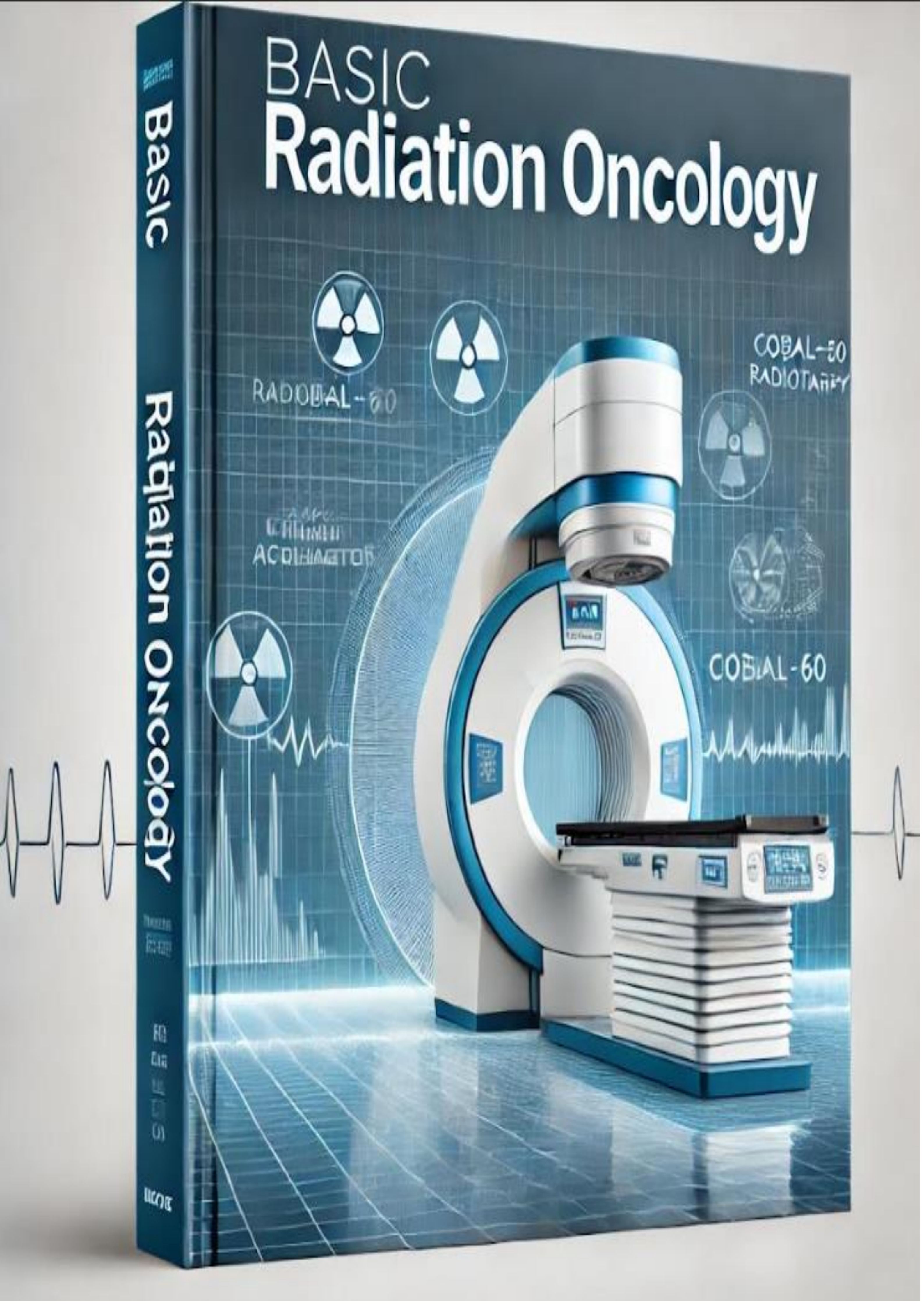
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Basic Radiation Oncology

Dr Abdul Waheed dar et. al

Medical and Research Publications

Basic Radiation Oncology

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Dedication

To my esteemed teachers,

who ignited the spark of knowledge and guided me with their wisdom, and to my beloved parents,

whose unwavering love, sacrifices, and encouragement

have been the foundation of my journey,

I dedicate this book with deepest gratitude and respect.

Foreword

In the ever-evolving field of oncology, radiotherapy has emerged as a cornerstone of cancer treatment. This book, Basic Radiation Oncology, serves as an essential resource for students and practitioners aiming to understand the foundational principles of this specialized domain. The authors, with their extensive expertise and dedication to the field, have created a guide that not only highlights the technical aspects of radiotherapy but also emphasizes the importance of empathy and patient care.

As advancements in technology continue to transform the landscape of radiation oncology, this book bridges the gap between theoretical knowledge and clinical application. By providing insights into modern techniques such as IMRT, SRS, and brachytherapy, along with a comprehensive overview of the role of radiation in various cancers, this text stands as a beacon for future professionals.

I commend the authors for their efforts in creating a comprehensive, accessible, and insightful resource. It is a testament to their commitment to advancing the field of radiation oncology and equipping the next generation of healthcare professionals with the tools to excel.

Acknowledgment

We extend our deepest gratitude to all those who have supported the creation of this book. To our mentors and colleagues, your guidance and shared knowledge have been invaluable. We are particularly thankful to our contributing authors and collaborators—Dr. Sumera Saba, Prof. (Dr.) Mashood Gh Nabi, Imtiyaz Ahmad Bhat, Aijaz Maqbool, Sadaf Shafi Gadoo, and Dr. Arshed Hussain Parry—for their contributions and expertise.

We also acknowledge the unwavering support of our families, whose patience and encouragement made this endeavor possible. Finally, we thank our students, whose curiosity and determination inspired us to compile this text. May this book serve as a foundation for their success and growth in the field of radiation oncology.

Need for This Book

The need for a concise yet comprehensive guide to radiation oncology is greater than ever. With advancements in diagnostic and therapeutic modalities, the understanding of radiotherapy's role in cancer management has become crucial for healthcare professionals. This book is designed to address the unique needs of MBBS and BSc Radiation Oncology and Radiodiagnosis students, offering a blend of theoretical concepts and practical insights.

From the fundamentals of radiotherapy techniques to the empathetic care of cancer patients, Basic Radiation Oncology aims to equip students with the knowledge required to excel in their careers. It also serves as a reference for practitioners seeking an updated perspective on radiotherapy. By emphasizing both technical expertise and patient-centered care, this book fulfills an essential role in advancing the practice of oncology.

Introduction

Radiotherapy, also referred to as radiation therapy, radiation oncology or therapeutic radiology, is one of the three principal modalities used in the treatment of malignant disease (cancer), the other two being surgery and chemotherapy. In contrast to other medical specialties that rely mainly on the clinical knowledge and experience of medical specialists, radiotherapy, with its use of ionizing radiation in the treatment of cancer, relies heavily on modern technology and the collaborative efforts of several professionals whose coordinated team approach greatly influences the outcome of the treatment. The radiotherapy team consists of radiation oncologists, medical physicists, dosimetrists and radiation therapy technologists.

The ultimate objective of radiotherapy: Highest dose to the tumor, Lowest dose to normal structures To Improve the therapeutic ratio

Evolution

The first reports of radiotherapy in India date back to the 1920s. By the 1940s, before independence, at least 4 radium institutes (Madras, Agra, Patna, and Lahore) were initiated in India. The contribution of eminent leaders, such as Drs K.M. Rai (Madras), Dr P.K. Haldar (Agra), Dr J.P. Sinha (Patna), and Dr M.L. Aggarwal (Amritsar), to the establishment of radiotherapy as a discipline in India were invaluable

- Initial Practice of radiotherapy
    - Mainly 2D planning
    - No accurate dosimetry
    - Limited knowledge of geographical location of tumor

- CT became available in 1972, soon used for RT planning- 3D CRT
- IMRT was first suggested by Brahme in 1982
- With all these advancements, precision of treatment delivery is increasing, More of normal tissue is being spared with increased dose to the tumor

Types of Radiation Therapy

- *External-beam radiation therapy*: This radiation type is mostly delivered as photon beams, x-rays or the gamma rays. Photon is the unit of light and is known to be the bundle of energy. The energy amount present within the photon tends to vary.

Photons that are found in gamma rays contain more energy as compared to the x-rays. This radiation type is administered with the help of a machine known as the linear accelerator (LINAC). This machine makes use of electricity for forming a current of swiftly-moving subatomic particles which in turn creates high-energy radiation used in treating cancer.

If you are being given the external-beam radiation therapy, then you will have every day treatment sessions for several weeks. The exact number of radiotherapy sessions will depend on various factors such as the dose as given.

- External-beam radiation therapy is also classified into different groups as **the 3D-CRT which stands for 3-dimensional conformal radiation therapy. It makes use of highly refined computer software with progressive machines for delivering the radiation very precisely to the target areas.**

- **There are some other methods as well, like**

- **3D-CRT**

3 Dimensional Conformal Radiotherapy is the use of 3 dimensional anatomical information to plan and deliver treatment so that the resultant dose distribution conforms as closely as possible to the target volume in 3 dimensions with minimum dose to the surrounding normal tissue.

- **IMRT**

Intensity Modulated Radiotherapy is a special form of 3D-CRT conformal dose delivery can be enhanced by generating a non-uniform photon fluence within each beam, calculated by an inverse treatment planning process designed to meet specified dosimetric objectives

Choosing patients for 3D-CRT & IMRT

<u>Conformal plan with 3DCRT</u>

Conformal treatment to reduce normal tissue toxicity. dose escalation without increase in normal tissue toxicity

<u>IMRT should be the treatment option when:</u>

- Concave dose distributions cannot be achieved by 3DCRT
- Extreme proximity to critical structures exist
- Re-irradiation of certain areas require maximal dose fall-off adjacent to irradiated area

- **STEREOTAXY**

The management and delivery of high precision image-guided high-dose radiation therapy with tumor-ablative intent within a course of treatment that does not exceed 5 fractions with steep dose gradients around the target

- "Stereo tactic" (or "stereo taxic") in Greek means movement in space.
- Stereo taxy is a minimally-invasive form of surgical intervention which makes use of three-dimensional coordinate system
  - To locate small targets inside the body and
  - To perform on them some action such as Ablation (removal), biopsy, injection, stimulation, implantation, radio surgery etc.

STEREOTACTIC IRRADIATION

Stereotectic irradiation refers to irradiation technique that uses computer calculated 3-dimensional coordinates to deliver a prescribed dose of ionizing radiation, Using multiple non-coplanar photon radiation beams(linac) or radiation from multiple Co-60 source (Gamma knife) with extreme precision to stereo tactically localized lesion primarily in the brain but attempts have been made to extend this technique to other parts of the body.

PRINCIPLE

- Precisely locate the target stereo tactically using special frames
  - Hold the target still
  - Accurately aim the radiation beam
- Shape the radiation beam to the target

- Deliver a radiation dose that damages abnormal cells yet sparing normal cells

TYPES OFSTEREOTACTIC IRRADIATION

With regard to sessions of dose delivery stereo tactic irradiation is divided into two categories

1. Stereo tactic radio surgery (SRS)
    - high dose is delivered in a single session
    - to treat stereo tactically localized intracranial lesions using rigid frame attachment
    - while avoiding nearby normal tissue & critical structures
2. Stereo tactic radio therapy (SRT)
    a. Delivering dose in multiple fractions
    b. to sterotactically localized target
    c. Using relocatable frame

RATIONALE FOR SRS

- Reduces risk of healthy brain & critical nerve damage.
- Allows for treatment in critical areas (e.g. retina, brain stem, chiasm)
- Allows for the safe treatment of lesions up to 4 cm

CLINICAL APPLICATIONS

- SRS
    - Originally developed for benign lesions of brain such as AVMs, meningiomas & acoustic neuromas
    - Used to treat functional disorders such as trigeminal neuralgia & movement disorders
    - Is occasionally used as boost in conjunction with standard treatment of malignant intracranial lesions
- Arteriovenous malformations (AVM)
- Benign brain tumors
    - Acoustic neuromas
    - Meningiomas
    - Pineal & pituitary tumors
- Malignant brain tumors including
    - Gliomas
    - Astrocytomas
- Metastatic brain tumors
- Functional disorders
    - Intractable Pain
    - Trigeminal Neuralgia
    - Psychiatric Diseases
    - Parkinson’s Disease and Epilepsy

Other radiation therapy options

Apart from the radiation therapy types as mentioned above, there are other options too, which include:

- Intraoperative radiation therapy (IORT): This type of radiation therapy is given to the cancerous tumor at the time of surgery. It is given either as external-beam or internal radiation therapy. This type allows the surgeon to keep away from healthy tissues in advance. And is highly helpful in cases where the tumor happens to be in closer proximity to the essential organs.

- Systemic radiation therapy: In this type, the cancer patient is made to swallow or take an injection of the radioactive materials which targets the cancer cells. The radioactive material then leaves the body via sweat, saliva, and urine. These discarded fluids are also radioactive in nature and people taking care of the patient must take proper safety measures.
- Radio immunotherapy: It is a kind of systemic therapy that makes use of the monoclonal antibodies for delivering the radiation dose directly to cancer cells. It works by delivering very low doses of radiation and causes no effect to the healthy cells.

MACHINES USED FOR RADIOTHERPY

- Cobalt 60
- Brachytherapy unit
- Gamma Knife
- LINAC-based systems (X-Knife)
- Cyber Knife

Cobalt 60

Cobalt therapy is the medical use of gamma rays from the radioisotope cobalt-60 to treat conditions such as cancer. Beginning in the 1950s, cobalt-60 was widely used in external beam radiotherapy (teletherapy) machines, which produced a beam of gamma rays which was directed into the patient's body to kill tumour tissue. Because these "cobalt machines" were expensive and required specialist support, they were often housed in cobalt units. Cobalt therapy was a revolutionary advance in radiotherapy in the post-World War II period

Natural cobalt is a hard, stable, bluish-gray, easily breakable metal with properties similar to iron and nickel. Its atoms contain 27 protons, 32 neutrons, and 27 .In 1735, a Swedish scientist, George Brandt, showed that the bluish color in colored glasses was due to a previously unknown element that he named cobalt. The melting point of cobalt is 1,495°C, its boiling point is 2,870°C, and its density is 8.9 g/cm3. The well-known isotope of cobalt is unstable radioactive Co-60. This isotope was discovered by Glenn Seaborg and John Livingood at California Berkeley University in 1930.

Co-60 is now produced commercially in nuclear reactors. Cobalt-60, produced by neutron irradiation of ordinary cobalt metal in a reactor, is a high activity gamma-ray emitter, emitting 1.17 and 1.33 MeV gamma rays with an activity of 44 TBq/g (1,200 Ci/g) are observed in fig 1. The main reason for its wide use in radiotherapy is that it has a longer half-life, 5.27 years, than many other gamma emitters. However, this half-life still requires cobalt sources to be replaced about every 5 years

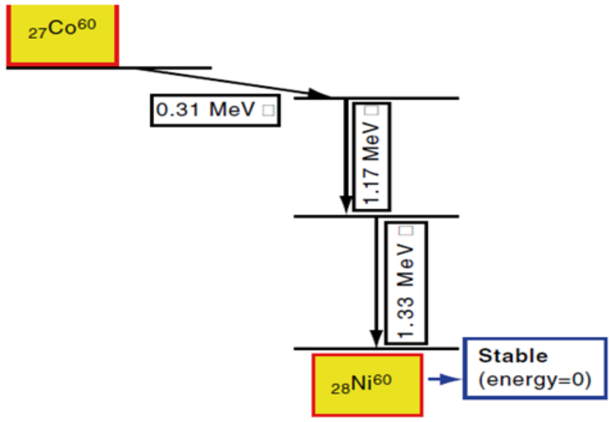
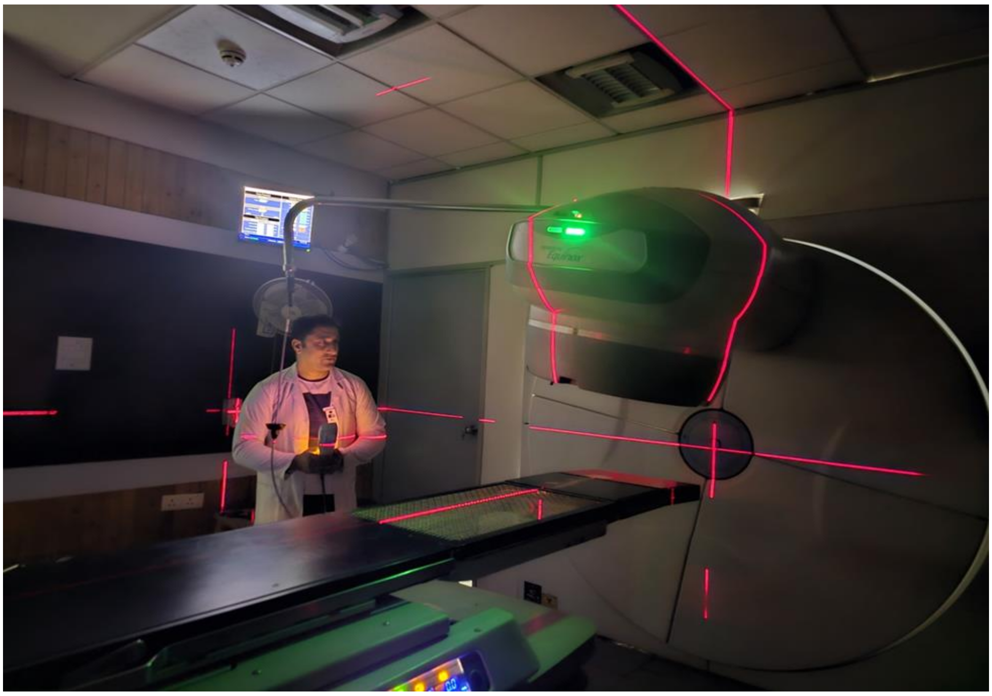


Fig 1

Co-60 teletherapy units have a cylindrical source 2 cm in diameter. The activity of the source is generally between 5,000 and 15,000 Ci . A source with an activity of less than 3,000 Ci is replaced with a new one; this is necessary after 5–7 years of use. Co-60 teletherapy units provide good performance for tumors with depths of <10 cm. Thus, the use of a linac is recommended for more deeply seated tumors.



Pic 1. Cobalt Picture

LINAC

The role of the cobalt unit has partly been replaced by the linear accelerator, which can generate higher-energy radiation, and does not produce the radioactive waste that radioisotopes do with their attendant disposal problems.

There are two types of accelerator that are used for radiation treatment Betatron and linac electron accelerators comprise 99% of all current accelerator machines used in radiation treatment. Cyclotrons, on the other hand, are heavy particle accelerators that are used for proton or neutron treatments.

A linear particle accelerator (often shortened to linac) is a type of particle accelerator that accelerates charged subatomic particles or ions to a high speed by subjecting them to a series of oscillating electric potentials along a linear beamline. The principles for such machines were proposed by Gustav Ising in 1924, while the first machine that worked was constructed by Rolf Widerøe in 1928 at the RWTH Aachen University. Linacs have many applications: they generate X-rays and high energy electrons for medicinal purposes in radiation therapy, serve as particle injectors for higher-energy accelerators, and are used directly to achieve the highest kinetic energy for light particles (electrons and positrons) for particle physics. The design of a linac depends on the type of particle that is being accelerated: electrons, protons or ions

The operational principle of electron accelerators. An electric impulse is deposited in the modulator. A specific control mechanism sends this impulse simultaneously to the electron gun and to the section responsible for microwave production (called the klystron or magnetron) at certain intervals (frequency: 50–200 Hz). The electrons liberated by the pulses are sent to the accelerator tube. An automatic frequency control module generates electromagnetic waves in the accelerator tube with the same frequency shown in fig 2 and pic 2

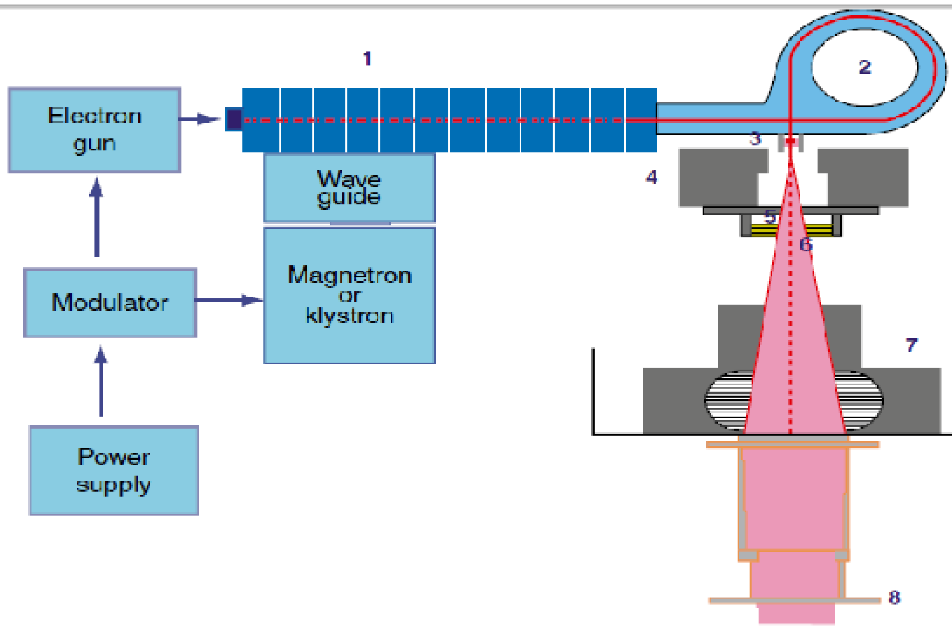
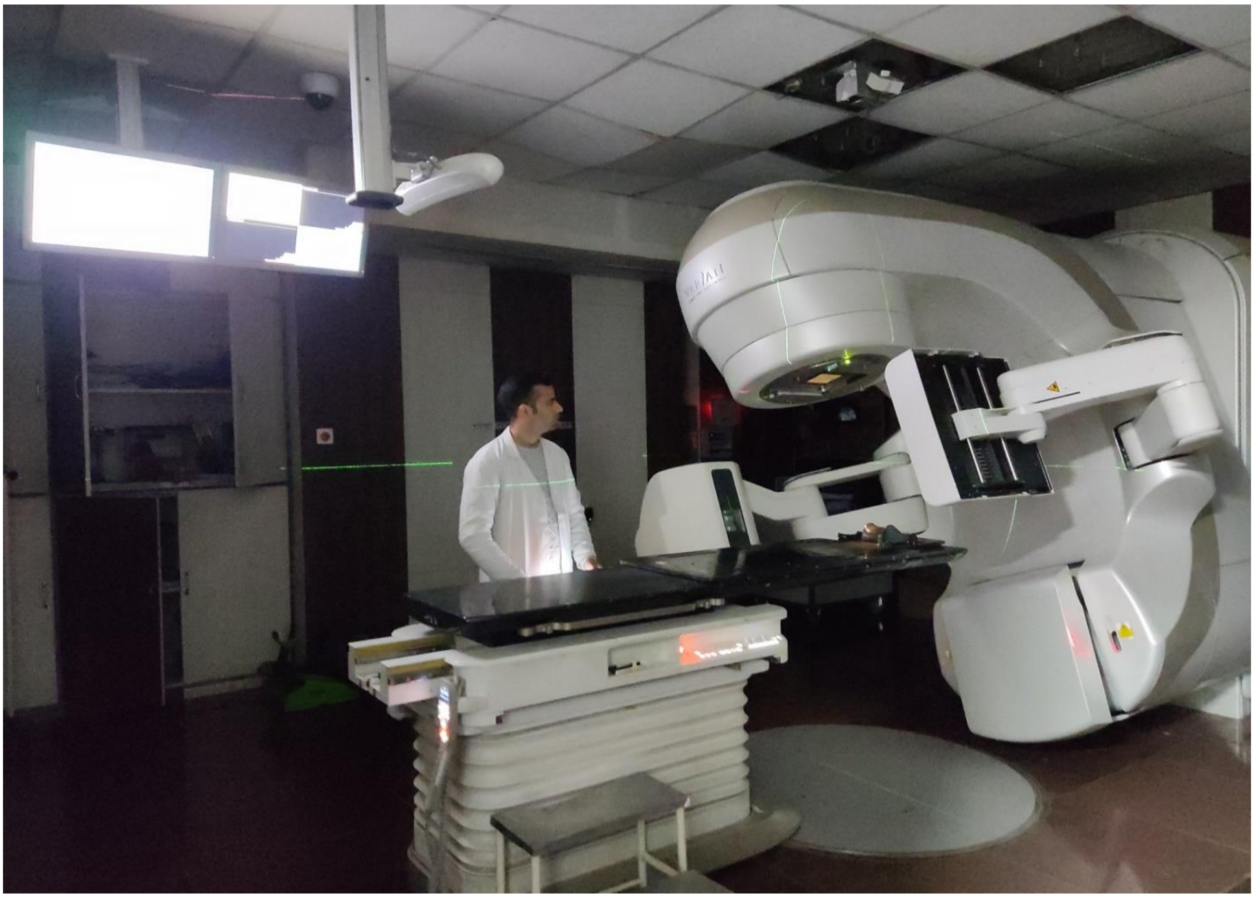


Fig 2:- General illustration of a linear accelerator. (1) The production and the acceleration of electrons, (2) The 270° bending of electrons, (3) Target and primary filter, (4) Primary collimators, (5) Main filter, (6) Ionizing Chamber, (7) Multileaf collimator, (8) Electron applicator



Pic 2 LINAC

Brachtherapy

Brachytherapy (brak-e-THER-uh-pee) is a procedure used to treat certain types of cancer and other conditions. It involves placing radioactive material inside the body. Form of radiation treatment in which radiation is delivered by small sealed radioactive sources arranged in a geometric fashion in & around tumour.

Evolution of brachytherapy

- Radioactivity was described by Becquerel in 1896
- Marie curie extracted radium from pitchblende ore in 1898
- Danlos and Bloc performed first radium implant (1901)
- First "schools" of brachytherapy at Stockholm , Memorial Salon Kettering and the Holt Radium Institute (Paris).
- Ra & Rn –two radioactive sources used extensively in the early years
- The term brachytherapy proposed first time by Forsell in 1931
- From 1940 – 1970s , Co^{60},Ta^{182}, Cs^{137}, Ir^{192} first used in brachytherapy
- Cs^{137} began to replace Ra^{226}
- In 1953, afterloading technique first introduced by Henschke in New York – removed hazard of radiation exposure. Also Ir used first time by Henschke
- LDR brachytherapy became the gold standard.

Brach therapy is a form of radiation therapywhere a sealed radiation source is placed inside or next to the area requiring treatment. Brachy is Greek for short. Brachytherapy is commonly used as an effective treatment for cervical, prostate, breast, esophageal and skin cancer and can also be used to treat tumours in many other body sites. Treatment results have demonstrated that the cancer-cure rates of brachytherapy are either comparable to surgery and external beam radiotherapy(EBRT) or are improved when used in combination with these techniques.

Types of Brachytherapy

1. Depending on use (surgical approach to target volume)

- Source in contact with but superficial to tumor: surface moulds
- Source inside the tumor/target
    - Interstitial
    - Intracavitary
    - Intraluminal
- Intravascular

2. Depending on source loading pattern:

Preloaded: inserting needles/tubes containing radioactive material directly into the tumor

After loaded: first, the non-radioactive tubes inserted into tumor

- Manual: Ir^{192} wires, sources manipulated into applicator by means of forceps & hand-held tools
- Computerized remote controlled after loaded: consists of pneumatically or motor-driven source transport system

- Manual Afterloading

Advantages

1. Circumvents radiation protection problems of preloading
2. Allows better applicator placement and verification prior to source placement.
3. Radiation hazard can be minimized in the OT / bystanders as patient loaded in ward.

Disadvantages:

specialized applicators are required.

3. Depending on Dose-Rate used

According To ICRU REPORT no.38 :

- *Low dose rate (LDR):* 0.4-2 Gy/hour Hours to days- Confinement to bed

  LDR A/L: 1970s using Cs^{137}

- *Medium dose rate (MDR):* 2-12 Gy/hour

  in Mid 70s Cs137-

- *High dose rate (HDR):* >12 Gy/hour (0.2 Gy/min)

  1st in 1968-joslin (cathetron)

  1984-PGI (Co^{60} source drawn to high intensity)

- *Ultra-low dose rate (ULDR):* 0.01-0.3 Gy/hour

- *Pulse dose rate:- Series of short HDR treatments (10 minute pulse repeated at 1 hr intervals) replacing the continuous LDR treatment lasting several days- PDR BT.Overall time remains same as LDR Source strength : 1 Ci*

ADVANTAGE of PDR: Radiobiologically nearer to LDR, optimization possible

4. Upon means of controlling dose delivered (duration of irradiation)

1. Temporary/Removable implants

When the radioactive source implanted into the tumor tissue is allowed to remain there for definite period. Ex Cs^{137}, Ir^{192}

2. Permanent implants:-

- when the sources are implanted indefinitely ex: Pd^{103}, Au^{198} interstitial form of brachytherapy
- Form of brachytherapy where sealed radioactive sources are directly implanted into the tumour in a geometric fashion
- First suggested in USA by Alexander Graham Bell (1903)
- At same time independently being used in France & Germany
- First case treated for an inoperable Parotid Sarcoma.

Advantages

- Higher local dose delivered in short period of time (biologically very effective dose) & Rapid dose fall off- Sparing of surrounding normal tissues
- Better tumor control and lesser radiation morbidity
- Cosmetic superiority
- Functional preservation of organs

Clinical criteria for selection of case

- Easily accessible lesions, at least from one side
- Early stage disease
    - T_1-T_2 and sometimes early T_3
    - Ideally total size of implant ≤ 5 cm
- Non DM /HTN
- No local infection
- Proliferative and ulcerative lesions preferred

Clinical applications of the Implant

- Head & Neck Tumours
    - Early stage oral cavity & oropharyngeal cancers:
        - Ca Tongue (oral tongue &BOT)
        - Buccal Mucosa
        - Ca lip
        - Ca floor of mouth
        - Retromolar area
        - Ca Tonsil
        - Hard & Soft palate
- Ca Breast: as Boost, as PBI
- Ca Prostate
- Soft tissue sarcomas
- Gynaecological Malignancies:
    - Ca Cervix for parametrium
    - Ca Vulva & Vagina
- Ca Anal Canal & Rectum
- Ca Penis & sometimes Ca Urinary bladder
- Ca lung & Pancreas

3. RADIONUCLIDE SOURCES

RADIOISOTOPES IN THE TREATMENT OF CANCER

Radioisotope therapy is a procedure where liquid radiation, such as Lutathera, along with amino acids to protect the kidneys, are administered through an infusion. The liquid radiation targets cancerous cells while causing minimal damage to surrounding healthy cells

Radioactive sources

- *Obsolete or historical*

  ^{226}Ra, ^{222}Rn

- Currently used sealed sources

  ^{137} Cs, ^{192}Ir, ^{60}Co, ^{125}I, ^{103}Pd,

  ^{198}Au, ^{90}Sr.

- Developmental sealed sources

  ^{241}Am, ^{169}Yb, ^{252}Cf, ^{131}Cs,

  ^{145}Sm

➢ Currently used sealed sources **Ir-192** near ideal radioisotope because

- Flexible & malleable – can be used in form of wires of any size
- Compatible with after loading techniques
- Ideal energy (0.3 – 0.4 Mev) – monoenergetic –
- more radiobiological effect
- Energy is low – thinner shields reqd for radiation safety
- β energy is low – so lesser filtration required
- No products
- Easily available, less costly

Limitation

- Short half life so source has to be replaced every 3 months

Element	Energy (MeV)	Half-life	HVL-Lead (mm)	Exposure rate constant	Source Form	Clinical application
Iridium Ir^{192}	0.397 average	73.8 days	6	4.69	Seeds in nylon ribbons; Metal wires; Encapsulated source on cable	LDR & HDR temporary implants HDR I/C Intravascular

4. PERMANENT IMPLANTS RADIOISOTOPES

Element	Energy (MeV)	Half-life	HVL-Lead (mm)	Exposure rate constant	Source Form	Clinical application
Gold Au^{198}	0.412	2.7 days	6	2.35	Seeds	Permanent Implants
Iodine I^{125}	0.028	59.6 days	0.025	1.45	Seeds	Permanent Implants
Palladium Pd^{103}	0.020	17 days	0.013	1.48	Seeds	Permanent Implants

5. Newer Isotopes

Name	$T_{1/2}$	Photon energy (KeV)	10^{th} VL	Comment
Samarium 125	340 days	41	0.2	Sensitization of cells to radiation damage by iodinated deoxyuridine due to photon energy
Americium 241	432 yrs	60	0.42	Low specific activity and α emitter
Ytterbium 169	32 days	93	1.6	Highest specific activity and lower tissue attenuation
Californium 252	2.65 yrs	NA	NA	Neutron emitter used in brachytherapy and as EBRT source. 2.3×10^{9} / sec (neutrons)

4. Role of radiation in management of common malignancies in India

Of the various treatments available for treating cancer – radiation therapy is one of the commonly used techniques. It makes use of high-energy radiation for shrinking tumors and killing the cancer cells. Some of the commonly used radiation types include the X-rays, charged particles and gamma rays. The radiation is delivered through a machine, either from outside the body or internally. The radiation that's given from outside is known as the external-beam radiation therapy while the one given internally is called the internal radiation therapy – known as brachytherapy.

Most of the cancer patients happen to receive radiation therapy at some point of their treatment course.

How radiation therapy works on the cancer cells?

A cell turns cancerous when the DNA gets damaged and the cell deviates from its path as a result of which it starts multiplying uncontrollably .Radiation therapy works by destroying the DNA of the cancer cells either directly or by creating charged particles in the cell that work to destroy the DNA. When the DNA of cancer cells gets destroyed, they either stop multiplying or die. When the cells die, they are further broken and discarded off the body through its natural process. However, during this process, radiation therapy even harms the normal cells round, which further leads to side effects.

When a patient is to be given radiation therapy, the doctor will take note of the probable damage the normal cells may have to undergo and the therapy is planned accordingly.

Why radiation therapy?

Radiation therapy is administered with two objectives – curative and palliative. When the objective of radiation therapy is to cure the cancer then it will work by removing the tumor or preventing its recurrence.

For curative purpose, radiation therapy is given as a stand-alone treatment or is combined with chemotherapy therapy.

For palliative purpose, radiation therapy works with the objective of relieving the cancer symptoms and cut down the discomfort the patient is experiencing.

National and international guidelines recommend radiotherapy for optimal management of many solid tumors as well as certain hematological malignancies. According to the GLOBOCAN 2012 report, the 5 cancers with the highest incidence rates in India are cancers of the breast, cervix, lip-oral cavity, lung, and colon-rectum. It is well established that radiotherapy plays an integral role in their curative treatment and is an effective treatment for symptom palliation in incurable cases.

5. Radiotherapy for benign disease

In the past, low to intermediate dose radiotherapy (RT) has been used to treat a range of benign diseases including peptic ulcers, tineacapitis (ringworm) and excessive uterine bleeding. RT for many of these indications has been discontinued because of the availability of other treatments and the associated small (subsequently identified) risk of radiation-induced cancer (RIC), a contraindication that is particularly pertinent for RT exposure of children and adolescents. Currently, the use of RT for benign disease is confined to a limited range of predominantly hyperproliferative and inflammatory benign diseases for which there is good evidence for RT as a first or second line of treatment. However, in many RT centres within the UK, it is rarely used; a situation that also pertains across much of Europe and North America. By contrast, RT departments in Germany have a long tradition of using RT for benign indications and a significant proportion of relevant publications come from this country.

Most radiotherapy (RT) involves the use of high doses (>50 Gy) to treat malignant disease. However, low to intermediate doses (approximately 3–50 Gy) can provide effective control of a number of benign conditions, ranging from inflammatory/proliferative disorders *e.g.*
Dupuytren's disease, heterotopic ossification, keloid scarring, pigmented villonodular synovitis. Benign tumours *e.g.* glomus tumours or juvenile nasopharyngeal angiofibromas ,neurological disorders. Current use in UK RT departments is very variable. This review identifies those benign diseases for which RT provides good control of symptoms with, for the most part, minimal side effects. However, exposure to radiation has the potential to cause a radiation-induced cancer (RIC) many years after treatment.

6. Toxicity of radiation therapy

Similar to various other treatments for curing cancer, the radiation therapy also comes with its share of side effects.
Radiation therapy is known to cause late or early side effects. As the name suggests, early side effects occur in a very short span after the treatment process or in some cases, the side effects can surface during the treatment process only, The common side effects of this treatment module include fatigue, nausea, skin irritation, hair loss mucositis and others.
Late side effects usually surface over months and years of the treatment process. These side effects can occur in any of the body's normal tissue that has received radiation. Chances of late side effects depend on the area where radiation was given as well as the dose.

Acute Radiation Syndrome (ARS)

Radiation sickness is damage to the body caused by a large dose of radiation often received over a short time. This is called acute radiation sickness. The amount of radiation absorbed by the body, called the absorbed dose, determines how bad the illness will be.Radiation sickness also is called acute radiation syndrome or radiation poisoning. Radiation sickness is not caused by common medical imaging tests that use low-dose radiation, such as X-rays, CT scans and nuclear medicine scans.

People exposed to radiation will get ARS only if:

- The radiation dose was high
- The radiation was able to reach internal organs (penetrating)
- The person's entire body, or most of it, received the dose
- The radiation was received in a short time, usually within minutes

Symptoms

The severity of radiation sickness symptoms depends on how much radiation you've absorbed. How much you absorb depends on the strength of the radiated energy, the time of your exposures, and the distance between you and the source of radiation. Symptoms also are affected by the type of exposure, such as total or partial body.

Initial symptoms,The first symptoms of treatable radiation sickness are usually nausea and vomiting. The amount of time between exposure and when these symptoms develop is a clue to how much radiation a person has absorbed.

After the first round of symptoms, a person with radiation sickness may have a brief period with no noticeable illness, followed by the onset of new, more-serious symptoms.

If you've had a mild exposure, it may take hours to weeks before symptoms begin. But with high exposure, symptoms can begin minutes to days after exposure.

Possible symptoms include:

- Nausea and vomiting.
- Diarrhea.
- Headache.
- Fever.
- Dizziness and disorientation.
- Weakness and fatigue.
- Hair loss.
- Bloody vomit and stools from internal bleeding.
- Infections.
- Low blood pressure.

An accident or attack that causes radiation sickness would lead to a lot of attention and public concern.

Late Effects of Cancer Treatment

- Long-term side effects of cancer treatment are side effects that last months or years after cancer treatment ends..
- Evaluating and treating long-term and late effects is an important part of cancer survivorship care.Some possible long-term effects of cancer and cancer treatment include the following;
  - Bone, joint, and soft tissue problems
  - Brain, spinal cord, and nerve problems
  - Dental problems
  - Digestion problems
  - Emotional effects
  - Eye and vision problems
  - Fatigue
  - Heart problems
  - High blood pressure
  - Hormone problems
  - Learning, memory, and attention problems
  - Long-term problems after surgery

- Lung problems
- Second cancers

7. Oncology emergency

An oncologic emergency is an acute health problem caused by the cancer or its treatment and requires immediate treatment

Classification Selected oncologic emergencies

Most oncological emergencies can be classified as metabolic, haematological, structural, or treatment-related

- Superior vena cava syndrome –
- Cardiac tamponade –
- Spinal cord compression –
- Hypercalcemia –
- Tumor lysis syndrome
- Febrile nutropenia
- Sepsis
- Arrhythmia
- Deep venous thrombosis
- Disseminated Intravascular Coagulation (DIC)
- Tumour bleed
- Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

Complication of anticancer therapy – Other medical emergencies as in non-cancer patients Organ system: – Cardiovascular, respiratory, neurological, hematological, gastrointestinal, urological, renal and metabolic, etc

Management of oncologic emergencies follows standard practice: establish diagnosis, evaluate organ function and prompt initiation of therapy Several oncological factors must be considered that may influence aggressiveness of management Aggressiveness of therapy should be influenced by reversibility of event, probability of a reasonable survival with adequate quality of life.

8. Palliative care

Palliative is specialized medical care for people diagnosed with a serious illness, and it can be integral to a patient's healing process. Alongside curative treatment, palliative care can enhance the patient's quality of life. The Latin root word is *palliat*, which means "cloaked." In a sense, palliative care acts as a healing cloak for a patient's pain. A palliative care team comprises several health care professionals that provide medical, social, emotional, and financial support to the patient and their family. This care is provided in hospitals, nursing homes, outpatient clinics, and sometimes at home.

Palliative care can include administering medication, advising changes to nutrition or diet, techniques for relaxing and relieving pain, emotional support, and more. Each patient case requires a tailored care plan for their unique needs. People who need palliative care are patients suffering from symptoms of life-threatening illnesses. They could be living with the following:

- Cancer

- Heart disease
- Blood and bone marrow disorders
- Alzheimer’s
- Kidney failure
- Parkinson’s
- Cystic fibrosis
- Dementia
- Stroke

Symptoms that palliative care can help heal

Palliative care can provide relief for symptoms such as:

- Pain
- Nausea or vomiting
- Depression or sadness
- Anxiety
- Constipation
- Fatigue
- Loss of appetite
- Trouble sleeping
- Shortness of breath

Types of palliative care

Palliative care comes in many forms, depending on the patient’s needs. These are the types of palliative care and what each looks like in practice.

Physical

The physical pain and side effects that accompany serious illnesses can feel overwhelming. When a patient is experiencing physical side effects from the illness or treatment, such as pain, fatigue, nausea, shortness of breath, and trouble sleeping, it can take a toll on their overall well-being. Palliative care specialists, pain specialists, or sleep therapists, might be called in to help manage these symptoms and side effects.

Social

While experiencing pain, discomfort, or sadness while you are ill, patients may find it difficult to connect with caregivers or family members about how they feel. Patients may not want to burden them and sometimes need an objective point of view or even just a ride to and from the hospital. Social workers offer support by devising how to call a family meeting or ride services information. They can even provide palliative care for caregivers when they’re feeling overwhelmed.

Emotional

During an illness, patients may feel physically in pain, but they can also experience a wide range of emotions. Patients might feel sad, angry, anxious, and grateful all at once. Emotional palliative care can look like gaining access to a support group or a mental health professional to help them cope with the emotions.

Mental

Alongside emotional care, illness’ symptoms, treatments, and medications can affect the mind. Patients might feel stressed and have hard time thinking clearly if they can’t sleep. They could be worrying about children or parents if they cannot take care of them. Mental health counsellors and support groups can suggest yoga, art, walking, and other relaxing activities.

Spiritual

While suffering from a serious illness such as cancer or dementia, patients may encounter thoughts about nearing death or seeking greater purpose upon surviving an illness. One aspect of palliative care can be spiritual, so if a patient belongs to a church, synagogue, masjid, or temple, leaders or community members of their chosen faith can help them deal with the situation in a positive way.

Financial

Finally, palliative care might come in the form of financial assistance. Hospital bills and treatments can add up. Patients may need child or family care while they're ill. Social workers or financial counsellors can talk through billing and insurance, help apply for disability payments or medical leave, find programs that deliver low-cost medicine, and ideate other financial alternatives.

9. Empathy in the care of patients with cancer

In the intricate dance between life and illness, there exists a sacred bond that often goes beyond the realms of clinical treatment, the profound connection between a cancer patient and their healthcare provider which includes the doctor and his team of nurses and the staffs involved in the treatment lead by the doctor himself.

A cancer diagnosis sends shockwaves through the very core of one's existence, and in this whirlwind of emotions, the doctor becomes more than a medical professional; they become a lifeline. Far beyond the prescription pad and treatment plans, it is the empathetic doctor and his team who weaves the narrative of hope, resilience, and survival.

In the labyrinth of treatments, surgeries, and uncertainty, the doctor transforms into a beacon of compassion. Their role extends beyond medical expertise; they become companions, listeners, and bearers of solace. Amidst the pain and fear, doctors are the architects of courage, administering not only medications but also doses of understanding and kindness.

The importance of an empathetic doctor and his team in the journey of a cancer patient cannot be overstated. They become storytellers, narrating tales of triumph over adversity. With every diagnosis, they offer not just medical insights but also a language of hope that patients can grasp onto. Doctors plant seeds of belief, nurturing a spirit that refuses to succumb to the challenges posed by illness.

Each step of the way, the team stand by patients, offering not just clinical support but also emotional sustenance. In the delicate balance between truthfulness and gentleness, they become translators of complex medical language, making it accessible to patients grappling with the intricacies of their condition. With their words and actions, doctors sow the seeds of courage that blossom into gardens of resilience.

For these healers, it's not merely a profession but a calling – a sacred duty to accompany patients on their journey to recovery. They celebrate even the smallest victories, understanding the profound impact of positive moments on the overall well-being of a patient. In setbacks, they provide solace and the reassurance that the journey is not faced alone.