Effect of an Institutional Triaging Algorithm on the Use of Multidetector CT for Patients with Blunt Abdominopelvic Trauma over an 8-year Period

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Predictors of CT Radiation Dose and Their Effect on Patient Care: A Comprehensive Analysis Using Automated Data

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Herbert Y. Kressel, MD

Hi. This is Herb Kressel, Editor of Radiology, and welcome to the January Radiology podcast. This month we have conversations with the authors of three particularly stimulating articles we’re publishing. First, we’ll be speaking with both Dr. Rebecca Smith-Bindman Professor of Radiology and Medical Imaging at UCSF who with her colleagues throughout the University of California system have reported on predictors of computed tomography radiation dose and their impact on patient care, a comprehensive analysis using automated data. Joining us for that conversation will be Dr. Jorge Soto Professor and Chairman of Radiology at the Boston University Medical Center. Dr. Soto and his colleagues at Boston University Medical Center did an interesting study on the impact of an institutional triaging algorithm on the use of multidetector CT and blunt abdominopelvic trauma over an 8-year period. These two authors are approaching the problem of optimization and justification of imaging exams using somewhat different but related approaches. Next, I’ll be speaking with Dr. Perry Pickhardt Professor of Radiology at the University of Wisconsin and a senior leader in the area of CT colonography. Dr. Pickhardt and colleagues have reported on colorectal findings at repeat CT colonography screening exams after an initial CT colonography screening exam which was negative for polyps greater than 5 mm. We certainly hope you find the discussions and the manuscripts of interest and look forward to hearing from your comments.

Herbert Y. Kressel, MD

Hi. This is Herb Kressel, Editor of Radiology, and welcome to the January Radiology podcast.

Today we have an unusual conversation featuring two intriguing papers in the January edition of Radiology. First, I’ll be speaking with Dr. Rebecca Smith-Bindman, Professor of Radiology Biomedical Imaging, Epidemiology and Biostatistics and Health Policy at UCSF who with her colleagues wrote a fascinating study entitled “Predictors of Computed Tomography Radiation Dose and Their Impact on Patient Care: A Comprehensive Analysis Using Automated Data.” Welcome Dr. Smith-Bindman.

Rebecca Smith-Bindman, MD

Thank you. A pleasure to be here.

H.Y.K. And we’re delighted to also have Dr. Jorge Soto, Professor and recently named the Chair of the Department of Radiology at Boston University Medical Center who with his colleagues wrote a study entitled “Impact of an Institutional Triaging Algorithm on the Use of Multidetector CT in Blunt Abdominopelvic Trauma over an 8-year Period.” That was quite a mouthful, but welcome Dr. Soto. Thanks so much for joining us.

Jorge A. Soto, MD

Thank you. Thank you for inviting us.

H.Y.K. Well these two studies might appear to be sort of incongruous and we just spent time sort of figuring out why I placed them together, but the rationale in my mind is clear because in managing the use of our resources we’re called upon both to optimize the techniques that we use and also to justify medically the indications for use of imaging technology. These two studies deal with somewhat different approaches to the same problem. Dr. Smith-Bindman has a very macro view of image resource utilization and dose over the UC system; and Dr. Soto has drilled, from a clear clinical problem, drilled down and developed a new algorithm to manage clinical indications which has had an impact on dose as well. So I hope this is an exciting conversation and I want to thank both of our discussants for joining us. I’ll begin with Dr. Smith-Bindman, Rebecca. Tell us about this UC dose consortium. What is it and what are some of the benefits from working in a large multi-centered group like this?

R.S.B. We responded for this application to call from project from the University of California, Office of the President, and we used it as an opportunity to sort share
expertise across the five University of California medical centers. We saw it as an opportunity; we have a lot of expertise at the individual hospitals, to really pull our expertise together to look at variation across the hospitals knowing that sometimes the identification of variation gives you insights in areas to improve. We also used it as an opportunity to strategize what metrics were important to report, how to validate the collection of data as well as the creation of metrics. We also used it, there’s an interesting law in California that requires reporting of radiation dose in the medical records, there’s a unique law in the country and had a brainstorm the solution across the UC’s to do that. So it was really an opportunity to just bring ourselves together.

H.Y.K. What data was collected? You don’t have to go into all the gory details, but I understood that it was automated and you used some large commercial systems for doing this. Can you tell us about the approach?

R.S.B. Absolutely. When we began the project we met with a whole lot of vendors of software products and ended up choosing a product called Radiometrics, Bayer’s product, to collect radiation dose information. So each of the institutions got this product and basically we pool on a single campus at UCSF all the DICOM data from all the CTs and got across all the UC campuses. So it was a way to not so much pick studies to report or selectively report, so basically we collect data on every CT across all the campuses.

H.Y.K. So basically you’re collecting the DICOM header data?

R.S.B. So basically it’s the DICOM header. The Radiometrics software also calculates a number of variables using the data, and then we export the data in Radiometrics and then do a lot of analysis sort of on the back end using various statistical programs of several full-time PhD biostatisticians who analyze the data to basically both ensure that we’re doing analysis that are comparable across institutions, that are valid, then come up with sort of simple answers to the questions are our doses the same, are they different, if they’re different, why are they different.

H.Y.K. I know you looked at CTDIvol and for some for the trunk exams you looked at SSDEs size specific dose estimates and DLP if I’m not mistaken.

R.S.B. So it turns out, we looked at all four of those measures, and it turns out they all give similar but not identical results. One of a pair of measures, CTDIvol and SSDE gives you a sense of the dose per slice and SSDE kind of takes into account patient size, CTDIvol is directly recorded by the scanner. The other pair of measurements, DLP and effective dose gives you a sense of the total dose output for the machine. How much radiation do the patients get? I think they work well together using all of them because effective dose to me is most easily understood, it can be compared to other sources of radiation, and it captures the whole imaging dose experience both how many slices you did and what the dose was per slice. But the CTDIvol is really what the technologists manipulate; and so that’s a piece of information that’s most helpful when you want to change your parameters, so both kind of work together well.

H.Y.K. You were looking at sources of variability and what are the sources of variability that are most important to consider?

R.S.B. One source of variability which is a very large source of variability which data confirmed is patient size. So in general the hospitals are using more dose in larger patients which makes sense. Which perhaps is not as obvious is an even larger source of variability, is what the institutions choose to do even for similar patients even after adjusting for patient size, sex, adjusting for the kind of the machine manufacturer and model; it was still enormous variation that was due to preferences by the individual institutions and the protocol for how they like to do CT. While some factors make sense, you expect larger patients to have larger dose, I was surprised by the amount of variation that was left over that was even greater than really has to do with just how we enjoy doing CT at the different institutions that wasn’t driven as much by patient need, but was driven by the radiologist’s, the medical physicist’s and the technologist’s choices at the institution.

H.Y.K. Now my experience whenever I’ve been in large rooms of department chairs looking at aggregate data when their doing any quality metric, someone always says but my patients are sicker, heavier, we’re different, how comparable were the case mixes? Are the institutions involved are they really comparable?

R.S.B. We did a lot of work, both in our initial work and in response to really thoughtful questions that you and the other editors provided, to answer that question. Are our patients similar? On the face of it, yes our patients are similar across the UC hospitals. We all see a similar mix of severely ill patients as well as patients we’ve seen in a routine outpatient setting. But we try to dive in a little bit deeper to say well actually how many patients do we see who need testing for pulmonary embolism and that was remarkable consistent across the hospitals. We dove in to say what’s the case mix of the patients in the hospital and those were remarkably similar so you get any measure that’s available – I wish there were more measures available, there are not, but using every measure that was available, our patients are pretty similar and when we dive into particular clinical problems, when we only looked at the variations for example for PE settings, it was enormous, the same as the overall variation.

H.Y.K. I’m not surprised because as I said that almost any of these discussions the hospitals tend to be a lot
more comparable than the variability that we experience. But one thing I did find sort of interesting and surprising is that the vendor factors, particularly things like iterative reconstruction had such a small effect overall. Is this that they’re not being used properly, they weren’t fully deployed, I mean the reports are typically around a 20% dose reduction from using these, so what do you think was going on here?

R.S.B. We did find that iterative reconstruction was important, it was statistically important, but as you say it was relatively modest. The secret getting low doses was not to get iterative reconstruction in our experience and you really I think hit the nail on the head when you said maybe it’s not being used appropriately, maybe it’s not being used to its capacity, we don’t know for our study which I should point out whether iterative reconstruction was used or used appropriately. We just know if the institution put it on their machine, whether it was available. That’s suggests that either number one, just putting it on the machine is not enough; or two, that’s it’s not as good as it’s made out to be. I think the medical physicists of which there are many on the paper; they’re feeling was it’s hard to use iterative reconstruction, to use it well. It’s not a button you turn on and off. So I think that if facilities really want to lower their doses, if they want to optimize the doses, what I learned from our paper is they got to sit down and look at their protocols. They got to look at multiple phase scanning, that that’s going to be a more direct route to getting optimized doses rather than iterative reconstruction. But we don’t really know why it didn’t sort of live up to what we thought it’s potential was.

H.Y.K. In terms of our podcast that’s where Dr. Soto comes in because that’s exactly what they did. They actually looked at the drill down issue. One of the things that you did highlight was the issues around multiphase CT which you found was a major source of both dose and also a source of variability. How do you think about these? Do you think it’s an issue of the variability and indications that there isn’t a consistent approach to these that everyone is just shot gunning these? What’s your sense about multiphase CT?

R.S.B. We drilled down a little bit into why there was so much variation in multiple phase CT. It wasn’t the indication. It was very different views across the institutions about what they gained by doing multiple phase CTs. For some clinical indications, some of our doctors said there’s no value in multiple phase, you just need one phase. Where other institutions had a much harder time giving up the extra phase and so I think the real problem is the lack of evidence basis between when we use multiple phase. I think something that’s so important in our analysis is that often dose is compared within the type of study. So you compare dose across institution in just multiple phase studies, or dose only in single phase studies, and that really mapped the profound differences in how often you use those particular protocols. That’s where the opportunities lie for dose reduction. It’s not so much tweaking your doses down in a multiple phase study, it’s making more prudent decisions about when to use those obviously much higher dose studies and that was a source of variation in our next analysis which you know obviously I can’t share all of it, but showed that’s where the opportunities where successful dose reduction occurred.

H.Y.K. Well I think Dr. Soto this kind of leads us to your study. In your study you looked at CT utilization rather than dose per se and optimizing utilization and technique for a very specific clinical indication blunt abdominopelvic trauma. What was the actual rationale? Why did you focus on this as an area to study?

J.A.S. So I work in a very busy level 1 trauma center and traditionally most of our patients admitted through the ED with trauma were being scanned with CT. As we all recall and lived through it, between 2008, 9, 10, there was a very significant increase in the media attention to the radiation dose that the public was receiving and that of course was made to our leadership and especially to our surgeons and our ER physicians. We assembled a multi-disciplinary group to look at one of the primary indications for CT at our institution and that was the blunt abdominal trauma and pelvic trauma and came up with a clinical algorithm, again developed with the surgeons and the ER physicians and the anesthesiologist etc. as to when would an abdominal CT be indicated in the patient that’s admitted with trauma. The paper has the details of that algorithm. It basically looks at general injury scale algorithms and then specific symptoms and signs relative to the abdomen and the pelvis and the algorithm was instituted and then a few years later what we did was retrospectively look at the effect at the algorithm because of course we notice in our clinical practice that the number of CTs had declined and then we had really questioned ourselves what was the effect on patient care and what was the indirect effect on total radiation dose.

H.Y.K. You results I thought were remarkably impressive. Can you highlight your key findings?

J.A.S. Right so we looked at 8 years worth of data. Four and a half years prior to the implementation of this new algorithm and two and a half years after the implementation of the algorithm and the results as you said were quite dramatic. There was a decrease in the frequency of use of CT in a trauma patient of about 32% just by including this clinical algorithm. At the same time, we saw an increase, a significant increase, in the positivity rate of the CT examinations and a decrease in the length of stay in the ER mostly because some of the patients who are in the past were being admitted and then had to wait for the CT examination to be performed were no longer going through the CT route but were discharged after a very short period of observation. The effect was very significant. We also found that not only the positivity rate of CT was higher, but also the injury severity score on
the patients that did undergo CT was significantly higher than those that did not undergo CT.

**H.Y.K.** It was very fascinating. Now how did the triage algorithm deal with the issue we were speaking about with Dr. Smith-Bindman, multi-phase CT? If I recall, you examined patients primarily in the portal venous phase.

**J.A.S.** Right. We at our institution had looked at the issue of multi-phase CT and trauma before we introduced the algorithm and the reason was that like many institutions still do, we had universal utilization of delayed phase imaging which of course led to an unnecessary increase in the dose for the vast majority of patients because the positivity rate in general is about 15 to 20%. What we did was change the approach to one in which we selectively used the delayed phases and what we do is the portal venous phase of course is a part in every patient, and then we used those five to ten minutes to evaluate the images either on the console of the CT scanner or at the PACS workstation and decide on the fly whether or not the delayed phase is necessary. And that ends up amounting to about a 25% utilization of delayed images which by the way we acquire with a much lower radiation dose than the portal venous phase and again this is work that we have done in the past and have published several times including what I would say is the first paper in Radiology a few years back.

**H.Y.K.** So selectively used they do make a difference?

**J.A.S.** Totally. Totally.

**H.Y.K.** And you're judging it by the type of injury and the initial findings to see if you want to wait and see for some blood accumulation or what?

**J.A.S.** Exactly. The way, just to simplify it for the residents, the fellows and the staff who are looking at these images day and night; is that if there’s any finding on the portal venous phase CT that in your mind could benefit from a delayed phase, to go ahead and acquire the delayed phase imaging. We do not want to look back at ourselves and say why didn’t we acquire the delayed imaging. We are conservative, but try to include as many patients as possible based on the findings of that portal venous phase imaging.

**H.Y.K.** Did you have any notable misses where you didn’t acquire it and there was negative outcomes?

**J.A.S.** That’s a great question. The data that we collected only had a limited evaluation of the outcomes of the patients, but our ER physicians did look at, in a more limited number of patients, of whether or not there were significant misses trauma related that were derived from the implementation of this clinical algorithm and the findings are that no, at least as long as we can tell, there weren’t any significant findings. There’s always a chance, it’s a retrospective study, always a chance of a patient going to a different institution etc. for further care, but we didn’t have a single significant miss that can be attributed exclusively to not acquiring the CT on that first admission.

**H.Y.K.** I want to thank you both. This has been a very fine discussion. I want to sort of have one final question and I’ll ask it to both of you. You know we have examples of sort of the drill down look at justification and the macro look at optimization and justification, how do you think different institutions or radiology departments should go about this to effectively manage the use of the imaging resources? Dr. Soto do you want to give us your view?

**J.A.S.** Sure I think both approaches are important and both are necessary. We need to really decide with our clinicians when is imaging really necessary and what type of imaging is necessary and then even if these studies indicated we, as Rebecca was pointing out, should really very carefully look at the available data to make educated decisions as to when is a multi-phasic exam necessary. Even I’d say furthermore the dose for each one of the phases should be looked at carefully because just the fact that we decide with good reasons that a multi-phasic exam is necessary does not mean that each phase needs to be acquired with the same radiation dose as we do for example in that trauma patient in whom we acquire the delayed phase.

**H.Y.K.** Thank you. Rebecca your thoughts? You’re sort of seeing this on both sides. How are people in the UC system using your data and what is the role of the sort of drill down versus the macro look?

**R.S.B.** I think you’ve made a very persuasive case by bringing Jorge and myself together that you have to really do both. And that’s sort of what we’ve tried to do across the UC. I’ll admit that there was a little bit of convincing I had to do to my collaborators to get them to value looking at data in this macro way. You know we’re used to looking at individual patients, not all of our patients so there was a little bit of hard sell there, but once people came on board with looking at the institutional differences, I think they all think it’s really helpful. It gives you a place to start and then the drill down for us came about when we tried to fix some of the variation and the fix doesn’t come from me giving the macro data, the fix comes from doctors, like Jorge was saying, okay where we’re using a lot of studies, where’s the opportunity to improve, how do we fix the individual problems? So I think putting both together is really powerful and I think individual institutions I think have to look at the overall doses. I don’t think quite frankly we’re doing a great job. I think the institutions in general don’t know how their doing and I don’t think it’s that hard. So I think starting with looking how you’re doing and then figuring out how to improve it is a wonderful combination. And I’m thrilled to have the chance to participate with Jorge on this today because as soon as we hang up I’m going to call.
him and see if he’ll help us on one of our trials. I think it’s great putting both of us together.

**H.Y.K.** Well those were good. I want to thank you both. I found this discussion very, very stimulating. I think people need a little help. The problem is so vast and I think people need some help in targeting effectively. I think the other thing that comes out – the importance of communication. You can’t do this in a vacuum and you can’t do it without having your clinicians, your surgeons, your

**J.A.S.** Again thank you for inviting us.

**H.Y.K.** Sure, bye-bye.

**R.S.B.** Thanks so much for including us.

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**Colorectal Findings at Repeat CT Colonography Screening after Initial CT Colonography Screening Negative for Polyps Larger than 5 mm**

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**Herbert Y. Kressel, MD** Hi. This is Herb Kressel, Editor of *Radiology* and today I’m joined by Dr. Perry Pickhardt, Professor of Radiology and Chief of GI Radiology at the University of Wisconsin. Dr. Pickhardt and his co-authors wrote a very provocative study entitled “Colorectal Findings at Repeat CT Colonography Screening after Initial CT Colonography Screening Negative for Polyps Larger than 5 mm.” Welcome Dr. Pickhardt. Thanks so much for joining us.

**Perry J. Pickhardt, MD** Thanks Dr. Kressel. Pleasure to be here.

**H.Y.K.** I understand that the CT colonography screening service has been up and running for quite a while at the University of Wisconsin. Can you tell us a bit about the program?

**P.J.P.** Sure we have been up now for over a decade largely on the heels of the original trial we published when I was back in the Navy, the military trial. Coming to the University of Wisconsin we had that data in hand and were able to get the local payers to cover it starting in April of 2004. So it’s been about 12 years now, over 12 years.

**H.Y.K.** How have you managed to build referrals? Do patients self refer, is this all from physicians, which physician groups have you been targeting?

**P.J.P.** Well we have – all along we’ve required physician referral just so we don’t cut out the internist or the primary care provider in the process. Admittedly at some point we’re thinking of maybe doing away with that, but we still engage the primary care providers as part of the decision makers in the process but what we find is it’s mainly patients that find out about us and drive the process.

**H.Y.K.** Thank you. In this study you looked at the rate of polyps identified after an initial negative screening. What’s actually the rationale here? What was your hypothesis?

**P.J.P.** Well so first of all this is a very unique opportunity since we’ve been doing this long enough now to not only have the first initial screen, but to have them come back five or ten years, between five ten years later so it’s really the first opportunity to get that data. Our hypothesis was that if we’re effective that we should see somewhat lower rates in terms of prevalence of important findings, cancers, large polyps, and so forth; and also the fact that we don’t report on isolated diminutive or tiny polyps, 5 mm or less. There has been concern out there that that practice would lead to higher rates of important findings and that was – another motivation was to try to gain more data in that area.

**H.Y.K.** Tell us exactly what you did in the study and how did you actually accrue the follow-up exams? Were these on a targeted interval or under some sort of specified period for a re-visit, who contacted the patients, and how did you run it?

**P.J.P.** Most of it we drew from over 5,000 patients that were screened with a negative result prior to 2010. We simply looked to see who had come back pretty much on their volition. We weren’t sending out formal letters until more recently. So we got about a quarter of patients back without really any effort. Now that means that there’s still a large number of patients that either haven’t come back or have gone on to perhaps screening with the different tests like colonoscopy or a fit test perhaps. We haven’t delved into that deeply in terms of what happened with the other patients, but the focus was really more on what are the findings in those patients that did come back for a repeat screening study.

**H.Y.K.** What were the key findings when you reviewed your data on the repeat studies?

**P.J.P.** So we did indeed find that there was an overall decreased rate of positive studies from about 14% down to about 12%. So not quite the decrease we were expecting and I’ll explain why in part that is in a moment. But
we also saw significant reductions in large polyps and the cancer rate which was initially about four and a half per thousand was down to about one and a half per thousand in that we found two cancers in the cohort of about 1400 patients. Those were encouraging findings and then I think further support this practice of not reporting the tiny lesions as they didn’t progress in that interval.

H.Y.K. As you probably know I go back to the barium days and this discussion sounds familiar to the discussions we were having in the late 60s and early 70s with Mort Marshak telling us not to worry about the diminutive polyps but he was suggesting concentrating on lesions over a centimeter. Our numbers are different now, but the concept stays the same. Now one of the difficulties in a study like this particularly when you’re using a reference standard of CT colonoscopy in some of the – CTC CT colonography to optical colonoscopy, is how do you do the lesion matching? How do you approach that to know that you’re doing an apples-to-apples comparison?

P.J.P. Well it’s always a challenge when you have what I would consider an imperfect reference standard and that complicates the research and we’ve published really extensively on that and in fact I think my last video podcast was focusing on those discordant lesions that weren’t found at colonoscopy after a positive CTC. So we are left with that. Over time sometimes these polyps emerge on a subsequent follow-up, but the basic matching algorithm hasn’t changed since our initial trial over a decade ago. Basically we require that the polyp at CTC and colonoscopy are within the same or an adjacent colonic segment and are generally within 50% of lesion size. That seems fairly generous but there are significant differences sometimes with how colonoscopy measures or sometimes just kind of eyeball the lesion size. Of course we also have lesion morphology and other things to try to increase that confidence. But in most cases it’s fairly obvious. There’s a one-to-one correlation but there are indeed many challenges to lesion matching.

H.Y.K. Pursuing this a bit more, there are 21 of the 161 total non-diminutive lesions were not further identified on optical colonoscopy and I know it’s kind of an open question what they’re due to, but you probably have experience with this, what’s your intuitive sense as to sort of what’s going on with these missing lesions?

P.J.P. Sure well that’s a great question. From our past experience we know that in fact some of these will be found to be real at further follow-up. Up to 40% of those where we review the case and feel that there’s a reasonable likelihood that it was something missed on their study. Whereas some other cases, and we always prospectively score our diagnostic competence, there are times when our diagnostic competence is a 1 out of 3 lowest and if they don’t find that lesion it may be the second or third lesion where the others are obvious and then it’s just a possible maybe, and if they don’t in fact find that lesion, we’re usually comfortable calling it a CTC false-positive. Certainly a mixture, but we know a significant fraction of those will be real and we need to really stay on the follow-up of those patients. We try not to let those slip through the cracks.

H.Y.K. One of the key subgroups were lesions identified which were formally diminutive and now non-diminutive. They’ve grown. What were some of the features of these lesions, where were they found, what was their morphology, and what was their histology?

P.J.P. In all of the non-diminutive lesions seen at this follow-up exam, about 30% of them could be identified on the initial screening study as a lesion 5 mm or less. In the vast majority of these cases they just barely ticked over the 6 mm threshold almost always staying between six and nine. In fact I’m not aware of any cases where they grew significantly faster than that. But we did actually, and we’ll talk about the two cancers later. In fact one of those we weren’t able to find any precursor lesion although it was a ten year interval between.

H.Y.K. I see. One of the things you highlight was the prevalence of right-sided flat lesions. I know you’ve been working on better understanding these and how best to identify them. What can you glean from this current study in that regard?

P.J.P. In fact I think other than the basic high level findings that we’ve already discussed, I think this is the most important and interesting part of this study, was the fact that so many of the lesions that made this repeat positive, it turned out to be flat, right sided lesions many of which were serrated. Going back to the initial screening study, in fact many of these were present and honestly didn’t grow much between five and ten years. So these are very indolent lesions that kind of stick around for a while but they do have cancer potential and it’s felt to be one of the main reasons why right-sided cancers are such an important issue at colonoscopy screening. Just to get into the numbers just a bit, I believe it was over 80% of the advanced adenomas found at the follow-up, the surveillance or repeat CT were right sided compared to about 45% or less than half on initial screening; and also about over half of them were flat compared with 11% on initial screening. We’ve shifted things significantly. Almost all of our important findings or many of them were these flat right sided lesions that were sort of below our capabilities on the initial screening. We’ve learned a lot since then and have published actually a paper focusing on serrated lesions in your journal knowing that these quite often coat with contrast. They tend to be flat and fairly subtle, but if you know what you’re looking for we’ve learned over time that we can be quite good at detecting these. So I think that is a very important subplot here.

H.Y.K. Great now there were as you mentioned two interval cancers. Can you tell us a little more about them, what were the circumstances?
**P.J.P.** One of them as I mentioned was a patient who had gone a full ten years between their initial screening study and the surveillance so right at the cusp of what we would consider too long of a follow-up interval. It was a localized cancer. Patient’s doing quite well and presumably cured, but going back to their initial screen we actually could not find any precursor lesion. So it was truly an interval cancer that doesn’t have an obvious benign precursor at least ten years before. In our experience that’s actually a fairly rapidly growing process to go all the way from presumably nothing to invasive cancer. The second case was actually a little more instructive and gets back to the flat polyp issue. There was about a 12 or 13 mm flat lesion that was coated with contrast and not recognized as a lesion on the initial screen and that progressed to cancer over I believe about five years, five or six year interval, and it was very instructive to further point out that these are the lesions that we are now picking up on the first try so hopefully the cancer rate will decrease even further in the future.

**H.Y.K.** Good so tell us what do you think are the key take home lessons from this study and how are you using this at your institution? Are you kind of sharing this with your referring docs or patients or whatever?

**P.J.P.** Well sure we try to get the word out whenever we can just in terms of the overall benefit of colorectal screening let alone the extra colonic findings which are a whole other area. But the real take home points were yes we confirm that our practice and timing of follow-up screening seems to be appropriate. I think as we go forward and learn even more about how or increase awareness of the flat lesions, I think we’ll get better and better at the first round of screening such that follow-up interval can probably extend beyond five closer to ten years as we move forward. And then the other important thing is this practice of not calling the tiny diminutive lesions in isolation because that leads often to inappropriate management. That practice is supported by the data here. I would agree with what you said earlier, in a perfect world I think we would really focus on 1 cm lesions for the sake of clinical efficacy and cost effectiveness, but currently 6 mm is still the standard of care.

**H.Y.K.** I do have to correct myself. Morton Marshak is someone I went to medical school with. Richard Marshak is the great guru of barium imaging of the colon. I can assure you if Richard was still alive he would certainly let me know about my error. Perry I want to thank you for this study, very illuminating and nicely done and for your fantastic work on this imaging application. Thanks so much for joining us.

**P.J.P.** Thank you very much. It’s a pleasure.