Lesson Plan Review
NSF GK-12 - Vibes and Waves in Action

Title of Lesson Plan: Diagnostic Medical Imaging

Description of the overall plan for how the lesson was conducted

Today, the class explored the advantages and disadvantages of different types of diagnostic medical imaging procedures. A projected PowerPoint presentation with pictures and videos was used to show how x-rays, computer topography (CT), nuclear medicine and magnetic resonance imaging (MRI) are used as tools within diagnostic medicine.

During the class, an x-ray film was passed around the room. After the presentation students were allowed to use the classroom computer to analyze a computer topography chest scan.

What transpired during the lesson?

The presentation started with a review of the basic concepts of radiation as discussed in the previous lesson. Once engaged in the subject, the classroom conversation began to focus more on medical imaging. Many students were interested in the subject and had family members who work as medical imaging technicians in the industry.

At the end of the class, I received a lot of questions. Some of the questions were on the educational requirements to become a medical imaging technician; others were on the acute and latent effects of the radiation used in these different procedures.

What worked during the lesson?

Having an actual x-ray scan and a three dimensional CT model provided students with tangible examples they could interact with.

What could have been improved to make a more effective lesson?

Some students had never heard of medical imaging and had no real interest in the subject. Developing a plan which engaged these students would have improved the presentation. In the future I would have students analyze actual medical images made from MRI, CT and nuclear medicine procedures for contrast and spatial resolution.
Medical Imaging using Ionizing Radiation

By

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X-ray radiography

2-D projection image created from difference in x-ray absorption rates between tissues

Advantages:
- Very high spatial resolution
- High contrast between air, tissue, and bone
- Very fast imaging acquisition time
- Inexpensive

Disadvantages:
- Poor differentiation between similar tissue types
- Loss of anatomical information along projection axis
X-Ray Chests
Computed Tomography

3-D anatomical image created from a series of 2-D pencil X-ray images.

Advantages:
- Creates high spatial resolution
- three dimensional images
- As with X-ray radiography, high contrast between air, tissue, & bone
- Fast image acquisition time

Disadvantages:
- High patient radiation exposures
- Again, as with X-ray, poor differentiation between similar tissues
- Can’t create usable images near implanted metallic objects (creates artifacts)
Three dimensional pictures using Computer Tomography
CT: Example Images
Nuclear Medicine - PET / SPECT

The patient is injected with a radioactive drug that concentrates in diseased tissue

Advantages:
- Only imaging method presently capable of performing all types of functional imaging tests.
- Extremely high contrast exhibited between diseased and normal tissue.
- Fast image acquisition time.

Disadvantages:
- Very high patient radiation exposures
- No anatomical imaging info.
- Very poor spatial resolution
- Very Limited availability of isotopes!
  - PET requires large on-site particle accelerator
  - SPECT isotopes produced only at a few foreign nuclear reactors (shortages common).
Diagnosis and staging: PET + CT
Magnetic Resonance Imaging

*Image is generated by perturbed hydrogen nuclei aligned with a large magnetic field.*

Advantages:
- MRI is excellent for differentiating between soft tissues in the body
- Has good spatial resolution
- Patient not exposed to ionizing radiation
- Can be used with certain *functional* imaging tests but at loss of resolution

Disadvantages:
- Very long image acquisition time (~30min)
- Uncertainties in lateral spatial dimensions of image due to magnetic field non-uniformities
- The enclosed scanner is an issue with patients suffering from claustrophobia
- Unable to image patients with metallic implants or pacemakers
Diagnosis and staging: MRI
MRI

f-mri: brain activity study
f-mri: lung oxygenation study
Diagnosis and staging: MRI vs. CT
Questions?