NMED-1200: RADIATION SAFETY & BIOLOGY

Cuyahoga Community College

Viewing: NMED-1200 : Radiation Safety & Biology

Board of Trustees:
January 2023

Academic Term:
Fall 2023

Subject Code
NMED - Nuclear Medicine Technology

Course Number:
1200

Title:
Radiation Safety & Biology

Catalog Description:
Potential effects of ionizing radiation on biological systems, especially humans including known high dose effects and theories of low dose effects. Radiation risks and applicable quantities and units. Estimating absorbed doses from internally administered radioactive materials. Safe handling of radioactive materials and the disposal of radioactive waste. Radiation safety regulations and safety guidelines including personnel monitoring and accurate record keeping.

Credit Hour(s):
2

Lecture Hour(s):
2

Requisites

Prerequisite and Corequisite
Departmental approval: admission to program.

Outcomes

Course Outcome(s):
Describe the sensitivity to and effects of ionizing radiation on the biological system.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Discuss human radiation absorbed dose including its sources, inevitability, risks, and safety.
2. Describe the molecular, cellular and tissue effects of ionizing radiation.
3. Describe the organ/systemic effects of ionizing radiation ways in which radiation causes organ/system/organism death.
4. Describe the genetic effects of ionizing radiation.
5. Describe the chronic somatic effects of ionizing radiation including at least three current theories.
6. Define critical and target organs describing what the differences are between them.
7. Discuss radiation characteristics, radiation energy transfer through interactions of radiation with matter, and the relationship of cell structures to the sensitivity of cells.

Course Outcome(s):
Explain general and medical safety regulations, licensing regulations, regulatory and resource agencies.

Objective(s):
1. Relate the appropriate methods of waste management including applicable limits for each method.
2. Identify general safety regulations, medical safety regulations, licensing regulations, and regulatory and resource agencies.

3. Define the "Radiation Areas" and describe their required postings.
4. List the required records in a Nuclear Medicine department including their content and length of retention.

Course Outcome(s):

Explain the ALARA (As Low as Reasonably Achievable) concept including the safe handling, disposal and waste management of radioactive materials and their principals.

Objective(s):

1. Define and utilize radiation safety terminology.
2. Describe the correct shielding of radioactive materials including selecting the correct shielding material as a function of radiation type, properly calculating shielding effects, and satisfying applicable regulations.
3. Explain the procedures for handling radioactive material.

Course Outcome(s):

Describe proper utilization of monitoring equipment and the recording of the results.

Objective(s):

1. List necessary radiation safety equipment and describe the proper use of each item.
2. Describe the types of monitoring, the regulatory conditions which require monitoring, and the methods of monitoring.

Methods of Evaluation:

a. Quizzes
b. Midterm
c. Final exam
d. Worksheets
e. Research paper
f. Presentation

Course Content Outline:

a. Radiation dose units
b. Molecular and cellular effects of ionizing radiation
    i. Cell biology
        1. Factors effecting energy deposition
        2. Theories and observations explaining effects
        3. Cell cycle stage versus radiosensitivity
        4. Factors effecting cellular response
        5. Law of Bergonie and Tribondeau
c. Sources of radiation exposure to the biological systems
    i. Background
    ii. Medical
    iii. Occupational
    iv. Benefits
d. Radiation hazards
    i. Internal versus external hazards
    ii. Particulate versus electromagnetic radiations
    iii. Emphasis on energy transfer into the system
    iv. Energy results in biological damage
e. Tissue and organ/system effects of ionizing radiation
    i. Classification by time of onset
    ii. Acute versus chronic
    iii. Healing
    iv. Specific tissue responses
f. Effects of ionizing radiation on DNA (deoxyribonucleic acid)

i. Genetic effects
ii. Particle mean free path, range, and energy
iii. LET (Linear Energy Transfer) versus target sensitivity

g. Chronic somatic effects (late effects) of ionizing radiation
h. Factors influencing absorbed dose from internal sources
i. Concentration and organ mass
ii. Effective half-life
i. Formulas for radiation absorbed dose
i. Inverse square law and distance
ii. Halve-value layer
iii. Relative biologic effect
iv. MIRD (Medical Internal Radiation Dose) method
j. Regulations, guidelines and licensing regulations
i. Radiation and medical safety regulations
ii. Licensing regulations
iii. ICRP (International Commission on Radiological Protection)
iv. NRC (Nuclear Regulatory Commission)
1. Code of federal regulations part 19
2. Code of federal regulations part 20
3. Code of federal regulations part 35
v. NBS (National Bureau of Standards)
vi. FDA (Federal Drug Administration)
vii. ODH (Ohio Department of Health)
viii. EPA (Environmental Protection Agency)
ix. Additional resource agencies
x. Monitoring
xi. Record keeping
k. Radiation dose limits
i. Public
ii. Occupational
iii. Medical
iv. Embryo/fetal
l. Radiation Areas
i. Definitions
ii. Posting
m. ALARA (As Low As Reasonably Achievable) Concept
i. Shielding
ii. Time
iii. Distance
n. Instrumentation and radiation safety equipment
o. Emergency management, decontamination and radioactive waste management
i. Personnel
ii. Prevention and containment
iii. Decontamination procedure
iv. Storage of contaminated materials

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Resources

Cherry, Simon, Sorenson, James A., and Phelps, Michael E. *Physics in Nuclear Medicine*. 4th. Philadelphia: W. B. Saunders Company, 2012.

Saha, Gopal. *Physics and Radiobiology of Nuclear Medicine.* 4th. Springer, 2013.

American Registry of Radiologic Technologists (ARRT). "Content Specifications for the Examination of Nuclear Medicine Technology"

Seeram and Brennan. *Radiation Protection in Diagnostic Xray Imaging (2017)*. Jones and Bartlett Learning, ISBN: 9781449652814

Radiologic Science for Technologists. 11th. Bushong, 2017. ISBN: 978-0-323-35377-9

Essentials of Nuclear Medicine and Molecular Imaging. 7th. Metler and Guiberteau, 2019. ISBN: 978-0-323-48319-3

. *Review of Nuclear Medicine Technology*. 5th. Bolus & Glasgow , 2018. ISBN: 9780932004963

Essentials of Nuclear Medicine Imaging. 7th. Mettler , 2018. ISBN: 9780323483193

Resources Other

Waterstram-Rich and Gilmore. Nuclear Medicine and PET/CT Technology and Techniques, 8th ed. 2016

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