potentially do now. We can't do it as part of the preliminary examination because it is not part of the legislation but a coroner can ask us to do extra or order us to do extra information without the need for a full autopsy. So this is the legislation s.25 allows us to do other procedures, and this is new technique that has just been pioneered here and in Switzerland where in fact you may have heard of angiograms where we can actually look at the blood vessels of the body. We can now actually do angiograms on the deceased. There is no beating heart so we actually use a heart-lung machine or the equivalent.

We actually do not have one of these heart-lung machines we have another pump but we basically take over the function of the body using an external pump and using that we can pump contrast around the body as if it is a living person and actually outline the blood vessels of the body. This has got great potential for the future so for example this case where someone has bled in the brain, we can do an angiogram and show that blood vessel and the aneurysm in that artery that has ruptured. Fantastic information for the pathologist and may not need or require an autopsy.

In clinical practice we can also use the CT scan to

guide us to do biopsies. We may not need to do a full autopsy and take full specimen of tissue, we can take partial specimens so we can do the same thing in the deceased. So under CT control we can take small fragments of any part of the body we choose. So for example here is the kidney, here is the CT scan to produce a piece of tissue and we can get histology to look under the microscope without having to resort to a full autopsy of opening the entire body.

So in conclusion what I would like to say is that I believe that CT scanning of the deceased is a very effective technique. It is not truly a virtual autopsy. It does not replace autopsy but it is very helpful. It has now become the cornerstone of our new legislation in which there is the preliminary examination which is world first legislation in which other legal people in the world are very interested in seeing and it is important because this legislation balances the demands of a medico-legal death investigation and the needs and rights of relatives

I believe that CT contributes to all those things that I said at the start was the role of the coroner. Finding causes of death. We assist the pathologists using CT to do that. Reducing the number of preventable deaths. By using CT we get accurate depiction of injury patterns and mechanisms so we can understand why people are dying, so therefore we can try and prevent that. And for the administration of justice I think we can find unsuspected pathology and assist courts in evidence, so I think we are living up to that role as well using the CT scan. That is all I would like to talk about tonight. I am very happy to take questions.

This was an image that you may remember from the bushfires. Even koalas are not free of our CT scanner so that is a koala but we can actually CT koalas as well and that is what a Koala looks like in the CT scanner. So thank you very much.

DR HOWLETT: Thank you very much Chris. There is a microphone circulating around the room. If you would please preface your question with your name for the benefit of the recording.

MR FERGERTY: Thank you very much Chris, it is absolutely fascinating. Of course you are talking about cases that come to the Coroners Court and there are many persons who die who never make it to the Coroners Court.

DR O'DONNELL: Yes.

MR FERGERTY: When I was an assistant pathologist before I went into orthopaedic surgery, the autopsy rate in teaching hospitals was over 80 per cent. Now it is probably less than 10 per cent. And my question to you is, do you think that your form of necro-radiology might in the future take over to help this problem of death occurring within teaching hospitals and yet we are not really achieving the real answer as to what the pathology may have been leading to death?

DR O'DONNELL: I think that the answer to that is absolutely. I think, there is already work going on in Japan in particular they have very, very low rates of autopsy in Japan and there is a very strong push in Japan to use this technology in hospitals in a hospital-related death. I do not know that it is all that popular in Australia yet but I think it is, certainly as we get this technique out to radiologist and pathologist, I think there is great

potential for trying to help hospitals understand why people die in hospital, not related to the coroner, it is not a particular issue of medico-legal death investigation, but just trying to work out why people die in hospital. I think there is great potential for CT and MRI and some of those other techniques, percutaneous biopsy techniques that I described. Absolutely.

MR NICHOLSON: My question is, you mentioned that in other states and territories the use of a CT scan is ancillary to an autopsy being ordered. Has any steps been taken to show to the standing committees of attorney-general or the ministers for health, the new Victorian legislation and the new Victorian system? You might be having success overseas but I wonder if it might be possible to have some success within Australia?

DR O'DONNELL: I guess my standard answer when I go to court is "It is not my area of expertise". Is that how you are meant to say it? The law? So I do not know the exact answer to that question. That is a very good question but what I do know is that Institutes of Forensic Pathology in Australia are increasingly using this technology. Queensland for example, in Brisbane. There is a CT scanner in Newcastle. There is a CT scanner going over mid next year for Perth who are about to install a CT scanner. So there is no question that the technology is going to be incorporated in the Institutes of Forensic Medicine but I suspect the same sort of thing will happen in those states as in Victoria.

I think the people who are involved with the system have to get comfortable with the technology before the legislators are able to feel comfortable of incorporating

it into their Acts. I suspect, I do not know, but it is pretty foreign I think to a lot of pathologists when it first starts and a lot of radiologists do not really understand it so we have to try and get it integrated into the process first, into the autopsy process first, and I think potentially then it can be integrated into a preliminary examination type concept as a triage type concept.

MR LAVOIRPIERRE: Chris, an outstanding talk. You alluded during your talk to the deterioration of tissues with the passage of time. One of the areas that comes readily to mind as to causing potentially a large number of problems is obviously things like the lung. In a situation like this where you have got an infiltration process within the lungs, how much can you actually rely upon the CT technique, in other words how frequently do you get the patient relatively close to the time of death and secondly how much can you actually rely upon what you are seeing and how frequently therefore do you then have to go into a biopsy of the lung tissue?

MR DONNELL: That is a very good question, Alain. The lung is probably the worst area for CT because there are lots of changes that happen to the body at or around the time of death that are not the cause of death. Aspiration for example. So it is very common around the time of death for the deceased person to vomit and for the vomitous to be aspirated into the lungs and that causes a lot of artefact. It resonates in my brain every time I look at a CT scan, Professor Cordner said to me the very first time I started he said, "You have to understand the artefacts." That is what I spend my time doing, trying to make sure

that every time I see something on a post-mortem CT that it is true pathology and not artefact, and the lung is probably the most difficult area. From time to time we can be certain if it is very focal pathology or a mass or whatever, that in many, many cases we cannot rely on the CT findings for definite diagnosis in the lung.

MR HAREWOOD: I very much enjoyed your presentation. For a dead radiologist, that was surprisingly animated. But I was also reflecting on the role of MRI and you mentioned that and I am sure that must be next on your agenda but if I were to cast forward then if with CT scan, MRI, percutaneous biopsy, possibly even laparoscopic or endoscopic examination of body cavities, what would you be looking for with a post mortem then? Why would you need to actually carry out a post mortem and what would you find that you could not find by these minimally invasive techniques?

DR O'DONNELL: Look, we have not got that far so we do not know what we are missing but the reality is that we are talking medicine of gold standards and to this time, the autopsy is still the gold standard. We do not know what we are going to find until you do the autopsy and so the problem is, until we have done lots of work with the CT, the MRIs and all these other procedures, we do not know what we are going to be missing. The major things I think that we would be concerned about would be injury patterns. The sort of subtle textural issues in the skin and the subcutaneous tissues which the pathologists rely so much on for determining types and patterns of injuries, what weapon was used, et cetera, et cetera. There is very, very specialised work to the pathologist which I think is

at the absolutely - they are at the limits of imaging, at this time anyway. Certainly on the limits of CT. I think MRI has great potential but MRI is extremely expensive, very problematic but there are institutes in Europe that do have CT and have MRI and do CT and MRI in all their cases as well so it is definitely the way of the future but whether it will absolutely ever replace the autopsy, I think it is very unlikely because there will still be these subtle issues that will not be able to be addressed by imaging. In many cases it will but not all.

MR HOWLETT: I now call upon Dr Lythgo, our medical vice president of the Society to give the vote of thanks.

DR LYTHGO: That was an absolutely fantastic talk. I was thinking back to when cat scans were introduced and the thing that affected me was that it did away almost overnight with the need for air in cephalograms which were an investigation of neurosurgical patients which were a horrendous experience for the patient and for the neurosurgical anaesthetist but as you see, it has moved on and it has taken over the world and it has also led to the development of this wonderful new specialty of necro-radiology. Now, one of the joys of working as an anaesthetist is that for a considerable part of the time our patients are asleep but think of the necro-radiologist, for heaven's sake. You would not even have to put on your high heels and makeup to go and see your patients. I think it is also got implications in the current controversy or the discussions of selection of medical students because I know that we all need warm, empathetic clinicians who are wonderful communicators but should we really, you know, be prejudiced against the

candidate who has the perfect personality profile to make a necro-radiologist. Anyway, that being said, Chris, you are a wonderful communicator and on behalf of the Medico-Legal Society, I thank you very much for your presentation tonight.

DR O'DONNELL: Thank you.

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