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مقرر دراسی

		1- بيانات المقرر
الفرقة /المستوى :	اسم المقرر : Radiotherapy الاشعاع العلاجي و تطبيقاته	الرمز الكودى :
6 hours academi	c 3 hours : عدد الوحدات الدراسية practical	التخصص :
This course include all know about the r including the mea types, what is mean b and indication, this side effects and prote about the radiation organs try to help th	I what the radiographer student should radio-oncology in this educational level on of radiation therapy , its sources and by radiation therapy as well as its types course give brief data about radiation retion finally we try to give enough data a effect on the different body tissue and e student to be effective member on his team work	2- هدف المقرر:
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By the end of Identify the radiation Has enough data al - Has data about of Recognize the m Has enough data about Has enough data about Finally has en	f this course, the student will be able to a therapy definition, its types and sources bout the cancer as its definition, structure, types and stages . cell cycle and its phases eaning and methods of radiation therapy lata about radiation department structure ( simulation room &linac). tut the effect of therapeutic and diagnostic radiation on breast and brain . hough data about side effects of radiation.	ا. المعلومات والمفاهيم :
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tumours, malignant tumours, metastasis.	
• tumour classifications – carcinoma, adenocarcinoma,	
squamous cell carcinoma, sarcoma, glioma,	
astrocytoma.	
• Describe the different phases of the cell cycle.	
• Describe how tumour cell growth differs from normal	
cell growth	
1 Apply different years of propagation simulator room	منامدان والمعالم
2 - How to protect the patient from the hazard of radiation by	ج- المهارات المهيد. الخاصة بالمقرر:
the use of the protective barrier.	
3- How to deal with Linear accelerator and simulation room	
5 – Apply the repair of different preparation artifacts.	
6- Use different senses to master the work	
1 - Able to deal with the audience with elegance and interest.	د- المهارات العامة م
environment.	
3 - Able to maintain professional rules to ensure the quality	
control of different techniques. 4 - Able to acquire new information and new experiences to	
cope with the development of the field of work.	
5- Able and work effently in radiotherapy department	
Identify the terminology of radiation	4- محتوى المقرر:
biology of cancer	
2- Characteristics of cancer cells.	
Define the following key terms – neoplasms, benign	
tumors, malignant tumors, and metastasis.	
<ul><li>3- an introduction to the basic principles of radiation</li></ul>	
. Sources and types & radiation	
• Describe the definition of radiation & mechanism of cell	
killing.	
• Define the radio resistant and radio sensitivity cells	
4- Indication of radiotherapy and its types	
- an introduction to the basic characteristics of	
simulation an introduction to the external and internal	

	1' .1
	radiotherapy
-	Different methods of radiotherapy
•	Describe the key characteristics of external
	radiotherapy.
5-	Describe the key characteristics of simulation
	Define the and differentiate between virtual and
	simulator device
6-	Basics of linear accelerator
7-	Linear accelerator uses and how it works.
_	an introduction to the external and internal radiotherapy
_	Different methods of radiotherapy
_	an introduction to the basic characteristics of radiation
	side effects
-	How to deal with side effects of radiation
	Describe the key characteristics of radiation side effects
	Describe the key characteristics of fudiation side critects
•	Define main side effects of radiation on different body
	organs
8-	Know about food and special situation during radiation
	treatment
9- 10	The pitfalls in radiation and limitations
10	
1	
1- 2-	Positive interaction with the lecturer by asking
	questions or answering them.
3-	Practical session with availability of all required chemicals and equipment for practicing
4-	Field visits to different radiation and
F	radiotherapy department.
5- 6-	Hand-outs to simplify of scientific material.
7_	E-t-mail and the set of second the she
/-	External readings of specialized books

1 - Remedial lectures.	6- أساليب التعليم والتعلم
2 - Remedial practicing lessons.	للطلاب ذوى القدرات المحدودة
3 - Simplified sketches for different techniques.	
4 - Training to answer model question exercises.	
. (Nhilasia, 7	
· - تعويم (تعرب - /	7
	ا- الإسانيب المستحدمة
1- Formative tests on monthly schedule	
2- Mid-term test evaluation	
3- Final written and practice tests	
	ب- التوقيت
1 - Formative test = 10 minutes.	
2 - Mid-term test after six weeks of teaching = 30	
minutes	
<b>3 - Final test 2hours for written exam and 2 hours</b>	
for the practical test	
	ج- توزيع الدرجات
Quiz : 10 marks	
Attendance: 10 marks	
Assignments: 40 marks	
Final written exams: 90 marks	
Total 150 marks	
	8- قائمة الكتب الدر اسية و المر اج
	اً۔ مذکر ات
Handouts for the lectures and practical sections	
Handouts for the lectures and practical sections	
Handouts for the lectures and practical sections	

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1 Courtesy of Linda Rego, Hawaii Tumor Registry	ج۔ کتب
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Nervous System Tumors	
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Week	Theory	Practice
1 <sup>st</sup> week	Basic Radiation Therapy Terms	Radiation department organization
2 <sup>nd</sup> week	Basic Radiation Therapy Terms	Types of radiotherapy
3 <sup>rd</sup> week	- biology of cancer	Cell cycle
4 <sup>th</sup> week	- biology of cancer	TNM system Tumour types
5 <sup>th</sup> week	- basic principles of radiation	
6 <sup>th</sup> week	Sources and types & radiation	Methods of radiation
7 <sup>th</sup> week	- basic characteristics of simulation	virtual and simulator device
8 <sup>th</sup> week	Linear accelerator	Linear device
9 <sup>th</sup> week	external and internal radiotherapy	Fractionation of radiation
10 <sup>th</sup> week	IMRT. Brachytherapy	Delivery of radiotherapy
11 <sup>th</sup> week	characteristics of radiation side effects	Recommendation of radiotherapy
12 <sup>th</sup> week	Management of radiation side effects	treatment
13 <sup>th</sup> week	Revision	Revision

# **CHAPTER 1**

# **Basic Radiation Therapy Terms**

# **Course description**

This course include all what the radiographer student should know about the radio-oncology in this educational level including the mean of radiation therapy, its sources and types, what is mean by radiation therapy as well as its types and indication, this course give brief data about radiation side effects and protection finally we try to give enough data about the radiation effect on the different body tissue and organs try to help the student to be effective member on his team work ر جمهورية مصر العربية

# Course knowledge

# By the end of this course, the student will be able to

Identify the radiation therapy definition, its types and sources

<sup>2</sup> Has enough data about the cancer as its definition, structure, types and stages.

Has data about cell cycle and its phases

**Recogn**ize the meaning and methods of radiation therapy

I Has enough data about radiation department structure (simulation room &linac).

<sup>2</sup> Has enough data about the effect of therapeutic and diagnostic radiation on breast and brain.

Finally has enough data about side effects of radiation.

# **Course skills**

# By the end of this course, the student will be able to

<sup>2</sup> How to protect the patient from the hazard of radiation by the use of the protective barrier. ' 'Calli

<sup>2</sup> How to deal with Linear accelerator and simulation room

Knows about external and internal radiotherapy

# At the end of this chapter the student will be able to:

Defied the definition of radiation

Identify the terminology of radiation

**cancer**: a general term for more than 100 diseases that have uncontrolled, abnormal growth of cells that can invade and destroy healthy tissues.

**radiation:** energy carried by waves or a stream of particles. Types of radiation used to treat cancer include x-ray, electron beam, alpha and beta particle, and gamma ray. Radioactive substances include forms of cobalt, radium, iridium, cesium, iodine, strontium, samarium, phosphorus, and palladium.

radiation oncologist: a doctor who specializes in using radiation to treat cancer.

accelerated radiation: radiation schedule in which the total dose is given over a shorter period of time. (Compare to hyperfractionated radiation.)

**adjuvant therapy** (**add**-joo-vunt): a treatment used in addition to the main (primary) therapy. Radiation therapy often is used as an adjuvant to surgery.

**applicator** (**ap**-lick-ate-ur): a device used to place an implant or a medicine into the body.

**brachytherapy** (**brake**-ee-**THER**-uh-pee): internal radiation treatment done by implanting radioactive material directly into the tumor or close to it. Also called internal radiation therapy.

**centigray** (**cGy**) (**sent**-uh-gray): the preferred measurement of the amount of radiation dose absorbed by the body (1 cGy = 1 rad).

chemotherapy (key-mo-THER-uh-pee): the use of certain types of drugs to treat cancer.

**conformal radiation therapy** (con-**for**-mul **ray**-dee-**A**-shun): a newer type of radiation treatment that uses a special computer to help shape the beam of radiation to match the shape of the tumor and delivers the beam from different directions. This reduces the amount of exposure to nearby healthy tissues.

**dosimetrist** (doe-**sim**-uh-trist):a person who plans and calculates the proper radiation dose for treatment.

**radiation physicist:** a person trained to ensure that the radiation machine delivers the right amount of radiation to the treatment area.

Radiation therapist: a person with special training to work the equipment that delivers the radiation.

**radiologist:** a doctor with special training in reading and interpreting diagnostic x-rays and scans and performing specialized x-ray procedures.

**electron beam** (ee-**leck**-tron): a stream of high-energy particles called electrons used to treat cancer.

**external radiation:** radiation therapy that uses a machine located outside of the body to aim high-energy rays at cancer cells.

**fractionation** (**frack**-shun-**A**-shun): dividing the total dose of radiation into smaller doses in order to reduce damage to healthy tissues

**hyperfractionated radiation** (**hi**-per-**frack**-shun-ate-ed): radiation schedule in which it is given in smaller doses and more than once a day, but the overall length of treatment is the same. (Compare to accelerated radiation.)

**high-dose-rate (HDR) brachytherapy:** a type of internal radiation in which the radioactive source is in place only for a few minutes and then removed. This may be repeated several times over a few days to weeks.

**intensity modulated radiation therapy (IMRT)** (in-**ten**-si-tee **mod**-you-late-ed): an advanced method of conformal radiation therapy in which the beams are aimed from many directions and the intensity (strength) of the beams is controlled by computers.

**internal radiation:** a type of therapy in which a radioactive substance is implanted into or close to the area needing treatment. Also called brachytherapy.

interstitial radiation (in-ter-stih-shul): a type of internal radiation in which a radioactive source (implant) is put directly into the tissue (not in a body cavity).

intraoperative radiation (in-truh-op-ruh-tiv): a type of external radiation therapy used to deliver a large dose of radiation to the tumor and surrounding tissue during surgery.

**linear accelerator** (**lin**-ee-er ak-**sell**-er-a-ter): a machine that creates high-energy radiation to treat cancers using electricity to form a beam of fastmoving subatomic particles. Also called mega-voltage (MeV) linear accelerator or a linac.

**medical oncologist:** a doctor who is specially trained in the diagnosis and treatment of cancer and who specializes in the use of chemotherapy and other drugs to treat cancer.

**palliative care** (**pal**-ee-uh-tiv): treatment intended to relieve symptoms caused by cancer, rather than to cure it. Palliative care can help people live more comfortably.

**port (also treatment field)**: the area of the body through which external beam radiation is directed to reach a tumor.

**proton beam therapy:** a form of external radiation that uses proton beams to kill cancer cells. Protons are parts of atoms that cause little damage to tissues they pass through but are very good at killing cells at the end of their path. radio-resistance: the ability of cells to not be affected by radiation.

**radio-sensitivity:** how susceptible a cell, cancerous or healthy, is to radiation. Cells that divide frequently are especially radiosensitive and are more affected by radiation.

**simulation:** a process involving special x-ray pictures that is used to plan radiation treatment so that the area to be treated is precisely located and marked.

**stereotactic radiosurgery:** a type of radiation treatment that gives a large dose of radiation to a small tumor area, usually in a single session. It is mostly used for brain tumors and other tumors inside the head.

**systemic radiation:** uses radioactive materials such as iodine 131 and strontium 89 to kill cancer cells.

**teletherapy** (tell-uh-**thair**-up-ee): treatment in which the radiation source is at a distance from the body (external radiation).

treatment field (or port): the place on the body at which the radiation beam is aimed.

**gamma rays:** high-energy rays that come from a radioactive source such as cobalt-60.

**x-ray:** a form of radiation that can be used either at low levels to make an picture of the inside of the body on film or at high levels to kill cancer cells.

Ministry of Health & Population

# **CHAPTER 2**

# **INTRODUCTION TO CANCER**

### **Goals and Objectives**

- an introduction to the basic characteristics of cancer
- biology of cancer

# Upon completion of this chapter you will be able to:

- Describe the key characteristics of cancer cells.
- Define the following key terms neoplasms, benign tumours, malignant tumours, metastasis.
- tumour classifications carcinoma, adenocarcinoma, squamous cell carcinoma, sarcoma, glioma, astrocytoma.
- Describe the different phases of the cell cycle.
- Describe how tumour cell growth differs from normal cell growth

# What Is Cancer?

Abnormal and unregulated proliferation (growth) of cells, arising from cells of a specific organ. Cancer cells have the ability to create their own blood supply.

How a Normal Cell Becomes Cancerous: Multistep carcinogensis



Fig. (1):-

# 1- Uncontrolled Proliferation

Cells in normal tissues have constraints or feedback mechanisms (homeostatic mechanisms) to regulate growth.

Cancer cells lack or fail to respond to normal homeostatic mechanisms that control cell division or cell growth.

The capacity for persistent, uncontrolled proliferation is the distinguishing property of malignant cells.

Without intervention, cancerous tissues grow in an endless manner, leading to tissue invasion, metastasis and ultimately death.

# Cell growth associated with carcinogenesis involves two classes of genes:-

- 1) Oncogenes.
- 2) Tumour suppressor genes.
  - <u>Oncogenes</u> which are present in all cells and serve as regulators of the cell cycle. Activation of oncogenes results in dysregulation of normal cell growth, which produces excessive cellular proliferation.
  - <u>**Tumour suppressor genes**</u> regulate and inhibit inappropriate cellular growth and proliferation. Mutation of these genes results in loss of control over normal cell growth.

# 2- Ability to Invade Surrounding Tissues

Cell populations that make up body tissues normally remain segregated (i.e. one type of cells does not invade physiologic structure belonging to a different type of cells).

In contrast, malignant cells lack the constraints that inhibit invasive growth. As a result, cells of a solid tumour can penetrate adjacent tissues, allowing the cancer to spread.

# 3- Decreased Cellular Differentiation and other cellular changes

Most normal cells evolve through the process of differentiation, which means that they develop from a primitive cell with few specialized properties to undergo its physiologic functions.

On contrast, Cancer cells have generally lost some or all of these differentiated characteristics and cannot perform the intended physiologic functions of their tissue of origin.

Malignant cells are also genetically unstable and lose the normal cell structure and function typical of the cells of their origin.

# 4- Metastasis: Ability to Establish New Growth At Distant Sites

<u>Metastasis</u> is the process by which malignant tumour cells spread to distant parts of the body. Metastasis is the cause of most cancer-related deaths.

Cancer cells have a unique ability to "break away" and metastasize, or spread to distant sites of the body. Cancer cells which break away from the original tumour mass frequently travel via the blood or lymphatic system, establishing a new secondary tumour (metastasis) elsewhere.

A cancer cell that has metastasized retains many of the characteristics of the original cancer cells. For example, a patient with breast cancer that has metastasized to the liver does NOT have liver cancer. This is often misunderstood by the patient. The breast cancer cells are growing in the liver, and the disease is treated with regimens against the original malignant breast tumour cells.

Sites and Characteristics of Metastasis:-

- Local metastases generally invade the lymphatic system.
- Distant metastases commonly involve the brain, lung, bone and liver.
- Each cancer has a distinct pattern of metastasis (e.g. prostate cancer commonly metastasizes to the bone, but rarely to the brain).



Fig. (2):-

#### **Major Risk Factors for cancer**

- Genetic predisposition
- Tobacco use ± Alcohol excess

- Lack of physical activity
- Environment and Diet
- Virus (HCV,HBV,EBV)
- Excessive Sun exposure

## **Classification of tumours**

Neoplasms or tumours are masses of newly formed tissue characterized by new and abnormal cell development.

# They may be benign or malignant.

- <u>Benign tumours</u> are generally encapsulated and slow growing. They usually resemble the cells from which they developed, generally do not metastasize, and rarely recur if removed. Benign tumours are not often harmful, but can cause harm and even death if the growth exerts pressure or occupies space required for vital organ functioning
- They are named by adding the suffix, "-oma", to the name of the cell type (e.g. lipoma is a benign growth in fat tissue).
- Malignant or cancerous tumours are uncontrolled growth of cells which manifest as:
  - Rapid proliferation
  - Decreased cellular differentiation -
  - Invasion of surrounding tissues
  - Ability to metastasize
  - A diagnosis of "malignant" versus "benign" cancer is made at the microscopic level through pathology review.
- Malignant tumours are classified by their tissue of origin. It is critical to know the cancer's tissue of origin because each type of cancer cell responds differently to therapy and the prognosis from different cancer cell types varies significantly.

# Malignancies are classified into hematologic and solid tumours.

- <u>Hematologic malignancies</u> include acute and chronic leukemias, multiple myeloma and lymphomas.
- 2) <u>Solid tumours</u> are further classified by the cells of origin:
  - a. *Carcinomas* : epithelial cells .two types
    - predominantly glandular or ductal in origin (adenocarcinomas),
    - stratified squamous epithelium (squamous cell carcinomas).

- **b.** Sarcomas : connective tissues such as bone, fat, cartilage and muscle and gonadal tissues.
- c. *Neural tumours* are classified based on the cells from which they arise.
  For example, a brain tumour arising from a *glial cell* is called a *glioma*; a brain tumour from an *astrocyte* is called an *astrocytoma*.

### How Is Cancer Diagnosed? (7 warning signs)

#### **Symptomatic**

- Persistent Cough
- Rectal bleeding
- Palpation of breast lump
- Weight loss
- Skin abnormality- change in a freckle or mole, red areas
- Coughing up blood/chest pain
- Change in bowel habits
- Persistent Abdominal pain
- Blood in urine
- Difficulty swallowing
- Hoarseness

# Imaging &laboratory

# A<mark>symptom</mark>atic

• **Blood test – Tumour markers:** are substances that can be found in the body when cancer is present. They are usually found in the blood or urine.

For many reasons, tumour marker itself is usually not enough to diagnose or rule out cancer

Alpha-fetoprotein (AFP): is elevated in hepatocellular carcinoma of liver and is useful to monitor response to treatment.

also elevated in certain testicular cancers (embryonal cell & endodermal sinus types)

CA 125 : is the standard tumour marker to follow patients with epithelial ovarian cancer during or after treatment.

**Prostate-specific antigen** (**PSA**) is a tumour marker for prostate cancer & It is the only marker used to screen for a common type of cancer.

• Screening study – PAP, PSA, colonoscopy,mammogram, total-body CT scan

• Radiographic imaging like CT or MRI & surgical biopsy and then to pathology .so pathologist makes the diagnosis of cancer

# **Grading and Staging of Malignant Tumours**

At the time of diagnosis, the pathologist will determine the tissue type of origin, the tumour grade and body imaging determine the stage of the cancer. These parameters offer important prognostic information and will guide the selection of treatment.

- <u>*Tumour grade*</u> reflects the histology of the cancer cells. It is based on the degree of differentiation (similarity to original tissue) of the tumour cells and their mitotic activity (an estimate of the tumour growth rate).
  - G1 Well differentiated (Low grade)
  - G2 Moderately differentiated (Intermediate grade)
  - G3 Poorly differentiated (High grade)
  - G4 Undifferentiated (Highest grade)
    - A higher grade generally correlates with a more aggressive tumour and a poorer prognosis.

- <u>**Tumor stage**</u>: signifies the extent of the disease. Most solid cancers are classified into stages depend on **The TNM staging** the most common staging system, and includes the evaluation of three variables:

- Size of the primary lesion (T)
- Involvement of regional lymph nodes (N)
- Presence of distant metastases (M)
  - Once established, T, N, and M are then subgrouped into stage class (Stage I to Stage IV)

# Molecular biology of cancer: The cell cycle

Understanding how normal cells and cancer cells grow leads to better understanding of:

- 1) The pharmacology of antineoplastic drugs in the treatment of cancer; and
- 2) The toxicities associated with these agents.
- *3)* Radiotherapy and many anticancer drugs reduce the level of uncontrolled cellular growth that is the hallmark of cancer cells.

# Phases of the Cell Cycle

As illustrated in Figure 3, the cell cycle includes four key stages: Gap1 (G1), Synthesis (S), Gap 2 (G2) and Mitosis (M).

# Following cell division in mitosis, cells are destined to either:

- Go back into the cell cycle at the G1 phase, or
- Enter a dormant or resting phase G0 where cells can rest, proceed to cellular differentiation, or die.

Most normal human cells exist predominantly in the differentiated G0 phase, during which they perform the work for which they are intended (e.g. kidney cells filter urine).



Many anticancer drugs are designed to target the cell cycle. Drugs with activity in a particular phase of the cell cycle are called cell cycle phase-specific.

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# **CHAPTER 3**

# **RADIATION THERAPY PRINCIPLES**

# **Goals and Objectives**

- an introduction to the basic principles of radiation
- Sources and types & radiation

# Upon completion of this chapter you will be able to:

- Describe the definition of radiation & mechanism of cell killing.
- Define the following radio resistant and radio sensitivity cells
- Indication of radiotherapy and its types .

# WHAT IS RADIOTHERAPY?

Radiotherapy is the branch of medicine that deals with the treatment of oncologic disease through ionizing radiations.

This discipline was born following upon the discovery of X rays (1895) and radioactive phenomena (1896), even though nowadays painless higher-energy radiations are used, which are similar to the radiations used in radiology.

# H<mark>ow does</mark> radiation work to treat cancer?

Radiation is energy that is carried by waves or a stream of particles. It damages the genes (DNA) and some of the molecules of a cell. Genes control how cells grow and divide. Radiation damages the genes of a cancer cell so that it cannot grow and divide any more.

This means radiation can be used to kill cancer cells and shrink tumors. The cell cycle and radiation The cell cycle phase is important in cancer treatment because usually radiation first kills the cells that are actively or quickly dividing. It doesn't work so fast on cells that are in the resting stage (G0) or are dividing slowly. The amount and type of radiation that reaches the cell and the speed of cell growth affect whether and how quickly the cell will die or be damaged.

# Types of cancer cells according to sensitivity of radiation

The term *radiosensitivity* describes how likely the cell is to be damaged by radiation. Different cancers respond differently to RT □Highly radiosensitive cancer cells are rapidly killed by modest doses of RT eg Lymphomas (30-36 Gy) & Seminomas (25-30 Gy)

□More radio-resistant tumors require higher doses of RT

- H&N CA (70 Gy/35 fx)
- Prostate CA (70-74 Gy)
- GBM (60 Gy/30 fx)

#### **Goals of radiation therapy**

Radiation is considered a *local* treatment because only cells in and around the cancer are affected. It cannot cure cancer that has already spread to distant parts of the body because most forms of radiation therapy do not reach all parts of the body. Radiation is used to treat cancer in several ways.

# **Cure or shrink early stage cancer:** *adjuvant therapy*

Some cancers are very sensitive to radiation. Radiation may be used by itself in these cases to make the cancer shrink or disappear completely. For other cancers, it may be used before surgery (as *pre-operative therapy*) to shrink the tumor, or after surgery to prevent the cancer from coming back (this is called *adjuvant therapy*). It may also be used along with chemotherapy in some cases. When radiation is used along with other forms of therapy, the treatment is planned by the surgeon, medical oncologist, and radiation oncologist, as well as the patient

#### **Treat symptoms caused by advanced cancer:** *palliative radiotherapy*

Some cancers may have spread too far to be cured. But even some of these tumors can still be treated to make them smaller so that the person can feel better. Radiation may help to relieve symptoms such as pain, trouble swallowing or breathing, or bowel problems that can be caused by advanced cancer. This is often called *palliative radiation*.

# **Stop cancer from recurring (coming back) in another area :** *prophylactic radiotherapy*

If a type of cancer is known to spread to a certain area, doctors often assume that a few cancer cells may have already spread there, even though imaging scans (such as CT or MRI) show no tumors. That area may be treated to keep these cells from growing into tumors. For example, people with some types of lung cancer may get *preventive* (or *prophylactic*) *radiation* to the head because this type of cancer often spreads to the brain.

# **RADIOTHERAPY – WHEN?**

Nowadays, the therapeutic route of more than 60% of oncologic patients includes radiotherapy. To ensure best results, radiotherapy can be used in association with other oncologic therapies, such as surgery, chemotherapy or both.

### 1) Elective Radiotherapy

A stand-alone therapy, with curative or radical intent, aimed at eradicating the disease.

### 2) Pre-operative Radiotherapy

Carried out before surgery, in order to reduce the tumor mass and foster its macroscopic removal.

# 3) Post-operative or Precautional Radiotherapy

Carried out after surgery as a precaution, to reduce the risk of local relapse.

# 4) Intra-operative Radiotherapy

All or part of the radiation dose is delivered during surgery.

### 5) Symptomatic or Palliative Radiotherapy

Carried out in order to relieve the symptoms associated with the advanced stage of the disease, such as pain, bleeding and tumor mass compression, this treatment aims only at improving the patient's quality of life.

# 6) Radiotherapy Associated with Chemotherapy

Carried out with drugs bringing about a "radiosensitizing effect", in order to ensure synergy and increase the effectiveness of radiation.

# Who gives radiation treatments?

During your radiation therapy, you will be cared for by a team of medical professionals.

#### Some of the people who may be on that team are listed here.

- A *radiation oncologist* is a doctor specially trained to treat cancer with radiation. This doctor will make many of the decisions regarding your treatment.
- 2) The *radiation physicist* makes sure that the radiation equipment is working the way it should and that it delivers the dose of radiation prescribed by your doctor.
- **3**) The *dosimetrist* helps the doctor plan and calculate the needed number of treatments. The dosimetrist is supervised by the radiation physicist.
- **4**) The *radiation therapist* or *radiation therapy technologist* operates the radiation equipment and positions you for treatment.

5) A *radiation therapy nurse* is a registered nurse with special training in cancer treatment. He or she will be able to give you information about your radiation treatment and advice on how to deal with any side affects you might have.

#### Sources of radiation (fig 4)

The more common sources of radiation used for cancer treatment are:

- 1) High-energy photons that come from radioactive sources such as cobalt, cesium, or a machine called a *linear accelerator* (or linac, for short). Photon beams of energy affect the cells along their path as they pass through the body to get to the cancer. This is by far the most common type of radiation treatment in use today.
- 2) Electron beams or particle beams are also produced by a linear accelerator. These are used for tumors close to a body surface since they do not go deeply into tissues.
- 3) Proton beams are a newer form of particle beam radiation. Protons are charged parts of atoms that cause little damage to tissues they pass through but are very good at killing cells at the end of their path. This means that proton beams may be able to deliver more radiation to the cancer while causing fewer side effects to normal tissues. Protons are used routinely for certain types of cancer, but still need more study in treating others. Some of the techniques used in proton treatment can also expose the patient to neutrons (see below). Proton beam radiation therapy requires highly specialized equipment and is currently only offered in certain medical centers.
- 4) Neutron beams are used for some cancers of the head, neck, and prostate and for inoperable tumors. They can sometimes be helpful when other forms of radiation therapy don't work. Very few facilities in the United States offer this type of treatment. Its use has declined over the years partly because of problems with getting the beams on target. Because neutrons can cause more DNA damage than photons, the effects on normal tissue may be more severe. Beams must be aimed carefully and normal tissue protected. Neutron beams are showing great promise in research with salivary gland cancers that can't be cured with surgery.

# Three Main Types of External Beam

Photons > X-rays from a linear accelerator Light Charged Particles Electrons Heavy Charged Particles The Electromagnetic Spectrum Protons Carbon ions Fig (4) Sources and types Ministry of Health & Population

# CHAPTER 4

# **RADIOTHERAPY DEPARTMENT**

# (Simulation room & devices)

# **Goals and Objectives**

- an introduction to the basic characteristics of simulation
- Basics of linear accelerator

# Upon completion of this chapter you will be able to:

- Describe the key characteristics of simulation
- Define the and differentiate between virtual and simulator device
- Linear accelerator uses and how it works .

# **RADIOTHERAPY DEPARTMENT** (Simulation room &devices)



Fig.(5):- RT clinical routine and data workflow for external beam treatment planning and delivery using the conventional simulator.

# **Centering and Simulation Room**

The first stage of radiotherapy is the location of the area to be treated, namely the target volume.

During this stage, the target is located by means of some dedicated equipment (universal simulators); diagnostic equipment is also used (CT and, under special circumstances, MR). According to the type of radiotherapy – external or internal – there are two different types of simulation.

# SIMULATION FOR EXTERNAL RADIOTHERAPY

During this stage, the technician and the radiotherapist will simulate the patient's position on the bed, and for special diseases they will work out some immobilization devices, that make it possible to faithfully reproduce such position, in every treatment session. It is crucial that the patient lies very still for the whole stage, not to compromise it. It is often necessary to apply dot tattoos (upon your consent) next to the centre and two of the corners of each "field" or entry points of the radiation, that is going to be delivered during treatment; all of which, in order to make localization easier.

# SIMULATION FOR INTERNAL RADIOTHERAPY

At this stage, the radiotherapist must establish the position of special applicators or guidewires, which will be "loaded" or filled with radioactive material afterwards. This operation can be carried out in an outpatient unit or under slight sedation. After setting the guidewires, X-rays are taken to accurately detect their location.

# Role of Simulation in RT process

The Simulation of the RT process belongs to the most important steps of whole treatment process. During Simulation the defined treatment set-up, which is prepared on the TPS, will be simulated on the Simulator using the light field projection and the radiographic or fluoroscopic modes provided by the conventional Simulator. This process will help to mimic the radiation therapy beams in terms of divergence. In principle the Simulation process will optimise the original treatment in order to have the optimum target coverage while minimizing the dose to normal tissues. The final configuration will be recorded permanently on radiographic film. 1.3.1 The

Conventional Simulator Traditionally the device that performs the RT simulation is the Simulator .

The Simulator is a machine that emulates the geometry and the movements of the treatment unit but diagnostic quality x-rays instead of high-energy treatment rays.

#### Disadvantages

- a) Image Quality: Although the Simulator is a useful tool to define the localization of the disease and the surrounding healthy tissues, there are many cases where soft tissues due to their low x-ray absorption are not visible on the fluoroscopy or radiography. To overcome this problem often contrast medium is used. Furthermore, while using the fluoroscopy mode, the magnetic coils of the Simulator image intensifier suffer from distortions resulting to a distorted final image. Also, the limited size of the image intensifier detector limits the amount of the visualized patient's volume.
- b) Accuracy: The Simulator is a hardware device composed of several mechanical parts including the x-rays head, the collimator, the gantry and the treatment couch. The mechanical components often introduce inaccuracies to the Simulation process. Therefore systematic quality control tests are needed. If the component under test does not fulfill the requirements it must be replaced.
- c) **Design Constrains:** The design of the Simulator components is such that they mimic the treatment machine. Even though in some treatment cases, it is not possible to perform the simulation because of difference between the LiNAC and the Simulator.

One such example is the non-coplanar beam set-up with combined table and gantry rotation. This set-up can be applied on the treatment machine in absence of the portal imaging component, but not on the real Simulator due to the interference of the tabletop with the image intensifier.

d) Clinical Costs: The installation of a Simulator is a high investment for the clinic in terms of hardware equipment, space, time and personnel. The Simulator must be installed on a room as a stand-alone device. This room of course requires the installation of special components that are necessary for the appropriate function of the Simulator. To manipulate the Simulator at least two specialised persons are needed: a technical assistance and the radiation oncologist. Furthermore the verified result of the Simulator must be recorded on radiographic films, which require an expensive process for their development.

### The Virtual Simulator

The alternative to the Simulator device is the use of the Virtual Simulator (VS) or CT Simulator or 3D-Simulator.

Although this concept has been originally introduced, scientifically and clinically, as VS and CT-Simulation in this work we prefer to use the term *3DSimulation* or 3D-Sim. The reason for that is that the 3D-Sim systems nowadays include several different functionalities that spread much further than the standard volume definition and geometric field planning, which used to be the standard system functionality for the CT-Simulators. In addition one can work using any 3D imaging modalities beyond the CT scanner, such as MR and PET for example.

# The main benefits of the 3D-Sim over the conventional Simulator are:

a) Absence of the physical patient: During the conventional Simulation process the physical patient must be present and get positioned on the Simulator couch. In 3DSim the patient's electronic data, mainly CT, are used for the simulation. 3D-Sim avoids the often-experienced *bottlenecks* in patient workload flow within a department of radiation oncology and reduces the systematic error caused due to the patient's repositioning on the Simulator's couch.

**b) Reduced Simulation Time and Personnel:** Using the Simulator the average time needed to perform the Simulation process is about 20min. The 3D-Sim provides tools and technique that can reduce the time needed for the Simulation process up to 50%. In addition the only professional involved to the simulation process in the radiation oncologist.

c) Less Constrains: 3D-Sim will never face the problem mentioned in paragraph (1.2.1- c). The component limitation of different treatment units can be adapted by the 3DSimulator and additionally collision detection algorithms can be applied as well in order to verify the geometric treatment validity.

**d**) Advanced Visualization: As already mentioned the Simulator can verify the simulation process using the light field projection and the 2D radiographic image. The 3DSimulator can reconstruct the computerized reconstructed radiograph (CRR) in real time and simulate this way the fluoroscopy mode of the Simulator. CRR has a number of benefits against the conventional fluoroscopy, like the large field of view that can

be used to reconstruct the patient volume and the selection of the tissues that will contribute to the reconstruction of the final image.

e) Lower Investment: Finally the 3D-Simulator is a lower investment for an oncology clinic in terms of money and space compared to the real Simulator. The only hardware needed is a personal computer (PC). The final treatment set-up can be recorded digitally or as hard copy on conventional printing paper.

# Linear particle accelerator (often shortened to LINAC)

Is a type of particle accelerator that greatly increases the kinetic energy of charged subatomic particles or ions by subjecting the charged particles to a series of oscillating electric potentials along a linear beamline; this method of particle acceleration was invented by Leó Szilárd.

Ionizing radiation in medicine works by damaging the DNA of cells including cancer cells.



#### Components

**The particle source ("Ion source"** in Figure 6 ). The design of the source depends on the particle that is being moved. Electrons are generated by a cold cathode, a hot cathode, a photocathode, or radio frequency (RF) ion sources. Protons are generated

in an ion source, which can have many different designs. If heavier particles are to be accelerated, (e.g., uranium ions), a specialized ion source is needed.

A high voltage source for the initial injection of particles.

- 1- A hollow pipe vacuum chamber. The length will vary with the application. If the device is used for the production of X-rays for inspection or therapy the pipe may be only 0.5 to 1.5 meters long. If the device is to be an injector for a synchrotron it may be about ten meters long. If the device is used as the primary accelerator for nuclear particle investigations, it may be several thousand meters long.
- 2- cylindrical electrodes ("drift tubes") lies within the chamber, electrically isolated in Figure 6 ) are placed, whose length varies with the distance along the pipe. The length of each electrode is determined by the frequency and power of the driving power source and the nature of the particle to be accelerated, with shorter segments ("L1" in Figure 6) near the source and longer segments ("L4" in Figure 6) near the target.
- **3-** sources of radio frequency energy, ("RF source" in Figure 6), used to energize the cylindrical electrodes. A very high power accelerator will use one source for each electrode. The sources must operate at precise power, frequency and phase appropriate to the particle type to be accelerated to obtain maximum device power.

Additional magnetic or electrostatic lens elements may be included to ensure that the beam remains in the center of the pipe and its electrodes. Very long accelerators may maintain a precise alignment of their components through the use of servo systems guided by a laser beam.

# How it works

Ion source gives bunch of electrons which are then accelerated towards first drift tube (Bottom scheme in Figure 2) because of their negative potential and drift tube's positive potential. When electrons comes inside tube, in that moment RF source shifts its polarity.

First drift tube then becomes negatively charged and second drift tube positively charged. Electrons comes outside of tube because of its inertia and in that moment they are pushed with first drift tube and attracted by the second one in the same direction (Top scheme in Figure 6). As electrons are accelerating, their velocity becomes bigger and they travel longer distance in the same time.

# How to use ? Conformal treatment

Blocks placed in the head of the machine

□Multileaf collimator that is incorporated into the head of the machine.

The beam comes out of the gantry, which rotates around the patient.

□ Pt lies on a moveable treatment table and lasers are used to make sure the patient is in the proper position.

□RT can be delivered to the tumor from any angle by rotating the gantry and moving the treatment couch.



# **Goals and Objectives**

- an introduction to the external and internal radiotherapy
- Different methods of radiotherapy

# **Upon completion of this chapter you will be able to:**

- Describe the key characteristics of external radiotherapy.
- Define the types of radiotherapy.
- IMRT.
- Brachytherapy.

# of Health & Population How is radiation given?

Most people think of radiation therapy as coming from a machine outside of the body, but radiation therapy can be given in a number of ways. Sometimes radiation is given more than one way at the same time, or different types of radiation may be given one after the other.

# A- External beam radiation

External beam radiation is the most widely used type of radiation therapy. The radiation comes from a machine outside the body and is focused on the cancer. It is much like getting an x-ray, but for longer. This type of radiation is most often given by machines called linear accelerators (LINACS).

Methods :

1- Conventional 3D-RT (using CT based treatment planning)

# 2- Stereotactic radiosurgery

□Focused RT beams targeting a well-defined tumor using extremely



External beam radiation can be used to treat large areas of the body. It also can treat more than one area, such as the main tumor and nearby lymph nodes. External radiation is usually given daily over several weeks. It is given in an outpatient clinic or treatment center, so you do not have to stay in the hospital.

# Types of external beam radiation

1- Three-dimensional conformal radiation therapy (3D-CRT) uses imaging scan pictures and special computers to very precisely map the location of a tumor in 3 dimensions. The patient is fitted with a plastic mold or cast to keep the body part still during treatment.

The radiation beams are matched to the shape of the tumor and delivered to the tumor from several directions. By aiming the radiation more precisely, it may be possible to reduce radiation damage to normal tissues and better fight the cancer by increasing the radiation dose to the cancer. A drawback of 3D-CRT is that it can be hard to see the full extent of some tumors on imaging tests, and any part not seen will not get treated with this therapy.

2- Intensity modulated radiation therapy (IMRT) is an advanced form of external radiation therapy that uses photon beams. As with 3D-CRT, computer programs are used to precisely map the tumor in 3 dimensions. But along with aiming photon beams from several directions, the intensity (strength) of the beams can be adjusted. This gives even more control over the dose, decreasing the radiation reaching sensitive normal tissues while delivering higher doses to the tumor.

Because IMRT uses a higher total dose of radiation, it may slightly increase the risk of second cancers later on. This is something researchers are looking into.

**3- intensity modulated proton therapy (IMPT)**, uses proton beams instead of x-rays. Protons are parts of atoms that cause little damage to tissues they pass through but are very good at killing cells at the end of their path.

It is a good choice for tumors near critical body structures, such as the eye, the brain, and the spine. Protons can only be put out by a special machine called a *cyclotron* or *synchrotron*. This machine costs millions of dollars and requires expert staff. Because of this, proton beam therapy is expensive, and very few treatment centers in the United States offer it. More studies are needed to compare outcomes between proton and photon treatment so that each is used for the cancer type for which it works best.

4- Stereotactic radiosurgery or stereotactic radiation therapy delivers a large, precise dose of radiation to a small, well-defined tumor. The term "surgery" may be confusing because no cutting is involved. Some tumors that start in or spread to the brain are treated with this technique, but it is used for tumors in other places, too, such as the spine, liver, pancreas, kidney, lung, and prostate.

In some cases, a head frame or shell is used to hold the skull still and allow for precise aiming of radiation beams.

Once the exact location of the tumor is mapped (using imaging scans), narrow radiation beams from a machine called a Gamma Knife® are focused at the tumor from hundreds of different angles for a short time. The process may be repeated if needed. Several machines, with names such as X-Knife®, CyberKnife®, and Clinac® work in this way.

#### 5- Tomotherapy

Is a form of image-guided IMRT.

Combination of CT imaging scanner and an external-beam radiation therapy machine.

6- Intraoperative radiation therapy (IORT) delivers radiation to the cancer during surgery. The radiation may be given externally or internally, and it is often used along with a course of external radiation given before or after the operation.

IORT is useful for abdominal (belly area) or pelvic cancers that cannot be completely removed (such as those that have grown close to vital body parts) and for cancers that tend to grow back after treatment. This allows a higher dose of radiation to reach the cancer. IORT is delivered in a special operating room lined with radiation-shielding walls.

# Treatment planning for external beam radiation

The process of planning external beam radiation therapy has many steps and may take several days to complete.

Through a complex process called *dosimetry*, computer programs are used to find out how much radiation the nearby normal structures would be exposed to in order to deliver the prescribed dose to the cancer. The doctor and dosimetrist will work together to decide on the amount of radiation you will get and the best ways to aim it at the cancer. They base this on the size of the tumor, how sensitive the tumor is to radiation, and how well the normal tissue in the area can withstand the radiation.

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# Cancer Volume

Volume of the tumor that needs to be irradiated for achieving cure

It depends on

- Visulazied or palpable mass
- Surrounding lymphatics
- Micrsocopic spread of tumour

# Dosing and treatment with external beam radiation

The total amount of radiation you will get is measured in units called Gray (Gy). Often the dose is expressed in *centigray* (cGy), which is one-hundredth of a Gray.

# **F**ractionation

Def : Total dose is spread out over course of days-weeks (fractionation) Allows normal cells time to recover, while tumor cells are generally less efficient in repair between fractions

□Allows tumor cells that were in radio-resistant phase of the cell cycle during one treatment to cycle into a sensitive phase of the cycle before the next tx is given. □RT given M-F/ 5 days per week.

□For adults usually administer 1.8 to 2 Gy/day, depending on tumor type □In some cases, can give 2 tx (2 fractions) per day

Other types

- *Hyperfractionated radiation* divides the daily dose into 2 treatment sessions without changing the length of the treatment. In this case, you would be treated twice a day for several weeks.
- *Accelerated radiation* gives the total dose of radiation over a shorter period of time by giving the same dose of radiation more frequently (more than once a day).

These types of schedules can make the radiation work better for some tumors. The down side is that radiation side effects are seen earlier and may be worse.

For external radiation, small, long-lasting or permanent (tattoo) marks may be put on your skin to show where treatment is to be focused.

Patient will need to stay very still and in the same position during each treatment, which can last up to 30 minutes. Sometimes a special mold or cast of the body part to be treated will be used to hold you in a certain position. This helps make sure that the patient in the right place .

# <u>B- Internal radiation therapy (brachytherapy)</u>

Internal radiation therapy is also known as brachytherapy, which means short-distance therapy. With this method, radioactive containers are placed into the tumor or into a body cavity close to the tumor. The advantage of brachytherapy is the ability to deliver a high dose of radiation to a small area. It is useful for tumors that need a high dose of radiation or a dose that would be more than the normal tissues could stand if it had to come in from the outside.

### Th<mark>e main</mark> types of internal radiation are:

- Interstitial radiation: the radiation source is placed directly into or next to the tumor using small pellets, seeds, wires, tubes, or containers.
- Intra-cavitary radiation: a container of radioactive material is placed in a cavity of the body such as the chest, rectum, uterus, or vagina.

Ultrasound, x-rays, or CT scans are used to help the doctor put the radioactive source in the right place. The placement can be permanent (long-term) or temporary (shortterm).

• **Permanent brachytherapy** involves using small containers, called *pellets* or *seeds*, which are about the size of a grain of rice. They are put right into the tumors using thin, hollow needles. Once in place, the pellets give off radiation for several weeks or months.

Because they are very small and cause little discomfort, they are simply left in place after their radioactive material is used up.

• **Temporary brachytherapy** can be *high-dose rate* (HDR) or *low-dose rate* (LDR).

Either type briefly places hollow needles, tubes, or fluid-filled balloons into the area to be treated. Radioactive material can be put in these containers for a short time and then removed.

<u>For HDR brachytherapy</u>, the radiation source is put into place for about 10 to 20 minutes at a time, and then removed. This process may be repeated twice a day over the course of a few days, or once a week for a few weeks.

<u>For LDR brachytherapy</u>, the radiation source stays in place for up to 7 days. To keep the implant from moving, you will need to stay in bed and lie fairly still. For this reason, you will be kept in the hospital during LDR therapy.

# **Goals and Objectives**

- an introduction to the basic characteristics of radiation side effects
- How to deal with side effects of radiation

### Upon completion of this chapter you will be able to:

- Describe the key characteristics of radiation side effects .
- Define main side effects of radiation on different body organs
- Know about food and special situation during radiation treatment

Radiotherapy, like any curative treatment and most medical therapies, produces side effects.

#### The significance of side effects depends on several factors:

- Type of patient
- Number of fractions and overall dose of radiation
- Type of lesion to be treated, location and extension of the irradiated area of the body
- The patient response to the treatment performed
- Side effects are usually temporary, and only under certain circumstances they can last for some time after treatment.

They can be classified into two categories: GENERAL SIDE EFFECTS and SIDE EFFECTS TO SPECIFIC AREAS OF THE BODY.

### **GENERAL SIDE EFFECTS**

## Tiredness

During radiotherapy some people complain of tiredness or fatigue, because their organisms use up a lot of energy; this is true especially for those patients who undergo this treatment at the end of a therapeutic route, started with surgery or systemic chemotherapy long-time before. Therefore, try to rest as much as you can and reduce your working hours.

# Loss of appetite

Loss of appetite can be due to several factors; it is important for patients to keep a healthy diet in order to maintain a constant and suitable weight.

### For this reason we recommend that the patients:

- Eat every time they are hungry, even between meals
- Try eating smaller but frequent nourishing and highly energetic meals
- Vary their diet (avoid eating always the same things)
- Use tasty sauces on meat and fish
- Avoid unpleasant smells

Write down your weight every week; should you notice significant differences, inform your physician, who may decide to prescribe a suitable therapy.

#### Skin reactions

Irradiated skin reacts like after sunburn, because it is extremely sensitive.

Treatment and advices :

- Patient wear comfortable clothes.
- use warm water and mild soap; avoid lotions, creams, deodorants or perfumed soap. Skin may become darker, a reaction which gradually settles down.
- Use an electric razor rather than wet-shaving.

# Mouth and throat problems

*Mucositis* (inflammation inside the mouth) is a short-term side effect that can happen when radiation is given to the head and neck area. It usually gets better within a few weeks after treatments are completed. Dry mouth and a loss of taste can be caused by radiation damage to the salivary glands and taste buds. Thick, sticky, rope-like saliva and swallowing problems may develop, too. These side effects often go away after treatmen-ts end, but in some cases may be permanent. Good nutrition is important for people with cancer.

If mouth pain and irritation make it hard to eat or swallow, you may need to have a feeding tube put into your stomach for a while so you can take in enough nourishment. Your health care team will help you develop a plan to manage your symptoms.

## RECOMMENDATIONS

• If you go out in the sunshine, cover your head to protect it, during radiotherapy and for several months afterwards.

### Irradiation of the oral cavity and neck

- **MUCOSITIS AND STOMATITIS**, with pain and difficulties in chewing. This is due to the fact that the mucous membrane in the digestive tract is highly sensitive to radiations.
- DRY ORAL CAVITY AND DIFFICULT SWALLOWING. This may happen because sometimes salivary glands are included in the treatment field, and consequently a smaller quantity of saliva is produced, whereas its viscosity increases, so that the mouth is more easily attacked by bacteria and fungi.
- TASTE CHANGES. Damage to the microvilli of the taste cells can lead to taste changes or loss of taste. There are often changes in the taste sensations of acid and bitter; the taste sensations of sweet and salty are the most involved. You are likely to recover fully from this within 2-4 months from the end of therapy, but some people report dulled taste even for a longer period (up to one year).

# RECOMMENDATIONS

- Always keep the oral cavity and teeth in optimal cleaning conditions
- Frequent mouth wash (3-6 times a day, especially after each meal)
- Avoid alcohol, cigarettes, spicy food and very hot foot and liquid
- Eat highly nourishing food, that does not irritate mucosa, and can be chewed and swallowed easily
- Remove dental prosthesis
- During and after radiotherapy ensure good oral hygiene
- Use small head soft toothbrush and fluorine toothpaste
- Use dental floss

- Avoid candies
- Do not EXTRACT teeth in the irradiation field, and ALWAYS

# CONSULT THE RADIOTHERAPIST BEFORE CARRYING OUT ANY TOOTH SURGERY.

• This kind of surgery could cause serious damage (bone necrosis) to the mandibular and maxillary bones, even some years after the end of radiotherapy.

### Chest irradiation

**SWALLOWING DIFFICULTY:** it is quite frequent in treatments involving the central area of the chest and the oesophagus.

# RECOMMENDATIONS

- Eat soft, easy to swallow food and integrate your diet with caloric beverages.
- NAUSEA AND VOMITING. This is a frequent problem if the irradiated area is near the stomach; such symptoms can be easily controlled with a suitable antiemetic therapy and disappear at the end of treatment.
- DIFFICULT BREATHING. Report any problem connected with breathing (dyspnoea, dry or productive cough); if necessary, a support therapy shall be carried out.

#### **Breast irradiation**

### • SKIN REACTIONS

Cutaneous erythema, i.e. redness of the skin in the irradiated area; the skin is red and painful, like after sunburn and it may itch. It usually appears after the third week of the radiotherapy cycle; the areas which are most sensitive to this phenomenon are the breast areola (the area around the nipple), the submammary sulcus and the axillary fold. At the end of treatment, hyperpigmentation will affect the irradiated area (that will darken).

# • BREAST TENSION

The breast will be swollen because of the accumulation of liquid under and in the skin; this is the consequence of radiations and surgery, that modify the collateral lymphatic circulation.

# RECOMMENDATIONS

- Avoid sun exposure and sun lamps for at least six months after the cycle of radiotherapy.
- Avoid aggressive detergents, alcohol perfume and tight-fitting clothes; use hydrating emulsions.
- **PLEASE REMEMBER**: all these side effects occur more frequently in patients who have undergone chemotherapy.

# Ir<mark>radiation</mark> of the abdominal and pelvic areas

# • NAUSEA AND VOMITING

Upper abdominal irradiations often induce nausea and vomiting, even though these side effects are frequently due to anxiety and stress, and not just to radiotherapy. Therefore, we recommend that you relax as much as possible. In case of major nausea and vomiting, undergo radiotherapy on an empty stomach or follow a light diet; if necessary, antiemetic drugs can be resorted to.

# • DIARRHEA.

Lower abdominal and pelvic irradiations can often induce diarrhea They appear around the third or fourth week of treatment, and their duration varies. Radiotherapy on the intestinal mucosa induces enteritis, which can be managed by following the below-mentioned dietary rules and tends to disappear at the end of therapy. In a small percentage of cases it may present months to years after the completion of therapy, with the following symptoms: bowel obstruction, chronic diarrhea or rectal bleeding.

# **RECTAL AND VESICAL TENESMUS AND PAINFUL MICTURITION**

These symptoms may appear when the treatment involves the pelvic area, in case of urogenital disease.

They are due to the inflammation of rectal and vesical mucosa. It consists of the early filling of organs (rectal ampulla or bladder) with involuntary contraction of sphincters. All of which implies a frequent need to pass stool and to urinate; despite straining, little stool, mucus or gas is passed. Frequent micturition, Painful micturition is rare.

# **RECOMMENDATIONS**

• Drink lot of fluid and, if necessary, resort to suitable local therapies (suppositories or enemas)

# DIETARY SUGGESTIONS

In general avoid fried food, fatty or spicy sauces, strong spices and herbs, red pepper, pepper and cocoa during therapy, eat one yogurt a day or use lactic ferments.

#### Cereals to be avoided

All bran cereals (bread, pasta, rice, rusks, biscuits or crackers)

Allowed cereals :White bread without its soft part, ordinary breadsticks, oat flakes, rice soup, toast, white rusks.

# Veg<mark>etables to be</mark> avoided

Salad, broad beans, peas, legumes, artichokes, beans, chick-peas, lentils, turnip-tops.

#### Allowed vegetables

Celery, Cooked Non Leafy Vegetables, Spinach, Endive, Small Quantity Of Tomatoes, Vegetable Purée, Boiled, Roasted Or Mashed Potates, Zucchini, French Beans, Carrots.

#### Fruit to be avoided

Dried fruit, blueberries, raspberries, plums, figs, red currant, quinces, walnuts, fresh coconut, avocado, pine-seeds.

#### Allowed fruit

Peaches, Citrus Fruit Juice, Pineapple, Scraped Apples, Bananas, Lemons, Tangerines

## Meat to be avoided

Smoked meat, tripe, pork meat, sausages, prepared meat, entrails, game

## Allowed meat

White Or Red Lean Meat, Cured Or Boiled Defatted Ham, Dried Salt Beef

## Fish to be avoided

Sea food and dried fish, eel and fatty fish

### Allowed fish

BOILED OR WITH LIGHT DRESSING

# Beverages to be avoided

# Travelling

Unless your physician advises you against it, you can drive if you feel like it, for there is no danger. Do not drive if you are taking antiseizure or anxiolytic drugs, or if you feel tired.

### Medicines

During treatment, the dosage regimen of some of your usual drugs may be modified. Write down the list of all the drugs you usually take and show it to your physician before or during radiotherapy

# Pe<mark>rsonal</mark> hygiene

Wash as usual; do not use any of the above-mentioned prohibited detergents whilst washing the irradiated area.

# Se<mark>xual behavi</mark>our

No changes in your sexual behaviour will be required because of treatment. As far as having children is concerned, during radiotherapy and for some time afterwards some precautions should be taken.

Fertile age women should take a pregnancy test before starting treatment.

Men are also recommended to take precautions during this period, in order not to have children.

# Clothes

Always wear loose-fitting light colour or flax clothes; avoid synthetic fibre clothes.

# **CHAPTER 5**

# **SPECIFIC CANCER RADIOTHERAPY**

# **Goals and Objectives**



- the basic characteristics of brain cancer radiotherapy
- Upon completion of this chapter you will be able to:
  - Deals with breast radiotherapy and its dose
  - Deals with CNS radiotherapy.

# ADJUVANT RADIATION THERAPY FOR INVASIVE BREAST CANCER

Breast cancer is the most frequently diagnosed type of cancer for women Invasive breast cancer usually requires surgical treatment, as well as treatment after surgery, including radiation.

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Two options exist for breast surgery: mastectomy (removal of the entire breast) and breast conserving surgery (BCS) (removal of the cancerous area and a small amount of surrounding tissue).

Mastectomy may be necessary based on tumour location, size and/or shape of the patient's breast; or it may be the patient's preference despite being eligible for BCS. If a patient is eligible and chooses to have BCS, a margin of normal breast tissue around the tumour is required to avoid additional surgery.

The first place for breast cancer to spread is the lymph nodes. Thus, the goal of surgery is to remove cancer from both the breast and the lymph nodes.

BCS plus RT is called breast conserving therapy and is used to reduce the likelihood of cancer recurrence. Radiation is generally recommended for patients who have had BCS for invasive breast cancer. Standard treatment includes a course of external-beam radiation therapy to the whole breast after BCS.

### Indications of breast radiotherapy

Type of Breast	Surgery		
Cancer	Breast-conserving*	Mastectomy	
T1/T2 and node negative	<ul> <li>Adjuvant whole breast radiation therapy (WBRT) alone (no regional nodal radiation therapy [RT]) is recommended</li> <li>Partial breast radiotherapy investigational as part of clinical trial if available, or in very select patients</li> </ul>	<ul> <li>No adjuvant radiotherapy recommended, if negative margins are achieved. Adjuvant RT can be considered when margin positive, but benefit not defined</li> </ul>	
T1/T2 and node positive	Adjuvant WBRT recommended in all cases		
	<ul> <li>Isolated tumour cells in nodes (N0 as per TNM staging): <ul> <li>RNI not recommended</li> </ul> </li> <li>Sentinel lymph node biopsy (SLNB) positive micromets: <ul> <li>RNI individualized based on risk assessment</li> <li>Warrant a discussion with a radiation oncologist:</li> </ul> </li> <li>Macrometastatic nodal disease: <ul> <li>RNI recommended</li> </ul> </li> </ul>	<ul> <li>Isolated tumour cells in nodes (N0 as per TNM staging):         <ul> <li>No adjuvant RT recommended</li> </ul> </li> <li>SLNB positive micromets warrant a discussion with a radiation oncologist:         <ul> <li>Chest wall with RNI individualized, based on risk assessment</li> </ul> </li> <li>Macrometastatic nodal disease:         <ul> <li>Chest wall and RNI recommended</li> </ul> </li> </ul>	
T3/T4 and node negative or node positive	<ul> <li>Radiotherapy to breast and RNI recommended</li> </ul>	Radiotherapy to chest wall and RNI recommended	

 Table 1
 Radiotherapy Recommendations for Invasive Breast Cancer Following Surgery

# Dose/Fractionation schedule

The majority of trials examining WBRT delivered doses of 40-50 Gy to the whole breast, and a boost to the primary site when indicated.12,22,24-28 In the NSABP B-06 trial, a dose of 50 Gy was delivered to the entire breast without a boost in patients with histologically negative margins

**Treatment Position** Supine – Arms abducted 90° or greater – Immobilization devices Alpha cradles, breast boards, plastic molds Prone – Improve dosimetry in large, pendulous breasts – Reduction of lung volume in field – Reduction of scatter to opposite breast Lateral decubitus – Improve dosimetry in large, pendulous breasts **Standard Breast Radiotherapy** Target the entire breast Dose of 45-50 Gy to whole breast – 1.8-2 Gy per day Electron boost to tumor cavity – 10-16 Gy 6 <sup>1</sup>/<sub>2</sub> weeks of treatment

# **CNS radiotherapy**



A schematic classification of intracranial tumours according to site

# Conventional treatment planning

The conventional technique for planning of cranial RT is based on simulator images The conventional methods can be divided into two types:

- (1) Using single fields or parallel-opposed pairs directly defined at simulation,
- (2) **using a 2Dtarget** volume reconstructed on a transverse or inclined patient contour.

#### Modern treatment planning

#### CT-based treatment planning

Using CT images as the basis for the treatment plan has the following main advantages over conventional 2D planning:

1. The target volume can be delineated on multiple tomographic slices to minimize assumptions made about the variation of the target shape superior and inferior to the centre.

- **2.** CT images can be co-registered with those from other modalities (e.g., MRI) to take advantage of the additional information contained in them.
- **3.** Electron density of the tissues (the required quantity for dose calculation) can be derived from the image intensity values (Hounsfield units) in order to take account of the inhomogeneities in tissue densities when calculating dose.
- **4.** Non-coplanar beams can be readily planned and visualised using CT images providing the required anatomical extent is imaged



#### Referances

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