BML 300: INTRODUCTION TO HEALTHCARE ENGINEERING

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Medical Imaging

Computed Tomography (CT)

CT scanner

How it works

- Provides high-resolution cross-sectional anatomical images
- Table moves through a circular opening in the CT scanner called the gantry, while an x-ray tube emits x-rays as it spins 360 degrees inside the gantry
- A detector array measures the amount of x-rays that pass through the anatomic part and cross-sectional images are generated from data.

uses

- Detects and confirms the presence of tumor
- Guides a biopsy
- Helps plan and monitor radiation and surgical treatment
- Helps diagnose problems with blood vessels and the heart
- Used for diagnosing abnormalities of the:
  - Brain, nasal passages, musculo-skeletal system, spine, abdomen, lungs and mediastinum

Other facts

- Average scanning time per anatomic region is only 10-20 seconds therefore many patients can be examined under sedation instead of anesthesia
- General anesthesia and is necessary for thorax imaging to control respiration and for timed contrast imaging to control movement
  - Ensures the clearest and most accurate images

Risks

- CT scans should be avoided during the first trimester of pregnancy
- Animals must be sedated or under anesthesia

Magnetic resonance imaging (MRI)

How it works

- Uses magnetic fields and radio waves to diagnose diseases and injury of soft tissue
- The atoms comprising soft tissue align with the magnetic field in the machine
- Radio waves pulsed into the field alter the atoms causing signals to be released and transmitted to a computer
- Signals then show up as either light or dark areas in the computer image

How it works cont’d.

- Primarily used to examine internal organs for abnormalities
- Imaging of large patients is limited to the limbs and head due to size constraints

uses

- Diagnosing abnormalities of the brain, spinal cord, and musculoskeletal system
- Diagnose or monitor treatment for conditions such as:
  - Tumors of the chest, abdomen or pelvis
  - Certain types of heart disease
  - Blockages, enlargements or anatomical variants of blood vessels
  - Diseases of the gastrointestinal tract
  - Cysts and solid tumors in the kidneys or other urinary tract organs

Risks

- Radio-frequency energy to excite molecules is similar to those from a radio or TV station
- Caution must be taken in patients with metal implants or pacemakers
- Requires general anesthesia to ensure the clearest and most accurate image possible

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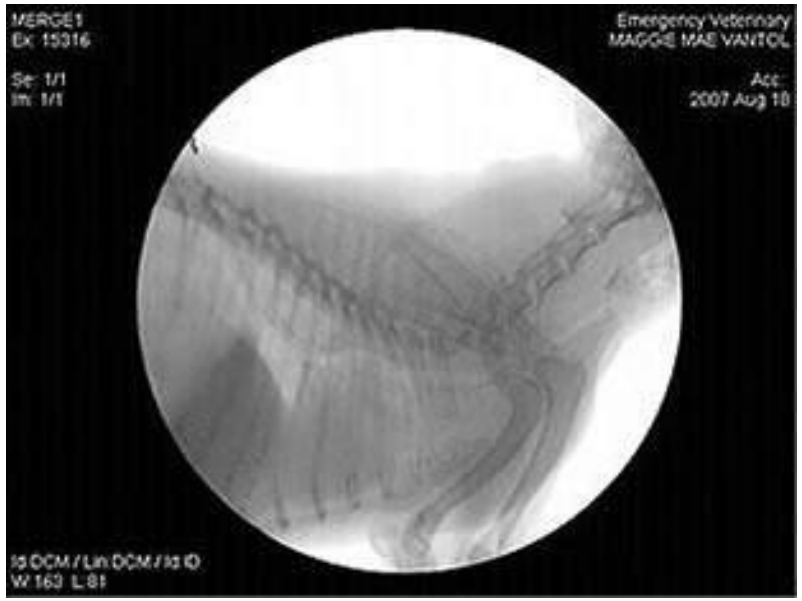
Digital Fluoroscopy

how it works

- Digital images are acquired at a rate of 1-8 frames per second
- The unit is used for myelography, contrast GI tract studies, and small animal general diagnostic imaging.



uses

- Special procedures such as angiography, venography, cardiac fluoroscopy, or evaluation for dynamic tracheal disease

Safety while operating

- Only persons required for a fluoroscopic procedure should be in the room during the procedure
- Use the smallest possible beam area, thereby reducing the scatter radiation to personnel.
- Fluoroscopic doses can also be minimized by reduction in the fluoroscopic time used
- Use the shortest possible distance from the image intensifier to the animal to reduce scattered radiation levels.

Digital or computed Radiography

How it works

- Computed Radiography uses a cassette system with imaging plate that contains photostimulable storage phosphors.
- The phosphors detect and store energy from the x-rays that strike the cassette.
- The light is captured, recorded, and processed into an image by a computer. The imaging plate is then erased by fluorescent light in the scanner, and is ready to be used again.

How it works

- Digital Radiography has no processing or erasing step
- Provides an instant digital image similar to a digital camera

How it works Cont’d.

- The digitized image can be manipulated: changing contrast and brightness, zoom in or out, and take measurements
- Images are stored in a secure file that is difficult to alter

uses

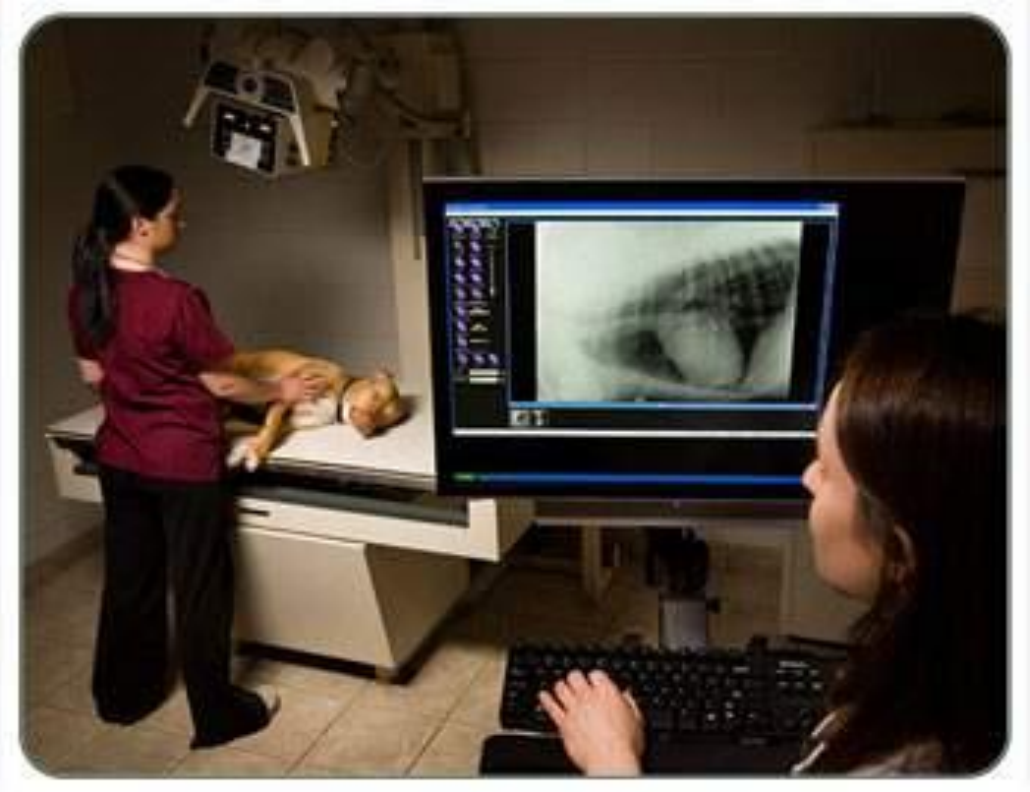
- Provides information about the internal architecture of abdominal organs, bones and areas such as the pelvic canal.

Safety While Operating

- Limit the X-Ray beam to the smallest area possible
- Align the X-ray beam properly with the animal and the image receptor
- Remain behind a protective barrier during the entire radiographic exposure
- Wear protective gloves and aprons having a lead equivalent of not less than 0.5 millimeter

Risks

- Some radiographs require sedation or general anesthesia



Ultrasound

How it works

- Uses sound waves to produce images of organs.
- Sound waves sent into the body are reflected off of an internal tissue interface.
- Hundred of these reflected signals provide an image of the organ, which can be visualized on the ultrasound machine monitor.

uses

- Areas frequently viewed with ultrasound:
  - Thorax, abdomen, eyes, brain, and tendons
- View abnormalities of organs and provides guidance for biopsies

risks

- The ultrasound exam is painless, most patients require no sedation or anesthesia, and tolerate the procedure well.

Nuclear Scintigraphy

how it works

- An animal is injected with a short-lived radioactive isotope which travels to specific organs/tissues

Uses

- Identifying lameness in equine patients where the cause of the lameness is difficult to localize by conventional methods
- Detects Porto systemic shunts, sub-clinical renal failure, and hyperthyroidism
- Evaluation of mucociliary clearance

Risks

- The animal is administered radioactive elements called isotopes or tracers that go through the bloodstream to the target organ
- Patient is usually isolated 12-24 hours after the exam to allow the body to become clear of the radioactive tracers

Endoscope

how it works

- a small camera is guided throughout the body via naturally existing orifices (nose, mouth,etc)
- Can reach most parts of the body without the need for open surgery

Uses

- Observe internal structures without surgery
  - Assists with diagnosis
- Minimally invasive surgeries (biopsy)

types of Endoscopy

- Gastrointestinal Tract
  - Esophagogastroduodenoscopy: esophagus, stomach and duodenum
  - Enteroscopy: small intestine
  - Colonoscopy, sigmoidoscopy: large intestine/colon
  - Proctoscopy: rectum and anus
- Respiratory tract
  - Rhinoscopy: nose
  - Bronchoscopy: lower respiratory tract

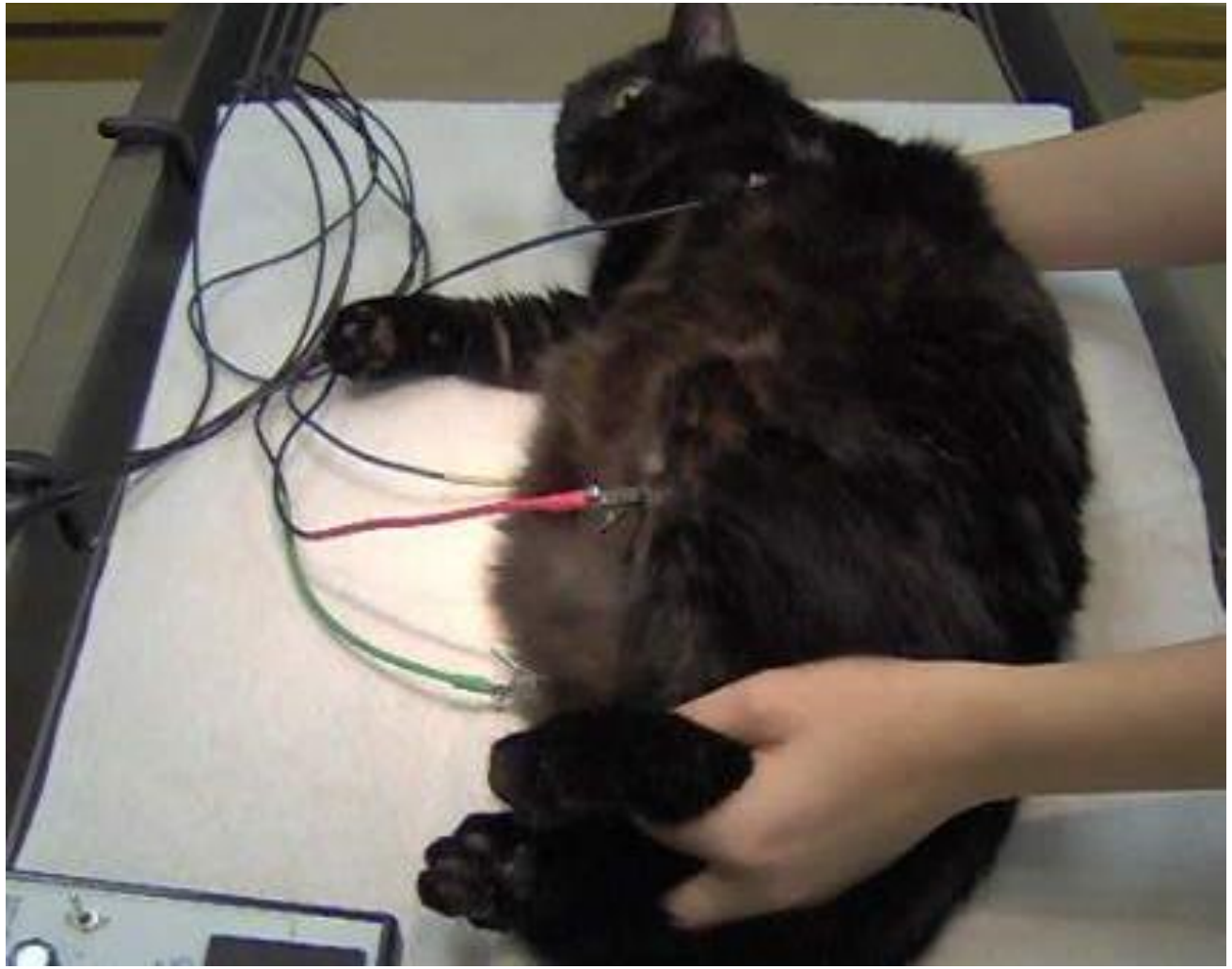
types of Endoscopy

- Ear: otoscope
- Urinary tract: cystoscopy
- Female reproductive system: gynoscopy
  - Colposcopy: cervix
  - Hysteroscopy: uterus
  - Falloposcopy: fallopian tubes
- Closed Body Cavities
  - Laparoscopy: abdominal or pelvic cavity
  - Arthroscopy: interior of a joint
  - Thoracoscopy and mediastinoscopy: chest organs

Risks

- Patient is usually anesthetized
- Complications (such as perforation of organs) due to the exam rarely occur
- Tearing of tissue may require surgical repair

Electrocardiograph



How it works

- Pet lies on its right side or stands
- Conductive gel or alcohol is applied to the skin to better transmit the electrical activity
- Clip or plate electrodes are attached to the pets limbs and chest wall which are attached to thin lead cables connected to the machine
- Typical recording duration is 30 seconds to 2 minutes

Uses

- Reveals abnormalities of heart rate and electrical rhythm.
- “Screening test” for serious heart disease, but should be used in conjunction with stethoscope exam, chest x-ray and echocardiogram

Safety AND RISK

- Neither sedation or anesthesia is needed
  - Some animals resist restraint and may need to be sedated, but it is not recommended due to the potential influence on the heart
- This exam is noninvasive and is not painful

Radiograph

How does it work

- Produced by transmitting x-rays through a patient
  - X-rays pass through less dense objects (fluid or air) and are absorbed by denser objects (bone)
- A capture device converts x-rays into visible light which then forms an image
- Denser objects (like bone) appear whiter, while less dense objects (air or fluid) appear black

Uses

- Used to examine and diagnose internal structures such as: bones, heart, lungs, and abdominal organs

Safety and Risk

- Radiography is painless
- Sedation may be needed to reduce stress and properly position animals
- Technicians restraining patients must wear protective apparel and monitor exposure

Safety with equipment

Identification

- Verifying the identify of the patient is the most important first step in imaging

restraint

- Whenever possible, use sandbags or other restraints instead of having persons hold patients during imaging

Access to imaging rooms

- No unauthorized visitors during imaging exams
  - This includes the owners of the animals being imaged

Radiation safety

- Control exposure levels by:
  - Maximization of distance from radiation source
  - Minimization of radiation exposure time
  - Proper shielding of radiation source
  - Proper shielding for personnel
- Personnel staying in the exam room should be protected by proper shielding.
  - thyroid shields, leaded glasses, gloves, and aprons

References

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