

**Frequently Asked Questions (FAQ)
Risks/Benefits of Medical Imaging Procedures
Utilizing Ionizing Radiation**

INTRODUCTION	3
1. What is ionizing radiation?	3
2. What are X-rays?	3
GENERAL INFORMATION	4
1. How much ionizing radiation exposure do I receive naturally (also known as background radiation)?	4
2. How does radiation exposure from medical imaging procedures compare with the amount of background radiation?	4
3. Is the millisievert (mSv) the best unit to measure a patient’s radiation dose?	5
4. What are the risks associated with medical imaging procedures that expose patients to radiation?	5
5. What are the risks associated with high doses or therapeutic doses of radiation?	5
6. What is the risk to patients who have multiple CTs and/or other medical imaging procedures over the course of their lifetime?	6
7. Does the government regulate radiation exposure to patients?	6
8. Should patients inquire if they have concerns? What questions should they ask?	6
9. If I have been treated with radiation for cancer in the past, or currently have cancer, then will medical imaging, such as CT, make it worse?	7
10. Is there a test that can show if you have had too much radiation?	7
11. What is contrast or contrast material? Why is it used? What are the risks?	7
12. What is the radiation dose from interventional radiology procedures (catheter based such as cardiac cath, angiography, and angiograms)?	8
13. What is the radiation exposure from ultrasound and MRI?	8
14. What medical imaging procedures trigger radiation detectors, such as those used at the USA border with Canada?	8
15. How do I keep track of my radiation exposure from medical procedures (CT, PET, nuclear medicine, angiography etc.)?	8
Patient dose tracking wallet card	9
16. What is radon and what is the risk from exposure to radon?	10

CT SCANS	10
1. What is the radiation dose to a patient who has three chest CTs in a year? What is the risk?	10
2. What should I do to limit my risk if I am having multiple CT scans?	10
3. For patients who are scheduling a CT scan, what factors should be considered for reducing their radiation dose?	11
4. What is being done to reduce the amount of radiation dose from CT scans?	11
5. Is there anything I can take to counteract the radiation effect from CT scans?	11
6. How do radiation doses from a PET scan compare with CT scans?	12
7. Can screening for cancer with CT cause cancer?	12
PEDIATRIC IMAGING	12
Why are children and young people at greater risk?	12
PREGNANT PATIENTS AND NURSING MOTHERS	12
1. What should be done if I am pregnant and I need a medical imaging procedure?	12
2. Should I be worried if I am pregnant and have to have a CT?	13
3. Should radiologists specifically approve head, neck, chest and extremity CT scans on pregnant patients?	13
4. Should I have a shield over my abdomen during the scan?	13
5. Will I be radioactive after the scan and hurt my fetus?	13
6. I am waiting in the room directly next to the CT scanner. Should I be worried about radiation exposure while I am waiting?	14
7. I am still concerned. How do I know the dose to my fetus from my CT scan if no one calculates it?	14
8. If I am breast feeding, what precautions should I take?	14
BEAUMONT SPECIFIC	14
1. What safety steps has Beaumont taken to ensure that the CT scanners and other equipment are operating properly?	14
2. How are patients scheduled on the Flash CT?	166
3. What is Beaumont doing to reduce radiation exposure for cardiac CT imaging?	16
4. What type of mammography equipment is used at Beaumont?	16
5. What is the advantage of the Flash CT for pediatric patients?	166
6. How much radiation exposure will I receive from a Heart CT done at Beaumont Hospitals?	17
REFERENCES	17

INTRODUCTION

1. What is ionizing radiation?

Ionizing radiation is the term for any waves or particles that have a very high energy, enough to overcome the force that binds electrons to their atoms, allowing for removal of an electron from an atom and/or molecule. The result of an ionizing interaction is an electron and an ion. Since ions have a different number of positively charged protons in its nucleus than negatively charged electrons orbiting the nucleus, it becomes more chemically reactive. Atoms that have an equal number of protons and electrons are generally not as chemically reactive.

2. What are X-rays?

X-rays are the most common form of ionizing radiation used in medical imaging. X-rays are photons, similar to light, but they have a higher energy than light photons. Other examples of ionizing radiation include gamma rays and charged particles like electrons, protons, and other heavy ions. Many of the X-rays used in imaging do not interact with our bodies, allowing creation of an image from the transmitted X-rays.

GENERAL INFORMATION

1. How much ionizing radiation exposure do I receive naturally (also known as background radiation)?

Naturally occurring sources of ionizing radiation include cosmic rays, radon, naturally occurring radioactive materials found in the ground (such as uranium) and in certain foods (such as bananas and brazil nuts). Since the origin of the earth, naturally occurring sources of radiation have continuously been a source of exposure to all life forms. There are certain places on earth where the average annual exposure to background is much higher than normal. In the U.S. the highest background radiation exposure are in states that have the greatest amounts of radioactive material in the ground and have higher exposure to cosmic radiation (such as Colorado). The lowest background radiation exposure is in states that are close to or below sea level without concentrated amounts of radioactive material in the ground (such as Florida).

An interesting fact is that the highest incidence of cancer is found in the 7-9 states that have lowest amount of background radiation; while the lowest incidence of cancer is found in the 7-9 states that have the highest amount of background radiation.

2. How does radiation exposure from medical imaging procedures compare with the amount of background radiation?

Some medical imaging procedures have zero radiation exposure (such as ultrasound and MRI).

Some medical imaging procedures have radiation exposure that is much less than U.S. annual average background radiation (3.1 mSv). Examples include dental x-rays, conventional x-rays (such as extremities, chest and head), and screening mammography.

Some medical imaging procedures have radiation exposure that is about the same amount as the U.S. annual average background radiation (3.1 mSv). Examples include head/brain CT, simple fluoroscopy procedures, and some nuclear medicine procedures (such as lung, kidney, liver, and brain scans).

Some medical imaging procedures have radiation exposure that is more than the U.S. annual average background radiation (3.1 mSv). Examples include CT scans of chest, abdomen and pelvis, interventional (catheter based) angiography, PET/CT and some nuclear medicine procedures (such as heart perfusion scans).

To obtain a table of typical effective radiation doses for different types of medical imaging procedures, go to <https://www.beaumont.org/services/radiology/radiation-safety>[1].

3. Is the millisievert (mSv) the best unit to measure a patient's radiation dose?

Yes, the mSv is widely accepted as the most appropriate unit of dose when discussing risk of cancer due to radiation exposure from medical imaging procedures. This unit is also called the effective dose because it takes into account the different sensitivities of various organ systems to cancer. It allows us to describe the average risk to a patient from the medical imaging performed on different parts of the human body. It is comparable to the older unit of millirem (mrem) that was previously used for radiation doses in the US.

4. What are the risks associated with medical imaging procedures that expose patients to radiation?

Risks of medical imaging at effective doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods (such as annually) are too low to be detectable and may be nonexistent [1]. For radiation doses greater than 100 mSv, a slight increase risk of cancer has been proven scientifically. No other health risks are associated with radiation exposure from diagnostic imaging procedures in the low dose range (< 100 mSv). Examples of procedures are CT, PET, nuclear medicine, and fluoroscopy.

For single procedures resulting in doses below 50 mSv or for multiple procedures over short time periods resulting in a total dose of 100 mSv, “predictions of hypothetical cancer risk in patient populations exposed to such low doses are highly speculative and should be discouraged [2].” Predictions at low doses used for typical medical imaging procedures may be more harmful than good. It may cause patients to refuse medical imaging procedures, placing them at substantial risk by not receiving the clinical benefits of the prescribed procedures.

Because of the lack of scientifically proven data at doses less than 50 – 100 mSv, the call center and its associated web site do not provide patients with estimates of cancer risk from diagnostic medical imaging procedures.

To obtain a calculated dose estimate for a specific procedure, contact the facility that performed the procedure and ask for the radiation safety specialist.

5. What are the risks associated with high doses or therapeutic doses of radiation?

In medicine, high doses of radiation are often used to treat patients who have been diagnosed with certain types of cancer. At high doses, the radiation prevents the cancer cells from reproducing, which causes the tumor to shrink and sometimes disappear. This field of medicine is called radiation therapy or radiation oncology. A majority of cancer patients are treated with radiation therapy at some point during their disease. A radiation oncologist may use radiation to cure cancer or to relieve a cancer patient's pain. Examples include external beam, intensity modulated radiation therapy, image guided radiation

therapy, high dose rate and low dose rate brachytherapy, radioactive implants, radioembolization, stereotactic radiosurgery, gamma knife, and proton beam.

For information regarding the risks from high dose or therapeutic doses of radiation, contact your physician directly.

6. What is the risk to patients who have multiple CTs and/or other medical imaging procedures over the course of their lifetime?

For radiation doses greater than 100 mSv, a slight increase risk of cancer later in life has been scientifically proven. When compared to the large cancer incidence rate in humans from all known causes, which is 25% to 33% (one in three to one in four), the number of predicted radiation induced cancers is very small.

Although the odds of developing cancer from 50 – 100 mSv is very small, the risk increases the more radiation exposure you receive and the younger you are at the time of exposure.

Because of the lack of scientifically proven data at doses less than 50 – 100 mSv, the call center and its associated web site do not provide patients with estimates of cancer risk from diagnostic medical imaging procedures.

Patient specific dose estimates can be calculated by a radiation safety specialist for patients that contact the facility that performed the procedure.

7. Does the government regulate radiation exposure to patients?

Regulations require that each mammography and CT machine is checked annually by a qualified medical physicist to ensure that the unit operates correctly and that the radiation output is within the regulated limits. The amount of radiation dose to patients is not regulated for most scans. This allows the radiation dose to be specific to each person's body habitus and results in the optimum image quality. Larger patients may need more output of x-rays to create a good image, but this does not necessarily mean they receive a larger dose.

8. Should patients inquire if they have concerns? What questions should they ask?

Yes, ask about the benefits that will be gained from the procedure. If you have had multiple CTs in the past, inform your physician, and ask about alternative imaging modalities, such as MRI, ultrasound, or conventional radiography. If this involves your child, ask for a referral to a medical imaging facility that has a radiologist who is specially trained in pediatric radiology. When you arrive at the imaging facility, ask whether the technologists are registered (ARRT – American Registry of Radiological Technologists).

9. If I have been treated with radiation for cancer in the past, or currently have cancer, then will medical imaging, such as CT, make it worse?

No. Low dose radiation from medical imaging does not affect known cancer. Patients who have received radiation therapy are at no greater risk of getting cancer from medical imaging procedures than patients who have not received radiation therapy.

If you are having frequent medical imaging procedures that are typically above 3 mSv each in any one year, or if you are changing health care providers, then it is a good idea to keep your own record and track your radiation dose in mSv. This could inform your doctor and help to maximize the benefit and minimize the risk to you from multiple CT scans.

To obtain a table of typical effective radiation doses for different types of medical imaging procedures, go to <https://www.beaumont.org/services/radiology/radiation-safety> [1].

To obtain a downloadable tool for tracking your lifetime radiation exposure, go to <https://www.beaumont.org/services/radiology/radiation-safety> and click on tracking card.

10. Is there a test that can show if you have had too much radiation?

No, there is no means of testing for lifetime radiation exposure from medical imaging procedures.

11. What is contrast or contrast material? Why is it used? What are the risks?

Contrast, contrast agents, or contrast media is any internally administered substance that has a different opacity (e.g. stands out) from soft tissue on x-ray and CT exams. **Contrast or contrast materials**, such as barium or iodine, are often used to produce pictures of major blood vessels throughout the body.

You should inform your physician of any medications you are taking and if you have any allergies, especially to barium or iodine contrast materials. If you have a history of allergy to x-ray contrast material, your radiologist or referring physician may advise that you take special medication for 24 hours before the exam to lessen the risk of allergic reaction. The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and radiology departments are well-equipped to deal with them. Another option is to undergo a different exam that does not call for contrast material injection. Also inform your doctor about recent illnesses or other medical conditions.

If you are breastfeeding at the time of the exam, you should ask your radiologist or referring physician how to proceed. It may help to pump breast milk ahead of time and keep it on hand for use until after the contrast material has cleared from your body, about 24 hours after the test. Contrast is not a form of radiation and it is not a dye.

12. What is the radiation dose from interventional radiology procedures (catheter based such as cardiac cath, angiography, and angiograms)?

Interventional radiologic procedures use diagnostic-type imaging equipment to assist a physician in the treatment of a patient's condition. These procedures frequently provide favorable medical results with minimal recovery time. In some cases these procedures avoid the need for conventional surgery or improve the prospects for a favorable outcome from surgery. Catheter based interventional procedures may expose a patient to doses equal to or greater than CT scans (7 mSv average) depending on the complexity of the procedure. In very rare cases, a patient may have skin reddening or even skin damage as a result of the procedure.

13. What is the radiation exposure from ultrasound and MRI?

Diagnostic medical ultrasound is an imaging technique that uses high frequency sound waves to view soft tissues, such as muscles and internal organs. Ultrasound is not a source of ionizing radiation and no risk is known to exist for this type of imaging procedure.

Magnetic resonance imaging (MRI) uses strong magnetic fields and radio waves to obtain images. MRI procedures are not associated with exposure to ionizing radiation.

14. What medical imaging procedures trigger radiation detectors, such as those used at the USA border with Canada?

In nuclear medicine, a trace amount of radioactive material is administered to the patient, then scanners are used to image the radiation emitted from the patient. For most common nuclear medicine procedures (including PET), about 90% of the residual radioactive material is gone within 48 to 72 hours. If a patient crossed the border within 3 days of a nuclear medicine scan, then the residual trace amount of radiation may trigger the very sensitive radiation detectors used to monitor the vehicles. It is recommended that patients carry documentation that they have had a nuclear medicine procedure and appropriate contact information if they plan to cross the border soon after the scan.

15. How do I keep track of my radiation exposure from medical procedures (CT, PET, nuclear medicine, angiography etc.)?

To obtain a table of typical effective radiation doses for different types of medical imaging procedures, go to <https://www.beaumont.org/services/radiology/radiation-safety>[1].

To obtain a downloadable tool for tracking your lifetime radiation exposure, go to <https://www.beaumont.org/services/radiology/radiation-safety> and click on tracking card.

16. What is radon and what is the risk from exposure to radon?

Radon is a naturally occurring radioactive gas found in soils, rock, and water throughout the U.S. Radon gas has been shown to cause lung cancer in uranium miners, and is considered a threat to public health by the Environmental Protection Agency because it can collect in homes, primarily in the basement. The EPA has set a recommended limit on the concentration of radon, which is 4 picocuries per liter of indoor air. Radon is the largest source of exposure to naturally occurring radiation.

You cannot see, feel, smell, or taste radon. Testing your home is the only way to know if the concentration of radon exceeds the recommended limits. The EPA recommends testing for radon in all rooms below the third floor.

The National Radon Hotline: 800-767-7236

CT SCANS

1. What is the radiation dose to a patient who has three chest CTs in a year? What is the risk?

The effective dose for a chest CT will vary between patients, but the typical effective dose for a standard chest CT is 7 mSv. Therefore, this patient's dose from 3 standard chest CTs equals 21 mSv.

If the benefits of the three CT scans are justified, then the benefit completely outweighs the risk from the radiation dose.

To obtain a table of typical effective radiation doses for different types of medical imaging procedures, go to <https://www.beaumont.org/services/radiology/radiation-safety>[1].

To obtain a downloadable tool for tracking your lifetime radiation exposure, go to <https://www.beaumont.org/services/radiology/radiation-safety> and click on tracking card.

2. What should I do to limit my risk if I am having multiple CT scans?

If you are having frequent medical imaging procedures that are typically above 3 mSv each in any one year, or if you are changing your health care provider, then it is a good idea to keep your own record and track your radiation dose in mSv. This informs your doctor, helps to maximize the benefit, and minimizes the risk to you from multiple CT scans.

To obtain a table of typical effective radiation doses for different types of medical imaging procedures, go to <https://www.beaumont.org/services/radiology/radiation-safety> [1].

To obtain a downloadable tool for tracking your lifetime radiation exposure, go to <https://www.beaumont.org/services/radiology/radiation-safety> and click on tracking card.

3. For patients who are scheduling a CT scan, what factors should be considered for reducing their radiation dose?

Patients and their referring physicians should discuss the risks of a CT scan, as well as the risks of not having the CT scan (i.e. potentially compromising an accurate diagnosis). A radiologist should be consulted if there remains a question as to whether or not a CT scan should be performed.

Once you arrive for the CT, ask the CT technologist if appropriate measures for dose reduction will be used. For example, the scanned area should be limited to the region of the body specified by your referring physician. The CT technique factors should be adjusted to the size of each patient's body. Newer scanners will adjust the radiation exposure automatically and reduce the exposure.

Repeated CT scans should be avoided, and certainly if the scans are being repeated only because the physician does not have access to the images from a recent CT scan. Usually the patient may request that their CT images be loaded onto a CD which they can take with them to their doctor's office. This service is usually available for nuclear medicine, PET, conventional radiology and mammography.

4. What is being done to reduce the amount of radiation dose from CT scans?

Manufacturers of CT scanners have made great strides in reducing dose. Newer CT scanners have built in dose saving features designed to provide the lowest dose while preserving the image quality.

Pediatric protocols are routinely available and used to significantly reduce the dose when compared to adult doses. When children need a CT scan, parents should ask about the right dose for their child's age and size.

For more information, visit The Alliance for Radiation Safety in Pediatric Imaging's "Image Gently" Campaign [3].

<http://www.imagegently.org/Procedures/Interventional-Radiology/Protocols>

5. Is there anything I can take to counteract the radiation effect from CT scans?

No, unlike a flu shot or vaccination, there is nothing you can take to counteract the radiation effect from CT scans.

For the most part, background radiation exposure is unavoidable. To limit your radiation exposure from medical sources, it is important to talk to your doctor about your imaging choices. It is important to realize that in a properly performed individual exam, the

potential health benefits almost always outweigh the potential risks of **radiation** exposure. If an imaging procedure is medically indicated, then patients should not hesitate to schedule it.

6. How do radiation doses from a PET scan compare with CT scans?

A whole body PET scan (primarily used for tumor imaging) has an average radiation dose of 14.1 mSv compared to CT of the abdomen and chest which has an estimated radiation dose of 14 mSv [1].

7. Can screening for cancer with CT cause cancer?

Typically, CT is not used as a screening modality, but only as a diagnostic modality for patients displaying certain symptoms. Full body CT used to screen for cancer is not encouraged or recommended by any medical organizations currently [4].

In most cases, the benefit of having a diagnostic CT far outweighs the risk of not having the exam. This is because forgoing a CT exam may result in not obtaining appropriate clinical diagnosis or treatment. For single procedures resulting in doses below 50 mSv or for multiple procedures over short time periods resulting in a total dose of 100 mSv , “predictions of hypothetical cancer risk in patient populations exposed to such low doses are highly speculative and should be discouraged [2].”

To reduce unnecessary radiation exposure, inform your referring physician about previous CT examinations.

PEDIATRIC IMAGING

Why are children and young people at greater risk?

There are two reasons. First, at earlier stages of development, cells are more sensitive to radiation. Second, the chance of developing a slow growing cancer is higher in pediatric patients exposed earlier in their life than in patients who are exposed later in their life. Because of this, pediatric protocols and fast scanners are available and may be used to reduce the radiation dose. For more information, visit The Alliance for Radiation Safety in Pediatric Imaging's "Image Gently" Campaign [3]

<http://www.imagegently.org/Procedures/Interventional-Radiology/Protocols>

PREGNANT PATIENTS AND NURSING MOTHERS

1. What should be done if I am pregnant and I need a medical imaging procedure?

Be sure that the medical radiation procedure is necessary and that the benefit outweighs the risk to both you and the fetus. You have a right to know the estimated dose and potential effects that might result from in-utero exposure. Communication between you

and the radiology team is based on the level of risk. The radiology team will routinely consider techniques and procedures that reduce the radiation dose while still obtaining the required information. When the fetus is directly exposed during a procedure and the dose is greater than 1 mSv, then a patient specific fetal dose calculation by a qualified medical physicist may be provided to the patient's obstetrician.

2. Should I be worried if I am pregnant and have to have a CT?

Scans that directly expose the fetus (such as CT of the abdomen or pelvis) may require prior approval by a radiologist. A fetal dose calculation by a qualified medical physicist may be provided after the scan. Radiologists and technologists work together to minimize the radiation dose to the fetus. This includes using alternate imaging modalities (such as MRI and ultrasound) and other imaging systems that may expose the fetus to a lower dose.

Many CT scans do not directly expose the developing fetus, such as:

- Head CT

- Neck CT (cervical or thoracic spine CT)

- Chest CT (Routine Chest, Chest PE, Heart scan, Chest CTA)

- Extremity CT (knees, legs, shoulder)

3. Should radiologists specifically approve head, neck, chest and extremity CT scans on pregnant patients?

No. Scans that do not include the abdomen or pelvis give very little radiation to the developing fetus. The exposure is highest in areas that go through the CT opening during the scan. The x-rays come out of the circular opening in a small, thin beam and pass through to the other side to make the image. If the fetus is outside the area exposed, then it will get very little radiation.

There is some scatter radiation, which are x-rays that deflect off tissue in your body and bounce through the body. These scatter x-rays can make it to the fetus, but there are not very many of them. The amount of scatter exposing the fetus depends on how close the fetus is to the scan region.

4. Should I have a shield over my abdomen during the scan?

No, using a lead apron over the abdomen during the scan of another body region does very little to reduce scatter radiation. This is because most of the scatter dose is deflected inside your body, and does not encounter the shield. A lead apron CANNOT be used for abdomen scans, because it renders the images unreadable by the radiologist.

5. Will I be radioactive after the scan and hurt my fetus?

No, once the scanner is off, the dose to you and your fetus stops.

6. I am waiting in the room directly next to the CT scanner. Should I be worried about radiation exposure while I am waiting?

No, the radiation dose in waiting rooms, corridors, and areas immediately adjacent to the CT scan room are protected with structural lead shielding that limits the radiation to background levels.

7. I am still concerned. How do I know the dose to my fetus from my CT scan if no one calculates it?

A patient specific fetal dose calculation may be provided for fetuses that receive direct CT exposure. CT scans that do not include the abdomen or pelvis give very little radiation. To put this in perspective, each person is exposed to natural background radiation, and this cannot be avoided easily. While you are carrying your fetus to term, it is also exposed to background radiation (BKG), which is about 2.3 mSv over 9 months. These are the estimated fetal doses for CT scans that do not directly expose the fetus.

Chest CT	less than 1 mSv	less than 4 months BKG
Heart CT	less than 0.06 mSv	less than 10 days BKG
Head, neck CT	less than 0.005 mSv	less than 1 day BKG

8. If I am breast feeding, what precautions should I take?

Nursing mothers should wait for 24 hours after contrast material injection before resuming breast-feeding. In nuclear medicine, sometimes the radioactive tracer (called radiopharmaceutical) used for the study may pass into the mother's milk and subsequently the child will consume them. To avoid this possibility, it is important for the nursing mother to inform her physician and the nuclear medicine technologist about this before the examination begins. Usually, you will be asked to discontinue breast-feeding for a short while, pump your breasts in the interim and discard the milk. Breast-feeding can often resume shortly afterwards.

BEAUMONT SPECIFIC**1. What safety steps has Beaumont taken to ensure that the CT scanners and other equipment are operating properly?**

Beaumont's administrative and medical directors, radiologists, technical directors, medical physicists and technologists are highly skilled in the proper use of the X-ray, CT, mammography and nuclear medicine equipment and are trained in the appropriate dose saving features for each piece of equipment and for each patient population (e.g., pediatric vs. adult; weight based radiation doses for cardiac CT and PET). Beaumont is committed to providing our radiologists and nuclear medicine physicians with the highest quality image with the lowest possible radiation dose to the patient.

Beaumont Hospitals – Royal Oak, Troy, Grosse Pointe and their affiliated off site centers have achieved the American College of Radiology Diagnostic Imaging Center of Excellence (DICOE) designation. This elite status requires that “best-quality imaging practices and diagnostic care” [6] are in place. DICOE status includes the requirement that a provider “must be accredited by the ACR in all modalities they provide in which the ACR offers an accreditation program” [6].

<http://www.acraccreditation.org/diagnostic-imaging-center-of-excellence>

Specifically, the following safety steps are taken to ensure that the CT scanners and other equipment are operating properly:

(1) Only board certified radiologists are employed at Beaumont and we have specialty trained radiologists in pediatrics, CT, mammography, MRI, and general radiology. Beaumont has dedicated nuclear medicine departments and employs only board certified nuclear medicine physicians.

(2) Acceptance testing of new X-ray generating and nuclear medicine equipment by medical physicists to ensure both the radiation dose and image quality meets specification.

(3) Annual performance testing (which includes an assessment of radiation dose and image quality) by the medical physicist.

(4) Routine QA (daily, monthly quarterly) performed by the technology staff in conformance with the manufacturer's specifications.

(5) Service, Repair and Follow up: whenever the X-ray equipment is not operating in accordance with manufacturer's specifications or government regulations, a service request is placed and either Beaumont or the manufacturer's service engineer responds by repairing the problem. The repairs to each X-ray generating machine are tracked. Often the medical physicist will verify that the service was effective after the repair is complete, especially for mammography equipment.

(6) Beaumont employs only board certified and registered technologists (RT) who operate the X-ray generating equipment, board certified CT technologists, and board certified nuclear medicine technologists. Since Beaumont has a student technology program, student technologist may also operate X-ray and nuclear medicine equipment under the supervision of the RT (registered technologist). (The only exception is the bone density scanners, where we may have non-registered personnel operating the equipment. In this case, comprehensive bone density scanner principles and radiation safety are taught by the medical physicist and successful passing grade on an exam is required).

(7) Preventative maintenance is performed routinely on all of the X-ray and nuclear medicine equipment either by Beaumont service engineers or by the manufacturer. This

is documented and reported to the Equipment Performance Committee in compliance with the Joint Commission. Each piece of equipment has a service and repair history.

(8) The operation of the X-ray equipment is also subject to State inspections as follows: every year for mammography equipment, and every five years for non-mammography X-ray generating equipment.

2. How are patients scheduled on the Flash CT?

We currently have Flash CT at Beaumont Hospitals Royal Oak, Troy and Grosse Pointe. Coronary CT/CTA and pediatric procedures are routinely scheduled on the Flash CT. Beaumont will schedule a patient on the Flash CT if it is ordered by their referring physician and they communicate that to our scheduling staff.

3. What is Beaumont doing to reduce radiation exposure for cardiac CT imaging?

Radiation exposure may also be reduced when technologists use special “gating” techniques to lower tube voltage during CT imaging tests. In June 2009, a Beaumont-led study published in the Journal of the American Medical Association showed that radiation exposure for heart CTs can be cut in half using these techniques with no effect on image quality [5]. Beaumont is the leader of a statewide collaborative research study of CT heart scanning that includes hospitals throughout Michigan.

4. What type of mammography equipment is used at Beaumont?

Digital mammography is used at Beaumont. Film is no longer used by Diagnostic Radiology or Nuclear Medicine. Beaumont also offers 2D and 3D breast tomosynthesis imaging. All of these images are processed through PACS (Picture Archiving and Communication System). This is a computer system for acquiring, storing, viewing, and managing digital medical imaging studies and related information.

5. What is the advantage of the Flash CT for pediatric patients?

Using a spiral (helical) CT unit to examine children is faster than other CT scanners, reducing the need for sedation and general anesthesia. New technologies, such as the Flash CT, make even faster scanning possible. For children this means shorter imaging times and less time required to hold still in order to produce clear images. Also, shorter scan times will make it easier for children to hold their breath during critical parts of the exam.

One of the best ways of limiting radiation exposure is to avoid CT scans that are not clearly needed. Other measures are to restrict the area scanned as much as possible and to “fine tune” the CT settings based on the reason for the exam, the body area being examined, and the child's size. Beaumont has specially trained pediatric radiologists who use the lowest radiation dose that will provide the needed diagnostic information.

6. How much radiation exposure will I receive from a Heart CT done at Beaumont Hospitals?

The average dose for Heart CT or CT angiography (without calcium scoring) is significantly less the national average of 16 mSv and estimated to be 9 mSv. Heart CT or CT angiography (without calcium scoring) using the Flash CT averages 2 mSv.

REFERENCES

[1] Radiation Dose Table of U.S. average effective radiation dose for conventional X-ray, CT, fluoroscopy, interventional, nuclear medicine and pediatric. These radiation doses are based on a recent article published in *Radiology* by Fred Mettler, M.D. and represent the average adult radiation effective dose in the U.S. (published 2008).

[2] Position Paper 25: American Association of Physicists in Medicine Position Statement on Radiation Risks from Medical Imaging Procedures 12/13/2011.

[3] The Alliance for Radiation Safety in Pediatric Imaging's "Image Gently" Campaign: <http://www.imagegently.org/Procedures/Interventional-Radiology/Protocols>

[4] RadiologyInfo.org developed jointly by the American College of Radiology and Radiological Society of North America.
[http://www.radiologyinfo.org/en/safety/index.cfm?pg=sfty_xray - 4#4](http://www.radiologyinfo.org/en/safety/index.cfm?pg=sfty_xray-4#4)

[5] **Radiation Dose From Cardiac Computed Tomography Before and After Implementation of Radiation Dose-Reduction Techniques**, JAMA, June 10, 2009.

[6] American College of Radiology
<http://www.acraccreditation.org/diagnostic-imaging-center-of-excellence>