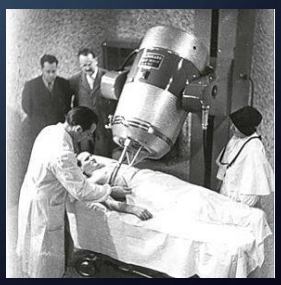
ADVANCES IN DIAGNOSTIC MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY

2019-2020 FCDS EDUCATIONAL WEBCAST SERIES

DECEMBER 19, 2019

STEVEN PEACE, CTR



CDC & FLORIDA DOH ATTRIBUTION

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FCDS would also like to acknowledge the Florida Department of Health for its support of the Florida Cancer Data System, including the development, printing and distribution of materials for the 2019 FCDS Annual Conference and the 2019-2020 FCDS Webcast Series under state contract CODJU. The findings and conclusions in this series are those of the author(s) and do not necessarily represent the official position of the Florida Department of Health.

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FLCCSC LMS – CEU QUIZ –FCDS IDEA

- Attendees must take and pass a 3-5 question CEU Quiz to get CEUs
- CEU Awards are Restricted to Attendees with a FLccSC LMS Account
- The CEU Quiz will be posted to FLccSC 1-2 hours after the webcast ends

- Only registered FLccSC Users will be given access to the CEU Quiz
- Florida attendees must have a Florida FLccSC Account to take the Quiz
- South Carolina attendees must have a South Carolina FLccSC Account
- New FLccSC States will follow similar instructions for the CEU Quiz

- Attendees can attend any of the live webcasts without receiving CEUs
- Recorded Sessions are also available for non-FLccSC Users – No CEUs

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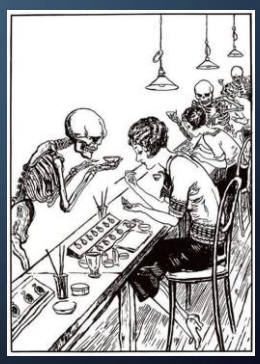
PRESENTATION OUTLINE

- Introduction to Medical Imaging and Therapeutic Radiology
- Progress in Diagnostic and Therapeutic Imaging Studies – Film to Digital
- Imaging Informatics – PACS / DICOM / Advanced Technology / CAD
- Imaging Equipment and Devices by Manufacturer/Maker
- So Many Types of Medical Imaging Studies
  - Imaging for Cancer Screening
  - Imaging to Confirm A Cancer Diagnosis
  - Imaging in Cancer Staging Workup
  - Treatment Planning and Simulation
  - Interventional Radiology – Ablation or Embolization
  - Radiological Therapeutics – Technique or Modality
- CoC STORE Definition for a Phase of Radiation
- Ambiguous Terms, Neoplasm Terms, DX Confirmation and Date of Diagnosis
- Documentation of Imaging Studies and Results
- Questions



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INTRODUCTION
MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY

- We focus a lot of training and QC on pathological tumor classification and cancer staging.
- We spend a lot less time providing training or technology updates for what has evolved into one of the most important tools in the multi-disciplinary toolbox – medical imaging.
- **Technological Advances since the 1980s** have made medical imaging increasingly more precise and reliable as a screening tool, diagnostic tool and in therapeutic radiology as well.
- These advances are **why we don't see as extensive surgical resections** with lymphadenectomies and the intent to cure with surgery alone…and have **moved to a multi-modality and multi-disciplinary team approach to cancer care that we did not have back in the early 1980s**.
- Radiologists can now do much of what surgeons used to do for pre-surgical cancer staging – without cutting into the patient to do it - imaging has come a very long way in a relatively short amount of time.

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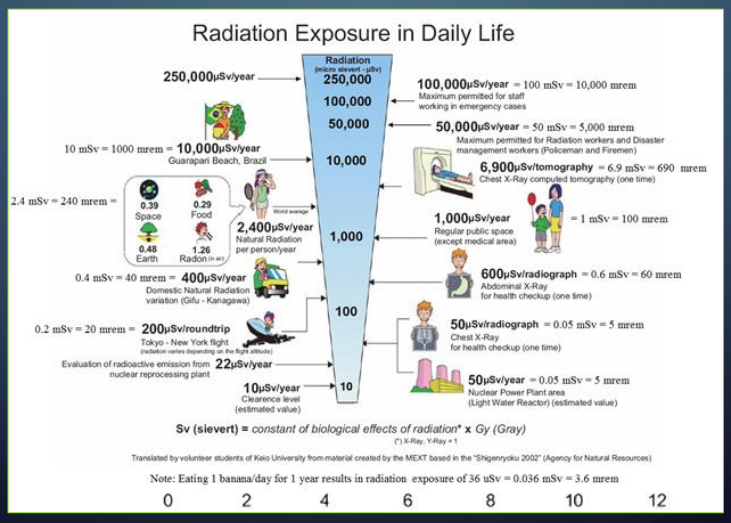
INTRODUCTION
MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY



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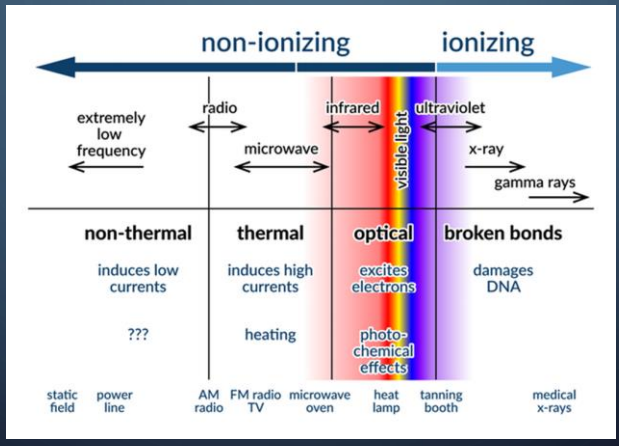
MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY



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INTRODUCTION
MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY

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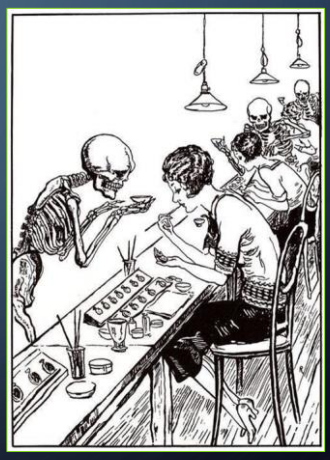
MEDICAL IMAGING AND THERAPEUTIC RADIOLOGY



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WHAT IS MEDICAL IMAGING?

- The set of equipment and techniques that produce images of the internal aspect of the body.
- Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues (physiology) – depending on the type of imaging performed .
- Medical imaging reveals internal structures hidden by the skin and bones
- Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities and to diagnose and even treat disease.
- Plain Film X-ray is the oldest and most frequently used form of medical imaging having been utilized since the early 1900s to detect and diagnose health issues.
- With the continuous and rapid advancement of medical and information technology, traditional X-rays have evolved into digital X-rays and serial imaging that can be reconstructed in 3D images.
- Modern digital type of medical imaging has a variety of benefits compared to the traditional X-ray.

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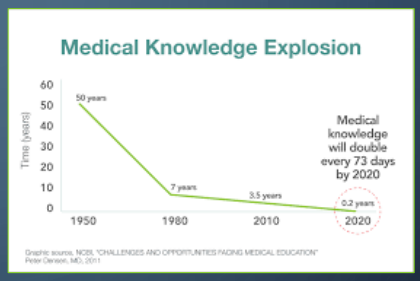
PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

- Diagnostic Radiology
- Clinical Cancer Workup
- Interventional Radiology
- Radiological Therapeutics
- Digital Revolution in Medicine



- Medical Imaging has much to do with generation of machine being used and whether or not the imaging requires plain film or if it is digital – but, we don't emphasize this in training
- Radiation as treatment has more to do with generation of machines being used, also
- Protocol Driven for Screening, Diagnostic Workup and Treatment Planning
- Attempts to Crosswalk Old Radiation to New Radiation and why it was a problem

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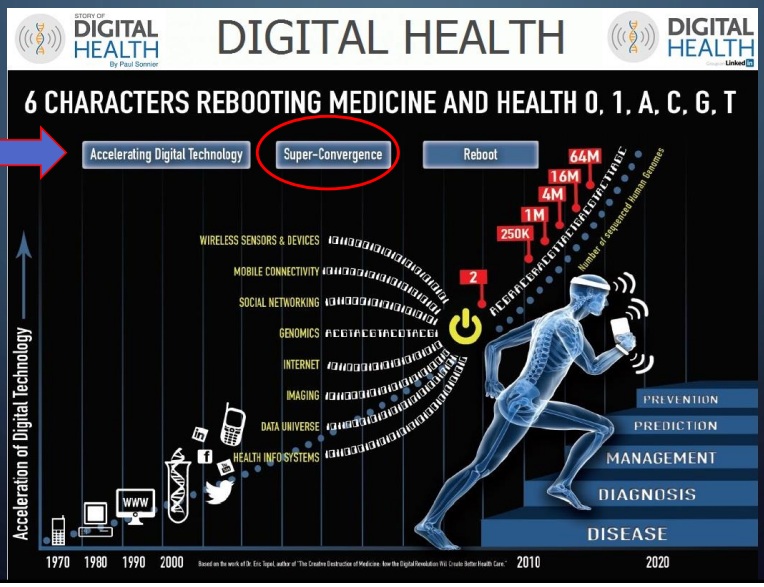

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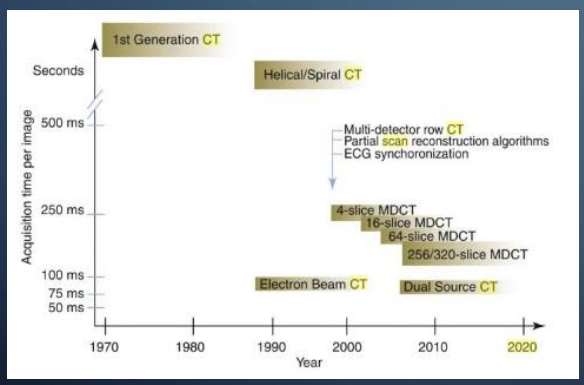

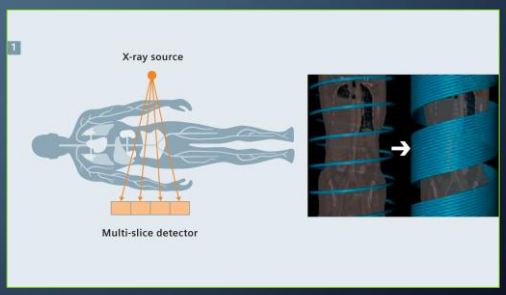

https://www.siemens-healthineers.com/en-in/computed-tomography/news/mso-back-to-the-future.html

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PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

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PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

- Traditional plain film X-rays remain an important tool for the diagnosis of many disorders.
- A beam of X-rays, produced by an X-ray generator, is transmitted through an object - the part of the body to be scanned.
- The X-rays are absorbed by the material they pass through in differing amounts depending on the density and composition of the material.
- X-rays that are not absorbed pass through the object and are recorded on X-ray sensitive film
- So, solid bones and organs are seen as defined white areas and darker areas are soft tissue or air
- Traditionally, medical X-ray images were exposed onto photographic film, which require film processing and printing before they can be viewed
- It takes time to process the film and film takes up a lot of space in hospitals and doctor offices.

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PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

- Digital Imaging is similar to a digital camera, where an electronic detector is used instead of film.
- This “electronic image” is processed by a computer, enabling it to be stored digitally, manipulated (enlarged or change angle, etc.) and viewed on screen immediately without processing.
- Computed Radiography (CR) was the first available digital technology for projection radiography.
- CR uses a photo-stimulable detector, which replaces the traditional screen-film cassettes
- Both Types – Plain Film and Digital Imaging use ionizing radiation.
- The ionizing radiation used in the production of X-ray images is carcinogenic and continuous exposure to these rays over time may cause damage to the body and increase the risk of cancer.
- CT uses computer processing to generate 3D-images from multiple projection radiographs
- A CT scan usually requires a higher radiation exposure dose than a conventional radiography examination. However, a CT scan delivers more detailed information.

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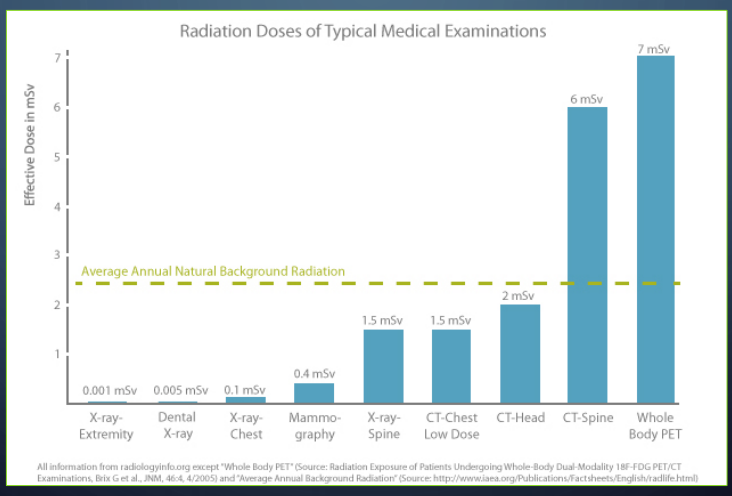
ADVANTAGES OF DIGITAL X-RAY OVER TRADITIONAL X-RAY

- Patient is Exposed to Less Radiation. Medical studies have revealed that a digital X-ray produces 80 percent less radiation than a traditional X-ray. While many consider traditional X-ray's minimal radiation exposure safe, a digital X-ray is found to be even safer.
- Digital Imaging is More Cost Effective and Efficient. Digital X-ray technology is easily available and offered at a low cost to medical institutions.
  - The cost effectiveness of a digital X-ray versus a traditional one is due to the fact that film is costly. It is not only expensive to purchase, but also costs to be developed.
  - Efficiency - with a digital X-ray, there is no need to spend time developing the image as it can produce and display an image in as little as three seconds.
  - Software gives the radiologist opportunity to change the angle, scope, size, details of image
  - Cost, efficiency, speed and software continue to improve as digital technology advances 19

ADVANTAGES OF DIGITAL X-RAY OVER TRADITIONAL X-RAY



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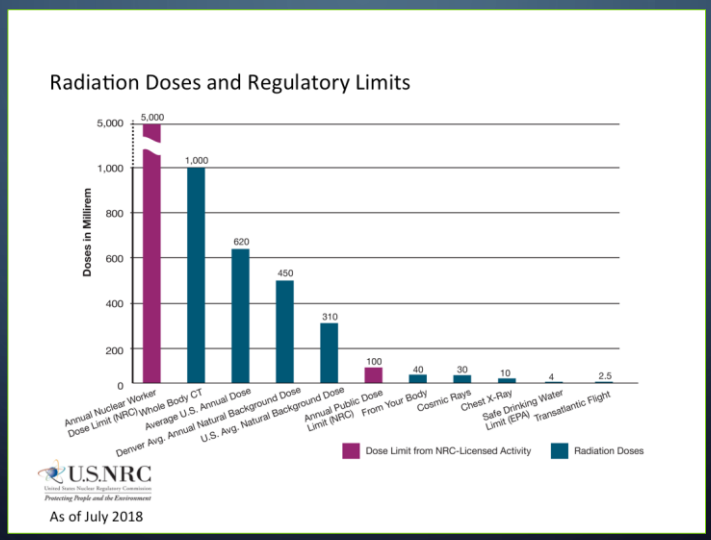
ADVANTAGES OF DIGITAL X-RAY OVER TRADITIONAL X-RAY



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OTHER ADVANTAGES OF DIGITAL X-RAY OVER TRADITIONAL X-RAY

- Other benefits of digital radiography is that storage space is unlimited as you can simply transfer digital images onto a hard drive for convenient access in the future.
- Film is difficult to store and maintain as images degrade over time.
- However with digital X-rays, the image does not lose its quality.
- No loss of fidelity, color degradation, clarity, detail, etc.
- Digital images can also be easily resized to a larger image without any distortion or loss of quality. For medical providers, this means an easier, more accurate diagnosis process.
- Digital technology is considered more environmental friendly than traditional technology.
- A digital X-ray does not require chemicals or film paper that is disposed into the environment as a traditional X-ray does.
- The greatest advantage is improvement in clarity and detail from film to digital and then image sectioning to finer and finer distance between images allowing computer to produce better image

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PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

- Computed tomography (CT) scanners have been available since the mid-1970s and have revolutionized medical imaging.
- CT scans provide far more detailed images than conventional X-ray imaging, especially in the case of blood vessels and soft tissue such as internal organs and muscles.
- The most prominent part of a CT scanner is the gantry – a circular, rotating frame with an X-ray tube mounted on one side and a detector on the opposite side.
- A fan-shaped beam of X-rays is created as the rotating frame spins the X-ray tube and detector around the patient.
- As the scanner rotates, several thousand sectional views of the patient's body are generated in one rotation, which result in reconstructed cross-sectional images of the body.
- These data are used to create a 3D visualization and views from different angles

PROGRESS IN DIAGNOSTIC AND THERAPEUTIC IMAGING STUDIES – FILM TO DIGITAL TO AI

- Molecular imaging is a relatively new discipline that allows the biological processes taking place in the body to be viewed at a cellular and molecular level.
- Most molecular imaging procedures are carried out with a PET or SPECT imaging device.
- A very small amount of a radioactive substance, called a radiopharmaceutical, is usually injected into the patient's bloodstream prior to the scan.
- Depending on the part of the body being targeted, different radiopharmaceuticals are used.
- Radioactive or Non-Radioactive - Gallium Citrate, Technetium, Sodium Iodide, Fluoride or Chromate, Gadolinium, etc. And, have been marketed as products like OncoScint or NeutroSpec.
- These radiopharmaceuticals attach themselves to the target organ or specific cells and are detected by the imaging device, which shows how they are distributed in the body.
- This distribution pattern helps doctors understand how well the organs and tissues are functioning.

IMAGING INFORMATICS – PACS / DICOM / ADVANCED TECHNOLOGY / CAD

Medical Imaging Standards for Software and Dx/Tx Modalities

- Medical Imaging Informatics – InfoRAD
  - PACS – Picture Archiving and Communications System that provides storage and access to images from multiple types of imaging machines and makers
  - DICOM - Digital Imaging and Communications in Medicine – International Standard is used globally to store, exchange, and transmit medical images.
  - DICOM enables the integration of medical imaging from multiple manufacturers
  - The DICOM Standard incorporates protocols for imaging techniques such as radiography, computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, and radiation therapy
  - SIIM – Imaging Informatics in Medicine

DICOM® Digital Imaging and Communications in Medicine

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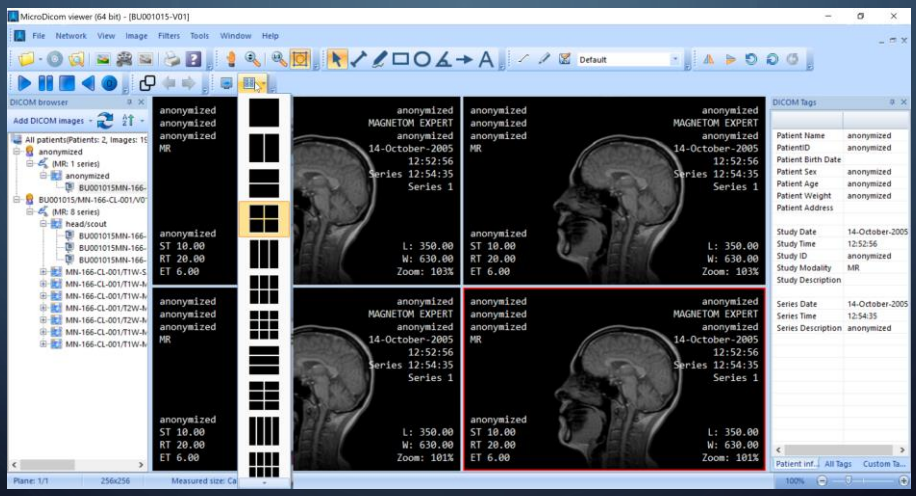
IMAGING INFORMATICS – PACS / DICOM / ADVANCED TECHNOLOGY / CAD



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IMAGING INFORMATICS – PACS / DICOM / ADVANCED TECHNOLOGY / CAD

Computer Assisted/Aided Diagnostics or CAD

- Imaging techniques in X-ray, MRI, and ultrasound diagnostics yield a great deal of information that the radiologist or other medical professional has to analyze and evaluate comprehensively in a short time. CAD systems process digital images for typical appearances and to highlight conspicuous sections, such as possible diseases, in order to offer input to support a decision taken by the professional.
- **CAD combines elements of artificial intelligence and computer vision with radiological and pathology image processing to evaluate conspicuous structures.**
- CAD examines tumor size, shape, texture, location, edges, smoothness, roundness, micro calcifications, nearby structures and other factors and compares them to other images and diagnoses held in the CAD database to look for similarities and differences to other tumors.
- CAS is an artificial intelligence database management system that grows each time a new tumor is added and new characteristics are identified – lung, breast, brain, colon, etc.

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WHAT DOES MEDICAL IMAGING INCLUDE

- So Many Types and uses for Medical Imaging Studies
  - Imaging for Cancer Screening
  - Imaging to Confirm A Cancer Diagnosis
  - Imaging in Cancer Staging Workup
  - Treatment Planning and Simulation
  - Interventional Radiology – Ablation or Embolization
  - Radiological Therapeutics – Technique or Modality

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WHAT DOES IMAGING INCLUDE

- Projection Radiography or X-ray
- Mammography 2D or 3D
  - Film or Digital
- Fluoroscopy
- Magnetic Resonance Imaging
- Nuclear Medicine
  - Thyroid Scan
  - MUGA Scan
  - Gallium Scan
  - Bone Scan
  - PET Scan (positron emission tomography)
  - Scintography or SCINT
  - SPECT (single photon emission computed tomography) or SPECT-CT
- Hybrid Imaging - PET-CT or PET-MRI

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WHAT DOES MEDICAL IMAGING INCLUDE

- Ultrasound Scan – endoscopic, endobronchial, other
- Elastography
- Photoacoustic Imaging
- Tomography – imaging by sections or sectioning
  - CT Scan
  - PET
  - PET-CT - Hybrid Imaging
  - PET-MRI – Hybrid Imaging
  - SPECT
  - Echocardiography – a type of ultrasound
  - Functional Near-Infrared Spectroscopy or FNIR/NIRS
  - Magnetic Particle Imaging – MPI Thermography
- Radiation-Sensitizing Agents and Radiation Therapy
- Image-Guided Biopsy
- Image-Guided Treatment – ablation and embolization

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MEDICAL IMAGING FOR CANCER SCREENING

- Cancer Screening aims to detect cancer before symptoms appear. This may involve blood tests, urine tests, DNA tests other tests, or medical imaging. The benefits of screening in terms of cancer prevention, early detection and treatment must be weighed against harms
- Diagnostic Imaging is used after suspicious results on a screening study or after some signs of cancer alert the physician to check the tissue to see if cancer is present
- Imaging for Cancer Screening – balancing radiation dose with outcomes & cost
  - Breast – clinical exam, mammography (film, digital, 2D or 3D, 3D tomosynthesis), MRI
  - Lung – low dose spiral/helical CT scan
  - Virtual Colonoscopy - a low dose CT Exam of the colon
  - Prostate – ultrasound usually accompanied by biopsy when risk noted
- CAD (computer-aided diagnostics software) in cancer screening medical imaging stuides
- Ultrasound – poor screening tool for most cancer sites due to multiple limitations
- PET or PET/CT – poor screening tool - may do more harm than good

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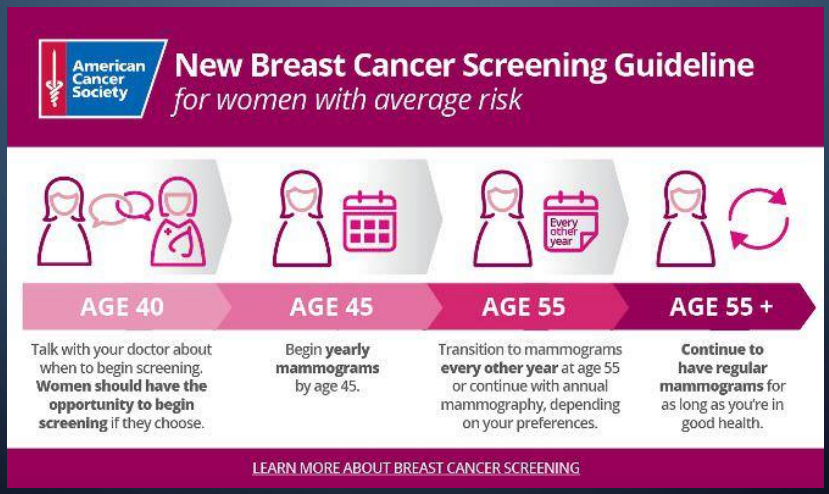
SCREENING MAMMOGRAPHY



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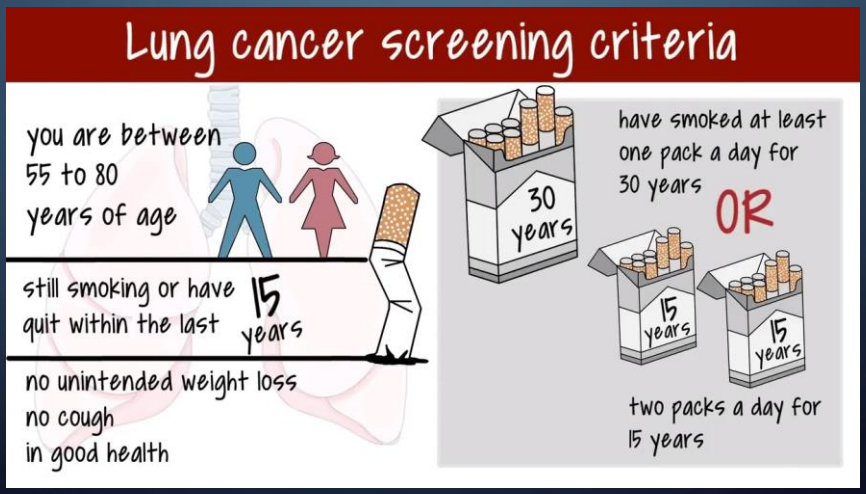
LOW DOSE HELICAL CT SCAN – LUNG CANCER



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LOW DOSE HELICAL CT SCAN – LUNG CANCER

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IMAGING MAY NOT BE FOLLOWED BY SURGERY

- Cancer Diagnostic Imaging
- Brain and CNS – MRI and CT or Functional Imaging (PET, SPECT)
  - Tumor Type and WHO Grade can be identified for some tumors
  - Patient age, neurological symptoms, tumor location and image characteristics – Meningioma, Glioblastoma, Atypical Teratoid Rhabdoid Tumor, Metastasis versus Primary - sufficient to develop treatment plan that may not be surgery
- Kidney – Dedicated Renal CT – can detect and stage renal cell carcinoma
  - MRI, Ultrasound, Angiography for workup – but start with CT of Kidneys
  - Small Tumors under 5cm may not have any treatment unless symptomatic
- Lung - Four trials reported results of LDCT screening among patients with smoking exposure. One large good-quality trial reported that screening was associated with significant reductions in lung cancer (20%) and all-cause (6.7%) mortality.
- EUS and/or MRI – endoscopic ultrasound and MRI for pancreatic cancer screening

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TREATMENT PLANNING AND SIMULATION


JOP. Journal of the Pancreas

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Pancreatic Cancer Imaging: The New Role of Endoscopic Ultrasound

Claudio De Angelis[1], Alessandro Repici[2], Patrizia Carucci[1], Mauro Bruno[1], Matteo Goss[1], Lavinia Mezzabotta[1], Rinaldo Pellicano[1], Giorgio Saracco[1], Mario Rizzetto[1]

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TREATMENT PLANNING AND SIMULATION

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https://med.emory.edu/departments/emergency-medicine/sections/ultrasound/image-of-the-fortnight/abdominal/mickey_mouse1.html

VIRTUAL COLONOSCOPY

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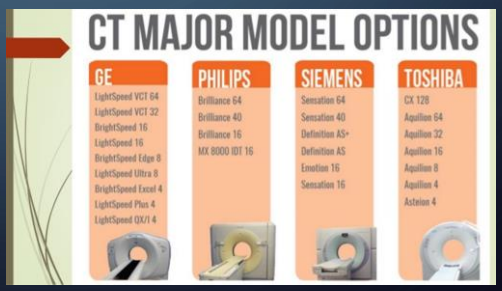
EQUIPMENT MANUFACTURERS

- IMAGING EQUIPMENT
  - Fujifilm
  - GE Healthcare
  - Hitachi Medical
  - Phillips Healthcare
  - Siemens Healthcare
  - Toshiba Medical Systems
  - Samsung Medison
  - Shimadzu
  - AGFA HelathCare
  - Carestream Health
- THERAPEUTIC EQUIPMENT
  - C.R. Bard
  - Elekta
  - IBA Worldwide
  - Varian Medical Systems
  - Accuray



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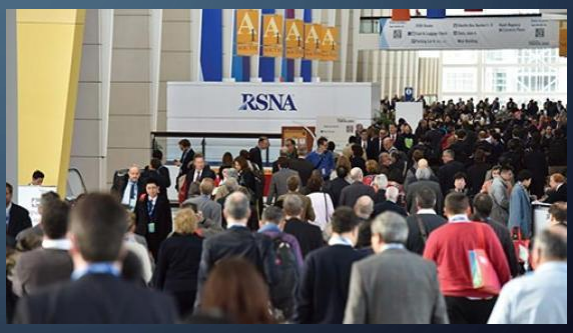
RSNA ANNUAL CONFERENCE

Radiological Society of North America – RSNA

McCormick Place, Chicago



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RSNA ANNUAL CONFERENCE

Radiological Society of North America – RSNA

McCormick Place, Chicago

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INTERVENTIONAL RADIOLOGY

- **Tumor Ablation – radiofrequency ablation, microwave ablation**
  - Ablation is the treatment of and removal of a part of biological tissue (primary tumor), traditionally by surgery but more recently using a wide variety of techniques, the newest of which is to use a catheter to target the tumor for ablation which improves outcome and reduces effects on surrounding tissues.
  - Tumor ablation is minimally invasive and used to treat tumors of the bladder, liver, kidney, bone, lung.
  - During tumor ablation, thermal energy (radiofrequency, cryoablation, laser, electrocautery, microwave, as source) is used to heat or cool tissue to cytotoxic levels (less than −40°C or more than 60°C).

- **Tumor Embolization - Y-90, radioactive beads or spheres, alcohol, TACE (chemo embolization)**
  - Tumor Embolization is the intentional blocking of an artery or vein to shut down the blood supply to a tumor reducing blood loss during resection.
  - Tumor Embolization is a procedure that can be performed prior to a planned surgical resection.
  - Tumors Embolization may be used to treat liver primary, liver metastasis, spinal tumors, some H&N

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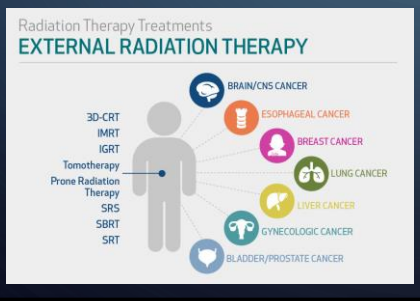
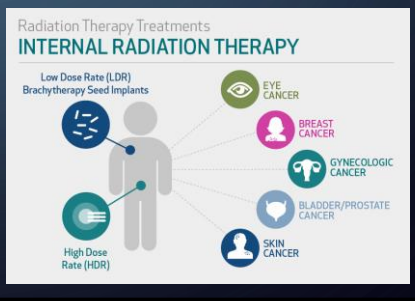
RADIOTHERAPEUTICS – RADIATION THERAPY

- Radiation Therapy Delivery - Techniques
  - External Beam Radiation – Gamma Rays, X-rays, Particle Beam (Proton, Neutron, Electron)
  - Internal Radiation Therapy – Brachytherapy
  - Systemic Radiation Therapy - Radioisotopes
- Dose, Volume, Number of Treatments (Fractionation & Total Dose)
- Radiation Therapy Delivery – Modality





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INTRODUCTION

- Radiation therapy uses high-energy particles or waves, such as x-rays, gamma rays, electron beams, or protons, to destroy or damage cancer cells.
- Your cells normally grow and divide to form new cells. But cancer cells grow and divide faster than most normal cells. Radiation works by making small breaks in the DNA inside cells. These breaks keep cancer cells from growing and dividing and cause them to die. Nearby normal cells can also be affected by radiation, but most recover and go back to working the way they should.
- Unlike chemotherapy, which usually exposes the whole body to cancer-fighting drugs, radiation therapy is usually a local treatment. In most cases, it's aimed at and affects only the part of the body being treated. Radiation treatment is planned to damage cancer cells, with as little harm as possible to nearby healthy cells.
- Some radiation treatments (systemic radiation therapy) use radioactive substances that are given in a vein or by mouth. Even though this type of radiation does travel throughout the body, the radioactive substance mostly collects in the area of the tumor, so there's little effect on the rest of the body.

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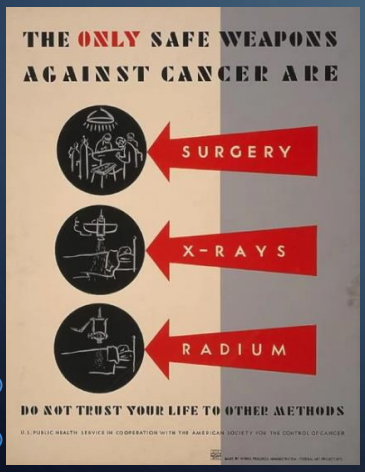
https://www.cancer.org/treatments/radiation/basics.html

BRIEF HISTORY OF RADIATION THERAPY



1895 – X-rays discovered - Roentgen
1898 – X-rays used to treat breast cancer
1898 – Radium rays discovered – Curie's
1901 – Roentgen won Nobel Prize in Physics
1910 – High energy x-rays treating deep cancers
1920 – Radioactive isotopes, new rays, new techniques
1920 – Fractionated Dose instead of Single Dose
1930-1950 – Orthovoltage Era & interstitial radiation
1950-1980 – Megavoltage Era – Cobalt therapy, linear accelerators
1970-1980 – Proton Beam devices
1990 – 3D Conformal/Stereotactic radiation therapy devices
2000 – Adaptive radiation therapy – image guided therapies

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Global Dermatology https://doi.org/10.3889/oamjms.2017.122

BRIEF HISTORY OF RADIATION THERAPY

Table 2

Different modalities of radiotherapy available for the treatment of dermatological diseases

TREATMENT	TYPE OF RADIATION	CLINICAL INDICATIONS
Low energy superficial kilovoltage	X-ray	Localised superficial skin cancers
Orthovoltage X-ray	X-rays	Localised superficial skin cancers
High energy megavoltage (MV) photons	X-rays	Rarely used. Skin cancer with deep penetration
Electron Beam Therapy (Linac)	Electrons	Large or thick lesions
Cobalt therapy	Gamma-rays	Like Linac, by which they are often replaced
Brachytherapy	Radioactive sources (e.g. Au, CO, Celsium, Iridium…) localised into tumour tissues (variable energy)	Tumours localised in critical sites

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Global Dermatology https://doi.org/10.3889/oamjms.2017.122

RADIATION THERAPY DELIVERY - TECHNIQUES

- External Beam Radiation Therapy
- Internal Radiation Therapy or Brachytherapy
- Systemic Radiation Therapy or Total Body Radiation Therapy
- Types of Radiation Therapy Devices
- Radiation Dose, Volume, Number of Treatments, and Fractionation

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RADIATION THERAPY DELIVERY – TECHNIQUES

- External Beam, NOS
- Low Energy X-Ray/Photon Therapy
- 2-D Therapy
- 3-D Conformal Therapy
- Intensity Modulated Therapy
- Stereotactic Radiotherapy/Radiosurgery - NOS
- Stereotactic Radiotherapy/Radiosurgery – Robotic
- Stereotactic Radiotherapy/Radiosurgery – Gamma Knife
- CT-Guided Online Adaptive Therapy
- MR-Guided Online Adaptive Therapy

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EXTERNAL BEAM RADIATION THERAPY

- Conventional external beam radiation therapy (2DXRT)
- Three-dimensional conformal radiation therapy (3D-CRT)
- Image guided radiation therapy (IGRT)
- Intensity modulated radiation therapy (IMRT)
- Helical-tomotherapy
- Photon beam radiation therapy
- Proton beam radiation therapy
- Stereotactic radiosurgery
- Intraoperative radiation therapy (IORT)
- Stereotactic body radiation therapy (SBRT)
- Volumetric modulated arc therapy (VMAT)
- High Definition Radiotherapy (HDRT) & High Definition Radiosurgery (HDRS)

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https://www.cancer.org/treatments/radiation/basics.html

INTERNAL RADIATION THERAPY - BRACHYTHERAPY

- Internal radiation therapy (brachytherapy) allows a higher dose of radiation in a smaller area than might be possible with external radiation treatment.
- It uses a radiation source that's usually sealed in a small holder called an implant. Different types of implants may be called pellets, seeds, ribbons, wires, needles, capsules, balloons, or tubes.
- During **intracavitary radiation**, the radioactive source is placed in a body cavity (space) , such as the rectum or uterus.
- With **interstitial radiation**, the implants are placed in or near the tumor, but not in a body cavity.
- Brachytherapy is further defined as **high dose or low dose** and should be coded as available.

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https://www.cancer.org/treatments/radiation/basics.html

HIGH DOSE OR LOW DOSE BRACHYTHERAPY?

- High-dose-rate (HDR) brachytherapy allows a person to be treated for only a few minutes at a time with a powerful radioactive source that's put in the applicator.
- The source is removed after several minutes. This may be repeated over the course of a few days to weeks. The radioactive material is not left in your body. The applicator might be left in place between treatments, or it might be put in before each treatment.
- Low-dose-rate (LDR) brachytherapy allows the implant to give off lower doses of radiation over a longer period.
- Some implants are left in from 1 to a few days and then removed. You'll probably have to stay in the hospital, sometimes in a special room, during treatment. For larger implants, you might have to stay in bed and lie still to keep it from moving.
- Some smaller implants (such as the seeds or pellets) are left in place – they're never taken out. Over the course of several weeks they stop giving off radiation. The seeds are about the size of rice grains and rarely cause problems.

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https://www.cancer.org/treatments/radiation/basics.html

SYSTEMIC RADIATION THERAPY - RADIOISOTOPES

- Certain cancers, such as thyroid, bone, and prostate are treated with radiopharmaceuticals (radioactive drugs) .
- A radiopharmaceutical is a liquid drug made up of a radioactive substance. It is sometimes bound to a special antibody (called a monoclonal antibody) that attaches to the cancer cells. Examples of radiopharmaceuticals used for systemic radiation include radioactive iodine, strontium, samarium, and radium.
- These drugs may be given in a vein (IV) or taken by mouth. They travel in the blood throughout the body. The antibody makes them attach to the cancer cells. They then give off their radiation and kill the cancer cells.
- Radioisotopes – I-131, Strontium-90, Strontium-89, Radium-223
- Radioimmunotherapy

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https://www.cancer.org/treatments/radiation/basics.html

TYPES OF RADIATION THERAPY DEVICES

- Most are referred to by who makes the machine/device
  - Varian
  - Siemans
  - Elekta
  - Accuray
  - C.R. Bard
  - IBA Worldwide
- CT Simulators for Treatment Planning
- Linear Accelerator or 'linac' for External Beam Radiation
- Stereotactic Delivery - Gamma Knife, X-Knife, CyberKnife, Clinac
- Implants (Brachytherapy)
  - Radioactive seeds - implants
  - MammoSite – catheter
  - Savi Breast Brachytherapy - catheter
  - High Dose Remote Afterloader – catheter
  - TheraSphere – radio embolization – glass beads via catheter

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COC STORE DEFINITION A PHASE OF RADIATION INCLUDES

- ✓ The first phase (Phase I) of a radiation treatment may be commonly referred to as an initial plan.
- ✓ A subsequent phase (Phase II) may be referred to as a boost or cone down.
- ✓ A new phase begins when there is a change in the target volume of a body site, treatment fraction size, modality or treatment technique.
- ✓ Up to three phases of radiation treatment can now be documented.

- Radiation Primary Treatment Volume
- Radiation to Draining Lymph Nodes
- Radiation Treatment Modality
- Radiation External Beam Planning Technique
- Dose per Fraction
- Number of Fractions
- Total Dose

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RADIATION THERAPY DELIVERY – MODALITY

Code	Label
00	No radiation treatment
01	External beam, NOS
02	External beam, photons
03	External beam, protons
04	External beam, electrons
05	External beam, neutrons
06	External beam, carbon ions
07	Brachytherapy, NOS
08	Brachytherapy, intracavitary, LDR
09	Brachytherapy, intracavitary, HDR
10	Brachytherapy, Interstitial, LDR
11	Brachytherapy, Interstitial, HDR
12	Brachytherapy, electronic
13	Radioisotopes, NOS
14	Radioisotopes, Radium-223
15	Radioisotopes, Strontium-89
16	Radioisotopes, Strontium-90
99	Radiation treatment modality unknown; Unknown if radiation treatment administered

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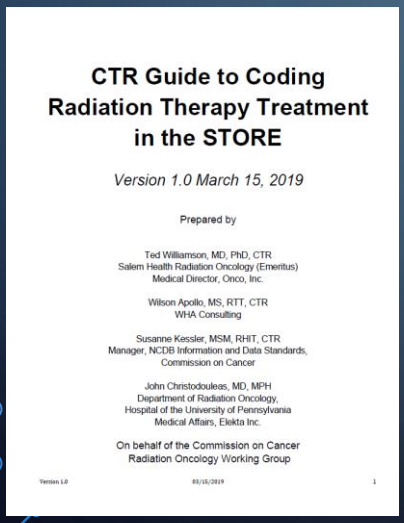
CASE STUDIES FOR CODING RADIATION THERAPY



CTR Guide to Coding Radiation Therapy Treatment in the STORE

Version 1.0 March 15, 2019

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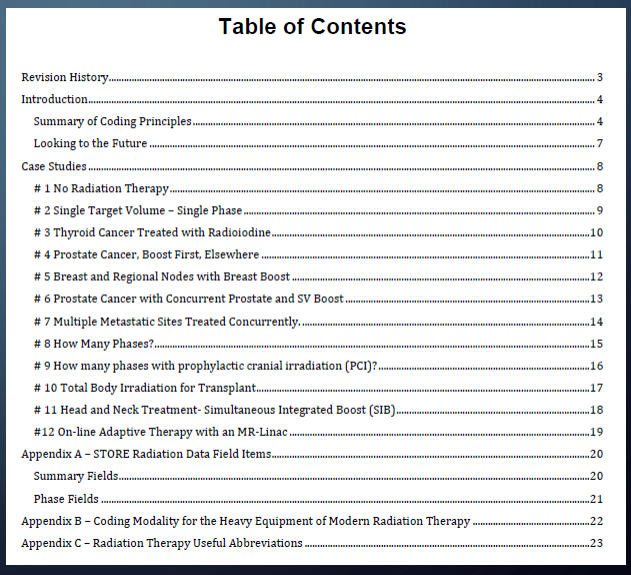

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NPCR NATURAL LANGUAGE PROCESSING

- Collaboration Project aimed at developing standard natural language processing algorithms for computers to read medical imaging reports (CT, MRI & PET/CT as starting point) and determine if tumor is present and reportable – similar to e-path natural language processing.
- Immediately recognizing limitations due to reporting ambiguity, nuances of disease, and lack of consistent terminology used by radiologists when reporting out medical imaging results.
- Starting with review of Brain/CNS and Lung and Standards for Structured Imaging Reports
- Ontario has been working with Digital Imaging Repository about developing effective algorithms for natural language processing with pretty high accuracy (over 90%) for algorithms for CT and MRI Examination of Abdomen/Pelvis Reports
- Integrating Natural Language Processing and Machine Learning Algorithms to Categorize Oncologic Response in Radiology Reports; J Digit Imaging (2018) 31:178-184
- https://doi.org/10.1007/s10278-017-0027-x

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AMBIGUOUS TERMS, NEOPLASM TERMS, DX CONFIRMATION AND DATE OF DIAGNOSIS

- Terms that Indicate Primary Tumor and/or Metastasis in Medical Imaging
- Ambiguous Terms in Imaging Diagnosis – not used same as we use them
- Date of Diagnosis from Imaging Diagnosis – verified by biopsy – suspected on imaging
- Diagnostic Confirmation = 7 (not 8, not 1, not 5 and not 9)
- Why are abstractors assigning Dx Confirm = 5? There is not one single cancer that is confirmed on biochem…NONE

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AMBIGUOUS TERMS, NEOPLASM TERMS, DX CONFIRMATION AND DATE OF DIAGNOSIS

BI-RADS Assessment Categories are:

- 0: Incomplete
- 1: Negative
- 2: Benign
- 3: Probably benign
- 4: Suspicious
- 5: Highly suggestive of malignancy
- 6: Known biopsy – proven malignancy

A BI-RADS classification of 4 or 5 warrants biopsy to further evaluate the offending lesion.[3] Some experts believe that the single BI-RADS 4 classification does not adequately communicate the risk of cancer to doctors and recommend a subclassification scheme:[4]

- 4A: low suspicion for malignancy, about 2%
- 4B: intermediate suspicion of malignancy, about 10%
- 4C: moderate concern, but not classic for malignancy, about 50%

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AMBIGUOUS TERMS, NEOPLASM TERMS, DX CONFIRMATION AND DATE OF DIAGNOSIS

BI-RADS – BREAST
C-RADS – CT Colonography
CAD-RADS – Coronary Artery Disease
HI-RADS – Head Injury
LI-RADS – Liver
Lung-RADS – Lung
NI-RADS – Head and Neck
O-RADS – Ovarian/Adnexal
PI-RADS – Prostate
TI-RADS - Thyroid

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DOCUMENTATION
IMAGING STUDIES AND RESULTS

- Always Include DATES – it is very important to document chronology of testing
- Always Include POSTIVE and NEGATIVE findings – equally important
- Summarize Findings – don't just copy and paste or you won't have enough space
- Support Imaging Findings by Including Physician Statements of Interpretation
  - Not just by the Radiologist – but, by medical oncology, radiation oncology, surgery
- When imaging text runs over – just move to another text field
- Try to keep imaging documentation in chronological order
- REMEMBER: Physicians will glean different information from different imaging depending on anatomy being scanned, level of detail, type of study performed, cost & insurance coverage,

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RESOURCES

- ACS – American Cancer Society
- ACR – American College of Radiology
- ASTRO – American Society for Radiation Oncology
- RSNA – Radiological Society of North America
- NCI – National Cancer Institute – About Cancer – Radiation Therapy
- NCI SEER – Surveillance, Epidemiology and End Results Program
- Commission on Cancer/American College of Surgeons – STORE Manual and CTR Guide to Coding Radiation Therapy Treatment
- CoC STORE Manual and Case Studies Coding Radiation Treatment
- Varian Medical Systems – Future of Radiation Therapy, Jan 2016
- Elekta – Motion Enable in Radiation – Volumetric Arc Therapy (VMAT)
- Vidar Systems – The Transition to Digital Imaging in Medicine
- Characteristics of Multislice CT – JMAJ 45(4): 175-179, 2002 - Katada
- Houston Methodist Radiation Therapy
- Radiation Oncology Data Capture – What's in STORE for You – Ted Williamson, MD, PhD, CTR – Onco, Inc.
- An Overview on Radiotherapy: From Its History to Its Current Applications in Dermatology, Global Dermatology/oamjms.2017.122
- A Blueprint for Cancer Screening and Early Detection: Advancing Screening's Contribution to Cancer Control – Wender, Brawley; CA Cancer J Clin 2019; 69:50-79, 2019 ACS

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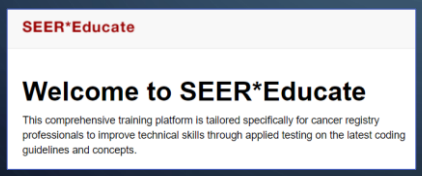
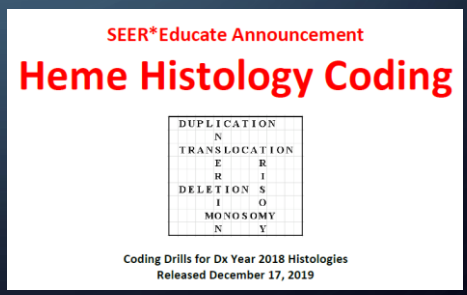
SEER CODING DRILLS FOR DX YEAR 2018 HISTOLOGIES

- SEER*Educate just released on December 17, 2019 - 120 new hands-on coding exercises for coding primary site, histology, and behavior and to reinforce the use of 2018 ICD-O-3 Updates and help registrars make sense of all the genetic abnormalities, mutations, and rearrangements involving the hematopoietic and lymphoid neoplasms in a document entitled, "*Introduction to Genetic Nomenclature*."
- Go to the SEER*Educate Website for these and several hundred other hands-on coding exercises and to check your own personal coding skills and ability to follow the Hematopoietic Histology Coding Rules



https://educate.fredhutch.org/



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120 MORE SEER CODING DRILLS FOR 2018 HISTOLOGIES

Check personal coding skills and ability to follow the Hematopoietic Histology Coding Rules under the Training Menu/CTR Prep Tests/CTR Prep – Coding Drill – Dx 2018 Histology (Heme and Lymphoid) on the SEER*Educate Website https://educate.fredhutch.org/

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Log in or sign up at **SEER*Educate** today by visiting https://educate.fredhutch.org/ and **Learn by Doing**!

QUESTIONS? JUST ASK…

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