

UNDUE EXPOSURE TO RADIATION



UNDUE RADIATION EXPOSURE *CHANGE PACKAGE*



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How to Use this Change Package

This change package is intended for hospitals participating in the Hospital Improvement Innovation Network (HIIN) project led by the Centers for Medicare & Medicaid Services (CMS) and Partnership for Patients (PPF); it is meant to be a tool to help you make patient care safer and improve care transitions. This change package is a summary of themes from the successful practices of high performing health organizations across the country. It was developed through clinical practice sharing, organization site visits and subject matter expert contributions. This change package includes a menu of strategies, change concepts, and specific actionable items that any hospital can implement based on need or for purposes of improving patient quality of life and care. This change package is intended to be complementary to literature reviews and other evidence-based tools and resources.

PART 1: ADVERSE EVENT AREA (AEA) DEFINITION AND SCOPE

Medical uses of ionizing radiation, such as X-ray diagnostics, interventional radiology, nuclear medicine, and radiotherapy, can provide significant health benefits for many patients. However, improperly applied or elevated doses of radiation in diagnosis and treatment can result in well-documented side effects and negative outcomes, including DNA damage. Unfortunately, even small radiation doses may carry a risk of deleterious effects.¹ Exposure to ionizing radiation may increase a person's lifetime risk of developing cancer.²

This revised Undue Exposure to Radiation Change Package published by HRET acknowledges the evolution of science and the following key revisions:

The 2018 updates to the Undue Exposure to Radiation Change Package include expanded resources to support establishing a Radiation Safety Officer (RSO) role in your organization, as well as enhanced Computerized Tomography (CT) dose reduction change ideas.

New resources to support your work in reducing undue exposure to radiation include:

- > Image Wisely website.
- > New Jersey HIIN Safe Imaging toolkit.
- > Washington State HIIN Safe Imaging Toolkit: 100K Children Campaign.
- > American College of Radiology (ACR) and American Association of Physicists in Medicine Radiation (AAPMR) Safety Officer Resources.
- > United States Nuclear Regulatory Commission Radiation Safety Officer (RSO) Qualifications.
- > ACR guidance for when routine chest x-rays are generally not appropriate.
- > Pulmonary Embolism Rule Out Criteria (PERC) to reduce use of CT.
- > Mayo Clinic Pediatric Head CT Clinical Decision Tool for educating parents about risks and benefits of head CT.

Magnitude of the Problem and Why this Matters

The science of medicine has evolved from simple visual observation to the use of technology to help diagnose and monitor patients. Diagnostic radiology, nuclear medicine, and radiation therapy have become routine diagnostic and therapeutic tools in the fight to identify, and eradicate disease.³ However, radiation used for early disease detection, more effective diagnosis, and improved monitoring of therapy may also be harmful. Many interventions using ionizing radiation are performed by clinicians who have minimal or no training in radiation effects and safety. Unnecessary and preventable injuries to patients and staff may result. Additionally, most patients are not counseled on the risks of radiation, nor receive appropriate follow-up to detect if an injury has occurred.⁴

The variety and complexity of human conditions make it difficult to predict with certainty a specific patient's response to radiation. However, recommendations from research and evidence-based practice suggest that optimized and effective doses of radiation were successful in achieving specific outcomes in diagnosis and therapy. In March 2009, the National Council on Radiation Protection and Measurements (NCRP) reported that patients' exposure to radiation has nearly doubled over the previous 20 years.⁵ Questions continue to be raised about the risks associated with exposure to radiation from medical imaging. Because ionizing radiation can cause damage to DNA, repeated exposures may increase an individual's lifetime risk of developing cancer. Although the risk to a patient from a single exam may not be great, multiple exams can significantly increase the chances of morbidity. Additionally, with millions of ionizing radiation examinations performed in the U.S. every year, the negative impact of radiation overuse is becoming a public health issue.

> HIIN Reduction Goals:

- Reduce the incidence of harm due to radiation by 20 percent by September 27, 2018.



PART 2: MEASUREMENT

A key component to making patient care safer in your hospital is to track your progress toward improvement. This section outlines the nationally recognized process and outcome measures that you will be collecting and submitting data as part of HRET HIIN. Collecting these monthly data points at your hospital will guide your quality improvement efforts as part of the Plan-Do-Study-Act (PDSA) process. Tracking your data in this manner will provide valuable information needed to study your data across time and help determine the effect your improvement strategies are having in your hospital at reducing patient harm. Furthermore, collecting these standardized metrics will allow the HRET HIIN to aggregate, analyze, and report its progress toward reaching the project's goal to to reduce all-cause inpatient harm by 20 percent and readmissions by 12 percent by September 2018.

Nationally Recognized Measures: Process and Outcome

> Suggested Process Measures:

- Determine procedural justification for diagnostic radiology, nuclear medicine procedures, or radiation therapy.
- Document doses for all diagnostic radiology, CT scans, or nuclear medicine.
- Document evidence of the use of a pediatric-radiation protocol or checklist.
- Establish pediatric patient abdominal, head, and thorax diagnostic reference levels (DRLs).
- Scan parameters for all CT scanners in the hospital.

PART 3: APPROACHING YOUR AEA

Suggested Resources and Toolkits

- > Imaging Wisely. Website: <https://www.imagewisely.org>.
- > New Jersey J HIIN Safe CT Imaging Toolkit Toolkit. Website: <http://www.hret-hiin.org/resources/display/nj-hiin-safe-ct-imaging-toolkit>.
- > Washington State HIIN Safe Imaging Toolkit: 100K Children Campaign. Website: <http://www.hret-hiin.org/resources/display/safe-imaging-toolkit-100k-children-campaign>.
- > ACR-AAPM Radiation Safety Officer Resources. Website: <https://www.acr.org/Search-Results#q=Radiation%20Safety%20Officer%20Resources>.
- > ACR Appropriateness Criteria. Retrieved at: <http://www.acr.org/Quality-Safety/Appropriateness-Criteria>.
- > Diagnostic Radiology: Radiography Practice Parameters and Technical Standards. Retrieved at: <http://www.acr.org/Quality-Safety/Standards-Guidelines/Practice-Guidelines-by-Modality/Radiography>.
- > EPA Radiation Protection Document Library. Retrieved at: <http://www.epa.gov/radiation/federal/fgr-14.html>.
- > Choosing Wisely Campaign. Website: <http://www.choosingwisely.org/>.
- > Image Gently. Website: <http://www.imagegently.org/>.
- > RadiologyInfo.org for Patients. Website: <http://www.radiologyinfo.org/>.
- > For other key tools and resources related to preventing and reducing undue exposure to radiation, visit www.hret-hiin.org.

Investigate Your Problem and Implement Best Practices

DRIVER DIAGRAMS: A driver diagram visually demonstrates the causal relationship between your change ideas, secondary drivers, primary drivers, and your overall aim. A description of each of these components is outlined in the table below. This change package reviews the components of the driver diagram to help you and your care team identify potential change ideas to implement at your facility and to show how this quality improvement tool can be used by your team to tackle new process problems.

AIM	PRIMARY DRIVER	SECONDARY DRIVER	Change Idea
		SECONDARY DRIVER	Change Idea
	PRIMARY DRIVER	SECONDARY DRIVER	Change Idea

AIM: A clearly articulated goal or objective describing the desired outcome. It should be specific, measurable, and time-bound.

PRIMARY DRIVER: System components or factors that contribute directly to achieving the aim.

SECONDARY DRIVER: Action, interventions, or lower-level components necessary to achieve the primary driver.

CHANGE IDEAS: Specific change ideas which will support or achieve the secondary driver.

Drivers in This Change Package

PREVENT UNDUER RADIATION	CREATE AWARENESS	DEVELOP EDUCATIONAL MATERIALS ON RADIATION SAFETY	Change Idea
	MANAGE THE DOSE	DEVELOP PROCESS TO COLLECT, STORE, AND ANALYZE PATIENT DOSIMETRY DATA	Change Idea
		EVALUATE EQUIPMENT PERFORMANCE	Change Idea
		IMPLEMENT PEDIATRIC PROTOCOLS	Change Idea
		MINIMIZE THE DOSE	Change Idea
		ENSURE PROPER UTILIZATION	DEVELOP THE ROLE OF RADIATION SAFETY OFFICER
	ENSURE PROPER UTILIZATION	DISSEMINATE BEST PRACTICES AND GUIDELINES THAT ARE SUPPORTED BY EVIDENCE	Change Idea
		HARD STOP SPECIFIC ORDER SETS TO REQUIRE DOCUMENTATION OF CLINICAL INDICATIONS	Change Idea
		MONITOR PERFORMANCE ON A REGULAR AND ONGOING BASIS	Change Idea
	AVOID THE "DON'TS"	DON'T ORDER DIAGNOSTIC STUDIES THAT HAVE NO PROVEN VALUE OR WILL NOT IMPACT THE COURSE OF TREATMENT	Change Idea
	PROTECT THE PATIENT	DEVELOP A SPECIFIC INFORMED CONSENT PROCESS FOR ALL EXAMS AND PROCEDURES	Change Idea
		EDUCATE PATIENTS AND THEIR FAMILIES ON RISKS	Change Idea

Primary Driver:

CREATE AWARENESS

Deficiencies in the awareness and understanding of radiation exposure risk by health care staff can adversely affect patient safety. Provider education about the risks of radiation exposure will help to improve clinical practice and reduce unnecessary radiation exposure.

Without understanding the risks of radiation overuse, physicians may order unnecessary imaging procedures (e.g., they may repeat a test instead of reviewing the results of tests already performed). Ordering physicians may be unaware of recommended criteria to guide their decisions about whether or not a particular imaging procedure is medically necessary or effective and may order high-risk imaging procedures without sufficient justification. The development and dissemination of guidelines by themselves are insufficient to alter long-standing clinical practices. To effectively reduce unnecessary radiation exposure, educational programs for all clinicians involved in the ordering process are necessary. These programs can update providers on the latest research about patient safety and test effectiveness, familiarize providers with the institution’s guidelines and recommendations, offer guidance on the specific roles of each provider, and outline resources and tools available to support decision making and mitigate perceived challenges.

Secondary Driver > DEVELOP RADIATION SAFETY EDUCATIONAL MATERIALS

A number of respected professional organizations, including the American College of Radiology (ACR) and the American College of Cardiology (ACC), have developed and are disseminating appropriateness criteria for medical imaging referral for a variety of medical conditions. Links to these helpful resources are noted in the References section and under Suggested Bundles and Toolkits listed on page 3.

Change Ideas

- > Provide education to build awareness about the risks associated with ionizing radiation with ordering providers, radiology technicians and technologists, ED staff and providers, nursing staff, and patients and families.
- > Provide ordering practitioners with resources that outline appropriate diagnostic imaging methods to address common clinical diagnostic and treatment issues.
- > Ask ordering practitioners to collaborate with a medical physicist to develop guidelines for a screening program that includes testing recommendations, testing efficacy analyses, and risk/benefit analyses.
- > Periodically assess practitioner knowledge and competency in this arena, and provide opportunities for educational updates.

Suggested Process Measures for Your Test of Change

- Percent of ordering practitioners who have completed a knowledge assessment.
- Gap analysis on the availability and use of diagnostic-imaging utilization and radiation-dosing guidelines.

Hardwire the Process

Regular education and assessments of performance are keys to successfully hardwiring awareness into an organization’s culture. Communicate the results of the ongoing assessments to relevant stakeholders in the organization, and provide the necessary education and training to improve performance. Include the knowledge assessment as part of ongoing professional practice evaluations for all ordering physicians.



Primary Driver:

MANAGE THE DOSE

Professional organizations, such as the ACR, the American Association of Physicists in Medicine (AAPM), and the National Council on Radiation Protection and Measurements, have endeavored to develop, with the support of the Federal Drug Administration (FDA), nationally established DRL for many imaging procedures.³ These DRLs can be used as benchmarks to compare a facility's practice as part of its radiation protection quality assurance program. If a national DRL is exceeded during any specific examination, the facility can investigate whether exposure can be reduced in the future without adversely affecting image quality. Additionally, ordering physicians may not have access to patients' medical imaging or radiation dose histories, records, or results. Without such information, physicians may reorder imaging procedures that had previously been performed, increasing patients' radiation exposure.

It is critical for health care facilities to develop systems to obtain and record accessible histories of imaging and radiation exposure for every patient admitted.

Secondary Driver > DEVELOP PROCESSES TO COLLECT, STORE, AND ANALYZE PATIENT DOSIMETRY DATA

A robust platform that facilitates radiation dose monitoring includes six major components: dose capture, effective dose conversion, patient-specific storage, dose analytics, dose communication, and data export.⁶

Change Ideas

- > Establish a system to record and retrieve CT radiation doses.
- > Review current process for radiology staff to verify various parameters: the right patient, right part, and right position. For CT scans, verification should also include technical set up parameters.
- > Adopt or create protocols that include how much radiation is expected to be exposed for each CT imaging exam. If the expected level is exceeded there should be process to promptly investigate.
- > Establish a process for routine review of actual performance compared to CT test standards.
- > Join the National Radiology Data Registry with the ACR.
- > Work with the equipment manufacturer for specific guidelines that will support dose optimization.

Suggested Process Measure for Your Test of Change

- Percent of exams (radiation therapy, nuclear medicine procedures, or radiation therapy) that have the dose of radiation documented.

Secondary Driver > EVALUATE EQUIPMENT PERFORMANCE

To ensure that radiographic and fluoroscopic equipment is functioning properly, the performance should be evaluated upon installation and monitored at least annually by a qualified medical physicist. Additional or more frequent monitoring may be necessary if repairs are conducted that might affect the imaging performance of the equipment and the radiation exposure of patients.⁷

Change Ideas

- > Launch a Radiation Safety Committee (RSC) that meets on a regular basis to develop guidelines based on the literature and research.
- > Ask the RSC to assess compliance with the standards and guidelines that are developed and implemented.
- > Ask the RSC to develop quality indicators (process, outcome, and balancing measures) for ongoing assessment.
- > Use technology to notify key staff in real time when alerts have been triggered.
- > Complete a performance evaluation of equipment and personnel at least annually and include an exposure analysis for patients and employees.

Suggested Process Measure for Your Test of Change

- Percent of equipment that is evaluated annually and evaluated after each repair that may affect performance.

Secondary Driver > MINIMIZE THE DOSE

One size does not fit all.¹² "As low as reasonably achievable" (ALARA) means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical.¹² This goal can be achieved by tailoring the examination to the age and condition of the patient, as well as by examining each radiograph as it is taken and terminating the procedure when a diagnosis is attained.

Change Ideas

- > Develop a platform to record and document radiation-dose information in the patient's health record.
- > Provide the patient with a patient medical imaging record card that contains documentation of the radiation exposure.
- > Develop a system to obtain a history of and to track previous examinations and procedures that have been performed in your facility and in other facilities.
- > Complete a critical analysis of your screening processes.

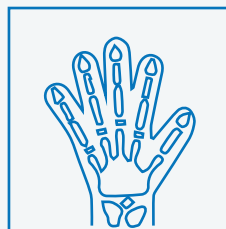
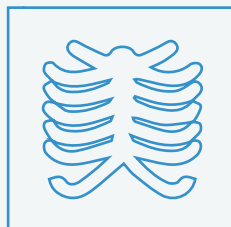
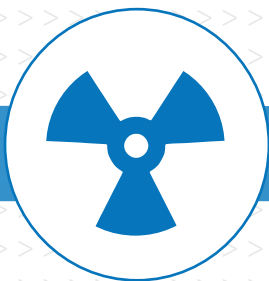
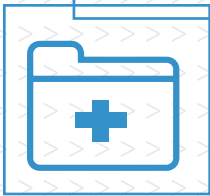
Suggested Process Measures for Your Test of Change

- > Percent of patients who received a patient medical imaging record card.
- > Percent of medical records that include documentation of the consideration of previous radiological procedures for specific patient populations (e.g., pediatrics) as recommended by your RSC.

Secondary Driver > IMPLEMENT PEDIATRIC PROTOCOLS

Change Ideas

- > Gather data on the number and ages of pediatric CT scans performed in ED and inpatient.
- > Use the pediatric CT protocols in the "image gently" resource to assist in the development of new protocols or to review the appropriateness of current protocols. Image gently lists three methods to provide child size radiation dosing: Create set up techniques for each scanner for all patients from newborn to adult (unless they have identical design, configuration, and software). (Image Gently) <http://www.imagegently.org/Procedures/Interventional-Radiology/Protocols>
- > Develop pediatric DRLs and have your technologists adjust techniques to achieve the desired DRL when the patient arrives.
- > Create technique charts or scanner embedded protocols for children depending on the frequency children are scanned in your department.
- > Provide education and specific strategies for technologists, physicists, and parents. Use resources available on imagegently.org.



Primary Driver:

ENSURE PROPER UTILIZATION

The Radiation Safety Committee (RSC), under the direction of the Radiation Safety Officer (RSO) is responsible for developing policies, processes, and procedures to ensure the capture, assessment, investigation, and monitoring of non-compliance with its guidelines and standards. Ionizing radiation-examination protocols should aim to recommend doses for each cohort of patients and type of examination as low as reasonably achievable (ALARA) to obtain adequate image quality.

Secondary Driver > DEVELOP THE ROLE OF RADIATION SAFETY OFFICER (RSO)

The RSO should implement a RSC to assist with quality improvement activities and to provide oversight to the RSO's responsibilities. To promote effective guideline development, performance management, and quality improvement, the RSC should be multidisciplinary. Members should be drawn from a breadth of relevant fields, including medicine, nursing, radiology, medical physics, and quality improvement.

Change Ideas

- > Identify subject matter experts within the organization to provide input and guidance.
- > Develop criteria for appropriate utilization of ionizing radiation for adults and children.
- > Use ACR-AAPM Radiation Safety Officer (RSO) Resources for guidance on RSO responsibilities, and for sample policies and forms for an X-ray Safety Program.
- > See the U.S. Nuclear Regulatory Commission for RSO Qualifications.

Secondary Driver > DISSEMINATE BEST PRACTICES AND GUIDELINES THAT ARE SUPPORTED BY EVIDENCE

To promote and enhance knowledge and awareness of best practices and provide initial and ongoing education on the recommended guidelines and processes. Members of the RSC and well-respected clinician champions can serve as effective educators in hospital meetings.

Change Ideas

- > Create and make accessible real time reference tools for ordering practitioners.
- > Provide the ordering practitioners with resources regarding appropriate diagnostic imaging methods at the time of ordering. These resources should help the provider address the clinical questions and optimize the dose of the procedure ordered.
- > Use PECARN guidelines for pediatric head injury guidelines for reducing unnecessary head CTs.
- > Use the Mayo Clinic's algorithm to reduce use of CT to diagnose appendicitis in children.

Suggested Process Measure for Your Test of Change

- Percent of ordering practitioners who are educated on recommended guidelines and processes.

Secondary Driver > HARD STOP SPECIFIC ORDER SETS TO REQUIRE DOCUMENTATION OF CLINICAL INDICATIONS

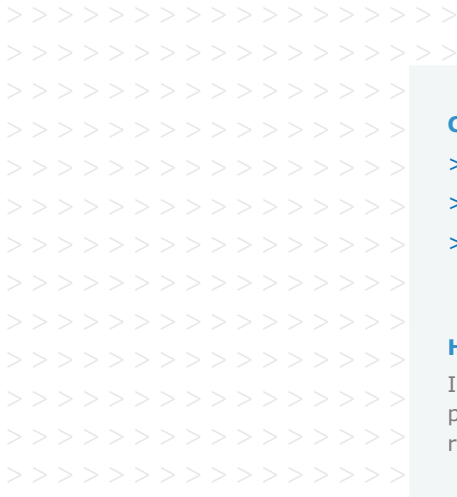
By utilizing "required fields," documentation of clinical indications and justifications for certain radiologic procedures can be monitored and evaluated to assess for appropriate ordering. The data collected on clinical indications and justifications provide valuable information that can be used for identifying both needed revisions to order sets or guidelines and training needs of practitioners. In addition to electronic hard stops, establish communication channels for radiologists to discuss the reason for the procedure and potential alternatives with the ordering provider.

Change Ideas

- > Use alerts to prompt reconsideration and justification for choices. Help providers "choose wisely."
- > Implement required fields for the documentation of indications and justification for certain high-dose radiologic procedures identified by the RSC.

Secondary Driver > MONITOR PERFORMANCE ON A REGULAR AND ONGOING BASIS

After the RSC develops standards and guidelines for ordering radiologic procedures, it should meet on a regular basis to review application of and compliance with these standards, as well as to make necessary revisions in guidelines and recommendations based on these assessments and analyses.



Change Ideas

- > Reassess and modify standard orders as necessary and appropriate.
- > Include physician radiation practices in Ongoing Professional Practice Evaluations (OPPE).
- > Conduct regular periodic assessments of ordering practices to assess alignment with established protocols to determine adherence. Track adherence by ordering practitioner or by location to identify trends.

Hardwire the Process

Implement hard stops. They are by nature a hardwiring technique. Require ordering physicians to use real time decision-making tools to ensure compliance with recommendations for limiting radiation exposure.

> Primary Driver:

AVOID THE "DON'TS"

The American College of Radiology recommends questioning certain diagnostic studies that have a tendency to be used in situations when they are not always helpful. The list's aim is to open discussion between patients and physicians about imaging test and reduce unnecessary tests.

Secondary Driver > DON'T ORDER DIAGNOSTIC STUDIES THAT HAVE NO PROVEN VALUE OR WILL NOT IMPACT THE COURSE OF TREATMENT

The American College of Radiology recommends five "don'ts" that physicians and patients should keep in mind:

1. Don't do imaging for uncomplicated headache.
 2. Don't image for suspected pulmonary embolism (PE) without moderate or high pre-test probability of PE.
 3. Avoid admission or preoperative chest x-rays for ambulatory patients with unremarkable history and physical exam.
 4. Don't do a CT for the evaluation of suspected appendicitis in children until after ultrasound has been considered as an option.
 5. Don't recommend follow-up imaging for clinically inconsequential adnexal cysts.¹¹
- Five new ACR Choosing Wisely recommendations were added to the "Don't" list in 2017. Two of the new recommendations pertain to abdominal CT protocol selection. The other three relate to recommendations radiologists should make to guide management of incidental findings.
6. Don't recommend ultrasound for incidental thyroid nodules found on CT, MRI or non-thyroid-focused neck ultrasound in low-risk patients unless the nodule meets age-based size criteria or has suspicious features.
 7. Don't use a protocol for abdominal CT that includes unenhanced CT followed by IV contrast-enhanced CT, except for the following indications: renal lesion characterization, hematuria work up, indeterminate adrenal nodule characterization, follow-up after endovascular stent repair, gastrointestinal hemorrhage, or characterizing a focal liver mass.
 8. Don't routinely use a protocol for abdominal CT that includes a delayed post-contrast phase after the venous phase, except for the following indications: renal lesion characterization, hematuria work up, CT urogram, indeterminate adrenal nodule characterization, hepatocellular carcinoma, and cholangiocarcinoma.
 9. Don't make the diagnosis of pelvic congestion syndrome on CT or MRI unless the patients meet clinical and imaging criteria.
 10. Don't routinely recommend follow-up for nonobstructed, asymptomatic, isolated, short-segment jejunojejunal intussusception in adults.

Change Ideas

- > Use the criteria for appropriate utilization of ionizing radiation to identify the procedures for which it will be necessary and advisable to institute hard stops (i.e., "choose wisely" reminders).
- > Develop and recommend alternate options to avoid frequent provider selection of procedures that trigger hard stops.
- > Use the Mayo Clinic's algorithm to reduce use of CT to diagnose appendicitis in children.
- > Remove routine chest x-rays from admission and pre-op order sets.



Change Ideas

- > Provide patients and families with access to information and tools that describe radiological procedures, risks, and alternatives.
- > Develop a process to educate patients and their families utilizing teach-back.
- > Utilize PECARN decision support tool to discuss benefits and risks of head CT for pediatric head trauma.
- > Provide patient dose tracking tools for those with chronic care needs.
- > Use teach-back method to ensure the patient or parent understood the reason for the test and the risk and benefits.
- > Provide patients with acute or chronic illness with a patient medical imaging record to track studies over time.
- > Provide information in written and verbal format. Use parent centered materials from imagegently.org and NJ HIIN Safe Imaging Toolkit.

Suggested Process Measure for Your Test of Change

- Percent of patients undergoing a diagnostic radiology, nuclear medicine, or radiation exam or procedure who did not receive educational materials.

Secondary Driver > MINIMIZE THE DOSE

One size does not fit all.¹² ALARA means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical.¹² This goal can be achieved by tailoring the examination to the age and condition of the patient, as well as by examining each radiograph as it is taken and terminating the procedure when a diagnosis is attained.

Change Ideas

- > Develop a platform to record and document radiation-dose information in the patient’s health record.
- > Provide the patient with a patient medical imaging record card that contains documentation of the radiation exposure.
- > Develop a system to obtain a history and to track previous examinations and procedures that have been performed in your facility and in other facilities.
- > Complete a critical analysis of your screening processes.

Suggested Process Measures for Your Test of Change

- Percent of patients who received a patient medical imaging record card.
- Percent of medical records that include documentation of the consideration of previous radiological procedures for specific patient populations (e.g., pediatrics) as recommended by your RSC.

PDSA In Action | Tips on How to Use the Model for Improvement

IMPLEMENT SMALL TESTS OF CHANGE		Test of Change Example
PLAN	Assemble a team (radiologist, ordering practitioner, radiology technologist, nurse, and educator) to review current practices and patient education materials. As a group, develop patient education materials to be given to patients and families.	
DO	Test the education materials with one physician and one patient.	
STUDY	Solicit feedback from both the physician and patient or family member. Use teach-back to validate the educational materials.	
ACT	Revise the educational materials as recommended. Test again with another physician and patient.	

Potential Barriers

- > Recognize that for many physicians, evolving technology will demand changes in their practice. The use of alerts, hard stops, and decision support tools may be unsettling for many providers. Some practitioners may perceive that they may be losing control or believe they are being told how to practice medicine. To help engage physicians in the use of technology, recruit one or two early adopting physicians champions to serve as peer "extension agents" to help spread best practices to peers.
- > Technology use requires a learning curve; different practitioners will adapt to new technologies and processes at different rates. Provide adequate training, support, and encouragement for practitioners unfamiliar with new technologies and systems.
- > Physicians may resist using standard orders, believing these represent cookbook medicine. Educating physicians regarding the proven value of standard order sets in reducing unnecessary imaging can mitigate this resistance and increase adoption. Presenting options for customization of orders and allowing opt-outs for patients with special needs can promote acceptance.
- > There is a need to balance the convenience of the speed and accessibility of CT scanning with the risk of exposure to ionizing radiation. ED physicians may be faced with frantic parent who may demand a CT scan for a head trauma. By providing the PECARN parental decision support tool, risks, and benefits can be clearly communicated and help align parental wishes with clinical needs.

Enlist administrative leadership as sponsors to help remove or mitigate barriers

- > Administrative leadership can aid in the efforts to prevent undue radiation exposure by: clearly communicating to physicians and staff the importance and direction of the initiative; soliciting input from physicians, staff, and patients; providing access to educational materials (e.g., physician-communication modules)¹⁴; supplying the necessary real-time resources to physicians and staff; and instilling accountability with program monitoring and use of OPPE.

Change not only the practice but also the culture

- > Weighing the clinical need against the potential negative effects of diagnostic radiology, nuclear medicine, and radiation exams and procedures requires not only changes in practice but also a change in culture. The hardwiring suggestions provided in this document will accelerate the adoption, but successful implementation of these practices to prevent undue radiation exposure requires strong leadership commitment and buy-in from physicians and other staff.

PART 4: CONCLUSION AND ACTION PLANNING

Radiology tests that diagnose and treat medical conditions can also be harmful to patients through improperly applied or elevated doses of radiation, or through repeated exposure to small amounts of radiation. Exposure to ionizing radiation may increase a person's lifetime risk of developing cancer.³ Increasing awareness for both patients and providers of the risks, ensuring proper utilization of the technologies, managing and minimizing the radiation dose, involving the patient in decisions, and creating a patient-specific tracking system of tests and dosages will help to prevent undue radiation exposure. Physician and leadership support of the initiatives, as well as hardwiring techniques are essential to a successful implementation.

PART 5: APPENDICES

APPENDIX I: UNDUE RADIATION EXPOSURE TOP TEN CHECKLIST

Associated Hospital/Organization: HRET HIIN

Purpose of Tool: A checklist to assess current practices to prevent undue radiation exposure in your facility

Reference: www.hret-hiin.org

2018 Undue Radiation Exposure Top Ten Checklist

PROCESS CHANGE	IN PLACE	NOT DONE	WILL ADOPT	NOTES <i>(Responsible and By When?)</i>
1. Develop a process to collect, store, and analyze patient dosimetry data. Provide patients with tools to track their personal medical imaging history.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2. Establish the role of Radiation Safety Officer to lead a Radiation Safety Committee that is responsible for evaluating performance of equipment and establishing and monitoring adherence to dosing and utilization protocols.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3. Create and implement a "Don't" list of exams that have little proven value or do not change the course of treatment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4. Participate in the National Dose Index Registry.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5. Establish a process to engage patients and families in informed decision making in weighing risk and benefit of imaging studies, especially with children. Require informed consent for specific invasive studies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6. Eliminate routine ionizing-radiation orders (e.g., a daily chest x-ray).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7. Periodically reassess staff and practitioner knowledge about the risks/benefits of ionizing radiation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8. Develop educational materials about radiation safety to maintain awareness with ordering practitioners, radiation technologists and technicians, ED staff and providers, nursing staff, and patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9. Utilize pediatric CT protocols that are specific to each scanners specifications.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10. Review current process for radiology staff to verify various parameters: the right patient, right part, right position. For CT scans, verification should also include technical set up parameters.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

APPENDIX II: EXAMPLES OF RADIOLOGY DECISION-SUPPORT SYSTEMS

Associated Hospital/Organization: Multiple hospitals/associations

Purpose of Tool: A non-exhaustive list of cloud-based reference tools available to patients, radiologists, radiology technologists, and ordering physicians

Reference: see below

Reference tools:

1. Radiation Passport (iOS – Cost): An education/tracking tool for patients.
Retrieved at: www.tidalpool.ca/radiationpassport/
2. iCat Medical Software (iOS – Cost): Reference tools for radiologists and other health care providers.
Retrieved at: www.icatsoftware.co.uk/
3. Radiology Toolbox (iOS – Free): Radiologist’s reference tool/calculator.
Retrieved at: <http://itunes.apple.com/us/app/radiology-toolbox/id415176373?mt=8>
4. RadX Mobile (iOS –Cost): Radiology technologist’s mobile positioning guide.
Retrieved at: <https://itunes.apple.com/us/app/radx-mobile/id375114750?mt=8>
5. Radiographic Calculator (iOS – Cost): Calculator for radiology technologist.
<http://itunes.apple.com/us/app/radiographic-calculator/id427543626?mt=8>
6. Appropriate Use Criteria (AUC) for Cardiac Radionuclide Imaging (iOS–Free): Reference tool for ordering physicians. <https://itunes.apple.com/us/app/appropriate-use-criteria-auc/id391068250?mt=8>

PART 6: REFERENCES

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15. Why Doctors Order Too Many Tests (It's Not Just to Avoid Lawsuits), *Time Magazine*, February 25, 2011.

