TRACE PROGRAM

Brenda Rinehart MBA, CRA, ARRT (R)(M)(CT)
Director Medical Imaging
Overlake Hospital Medical Center
In the past few years’ radiation exposure has become a virtual celebrity and everyone has something to say about CT over-utilization and radiation exposures.

- FDA’s investigated of more than 600 patients that were exposed to elevated doses for brain perfusion CT

- California took the initiative to be the first state to adopt laws specific to recording, tracking, and reporting radiation dose to the patient and referring physician.

- This created a firestorm for vendors who scrambled to produce “quick fixes” that would enable their equipment to perform these tasks.
“Tracking radiation dose delivered to patients for medical purposes is gathering increasing attention from professional societies and regulatory groups.”

“Patient concern about repeated radiation exposure has prompted a National Institutes of Health (NIH) plan to require all makers of CT and other radiation-producing scanners used at NIH clinics to have software to track a patient's radiation dose and log it into an electronic medical record (EMR).”

“In February, the FDA announced a new initiative to reduce unnecessary radiation exposure from CT, nuclear-medicine, and fluoroscopy exams. The agency’s three-pronged approach will include issuing safeguard requirements for device manufacturers, incorporating quality-assurance measures in mandatory CMS accreditation for imagers, and creating national dose registries to aid in the development of diagnostic-radiation reference levels.”
This flyer provides recommendations to help you provide your patients with the appropriate amount of radiation exposure from CT exams.

Please post flyer in each CT control box.
As a result of the potential dangers associated with ionizing radiation, the Centers for Medicare & Medicaid Services (CMS) will require the accreditation of facilities providing advanced imaging services (CT, magnetic resonance imaging (MRI), positron emission tomography (PET), nuclear medicine) in non-hospital, freestanding settings beginning January 1, 2012. In addition, the state of California has mandated that facilities that furnish CT X-ray services become accredited by July 1, 2013. This California law also requires the documentation of the dose of each CT exam; annual verification of each dose by a medical physicist; and reporting dose errors to patients and physicians. In addition, in May, the American College of Radiology (ACR) launched its National Radiology Data Registry (NRDR),
Right test

1. In order to reduce the exposure of the patient
to ionizing radiation, use other imaging
techniques, such as ultrasound or MRI,
whenever these tests will produce the required
diagnostic information at a similar quality
level.\textsuperscript{17}

2. Create and implement processes that enable
radiologists to provide guidance to and
dialogue with referring physicians regarding
the appropriate use of diagnostic imaging
using the American College of Radiology’s
Appropriateness Criteria\textsuperscript{\textregistered}.\textsuperscript{17}

Effective processes
10. Create and implement policies and procedures
delineating those responsible for approving
changes to password-protected diagnostic
imaging protocols and for monitoring new
developments in diagnostic imaging. Provide
for oversight of these policies and procedures
and related activities, including control of the
9. Record the dosage or exposure as part of the study’s summary report of findings.

or the equipment before initial use and periodically thereafter.

Actions suggested by The Joint Commission
Health care organizations can reduce risks due to avoidable diagnostic radiation by raising awareness among staff and patients of the increased risks associated with cumulative doses and by providing the right test and the right dose through effective processes, safe technology and a culture of safety.

Right test
1. In order to reduce the exposure of the patient to ionizing radiation, use other imaging techniques, such as ultrasound or MRI, whenever these tests will produce the required diagnostic information at a similar quality level.
2. Create and implement processes that enable radiologists to provide guidance to and

appropriate doses. Minimizing radiation doses from exams repeated due to insufficient image quality or lack of availability of previous studies to identify the causes. Address and resolve these problems through education and other measures.  

9. Record the dosage or exposure as part of the study’s summary report of findings.

See relevant Joint Commission requirements:
LD.04.04.07 (hospital and critical access hospital);
LD.04.04.09 (ambulatory)

Effective processes
10. Create and implement policies and procedures delineating those responsible for approving changes to password-protected diagnostic imaging protocols and for monitoring new developments in diagnostic imaging. Provide for oversight of these policies and procedures and related activities, including control of the
Effective processes

13. Ensure all physicians and technologists who prescribe diagnostic radiation or use diagnostic radiation equipment receive dosing education and are trained on the specific model of equipment being used. Institute a process for annual education, review and competency testing.

Right test

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2. Create and implement processes that enable radiologists to provide guidance to and

See relevant Joint Commission requirements:
LD.04.04.07 (hospital and critical access hospital);
LD.04.04.09 (ambulatory)

Effective processes

10. Create and implement policies and procedures delineating those responsible for approving changes to password-protected diagnostic imaging protocols and for monitoring new developments in diagnostic imaging. Provide for oversight of these policies and procedures and related activities, including control of the
15. Have a qualified medical physicist test all systems periodically. Test results and a comprehensive test report should be reviewed by a qualified medical physicist.

16. Ensure that recommended quality control, calibration (including daily functional tests), and comprehensive testing protocols are followed.

17. Invest in technologies that optimize or reduce dose. Identify in writing these activities, their frequencies, and who will perform them.
In addition, The Joint Commission:

19. Endorses the creation of a national registry to

20. Encourages manufacturers to incorporate dosage safeguards into equipment and to

21. Supports stricter regulations designed to eliminate avoidable imaging and monitor the appropriateness of self-referred imaging studies (referral of a patient to a facility in which the referring physician has a financial interest).
TRACE

Tools for Radiation Awareness and Community Education
Toshiba’s
Putting Patients First Grant
Offered Through AHRA

Like many healthcare organizations, we maintain a balanced scorecard (dashboard) of improvement metrics. Our quality improvement initiative this year is centered on Radiation Safety in all aspects of radiation producing imaging.

We were awarded the grant and began down the circuitous path of developing the TRACE program.
Getting Started

Goals

Research

Focus for the program

Broke our Goals into two phases:

- Do without additional capital and operational resources

- Requires an operational or capital budget
Phase One

New policy and procedures
Patient and community education
Staff education
Fluoroscopy dose reduction through physician education and dose awareness
CT dose reduction through protocol/practice change

Phase Two

Recording/reporting dose on images, reports, and in the medical record
Patient and referring physician notification for excessive radiation dose
CT Dose reduction for the 64-slice provided through ASIR technology
Physician Champion

According to our physician champion, Mark Pfleger M.D., Vascular Interventional and Neuroradiologist and President of Overlake Imaging Associates, “Medical Imaging is an ever expanding important tool in diagnosis. Radiography, fluoroscopy, and CT (computed tomography) require ionizing radiation in order to generate images. We are committed to providing these services in an environment that is as safe as possible. The TRACE program allows the patients to be an active participant in their own care. Patients can keep track of radiation exposure for an individual test and cumulative dose over time, as well as reference this to standard background radiation levels. This knowledge is also used by physicians and technologists to keep exposure to a minimum whenever an imaging test is required.”
New Policy and Procedures

*Reality*—we found that we had several smaller policies and procedures that addressed some elements of radiation safety such as radiation monitoring and protective apparel, but lacked a comprehensive approach to overall radiation safety. There were no established guidelines for radiation dose, and no discussion of patient risk or patient and community education.
**Challenge**—In order to alter our policy, we had to consider all of the research that actually went into the program.

We had several meetings with our physicist to decide on the key elements, such as which measure of dose to use (mGy, Gy, Rad, mSv, Rem, etc.), which regulatory agencies’ recommendations to consider, which governing or professional organization’s recommendations to consider, and how best to roll-out a comprehensive program.

We also had to consider elements of risk management and that any changes to our policy had to be reviewed and signed off by the radiation safety committee.
## NEW Policies and Procedures

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Patient and Community Education

_Reality_—the public is inundated with information regarding radiation dose and not all of that information is valid. Like anything else in the media, if it sells, it’s often published. The recent tragedy in Japan has stirred up even greater concern about radiation and its effects.

The important aspect of medical imaging, radiation producing or not, is that it is ordered by the patient’s physician and the benefit of the exam is supposed to outweigh the risks of the exam.

According to the Society of Interventional Radiology (SIR) “In general, the risk of radiation is low compared to other procedural risks, and the benefits of imaging guidance are great. Image-guided procedures typically cause less morbidity and mortality than the equivalent surgical procedure. An informed patient will virtually always agree that the potential harm due to radiation is less than the potential harm due to a procedure that is cancelled, incomplete, or clinically inadequate because of concerns over radiation.”
**Challenge**—finding a consistent and reliable source of information is essential for education of the general public.

To share information, we had to first understand that information, and with all of the variable ways to measure and report dose (mSv, Gy, mGy, R, etc.) just deciding on which “language” to use was a challenge.

For example, the definition of dose itself as defined by the ACR is as follows, “Dose (also known as absorbed dose): the amount of energy imparted by radiation to specified matter, (e.g., soft tissue) per unit mass. The unit of dose is the gray. An older unit still used in the literature is the rad (radiation absorbed dose). 1 Gy = 100 rad.”
We found that Radiologyinfo.com had the easiest to understand public material, so we chose to model our patient and community education utilizing the examples provided on their website.

Radiologyinfo.com recommends mSv as a standard expression of dose, so we produced our educational dose information expressed in mSv.

The next hurdle was that our equipment either did not express dose at all (for instance, just fluoroscopy time) or it expressed it in different ways (for instance CT is expressed in DLP), which had to be converted to mSv.
Overlake is accredited by the American College of Radiology in Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine and Ultrasound. Accreditation is earned by organizations that undergo a rigorous onsite inspection and evaluation of equipment and facilities, meet quality and safety guidelines and ensure personnel are educated and certified in medical imaging.

To schedule an imaging procedure call: 425-688-5700

To speak to a Medical Imaging staff member call: 425-688-5564

OVERLAKE
Hospital Medical Center
Medical excellence every day™

1035 116th Ave NE
Bellevue, WA 98004
**Your Safety is Our Top Priority**

**What is a dose of radiation?**
Unlike medications, radiation is not measured simply by quantity. Rather, radiation is more like sunlight; in that radiation dose is measured by the length and intensity of exposure. For example, the sun is most intense closer to the equator in the summer months. You may get a sunburn after only ten minutes of full-sun exposure in a place such as Cancun, Mexico. By contrast, 10 minutes of full-sun exposure in Western Washington would not have the same effect because the intensity of the sunlight is very different. Similarly, in diagnostic imaging the amount of radiation received depends on such factors as the type of diagnostic test, the size of the patient and the part of the body being examined.

**How is radiation dose measured?**
There are many ways to measure radiation dose. For patients, the most important way to measure radiation dose is termed "effective dose," which measures patient risk by assessing the long-term effects of radiation on body organs and tissues. Although there are many ways to express the quantity of radiation received, effective dose is most often expressed in milliSieverts (mSv).

Ionizing radiation is used daily in hospitals and clinics as part of X-ray, Nuclear medicine, and Computed Tomography (CT) diagnostic imaging procedures. These imaging procedures provide important information to your doctor about your health and help ensure that you receive appropriate care. Physicians and technologists performing these procedures are trained to use the minimal amount of radiation necessary.

**What does radiation risk mean?**
Risk level means the approximate lifetime risk of fatal cancer for an adult as the result of radiation exposure. Risk level is further defined as follows:
- Negligible: < 1 in 1,000,000,000
- Minimal: 1 in 1,000,000 to 1 in 100,000
- Very Low: 1 in 100,000 to 1 in 10,000
- Low: 1 in 10,000 to 1 in 1,000
- Moderate: 1 in 1,000 to 1 in 200

**How is radiation risk calculated?**
Radiation risk is calculated by comparing the radiation from a diagnostic test to everyday background radiation we receive from the environment, or by comparing diagnostic radiation to the radiation we receive when flying in a plane, or the radiation we would receive if we engaged in a high-risk activity such as smoking a cigarette. For example, according to radlogixinfo.com, a chest X-ray dose is 0.1 mSv, and is equivalent to 10 days of normal background radiation. This is considered a minimal risk.

**Radiation Safety**

**Does radiation risk vary with age?**
Children are more susceptible to the effects of radiation because their cells are still growing and developing. However, radiation dose is dependent upon the size of the patient. A greater dose of radiation is needed to penetrate larger amounts of tissue and bone. As a result, for similar imaging procedures a child will usually be exposed to much less radiation than an adult.

**How will I know how much radiation I’ve received for a diagnostic test or procedure?**

At Overlake’s Medical Imaging Department, we are committed to helping our patients track their diagnostic radiation exposure. We will track, record, and report radiation dose for each exam, and when this is not possible, we will estimate the radiation dose received based on normal exam levels. This information will be recorded on your imaging examination report and provided to your referring physician. Also, an estimate of the amount of radiation you are expected to receive will be provided to you upon registration.

When considering the very small risk of harm from a medical imaging procedure the first question to ask is this: Will the benefits of the imaging procedure greatly outweigh the risk? The answer is almost always, “yes.”

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**Exam Type** | **Average Dose** (mSv) | **Risk**
--- | --- | ---
Chest X-ray | 0.1-0.3 mSv | Minimal
Spine X-ray | 1.5-1.8 mSv | Very low
Hand/FOOT X-ray | 0.001-0.002 mSv | Negligible
Head CT | 2-3 mSv | Very low
Chest CT | 7-8 mSv | Low
Spine CT | 5-6 mSv | Low
Abdomen Pelvis CT | 13-15 mSv | Low
UGI Fluoro Exam | 6-8 mSv | Low
Manamography | 0.4-0.6 mSv | Very low
NM Renal Scan | 2-2.5 mSv | Very low
NM Bone Scan | 6-7.0 mSv | Low

Dose ranges are based on the average adult. Average Adult Dose by Exam Type.

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**My Radiation Exposure**

<table>
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<tr>
<th>Date</th>
<th>Exam</th>
<th>Dose (mSv)</th>
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Notes: These risk levels represent very small additions to the 1 in 5 chance to die of dying from cancer. - radlogixinfo.com
Giving you peace of mind.

Our Medical Imaging department wants you to know our Tools for Radiation Awareness and Community Education (TRACE) program is one of the first programs to address radiation safety in the region and we are helping other organizations to do the same.

For more information, please visit us at www.overlakehospital.org/RadiationAwareness.
Website

Prior to the project our website was designed with basic patient information regarding imaging procedures and some marketing information.

During the project, we worked with our marketing department to update our website with radiation safety educational material and with links to radiologyinfo.com for access to radiation safety videos and FAQ’s.

In addition, we added our ACR certification seals to our website as a symbol of the highest standards in radiation safety. We are ACR certified in every certifiable modality.
Patient Letters

Utilizing on-line resources we created a patient letter that would be given to patients before their scheduled exam. The research required for this endeavor was the most daunting.

We discovered multiple tools on-line to calculate and convert dose.

The patient letter was designed to outline expected radiation dose for a given exam. To make the task a little easier, we created ranges from the available information to cover multiple views and patient sizes. For example, a chest x-ray range is 0.1-0.3 mSv. This range covers a one view or two view chest x-ray for a small to large patient.

In addition to dose, the letter provides a dose equivalency to background radiation and an explanation of risk.
According to Radiologyinfo.com, “We are exposed to radiation from natural sources all the time. The average person in the U.S. receives an effective dose of about 3 mSv per year from naturally occurring radioactive materials and cosmic radiation from outer space. These natural "background" doses vary throughout the country.”
We created the letters for all radiography, fluoroscopy, computed tomography, and nuclear medicine exams.

The letters were vetted through executive leadership, marketing, and risk before they were approved for dissemination.

The calculations were garnered through the Radiologyinfo.com website and correlated to our equipment through our physicist.

When explaining the risk associated with the exam, we utilized radiologyinfo.com’s chart for additional risk of fatal cancer for an adult from specific radiation exposure.
Welcome to Overlake Hospital's Medical Imaging Department where you can expect Medical Excellence Every day. As a part of our commitment to your safety, you are being provided this letter on Radiation Awareness.

Accreditation

Overlake is accredited by the American College of Radiology in Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine, and Ultrasound. Accreditation is earned by organizations that undergo a rigorous onsite inspection and evaluation of equipment and facilities, meeting quality and safety guidelines, and ensure personnel are educated and certified in medical imaging.

Today's Exam

You are scheduled for a Chest X-ray today. You can expect to receive 0.1-0.3 mSv of radiation for this exam. This dose is equivalent to 10 days of natural environmental radiation that you are exposed to everyday. This risk is considered minimal.

Radiation Dose

There are many ways to measure radiation dose. For patients, the most important way to measure radiation dose is termed "effective dose," which measures risk by assessing the long-term effects of radiation on body organs and tissue. Although there are many ways to express the quantity of radiation received, "effective dose" is most often expressed in millirems (mrem).

Ionizing radiation is used daily in hospitals and clinics as part of x-ray, nuclear medicine, and computed tomography (CT) diagnostic imaging procedures. These imaging procedures provide important information to your doctor about your health and help ensure that you receive appropriate care. Physicians and technologists performing these procedures are trained to use the minimal amount of radiation necessary.

Radiation Risk

Risk level means the approximate lifetime risk of fatal cancer for an adult as the result of radiation exposure. Risk level is further defined as follows:

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- **Very Low**: 1 in 100,000 to 1 in 10,000
- **Low**: 1 in 10,000 to 1 in 1,000
- **Moderate**: 1 in 1,000 to 1 in 500

If your condition has resulted in the need for frequent radiologic studies, you may wish to speak with your primary care physician about radiation dose. It is important that all of your treating physicians have your complete imaging history.

Additional Information

For more information on radiation risk and dose, please see our Radiation Safety brochure available in the waiting area, or our website at www.overlakehospital.org/radiationsafety.

Chest X-ray
Staff Education

**Reality**—our department is staffed with approximately 100 employees, made up of technologists, administrators, nurses, and support staff.

While we expect our technologist to have a basic knowledge of radiation principles, such as ALARA, we have an entire sub-set of employees with very little knowledge of radiation principles at all.
Challenge— in order for the program to be successful we would have to arm all of our employees with a greater depth of knowledge and decide which employees would be referenced for various types of information.

For instance, would we expect our front desk staff to field questions about background radiation equivalencies?
Deciding on the method of communication and providing the time and opportunity for staff to learn is often a challenge.

In our department, every employee is expected to access their email daily. As we all understand, the challenge with email is that long emails are often ignored and emails are always one-way communication.

As a result, we often use email as a heads-up notification before we roll-out education or a summary of the items that have already been discussed or dispersed.
**Results**— we decided the most effective method for educating the staff would be single modality staff meetings and one-on-one conversations with staff and leads/supervisors.

This was followed by an email summary and hand-outs of the posters and brochures, and links to web-sites that provide additional information.

We worked within our leadership team to create additional resources such as an FAQ for the staff to use in anticipation of the questions that might be asked by physicians and patients upon receiving radiation dose information.

We made the decision early in the process to direct all detailed questions directly to the technologists, and in the event of any unanswerable question, to direct them to management.
Fluoroscopy Dose Reduction through Physician Education and Dose Notification

**Reality**—physicians that do not have a background in radiology are often uninformed about radiation dose or appropriate imaging protocols.

When we examined our environment we found two areas of concern: Multiple or incorrect CT exams ordered on patients and high fluoroscopy patient dose specific to particular procedures (i.e. some ERCP’s, some vascular, some catheterizations, and thrombectomies, etc.); basically, any procedure that is complicated or has the potential to be a long procedure.
According to the Society of Interventional Radiology, “Radiation data are available to the operator during the course of a procedure. It is the operator’s responsibility to be informed about dose levels and to include radiation dose in the continuous risk-benefit balance used to determine the value of continuing a procedure.”(2)

Raising awareness of a particular issue through discussion or measurement of goals often changes behaviors and outcomes. The leadership team felt that by bringing the radiation dose to the attention of the fluoroscopist, it would raise awareness and have the potential to lower the overall radiation dose
Challenge—there were no set guidelines in our policies and procedures to guide us in determining how much radiation is too much given the type of procedure being performed.

As a result, we did extensive research for this information online, in journals, through colleagues, and through professional resources, such as the Advisory Board.

We hired our physicist to provide professional opinions and to help us make sense of what we were reading in the literature. What we determined was that basically there was not a consensus among professional organizations, regulatory agencies, or physicists.

The FDA issued the strongest recommendation in 1995, which in summary states that an initial notification to the fluoroscopist should occur at 1,000 mGy. Various other organizations, including the ACR, support varying levels for initial notification from 3,000 mGy to 5,000 mGy.
According to SIR, “Deterministic Effects of Single-delivery Radiation Dose to the Skin of the Neck, Torso, Pelvis, Buttocks, and Arms can result in transient erythema and Epilation at 2,000-5,000 mGy.”

For our purposes, we chose to follow the strictest standard and begin notification at 1,000 mGy, followed by 2,000 mGy, and final notification at 3,000 mGy.
General radiography and even computed tomography do not generally reach radiation dosages of 1,000 mGy (1 Gy) unless repeated.

Although the focus in the media leans toward CT exposure and over-utilization, unless studies are repeated or there is a malfunction that creates the issues that occurred in the brain perfusion cases presented at Cedar Sinai, the patients are not expected to receive 1,000 mGy of radiation and therefore, would not reach the FDA recommendation for the first notification point.
Examining our equipment, we identified 15 pieces of fluoroscopy producing equipment, excluding mini-c-arms, all of various age and manufacturer.

Each piece of fluoro producing equipment records differently (Gray, Microgray, Milligray, Centigray) including one piece of equipment that only records fluoro time.

“The FDA made additions to their regulations entitled “Performance Standard for Diagnostic X-ray Systems and their Major Components.” The additions required that fluoroscopic equipment manufactured after June 10, 2006, display air kerma rate and cumulative air kerma.

In order to keep the notification standard at 1,000 mGy, 2,000 mGy, and 3,000 mGy, we would have to compute the correlated dose for each piece of equipment and post it on the equipment for the technologist.
Communicating with the medical staff can be a daunting task, as it can be for any large group of busy individuals.

Finding the best way to illustrate and educate our medical staff to policy and procedural change was a challenge.

We had to be certain to vet our plans with the medical staff office, our physician champion, and other key stakeholders.

Another key to communicating the notification of dose to the fluoroscopist was to delineate the difference between notification and decision making.

We recognize that our technologists are informing the fluoroscopist that they have reached a specific dose (1,000 mGy, 2,000 mGy, and 3,000 mGy) and not deciding for them when to stop applying fluoroscopy. The decision to proceed or cease is the fluoroscopist’s/physician’s.
**Results**—once we established our notification guidelines, we set the changes into our policy and procedure. We worked with our physician champion, to be certain the policy changes were in-line with the radiologist’s expectations.

In conjunction, we worked with Marketing to create educational posters to display in surgery, SPU, Cardiac Catheterization Lab, main hallways, and the physician’s lounge.

The posters were designed to be simple, easy to read quickly, and informative about the change to fluoroscopist notification during procedures where the dose to the patient reaches 1,000 mGy, 2,000 mGy, and 3,000 mGy.

In addition to the posters, we utilized our medical staff office to send specifically crafted email notifications to the medical staff involved in fluoroscopy.
ATTENTION:
New Verbal Notification Protocol Related to Radiation Safety

Overlake’s Tools for Radiation Awareness and Community Education (TRACE) program is the most comprehensive radiation safety program in our region. The program is designed to educate our patients, staff, and physicians about radiation dose and the associated risks.

One newly implemented tool is a verbal notification at three (3) defined dose thresholds during fluoroscopic procedures. The radiologic technologist will inform the fluoroscopist when patient dose has reached the equivalency of 1,000, 2,000, and 3,000 mGy safety thresholds as established by the FDA and ACR. In addition, patients and referring physicians will be notified by letter when the patient’s dose exceeds 3,000 mGy.

For more information on the TRACE program or specific radiation safety enhancements, please see our web site:
www.overlakehospital.org/RadiationAwareness

If you have any comments or concerns, please call Michael Wade, Operations Manager, Medical Imaging, at 425-688-5240.

OVERLAKE Hospital Medical Center
Medical excellence every day
Methods of Reducing Patient/Operator Radiation Exposure
In Toshiba Vascular Suite

Regular Fluoro Mode (left pedal) 4 levels
1. High (20 frames/sec)
2. Normal (15 frames/sec)
3. Middle (15 frames/sec)
4. Low (7.5 frames/sec) Lowest Effective Dose to Patient

High Level Fluoro DSA (digital subtraction) vs. DA (cine-run)
1. Changing AEC Dose (μR) is proportional
   - AEC Dose Options: 100μR, 200μR, 300μR, 400μR (default), 500μR
   - Changing from 400μR (default) to 200μR will result in ½ Effective Patient Dose
2. Frame Rate Options: 15/sec, 10/sec, 6/sec (lowest dose to patient)
3. DSA is a 10-fold increase in patient dose vs. DA per Toshiba Clinical Representative
4. Possibility of decreasing “time-out” period (time after DSA/DA stops recording)

Collimation (Shutters/Soft Filters)
1. Filters greatly reduce scatter radiation exposure to those in the room
2. Lead drapes/overhead shield also accomplish lower operator exposure levels

Magnification
5. Any step up in magnification results in a direct increase in patient dose

SID/OID (source to image/object to image distance)
- The following applications lower radiation to individuals in room
6. Lowering table height to minimum SID
7. Lowering IR (image receptor) as close to patient as possible
- The following applications lower radiation to patient
1. Raising table height to maximum SID (decrease in entrance skin exposure)
2. Lowering IR (image receptor) as close to patient as possible

***It is the Fluoroscopist’s responsibility to tailor the radiation exposure to patient and operator to be as Low As Reasonably Achievable based off patient’s size and body part***
CT Dose Reduction

**Reality**—our department has two GE CT scanners: one 64-slice situated in the emergency department, and one 16-slice in the main department. Sixty-percent of our overall CT volume is emergency department driven. The majority of the outpatient CT volume does not come through the main hospital facility.

We began looking at CT dose reduction as a three-phased approach in keeping with the recommendations heard in the professional community, and while attending AHRA sponsored seminars: First dissect your protocols, second dissect your practice, and third look to technology.
**Challenge**—the chicken or the egg, proverbially speaking, was the issue created by the interdependencies of technology changes, protocol changes, and practice changes.

In addition we were facing a staffing shortage and loss of our lead CT technologist just as the program was starting to take shape. With three of our eight staff members leaving, we were faced with using temporary staff for the first time in over four years.

We researched the technology available for our GE scanners to reduce radiation dose. In order to upgrade our GE 64-slice scanner with ASIR technology, we will require administrative approval and budgeted capital funding.
Results— we decided to break the CT changes into two phases, as explained previously, we divided up the work that we could do today and that which required additional capital or operational resources.

Our technologist team attended a regional seminar sponsored by AHRA, entitled: CT Radiation Dose Reduction.

The CT technologists were able to apply simple practice changes like more precise centering, being consciously aware of the patient’s breathing, and avoiding Z-axis creep and we were able to purchase bismuth shielding for breast and thyroid protection.
Phase 2—with the addition of the ASIR technology for our 64-slice scanner, we will revisit our protocols and work with our radiologists to determine the amount of noise in the images that they determine to be acceptable while maintaining diagnostic quality.
Recording and Reporting Dose—Phase 2

Reality—“As stated by the ACR, Direct patient care radiation dose-related information provided by dosimetry systems should be recorded in the patient’s medical record. If cumulative air kerma or kerma-area-product data are not available, the fluoroscopic exposure time and the number of images acquired should be recorded in the patient’s medical record.” (2)

Until recently, fluoroscopy time was the only recorded element of radiation dose, and fluoroscopy time requires a physicist’s calculation to determine dose.

CT dose, recorded as dose length product (DLP), is available on our GE scanners, but is not recorded in the DICOM header or on the patient’s images.
**Challenge**— in order to get the dose dictated into the report, we would have to develop a method for each modality to record dose in mSv, the universal patient ‘language’ we decided to use.

We could not issue patient letters estimating dose for a given examination in mSv, and then report the actual dose in another ‘language,’ such as mGy.

In addition, we currently do not use an independent full functioning radiology information system (RIS) or other software component that would assist in tracking the reported dose or storing it in the medical record automatically.

Due to the complexity of this problem, we are exploring possible software solutions for long-term storage and retrieval of the data, as well as tools to assist the radiologists in dictating this information, such as auto-populating templates.
Reality—according to the Society for Interventional Radiology, “If the cumulative air kerma at the reference point exceeds 3 gray, provisions should be made for follow-up of those areas for determination of radiation effects...In such circumstances there should be documentation in the medical record that the patient was advised of the potential for radiation injury to the skin and was given instructions for proper follow-up.” (2)

Until our program began, our organization did not have the ability to record this information. In recording it, we recognize that some exams, by the nature of their length and complexity, will fall into the range in excess of 3 gray.
**Challenge**— vetting this particular change with our Quality Improvement Committee will be the first step of introducing this change to the medical staff.

Further education of the medical staff is necessary to field the potential patient questions associated with this type of notification.

In our organization, risk management would need to assess the letters and consult with other resources to determine the potential issues.
Going Forward

Purchase a DAP monitor for the fluoroscopic room in the main department. Currently this machine only records fluoroscopy time. “The DAP meter is a transmission type air ionization chamber mounted on the face of the x-ray tube collimator, which integrates the dose over the entire image field.” (2)

Purchase the ASIR for the GE 64-slice CT, pending administrative approval. We will

Submit our request for excessive dose notification letters to the Quality Improvement Committee and vet the change through our Risk management department.

Convert from Meditech to EPIC Radiant which offers access to dose index registries and permanent storage of cumulative radiation dose information, as well as, software that provides the ability to set-up notifications in the system to alert ordering physicians to potential radiation dose issues due to multiple radiation producing imaging procedures and EMR applications for physician order entry that check appropriateness criteria for computed tomography and other radiation producing exams
Victory

Education and Awareness were two of the desired outcomes of the program and this example illustrates that we are well on our way to achieving results.
New Market-Place Solutions for Reducing/Tracking Dose
ASiR™ High Image Quality and Low Dose: Forget compromise

Conventional CT image reconstruction techniques are simple and fast, but have limitations, as they are sensitive to noise and artifacts.

ASiR extracts noise by modelling its root causes for each patient and application type.
Sapheneia Clarity™ CT Solution acts as a DICOM node that receives CT studies from the modality, processes the data, and then forwards the enriched detail resolution study to the selected destination as described in Figure 1. This destination can be any DICOM node, typically either the PACS system or a specific workstation.

Based on the Series Description, appropriate parameters are selected.

CT Scanner → Data to process → Sapheneia Clarity™ CT Solution Server

Enriched detail resolution data

Scanner is identified based on DICOM header

All other series

PACS / Workstation

original data
| Normal dose (80 mAs) | Ultra low dose (20 mAs) | Sapheneia Clarity™ CT Solution processed ultra low dose (20 mAs) |
DoseMonitor™ provides near-time visibility and alerts to potential excessive patient radiation dose before additional exposure occurs. Using DoseMonitor’s proprietary intelligence engine, healthcare facilities can now compare, aggregate and interpret data from ionizing radiation sources on a patient, study or modality basis to accurately depict cumulative exposure levels. Customer controlled multi-level alerts assure timely notification of the DoseMonitor™ warnings. DoseMonitor™ offers the potential integration to other third party systems for reporting.

Based on industry standard architecture, DoseMonitor™ is vendor agnostic and supports all major X-ray imaging equipment manufacturers that produce DICOM images.

Features include:
- Patient dose repository
- Robust reporting capabilities
- Modality dose monitoring using standardized dose values from diagnostic imaging equipment.
- Pre-visit/real-time cumulative dose patient profile.
- Customizable alerts and notifications using red/green/yellow system when a test is ordered.
- Rapidly deployable

DoseMonitor offers the following capabilities:
- Identifies devices and examination procedures that do not meet dose specifications.
- Compares, aggregates and interprets data from ionizing radiation sources on a patient, study or modality basis.
- Mathematical algorithms combine with technology dose values to calculate exposure.
- Integrates OEM, calibrated data and calculated data to assess exposure.
- Reports patient/visit summary, study level statistics, modality level statistics, e-mail alerts to ensure timely notification.
- Compatible with any vendor imaging technology.
RadTrac Helps Patients Avoid Medical Radiation Overdose with Radiation Dose Tracking

RadTrac uses a system that allows for mining of previous patient radiation exposure through patient records as well as a radiation dose tracking system that follows a patient through their time at a health care facility, building a database of radiation exposure to a particular patient.

Excess Medical Radiation – Radiation Exposure Limits

Through our ability to track radiation exposure we can prevent medical radiation overexposure by notifying a patient’s physician and the facility when levels become close to Radiation Exposure Limits.

RadTrac’s Radiation Dose Tracking System (RDTs) not only tracks a patient’s exposure to radiation, it also has a flagging system that is set to follow Radiation Exposure Limits. Once a patient becomes close to a radiation exposure level that is dangerous, that patient is flagged in the system. The flag must be reviewed by the facility or physician before a patient can be treated.

RDTs uses an algorithm to assign a risk factor. That risk factor will be assigned as follows:

- **GREEN**: The patient has had no diagnostic radiation exposure within the last year.
- **YELLOW**: The patient has had moderate diagnostic radiation exposure within the last year and would need a physician’s approval for further diagnostic radiation dosing. OR the patient has had minimal to moderate diagnostic radiation exposure within the last year, but the order for the particular imaging study will increase exposure above recommended limits.
- **RED**: The patient has had moderate to heavy amounts of diagnostic radiation exposure and the ordered diagnostic imaging study will increase the patient’s radiation exposure above the recommended limits.
Questions?