Medicine and Surgery degree course
Integrated Course: **Diagnostic Imaging and Radiotherapy**
SDS: **MED/36**
4 ECTS
Professors:
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PREREQUISITES

No prerequisites are needed.
It would be desirable for the student to know the basics of Anatomy, Physiology, Physics, General Pathology, as well as Oncology to better understand the methodological indications of the main pathologies of the cardiovascular, neurological, gastroenteric, respiratory, urinary and endocrine system.

LEARNING OBJECTIVES

The course aims to present the range of possibilities offered by diagnostic imaging, making the student aware of the possibilities and limitations of techniques and methods, as well as the risks associated with their use, in order to clarify the indications in accordance with the risk/benefit ratio. The student must be able, respecting the risk-benefit ratio, to inform the patient of the best diagnostic process to be followed in the different morbid syndromes, to understand the meaning of the radiological report and its implications, explaining the content to the patient, advising him for any further investigation or carrying him towards the most suitable therapeutic choice. The student must also understand the basic elements of Clinical Radiological Anatomy.

COURSE SYLLABUS

Diagnostic Imaging: definition, history, and future perspectives. Ionizing radiation, short reference to the formation of the X-ray image and the fundamental radiological techniques: brightness intensifier, digital angiography. Computed tomography: principles and indications. Digital radiology. Natural contrast and artificial contrast. Contrast agent. Routes of administration of contrast agent. Chemical and pharmacological characteristics of contrast agent. Indications for the use of contrast agents. Side effects and adverse reactions to contrast agents. Ultrasound and ecodoppler: brief review of the physical principles and discussion of the main fields of application. Magnetic Resonance: brief review of the physical principles and discussion of the main indications. Diagnostic procedures of the main pathologies

(head, neck, thorax, breast, cardiovascular, abdomen, musculoskeletal system, urogenital system). The written radiological report and the images: how to interpret them. Principles and indications of interventional radiology. Indications to interventional radiology (diseases of the head and neck, respiratory system, breast, urogenital, systemic diseases, musculoskeletal diseases). Radiation protection of the patient and the professionals exposed. Legal aspects of radiation protection.

Physics of ionizing radiation and principles of radiation protection: during the lecture the following principles will be discussed in depth: the principles of dosimetry and related parameters, radiation protection, production and properties of x-rays and gamma rays, interaction with the matter of corpusculated and electromagnetic radiation. 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. Torque production. The principles of the biological effects of ionizing radiation (stochastic and deterministic), the units of measurement of ionizing radiation and quantification will also be discussed.

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

Equipment in nuclear medicine (gamma camera, PET and SPECT): during the lectures will be illustrated the following topics: principles of scintillation detectors; Definition of energy resolution of a detector; The gamma camera; Characteristics and dimensions of the detector; Photomultipliers; Positioning circuits; Collimators: physical and construction characteristics; Type of modern camera range: systems with 1, 2, 3 heads; fixed and variable geometries; processing systems; Hints of detector electronics; Preamplifier; Formation and amplification of pulses; Discrimination; Dead time problems; Digital analog converter Digital image recall in Nuclear Medicine; Quality assurance in Nuclear Medicine; Calibration of the camera range; main quality control modes; SPET-CT multimodal tomography. Acquisition protocols: static, dynamic, tomographic and gated studies; the principles of positron emission tomography; PET tomography detectors.

Indications and applications to gamma camera and SPECT scintigraphy study (thyroid scintigraphy, myocardial scintigraphy, bone scintigraphy, lymphscintigraphy, pulmonary scintigraphy, cerebral scintigraphy): The main

applications of traditional nuclear medicine with gamma camera and spect technology will be addressed in the study of thyroid pathology (hyperthyroidism hyper or hypo functional nodules etc.), in Cardiovascular study of the coronary reserve of myocardial infarction. The applications of nuclear medicine in the study of benign and malignant bone pathology will also be explored. Lymphscintigraphy in the study of the lymphatic system and the sentinel lymph node in the breast and in the study of melanoma, pulmonary for the evaluation of pulmonary embolism; cerebral scintigraphy for the study of Parkinson's and parkinsonisms by molecular imaging.

Indications and applications under study with PET in oncology: during the lectures will be discussed the main applications of positron emission tomography in oncology. In particular the role of molecular imaging in the study of lymphoproliferative syndromes (Hodgkin's lymphoma and not Hodgkin's), the study of various solid neoplasms such as ovarian cancer, lung and breast; in the field of neuro oncology will be illustrated the emerging role of nuclear medicine in primary and secondary neoplasms of the brain. Finally the role of the pet in the study of prostate cancer will be illustrated. The following radiopharmaceuticals will be described in their dynamic and kinetic properties: fluorodeoxyglucose, fluorocoine, fluorodopa.

Indications and applications under study with PET in the neurological field: In the neurological field will be illustrated the PET applications in the main neurodegenerative syndromes such as Alzheimer's and dementia. The role of PET imaging in the study of Parkinson's and parkinsonism will also be illustrated. It will be fundamental for the student to know the physiopathological basis of these diseases and the radiopharmaceuticals used in the studies of positron emission tomography (fluorodeoxyglucose, radiopharmaceuticals for amyloid imaging).

LEARNING OUTCOMES

At the end of the course, the student must develop 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 diagnostics; study of diseases in cardiovascular, neurological, oncological, musculoskeletal; know the basics of radiometabolic therapy and the main applications in oncology.

COURSE STRUCTURE

The course consists of 20 hours of Radiodiagnostics lectures and 20 hours of Nuclear Medicine lectures. The Professors use didactic tools such as presentations organized in powerpoint files with explanatory diagrams, illustrations and images to describe the various cellular structures. Movies and animations will be used to integrate the processes described in class. The Nuclear Medicine module includes interactive lectures with exercises in the classroom (both solo and group). Attendance is mandatory.

COURSE GRADE DETERMINATION

The exam consists of two parts: a written test and an oral test. The paper consists of multiple-choice questions, with only one exact answer, on topics covered in class. The student answers 30 questions (each correct answer gets a score of 1).
To take the oral exam, the student must have obtained at least 18 /30 in both subjects. The written examination constitutes a selection test; It is in the oral test that the student is given the opportunity to demonstrate his preparation by discussing the topics of the course and demonstrating that he has acquired the ability to use an adequate scientific language. The final assessment will be based mainly on the outcome of the oral test.

READING MATERIALS

Didactics material: slides provided by the Professors

Scientific papers

•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

- Fondamenti di Medicina Nucleare a cura di Duccio Volterrani ISBN 978-88-470-1684-2; DOI 10;1007/978-88-470-1685-9 © Springer-Verlag Italia 2010

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

Recommended books

- Passariello, Simonetti, *Compendio di Radiologia*, Idelson-Gnocchi.

- Mettler, *Essential of Radiology,* Elsevier – Health Sciences Division