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Introduction

Dr. Tom Slovis: Dr. Donald Frush is Chief of the Pediatric Radiology Division, Duke University Medical Center. Don has been extremely active in The Society for Pediatric Radiology and in Paris last May won the Caffey Award for the best paper. It was on dose reduction from CT in children.

Dr. Frush: For this next segment, we hope to give you a perspective on what the radiologist can do for dose reduction. I say with all due respect that being a radiologist up here is very intimidating, given the expertise of the previous speakers.

I'd like to introduce what Lane and I are going to go over. I really want to emphasize that while we are predominantly talking about pediatric CT, we are really talking about all CT. I think this is one venue in which pediatric radiologists are on the leading edge. Much of what we do in pediatric radiology is to follow the leads that have been put forth by our adult colleagues. Pediatric subspecialists are now redefining the way that people look at CT for all ages, and we all ought to be proud to be a part of that. I think it is a radiologist issue rather than just a pediatric radiologist issue.

The topic has even broader impact. The radiation issue is not just for radiologists. This is a shared responsibility between clinicians, technologists, radiologists, industry, and leading medical organizations.

Dr. Donnelly will go over a little bit of the historical parallels with the discovery of X-rays and review what happened about 6 months ago with the series of articles in *AJR*, and what caused us to focus our attention on these issues today. We will also discuss some of the strategies that we feel are helpful in minimizing the radiation dose.

Figure 1 illustrates the fact that CT is an important source of radiation dose and whether it is 60+% as previously quoted or 40% doesn't matter (Fig. 1). This is an extremely important issue. The medical importance of CT probably hasn't been emphasized as much, and one of our mandates is to talk about the benefits of CT. CT is a tremendously helpful modality; it's the only modality that we can look at everything in the body: chest, abdomen, brain, bone, etc., whereas the other modalities have some substantial limitations. This certainly wasn't reflected in the *USA Today* article. We use CT for a great number of scenarios, which I think you are all familiar with. What is happening and what draws us here today is that we are depending on CT for diagnosis of the more common diseases such as appendicitis, renal stones, and pulmonary emboli. At Duke, we don't do conventional angiograms much anymore – we do CT angiograms. We are not talking specifically about pediatric CT, but these applications support the importance on a more global scale. When you start discussing the issue of CT radiation dose and cancer risks, and one needs to look at screening examinations for lung cancer and coronary artery calcification and abdominal screening. These are a much more substantial

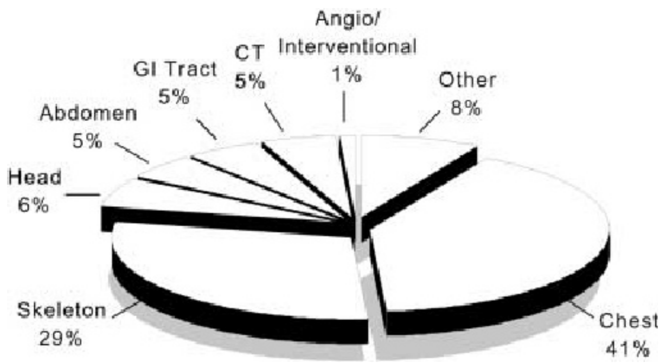

Fig. 1. Importance of CT radiation (from UNSCEAR; 2000): CT accounts for only 5% frequency of imaging using radiation, but greater then 40% of the total dose

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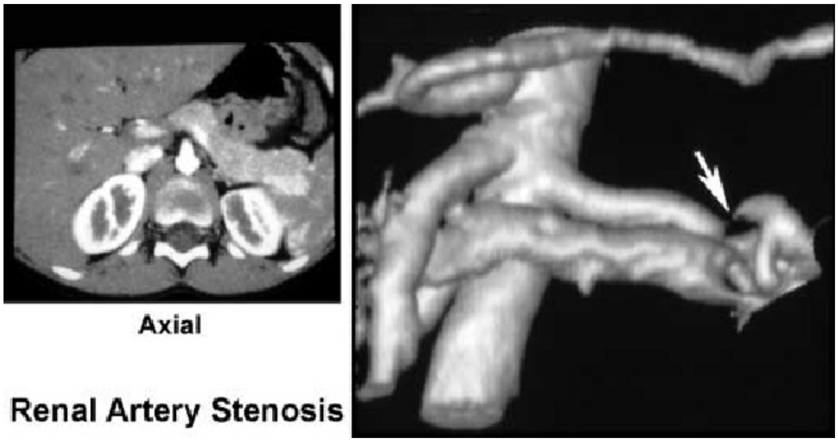
Fig. 2. Importance of CT



health issue for the entire population given their frequency.

These are the kinds of things we can do especially with the new multi-detector technology (Fig. 2). This is a child who has a thin upper pole of the left kidney. On CT angiography you can see the stenosis to a branch of the upper pole. This was less than 10 s worth of imaging at about 64 mAs, a fairly low-dose study. This multi-detector technology really has changed the way we look at scanning with the ability to scan larger areas quickly or smaller areas with a faster scan time. Articles are coming out with the CT angiograms performed from a patient from head to feet. Nothing scares me more for kids than being able to do that. Because you can, people do! You can obtain very thin slices, 1.25 mm, with 8 detectors or 16 detectors units. There is a real risk of doing more because we can, not because you should! That's what we are trying to prevent. We are trying to understand what you *need* to see and what you *can* see. Multi-detector CT is a great technology, but only when used correctly.

Multi-detector scans are much more complicated. The options are incredible. How do we use them well? We've got detector configuration and slice thicknesses, table speeds, gantry rotation times, etc. In addition, we must learn a whole new concept of pitch. It seemed to take me years to figure out pitch with the helical scanner; now I need to begin again. It's all very confusing! The bottom line is that there are a lot of different parameters we have to deal with. Tables 1 and 2 demonstrate what you can do with the HQ and HS modes (GEscanner) in terms of configurations, table speeds, and section thickness. HS mode gives us more options. I remember seeing this 3 years ago and having no idea what to use. I just want to scan the abdomen or chest. Who will help me pick the right settings? For example, if you take a hypothetical chest CT in a 10-year-old child with a range of parameters listed (including 100, 120, 140 kVp, 60–120 mA, and 0.5–1.0 s gantry cycle times), you can get more than 375 different scans, some of which would be appropriate and some inappropriate, depending on the indication. It ends up being very confusing. Part of our problem is not understanding dose; part of our problem is not understanding how to perform the CT scan, dose aside. We have literally dozens of options that we are exposed to now in terms of pediatric scanning. There is a risk with the complexity.

Table 1. Pediatric multislice CT. Specific scan parameters. GE high-quality (HQ) mode

Detector configuration (mm)	Table speed (mm/rotation)	Section thickness options (mm)
1.25	3.75	1.25, 2.5
2.50	7.50	2.5, 3.75, 5.0
3.75	11.25	3.75, 5.0, 7.5
5.00	15.00	5.0, 7.5, 10.0

Table 2. Pediatric multislice CT. Specific scan parameters. GE high-speed (HS) mode

Detector configuration (mm)	Table speed (mm/rotation)	Section thickness options (mm)
1.25	7.5	1.25, 2.5
2.50	15.0	2.5, 3.75, 5.0
3.75	22.5	5.0, 7.5
5.00	30.0	5.0, 7.5, 10.0

There are a number of risks with CT and certainly radiation is one of them. It is a problem and it's an increasing issue. One way to look at inappropriate radiation due to lack of understanding with CT is that it is an error. I'm giving this concept of error here and I'll address it a little bit further along, but, I'd like to have you start thinking about the concept that if you use a wrong technique, that is considered a medical error. This is something that is very important currently.

I'd like to introduce Dr. Donnelly who will talk on the historical perspective and the emphasis on CT radiation and some of the strategies.