Panel discussion

**Moderator: Elliott K. Fishman, MD**

**ELLIOT K. FISHMAN, MD:** I want to go through a few issues that we may have touched on briefly and a few things we’ve put off. Let me start with coronary artery imaging. I want to have the panel’s opinion. There are two things that you read a lot about or you see on TV. One is doing cardiac CT for coronary imaging from the ER. There’s the triple threat, whatever triple threat or quadruple threat really mean. Do people see that as viable? In the next 18 to 24 months, will cardiac imaging be like pulmonary embolism as we do it now—if there is a suspicion of PE, get a CT. Is that something we’re going to be doing 24/7 with cardiac imaging?

**MICHAEL POON, MD:** At the ER at Cabrini, I see this request for patients with chest pains. But from a practical standpoint, you don’t do too many triple rule-outs. If you really look at the patient and get a history, the history is everything. How many times are they really not sure that it’s dissection PE or a true coronary syndrome, unless you talk to the patient. For anyone with chest pain, you just do the protocol. But if you talk to the patient and get a good history, you can usually narrow it down to which ones are more likely. Frankly, I don’t think it’s easy to do a triple rule-out right. Technically it’s more difficult, and if you’re trying to get a good pulmonary phase, you might have to give up on the coronary phase.

Even with 64-slice CT, I don’t think it’s a slam dunk. To provide it 24/7 in the ER, you’d better have a lot of people who can spend time, and work with you and do the postprocessing. Gil Raff, who just finished a study in the ER for the triple rule-out, said that the dissection of PE is so rare. So he almost redesigned the entire study just for the coronary rather than include everything.

**STEPHAN ACHENBACH, MD:** I absolutely agree with both points. Very infrequently is there really no clue about what’s going on with the patient. Very rarely is there the absolutely open question as to whether this patient has coronary disease or aortic dissection. If you do suspect aortic dissection, there are other things you can do, like a transesophageal echocardiography (TEE) or even a transthoracic echo to look for effusion or aortic insufficiency.

The second is the technical side. It’s not so easy to perform a scan that covers everything, and if you do that, you administer lots of radiation and lots of contrast because we have to use very high resolution and low pitch to cover the coronaries, but yet you have to cover a large volume, or we have to devise specific protocols that scan the upper half of the thorax a little faster and then slow down for the heart or something complicated like that. It’s not as straightforward as one might think.

**RICHARD D. WHITE, MD:** I totally agree. I dangled the idea in front of the head of our emergency room, and it didn’t stick. They felt that it was a rare patient in whom they didn’t have a strong conviction that it was one or the other, so they would not want an optimized exam for that. I’m concerned about this getting in the way of the patient who’s having an acute coronary event and needs to get to the cath lab, or the type A dissection patient getting into the OR and getting the TEE on the table. So I think it has a lot of pitfalls, and we’re not pushing it.

**FISHMAN:** It’s very interesting. It’s amazing the amount of publicity that triple rule-out has gotten, more in the lay press than anywhere else. So, if questions are asked of us, they are mainly from people who aren’t doing cardiac CT now, but who are interested in doing it. As a concept, it sounds very good, until you get down to the practice and the logic of doing it.

There was a comment about cardiac CT and for coronary imaging that if there’s too much calcification, it may not be the right study to do. We all say that, but does anyone have a good sense of what is “too much” calcification? In our minds, we all know what it is; but is there something we could tell someone else, “If you see this much, don’t do the scan.” Does anyone have any rules?

**JILL E. JACOBS, MD:** That’s the problem. That’s why I said that we don’t use a specific number. I’ve been impressed by the fact that on the initial calcium score, you see calcium, and you think you may have a hard time seeing the lumen through it, and there are calcifications that are very easy to see beyond, and then it seems to be the coarser calcifications that are harder. But I certainly haven’t been able to predict which I will be able to see through and which I won’t.

**FISHMAN:** To follow-up that question, Jill, on how many patients have you done a CT and then said, “No, I’m stopping here. I’m not giving the contrast.”

**JACOBS:** Very few, actually. Those tend to be patients who had calcium scores in the thousands. We look at the
distribution of calcium and we look at what the clinical question is. If they’ve had prior studies that point to a specific coronary artery the clinicians are particularly concerned about, we look at that artery and see how much calcium is in that vessel. If we decide to go through with the cardiac CT angiogram, we talk to the patient, let him/her know what the limitations of the study are, discuss radiation issues, and then decide whether or not we want to go through with the study.

ACHENBACH: I would absolutely like to second that point. It’s not so much the total amount of calcium, it’s a lot about the distribution. If you have a certain volume sitting in the proximal LAD, it might be a lot worse than if you have a lot more distributed all over the coronary system. Another point I would like to add is that calcium by itself is not so bad. What’s really bad is calcium plus a little bit of motion. If you have high-contrast structures and add a little bit of motion artifact, it completely destroys image quality, and it can cause false positives and false negatives. Calcium plus motion is really, really bad.

J. JEFFREY CARR, MD, MSCE: The protocol tells the techs what to do. If they look on their precontrast scan, it looks like a little tree from the left main, and you see the branches of calcified plaque on the noncontrast scan, then I say, “Go over and look at the right and see if you see calcification there.” If there are dense calcifications, then they call us and we look at it, or we bring it up on the PACS to look at it. If you’ve really got a pipe the whole way down, I think it’s likely not to be very useful to do the scan.

FISHMAN: Then it seems that people have a very high threshold before pulling the plug on the study. That’s a good way of looking at it.

WHITE: We use a different approach. We stack the deck so that it doesn’t become a big issue. We rely very heavily on the data on the slide Stephan presented, looking at the likelihood that there is stenotic disease and the association of calcification with stenotic disease. So we are very reluctant to image a 60-year-old man, regardless of what the nature of his symptoms are because he’s likely to have stenotic disease and likely to have calcium. So by targeting the right patients, by the time we’ve invested the team into the beta-blockade, getting the patient on the table, and all of that, we’ve made a major commitment, and to back out then is difficult. So we’ve been very proactive in trying to select the right patient.

ACHENBACH: There is always the question whether you have the right patient. With a 47-year-old woman who needs coronary artery disease ruled out, do we have to do calcium scoring at all or should we just go right ahead and do the CTA? That’s what we do. We don’t do the calcium scoring.

WHITE: We just focus on coronary CTA in the right patients. That’s been our approach, and we believe it has worked well.

ACHENBACH: Absolutely.

FISHMAN: As we mentioned earlier, the number of people who are doing coronary CTA is relatively small. But the number of people who want to do it is very large. Maybe we should separate the questions for radiologists and cardiologists. If someone says to you, “I want to get started. I have a 64-slice CT coming. How do I go about it?” Where do I start? What do I need to know? What do I need to learn?” If you had to tell someone what three things they would need to do, what would your recommendations be?

WHITE: I would say: Discover that there is a workstation. Be willing to touch the thing, and resign yourself to the fact that you’re going to be doing the primary analysis on that workstation. I think there’s a perception that something polished will be handed to them by the technologist and it’s ready to read. That’s the misperception. We go right back to the question of whether or not the physician is willing to touch the workstation, learn to use it, and interface with that data. That’s the biggest obstacle, and it scares people.

ACHENBACH: I think there is not too much difference between radiology and cardiology on this. They both have to go through a learning process.

The first step is that cardiologists have to learn about CT and radiologists have to learn more about coronary artery disease and coronary anatomy. So that’s a basis that both have to establish. Then, the second step is that they really have to learn how to acquire cardiac CTA data. They have to learn the few important issues because the most important step in doing CTA is to acquire very good data. If you have very good image quality, reading is very easy. If you have poor image quality, reading is very difficult. So people have to learn a few tips and tricks about how to acquire the data.

WHITE: I agree. But I think it’s very frightening to people that they are going to have to make more of a commitment to working with the data.

ACHENBACH: The third step (and, as usual, we agree), is that they really have to sit down and learn how to interpret and read the original data and not rely on any preformatted reconstruction that is being done for them, no matter how fancy the software is.

One other thing I would like to point out that I think is very important when you start doing this: Initially you have to be very conservative and only study the patients in whom you expect to have very good results. Take a 50-year-old athlete with a low heart rate and a low likelihood of disease, but coronary artery disease needs to be ruled out. Or do the occasional bypass patient because bypasses are easy to do. Then, gradually move on. At first, be very conservative and expand your indications after awhile.

Usually what I see happening is that people want to get into cardiac CT, and they start scanning a lot of patients who are very difficult to evaluate: Patients with stents and patients with diabetes and 3 previous myocardial infarctions. Those are terribly difficult to evaluate. So it makes much more sense to be conservative in the indications at first and slowly expand based on that.
CARR: There’s the other dimension about knowing what to do once you’ve acquired the data and you’ve interpreted the data, and that is how to manage the patient. We have a long way to go on that. We alluded to the fact that coronary artery disease is more than just stenosis. We need to understand how to use that data to impact patient care. It’s critical, as Stephan alluded to, to have the right patient, because if you scan everybody or you bring in asymptomatic people, you will have a very hard time knowing how to manage a 30% lesion or a 40% lesion in an asymptomatic person.

So my big caveat is to make sure that you have indications that you understand, because you need to understand, when you get the results that you’re likely to get, how to apply those to your patient population. You don’t want your referring physicians to say, “Why did you do this? What do you expect me to do when you tell me that there’s a 30% lesion in an asymptomatic man?” I think it is critically important to have the right patient, the right technique, and the right interpretation.

ACHENBACH: You need to avoid opening it up to just any patient who walks in, otherwise you get these findings and nobody knows what to do with them. The other thing that I’ve seen happening is that once you start offering this, then the cardiologists tend to send you patients in whom they really don’t want to do an invasive angiogram, like a very sick, 85-year-old renal failure patient with atrial fibrillation. They are not good candidates for CT, either, but they’ll try to get rid of those difficult angiograms. It’s really about making a choice and scanning the right patient in the beginning.

JACOBS: What’s really interesting about this discussion, being a radiologist sitting between two cardiologists, is that the cardiologists talked about radiologic stuff they needed to know, and we radiologists learned about all the cardiology things we need to know. What’s become apparent is that it should be a cooperative effort, that to get the right patient population, you need to talk to your referring physicians. We have to be on the same page about which patients are going to be good candidates for the study and which are bad candidates.

As radiologists, we need to know what the cardiologists expect to get from the study. As cardiologists, you need to be aware of all the radiologic knowledge that you need to perform the study well and to interpret it. So political issues aside, it’s become very apparent that we all need to work together on this.

ACHENBACH: I think it’s a very good point. We frequently have radiologists and cardiologists coming together now when we offer courses and little fellowships. That’s usually a very good experience. First of all, they lose the fear they had by getting to know each other. Also, they learn from each other, and they recognize that they need knowledge from both fields. We frequently have teams coming in with cardiologists and radiologists and being trained together.

POON: I have a point about the workstation, as we talked about earlier. That seems to be a big unknown to many cardiologists. They’re not aware that it requires a significant amount of time, and that you need to have very good training to be savvy on the workstations and get through the case. After they go through these training programs, a lot of them are complaining that it takes them an hour to go through a case. The training program has to make them really understand that this is not a modality like echo, where you just look at the image and read. This is an image for which you have to create the view that you need. It’s not just going to come out. You can get anything you want, but you have to know what you want.

CARR: Let me follow up on that. I love that analogy to echocardiography because I think that multidetector CT is really very much like echocardiography, except you don’t have the technologist. When I’m interrogating the volume in reformat, it’s almost like I have the transducer in my hand. So I’m able to go to the short axis, the long axis, the vertical long axis, and the four chambers. If you’re used to doing your own ultrasound, with CT, it’s almost like you have that transducer and you don’t have to worry about the artifacts and shadows from the ribs, and you have this great field of view. In many ways you have that interactivity that you have with ultrasound, but the problem for physicians—radiologists and cardiologists—is that we’ve come to rely on our technologists to get us 80% of the way here. With CT now, we’re 100% there, but we have to pull out the information, and that’s where the workstations become so critical.

FISHMAN: I think a lot of this is going back to where we started in radiology. A lot of radiologists now have gotten used to being in a darkroom, with everything sent to them on a work list, and they stay in that work list just going through the PACS and reading and reading. Way back when in CT, you sat at the monitor, you looked at the images, though most of the time it was axial. It’s kind of going back to where we started. You just have to get into those data sets. It is true, the biggest complaint is that people feel the workstations don’t work. Usually that’s in part because they don’t know how to use them.

One of the things that’s very compelling about cardiac CT is that you can get very nice images. Every magazine and every journal has beautiful images. You get the feeling that those images just come out in 3 seconds flat. There is a perception that it should be really easy: Just press a button and out pops those images. I think the more you do it, the more you realize what a challenge it is.

In terms of education, I think the hardest thing is that most education at a postgraduate level is done in big rooms with a lot of people. Someone’s lecturing to 300 people. That’s always seemed to work pretty well for most things. I’m sure cardiology is like radiology. For a lot of
cardiac imaging, there are some techniques that can be in a lecture on how to do it, how to give the beta-blockers, etc. But, beyond that, the rest becomes very much hands-on.

You can’t watch someone else using a workstation and think you’re learning. It’s kind of like watching somebody playing Nintendo. I can watch my son play Nintendo all day long, but if I get that thing in front of me, it’s not so easy to keep up. It’s very much like that; it’s definitely not a spectator sport. That makes it much harder because all of our training trying to do as much as possible in as little time as possible really falls apart. You need to be able to spend the time. There’s no way to rush computer training. You can probably use better techniques, maybe some Web training, or ways to make it a little easier on people, but the reality is that there’s no better way, day in and day out, than just doing it. The computers are easier now, but no matter how easy they get, they will not eliminate the need for time to learn how to use it.

POON: I agree. That’s why I train only about 2 people a week. With more than 2, you lose that interactive phase, which is crucial. Once you get a group of people together, you can’t show them why you go from one phase and one technique to another. You really almost have to hold their hand and say, “Click this button, you get this. That button, you get that.” I agree that you cannot learn to overcome the technology part in a classroom. You really need to sit one-on-one with somebody who knows how to do it and have them tell you what to get and how to rotate to look at what you need to see.

FISHMAN: That brings up a point we commented on before. Whether it’s through societies or organizations, how exactly do you do that? Training 2 people at a time may take 3000 years to get people trained. I know from some of the ACC/ACR conference calls that one of the issues is training and documentation of training. The challenge is that there are very few places that do training. As you said, it’s hard to train a lot of people at a time. Yet everyone wants to learn right now. So that’s a real challenge for all of us.

MARILYN J. SIEGEL, MD: Each radiology group or practice needs a champion or expert in the 3D workstation. Then that person, in turn, can try to educate the rest of the practice. To take the whole practice to hands-on courses won’t work. One person must be identified who will become the expert in that practice.

FISHMAN: So, really the learning process is definitely an important factor. One thing that will probably make it easier is that the scanners will begin to have more functionality than they have now. Workstations will have more custom-designed software.

So in saying that, I’d like the panel’s opinions on what would be the best change that could improve cardiac CT angiography, particularly coronary artery imaging. What changes would you like to see, whether from a workstation perspective or from a scanner perspective? What do we really need to do better cardiac imaging, more robust imaging?

POON: From a scanner standpoint, I think the temporal resolution is still a problem. That creates a problem for the practitioner to get the patient ready to scan—I think that’s the bottleneck. Scanning is easy, but getting the patient ready to be scanned is hard. So, if you can make the temporal resolution even faster, then you can scan any heartbeat. That would be one major advance.

In terms of the workstation, I think the hardest thing is to come up with a standard protocol to report findings. The hardest thing to teach is, “This is my way of doing it.” There’s another way of doing it. We all have different results. The basic elements are more or less the same, but what do we need as a standard report? It would be very helpful to teach someone, “These are the basic elements.” Stephan talked about the quality of the study, and the certain anatomic structure, what we can call, what we cannot call, and whether or not you want to have function every time.

Then you have a set of things that you say, “I can teach you how to do this to get all these things.” Obviously, every patient is a little bit different. But, if we can have some kind of consensus on the basic elements that you need, and then focus on those and teach, then we have some teaching points. Right now, some people like to do an axial read; some people do 3D volume rendering and then go to MPR. But I think this is all because we don’t know what we want to report, so we all have a different way of approaching it. Once you know what you need, then the method of reading can be very much standardized.

JACOBS: I agree in terms of the temporal resolution. We have a way to go with that. It would be nice to be able to get some perfusion information without a tremendous radiation dose to a patient. Also, on the postprocessing end, it’s still taking way too long to process a lot of these cases. Some of that is just caused by the tortuosity of the vessels. It’s very difficult to orient yourself constantly in different directions so that you can see the vessels optimally. That’s where software will really help us in isolating the vessels easily and in interrogating the short axis of the vessels more easily than we can right now. That will help a lot.

FISHMAN: In terms of temporal resolution, right now we were saying it’s around 150 to 160 msec. What do you think the ideal is? Electron-beam CT was 100 msec. What would you like to see?

JACOBS: Ultimately, it would be nice to be at the same level as conventional cardiac catheterization and be able to really see much better than we are. That’s why we’re still overestimating stenoses. It’s just a resolution issue.

FISHMAN: So, you’d like to see a 20- to 50-msec range.

JACOBS: Right.

ACHENBACH: As far as coronary artery imaging is concerned, we are used to an incredibly high standard. That’s invasive coronary angiography, which gives perfect results in almost 100% of cases, incredibly high temporal and spatial resolution. In order for CT coronary
imaging to make it, we will have to have a similar quality in almost every patient, and that’s the major problem that we have right now. We have unbelievably good image quality and very confident interpretation in some patients, but not in all patients. We need to get to a level where we can achieve that very, very high image quality, and high confidence level in reading in almost all of the patients. That’s what I see happening.

As you said, you see those spectacular images, but when you start doing it yourself, the results don’t look like that at all. So what we need for this to really be a breakthrough is to have improvements in scanner technology that make us get almost-perfect results in almost all of the patients. That means we have to have higher temporal and spatial resolution.

On the postprocessing side, I think we have everything we need. All the further changes being made are like making a car that is very good already a little bit more comfortable. Basically we have all we need to interpret our data set. The only thing that would be nice would be to have a really cool tool that shows what we have seen in one image that we can print out and hand to somebody else. The major thing we need is better image quality when we acquire the data.

CARR: I’m going to take the population perspective on this. With the aging of the population in the U.S. and in Europe and this epidemic of cardiovascular disease, we really need training of physicians. I really don’t know over the next 10 to 15 years how we’re going to be able to handle the sheer volume of cardiac CT that will come down the pike. I was joking at an ACC meeting that everybody’s fighting to do cardiac CT. But, my prediction is that in 10 years we’re going to be fighting to get rid of cardiac CTs. It’s going to be much like mammography, in that they’re going to drive the reimbursement down. So training enough physicians to handle the volume is going to be a big thing.

We need to find people who really know how to interrogate the images, make the correct diagnoses, and report them in a way that our clinical brethren can understand what we mean. To report them, we need to know what’s important and what’s not important.

From a technical point of view, I agree with Stephan in that the workstation is close to being there. There needs to be a lot of work on reporting the results, so that we can take a complex image report and get it out into the clinical realm so that medical students, fellows, residents, referring physicians, and consultants can take a report and understand what we think the results are.

Finally, from a technical point of view, I’d really like a detector that was about the length of the heart, roughly 100 mm, so that you could do pretty close to the whole heart without having to move the table. I believe that just moving the person through the gantry creates some spatial resolution motion on sharpness, related to the spiral acquisition. We could potentially eliminate that with a wider detector that got us the proximal coronary arteries in one shot.

WHITE: The only thing I’d have to add is that we’re going to be very dependent upon the technologist. Support for the development of a new species of physician-assistant technologist would be very beneficial. Someone who will supervise the acquisition and do some fundamental postprocessing to get the physician at least something that’s been optimized will become more and more essential, although I still see us interfacing with most of the important data. Then, in my case, I’d like to have more techs who are ready to take the patient from CT over to MR to complete the story. So, it would entail cross training techs too. I think that the echo success is largely dependent upon the rearing of a unique species of tech who is distinctly different from the standard ultrasound technologist.

FISHMAN: Sounds like a super tech, who could really just do dedicated cardiac imaging.

WHITE: We’re able to do it, but it doesn’t come easy. It’s not necessarily embraced, and it defies the normal pattern. But I think we’re going to have to do that.

FISHMAN: In terms of technology, you showed a few images from PET/CT. Do you think that’s going to be a very important factor?

WHITE: I once thought so. Our experiment with it in dedicated cardiac was interesting, but I got out of it. I found it very hard to keep 2 technologies state of the art. It might be a state-of-the-art PET CT scanner, but at the same time it might not be a state-of-the-art CT scanner, nor a state-of-the-art PET scanner. I have lost a lot of interest in hybrid systems for that reason.

SIEGEL: I agree. I think that dedicated software has really improved. But I think there are steps they can take to improve coronary software so it’s really dedicated to coronary. I don’t think that exists now. But is there a way to improve that process that would make it easier to teach people? I know that there are vendors that are trying to come up with a cookbook-type of thing. How to do it with CDs, and so on, and none of that exists just yet.

FISHMAN: I agree with everything everyone said. In terms of the scanners, the temporal resolution has to go to that 50-msec range. There’s no doubt that we’ll be there. The question is, will it be this year, next year, or the year after? It will happen, and it will be a big driving force.

I disagree a little bit on the workstation, since we’re involved in workstation development. I think workstations today are pretty good, but it’s pretty good only based on what we had before.

I think the amount of sophistication and the amount of quantification that can be done automatically will improve. That could be with a perfusion-based design, or just the ability for better segmentation of vessels and then quantifying stenosis. As Stephan said, you have to eyeball what the relative stenosis is. Computers should be good at that, particularly as spatial resolution gets better.

One of the things that I look forward to is a tool that will make things more reproducible. One of the concerns now is what if you have 3 readers look at the same cardiac imaging—what is the reproducibility? I’ve not seen a really good study about this. That type of
multicenter trial is necessary, and it has happened with colon and with other areas as well. What is the reproducibility of saying it’s 50% stenosis? That’s something that really has not been addressed as well as it should. That robustness of being able to say that 10 people read it and 10 people get the same answer, that’s very comforting as technology gets into the mainstream. If the “experts” can’t agree on results, that’s going to be a little bit more worrisome. Technology plus processing could really help in that regard.

If you were to make a recommendation about education support, what would it be? What could be provided to radiologists, cardiologists, and technologists that would really help from an educational perspective?

A meeting like this is very helpful, because our presentations and discussions will be distributed in a supplement to Applied Radiology. People will be able to read it and see it online. But what else could be done?

POON: I think we could use help in putting together some teaching files in terms of how an expert would dissect a case and disseminate those kinds of teaching materials. Any kind of material that can help them to get over the initial learning phase of getting comfortable, looking at the workstation and what kind of view that you need to do could be offered through a teaching file. That would require a lot of money and a lot of effort to do it right and to make it more interactive, perhaps. It might help to set up this type of interactive teaching material, rather than just still-frame images.

FISHMAN: It’s interesting, in the area of colon cancer, there’s a national trial going on now from ACRIN. To try to maintain a level of quality, the study includes 20 institutions. But, in order for you to be accepted, you had to pass a test with a certain score. They did training and tested people with a set of cases. If you didn’t pass with a 90% grade, you could not be part of the trial. So they were raising the standards. Maybe we could use that for cardiac imaging, where there’s a set of 25 to 75 cases, and physicians have to make sure they agree with the correct answers. That might be something useful. It could be Web-based, where the cost and speed of distribution is minimized.

JACOBS: I agree. One of the best ways to learn is to see a whole range of different cases and to know how to approach them. If people were able to load a teaching file series onto a workstation, go through a variety of pathology, learn how to approach it at the workstation; and then actually see a video of what an expert would do, what views were most helpful, how you get those views, that would be really helpful.

ACHENBACH: I echo what my two colleagues have said. Any form of hands-on training that could be supported would be good, whether it’s small courses, with hands-on training on workstations and interaction with experienced teachers, or whether it’s materials and handouts. I personally favor the idea of just loading cases onto the workstation that you’re going to use anyway. So you’re learning on the workstation that you use every day, and have these cases, and have angiographic correlation right next to them. Anything that provides you hands-on training would be a good thing to do.

As the president of the Society of Cardiovascular CT (SCCT), I know that any support of the society would be very useful, because we then would, in turn, have more resources for our efforts for education guidelines, education, and all the other things that are necessary.

CARR: On a practical level, it seems that manufacturers of workstations for cardiac CT should be required to have a mobile classroom of 3 or 4 workstations. They could do a road trip across their territory so that people could actually try out the workstation, and they could take it to conferences. We did this with mammography with sets of cases. But it was much easier because it was film-based, or the original digital-based. For cardiac CT, actually being able to sit at the workstation and explore on your own is incredibly powerful.

I think that the manufacturers should come to the table with more opportunities for people to train; because when you get home you’re there with your workstation alone. You might have an application person come in when you first get it, but that might not be the ideal learning time for you—it might be 3 or 4 or even 6 months down the road. I think the idea of having easy opportunities for physicians to interact with people knowledgeable of both the software and the image data would be really valuable.

FISHMAN: We’ve been doing this for about the past nine years. We run a 3D course in the spring at Hopkins. Initially, we started with 10 workstations; now it’s more than 20 workstations. In the beginning, people would go and look at the workstations. People now come at 6:00 am for special sessions, through 7:00 pm, all day long. I really think it is definitely the way to go. The biggest problem with workstations is the physical size, and shipping things around is very difficult. It’s not even the cost of the workstation as much as the actual shipping. It would be nice if they could develop simulators that you could run on PCs. Maybe you couldn’t do the processing, but you could at least run through a lot of the steps.

WHITE: We’ve been giving visiting fellowships for years. I’ve always noticed that when a physician and a technologist come together, that group is more successful when they go back. So don’t just think of the physician or just the technologist, but instead a teambuilding idea. I really sense that is key.

SIEGEL: I think interactive teaching files, Web-based or CDs, would be helpful. These can be easily loaded on a workstation. The experts can present typical cases and give tips of the trade on how to obtain the correct views and which views would be most helpful. A variety of different pathologies should be presented. Then, the radiologist can be given unknown cases. The radiologist tries his or her hand at these and then the cases are represented by the
expert. There are training sets available for reading pulmonary nodules, so it would seem reasonable to create training sets for teaching cardiac CT.

**FISHMAN:** One issue, of course, that is always very tricky is multiple vendors. If you have a workstation from one vendor, and are being shown how to do it on equipment from another vendor, it really isn’t very helpful. If you’re learning on a different workstation, you can learn the concepts, but it’s really the hands-on you need to learn—which way the mouse works, and all the buttons.

**ACHENBACH:** But that’s why I think in those training courses it’s important that you emphasize the very basic aspects of the workstation in those training courses. On any workstation, MPR and MIPs are always available. If you go to training courses, or if you provide training courses, they teach you the most fancy, dedicated product they have on that specific workstation. But that is not going to be useful when you go back home. You have to train on the most basic aspects of the workstations, because I believe those are transferable.

**SIEGEL:** I agree. I think there are general concepts that you can get across in training courses, whether Web-based or on CDs. However, as Elliot pointed out, learning a workstation may require each of the vendors to produce their product-specific program. Learning how to use a workstation requires hands-on training and this will likely need to be specific for the user’s scanner.

I think there are general concepts that you can get across. In many meetings, CDs are handed out, and people run to get them. They want them. They try to get as much as information as they can. I don’t know how useful they are, but that might be one thing to research. “Does that help you? How do you like your education?” If it’s hands-on, then you know the answer—somebody has to be there, they’re going to have to go to meetings, and somebody needs to come in. If there’s a value to other types of education, then those should be produced.

**FISHMAN:** I think in terms of handouts and meetings, I think radiologists and cardiologists are the same. They have not outgrown being medical students. If something is lying there, they take it. I have 9000 pens at home. Why do I always take the pens? I don’t even like them. I think the amount of information that people gather would be really very impressive, if they actually used it.

No matter how good the tools are, whether it’s hardware or software, no matter how good the training is, there’s no way of getting around spending the time. I think one message we all agree on that most of us have said is that if you want to do cardiac CT, it’s going to take time; it’s an investment of your time.

Workstations can be easier and faster, and scanners will get better. But unless you put the time in, it’s really not going to matter. I think cooperative effort from everybody—from technologists, radiologists, and cardiologists—is really the way things will work very nicely. This meeting is a very good step in that direction. The amount of material we’ve covered today has really come together very nicely.

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