Dr. David Cheng, Dosimetry Planning for Thyroid Cancer January 9, 2011Welcome to Yale Cancer Center Answers with doctors Francine Foss and Lynn Wilson. I am Bruce Barber. Dr. Foss is a Professor of Medical Oncology and Dermatology, specializing in the treatment of lymphomas. Dr. Wilson is a Professor of Therapeutic Radiology and an expert in the use of radiation to treat lung cancers and cutaneous lymphomas. If you would like to join the conversation, you can contact the doctors directly. The address is canceranswers@yale.edu and the phone number is 1-888-234-4YCC. This evening, we welcome Dr. David Cheng to the program. Dr. Cheng is Associate Professor of Diagnostic Radiology, Chief of Nuclear Medicine, and the Nuclear Medicine Residency and Fellowship Director at Yale School of Medicine. Here is Francine Foss.Foss Let's start the evening off by having you describe for us what nuclear medicine is?Cheng Nuclear medicine has been around since about World War II, probably even before that, when Madame Curie discovered radium. The difference between that and nuclear medicine is that we use what is called a radioactive tracer, tracer meaning the trace amount so that we do not induce any kind of pharmaceutical effects, but it gives us the biodistribution and it gives us the mechanism of action of the molecule, and so we are able to image because of the radioactive decay of the radionuclide.Wilson How did you become interested in this field?Cheng Actually I was a scientist, so I got my PhD in Biomedical Physics from UCLA and I was very fortunate to be trained and taught by the people who built the first positron emission tomography equipment, and so I got really interested in the physics and the technology of that. It was at that time that I realized I also wanted to bridge over to talk to patients, and so I looked into medical school and I investigated and I volunteered like everyone else and then I applied and fortunately, I was able to be admitted, and so then I graduated and I did residency training.Foss Can you clarify for our listeners what your role is as a nuclear medicine physician, what do you actually do and how do you interface with patients?Cheng Most of nuclear medicine today is diagnostic, however we do therapies. The most common therapy we do is probably thyroid cancer and we use a tracer called radioactive iodine. The thyroid gland is the only organ in the body that concentrates and traps the iodine, and so by giving the radioactive iodine we can spare the rest of the body, the rest of the organs in the body, so it is targeted for any kind of thyroid cells. We do treatment in that sense for both hyperthyroidism as well as thyroid cancer. The others are really diagnostic and we help our colleagues in terms of staging cancer patients as well as many, many benign situations, such as acute cholecystitis or HIDA scan. We do a lot of pulmonary embolism studies for emergent shortness of breath patients and we do gastrointestinal bleeding scans, so we do a multitude of scans that can help our colleagues.Wilson David, what is Iodine-131, getting back to the therapeutic side for a second. Describe that for us3:45 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3 and how do you measure the dose, how do you know how much to give? Tell us a bit of the detail associated with the management of thyroid cancer.Cheng Iodine-131 is only one isotope of many in the iodine family. Iodine-131 has

interesting characteristics. For example, it has a gamma decay of 364 keV as well as a beta particle with a maximum kinetic energy of 606 keV. It is the beta emission that does the destruction of the cells, and hence we harness that for the therapeutic purposes, but the gamma emission enables us to image and so if there are metastases from the thyroid gland, we move to visualize it.Foss Some folks get a little bit scared when we use the word radioactive, and you mentioned gamma rays and beta particles, could you just go through briefly what is radioactivity, what are the three kinds of particles, and how do you use those?Cheng It is important to know that there are different types of emissions and the radioactivity that we are most concerned about is what we call ionizing radiation. It is this high energy that ionizes many molecules of gas as well as liquids that I think people are mostly concerned about. However, the body is very resilient, in that if it takes some kind of damage, let us say from a diagnostic test, the body repairs itself and it repairs itself very well. It is quite safe when you understand at what ratio under which the radiation can be tolerated and the body can repair itself.Wilson David, could you discuss some of the other treatments such as Zevalin, Bexxar, what those are used for and how you would administer those for patients?Cheng Zevalin and Bexxar are what we call radio-immunotherapies. The immuno part comes from the antibody that is targeted for a receptor called CD20, which is in B cells. We tagged along a radioactive atom. Zevalin is the Yttrium-90 and Bexxar is the Iodine-131, so that in addition to the pharmacologic effect of the antibody, you now have the added radiation that is local radiation so that you can get better control of the disease.Foss David, when we give these therapies, I think it is important for people to know that this is kind of a one-shot deal, unlike chemotherapy where you come in every couple of weeks and you get a dose, with these radiolabeled antibodies, you actually come in and you get a therapeutic dose, and then that basically stays in your system for a very long time.Cheng That is correct. It is important for everyone to understand that we give these internally, which is either in terms of the Zevalin and the Bexxar, it is an intravenous administration, but the radioactive iodine is an oral administration. However, once the body absorbs it, whichever route it goes through, it is up to the body to handle it and to excrete it. We cannot actually influence its biodistribution, we can only understand the biodistribution and therefore protect the critical organs that we need to.7:52 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3Foss
Can you talk a little bit about precautions that a patient may need to take after they get one of these therapies?Cheng For the patient, we are concerned about side effects, and that is damage to the critical organs, and different therapies or tracers have different biodistributions, and so therefore different critical organs will need to be considered. In terms of bystanders, meaning family members, some of these isotopes have a gamma emission, such as Iodine-131, the Zevalin with Yttrium-90 does not really have a gamma radiation, however it has some radiation called bremsstrahlung, which is a much lower energy. So family members will get some radiation, and so we give a lot of advice on how to protect family members in terms of the distance they should be apart, the

amount of time, and how the patient should handle the excrements.Wilson Are these outpatient procedures, or does the patient spend a night or several nights in a hospital?Cheng For Zevalin and Bexxar, they are outpatients. Radioactive iodine has been outpatient at Yale for many years, however, in the past we have hospitalized the radioactive iodine therapies that are above 33 mCi.Wilson Are these therapies given at every hospital, or are they special to Yale, and can patients be refereed to you for this type of treatment?Cheng Radioactive iodine is quite widely available; however, I believe most hospitals do not do high-dose treatments. So, yes, we do get referrals from all over the state. I have gotten some referrals from New York as well as from Boston, just because some centers are not comfortable in handling high-dose therapies. In terms of Bexxar and Zevalin, I believe any center that has a good oncology unit as well as a nuclear medicine unit that can handle the way the radiopharmacy probably can offer these treatments.Foss It is interesting, just going back in history, I was involved in the first studies with Bexxar, which is the I-131 emitting isotope, and at first we actually did keep patients in hospital rooms, in lead-lined hospital rooms, before we really understood about the distribution of the isotope and the risk involved, which as you said, is minimal. But that brings up another point I wanted to stress, and that is that we actually can do things to protect normal tissue, and the Bexxar is a good example because we block the thyroid gland so that it does not take up the iodine when we treat lymphoma patients with Bexxar.Cheng That is a good point Francine. Any molecule that is labeled with iodine can potentially be cleaved off, and as a free iodine, of course, as I mentioned earlier, will then be taken up and sequestered in the thyroid gland. So if the patient has a thyroid gland, then there is a risk that the thyroid gland will soak up these free iodines that are a byproduct of the metabolism. As you mentioned, we do give a high-dose code that means nonradioactive iodine, so that the thyroid gland will be11:48 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3 overwhelmed and saturated with the nonradioactive iodine, so that the radioactive iodine will have a tough time competing.Wilson David, aside from risks to the family, and the precautions that go along with that to prevent problems, what sort of specific health risks might the patient be exposed to, and how do you advise them? What sort of things do you get concerned about as the physician when you administer these treatments?Cheng For radioactive iodine, the risks that we pay the closest attention to are both to the lungs as well as to the bone marrow. These have probably the lower threshold amongst the other organs that the iodine biodistribution will cover, and so we make sure that we are below a certain threshold beyond which there is a significant risk to permanent damage.Foss That brings up the question of dosimetry, and I think we have touched on this word a couple of times in the conversation, but could you just explain to us what dosimetry is?Cheng Dosimetry actually has a very long history and I came across an article saying it dates back to the late 1800s, but, of course, over the years, we have gotten more sophisticated and calculations become more precise, and so we can better understand and also better predict the outcome of the radiation

exposure. Dosimetry is to estimate how much radiation dose gets absorbed in certain areas, and so for us, we do internal dosimetry, so we are talking about different types of tissues, different organs, and with different isotopes, the biodistribution would be different, so that is what we deal with.Wilson We are going to take a short break for a medical minute. Please stay tuned to learn more information about dosimetry and nuclear medicine with Dr. David Cheng.Wilson Welcome back to Yale Cancer Center Answers. This is Dr. Lynn Wilson and I am joined by my co-host Dr. Francine Foss. Today we are joined by Dr. David Cheng, and we are discussing dosimetry and nuclear medicine. David, we talked a fair amount before the break about the15:03 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3 therapeutic procedures that you do. Tell us and our listeners a bit about diagnostic procedures and PET scanning, for example.Cheng A PET scan is one of the newer modalities of nuclear medicine and PET stands for Positron Emission Tomography. The signal actually comes from the annihilation of antimatter called positron, which is emitted from the nucleus, and so we get the signal from the annihilation of this antimatter when it collides with an electron close to the origin. It is a very, very nice imaging modality. It is higher resolution than our gamma cameras in standard nuclear medicine practice, and also we happen to tag on this kind of radionuclide with a molecule called deoxyglucose. I am sure many of you have heard of something called FDG, which stands for fluorodeoxyglucose. The deoxyglucose part is a sugar analog, a glucose analog, and hence it has the same distribution as glucose, except the affinity is not as high for the glucose receptors as regular glucose. Hence, we need to control the sugar of the patients we inject that in, and we have certain recommendations on how we can control that as part of a preparation for the patients before they come to us.Foss This is a bit of a complicated question, but could you tell our listeners how ingesting this radiolabeled sugar molecule detects tumor sites?Cheng We give this molecule using the intravenous line, because if you give it orally the stomach would digest it, and then it would not get absorbed very well. So we give it intravenously, and as I mentioned earlier, it will follow the same biodistribution with glucose, and since the body thrives on glucose, it will follow wherever the organ that thrives on glucose the most, which would be the brain, and other organs including the heart, liver, the kidneys, spleen and other organs will also need that. Now, if you have a tumor or an infection, either a benign or a malignant tumor, it has a higher demand for the glucose, and therefore the distribution of this molecule to those particular tissue types will be increased, and hence we get a contrast between what is normal and what is abnormal.Wilson When we do a PET scan, and say someone has a tumor in the lung, and that lights up so to speak on the scan, do you do some additional imaging with the PET portion, such as a CAT scan, for example, so that one can see exactly where in the body relative to other organs where that abnormality might be?Cheng When PET technology first came out, it was a PET-only scanner, and now recently it has combined with a CT scan, so we call it a PET/CT scan, and the CT scan provides the anatomic location of these abnormal signals, and so now we are able to not

just say, yes this is in the lung, but we are able to tell you which lobe it is in, and if it is in the spleen, we will be able to tell you it is in the spleen and with confidence.Wilson You had discussed some of the risks associated with the therapeutic procedures, are there any risks with PET/CT scanning?19:01 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3Cheng There are very, very minimal risks. There is a CT portion, which provides some external radiation. We at Yale use one of the lowest techniques, meaning the lowest current, and hence the lowest radiation to the patient's body that we can and still resolve the tissue type, and so we have one of the safest emission characteristic and profiles on that. There is a minimal risk on that, and then there is the PET part, which is also minimal. The dose that we use is a standard dose, and it gets excreted quite well in patients, and so the risk there is also very minimal.Foss The PET scan is extremely sensitive and that is one of the problems that we have run into in the clinic, sometimes the PET scan will be positive and we do a biopsy and we do not see any tumor there. Can you comment on any ways that we might try to make this imaging technique a little bit better, or are we always going to be dealing with the fact that it is so sensitive that it is picking up everything?Cheng That is one of the problems, it is very sensitive, and the specificity, unfortunately, cannot improve too much on the technology that we have. However, let me say that there is a new PET/MR on the market, it came on display in Chicago about a week ago, and I am very interested in that. The MR can give you more information on the soft tissue that this signal is coming from. The CT gives you contrast and gives you anatomy, it does not give you much information as MR would.Wilson At Yale there is a Nuclear Medicine Consultation Clinic, discuss the interaction that you have with other physicians within their center here at Yale, and physicians outside of Yale?Cheng I started this clinic about three years ago, and it came out of a thyroid treatment patient population, because we do a lot of counseling, we do a lot of coaching for patients on how to protect their family members and all of that, and it just took up too much time in our regular practice. So we decided to have that separate so that we can dedicate the time and an attending physician so that patients can understand all of that, and still have time to prepare their environment in the house and all their loved ones. Since then, we have also incorporated this precautionary counseling to all types of patients that need the treatment. So, Bexxar and Zevalin patients are also a part of that group, and although we do not do many of them, we do also do Samarium 153 bone palliative patients.Wilson Does this require a visit by the patient and/or their family prior to the procedure, what are the logistics of the coaching and counseling?Cheng We time it in such a way that these clinic visits will precede the treatment by about two to three weeks, so that they have time to prepare and address whatever needs they may have, and we encourage family members to attend, but certainly at least the patient and the caretakers of the patient.22:49 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3Foss Is this service available to outside physicians who, say, for instance, may have a question about whether a particular kind of nuclear medicine scan is appropriate

for a patient?Cheng The clinic is really aimed for the general population and if they call us, we would not refuse to answer any of their questions, but they may not require an extensive counseling, such as a clinic, if they are getting services in another hospital. We never refuse to help anyone understand what is about to happen to them; however, currently our appointments have been scheduled for out patients but we welcome any outside referrals as well.Wilson What would be the best way for a physician or a patient to contact your service?Cheng The best way is probably to call our Nuclear Medicine Clinical Area, and the number is (203) 200-5610.Foss Since we have Dr. Wilson here today also, and Dr. Wilson is a radiation therapist or a radiation oncologist, I am interested to know from the two of you, about what the interaction is between nuclear medicine and radiation oncology, if there are areas of overlap or what the difference is, again, between what you do Lynn and what you do David.Wilson David and I actually have worked together quite a bit over the years in both lymphoma patients and lung cancer patients, which are two types of patients I generally take care of, and David's services have been terrific in terms of the PET scan side of things, in particular, and helping me identify exact locations of tumors, their metabolic activity, if patients have localized versus more disseminated disease, and with the information that David has been able to provide to me, I can then formulate a treatment plan for that patient if we are going to use radiotherapy or radiation treatment, and that generally comes in the form of external beam treatment that is given by a linear accelerator. Actually we have worked quite closely over the years in managing these types of patients with David helping me on the diagnostic side so that we can come up with extremely precise plans for these patients in terms of their radiation treatment.Cheng Thank you, that was very kind of you Lynn. I think with my biomedical physics background, there is a lot of overlap, or I should not say overlap, but certainly similarities between our two fields in that we deal with radiobiology, we deal with how radiation interacts with matter, and quite frankly, also dosimetry as well, although in our case, we focus more on internal dosimetry, so, there are certainly a lot of similarities in that. The differences will come in that we cannot control where the radioactivity goes once we administer it intravenously, and so we have to know ahead of time how the biodistribution is, and we have to estimate if we were to increase the dose, what would be the absorption and exposure of organs internally from this radiation.26:12 into mp3 file http://yalecancercenter.org/podcast/jan0911-cancer-answers-cheng.mp3Foss There are some interesting new advances in the whole field of nuclear medicine and looking at creative ways to image, say, intracellular pathways in research, could you tell us a little bit about where the field is going?Cheng There is a research arm at Yale called the PET Center, again, PET stands for Positron Emission Tomography, and they are purely research, although they do human subjects as well as animals. They have a lot of radiochemists that try to develop specific tracers for specific questions for specific diseases, and by putting a positron emitter isotope onto the molecule, we can look at the biodistribution, the binding characteristics, so we can get a lot of information from that.Foss Can you give us an example of how that might

work in a different disease?Cheng I will give you an example. The PET Center works closely with some of the pharmaceutical companies including Pfizer, who is very strong on CNS receptor work so they do a lot of neurodegenerative research, they use these isotope tracers to see where the biodistribution is, and then also to see what is the receptor occupancy, so that they can dose their medication appropriately.Wilson David, what do you think are some of the special offerings and techniques that might differentiate Yale from some other centers in the state and outside of the state? What do you think are some of the highest quality aspects of your program?Cheng In terms of technology, if you have the resources, you can get the latest scanner, but aside from that I think you have to look at the faculty, and I have put in a lot of time and effort in finding faculty for recruitment, and I think our faculty is quite superior where most of us have more than one subspecialty experience. Two of us have internal medicine as well as nuclear medicine. One faculty was in OB/GYN practice before nuclear medicine, and the latest and the youngest of the faculty, although he only did nuclear medicine residency, also has a PhD in Health Physics, and so we have much more balance in asserting a wider scope of understanding of field, and to both protect and to advance the field of nuclear medicine.Dr. David Cheng is Associate Professor of Diagnostic Radiology, Chief of Nuclear Medicine, and the Nuclear Medicine Residency and Fellowship Director at Yale School of Medicine. If you have questions or would like to share your comments, visit YaleCancerCenter.org, where you can also subscribe to our podcast and find written transcripts of past programs. I am Bruce Barber and you are listening to the WNPR Health Forum on the Connecticut Public Broadcasting Network.