Master Degree course in Medicine and Surgery

Integrated course: **Diagnostic Imaging and Radiotherapy**
SDS: **MED/36**
Number of ECTS : 4
Professor Agostino Chiaravalloti (2 ECTS) : agostino.chiaravalloti@unicamillus.org
https://www.unicamillus.org/it/personnel/agostino-chiaravalloti/
Professor Renato Argirò (2CFU) : renato.argiro@unicamillus.org
https://www.unicamillus.org/it/personnel/argiro-renato/

PREREQUISITES

There are no propaedeuticities for the Diagnostic Imaging and Radiotherapy module. It would be desirable for the student to be familiar with the basics of medical pathologies and in particular oncology, general pathology, neurology.

LEARNING OBJECTIVES :

1.Physics of ionizing radiation and principles of radiation protection

2.Radiopharmaceuticals (synthesis and management, main radiopharmaceuticals for use in SPECT and PET and for radiometabolic therapy)

3. Equipment in nuclear medicine (gamma chamber, PET and SPECT)

4. Indications and applications to scintigraphic study with gamma camera and SPECT (thyroid scintigraphy, myocardial scintigraphy, bone scintigraphy, lymphoscintigraphy, lung scintigraphy, brain scintigraphy);

5. Indications and applications to PET study in oncology.

6. Indications and applications to the study with PET in the neurological field

LEARNING OUTCOMES

At the end of the course, the student should acquire the following cognitive skills: know the general principles of nuclear medicine (diagnostic equipment, radiopharmaceuticals for diagnosis and therapy); know the main applications of nuclear medicine in the diagnostic field; study of pathologies in the cardiovascular, neurological, oncological, and musculoskeletal fields; know the basics of radiometabolic therapy and the main applications in the oncological field.

COURSE SYLLABUS

Physics of ionizing radiation and principles of radiation protection: the principles of dosimetry and related parameters, radiation protection, production and properties of x-rays and gamma rays, interaction with matter of corpuscular and electromagnetic radiation will be covered in depth during the lecture. The

spectrum of electromagnetic waves. Ionizing and non-ionizing radiation. Electromagnetic waves: wave model and corpuscular model. The discovery of x-rays. Interaction of alpha and beta rays with matter. Interaction of x-rays and gamma rays with matter. Photoelectric effect. Compton effect. Pair production. Principles of biological effects of ionizing radiation (stochastic and deterministic), units of ionizing radiation, and quantification will also be covered.

Radiopharmaceuticals (synthesis and management, main radiopharmaceuticals for use in SPECT and PET and for radiometabolic therapy): the main aspects of preparation and use of radiopharmaceuticals in radioisotopic diagnostics and therapy will be explained during the lectures. Preparation and quality control; management of diagnostic examinations and therapeutic procedures including dosimetry in Nuclear Medicine. Hints on the production and use of radionuclides for diagnostic and therapeutic purposes; Molybdenum/Technetium generators; use of Technetium in simple preparations of Radiopharmaceuticals; Radionuclide handling cells and their characteristics.

Equipment in nuclear medicine (gamma chamber, PET, and SPECT): the following topics will be covered during the lectures: principles of scintillation detectors; Definition of energy resolution of a detector; The gamma chamber; Detector characteristics and dimensions; Photomultipliers; Positioning circuits; Collimators: physical and constructive characteristics; Types of modern gamma chambers: 1-, 2-, and 3-head systems; Fixed and variable geometries; Processing systems; Hints of detector electronics; Preamplifier; Pulse formation and amplification; Discrimination; Dead time issues; Analog-to-digital converter Recalls on digital imaging in Nuclear Medicine; Quality assurance in Nuclear Medicine; Calibration of gamma chambers; Main modes of quality control; Multimodal SPET-CT tomography. Acquisition protocols: static, dynamic, tomographic and gated studies; The principles of positron emission tomography; PET tomography detectors.

Indications and applications to scintigraphic study with gamma camera and SPECT (thyroid scintigraphy, myocardial scintigraphy, bone scintigraphy, lymphoscintigraphy, lung scintigraphy, brain scintigraphy): during the lectures The main applications of traditional nuclear medicine with gamma camera and spect technology in the study of thyroid pathology (hyperthyroidism hyper- or hypo-functioning nodules etc), in Cardiovascular Scope study of coronary reserve of myocardial infarction will be addressed. Applications of nuclear medicine in the study of benign and malignant bone pathology will also be explored . Lymphoscintigraphy in the study of the lymphatic system and sentinel lymph node in the field of senology and in the study of melanoma, pulmonary for the evaluation of pulmonary embolism ; brain scintigraphy for the study of Parkinson's and parkinsonisms by molecular imaging.

Indications and applications to the study with PET in oncology: During the course of the lectures, the main applications of positron emission tomography in oncology will be addressed. In particular, the role of molecular imaging in the study of lymphoproliferative syndromes (Hodgkin's and non-Hodgkin's lymphoma), the study of various solid neoplasms such as carcinoma of the ovary, lung, and breast will be illustrated ; in the neuro oncology field, the emerging role of nuclear medicine in primary and secondary neoplasms of the brain will be illustrated. Finally, the role of PET in the study of prostate cancer will be illustrated. The following radiopharmaceuticals will be described in their dynamic and kinetic properties: fluorodeoxyglucose, fluorocholine, fluorodopa.

Indications and applications to PET study in neurology: In neurology, PET applications in major neurodegenerative syndromes such as Alzheimer's and dementia will be illustrated. The role of PET imaging in the study of Parkinson's and Parkinsonisms will also be illustrated. of paramount importance will be for the student to know the pathophysiological basis of these diseases and the radiopharmaceuticals used in positron emission tomography studies (fluorodeoxyglucose, amyloid imaging radiopharmaceuticals).

COURSE STRUCTURE

The teaching consists of lectures, 20 hours of Radiodiagnostics and 20 hours of Nuclear Medicine. Lecturers will use teaching tools such as presentations organized in powerpoint files with

explanatory diagrams, illustrations and images to describe the various anatomical structures and major findings. Movies and animations will be used to supplement the processes described in class. Interactive lectures are planned for the Nuclear Medicine module with performance of in-class exercises (either alone or in groups). Attendance is mandatory.

COURSE GRADE DETERMINATION

The exam consists of two parts: a written test and an optional oral test. The written consists of multiple-choice, single-answer questions on topics covered in class. The student answers 31 Nuclear Medicine and Radiodiagnostics questions (each correct answer is given a score of 1, all correct answers correspond to Praise).

To enter the oral examination, which is optional, the student must have scored at least 18 /30. The written exam constitutes a barrier or selection test; it is in the oral test that the student is given the opportunity to further demonstrate his or her preparation by discussing the course topics, to reason about problems inherent to Diagnostic Imaging by demonstrating that he or she has acquired the ability to express himself or herself with adequate scientific language. The final evaluation will be based on the outcome of the written and oral test (the latter optional).

➢ *Unsuitable: major deficiencies and/or inaccuracies in knowledge and understanding of the topics; limited ability to analyze and synthesize; frequent generalizations.*

➢ *18-20: barely sufficient knowledge and understanding of topics with possible imperfections; sufficient skills of analysis synthesis and autonomy of judgment.*

➢ *21-23: routine knowledge and understanding of topics; ability to analyze and synthesize correct with coherent logical argumentation.*

➢ *24-26: fair knowledge and understanding of topics; good analytical and synthesis with rigorously expressed arguments.*

➢ *27-29: complete knowledge and understanding of topics; remarkable analytical skills, synthesis. Good autonomy of judgment.*

➢ *30-30L: excellent level of knowledge and understanding of topics. Remarkable skills of analysis and synthesis and autonomy of judgment. Arguments expressed in an original way*

READING MATERIALS

Slides given by the Professors

Articles:

Choline PET or PET/CT and Biochemical Relapse of Prostate Cancer A Systematic Review and Meta-Analysis. Evangelista et al. Clin Nucl Med 2013;38: 305Y314

Clinical Applications of Nuclear Medicine. Moriguchi et al. http://dx.doi.org/10.5772/53029

Molecular imaging of brain tumors with 18F-DOPA PET and PET/CT Calabria et al. Nucl Med Commun. 2012 Jun;33(6):563-70. doi: 10.1097/MNM.0b013e328351d566.

Low-dose CT and contrast-medium CT in hybrid PET/CT systems for oncologic patients. Chiaravalloti et al. Nucl Med Commun . 2015 Sep;36(9):867-70. doi: 10.1097/MNM.0000000000000314.

18F-labeled radiopharmaceuticals for the molecular neuroimaging of amyloid plaques in Alzheimer's disease Am J Nucl Med Mol Imaging 2018;8(4):268-281

Theranostic approaches in nuclear medicine: current status and future prospects. https://doi.org/10.1080/17434440.2020.1741348

Response Assessment in Neuro-Oncology working group and European Association for Neuro-Oncology recommendations for the clinical use of PET imaging in gliomas. Neuro-Oncology 18(9), 1199–1208, 2016 doi:10.1093/neuonc/now058

Primary brain tumours in adults http://dx.doi.org/10.1016/S0140-6736(18)30990-5

Textbooks:

Essentials of Nuclear Medicine and Molecular Imaging 7th Edition - August 17, 2018 Authors: Fred Mettler, Milton Guiberteau eBook ISBN: 9780323567893 Hardcover ISBN: 9780323483193