OVERVIEW OF CANCER TREATMENT AND THE ROLE OF RADIATION THERAPY IN CANCER MANAGEMENT

Abbas Abdus-salam

Over the last several decades, starting from about the middle of the last century, cancers have increasingly become a major public health challenge worldwide. The reasons for this are not far-fetched. For much of the world's known recorded earlier history, infections posed the greatest mortal dangers to humanity. From Dengue fever, to malaria, to typhoid/cholera, to tuberculosis and sundry viral and non-viral epidemics, even pandemics, mankind was pummeled by diverse kinds of infections resulting in huge loss of lives and/or general well-being.

Mercifully, however, the tide began to change about the middle of last century. The accidental discovery of penicillin by Sir Alexander Fleming in 1928 heralded the era of powerful antibacterial drugs for use against major infections. This eventually led to the huge leaps made in pharmaceutical manufacturing in that same century making most infections treatable, and their contribution to human morbidity and mortality significantly degraded. With this decline, non-communicable diseases including

cardiovascular events, diabetes and cancers acquired greater prominence in much of the West, especially.

The increase in this prominence of the cancer-burdens in particular was, in addition, facilitated by advances in diagnostic and imaging sciences including the Computed Tomography (CT) Scan, Magnetic Resonance Imaging (MRI), Medical/Clinical Ultrasonography, Radioisotope Scintigraphy, and Positron Emission Tomography (PET), to mention a few. All these coupled with some other medical advances like the development of sophisticated tumour markers made detection of cancer easier, and more frequently, especially in the early stages.

Notwithstanding the above it is known that the increase in cancer incidence may not only a result of the improved diagnostics. Possibly due to temporally accumulating genetic alterations in man's genome, some viral exposures, and the unhealthy life-style choices increasing numbers of people make globally—e.g. alcohol consumption, cigarette smoking, consumption of unwholesome fast foods, lack of outdoor lifestyle, etc.—it is known empirically that is no question of that there, indeed, is a true increase in the development of various cancers in man.

Cancers can be tackled in many different ways. For instance, we can aim to prevent its development by make more healthy lifestyle choices like reduction in smoking and alcohol intake, reducing obesity and cutting exposure to carcinogenic agents, especially in the industry and in our food. This is called primary prevention. We can also do secondary prevention which involves mass screening to detect identifying cancer precursors, as well as to detect early cases, and thus offer quick and effective treatment.

Clinical cancer management can be classified into cancer-specific treatment including surgery, chemotherapy; and, supportive treatment like treating pain, and correcting electrolyte and haematological derangement. These are often combined in the course of treating a cancer patient. In addition, multiple treatment modalities are often deployed to treat different cancer types and clinical presentations.

Cancer Treatment Modalities

There are many different cancer treatment options. What treatment options are adopted is dependent on the diagnosis, the specific cancer type and the body organ-system involved, the stage of the disease and each patient's general clinical and oncological status.

The treatment options available include:

- Surgery-surgical resections, decompression, or biopsy
- Radiation Therapy—local and general
- Chemotherapy
- Hormone Therapy
- Immunotherapy
- Targeted Therapy
- Use of radioactive isotopes orally or by injection

The primary diagnosis—i.e. the specific cancer type/ organ involved—is what usually determines the choice of treatment. However, the stage of the disease may indicate the need to modify the treatment options or dictate the order in which they will be administered. An organ-confined breast or prostate cancer may be amenable to surgery alone, as is a significant number of brain tumours. However, if there are distant metastases, such patient will require further treatment including chemotherapy

and radiotherapy. If the patient also has hormone sensitive tumours, she/he may be administered hormonal treatment as well.

Furthermore, patients' general condition (clinical performance level) may influence the choice and extent of treatment. These include the age of the patient, physical stamina as measured by a Performance Status assessment, and the patients' desires. A patient who desires to preserve fertility, for instance, may not accept hysterectomy for early-stage cervical cancer, but ask for radiation treatment instead.

Patients' Clinical Performance Status

Clinical Performance Status is a measure of the patients' general stamina and ability to care for themselves. It assesses the patient's general well-being and ability to perform routine daily tasks like ambulating, feeding themselves, taking a bath / grooming, getting out of bed etc. Assessment of this performance status of each patient is an important part of cancer care because cancer treatment by itself can be debilitating and weigh heavily on patients' quality of life. It is therefore important that patients' cancer treatments are tailored to their performance status to avoid tipping over some patients with borderline capabilities.

On the other hand, corrective measures may need to be taken to improve certain patients' performance status where possible with a view to facilitating their ability to withstand the rigors of treatment and improve their chances of survival. These corrective measures may be in the form of blood transfusion / haematological augmentation, nutritional interventions or pain management. And to achieve this, it may be necessary to

employ the services of other clinical/oncological workers like nutritionists/dieticians, clinical psychologists, and pain medicine specialists.

There are two clinical (eponymous really) tools of assessing patients' performance status. These are the Karnofsky Method and Zubrod Method. The Zubrod Scale is also referred to as the Eastern Cooperative Oncology Group (ECOG) Scale and is adopted by the World Health Organization and more widely used. The two scales (Karnofsky and ECOG) use a diametrically opposed scaling system. Karnofsky's Scale is from 100 to 0. It is however graduated in 10s with 10 being the lowest score and 100 the highest. The ECOG on the other hand is from 4 to 0.

In the Karnofsky's scale (the Karnofsky Performance Status) the patient with normal, unimpaired daily activity has the highest score of 100 and the least responsive/ moribund patient has a score of 10. This is opposite to ECOG where the highest score of 4 goes to the moribund patient, and the lowest score of zero (0) to the normal patient, (Tables 1a and 1b). Note from the table that dead patients are ascribed 0 and 5 scores in the Karnofsky's and ECOG scales respectively. However, performance status for a dead patient is superfluous.

Table 1a: Eastern Cooperative Oncology (ECOG) Performance Status Scale

0	Asymptomatic (Fully active, able to carry on all activities without restriction)
1	Symptomatic but completely ambulatory (Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature. For example, light housework, office work)
2	Symptomatic, <50% in bed during the day (Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about more than 50% of waking hours)
3	Symptomatic, >50% in bed, but not bedbound (Capable of only limited self-care, confined to bed or chair 50% or more of waking hours)
4	Bedbound (Completely disabled. Cannot carry on any self-care. Totally confined to bed or chair)
5	Dead

Table 1b: Karnofsky Performance Status Scale

100	Able to carry on normal daily activity and work, No complaints—no evidence of disease
90	Minor signs and symptoms of the disease
80	Normal activity with some effort. Some signs and symptoms of the disease
70	Unable to work. Able to care for most personal needs. Some assistance needed
60	Care for most personal needs. Occasionally required assistance
50	Requires frequent assistance and medical care

40	Unable to care for self. Requires hospital care. Rapid progression of the disease
30	Severely disabled. Requires hospital admission
20	Very sick. Hospital admission. Active, supportive treatment
10	Moribund
0	Dead

Cancer Treatment Modalities

Surgery

Most solid tumours will require surgical intervention at one stage or the other, for diagnosis and / or treatment Surgery is, therefore, an important treatment modality for cancers. As a diagnostic tool, the primary role of surgery is taking biopsy for histological diagnosis. Biopsy can be excisional or incisional on the primary lesion; it can also be lymph node biopsy. in addition, the full extent of many cancers requiring comprehensive staging is most often determined with surgical staging.

As for its role in the treatment of cancers, the extent of surgery for definitive treatment varies greatly. Some early-stage tumours may be amenable to minimal surgical resection (even by minimally invasive procedures) while others may require extensive lesion excision with or without the lymph nodes involved. In the abdomen, for instance, surgical treatment may be accomplished with key-hole, minimal-access laparoscopic procedures. It may instead require more extensive procedures like open laparotomy, total organ removal (e.g. hysterectomy/ oophorectomy, or colectomy). Organ removal may be complete or partial depending on extent of the disease.

All said, surgery is particularly suited for early-stage

cancer cases and provides one of the best opportunities for cancer cure and long-term control. It can be offered as a single-modality treatment or in combination with other treatment modalities.

Chemotherapy

Cancer chemotherapy involves the use of specialized drugs for controlling the tumour-growth. The drugs can be administered into the body systems through different routes, including orally, intravenously, intrathecally, intramuscularly, and even topically. Chemotherapy is an important modality of treatment especially in advanced, metastatic diseases where the systemic disease-burden and/or an advanced local disease may not infrequently be beyond the reach of surgical extirpation.

Cancer chemotherapy can be employed in different ways. It can be used as a single-modality of treatment; or, as neo-adjuvant and adjuvant therapy with other cancer-treatment modalities.

Neo-adjuvant chemotherapy is when the therapeutic drugs/agents are administered to a patient with cancer before any other major treatment is undertaken. The other major treatment in this respect is actually most often surgery. Thus, neo-adjuvant chemotherapy may be deployed to reduce the size of a particular tumour to ease surgical intervention. It is easier to surgically manipulate a smaller-sized tumour than a very big one and is likely to improve outcome of surgical intervention. One other benefit of neo-adjuvant chemotherapy vis-à-vis surgical manipulation of cancers is that it aids the reduction of the chances of the viability of cancer cells that may get shed systemically during surgical dissections. This serves to reduce the chances of micro-metastases as well as

scar recurrence, for instance. Also, it may help improve the cosmetic outcome following surgery due to easier handling of smaller tumour intraoperatively.

Neo-adjuvant chemotherapy is also helpful in patients receiving radiation treatment. Some of the chemotherapy drugs act as radio-sensitizers to improve patients' response to radiation treatment. This may reduce the overall dose of radiation required for treatment with consequent reduction in possible toxicity. The debulking (reduction in size) that may accompany neo-adjuvant chemotherapy can also improve radiotherapy technique and reduce the radiation-field size. These are capable of improving the treatment outcome and the chances of cure or long-term control.

It must however be remembered that neo-adjuvant chemotherapy may also worsen the potential side effects of radiation treatment.

On the other hand, adjuvant chemotherapy is when chemotherapy is administered following some other major treatment modality including surgery and radiation treatment. Adjuvant chemotherapy is aimed at systemic micro-metastasis, as well as residual lesions not removed by surgery or radiotherapy; thereby improving the general treatment outcome.

Yet another method of deploying chemotherapy in clinical-oncology practice is as concurrent treatment, especially in patient receiving radiotherapy. This involves concurrent administration of chemotherapy drugs during the entire duration of radiation treatment. The drugs can be administered daily or weekly and is believed

to potentiate the effects of radiotherapy (i.e. act as radiosensitizer) and improve treatment outcome.

Classifications of Chemotherapeutic Agents

There are many different chemotherapy agents and they are grouped together based on certain characteristics including their origin/chemical properties and mode of action. Some of these different groupings are shown below, in table 1:

Table 2: Classification of Chemotherapeutic Drugs

<table>
<tr><td>Alkylating agents</td><td>Cisplatin, Busulfan, Cyclophosphomide</td><td>Inhibit DNA replication and transcription by donating an unstable alkyl group which reacts with proteins and the DNA</td></tr>
<tr><td>Anti-Metabolites</td><td>5-Florouracil, Methotrexate, Mercaptopurine</td><td>Inhibit DNA replication either by replacing DNA components or blocking DNA synthesis</td></tr>
<tr><td>Cytotoxic Antibiotics</td><td>Adriamycin, Actinomycin D, Bleomycin</td><td rowspan="2">Inhibits DNA by blocking Topo-Isomerase</td></tr>
<tr><td>Topo-Isomerase Inhibitors</td><td>Irinotecan, Topotecan</td></tr>
<tr><td>Vinca Alkaloids</td><td>Vincristine, Vinblastine</td><td>Inhibit microtubule formation by binding to tubulin thereby halting cell division</td></tr>
</table>

Side Effects of Chemotherapy

Chemotherapeutic agents/drugs are cytotoxic moieties, targeted at cancer cells, and may be administered orally through the digestive system, intravenously directly into

the bloodstream, intrathecally into the cerebrospinal space and sometimes topically. The intrinsic toxic potentials however means they can also do harm to the body either in general, or to some specific organ/system.

Some of the major general side effects of chemotherapy are nausea and vomiting, fatigue, loss of hair, bone marrow suppression leading to anaemia, immunosuppression and reduced platelet counts. Virtually all the different chemotherapy drugs exhibit these general side effects to varying degrees. Therefore, all patients being worked up for chemotherapy must have baseline check of the functional status of some of their body functions with some laboratory analysis, like Full Blood Count (FBC) and Electrolyte, Urea and Creatinine check. A packed-cell volume (PCV) of at least 30% is, on the average, desirable before commencing chemotherapy. Platelets must be 100,000/mm3 and above. Because chemotherapy drugs are usually metabolized in the liver and cleared in the kidney, normal liver and kidney functions need to be ensured. Thus, when chemotherapy becomes imperative in the face of compromised liver and kidney functions, necessary adjustments must be made to the doses of the drugs.

In addition, certain ones among this whole lot of chemotherapeutic agents have specific side effects that must be factored into the treatment planning. The anthracyclines including Doxorubicin are cardiotoxic. Therefore, clinical cardiac assessment and other ancillaries including electrocardiography (ECG) and Echocardiography must be done before administering the drugs. Cisplatin is ototoxic, so a hearing assessment needs to be done prior to drug administration.

Nausea and vomiting are countered with anti-vomiting drugs including Maxol on, ondansetron and granisetron. Dexamethasone administered pre and post chemotherapy also helps reduce nausea and vomiting. It also helps reduce pain and also aid the anti-cancer activities of many chemotherapy drugs.

Tumour lysis syndrome occurs when large number of cells break down precipitously following systemic administration of chemotherapy agents, releasing the genetic materials of the 'dead' tumour cells into the blood stream in the form of uric acid. This can lead to dangerous hyperuricemia that may elicit different kinds of complications including acute renal failure. Administration of xanthine oxidase inhibitors (XOI) like allopurinol can help prevent or mitigate this complication-profile; so is maintenance of adequate pre- and post-chemotherapy hydration to maintain high urine output.

Hormone Therapy

Hormone therapy is usually used as part of a multi-modal treatment in combination with other treatment modalities. Many species of cancers are hormone-dependent, responding to respective normal body hormones which then aid in their growth and aggressiveness. Breast cancer and prostate cancer are two very common examples of these. Such cancers can be managed partly with hormone manipulation often in the forms of drugs that are antagonistic to the actions of the hormone. This antagonism may come in the form of blocking the hormone receptors, disrupting the production of the hormones or impersonating the real hormone or its end-organ effect, thereby leading to a negative-feedback reduction of the production of the

specific hormone.

Immunotherapy

Immunotherapy is another available modality for cancer treatment. This may be in the form of targeting cancer cells with antibodies that would attack them, or strengthening the body's natural immune system against the tumour cells. In this realm of clinical oncology, a new wave of monoclonal antibodies is now being used to treat different cancers. However, these drugs are usually expensive.

Targeted Therapy

Targeted therapy forms part of the new branch of medicine called Precision Medicine. The idea is based on the fact that there are, sometimes, specific proteins and enzymes that are critical to cancer-survival by maintaining the ability of the cancer cells to grow, divide and spread. Monoclonal antibodies are therefore used as targeted therapy which exerts their effect through the immune system. As a rule, at least for now, the names of these agents usually end in -mab. Examples include trastuzumab and bevacizumab.

Another class of targeted therapies are drugs with low molecular weight which enables them to pass through cell surfaces into the intracellular space to attack intracellular targets. These are classified into two. They are either protease inhibitors with names ending in -mib or kinase inhibitors with names ending in -nib. Examples include bortezomib and carfilzomib, and, sorafenib and ceritinib, respectively.

However, as for of now, targeted therapies are usually

expensive and beyond what many people in the world's low- and medium-income countries can afford.

Radioactive drugs treatment

Certain cancers can also be managed with ingestion of some select medical radioactive nuclides. This treatment modality is handled by Nuclear Physicians who administer the treatment and manage the procedure including the logistics and side effects. Thyroid cancer is a common example of cancers that can be treated with a well-selected radionuclide. Some groups of thyroid cancers are well-differentiated and are able to concentrate iodine substrates in the body just like normal thyroid tissue. If fed with radioactive, potentially cytotoxic, iodine, the cancer cells will concentrate them with consequent targeted delivery of radiation to the affected area. Papillary and follicular thyroid carcinomas are usually amenable to Radio-Active Iodine (RAI) treatment using Iodine-131 radioisotope.

Radiotherapy

Radiotherapy involves the use of certain ionizing radiations like X-rays, gamma rays (also called photons), electrons, protons and neutrons as cancer-cell cytotoxic agents. Ionization is key to the utility of these radiation types in treating cancer. It is the process of ionization in the cancer cells that leads to the death of the cells, and the cure or palliation for the patients.

Radiotherapy is a major cancer treatment-modality and a cancer treatment facility cannot, in all practical terms, be said to be complete without the ability to offer radiation treatment. The International Atomic Energy Agency estimates that about 50% of patients diagnosed

with cancer will require radiation treatment in the course of their care. This percentage will even be higher in advanced cases where radiotherapy plays very important roles in palliative treatment and symptom control.

Radiotherapy is a local treatment except in the now rare cases where it is administered as Total Body Irradiation (TBI) or Total Skin Irradiation (TSI) when it is applied to the whole body. Outside these, radiation treatment is local by nature, and the effects are therefore limited to the area in which it is applied.

Types of Radiotherapy

The modality of delivering clinical radiotherapy can be divided into two types; Teletherapy and Brachytherapy.

Teletherapy, also known as external beam radiotherapy (EBRT) involves the use radiation for treatment in which the radiation source is at a significant distance from the area being treated. (Figure 1) Early teletherapy equipment are made using radioactive elements as sources of the radiation. The most popular ones are made from Cobalt-60 radioactive sources (Figure 2).

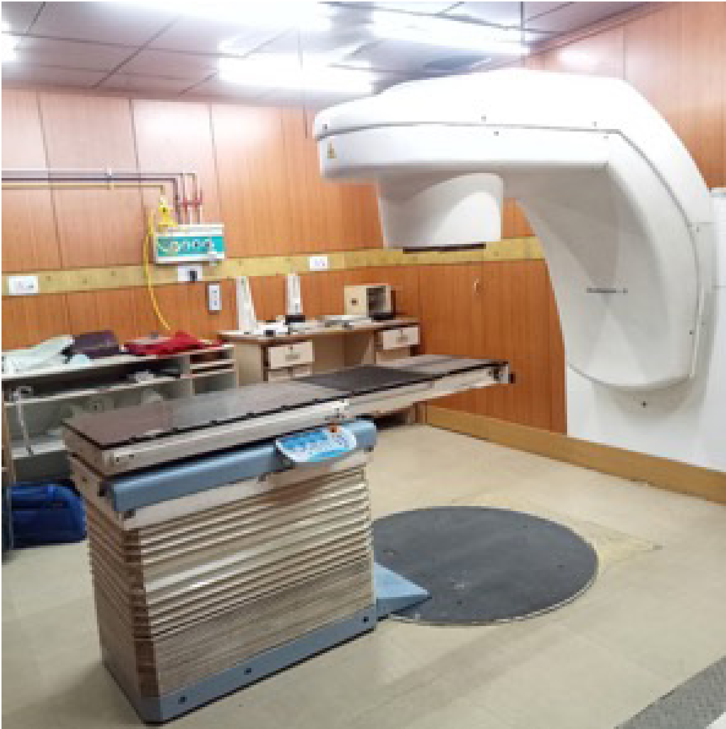

Figure 1: A telecobalt machine using Cobalt-60 radioactive source

Subsequent machines used for this form of radiotherapy are made with artificially produced radiation-sources which are then accelerated to achieve the desired energy levels. The most common ones of this sort are linear accelerators (LINAC) which can be made to produce electrons and x-rays (photons) or electrons alone. There are also accelerators for protons and neutrons but these are much less common and only available in highly specialized centers.

One major advantage of LINAC in addition to the ability to produce photons or electrons is the ability to vary the

energy of the produced radiation; unlike the Cobalt-60 equipment which are limited to single energy. The ability to vary the energy can help to tailor radiation to the specific size of a tumour and its depth in the body.

Electrons have the advantage of low penetration and are particularly useful in treating lesions of the skin. Protons have the advantage of being able to sharply deliver all their doses in a confined area leading to reduced radiation to normal adjacent organs.

Brachytherapy

In contrast to Teletherapy, Brachytherapy is the form of radiation treatment in which the radiation source is within or in close proximity to the part of the body being treated. Therefore, Brachytherapy invariably uses radioactive sources which emit their radiation to the organ to be treated. These sources could be in delivered in the form of wires, needles, plaques or seeds.

Furthermore, Brachytherapy can be classified in many different ways based on some peculiar characteristics. (Table 3)

Temporary Brachytherapy are treatments in which the radiation sources are removed when the planned amount of radiation dose has been delivered. In **Permanent Brachytherapy** on the other hand, the radiation source is left permanently in the patient. However, permanent brachytherapy is usually done with radioactive sources of short half-lives such that after a few days, the risk of radiation to people nearby is much reduced or insignificant.

Brachytherapy can also be classified on the basis of the rate at which the planned dose is delivered (i.e. dose rates). In **Low Dose Rate** (LDR) Brachytherapy, the dose

rate is under 2Gy/Hr (2 Gray per hour). This was the form in which Gynaecology brachytherapy for cervical and endometrial cancers used to be done, i.e. LDR treatment, which meant the patients had the sources left in them for days. But, in **Medium Dose Rate** (MDR) brachytherapy, the dose rate is scaled up to between 2 and 12Gy/Hr.; while in **High Dose Rate** (HDR), the dose rate is about 12Gy/Hr.

Brachytherapy can also be classified based on the method of its application in the body organs/systems as intracavitary, intraluminal, interstitial or Plasiotherapy. Brachytherapy equipment is more compact and relatively cheaper than teletherapy equipment. (Figure 3)

Figure 2: Gynosource 3-channel brachytherapy machine

Table 3: Classification of Brachytherapy

<table>
<tr><td></td><td>Basis of Classification</td><td colspan="5"></td></tr>
<tr><td>A</td><td>Length of Implantation</td><td colspan="2">Temporary Brachytherapy</td><td colspan="3">Permanent Brachytherapy</td></tr>
<tr><td>B</td><td>Dose Rate</td><td>Low Dose Rate (LDR)</td><td colspan="2">Medium Dose Rate (MDR)</td><td colspan="2">High Dose Rate (HDR)</td></tr>
<tr><td>C</td><td>Application Method</td><td>Intracavitary</td><td colspan="2">Intraluminal</td><td>Interstitial</td><td>Plasiotherapy</td></tr>
</table>

Radiotherapy Treatment Planning

Radiotherapy is, by nature, precision medicine because it requires that well-delineated areas of a body's organ/system involved with tumour is precisely targeted with radiation while sparing the uninvolved tissues(s). The process by which this precision targeting and delivery of radiation dose is done is called treatment planning.

The process has improved over the years from using the plain X-ray study to that of advanced imaging techniques including MRI and PET for tumour delineation. Radiation dose-delivery has also moved from two-dimensional (2D) treatment planning to three-dimensional (3D) conformal planning able to define the targeted area more precisely. Other recent improvements in radiation treatment delivery include Intensity Modulated Radiation Therapy (IMRT), Image-Guided Radiation Therapy (IGRT) and Stereotactic Body Radiotherapy (SBRT).

Treatment planning usually happens after a patient has been properly diagnosed and the extent of the disease defined clinically. This will involve histological diagnosis in most cases, as well as some clinical/ancillary investigations to appraise the involvement of some critical organs/systems in the body, like the liver and lungs. Noteworthily, it is often important to look out for liver and lung metastases because they usually do not present with symptoms in the early stages.

After the decision for radiotherapy has been made and the area to be treated determined, the patient goes to the Simulator for detailed scanning and image acquisition of the relevant areas. This is often done with the CT, MRI or PET scan depending on the facilities available at each treatment centre. Multiple imaging modalities may also be combined to improve the accuracy of the treatment-field delineation. For example, while a CT or MRI may show the mere presence of enlarged lymph nodes, other advanced imaging modalities like the positron emission tomography (PET) may be able to demonstrate the presence of active disease in these lymph nodes, thereby improving the targeting accuracy.

The acquired images are then fed into the treatment planning computer where the radiation oncologist will mark out the areas to be treated. This process is called "contouring" and requires good knowledge of radiographic anatomy. After the contouring, the medical physicists or therapy radiographers will plan the appropriate radiation fields to be used to achieve the objective of the contouring. The radiation oncologist will then review the applied fields to ensure that the tumour being put up for treatment is well covered and the nearby uninvolved organs are spared. Finally, the planning would be approved by the radiation

oncologist when the desired objectives of the planning have been met.

To summarize, radiation treatment-planning involves:

- Diagnosis and defining the extent of the disease—i.e. staging
- Simulation with CT, MRI, PET or a combination of the three
- Contouring by the Radiation Oncologist
- Definition of the radiation beams by the Medical Physicists or Therapy Radiographers to achieve the stated plans
- Final review/approval of the applied beams by the Radiation Oncologist when the desired objectives have been met

Radiation Treatment Delivery

The planned radiation dose is delivered using the teletherapy or brachytherapy equipment, as the case may be. The dose of radiation is specified in Gray (Gy) and the total amount is usually given in divided doses called fractions. For uniform distribution of the radiation dose within the tumour mass, multiple radiation beams (fields) are used. Radiation amount is prescribed specifying the total dose, fractionation regime and the treatment period, e.g. 45Gy in 12 daily fractions over 4 weeks.

Fractionation

Radiation doses are usually administered in divided portions called fractions. The fractions can be administered daily, alternate daily, and sometimes multiple times daily until the total dose is delivered. There are different types of fractionations, usually based on the fraction-size and frequency.

Normal (Conventional) Fractionation: Conventional fractionation involves administration of 2Gy of radiation every day with the exception of Saturdays and Sundays. This is the most common treatment-pattern used in much of clinical oncology.

Hypofractionation: This involves giving less than one fraction per day with usually larger than 2Gy per dose. This fractionation pattern is useful in late responding tissues including breast and prostate cancers. Skipping every other day is another common form of hypofractionation regime.

Hyperfractionation: This involves administration of multiple fractions within a 24-hour period; but, with each fraction being at least 6 hours apart. The dose is often smaller per fraction compared to conventional fractionation. This is usually employed for rapidly growing cancers with high tumour-doubling time.

Accelerated Fractionation: In most (if not all) the previously mentioned fractionation patterns, the overall treatment durations are usually the same with only the number of fractions and frequency of administration being different. In accelerated fractionation, however, the overall treatment time is reduced. This is also usually applied in tumours that are rapidly growing.

Indications For Radiotherapy

Radiation treatment may be considered for the following reasons in cancer patients:

- ***Radio-sensitive tumours:*** Radiosensitive tumours are most likely to do well with radiation exposure. Different tumour cells have different response rates to radiation treatment. In addition, cells in

different phases and compartments in the cell-cycle have different radiosensitivity.. Thus, highly proliferative tumours with high proportion of poorly differentiated or undifferentiated cells respond well to radiation.

- ***Unresectable tumours:*** Metastatic and locally advanced tumours may be unresectable at presentation. Such tumours may be first treated with radiotherapy to reduce the size and improve surgical handling—i.e. neoadjuvant radiotherapy
- ***Incompletely resected tumours:*** Despite extensive surgery, total resection of some tumours may not be achievable. The residual tumour will benefit from radiation to the tumour bed—i.e. adjuvant radiotherapy
- ***Inaccessible tumours:*** Some tumour may be located in parts of the body difficult to access for surgical resection. Nasopharyngeal Cancer is an example of such tumours and are effectively treated with radiation.
- ***Cosmetically sensitive areas:*** Cosmesis may also be a reason why radiotherapy may be preferred over surgery in cancers involving some sensitive organs/ systems, e.g., in the maxillofacial / craniofacial regions. Patients may in such cases prefer minimal or no surgery, combined with radiotherapy to preserve desired body image.
- ***Palliative cases:*** In advanced cases where cure may not be a realistic option, radiation treatment may be used to achieve tumour growth-restraint and improvement in the patients' quality of life.
- ***Symptomatic treatment in advanced cases:*** Radiotherapy is particularly suited for symptom

control in advanced disease. Pain, bleeding, imminent bone fractures are advanced conditions that may be mitigated radiation treatment.

Nuclear Medicine

Nuclear medicine involves the use of unsealed radioactive sources administered either orally or intravenously to the patient to treat some types of cancer. The radioactive sources used include Technetium-99m, Gallium-67, Iodine-131 etc. Unlike in conventional radiotherapy, nuclear medicine radioactive isotopes usually have short half-lives measured in hours and days. This means that patient treated in nuclear medicine may need to be isolated for only a few hours or days after which they pose no danger to other people or even themselves from continuing radiation exposure. Thus, nuclear medicine plays important roles in the management of cancer patients. In addition to its diagnostic function through bone scan, cardiac scan, renal scan and positron emission tomography (PET) scan, it also has some therapeutic functions in well-selected clinical cancer cases. Currently in Nigeria, radioactive Iodine treatment is performed at the University College Hospital, Ibadan for well-differentiated thyroid cancers.

References and Suggested Further Readings

1. Jedy-Agba E, Curado MP, Ogunbiyi O, Oga E, Fabowale T, Igbinoba F, Osubor G, Otu T, Kumai H, Koechlin A, Osinubi P, Dakum P, Blattner W, Adebamowo CA. Cancer incidence in Nigeria: a report from population-based cancer registries. Cancer Epidemiol. 2012 Oct;36(5):e271-8. doi: 10.1016/j.canep.2012.04.007. Epub 2012 May 22. PMID: 22621842; PMCID: PMC3438369.
2. Clancey JK. Karnofsky performance scale. J Neurosci Nurs. 1995 Aug;27(4):220. PMID: 7499924.
3. Karnofsky DA, Abelmann WH, Craver LF, Burchenal JH. The Use of the Nitrogen Mustards in the Palliative Treatment of Carcinoma – with Particular Reference to Bronchogenic Carcinoma. Cancer. 1948;1(4):634-56.
4. Oken MM, Creech RH, Tormey DC, et al. (1982). "Toxicity and response criteria of the Eastern Cooperative Oncology Group". Am. J. Clin. Oncol. 5 (6): 649–55. doi:10.1097/00000421-198212000-00014. PMID 7165009.
5. Abdus-Salam A, Ogunnorin O, Abdus-Salam R. HIV Seroprevalence in Patients with Carcinoma of the Cervix in Ibadan, Nigeria. Ghana Med J. 2008 Dec;42(4):141-3. PMID: 19452021; PMCID: PMC267383.
6. Abdus-Salam, A.A., Folorunso, S., Akinlade, B., Jimoh, M. and Salako, B. (2020). Radiation Oncology in Nigeria; rescuing a fast receding, yet crucially important medical specialty. African Journal of Medicine and Medical Sciences.Vol.49. No.3:339-344pp.

7. Siegel RL, Miller KD, Wagle NS, Jemal A. Cancer statistics, 2023. CA Cancer J Clin. 2023 Jan;73(1):17-48. doi: 10.3322/caac.21763. PMID: 36633525.
8. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024; 74(3): 229-263. doi:10.3322/caac.21834.