Setting Up a Cancer Centre: A WHO–IAEA Framework

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SETTING UP A CANCER CENTRE: A WHO–IAEA FRAMEWORK

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FOREWORD

Cancer is a leading cause of death worldwide, accounting for nearly ten million deaths in 2020. The cancer burden is growing globally, exerting tremendous physical, emotional and financial strain on individuals, families, societies and health systems. Many of these systems in low and middle income countries are being challenged in managing this burden, leading to large numbers of cancer patients around the world without access to timely, high quality diagnosis or the required treatment.

A proper diagnosis is a fundamental step for appropriate and effective treatment because every type of cancer requires a specific treatment regimen. Treatment usually includes radiotherapy, chemotherapy and/or surgery. Determining the goals of treatment is an important step. The primary goal is to cure cancer or to prolong life for a considerable period of time. Improving the patient's quality of life is also an important goal. This can be achieved by supporting the patient's physical, psychosocial and spiritual well-being and providing palliative care during the terminal stages of cancer.

The basics of delivering cancer care involve empowering and engaging communities; improving health literacy; enhancing diagnostic capacity, including pathology and referral mechanisms; and arranging access to and coordinating appropriate treatment. Cancer centres are a major resource in ensuring the success of this comprehensive approach to dealing with cancer and can be planned appropriately.

In 2018 the IAEA and the World Health Organization (WHO) decided to issue a joint publication to guide the establishment of a cancer centre. The aim was to help physicians, policy makers and programme managers develop cancer treatment facilities in a phased manner. As many countries are developing or expanding such facilities, the goal was to present the critical issues and factors to be considered in planning and/or expanding cancer treatment services.

A group of experts from the IAEA and WHO and their Member States met at an IAEA technical meeting in Vienna in February 2019. Follow-up meetings were held in April, May and July 2019. A consultancy meeting of 25 experts was organized in Vienna in November 2019, where the draft report was reviewed and finalized. This guide is a supplement to a more comprehensive publication and highlights the key elements of that version. It describes the features of multidisciplinary cancer care and details the infrastructure, human resources and equipment needed for different services, with the aim of helping national programme managers and planners as they expand their cancer care capacity. This framework is intended to be implemented in accordance with local conditions and resources, thereby systematically improving the capacity for cancer care in a particular country.

This publication was made possible by contributions and reviews from a broad range of experts. The IAEA wishes to acknowledge in particular the contributions of B. Mikkelsen and C. Varghese (project focal point) of WHO. The technical officer responsible for this publication was M. Abdel-Wahab (IAEA).

EDITORIAL NOTE

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EXECUTIVE SUMMARY

Cancer is a leading cause of death globally, and projections indicate that its incidence rates will continue to increase over time. Late stage presentation and inaccessible diagnosis and treatment are common. There is a substantial shortfall around the world in the provision of cost effective cancer prevention, diagnostic and treatment services. While there are interventions to address the burgeoning cancer burden in low and middle income countries, they are not reaching the people in need, leading to vast disparities in the availability of cancer services between countries of different income levels around the world.

Cancer centres are facilities designed primarily for providing cancer care. However, they are also essential for creating and implementing new evidence through their engagement in research and education. In addition, they provide guidance on all aspects of cancer within a country. While there is a wide variation in access to cancer centres around the world, they are recognized as a critical part of the health care system when developing a cancer control strategy. Cancer centres include services relating to prevention, diagnosis, multidisciplinary treatment, supportive care, research and education, and have core services supporting these elements. The level at which these services are provided depends on the local context and, as a result, are implemented step by step and are constantly evolving to cope with the demands of the cancer burden.

1. INTRODUCTION

1.1. BACKGROUND

Cancer is an established public health priority and leading cause of death globally. In 2020, there were more than 19 million new cases of cancer and almost 10 million deaths from cancer worldwide [1]. Globally, approximately one in six deaths is due to cancer [2].

The capacity to prevent and control the cancer burden varies significantly between and within countries. In countries where health systems are not fully developed and face resource constraints there is limited access to diagnosis and treatment, resulting in late presentation. There are major deficits in the provision of cancer services across the cancer continuum, from prevention to survivorship care. In 2019, for example, only 26% of low income countries reported having pathology services available in the public sector [3]. In contrast, more than

90% of high income countries reported that cancer treatment services were available compared with fewer than 30% of low income countries [3].

The consequences of this inequity and insufficiency of capacity in cancer care are avoidable deaths from cancer and a failure to achieve global targets to reduce premature mortality and achieve universal health coverage, as articulated in the WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020 and in Target 3.4 of the UN Agenda for Sustainable Development [4, 5]. The global cancer burden is predicted to rise to between 29 and 37 million new cancer cases by 2040, with the greatest increases in low and middle income countries [6]. The need to scale up capacity is therefore immediate.

1.2. OBJECTIVE

The objective of this publication is to propose a framework to develop a cancer centre and/or to strengthen the provision of services in an existing cancer centre. This framework is expected to be used as a guide to implementation, taking into consideration the local context and resources.

1.3. SCOPE

While not losing sight of necessary prioritization and planning of the health care and cancer care sectors, this publication focuses on setting up a cancer centre. Sections related to core cancer services specify human resources and equipment in different domains. The levels of service are only a guide for incremental improvement in capacity as the local context allows and are not to be taken as predefined conclusions.

The purpose of this publication is to provide the context and requirements for specific services in a cancer centre. It is not to define the level of cancer care as a whole. Thus, it can be used as a tool to evaluate and improve the level of services and build them up to a level required within an individual cancer centre and also to support the planning of new cancer centres. An increase in capacity in a cancer centre should be framed within a broader national context of comprehensive cancer control planning and be cognizant of the potential exacerbation of inequalities associated with higher cost, and with centralized services being inaccessible to significant portions of the population.

1.4. STRUCTURE

This publication describes the essential elements of a cancer centre. After the introduction and background information on cancer centres, an example of a care pathway for a patient with cervical cancer is presented to demonstrate the typical flow of the patient experience through a cancer centre. Sections on each of the essential elements of a cancer centre are then presented, including:

— Establishing a cancer centre;
— Patient care pathways;
— Infrastructure;
— Diagnosis and staging: Facility requirements;
— Multidisciplinary and multimodality treatment: Facility requirements;
— Palliative and supportive care: Facility requirements;
— Additional disciplines: Preventive oncology and oncology nursing;
— Information systems, medical records and registry;
— Education, training and research;
— Governance, administration and financing;
— Advocacy, community engagement and partnerships.

2. ESTABLISHING A CANCER CENTRE

2.1. WHAT IS A CANCER CENTRE?

Cancer centres are an important element in the provision of services and exertion of leadership in cancer care [7–9]. They are facilities for the control of cancer, serve as a guiding institution for all aspects of cancer control and are instrumental in operationalizing and achieving the goals of countries. Teaching, guiding, capacity building, service model development and provision of technical support for a government and its partners are some of the key responsibilities of the cancer centre.

The term ‘cancer centre’ does not have an accepted definition. Nonetheless, there are certain principles and functions that characterize these centres. At its core, a cancer centre provides coordinated, multidisciplinary care that includes all services generally available in a country, including for example, pathology, radiotherapy, surgery and systemic therapy. It may thereby act as a ‘cancer centre’ even if other non-oncology services are provided in the same facility. The term

'accredited' or 'designated' can be used, according to the mandate of a national authority responsible for defining and assessing such requirements.

Additionally, cancer centres should have a broader scientific agenda. For example, the United States National Cancer Institute defines cancer centres as those that have a scientific agenda focused on three main areas: (1) basic laboratory; (2) clinical; (3) prevention, cancer control and population based science, or a combination of these areas [10].

The mainstays of cancer diagnosis are pathology, laboratory services and medical imaging, for treatment includes cancer surgery, systemic therapy and radiation therapy. One purpose of consolidating these three treatment modalities within a single facility is to optimize seamless access to quality care. Equally important is that cancer treatment requires multidisciplinary collaboration to optimize treatment planning (therapy choices and sequencing). In addition, concentrating care leads to higher volumes that support development of focused expertise. Multiple studies have shown that centres with a higher surgical volume have superior outcomes, with lower complication rates and higher 30 day post-operative survival. Cancer centres provide a venue for optimizing a patient centric approach to cancer management and are part of the wider health care system. They may be freestanding or part of larger organizations, such as a health science faculty or school, hospital or group of hospitals that share infrastructure and services. Basic cancer screening and diagnostic services should also be available in the community, allowing timely access for patients suspected of having cancer. Thoughtful organization of the wider health care system in balancing centralized services with decentralized ones is vital in optimizing cancer outcomes, especially in settings with limited resources (see Fig. 1).

As specialized facilities, cancer centres require considerable investment to secure the appropriate facilities, human resources and equipment [11]. In

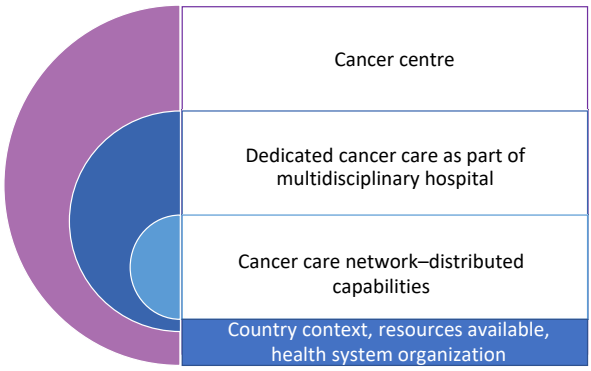


FIG. 1. Wider health care system approaches for expanding cancer care capacity.

low resource settings, in particular, care is needed to ensure that a cancer centre can promote equitable access and universal health coverage. It should not be seen as diverting resources away from lower levels of the health care system but rather as a resource for the entire community. The critical mass of specialized professionals, facilities and equipment in cancer centres should act as a catalyst for the development of similar resources and a high quality cancer system comprising regional or satellite centres. It will support training health professionals and leaders at all levels of the health system. Indeed, these benefits can have a ripple effect on the other health sectors [12].

2.1.1. Benefits of a cancer centre

The benefits of cancer centres go far beyond clinical care. They contribute to strengthening health systems by targeting cross-cutting system-related issues. They should serve as hubs for the training of the health professionals and as flagships for the implementation of a national strategy of quality care. Finally, they should contribute to global cancer care by engaging in relevant research and leveraging existing networks.

2.1.2. Role of a cancer centre in a cancer control programme

Cancer control programmes are public health programmes that aim to reduce the number of cancer cases and deaths and improve the quality of life of cancer patients globally. These programmes are driven by the National Cancer Control Plan, a roadmap for implementing systematic, equitable and evidence based strategies for prevention, early detection, diagnosis, treatment and palliation [13].

Cancer centres are an integral part of a cancer control programme, providing services and assistance in connecting the different components of the National Cancer Control Plan. Collaboration at the national and international levels is important in advancing cancer control, and cancer centres should help lead the coordination of effective partnerships in cancer control.

Scaling up effective diagnostic and therapeutic services, including medical, surgical, radiotherapy and palliative care, by establishing cancer centres could bring substantial health, economic and societal benefits, and help close the global equity divide in access to cancer care services. Just US $1.00 invested in cancer care leads to a direct productivity return of $2.30 and a full return based on both direct productivity and societal gains of $9.50 [14].

Although a cancer centre may operate as an independent institution, it is very much part of the cancer control plan and architecture. The cancer centre acts as the link between various components of cancer control, and helps to

interconnect all levels of care, other disease programmes, overall health systems and services. Investments in cancer centres as part of a national strategy thus capture synergies and opportunities to enhance care delivery.

2.2. FRAMEWORK FOR DEVELOPING A CANCER CENTRE

This guide describes the components of a cancer centre based on service delivery and coordination among services and specialties. A country that has not yet established a national cancer centre should strive to gradually expand services using a phased implementation strategy. The details of how these services can be implemented will vary depending on the specific cancers being treated and on the existing resources that are already available in the country. Implementation programming may differ among countries and require individualized planning, the details of which go beyond the scope of this guide. An illustration of the clinical processes along the cancer care continuum is shown in Fig. 2 [15]. Cancer centres are expected to cover the elements presented along the continuum at different levels.

These services must be organized to deliver care that:

— Is evidence based;
— Is patient centred and multidisciplinary;
— Is well organized and coordinated;
— Ensures the safety and quality of care;
— Has a clinical and translational research capability.

A patient centred approach is a crucial component of high quality health care. Cancer services should be respectful of, and responsive to, the preferences, needs and values of patients and their caregivers.

Multidisciplinary care requires a highly trained team of medical, nursing and allied health professionals who consider all relevant treatment options and cooperative recommendations on individualized treatment and care policy for every patient. The recommended treatment plans or interventions need to be considered by the care team in consultation with patients and caregivers.

A successful multidisciplinary cancer service delivery model requires open communication among team members. Transitions among providers and levels of cancer care are sensitive, and flexible agreements should ensure the best interests of patients. Education and training of providers in communication, teamwork and processes of care are advised to improve capacity and outcomes. ‘Patient navigators’ and ‘nursing case managers’ can help patients through the care pathway and improve coordination and effectiveness [14].

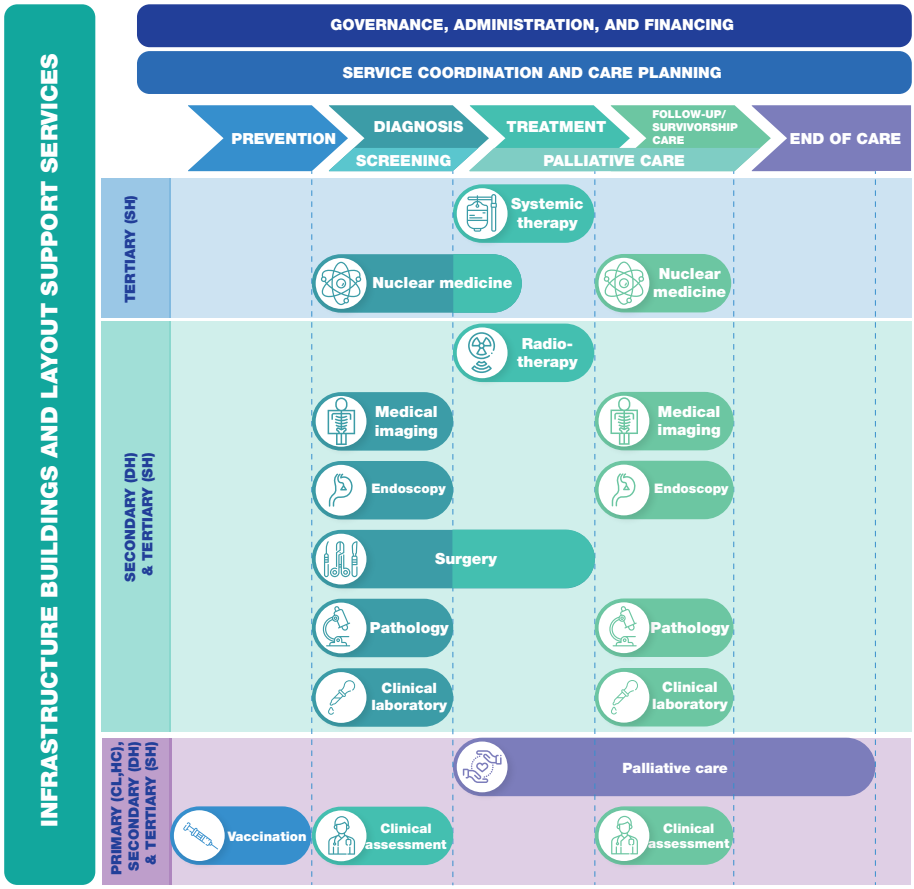


FIG. 2. Component functions of the cancer care continuum show how clinical units are interrelated and interdependent (partially adapted from Ref. [15]).

Both prevention and screening activities will benefit from an effective educational programme to raise awareness of cancer risk factors, symptoms and treatment options. This is particularly relevant for childhood cancer, where the majority of cancers cannot be prevented. Early detection campaigns and training of the health workforce in warning signs and symptoms contributes to timely referrals, which has a positive impact on treatment outcomes [16, 17].

Clinical and translational research have critical roles in advancing cancer care and improving outcomes. Clinical trials are the accepted scientific approach for addressing clinical questions and establishing standards and evidence based guidelines to secure effective and safe treatment interventions.

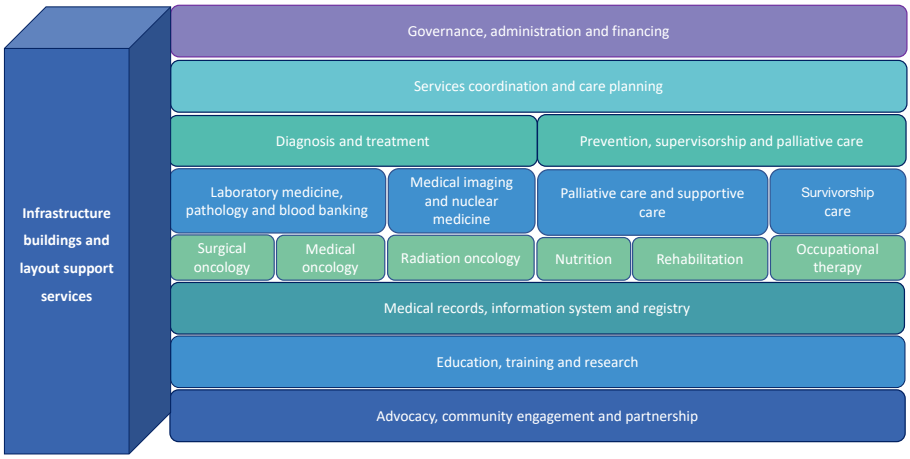


FIG. 3. Schematic representation of the elements of a cancer centre.

In addition to the elements just described, there are many other elements of a cancer centre. Figure 3 presents the schematic representation of these different elements, such as medical records, the information system and registry, education, training, research, advocacy, community engagement and partnership.

3. PATIENT CARE PATHWAYS

A care pathway is defined as "a complex intervention for the mutual decision-making and organisation of care processes for a well-defined group of patients during a well-defined period" [18]. It differs from a clinical pathway (or patient flow) [19] in that it also covers interventions preceding patient admission to a clinic and following discharge, including activities in outpatient units and other health care facilities.

The definition of care pathways is underpinned by the evidence and best practice in key elements of care, as well as documentation, monitoring and evaluation of variances and outcomes. The rationale for creating care pathways is based on the standardization of clinical processes, which reduces variations in the delivery of care, optimizes the use of available resources, and helps keep costs to a minimum [20]. Connecting all activities along a care pathway facilitates understanding of their sequencing, and of the roles and responsibilities of different members of a multidisciplinary care team. Having a full picture can be

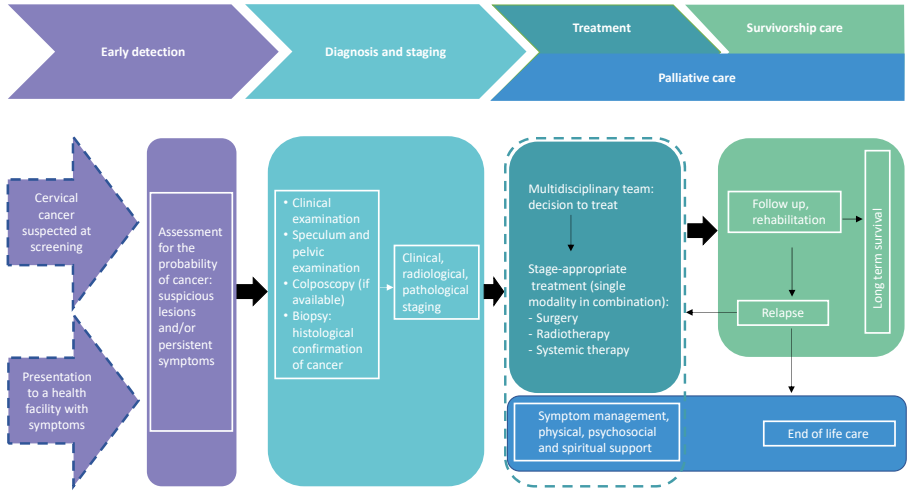


FIG. 4. Early diagnosis and screening pathways using an example of cervical cancer care [22]. The sequencing of activities is organized along the continuum of cancer.

useful in minimizing diagnostic and treatment delays by scheduling some of the activities at earlier times or in parallel [18, 21]. The main goal of care pathways is to enhance the quality of care by improving coordination, reducing fragmentation of services, enhancing patient safety and satisfaction, and optimizing the use of resources.

Pathways related to two distinct cancer early detection strategies — screening [16, 22] and presentation with symptoms — are presented in Fig. 4 [22]. Both pathways must be easily accessible for achieving two major goals of early detection: prevention of pre-cancerous cervical lesions developing into invasive cancer; and identification of invasive cancers at early points of progression, when treatment is more likely to achieve cure, is more feasible, better tolerated and less expensive [23]. Once invasive cancer is detected, further sequencing of diagnostic and treatment procedures is the same regardless of the access pathway. Access to a pathology service is essential at this stage, as a definitive diagnosis of cancer must be based on histopathological confirmation. Clinical, radiological and pathological findings are evaluated to determine the extent of cancer spread or the stage of cancer. Diagnosis and the stage, together with the patient's characteristics (age, co-morbidities, etc.), will guide the choice of appropriate treatment and the assessment of prognosis.

Evidence based clinical practice guidelines must be developed and adopted in each cancer centre. Cancer pathways should be developed based on national/regional normative guidance.

3.1. MULTIDISCIPLINARY CARE

Cancer services should be oriented towards a patient centric model of care with multidisciplinary collaboration between pathology, radiology, surgery, and medical and radiation oncology to determine the optimal multidisciplinary, stage specific treatment plan for a given patient and cancer presentation. Many cancers are treated with curative intent and require more than a single treatment modality. For this reason, physical co-location of cancer treatment services to permit interdisciplinary collaboration is essential. In the case of childhood cancer, the health systems should be prepared to respond to the special needs of children through coordinated services, including the provision of family centred multidisciplinary care [12]. Standardization of care based on evidence based practice guidelines is a fundamental oncology management principle that should be applied regardless of which professional is the first point of contact within the centre.

An optimal approach to cancer planning is the 'multidisciplinary clinic' in which patients with newly diagnosed cancer are seen by surgical, medical and radiation oncology specialists. When multidisciplinary collaboration is not facilitated by co-location of services, multidisciplinary team (MDT) meetings are used to coordinate care. The MDT reviews the clinical, histological and staging findings and makes consensus recommendations on and optimal treatment and care plan for an individual patient. An MDT is composed of healthcare providers specialized in different areas of cancer care. A core oncology MDT may comprise surgeons, radiation oncologists, medical oncologists, pathologists, radiologists, oncology nurses, and either a palliative care specialist or an oncologist with palliative care training [24]. Other professionals, such as pharmacists, social workers and nutrition specialists, among others, are usually included. MDTs are critical in ensuring quality in cancer care and improving patient outcomes [25, 26].

Symptom control/palliative care must be included in the cancer care considerations of all cancer patients; it is an approach that improves the quality of patients' life and their families through the prevention and relief of suffering by assessing and treating distressing symptoms and other problems: physical, psychological, social and spiritual. Early integration of palliative care into treatment has been demonstrated to be beneficial for cancer patients [27].

Similarly, survivorship care is a core element of care provision at any cancer centre. It focuses on health and the physical, psychological, social and economic issues affecting cancer patients [28]. Survivorship care plans must be developed and implemented, including clear guidance on post-treatment care pathways.

4. INFRASTRUCTURE

A well-developed and functioning infrastructure is essential for delivering the responsibilities of a cancer centre. A cancer centre's infrastructure should enable efficiency of movement, integration across levels and departments, optimal use of resources and machinery, reduced waiting times, decreased length of stay, cost efficiency improvements and improved patient and staff safety and satisfaction. Infrastructure development should be incremental and coordinated across different services. Provision for expansion should be made at the outset, based on a set of defined interventions. Infrastructure must be maintained and be responsive to the changing needs of the patient population and the requirements should have metrics to evaluate its effectiveness that should be followed.

A cancer centre's location and any evaluation of its infrastructure and equipment must be based on a detailed analysis and ongoing evaluation of the following attributes:

— Existing population;
— Cancer case numbers and established disease estimates and projections;
— Existing and planned healthcare infrastructure and growth estimates;
— Estimated number of patients expected to visit the hospital across various departments: Out-patient visits, in-patient admissions, chemotherapy/day care visits, radiation therapy visits, surgical cases, imaging and laboratory visits;
— Operational assumptions to manage the estimated patient load;
— Bed capacity, equipment and human resource requirements;
— Phased construction of the comprehensive cancer centre and operation of facilities.

Infrastructure planning should also take into account the following specific situations:

— Setting up a stand-alone cancer centre;
— Expanding an existing facility to include one or more components of cancer care;
— Sequencing the setting up of various cancer care components in a location in a phased manner;
— Creating an integrated care network where the organization is planning multiple centres with similar or distinctive capabilities that rely on each other operationally, such as:
    - A network of hospitals across a region or country;

- Referral hospitals which act as hubs, with smaller centres as spokes;
- Centres catering to specific needs such as paediatric, ambulatory, palliative care, diagnosis, screening and research.

— Including contingencies for future expansion, disaster preparedness, etc.

Additionally, when establishing or scaling up diagnostic imaging, nuclear medicine and radiotherapy services, it is essential that appropriate legal, regulatory frameworks and related national regulatory infrastructures are in place for the safe and secure delivery of these services for diagnosis and treatment. These must be in line with relevant international safety standards and nuclear security guidance. The IAEA has issued several requirements and guidance publications related to the legal and regulatory framework [29–31]. The radiation protection of people and the safety of radiation sources need to be ensured in line with the requirements of an IAEA publication on occupational radiation protection [32]. This includes requirements related to the justification and optimization of radiation protection of patients and prevention and management of unintended and accidental medical exposure, as well as the guidelines provided in an IAEA publication on radiation protection and safety in medical uses of ionizing radiation [33].

The infrastructure required for specific needs is discussed, where appropriate, throughout the following sections. The parameters listed in Table 1 can help in identifying the appropriate configuration of the cancer centre and also in determining the specifications for contracting engineering services for electrical, mechanical, plumbing, water, medical gases and drainage system needs.

TABLE 1. ESTIMATING INFRASTRUCTURE REQUIREMENTS

Scope of facility/ service/network	Key elements to configure scope	Evaluation criteria
Location, size and phasing of facility	Statistics	Population, cancer burden, estimates and projections, procedure caseloads, operational assumptions of beds, equipment and manpower, travel time analysis, other existing and upcoming infrastructure, growth estimates
Location, size and phasing of facility	Other key inputs from surveys	Number and type of hospitals, specialties, beds, dedicated allocations to oncology, geographies being served, patient footfall, equipment, diagnostics, lab work and histopathology centres, details of treatment modalities

TABLE 1. ESTIMATING INFRASTRUCTURE REQUIREMENTS (cont.)

Scope of facility/ service/network	Key elements to configure scope	Evaluation criteria
Clinical drivers	Clinical assumptions	Demographic mix (%), radiotherapy, chemotherapy, systemic therapy, number of cycles/sessions, surgeries, average length of stay, conversion to diagnostics, repeat out-patient department (OPD) ratios, etc., late stage patients and/or concomitant risk factors such as chronic obstructive pulmonary disease, heart failure and coronary diseases, metabolic disorders
Clinical drivers	Key clinical outputs	Weighted average % radiotherapy, chemotherapy, systemic therapy, number of cycles/sessions per patient, average length of stay, conversion ratios, etc.
Centre configurations	Capacity utilization limits	Inputs around average duration of treatments, etc., and capacity utilization limits for key equipment, beds, etc.
Centre configurations	Detailed configuration	Configurations based on utilizations
Centre configurations	Existing infrastructure/ upgrade plans	Inputs on extent of current infrastructure available which can be used. Incremental configuration to be built
Network design	Network and referral principles	Inputs for defining a centre in each location or town Key assumptions for distributed care (cycles in centre 1 versus centre 2, % radiation in every centre, % brachy in every centre, % patients to repeat diagnostics, dropout rates, etc.) Distributing care based on patient geographical location; define consortia and sustained partnerships for referral and financial compensation when human and physical resources are scarce; integrating skilled facilities with cancer centres, for referral in remote areas
Network design	Demographics and patient flows	Population, affluence metrics Inflow, outflow from state Distribution into districts Share of patients likely to be covered

TABLE 1. ESTIMATING INFRASTRUCTURE REQUIREMENTS (cont.)

Scope of facility/ service/network	Key elements to configure scope	Evaluation criteria
Network design	Key network volume outputs	Total cancer patients, OPD, radiotherapy, chemotherapy, systemic therapy, diagnostic volumes and bed nights.

4.1. BUILDINGS AND LAYOUT

As mentioned earlier in this guide, a framework for a cancer centre involves a spectrum of activities. Therefore, the clinical programme for cancer centres must make provision for the following clinical departments in its design and should be physically designed to optimize patient flow with a patient centric model of care:

— Urgent care and emergency care with easy access and connectivity to diagnostic areas, operating theatres (OTs) and in-patient facilities.
— Out-patient consultation area, which includes consultation chambers, support departments for counselling, nutrition and physiotherapy that can be planned as per the disease management groups. The out-patient facility and diagnostic services experience maximum footfall and hence are ideally located closest to the main entrance. In centres where the out-patient services are mainly designed for adults, some areas should accommodate children's needs (e.g. imaging) [34].
— Critical and acute care services, including intensive care units for both medical and surgical care.
— Diagnostic modalities should be located so they are accessible to the emergency room (ER) and out-patient as well as in-patient facilities:
    • Radiology modalities. Magnetic resonance imaging (MRI), computed tomography (CT), ultrasonography, X ray, fluoroscopy and mammography.
    • Nuclear medicine. Positron emission tomography/computed tomography (PET–CT), single photon emission computed tomography/ computed tomography.
    • Endoscopy areas.
    • Laboratory facilities, which include haematology, blood bank, biochemistry, cytopathology, surgical pathology, molecular pathology, microbiology, molecular biology and immunohistochemistry.

- Non-invasive cardiology.

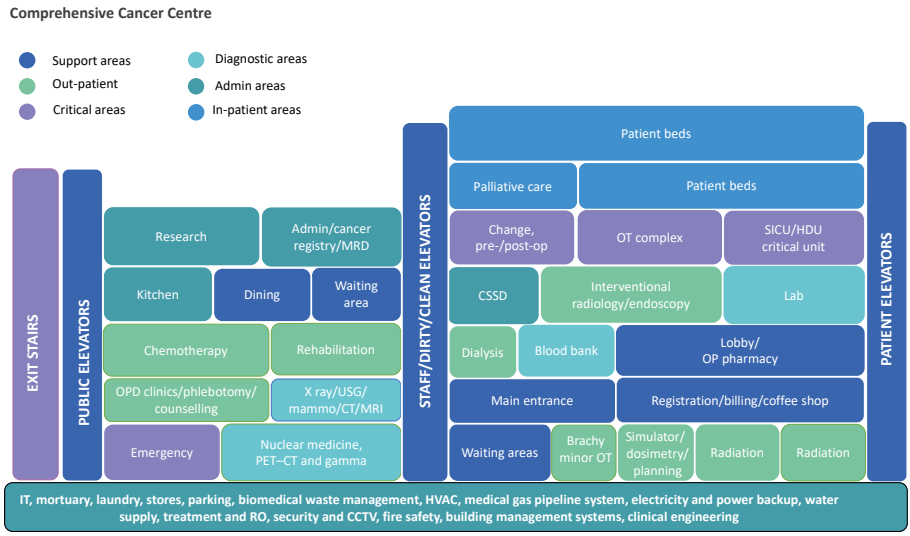
— Treatment modalities:
  - Systemic therapy (chemotherapy, immunotherapy, targeted therapy). Provided through in-patient care or day care facility delivery, where patients walk in pre-scheduled for a few hours every day, or continuous infusion as per their plan over several days.
  - Bone marrow transplantation unit.
  - Radiation therapy. A day care facility that must adhere to specific regulatory requirements with the necessary complement of support areas.
  - Nuclear medicine. Radiopharmaceutical therapy, which also needs to comply with regulatory guidelines.
  - Interventional radiology.
  - Surgical oncology. OTs, admission and recovery areas, anaesthesiology.

— Pharmacy facilities:
  - Out-patient dispensary. This would be best placed close to the out-patient consultation area for the convenience of patients.
  - In-patient pharmacy services, if required.
  - Parenteral therapy (chemotherapy, immunotherapy, targeted therapy, parenteral nutrition, fluids) preparation facilities. These would be best placed close to the day care administration area for convenience and ease of transportation.

— Nursing, palliative, supportive care and rehabilitation:
  - Nursing services.
  - Palliative care.
  - Psychosocial care.
  - Nutritional services.
  - Survivorship care.
  - Supportive care.
  - Rehabilitation.

Based on estimated footfall, the hospital must plan adequate waiting areas, washroom facilities, elevators and staircases, billing and registration counters. The calculation of loads on support services, such as a central sterile services department (CSSD), medical gases, kitchen, dining, water, housekeeping, sewage treatment plants, laundry and access to a Wi-Fi network are made based on the number and area of all clinical departments.

Depending upon individual preference, available space, size of hospital and future plans, these departments are arranged and planned in a manner that optimizes patient, staff and material flow. The various components of a cancer centre are shown in Fig. 5, with one suggested layout presented of various



Note: Satellite services, e.g. pharmacy and surgical services, can be used to support patient centric care.
Pharmacy aseptic unit/preparation facilities (close to the systemic anticancer treatment (SACT) administration area).

FIG. 5. Representative stacking of various services and departments at a comprehensive cancer centre.

departments along with other essential hospital services such as academic areas, IT, mortuary, stores, laundry, food services, engineering services, such as heating, ventilation and air conditioning, power backup, drainage system, biomedical waste management system, supply of medical gases, parking, risk management — security, fire safety, infection control and radiation safety, etc., in order to enhance efficiency.

Furthermore, cancer centres should explore key technological enhancements, such as a pneumatic chute system to transport samples, supplies and medicines, thereby conserving human resources, central monitoring stations and building management systems that suits their requirements. However, the chute system should not be used to transport hazardous medicines. A proper flow between departments is essential; Fig. 6 shows the optimal circulation pattern in a cancer centre, integrating specialties in the environment to effectively deliver multidisciplinary and comprehensive cancer care [35].

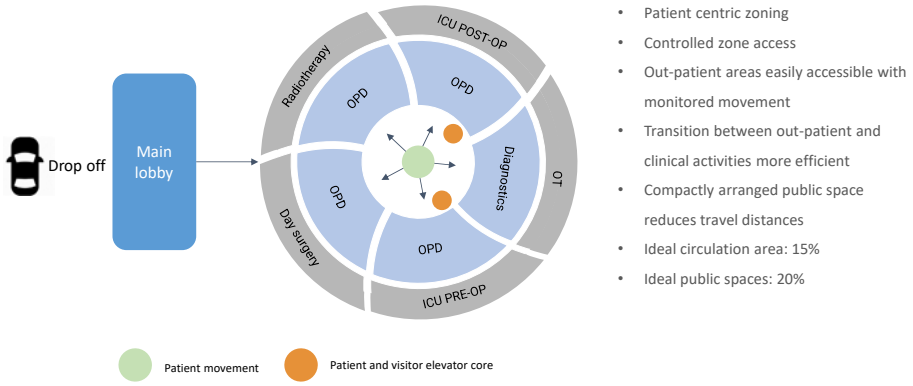


FIG. 6. Circulation pattern in a comprehensive cancer centre.

4.1.1. General planning considerations

All designs must have a state of the art, comfortable, well-lit scheme, with departmental zoning facilitated by clear zones of movement for patient, staff, materials and use of intuitive signage to facilitate the following:

— *A good patient experience.* Focusing on ensuring dignity, privacy, convenience, optimizing treatment compliance and better outcomes.
— *Infection control.* Clear segregation of dirty and clean material movement to ensure highest standards of hygiene and adherence to standards, specifically in areas such as OTs, ICUs and immunocompromised wards. Proper isolation facilities should be provided, including laminar flow rooms and positive/negative pressure rooms for severely immunosuppressed patients, and central sterile services department. Biomedical waste must be segregated, collected and disposed of in compliance with regulatory requirements and national standards.
— *Movement.* Segregated entry, passages and exits for emergencies, regular patients, staff supplies and waste, as well as compliance with standards for necessary space for accessibility, corridor widths, distances, sizes of unit and access controls.
— *Building safety.* Adherence to all national building norms as well as all other regulatory requirements for radiation, area specification, etc. Cancer centres include complex medical equipment, and it is essential that they are in compliance with national fire safety norms and hold up to date licences and certificates.

— *Hospital standards.* These must comply with applicable national standards and requirements of the relevant atomic energy authorities.
— *Efficient and green hospital design.*
— *Scalability.* Modular, flexible and adaptable designs are needed.
— *Standardization.* Should have the same look, feel and touch schemes across platforms and programs within the cancer centre, and potentially across cancer centres, within the overarching cancer network.
— *Engineering and support services.* Comprehensive and scalable engineering support services for efficient, automated management of heating, ventilation and air conditioning (HVAC), medical gas pipeline system, water treatment, specific drainage norms, IT and communications, storage spaces, etc., in compliance with national and international hospital norms. HVAC systems are a key requirement of the manufacturers of specialized equipment such as linear accelerators (linacs), PET–CT, MRI and other radiology equipment as well as surgical suites and the laboratory facilities.

Pharmacy aseptic facilities will require an air handling unit with appropriate specifications (refer to Section 5.3.4) to ensure aseptic conditions for parenteral therapy (chemotherapy, immunotherapy, targeted therapy, parenteral nutrition, fluids). Uninterrupted electricity supply and temperature maintenance in defined ranges for the equipment are important considerations.

5. DIAGNOSIS AND STAGING: FACILITY REQUIREMENTS

5.1. LABORATORY MEDICINE, PATHOLOGY AND BLOOD BANK

5.1.1. Rationale

The evolving management of cancer patients aims to develop a tailored treatment plan for each patient. The diagnostic part of this process involves up to date laboratory and imaging work. The clinical laboratory is therefore an essential department in any cancer care centre. The role of pathology and laboratory medicine (PALM) services includes:

— Diagnosis by examination of patient samples, such as blood, urine, bodily fluids and tissue.

— Assessment of the cancer and the general health status of the patient by examination of blood, urine and other bodily fluid specimens.
— Monitoring of the progression and treatment response of the patient's cancer by checking various laboratory parameters.
— Blood banking is an important part of pathology and laboratory medicine. The cancer patients receiving cytotoxic therapies are at risk of developing different types of cytopenia. They may require whole blood or blood component transfusion.

5.1.2. Key features

The key features of pathological and laboratory services include human resources, physical infrastructure and equipment, laboratory information systems with a monitoring and evaluation framework, quality assurance (QA) and management processes. Specific attention must be paid to documentation at all phases: pre-analytical, analytical and post-analytical; and timely communication of findings, especially critical results. Access to a blood bank (either internally or externally) is required, including storage and administration of blood components. It is important to comply with all regulatory requirements, in particular those related to mandatory reporting and adherence to confidentiality regulations.

WHO provides guidance on establishing a pathology laboratory in the context of cancer control [36] and selection on essential in vitro diagnostics including for cancer [37].

5.1.3. Human resources

A PALM department requires specialized accredited physicians including a pathologist, cytologist and microbiologist. It also requires biomedical laboratory technologists, clerical and other support staff, biomedical engineers, IT specialists, phlebotomists, etc.

5.1.4. Infrastructure and equipment

The department should be organized and arranged according to the laboratory's workflow, allowing maximum efficiency. Care should be taken to establish and maintain a strict, quality controlled environment, such as the humidity level, room temperature, an uninterrupted power supply, etc. Adequate equipment and technologies should be selected according to services provided [15, 36]. Inventory management and supply chain availability are key features for uninterrupted and timely laboratory services. This section organizes laboratory services into different levels. They are indicative and are not based

on a strict definition. There are three levels that describe the facilities needed. These levels refer specifically to laboratory services, and not the level of the cancer centre as a whole. The first level represents the most basic laboratory services. Upgrading to the second and third levels depends on the complexity and extent of the care practised in the organization. In all centres, even in the most sophisticated centres in highly rated institutions, the first level is the foundation and the second and third levels must be fully functional and highly automated to accommodate the high workload. Moreover, there are no clear-cut lines between levels within departments (see Table 2).

5.1.5. Quality assurance

Reliable and reproducible results from PALM services can only be achieved through implemented QA programmes. All tests performed are closely monitored and quality controlled. Standardized, structured reporting using available templates developed by international or national bodies is recommended. Accreditation of PALM services by a national accreditation body is recommended. Though not every cancer centre has the capacity for the secondary review of cancer diagnosis, some national accreditation standards suggest that every patient should have two pathologists (one primary, one secondary reviewer) examine their specimen for QA prior to initiating treatment in order to confirm a cancer diagnosis [36, 38].

5.2. MEDICAL IMAGING AND NUCLEAR MEDICINE

5.2.1. Rationale

Medical imaging and nuclear medicine are essential services in the establishment or improvement of any cancer centre. A Lancet Oncology Commission co-authored by the IAEA shows that scaling up access to nuclear medicine and medical imaging services would avert nearly 2.5 million cancer deaths worldwide by 2030 and yield global lifetime productivity gains of US $1.41 trillion — a net return of over $200 per $1 invested [39, 40]. Specifically, medical imaging and nuclear medicine are essential for achieving the best outcomes for patients with cancer, as cancer imaging spans the health care pathway — from early diagnosis, staging (location and potential spread of the disease) and therapeutic planning, assessment of therapeutic response, image guidance for interventions, evaluation of complications or co-morbidities, and planning/image guidance of palliation.

TABLE 2. LIST OF EQUIPMENT FOR ESTABLISHING A CLINICAL LABORATORY

Device category	Instruments
Infrastructure for all levels	Specimen refrigerator and freezer, reagent refrigerator and freezer Deionized water source Clean hoods, dirty hoods Thermometers Centrifuges Water baths Heating blocks, heating stages pH meter Racks, flasks, tubes, heaters, slides, slide covers Microscopes: upright, phase contrast, stereo, inverted, etc. Incubators, atmospheric air and 5% CO_2 incubators Monitor and alarm systems Backup electric generator Computers, laboratory information system, and electronic medical record
Laboratory by service level	
Level 1 Biopsy collection and management of local patient treatment (up to 250 000)	Complete blood count analyser with auto differential 5 diff or 3 Chemistry analyser Coagulation analyser Automated immunoassay analyser Urine analysis Microscope with phase contrast Spectrophotometer Electrophoresis Manual nucleic acid extraction tools and polymerase chain reaction (PCR)
Level 2 Complete cancer diagnostics suite (up to 1 million patients)	Histology services Flow cytometer Automated immunohistochemistry system Automated PCR purification Fluorescent microscope Digital pathology slide scanner Fluorescence in situ hybridization slide cycler PCR microtube DNA cycler

TABLE 2. LIST OF EQUIPMENT FOR ESTABLISHING A CLINICAL LABORATORY (cont.)

Device category	Instruments
Level 3 Cancer referral/ reference testing (more than 1 million patients)	DNA extraction and liquid handling PCR and real time quantitative PCR Genetic analyser and sequencing reactions Image analysis system with software for chromosome pathology and haematopathology Confocal microscope Image analysis and tracking software Research support devices: • Binding studies[a] • X ray crystallography structure[a] • Super resolution microscope[a] • Single molecule localization biplane nanoscope[a]
Equipment required by departments	
Haematology laboratory unit	Complete blood count with differential counts (level 2) Bone marrow and cerebrospinal fluid aspirate (level 2) Cytochemistry (level 2) Bone marrow biopsy: Blood cell counter with auto diff (level 1) Image analysis system with software for:chromosome pathology and haematopathology (level 3) Flow cytometry system for immunophenotyping, providing state of the art single cell analysis technology (level 2) Automated immunohistochemistry system (level 2)
Clinical chemistry unit	Spectrophotometry (level 1) Electrophoresis equipment (level 1) Immunoassay (level 1)
Histopathology unit	Cytopathology (level 2) Chromosome pathology (level 2) Surgical pathology (level 2) Immunohistochemistry (level 2) Histology (level 2) Tissue procurement facility (level 2) Fixing, staining equipment and microtome (level 2)[a] Super resolution microscope (level 3)[a] Single molecule localization biplane nasoscope (level 3)[a] Confocal microscope (level 3)[a] Image analysis and tracking software (level 3)

TABLE 2. LIST OF EQUIPMENT FOR ESTABLISHING A CLINICAL LABORATORY (cont.)

Device category	Instruments
Molecular biology core facility	Manual DNA extraction (level 1) PCR processes, PCR product cleanup and liquid handling tasks (levels 1 and 2) Electrophoresis equipment (levels 1 and 2) Genetic analyser and sequencing reactions (level 3): • Next generation sequencing analyser
Core for biomolecular structure and function	Protein expression and purification (level 3) and protein characterization[a] Binding studies[a] X ray crystallography structure[a]
Blood bank facility	IT and registry system of donors Area and supplies for blood donation Temperature controlled storage and barcoding system Equipment for blood component separation and storage

[a] Devices required for research purposes.

Imaging includes therapeutic interventions, together with image guided procedures such as radiofrequency tumour ablation, vertebroplasty and image guided nerve blocks. Moreover, molecular imaging has emerged rapidly, with diagnostic and therapeutic applications of nuclear medicine becoming more common in oncology. The IAEA's Medical Imaging and Nuclear Medicine Global Resources Database (IMAGINE) maps imaging resources currently available as estimated per country and territory.[1]

5.2.2. Key features

The cancer centre should be equipped with the appropriate number and types of imaging instruments that best serve the population. And while the complexity and sophistication of the imaging equipment selected will depend upon available

[1] The IAEA provides consultations and training fellowships for Member States, on request and in compliance with country policies (note that the sophistication of such training programmes varies according to the complexity of the planned cancer centre and the expected patient case mix).

resources, mapping the local epidemiological cancer landscape will help calculate the estimated number of patients the cancer centre should expect.

The imaging department should develop specific processes for handling referrals, providing timely appointments, and providing patient instruction and nursing care, if needed. It should have a rigorous process for managing images, standards for reporting and turnaround time, communication back to referring physicians, etc. The process needs to secure storage of images, appropriate radiation protection and MRI safety procedures [7].

5.2.3. Human resources

Running an imaging department requires the advance hiring of adequate numbers of skilled personnel, including medical doctors specializing in radiology and nuclear medicine. As telemedicine services become increasingly common, expansion of telemedicine, especially teleradiology services, may provide multidisciplinary support for centres [41].

The basic skilled human resources required for a medical imaging department include a general radiologist, radiographer and a medical physicist qualified in diagnostic radiology. The general radiologist should be capable of interpreting ordinary radiographs (X rays), ultrasound and CT. In facilities providing care for infants and small children, personnel should be available to provide sedation and anaesthesia services. Expanded medical imaging and nuclear medicine services require similar personnel, particularly radiologists specializing in areas such as breast imaging, chest and abdominopelvic, neurological, musculoskeletal and basic interventional radiology.

More sophisticated imaging and nuclear medicine services would also have an interventional radiologist and a spectrum of image guided interventions; a nuclear medicine physician or radiologist specializing in hybrid imaging; and a physician with special qualifications in therapy with non-sealed radioactive probes. They should be capable of performing advanced applications in CT, MRI and ultrasound, advanced interventional radiology and hybrid imaging such as PET–CT and perhaps PET–MRI, as appropriate. Additional specialists will be needed according to the cancer imaging provided, such as a clinical engineer, radiopharmacist and radiochemistry specialist(s) if molecular imaging research programmes are implemented.

5.2.4. Equipment

Medical imaging and nuclear medicine will require a variety of equipment. It is expected that with the expansion of services there will be an incremental increase in equipment, human resources and related support services. The

full range of equipment for medical imaging and nuclear medicine function is listed below:

— Plain radiography (X ray) units are the baseline equipment. They are cost effective, have a relatively small footprint and do not require complex planning. X ray units can handle different applications such as skeletal, chest and abdominopelvic imaging, and are easily operated.
— Fluoroscopy uses plain X rays to acquire real time images, much like a 'video-clip'. It is a key modality for many image guided procedures. Interventional radiologists use fluoroscopy frequently, and fluoroscopy units are central to interventional radiology areas.
— Mammography's are key to screening programmes for early detection of non-palpable breast lesions, and for guiding stereotactic biopsies of suspicious lesions. Mammography units have a small footprint and do not require complex construction.
— Ultrasound, sonography or echography use sound waves rather than ionizing radiation to produce an image. A wide range of instruments and transducers is available — from basic to complex. Ultrasound has proven clinical value for the detection of breast, thyroid, kidney, pancreatic, uterine, ovarian, adrenal, gall bladder, spleen and liver cancers, as well as those in other locations and organs. While it has a small footprint and simple infrastructure, ultrasound requires skilled physicians and technologists or sonographers. Wherever breast imaging is implemented, ultrasound is a requisite modality.
— CT is essential for cancer detection as well as for staging, monitoring of treatment response, guiding therapy and biopsies, and detecting recurrence. Also, the sophistication of multidetector CT can range from a single detector to 640 detector rows, with single or dual X ray tubes. For the majority of oncological applications, a lower cost unit with at least 16 detector rows will be enough to cover some imaging indications for the brain/head and neck, chest, abdomen, pelvis, extremities, and bone and soft tissue tumours. However, to increase image resolution and lesion detectability (and to enable *multipurpose* use of the CT scanner, as for imaging pulmonary thromboembolic complications or pathological fractures), more detector rows, for example, 64 are warranted. The number of CT units will depend on the size of the cancer centre, its complexity, and the number of patients (including out-patients) to be covered. One multidetector CT scanner can perform at least 1500–2000 examinations per month if operating hours are extended. CT has a larger footprint than X ray, mammography or ultrasound machines.

— MRI is more sophisticated and is superior for brain, cerebral metastasis detection, local detection, staging of bone, soft tissue cancers, colorectal cancer local staging and liver metastasis detection. It serves a complementary role in breast cancer detection, is becoming important in prostate cancer, and for gynaecological tumours. MRI requires a larger footprint and more complex infrastructure, and therefore carries a higher cost. A 1.5 T machine is the minimum advised magnetic field strength. One single state of the art MRI can perform about 800–1200 examinations a month.
— Angiography is the visualization of vessels or lumina, often following injection of contrast. Today, conventional angiography (often through fluoroscopy) is used mostly for guiding therapy, such as embolization or chemoembolization, catheter placement, and special interventional radiology procedures such as cryoablation and radiofrequency ablation of tumours. Angiography can guide surgery and hybrid therapies. Most diagnostic angiography applications are now addressed by the vascular imaging capacity of ultrasound, CT and MRI.
— Nuclear medicine and molecular imaging are used for diagnosis and staging as well as for therapeutic purposes. 'Theranostic' modalities require the administration of radiopharmaceuticals inside the bodies of patients to generate images and are considered for specified indications. For example, patients with thyroid cancer and, more recently, neuroendocrine tumours or metastatic prostate cancer may benefit from these therapies. The technique uses radiation and requires complex infrastructure. The footprint is larger compared with X rays, ultrasound, mammography and even compared with CT and MRI, since these modalities require specialist personnel, special areas for radioactive waste disposal, a hot lab, a radiopharmacist to manipulate radioactive material, an injected patient's room and other special spaces.

Nuclear medicine and molecular imaging are of proven clinical value for staging, therapy monitoring, recurrence detection, biopsy guidance or planning interventions, though resource requirements and relative value must be taken into account. The level of sophistication can range from a basic SPECT (single photon emission computed tomography) camera to digital hybrid systems — a decision that will depend on the level of complexity of the cancer centre, budget and logistics. Hybrid PET–CT has become a frequent imaging method to stage cancer and assess therapeutic response. It is important to secure timely access to (18)F-fluorodeoxyglucose, the most common radiotracer used in PET–CT.

A single PET–CT can perform up to 400 exams per month. Furthermore, when the run-time of the unit is extended, with standardized and optimized acquisition protocols, up to 600 exams per month can be conducted. The IAEA

has published technical reports on establishing a comprehensive nuclear medicine and PET–CT service. Using PET–CT as an example (as the majority of PET–CT examinations relate to cancer), the IAEA publication Planning a Clinical PET Centre [42] includes recommendations for space requirements and layout, including the infrastructure needed for appropriate functioning of the centre [43].

The radiology information system, picture archiving and communications system, and digital imaging and communications system format images, and workstation areas where the imaging professionals view and interpret images are described in an IAEA publication on Worldwide Implementation of Digital Imaging in Radiology [44]. Anticipated digital imaging and communications and picture archiving and communications system software and user licence renewals/updates and related costs can potentially be negotiated up front, or at least clarified as part of the initial procurement contract. Overlooking long term hardware maintenance and software contracts can hinder the functioning of the medical imaging unit. There are many such examples in low resource settings of unexpected long term post-procurement costs [15].

5.2.5. Quality assurance

Quality management in medical imaging is essential to avoid unnecessary and repeated exposure or suboptimal image quality as a result of a failure to optimize systems. This includes selection of the appropriate technical exposure parameters and scan protocols during imaging, as well as assurance that the acquisition systems are functional, the correct image processing is performed, and the viewing devices are optimized to facilitate reporting. As a result, significant resources must be invested to ensure safe, quality and effective services. The core imaging team must be engaged in QA activities. This includes timely and accurate reporting. Double reading of a proportion of certain imaging studies (e.g. some mammography studies) is a common QA procedure. Similarly, within a facility containing sources of radiation and radiation emitting equipment, medical physicists are usually responsible for radiation safety and the protection of patients, staff and the general public who have access to the premises [45–47].

5.3. PHARMACY

5.3.1. Rationale

Cancer treatment involves the use of a wide variety of powerful and often very expensive pharmaceuticals. The pharmacy service plays a critical role in

cancer treatment, including providing information and advice, and helping select appropriate pharmaceutical therapies and monitor for drug to drug interactions.

The pharmacy service is responsible for safe, cost effective and appropriate procurement, compounding, prescription verification, preparation and dispensing of SACT, including cytotoxic chemotherapy, biological therapy, immunotherapy, targeted therapy and associated supportive medicine. These tasks must be completed in accordance with legislative requirements, adhering to professional and national standards and local policy. Pharmacists who provide pharmaceutical care to patients with cancer need to have the appropriate skills and competencies to ensure the safe use of these medicines. The complexity of cancer patient care, SACT cost, toxicity potential, medication errors, safe preparation, administration and disposal of cytotoxic medicines highlight the fundamental function of pharmacies in cancer centres, regardless of a country's resource level.

5.3.2. Key features

Pharmacy resources and needs may vary, but key features for all cancer pharmacy services include human resources, infrastructure, consistent access to medicines, devices, equipment, educational resources for both staff and patients, QA and management processes. In-patient and out-patient medicine management needs must be addressed, as well as the needs of patients transitioning beyond the cancer centre. It is mandatory to comply with all regulatory requirements, including requirements for personal protective equipment, safe handling, preparation and disposal of cytotoxic medicine waste.

5.3.3. Human resources

Adequate human resources to deliver the service are important. The cancer pharmacy workforce consists of a range of professionals, including qualified pharmacists and support staff (technicians/technologists/assistants) for both clinical and non-clinical tasks (including aseptic and technical services). Pharmacy staff form part of the multidisciplinary team, which includes cancer specialists, nursing staff, allied health professionals and other support staff.

5.3.4. Equipment

Cancer pharmacy services cover several equally important areas:

— Clinical pharmacy focuses on patient care and medicine optimization, both for in-patients and out-patients. This involves working with the health care team to develop the patient's initial care plan, monitoring the patient's

compliance and therapeutic response to their medicines (e.g. side effects and allergies), and providing ongoing consultation and advice to prescribers on adjustments to the medication regime. Cancer pharmacists are an important part of the patient care team and contribute highly specialized knowledge about the medicines used for cancer. Pharmacists advise on best practices, appropriate dosages, the formulation of cancer drugs, routes of administration and delivery techniques, therapeutic windows, acute and long term drug toxicities, the management of cancer and drug related complications and side effects, drug interactions and safe handling of hazardous drugs.

— Dispensary services obtain, store and distribute medicines, review prescriptions and medication orders for appropriateness and accuracy, perform medication reconciliation and report adverse drug reactions and events. For a cancer centre this includes oral SACT as well as supportive medicines such as antiemetics and granulocyte colony stimulating factor. Pharmacists and pharmacy support staff should ensure that all medicines dispensed by the pharmacy are stored, handled and distributed reliably and safely. This should be standardized across all dispensary areas.
— Inventory management involves procuring good quality and cost effective medicines, managing the formulary of available and allowed medications, securely storing, distributing and disposing of medicine waste. Pharmacists should also play a role in the local formulary committee (e.g. the drugs and therapeutics committee) to take part in the decision making process on the range of medicines to be used, and guidelines related to their use.
— Aseptic preparation of medications is an important facet of the service. Cytotoxic chemotherapy is designated as hazardous and should be prepared in a controlled environment by trained staff. It is mandatory to comply with all regulatory requirements, including facilities, equipment and personal protective equipment for the safe handling, preparation and disposal of cytotoxic medicine waste. All preparation must take place under the supervision of a pharmacist, who will ensure that robust standard operating procedures are in place for every aspect of that service, including cleaning, maintenance and monitoring of the facilities and equipment, staff training, prescription verification, worksheet and label production, aseptic technique, final product checking and release. Where preparation facilities are not available or lack capacity, it may be possible to buy pre-prepared products from a commercial provider.
— Educating patients and caregivers about prescribed medicines is where the cancer pharmacist plays an optimal role to provide patient directed education, information, advice and tools to improve medication adherence with complicated regimes. Private areas for confidential discussion about SACT and supportive care medicines are important.

— Educating health care professionals in the safe and effective use of medicines.
— Electronic prescribing: SACT regimens (a combination of one or more SACT agents typically used to treat patients) are complex and prescribing them is a specialized process. Even simple regimes such as those used in out-patient practice frequently require intravenous administration of several different SACT medicines. These medicines require individualized doses according to patient size and toxicity from previous treatments, together with the administration of both intravenous and oral antiemetics. The complexity of SACT regimens, the narrow therapeutic window of the medicines themselves and the intermittent nature of treatment makes the implementation of computerized SACT ePMA (electronic prescribing and administration of medicines) or eP (electronic prescribing) packages a vital component of a modern and efficient service. Where IT systems are in place within the health care setting it is important that SACT ePMA is carried out on a system that is designed for this purpose. Where IT systems are not in place within the health care setting, then paper pro forma prescriptions should be available with sufficient governance structures to allow safe prescribing of recommended treatments for that specific cancer type — i.e. to facilitate standardization and prevent errors. The cancer pharmacy service will usually take on the responsibility for the set-up and maintenance of an ePMA system or a paper pro forma system, and this should be taken into account when planning the pharmacy workforce.

5.3.5. Quality assurance

Quality assurance and management are an essential part of any cancer service, including pharmacy and the aseptic preparation service. The consequences of errors cannot be understated. Quality of care is ensured by the establishment of standard operating procedures, so a significant investment in resources must be included to ensure safe and effective delivery of SACT. Cancer pharmacists are often involved as part of the core team in the development of standards related to patient safety, including clinical governance. Cancer pharmacists serve as members of policy making committees that impact medication use and safety, and regularly evaluate and report on the performance of the pharmacy service.

6. MULTIDISCIPLINARY AND MULTIMODALITY TREATMENT: FACILITY REQUIREMENTS

An optimal approach for cancer care is the 'multidisciplinary clinic' in which patients with newly diagnosed cancer are seen together by the surgery, radiation oncology and medical oncology departments to plan their treatment, supported by pathology and medical imaging expertise. The formulation of a treatment plan is a critical starting point in the management of people diagnosed with cancer and must be done in a coordinated way, facilitated by the structures and functions of cancer centres.

6.1. CANCER SURGERY

6.1.1. Rationale

Surgery is the most important part of cancer diagnosis and curative treatment. It fulfils various functions, including obtaining tissue for pathological evaluation for diagnosis and staging, primary curative tumour resection and for palliation of symptoms related to cancer or cancer treatment.

Data suggest that by 2030, out of 21.6 million patients with cancer, roughly 80% (17.3 million) will require surgery. Of these, more than half (10 million) will reside in low and middle income countries [48], where the access to complex surgery is very limited.

6.1.2. Key features

It is important to integrate surgery effectively with diagnosis and treatment (see multidisciplinary care). At facilities with minimal surgical capacity, trained providers may perform biopsies of abnormal masses, including lesions of the skin, breast, oral cavity and uterine cervix, as well as enlarged lymph nodes. Histological materials must be preserved, processed and analysed promptly by pathologists. Additionally, these providers may also be able to perform basic palliative procedures, such as tracheostomy, drainage of pleural effusions, and repair of non-functioning colostomies.

Most cancer centres should be able to perform curative and palliative surgical procedures, such as local excisions, mastectomy, hysterectomy and colectomy. More complex surgical care, such as pancreaticoduodenectomy, esophagectomy, and lung resections, may be performed at higher volume facilities by surgeons trained in the appropriate subspecialties and with more capacity for

imaging, critical care, peri-operative nurses, interventional radiology, symptom management, and post-operative rehabilitation services. The volume of a cancer centre and the complexity of its accompanying services is important in planning surgical capacity, as more favourable cancer outcomes are associated with a greater volume of cancers treated and the extent of training for cancer health care professionals.

6.1.3. Human resources

To deliver safe and effective cancer surgery, the educational and health care systems in a country must train and retain adequate numbers of individuals in the fields of surgery, anaesthesia, critical care, nursing and the relevant technicians for these fields. For childhood cancer, surgical competencies vary according to the different levels of complexity. For level 1 settings, adult subspecialty surgeons include neurosurgeons and orthopaedic surgeons. For level 2, some paediatric subspecialty surgeons (neurosurgeon, orthopaedic surgeon, ophthalmologist) should be available while for level 3, a full range of paediatric subspecialty surgeons should be available to provide care for children [34]. Specialized training in cancer surgery generally requires dedicated time at tertiary referral hospitals. A workforce strategy linked to a labour market analysis should be used to ensure that an adequate number of cancer health care professionals are trained to the full scope of their practice, retained and their capacity built. At a minimum, retention requires an adequate salary, supportive working conditions and opportunities for professional development that also enhance competencies. Surgeons and other health care providers involved in cancer care should receive education in professional schools and postgraduate settings on the principles of clinical research and evidence based medicine.

6.1.4. Equipment

Even in resource constrained settings where many patients present with advanced disease and may not be candidates for curative surgery, palliative surgery, such as relief of intestinal obstruction or creation of a tracheostoma for airway obstruction, can play an important role in relieving suffering. Other services need to be in place to ensure that cancer surgery is safe and effective. These services include imaging, laboratory medicine, anaesthesia, blood banking, pre- and post-operative care, critical care, nursing, anatomical pathology, symptom management and rehabilitation, as well as a reliable supply chain for the myriad supplies and instruments necessary for anaesthesia, surgery and hospital care [15].

Accurate pre-operative planning includes evaluating and optimizing the cancer patient's overall health, functional status and nutrition. The operative approach is often informed by pre-operative imaging and/or endoscopy, as well as an understanding of the tumour biology from a pathology review. Peri-operative care relies on safe anaesthesia tailored to the operation, as well as nursing care responsive to the potential complexities of an operation and the potential co-morbidities of individual patients. Safe blood products must be available for safe surgery. When possible, however, administration of blood products should be avoided, given potential short and long term risks. Specialty nursing, physical therapy, occupational therapy and nutritional support greatly impact peri-operative outcomes and recovery.

Anaesthesia expertise available at facilities with varying levels of surgical services (levels 1–3 surgical services) will inevitably vary. Basic safety standards and guidelines for pre- and post-anaesthesia care and monitoring should be ensured.

6.1.5. Quality assurance

Quality assessment and monitoring require real time capture of standardized metrics as well as evaluation of adherence to guidelines for cancer diagnosis, treatment and symptom management. Guidelines may be national, international or developed by medical professional societies. Commonly tracked metrics include time from biopsy to pathological diagnosis; time from diagnosis to definitive surgical treatment; and time from surgery to start of adjuvant therapy. Standards of synoptic reporting have been developed for imaging, pathology and surgery. Metrics evaluating quality of cancer specific surgeries may include lymph node evaluation, tumour margins, success in removing all gross tumour, organ sparing and incidence of post-operative infection and 30 day post-operative mortality.

Quality assurance should be introduced through routine conferences on morbidity and mortality that allow for review of any peri-operative complications and provide an opportunity to identify system factors that contribute to those complications. Within a surgical department, efforts should be made to identify a surgeon responsible for promoting quality and implementing evidence based quality standards, such as a safety timeout before and after an operation. Such morbidity and mortality conferences may also be useful in evaluating multidisciplinary cancer management. Institutions with level 2 and level 3 surgical services should routinely assess quality of cancer care prospectively and retrospectively through audits.

6.2. MEDICAL ONCOLOGY AND SYSTEMIC THERAPY

6.2.1. Rationale

Medical oncology is an essential component of multidisciplinary cancer care. Systemic therapy can be delivered alone, concomitant with radiotherapy or sequentially to surgical or radiotherapy procedures for neoadjuvant, adjuvant or palliative treatments and reinforcing the need for a multidisciplinary approach. Where potential cure, overall survival and quality of life gains are the main goals, treatment choice should be based on medicines that confer meaningful clinical benefit and, according to institutional guidelines, national medicine lists [49, 50]. Systemic therapy prescription (such as chemotherapy, endocrine therapy, immunotherapy and targeted therapy), supportive care and monitoring of symptoms and outcomes during and after treatment are essential activities for trained providers in medical oncology, who are generally medical oncologists or haematologists. Systemic therapy is an essential curative treatment for most haematological and solid tumour diagnoses, though indications will depend on the extent of disease [51]. For paediatric oncology services, as for adult oncology services, coordination of care with other essential multidisciplinary services, including surgery, radiotherapy and supportive services, is essential.

6.2.2. Key features

While the needs and resources of countries will differ significantly, key features for a medical oncology service include human resources, infrastructure, consistent access to medicines, devices and equipment, blood banking, a monitoring and evaluation framework, QA and management processes. In-patient and out-patient oncology needs must be addressed, with attention to the extended monitoring and hospitalization needs of patients, intensification of care as well as coordination with emergency/acute and intensive care, rehabilitation and palliative care services. It is mandatory to comply with all regulatory requirements, including for personal protective equipment and safe handling, prescribing, dispensing and disposal of systemic therapy agents [52].

6.2.3. Human resources

The core team generally involves medical oncologists and/or haematologists; medical officers and trainees (physicians with some training in oncology care but practising under the supervision of trained oncologists); nurses trained in administration of cancer therapies and supporting patients before, during and after cancer treatment; pharmacy staff trained in preparing

and monitoring systemic therapy; multidisciplinary staff (including psychosocial staff) and other support staff (including data and ward clerks). Where possible, staff should include nutritionists and palliative care specialists. For paediatric oncology services, the core team members are as noted above, with the need for paediatric oncologists. In many settings, paediatricians join the roster of providers to support continuity of care, and it is helpful for nurses and multidisciplinary providers to receive dedicated training in the management of children with cancer. Access to specialized paediatric providers (e.g. a paediatric anaesthesiologist) — where feasible — ensure safe, effective care for intravenous therapy administration and procedures (e.g. bone marrow aspirates/biopsies and imaging studies in infants).

6.2.4. Equipment

Medical oncology services typically span three main areas:

— *In-patient area.* This includes beds for complex/infusion chemotherapy and laboratory monitoring of drug levels (e.g. methotrexate); appropriate facility and support for patients with febrile neutropenia; and an isolation area for immune suppression during a bone marrow transplantation. In the most advanced centres, specialized in-patient units provide dedicated services, such as bone marrow transplant services.
— *Out-patient clinic area.* This area includes space for out-patient consultations (e.g. for disease evaluations or laboratory monitoring), and ideally an area for isolation and a dedicated area for acute care (for patients pending evaluation with suspected febrile neutropenia or resuscitation needs).
— *Day care/chemotherapy administration area.* Examples include beds, couches, chairs (e.g. 30 of a 250 bed hospital [53]).

Properties common to these three areas include:

— *General.* Attention to hand hygiene (e.g. bedside pumps for hand hygiene products and/or sinks with soap accessible to each patient) and isolation areas for specific conditions, such as bone marrow transplantation or highly contagious conditions (i.e. herpes zoster virus infections) to optimize infection prevention and care.
— *Equipment.* Fully equipped crash cart and automated emergency devices to run emergency codes for immediate resuscitation and stabilization prior to ICU, if needed [15]. Infusion pumps/syringe pumps commonly used for daily continuous infusion chemotherapy protocols, parenteral nutrition, opioid titre for severe and uncontrolled oncological pain.

The following areas may be centralized within a centre, or be located within the three medical oncology areas listed above:

— *Systemic therapy preparation area.* This location should be a dedicated area with safe handling facilities to protect staff from repeated exposure to SACT agents (see Section 5.3.4).
— *Secure storage areas for systemic and supportive therapy.* This location includes cold chain and secured access (e.g. locked cabinets for opioids).
— *Access to the point of care laboratory area.* Where appropriate, this area provides access to process and/or review quick complete blood count, or tumour analysis laboratory results.
— *Area with accessible personal protective equipment.* Includes gowns, gloves and masks for providers and/or family members and patients.
— *Counselling area.* Private area for confidential discussions with families.
— *Procedure area.* A separate area for procedures (such as venepuncture, lumbar punctures), particularly for children.
— *Respite, play and recreation areas.* Patient and family centred areas for respite (e.g. areas for families to prepare their own meals), play and recreation (e.g. adolescent specific areas) where no medical procedures or activities occur, can enhance the quality of life, particularly in centres caring for children or adolescents.

Other services that communicate with the medical oncology service include:

— *Laboratory, biochemistry, haematology, microbiology, histopathology, immunophenotyping and immunohistochemistry and molecular testing.* All results should preferably be available through a common information system platform. Sample core services are outlined in the WHO publication Model List of Essential In-Vitro Diagnostics [37].
— *Medical record system and information technology.* The health management information system should preferably be electronic and include all chemotherapy protocols, antineoplastic prescriptions and laboratory examination results, and they should be reviewed at least annually to ensure compliance with institutional guidance.

6.2.5. Quality assurance

Quality management is essential in medical oncology, given the potentially serious (debilitating to lethal) consequences of misadministration of systemic therapy and supportive care. Consequently, significant resources must be invested to ensure safe, quality and effective delivery of systemic therapy, point of care

monitoring before, during and after therapy, and documentation and review of adverse events affecting patients, families or providers. The entire core medical oncology team must be engaged in QA activities. Patients should be involved in QA processes, with institutional resources committed for patient education, engagement and feedback. Sample resources are available to guide set up in different resource settings [54, 55].

6.3. PAEDIATRIC ONCOLOGY

6.3.1. Rationale

Paediatric oncology is an essential component of multidisciplinary cancer care for children. Acute leukaemia, particularly acute lymphatic leukaemia is the commonest childhood malignancy (28%) and, if treated properly cure rates over 90% can be achieved. Brain and spinal cord tumours constitute the next largest group (26%), and Wilms tumour, rhabdomyosarcomas, lymphomas and bone cancers make up the rest. A multidisciplinary team led by a paediatric oncologist is necessary for the optimal management of childhood cancer. The paediatric oncologist should have a postgraduate qualification in paediatrics followed by training in a specialized paediatric oncology unit for two to three years in a tertiary centre or a cancer hospital. Knowledge of comprehensive clinical diagnosis, cancer staging and management of children, including integrated treatment planning according to tested clinical protocols, are essential. Systemic therapy which includes chemotherapy, endocrine therapy, immunotherapy and targeted therapy, supportive care and monitoring of symptoms and outcomes during and after treatment are essential activities for the paediatric oncologist. Coordination of cases with surgeons, radiotherapists and other health care professionals is necessary.

6.3.2. Key features

Provision of a state of the paediatric oncology services required a good diagnostic service since treatment protocols are now risk adapted. For a child with leukaemia, basic haematology, immunophenotyping, cytogenetics, including fluorescent in situ hybridization and molecular tests, are necessary for comprehensive diagnosis and risk stratification to choose the appropriate protocol. Response to treatment and subsequent management requires monitoring of minimal residual disease by flowcytometry or molecular tests, and this is true for all other childhood cancers. A good paediatric oncology service would require human resources, infrastructure, consistent access to medicines, devices and

equipment, blood banking, including components, a monitoring and evaluation framework, and QA and management processes. Follow-up is essential since childhood leukaemia has a two year maintenance period during which the child must be given oral medication with periodic review of blood counts.

6.3.3. Human resources

The core team generally involves: medical paediatric oncologists and/or haematologists; medical officers and trainees (physicians with training in general paediatrics but practicing under the supervision of trained paediatric oncologists); nurses trained in the administration of cancer therapies and supporting patients before, during and after cancer treatment; pharmacy staff trained in preparing and monitoring systemic therapy; multidisciplinary staff (including psychosocial staff) and other support staff (including data and ward clerks). Where possible, multidisciplinary staff should include trained nutrition and palliative care specialists. Access to specialized paediatric providers (e.g. a paediatric anaesthesiologist) — where feasible — ensures safe, effective care for intravenous therapy administration and procedures (e.g. bone marrow aspirates/biopsies, imaging studies in infants).

6.3.4. Equipment

The equipment list for paediatric oncology is similar to medical oncology. The following areas should be provided for children with cancer:

— *Procedure area.* A separate area for procedures (such as venepuncture, lumbar punctures) is preferred, particularly for children.
— *Respite, play and recreation areas.* Patient and family centred areas for respite (e.g. areas for families to prepare their own meals), play and recreation (e.g. adolescent specific areas) where no medical procedures or activities occur, can enhance the quality of life, particularly in centres caring for children or adolescents.

6.3.5. Quality assurance

Apart from what has been listed for medical oncology, monitoring of the quality of venous access and infections related to central venous devices is essential in children with cancer. Also, documentation of all episodes of febrile neutropenia and its management is required. Disease free survival for all children treated at a centre must be recorded and reviewed periodically. Long term

follow-up with evaluation of drug toxicity and endocrine function is essential for all survivors of childhood cancer.

6.4. RADIATION ONCOLOGY

6.4.1. Rationale

Radiation oncology is an essential component of cancer management and part of multidisciplinary cancer care. In optimal settings, over 50% of all cancer patients need radiation as part of their treatment management plan, as it contributes significantly to improvements in local tumour control and overall survival in many disease sites, and can also be used for disease palliation [56]. Access to radiotherapy is limited in some regions, primarily in low and middle income countries, due to many barriers including perceived high capital investment and maintenance costs, the need for a complex infrastructure and a lack of human resources and services [57–59]. These disparities in access to radiotherapy can also be seen in high income countries [60, 61].

6.4.2. Key features

The needs and resources of countries will differ significantly, but the list below provides an overall framework of the processes in radiation oncology. Key features to be considered for a radiation oncology service include human resources, infrastructure and equipment, a monitoring and evaluation framework, QA and management processes. External beam radiation therapy (EBRT) and brachytherapy (BT) are standard modalities [62]. It is mandatory to comply with all regulatory requirements, in particular radiation protection and safety.

The following list provides an overview of the radiation oncology process:

(1) *Clinical evaluation of the patient.* If possible, all patients should be evaluated in a multidisciplinary setting. This should involve assessment and staging of the tumour through a physical examination, evaluation of all available imaging, and a decision on whether to prescribe radiation therapy.
(2) *Therapeutic decision making.* Care goals (curative or palliative) should be determined next. If curative, a decision should be made as to whether treatment is given neoadjuvantly or adjuvantly. Radiation prescription and dose time, as well as the volumes to be treated, should be determined. All patients should be asked for their consent for radiation therapy and be informed about its benefits and potential adverse effects.

(3) *Patient immobilization.* The need for immobilization for simulation and treatment should be determined and planned for.
(4) *Patient simulation.* Simulating the patient in the treatment position, localization and selecting position of simple field arrangements.
(5) *Target volume determination.* Tumour volume, potential tumour extent and potential routes by which it may have spread should be determined. Sensitive organs and tissues should be identified. Tumour volumes and organs at risk should be contoured.
(6) *Treatment planning and evaluation.* Treatment technique, fields, modality and energies should be selected. Custom beam modifiers or compensating filters should be developed as needed. Dose distribution should be computed and verified for accuracy. Dose volume histograms should be evaluated to ensure that the tumour is receiving an adequate dose and that organs are receiving doses below the threshold they can tolerate.
(7) *Simulation of treatment.* Radiographic documentation of treatment ports should be done to verify the fields.
(8) *Treatment*. Treatment data should be transferred to the treatment machine and initial verification of treatment set-up should be done. The accuracy of repeated treatments and record keeping should be verified.
(9) *Patient evaluation during treatment*. All patients should be evaluated during treatment at least weekly to manage the adverse effects of treatment and to assess response to treatment. A standardized grading system should be used to grade toxicities weekly so that they can be easily compared from week to week. When needed, the palliative therapy team and supportive therapy team (e.g. dietician for head and neck cancer patients) should be involved to ensure patients are well supported to be able to continue and complete treatment as planned.
(10) *Follow-up evaluation*. All patients should be followed up after radiation for evaluation of treatment response/recurrence and management of late toxicities. All recurrences should be discussed in a multidisciplinary setting to design the best possible treatment plan for the patient and to counsel the patient appropriately. Interval for follow-up will be determined by the tumour type and resources available at the centre but is generally every 3–6 months for the first two years and then every 6–12 months for at least five years.

6.4.3. Human resources

A core radiation oncology team consists of radiation oncologists, medical physicists, and radiation therapy technicians. The expanded team also includes other health professionals involved in multidisciplinary cancer management,

such as specialist nurses and anaesthesiologists with training and expertise in paediatrics, to provide sedation and anaesthesia services for infants and children receiving radiotherapy. Staffing levels are dependent on the complexity of the radiotherapy procedures (the IAEA has extensive, publicly accessible, guidelines on staffing a radiotherapy centre [63]).

Core team practitioners must have undergone structured, practical, competency based training, as well as formal academic education [64]. The IAEA has issued guidance publications, including syllabuses, on the education and training of all professionals involved in radiotherapy [65, 66]. The timeline for the education and training of professionals lasts several years, so careful planning is needed when setting up or expanding a radiotherapy programme [64]. Additional requirements are applicable to paediatric radiation oncology services, including specialized training for management of children, incorporation of staff for anaesthesia, childcare and other psychosocial staff, and multidisciplinary service delivery with paediatric oncology service providers.

6.4.4. Infrastructure and equipment

The IAEA recommends that radiotherapy facility design allows for future expansion without disrupting existing services. It has published a report that introduces the concept of five functional areas: reception; administration and waiting areas; clinical consulting areas; external beam radiotherapy; brachytherapy; and the imaging and treatment planning area [67]. These areas together constitute an overall footprint of approximately 1450 m^2 and should be positioned in accordance with the preferred workflow of the staff and the patients. The radiotherapy facility should be conveniently sited in the centre's infrastructure. As rooms containing radiotherapy treatment equipment (EBRT and BT bunkers) are highly specialized, a core implementation team with adequate expertise needs to be constituted to design the facility and to manage the construction. The IAEA has issued extensive guidelines on the appropriate buildings and essential equipment for a radiation therapy unit [68–70].

The equipment required for the comprehensive cancer centre's radiotherapy facility includes external beam and brachytherapy treatment units; imaging for treatment planning and simulation; computerized treatment planning systems; oncology information system; dosimetry; quality control and safety equipment; mould room equipment, and positioning and immobilization devices including consumable equipment [70–72].

6.4.5. Quality assurance

Quality management in radiation oncology is essential because of the potentially serious and lethal consequences of radiotherapy misadministration. As a result, significant resources must be invested to ensure safe, high quality and effective services, and the core radiotherapy team as a whole must be engaged in quality control activities. Within a facility containing radiation emitting equipment, medical physicists are usually responsible for the radiation safety and protection of patients, staff and the general public who have access to the premises [73, 74].

6.5. ONCOLOGY NURSING

6.5.1. Rationale

Oncology nursing is an important part of cancer control as the role of the nurse extends across the cancer continuum. Oncology nurses play an important role in cancer prevention, screening, detection, treatment, survivorship, palliative care and research [75]. In some settings, the primary functions of oncology nurses are to provide direct patient care in acute care hospitals, radiation and medical oncology clinics and hospice/home based settings, where they practice in association with surgical, radiation, medical, paediatric and gynaecological oncology [76].

6.5.2. Key features

Oncology nurses ease the burden of the cancer treatment journey by delivering evidence based, person centred care to both the patients and the family/caregiver [77]. The key responsibilities include:

— *Cancer treatment.* Deliver systemic anticancer treatments, assess and manage treatment specific symptoms from surgery, radiation therapy, systemic anticancer treatments and other treatments, such as peripheral stem cell transplantation, and assess patients for oncology emergencies.
— *Supportive/palliative care.* Provide such care to both the patient and the family/caregiver, including education of the patient and family/caregiver, assessment and management of pain and other symptoms, provision of psychosocial and spiritual care in a culturally sensitive manner and empowerment of patients and their families to accept the responsibility for the self-management of the disease.

— *Survivorship care.* Provide psychosocial support, education about the late side effects of cancer treatments and the physical changes resulting from cancer and its treatment.
— *Research*. Develop new knowledge that can improve the outcomes of the patient and the family/caregiver [78–80].

In addition, as combined modality treatments are often used, the radiation oncology nurse assesses and manages patients experiencing overlapping symptoms [81].

6.5.3. Quality assurance

Although oncology nursing is an established field of nursing, it is still underdeveloped in certain low and middle income countries [82–84], where nurses often practice in the field of oncology without having had specialist education and training [85, 86]. In addition, there is no universal standard for oncology nursing education and training. Also, this education and training may range from hospital based certification to post-registration diploma level, baccalaureate degree, postgraduate diploma in oncology nursing and clinical Master's degrees. The roles of the clinical nurse specialist, nurse practitioner and advanced practice nurse are also confusing, and there is a lack of clarity about the competencies and responsibilities linked to the specific roles [87]. At a minimum, nurses caring for people with cancer should receive an oncology focused orientation, be educated and trained to handle, reconstitute (if applicable) and administer anticancer drugs safely and manage side effects, and receive continuing professional education to update clinical practice and maintain quality care [66, 88–90]. Clarifying roles, competencies, developing or adapting existing clinical guidelines and standard operating procedures and implementing them can enhance the best evidence based care.

6.5.4. Infrastructure and human resources

The goal of staffing norms in oncology is to ensure the provision of safe health care delivery. When calculating registered nurse to patient ratios, the number of patients, intensity level of the care needed, the availability of technology, the characteristics of the unit and the experience and knowledge and skills of the nurses should be considered [91]. Although definite guidelines do not seem to be available, suggested guidelines for in-patient unit staffing for both day and night shifts can be found in the literature.

7. PALLIATIVE AND SUPPORTIVE CARE: FACILITY REQUIREMENTS

7.1. PALLIATIVE CARE

7.1.1. Rationale

Cancer and its treatment can cause physical symptoms and side effects. It can also lead to emotional, social and financial challenges. Palliative care aims to treat the patient as a whole, not only the sickness. The objective of palliative care is to prevent and treat the symptoms and side effects of the disease and its treatment at the earliest stage, in addition to any related psychological, social and spiritual problems.

7.1.2. Key features

Palliative care should be accessible at all levels of the health care system and can be delivered alongside therapies such as surgery, radiotherapy and chemotherapy. Policies and resources should reinforce the appropriate integration of palliative care, ensure access to pain medications (including opioids) with the aim of improving the quality of life of patients and families, and should not be seen as being synonymous with end of life care [92]. All staff involved in the care of patients with cancer should receive at least basic training in palliative care.

7.1.3. Infrastructure and human resources

7.1.3.1. Cancer centre based palliative care

Facility based palliative care should include an out-patient palliative care clinic, a palliative care consultation service for in-patients, a palliative care day care service, an in-patient palliative care unit and a palliative care outreach/home care service. An out-patient palliative care clinic can provide low cost care to patients and, when included with an in-patient consultation service, can be a particularly effective model where resources are limited.

An in-patient palliative care unit offers palliative care beds and allocates staff trained in palliative care available 24 hours a day. The required professionals include doctors and nurses with at least basic training in palliative care, ideally supplemented by consistent access to team members with specialist palliative care training. A full complement of multidisciplinary providers to serve the holistic needs of patients and families — such as psychologists, pharmacists,

physiotherapists, spiritual care providers, dieticians and volunteers — can strengthen the team and the service offered. Access to treatment options offering palliation of distressing cancer symptoms, such as interventional radiology, radiotherapy and salvage surgery, can be part of care from the cancer centre.

7.1.3.2. Home based palliative care

Many patients feel more comfortable in their home than in a health care setting, especially while under treatment or towards the end of their life. Through a home based approach, family members can receive advice and support as caregivers and referral to additional services can be facilitated by the home care team. Resources for transport and communication are vital to continuity of care. A full time nurse and a part time doctor are the minimum requirements for a home care team, depending upon the resources available. A multidisciplinary team of nurses, doctors, psychologists/counsellors, social workers and community health workers, or well-trained volunteers, are needed. Each patient should have a health record in place, ideally integrated with centre and community based service records. Records of prescriptions and use of all medicines (especially morphine and other opioids) should be maintained in line with local laws and regulations. Minimum basic training in palliative care for doctors, nurses, community health workers and lay volunteers is essential to provide home care services, along with access to staff with specialized training in palliative care.

7.1.3.3. Community based palliative care service

Health care professionals, community health workers and/or lay volunteers typically provide community based palliative care services. These services at a community health centre can include out-patient services offered during defined hours, home based support and, in some cases, in-patient services. Health care professionals based at a community health centre can offer out-patient services such as more advanced symptom assessment and management and respite services for families. They can support home based services by supervising community health workers and volunteers and visiting patients at home when needed. Mobile phones can also be used in order to keep in touch with patients and family members.

Additionally, community health centres with in-patient beds can provide short term respite, additional symptom management, or uncomplicated end of life care for a few in-patients at any one time to better support the preferences and needs of patients and families, often in a more home-like environment than a hospital in-patient setting. Training should be provided to medical doctors, clinical officers or assistant doctors, nurses and nursing aides, and they should

receive the minimum hours of training in basic palliative care, in alignment with national and international recommendations. The nurse(s) and doctor(s) can then provide training to community health workers or volunteers. The latter groups, supported by health care professionals, can be trained to provide or to support community based services in continuity with home based services.

7.1.3.4. Paediatric palliative care

Palliative care for children involves care of the child's body, mind and spirit, recognizing age appropriate developmental needs, distinct disease trajectories and treatment needs in children and adolescents. It also involves supporting the family. Building on general palliative care principles and practices, providers of paediatric palliative care also require distinct competencies alongside different assessment tools and pharmacological and non-pharmacological management approaches for children and adolescents with cancer. The minimum staff required for paediatric palliative care services includes a nurse and a doctor, supported by community health care workers, all of whom should have at least basic paediatric palliative care knowledge and competence. If resources allow a team will ideally include providers with specialist training in paediatric palliative care, including paediatricians, paediatric nurses, psychologists, social workers and other allied health therapists, such as child life workers, music and art therapists, and rehabilitation specialists.

Regardless of whether the service is hospital based, community based, and/or home based, the core team could be the same, with services ideally offered in a child friendly environment. In addition to facilitating discussion of goals of care with families and age appropriate assessment and management of symptoms, providers of paediatric palliative care can often facilitate care coordination and access to other therapies as necessary [93].

7.1.4. Quality assurance

Establishing and implementing clinical guidelines and standard operating procedures, adapted to the local context, ensures best available evidence based care. Prescribing and administration of palliative care interventions, including opioids, should be carefully documented and monitored as per national regulations. Patient reported outcomes and validated quality of life questionnaires should be used to guide interventions and programmes.

7.2. SUPPORTIVE AND SURVIVORSHIP CARE

7.2.1. Rationale for supportive care

Supportive (or psychosocial) care for patients with cancer includes assessment and anticipatory management of the needs of patients and families from diagnosis and throughout the disease trajectory, encompassing emotional, spiritual, interpersonal and material/financial needs. Given the sustained duration of many treatments for cancer, support to reduce patient and family distress and to promote treatment adherence are vital.

7.2.2. Infrastructure and human resources

Psychosocial services based in a comprehensive cancer centre may:

— Be provided by trained social workers and psychosocial professionals, starting with part time staff (staff that have responsibilities for other patient populations, or are available for consultation) who may receive added training and peer support to manage serious chronic illness.
— Be complemented by lay volunteers and support staff.
— Include patient and family education and counselling, including group education; needs assessment and provision of resources and support, including for financial burdens, housing, transportation and meal support; support preparing for procedures; assessment and support for treatment adherence.
— Include efforts to provide individualized psycho-education (to help people understand how to cope with the impact of cancer) and counselling, assessment and management; psychosocial follow-up in survivorship; child life, social interaction, recreation and respite support; support for siblings of children and adolescents with cancer; and consultation services involving legal and ethics experts; support for reintegration into schools and workplaces.
— Be provided in conjunction with palliative services.
— Have specialized training and education where children are involved and be accredited to provide developmentally appropriate assessment.
— Be used for managing cases of children with cancer and their families [94].

Community based psychosocial services may:

— Be provided by or with non-governmental organizations (NGOs), and with support from parent/family advocacy groups or councils.

— Provide patient and family education and counselling, including group education; needs assessment and provision of resources and support, including for housing, transport, and meal support.
— Include services linked with school programmes, community based legal/health services; vocational programmes for families; integrative health services, and links with traditional and complementary medicine providers and services, as appropriate (based on the local context); recreation and respite support.

7.2.3. Rationale for survivorship care

Survivorship care is an integral component of mature cancer programmes. In addition, support through ostomy, prosthetics and rehabilitation services are essential [95] as well as access to occupational therapy [96].

7.2.4. Key features

Core survivorship care services include anticipating any issues around managing the physical and functional effects of a cancer diagnosis and therapy, and early recognition of cancer recurrence or second malignancies. This includes providing appropriate counselling, and engaging patients and families in decision making, treatment planning and follow-up; optimizing patient function; and incorporating patient values and preferences in any further treatment they may need. Expanded services can include long term follow-up monitoring and care after completion of treatment, as well as surveillance and research.

An example that highlights the need for these care services is noted in childhood cancer survivors who require lifelong surveillance. Evidence based guidelines for long term follow-up of late effects should be developed and followed to guide the management of the specific domains related to childhood cancer survivorship care: physical effects, psychosocial effects, chronic medical conditions, prevention and surveillance of relapse disease and risk of developing new cancers, as well as education regarding health promotion for a better quality of survivorship. Core actions regarding childhood cancer survivor care include adequate multidisciplinary infrastructure, individualized care plans and strengthening referral pathways between the paediatric subspecialties and the primary care provider.

7.2.5. Infrastructure and human resources

Cancer centre based survivorship services may:

— Be provided by the multidisciplinary professionals available, while expanded services can be provided with specialists in late effects of diagnosis and survivorship.
— Include provision of patient centred documentation to summarize the diagnosis and treatment received (e.g. a survivorship passport); patient empowerment and education; and management based on symptoms/signs of late effects (e.g. ototoxicity, cardiotoxicity).
— Include engagement and follow-up with fertility services; comprehensive and anticipatory long term follow-up monitoring and care (e.g. for neurophysiological function, gonadotoxicity, functional outcomes and coping); research programmes (such as long term surveillance research); and risk reduction and health promotion.

Community based survivorship services may:

— Be provided by or with NGOs, as well as by trained multidisciplinary professionals.
— Include support at the primary health care level for core preventive and health maintenance activities, such as re-establishing immunization after patients complete therapy, as appropriate; and the history, physical examination and patient education to recognize signs of recurrence/relapse or second malignancies.
— Include attention to the needs of family caregivers, and to transitional and care needs for paediatric, adolescent/young adult and older adult survivors, including communication and exchange of data with cancer centre based services for identified needs.

7.3. NUTRITION

7.3.1. Rationale

Malnutrition, both undernutrition and obesity, is highly prevalent in cancer patients and thus requires particular attention as part of comprehensive services provided at cancer centres. Cancer patients who are malnourished have lower survival rates and face other long term consequences such as reduced functional capacity, decreased bone density and increased risk of metabolic syndrome.

Malnutrition in cancer patients may result from treatment induced effects on oral intake such as nausea, vomiting, constipation, diarrhoea, xerostomia, mucositis, dysphagia and loss of appetite, or it may come from site specific, tumour induced effects on energy balance, including hypermetabolism, malabsorption, dysmotility and obstructions. The short term consequences of malnutrition may include decreased treatment tolerance, increased treatment delays, fatigue, susceptibility to infections, increased hospitalization and treatment cost.

7.3.2. Key features

The awareness of the importance of nutritional support in treating cancer patients is growing, and cancer centres must plan to incorporate medical nutrition therapy (MNT), either as an MNT unit, or integrated resources considering the level of complexity of the planned cancer centre. MNT should include three phases: nutrition screening, nutrition assessment and nutrition management. Nutrition screening is the first step in identifying patients who may be malnourished or who are at risk of developing malnutrition. There are many malnutrition screening tools available for cancer patients and a tool should be chosen that is validated in the setting in which the tool is intended for use. Nutrition assessment should be undertaken in all cancer patients who are identified by nutrition screening as being at high risk of malnutrition. The nutritional assessments should justify, inform and guide nutrition management. There are several aspects to nutrition assessment that require varying levels of assessment tools and capacities: dietary intake, nutrition impact symptoms and body composition. Nutritional management should be provided at some level to all patients identified with reduced dietary intake, nutrition related symptoms and changes in body composition. The goals of nutrition management are to preserve lean mass, prevent fat mass gain, prevent nutrient deficiencies, minimize nutrition related complications, maintain functional capacity and maximize quality of life. Nutrition management includes nutrition counselling, oral nutrition supplements, supportive feeding and drug therapy.

7.3.3. Infrastructure and human resources

MNT should be a mandatory component of supportive care for all cancer centres. All components of MNT (screening, assessment and management) can be offered in a cancer centre and customized to the staff, funds and nutrition resources available. There are many nutrition resources available for cancer centres, and centres should consult with national, regional or international nutrition and dietetics organizations and available consensus guidelines for assistance when establishing an MNT module within the cancer centre. Standard

operating procedures for all levels of cancer centres should be centre specific and based on evidence, guidelines and resources. Procedures should cover the continuum from diagnosis to survivorship.

Cancer centre based nutrition services may:

— Be provided by a variety of personnel, including nurses, practitioner, dietician, or an oncology specialist dietician;
— Include a range of nutrition assessments which require varying levels of equipment, including scales, stadiometers, tape measures, or dual energy X ray absorptiometry;
— Have resources to offer a range of nutrition support, including nutrition counselling, oral nutrition supplements, enteral or parental nutrition and drug therapy.

7.3.4. Quality assurance

Clinical nutrition guidelines and standard operating procedures should be adapted to the local context and be in line with best available evidence. Prescribing and administration of nutrition support should be carefully documented and monitored as per national regulations. Nutrition assessment should be used to guide interventions for patients. Body composition measurements should always be undertaken according to standard operating procedures and regular quality control checks.

7.4. REHABILITATION, PHYSICAL AND OCCUPATIONAL THERAPIES

7.4.1. Rehabilitation

The aim of cancer rehabilitation is to help patients return to the highest level of function and independence possible, at the same time improving the overall quality of life — physically, emotionally and socially. Cancer centres should set up a service for physical therapy and occupational therapy services for out-patients and in-patients. Specially designed orthosis and prosthesis are required and may be manufactured on-site or procured as needed. Specially trained staff are critical to the running of these services.

7.4.1.1. Stoma care

People with abdominal, bowel or bladder cancers may need a temporary or permanent ostomies part of their treatment. Stoma clinics with trained providers are an integral part of the cancer services. The services provided by these clinics include:

— Management of urinary and faecal incontinence;
— Management of draining wounds, fistulas and non-healing wounds (pressure sores, leg ulcers);
— Pre-operative counselling for ostomy surgery;
— Stoma siting;
— Arrangement of an ostomy visitor;
— Post-operative counselling;
— Selection of appliances and teaching appropriate pouching technique;
— Irrigation procedures for colostomies;
— Practical education for patient and family;
— Nutritional guidance for ostomates;
— Discussion of pregnancy, sex problems and vocational needs of ostomates;
— Follow-up care;
— In-service education;
— Training programme in enterostomal therapy.

7.4.1.2. Prosthetics

There are various types of prostheses, some of which can be worn on the outside of the body. They can be put on and taken off (external prostheses) and other prostheses are inserted during surgery. For instance, cancer patients may require a prosthesis due to loss of a breast, eye, leg, or arm. An implant may be used in the penis, or in a breast, testicle, or bone. An electronic voice device may be also required if the larynx has been affected by cancer. Wigs that are used due to hair loss from some types of chemo are seen as prostheses as well.

7.5. SURVIVORSHIP CARE

After active treatment for cancer, a plan can be developed to monitor for cancer recurrence or spread, follow-up and management of health problems related to cancer diagnosis or cancer treatment, and to assess for the development of other types of cancer [14]. These services are essential to manage the

consequences of cancer diagnosis and treatment and they comprise routine examinations and/or tests.

8. PREVENTIVE ONCOLOGY

8.1. RATIONALE

WHO 'best buys' for control of the main risk factors for non-communicable diseases (NCDs) are relevant for the primary prevention of cancer and should be used for setting priorities in countries [97].[2] Activities should be selected according to the country's cancer burden, contextual cost effectiveness, ensuring equity and acceptability. Population wide interventions generally have a greater potential impact. Individual interventions should be part of a broad integrated national strategy and not be implemented in isolation. Cancer centres should include services for cancer prevention and leverage the status of a comprehensive centre which will attract a large clientele. A cancer prevention unit can help to coordinate the work in the cancer centre with activities in the wider community. This unit could be set up with a separate entrance to make it less intimidating for walk-in clients. The clinic can offer advice to questions from the public and highlight cancer prevention and detection messages. Staff trained in community medicine with skills in cancer prevention and screening can lead such services.

Comprehensive cancer centres have a significant role in cancer prevention. The centre should provide evidence based guidance on prevention relevant to the local context. All departments will have a role in prevention, especially cancer epidemiology and cancer registry. The role of preventive oncology in a comprehensive cancer centre includes:

— Development and dissemination of information related to cancer risk factors;
— Technical support for local and national government cancer control programmes;
— Tobacco cessation programme;
— On-site cancer detection and screening services;
— Cancer related health check-up;
— Screening services for walk-in clients;
— Outreach programmes;

[2] WHO has identified a set of affordable, feasible and cost effective intervention strategies to reduce the economic burden of NCDs on societies, known as NCD 'best buys'.

— Patient support groups;
— Early cancer detection centres in peripheral hospitals;
— Training and utilization of community pharmacists and other providers to promote healthy behaviour and to identify ‘red flag’ symptoms that may represent cancer.

8.2. HUMAN RESOURCES

A preventive oncology department generally requires trained providers in preventive oncology or community medicine, counsellors, social scientists and communication specialists, and may also include providers for carrying out community based cancer interventions such as screening.

8.3. INFRASTRUCTURE AND EQUIPMENT

Basic screening facility capacities such as for cervical cancer, may also need to be available. Linkages with other departments and services should also be promoted. Outreach activities are important and a mobile team could be used to reach out to the population.

9. PAEDIATRIC CANCER SERVICES

Because it is generally not possible to prevent cancer in children, the most effective strategy to reduce the burden of cancer in them and improve outcomes is to focus on a prompt and correct diagnosis followed by effective and evidence based therapy with tailored supportive care.

9.1. EARLY DIAGNOSIS

When identified early, cancer is more likely to respond to effective treatment and result in a greater probability of survival, with less suffering as well as less expensive and less intensive treatment. Significant improvements can be made in the lives of children with cancer by detecting cancer early and avoiding delays in care. A correct diagnosis is essential to treat children with

cancer because each cancer requires a specific treatment regimen that may include surgery, radiotherapy and chemotherapy.

Early diagnosis consists of three components [16]:

(1) Awareness of symptoms by families and primary care providers;
(2) Accurate and timely clinical evaluation, diagnosis and staging (determining the extent to which a cancer has spread);
(3) Access to prompt treatment.

Early diagnosis is relevant in all settings and improves survival for many cancers. Programmes to promote early and correct diagnosis have been successfully implemented in countries of all income levels, often through the collaborative efforts of governments, civil society and NGOs, with vital roles played by parent groups. Childhood cancer is associated with a range of warning symptoms that can be detected by families and by trained primary health care providers.

Screening is generally not helpful for childhood cancers. In some select cases, it can be considered in high risk populations. For example, some eye cancers in children can be caused by a mutation that is inherited, so if that mutation or disease is identified in the family of a child with retinoblastoma, genetic counselling can be offered and siblings monitored with regular eye examinations early in life. The genetic causes of childhood cancers are relevant in only a handful of children with cancer. There is no high quality evidence to support population based screening programmes in children.

9.2. TREATMENT

A correct diagnosis is essential to enable appropriate therapy to be prescribed for the type and extent of the disease. Standard therapies include chemotherapy, surgery and/or radiotherapy. Children also need special attention for their continued physical, cognitive growth and nutritional status, which requires a dedicated multidisciplinary team. Access to effective diagnosis, essential medicines, pathology, blood products, radiation therapy, technology and psychosocial and supportive care are variable and inequitable around the world.

However, cure is possible for more than 80% of children with cancer when childhood cancer services are accessible. Pharmacological treatment, for example, includes inexpensive generic medications included on the WHO List of Essential Medicines for Children (27 cytotoxic agents, five targeted therapies and four hormone treatments for childhood cancer). Children who complete

treatment require ongoing care to monitor for cancer recurrence and to manage any possible long term impact of treatment [12].

10. INFORMATION SYSTEMS, MEDICAL RECORDS AND REGISTRY

10.1. RATIONALE

Information systems, the medical records department and hospital based cancer registries (HBCR) are closely related and are essential capacities of a cancer centre.

10.2. GOVERNANCE

Cancer centres should have a multidisciplinary medical records and an HBCR committee that periodically reviews reports. The medical records committee must cover audit findings, gross death rate, net death rate, quality indicators, and proposals for the disposal of any records, and should review a defined number of files each from medical, surgical, radiation, medico-legal cases and cases of death. They are also expected to review reports on data to external agencies, any missing files, nil reports, completion of medico-legal cases and death files, International Statistical Classification of Diseases and Related Health Problems coding, and the percentage of incomplete files. The HBCR committee oversees annually the reports generated to establish evaluation of outcomes according to cancer types, stage and clinical protocols with the aim of improving patient care.

10.3. INFORMATION TECHNOLOGY AND SYSTEMS

Information technology and management systems should outline the hardware requirements and software modules that can be aligned and incorporated into the functional specifications of their design and architecture. This will range from various clinical, operational and business modules of the hospital information system (HIS) to a comprehensive approach to solutions that integrates HIS with modules/packages such as the computerized patient record system, radiology information system, laboratory and pathology information

system, pharmacy inventory management system, eP (if available), customer relationship module, patient portal as well as applications such as enterprise resource planning and asset management frameworks. HIS and electronic medical records (EMR) are currently considered an important part of every hospital and health care network and are relied on by all the care delivery processes depend.

The HIS automates clinical, EMR, administrative and inventory functions for the hospital to successfully handle in-patients, out-patients, emergencies, day care and patient referral, along with specific modules to manage human and financial resources and provide an uninterrupted supply chain. Figure 7 shows the components of the technology that can be utilized in a cancer centre.

The HIS should ideally include the following components:

— Help desk, scheduling and patient registration;
— Admissions, discharges and transfers;
— Physician orders and clinical support;
— Billing, package, contract management and accounts;
— In-built enterprise resource planning interface;
— Laboratory and pathology information system:
  - Contract management, registration, accounts receivables and billing;
  - Procedures, reporting and work list;
  - Quality control;
  - Printing, reading and barcode generation;
  - Interface with most equipment.

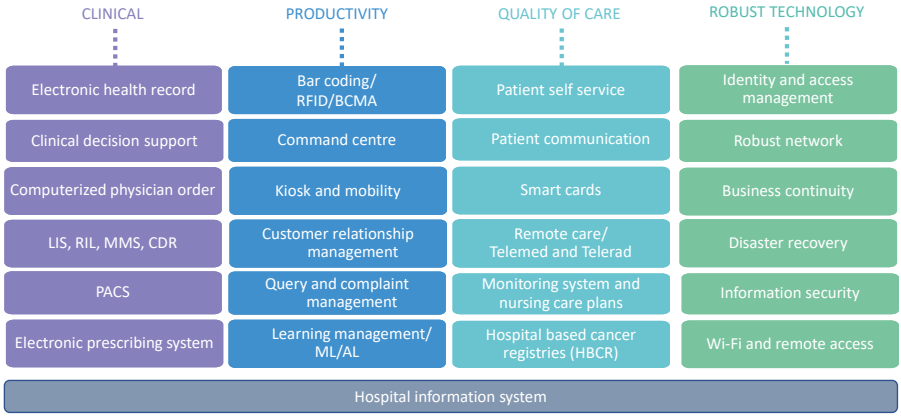


FIG. 7. Information technology that can be applied to a comprehensive cancer centre.

— Radiology Information System:
    - Registration, scheduling, billing, contract management and accounts receivables;
    - Procedures, reporting and work list;
    - Interface with Picture Archiving and Communications System;
    - Built-in enterprise resource planning interface.
— Material Management System:
    - Item master maintenance;
    - Item indents and issues;
    - Reorder level, reorder quantity, minimum and maximum stock levels for each store;
    - Quotations and preferred vendor, purchase requests, orders creation and approval process;
    - Consignment stock receipt, consumption and regularization;
    - Expired stock and quarantine;
    - Last in, first out; first in, first out; first expiry, first out methods;
    - Periodic physical stock taking and adjustments with tracking.
— Clinical Data Repository:
    - Must integrate with the chosen HIS;
    - Access to patient medical records.
— Pharmacy Inventory Management System:
    - Medicine stock control;
    - Medicine ordering;
    - Patient specific record of medication supply;
    - Management of formulary;
    - Aseptic worksheet and labelling system.
— eP:
    - Ideally integrate with EMR and pharmacy inventory management system;
    - eP record for patients;
    - Standardized prescribing for SACT;
    - In-patient eP medication charts/out-patients, where available.

10.4. DATA PROTECTION AND CONFIDENTIALITY

As well as preventing unauthorized access, the aims of confidentiality measures in cancer registration are to ensure: (a) the preservation of anonymity for individuals reported to the registry and, if necessary, also for those making such notifications; (b) that cancer registry data are of the best quality possible;

and (c) that the best possible use of cancer registry data is made for the benefit of cancer patients, for cancer control and for medical research [98].

All patient records are governed by data protection acts to be kept secure and confidential [99]. It is also a condition of registration with medical councils to respect patient confidentiality. Every facility must comply with a legally permitted and documented access to the records process.

10.5. MEDICAL RECORDS

The medical records department is responsible for the maintenance of medical records and medical record services. Medical records are used to inform the HBCR tasked with the monitoring and planning of patient care at the institutional level. The major functions of a medical records department include:

- Admissions procedure, including patient identification and the development and maintenance of the master patient index;
- Retrieval of medical records for patient care and other authorized uses;
- Discharge procedure and completion of medical records after an in-patient has been discharged or died;
- Coding diseases and operations of patients discharged or having died;
- Filing medical records;
- Evaluation of the medical record service;
- Completion of monthly and annual statistics;
- Medico-legal issues relating to the release of patient information and other legal matters.

The main uses of the medical records are:

- To use the master patient index to identify the patient and locate the patient's medical record;
- To document and store the entire course of the patient's illness and treatment;
- To communicate between attending doctors and other health care professionals providing care to the patient;
- For the continuing care of the patient;
- Maintenance and regulatory intimation of deaths and other statistics;
- For research of specific diseases and treatment;
- The collection of health statistics [100].

Medical records are increasingly relevant for:

— Helping create management scorecards to improve operational performance, provide health care statistics and aid medical research.
— Helping judicial authorities, insurance authorities, investigating officials, enquiry officials, by providing required documents/information in time. The key to disposing of any medical negligence claim rests almost entirely on the quality of medical records [101, 102].

10.6. CANCER REGISTRIES

There are two main types of cancer registry: (a) hospital based cancer registries record information on all cancer patients observed in a particular hospital. Their main aim is to plan, monitor and improve patient care at an institutional level. Their data are of limited value for epidemiology because it is not possible to define the population from which their cases arise. (b) Population based cancer registries seek to collect data on all new cases of cancer which occur in a well-defined population. As a result, and in contrast to hospital based cancer registries, they can provide data on the occurrence of cancer in a particular population. Thus, they are of particular value for epidemiology and public health [101].

Population based cancer registries (PBCRs) play an important role in epidemiology by quantifying the incidence and prevalence of the disease in the community and as a source to ascertain the number of cancer cases in intervention, cohort and case-control studies. Their data are also important in planning and evaluating cancer-control programmes by: helping to establish priorities and forecast future needs; monitoring cancer occurrence in relation to the prevalence of important risk factors; helping to assess and monitor the effectiveness of screening programmes; and evaluating cancer care through survival statistics. The data items to be collected by a population based cancer registry are determined by their aims, the data collection methods to be used and the resources available. The emphasis should be on the quality of the data rather than their quantity. The completeness and validity of the data should be monitored regularly. Population based cancer registries are particularly useful in countries where reliable, cause specific mortality data are largely unavailable.

One of the main advantages of hospital registries is that they have ready and instant access to medical records, the primary source of cases. A comprehensive cancer centre should have a HBCR that facilitates planning and monitoring cancer care of the consulting population. Data collected by an HBCR are also used for physician education, for some types of research, for facility

utilization assessment and as an important source for PBCRs in the area. The data items collected by a hospital registry are more extensive than those collected by a PBCR. It is important to clarify that an HBCR does not attempt to register all cancer cases occurring in any defined population; thus, incidence rates cannot be determined. Changes over time in the numbers of any type of cancer or patient characteristics may only reflect shifts by patients (or doctors) from one institution to another. The cancer cases in any one hospital (or group of hospitals) may not be representative of all cancer cases that are occurring in the area. For instance, certain institutions are referral centres for specific types of cancer or for particularly difficult or extensive tumours.

Hospital cancer registries produce reports on the numbers of cancers seen in the hospital per year by cancer site, stage, age and sex. These results may be presented as proportional incidence ratios (i.e. the frequency of cancers of a particular site in relation to the total number of cancer cases). They may also provide information on methods of diagnosis, treatment methods, response to treatment and survival at an institutional level. The hospital registry data may also be used to forecast future demands for services, equipment and manpower in a given hospital. Although these registries cannot provide incidence rates in the general population, they may be used for epidemiological purposes. For instance, case control studies may be set up to investigate the aetiology of a particular cancer by comparing the characteristics of cases with those of a control group. This control group may be formed by patients with other types of cancer or by other hospital patients [103].

11. EDUCATION, TRAINING AND RESEARCH

11.1. TRAINING, ONGOING EDUCATION AND ACCREDITATION

It is recommended that all health care professionals involved in the work of a cancer centre receive adequate academic education and clinical training. National or international guidelines typically lay the basis for the definition of the path to be followed to become a professional competent to work independently in one or more specialties.

The types of education and training include structured and supervised clinical training, workshops, lectures and on-line education courses, continuous professional development and courses to prepare for certification exams or to give continuous professional development credits. Training programmes should be developed in collaboration with an academic university in the country.

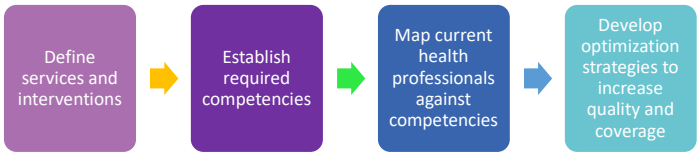


FIG. 8. Path to continuing professional development for cancer care professionals.

Curriculums should be developed in line with national accreditation and local needs. IAEA and WHO curriculums are available in handbooks and can be adapted to fit local needs [66, 104–111]. Before initiating a training programme, objectives, curriculums, time frame, and distribution of responsibilities should be outlined and approved in writing by the local health and professional counsels. The centre also needs to ensure there are sufficient patients and faculty in order to accomplish the goals of training. Exchange programmes in the region and various e-learning resources offered through the IAEA and professional societies can be used to supplement educational activities. Figure 8 summarizes the key steps for identifying potential areas for continuing professional development activities.

When setting up a cancer centre it is important to:

— Identify the required professionals and other services that will be offered by the centre;
— Refer to international or national standards and guidelines to define the responsibilities of each group of professionals;
— Identify the appropriate competencies that must be met, as well as the relevant educational and training paths;
— Establish a roadmap and timeline for planning, recruiting and providing ongoing training, where necessary.

11.2. RESEARCH

11.2.1. Rationale

A clinical research programme is an essential component in any cancer centre. It has an intrinsic goal of generating or contribute to generate knowledge, but also adds value by: contributing to the clinical training programmes; creating multicentred research networks; leveraging other available resources; and strengthening quality and safety culture in the centre. It can also be a vehicle to accurately assess outcomes as a continuous quality improvement tool. Research is also key for integrated medical training. The complexity and organization

of the research programme will vary according to the characteristics of the cancer centre.

11.2.2. Introduction

In the context of a cancer centre, research can be defined as a structured and systematic way of producing new knowledge that provides the foundation for better patient care and community benefit. Research in health covers a wide scope, on a continuum from basic research through clinical research to health economics and patterns of care research that supports changes in policy making.

Basic research involves extensive in vitro or in vivo studies to identify new disease mechanisms, response pathways to treatments or new molecules or treatments with potential clinical use. Translational research links basic research to later phases of clinical research.

Clinical research is often the biggest research component in cancer centres. It can be defined as any health related research that involves human subjects, their tissues or data. WHO defines clinical trials as any research study that prospectively assigns human participants or groups of humans to one or more health related interventions to evaluate the effects on health outcomes. In this context, interventions include, but are not restricted to, drugs, cells and other biological products, surgical procedures, radiological procedures, devices, behavioural treatments, process of care changes, preventive care, etc. [112].

Clinical trials are usually conducted in four phases that build on each another: phase I studies, where the safety of a new intervention is tested; phase II, where interventions proven to be safe in phase I are tested for efficacy to test the benefit or response; phase III trials compare the safety and effectiveness of an experimental intervention against a reference treatment; and finally phase IV, where studies test approved interventions on a larger scale over a longer period of time to obtain complete knowledge of the performance of these interventions.

Community based research concentrates on structural, social and physical environmental matters, in addition to implementation research, over active involvement of society members, organizational representatives and researchers in all aspects of the research process [113]. In this case, the centre of gravity is displaced towards the community centres, while the cancer centre provides research coordination and support, sometimes in collaboration with other partners, such as local universities.

Research is one of the pillars that build the activity in a modern hospital (and cancer centre). It is not optional and cannot be ignored in the design of a comprehensive cancer centre.

11.2.3. Governance

Research is a controlled, formalized and institutionalized activity. It is also highly regulated in order to protect vulnerable individuals, research ethics and to preserve accountability in the funding institutions [114].

Research governance is needed to safeguard investigators and participants in the research by providing a clear framework within which to work. Research governance is a comprehensive and integrated system for administration and supervision of a research programme. The concept goes beyond the administrative and operations related activities and includes a more broad set of regulations, principles and standards of good practice used to: achieve and continuously improve research quality; preserve and enhance scientific quality and reduce fraud and misconduct; mitigate possible risks associated with proposed interventions; monitor and evaluate performance; promote good practices; ensure accountability of the funding institutions; resolve ethical issues associated with the research question or method; and protect vulnerable groups [115, 116].

The basis for the development of a research governance policy is given by the good clinical practice (GCP) guideline, a global ethical and scientific standard for designing, conducting, recording and reporting trials that involve human subjects [117]. The foundation for the guideline is the Declaration of Helsinki, a set of ethical principles regarding human experimentation developed and adopted by the World Medical Association at the 18th World Medical Assembly in 1964 in Helsinki and amended in 1975, 1983, 1989 and 1996. Research Governance Frameworks have been tested in various income and regional settings [116, 118, 119]. Research programmes are often enhanced and improved with the implementation of these Research Governance Frameworks.

Central to the Research Governance Frameworks is the ethics committee, or institutional research boards. The Declaration of Helsinki states that research protocols have to be reviewed by an ethics committee, which must be independent of the investigator, the sponsor, or any other type of body that may exert undue influence. The International Council on Harmonisation describes an institutional research board as a group that protects the rights, safety and well-being of people involved in clinical research by reviewing and approving all aspects of the research protocol. The institutional research board has the authority to approve, disapprove, monitor, or require modifications in all research activities under its jurisdiction. These boards are also called independent ethics committees in Europe.

11.2.4. Human resources

In setting a sustainable human resources model for research in a cancer centre, it is important to create a qualified research team and a team based approach to research. Staffing a research programme requires an understanding of the type of research that will be performed. Human resources fall into three different staff categories: research, support and administration.

The research staff is responsible of the scientific component of the research programme. The principal investigators, or coordinating study investigators, are also responsible of the overall integrity of the research conducted.

Staff research associates or research staff assistants, perform tasks or procedures to support supervised research. They play a very important role in ensuring the continuity of the research programme. Study/research coordinators, sometimes in association with the study nurse, connect the research protocol with the needs and reality of the patients — the subject of the study. Depending on the research profile performed at the cancer centre, the profile of the support staff varies from laboratory technicians to data management specialists, pathology laboratory technicians, cancer registry data collection specialists and statisticians, and dedicated pharmacy staff.

The administrative staff will support the research activities by providing administrative support to the research programme. This includes document management, coordination and communication support.

Training human resources is essential for a successful and sustainable cancer research programme. The Association of Clinical Research Professionals, in collaboration with the Joint Task Force for Clinical Trial Competency, have developed a framework of eight core competency domains designed to standardize the professional development of the workforce involved in clinical research [120, 121].

11.2.5. Infrastructure and equipment

Infrastructure comprises physical structures and facilities that are crucial and/or should support activity leading to successful research processes and outcomes. This includes buildings, transport and communication, water and power supply, etc. The infrastructure and equipment needed for setting up a research programme in a cancer centre depends on the type of research planned.

Clinical research requires core treatment facilities, access to central services, document management infrastructure, equipment and administrative areas. Depending on the type of research, core treatment facilities include: specialized calibrated equipment; surgical areas including an intensive care unit; blood, biomarker and other sample collection and processing; and monitoring

and specialized nursing areas. Access to central services, such as specialized laboratory, pathology, imaging or pharmacy services, including aseptic preparation facilities, together with the skilled personnel, is essential to the conducting of clinical research.

Source documentation management infrastructure and equipment is necessary for compliance with GCP. All clinical trial information must be recorded, handled and saved for precise reporting and interpretation. This principle applies to all records, regardless of media type used. Filing and archiving the trial master file is a mandatory requirement for two main reasons: adequate reporting, interpretation and verification (including the tracking of all events); and for ensuring the protection of the participating individuals.

Some basic support infrastructure is also needed. This includes meeting and working areas; access to libraries (including licences for e-libraries) and archives; computers and internet access (including videoconferencing) and data storage (either physical or cloud space); interview equipment (especially for community based research); office space and equipment; and publishing and printing equipment.

11.2.6. Quality assurance and safety

Any research programme requires an integrated and comprehensive system to ensure quality and safety. These are related concepts, safety being a consequence of a strong approach to quality management. A quality management system (QMS) includes all activities of the overall management of the programme that determine the quality policy, objectives, and responsibilities and their implementation.

Quality management is a transversal activity in a cancer centre that has to be managed in an integrated and comprehensive way through a QMS that includes a research component. Depending on the complexity of the cancer centre and the research programme, it may be worth creating, implementing and maintaining a subsystem for the research programme, connected to the main QMS.

The QMS applies to all activities related to the research programme. It also defines the responsibility, authority and interrelationships of personnel who manage and perform research projects. The QMS also informs institutional policy making to pursue excellence in the execution of research projects.

Depending on the criteria used for setting it up, the main components of the QMS are the policy statement (level 1), the pyramid of documentation (level 2, procedures; level 3, SOPs and work instructions; level 4, records), the control and monitoring system, the quality audit system and the quality committee.

The level of research complexity will vary by the size of the cancer centre. For example, a small hospital based centre may limit research to retrospective

studies of patient charts to evaluate outcomes, while a large comprehensive cancer centre can have a wider variety of research capabilities, from basic research to phase I–III studies.

12. GOVERNANCE, ADMINISTRATION AND FINANCING

12.1. GOVERNANCE

Hospital governance is defined by the oversight structure of the organization put in place to oversee and hold the hospital management accountable in its objective to maximize stakeholder value. Governance begins at the top with the establishment of the Board. The Board, with its appointed Board of Directors, as custodian of stakeholder interests, is expected to provide stewardship and direction, as well as an evaluation of the management's performance.

Boards are expected to review the risk management and internal control systems with a view to determining that they remain appropriate and are functioning effectively. The Board acts as the trustees to the property and welfare of the organization. It defines the vision, mission, values, objectives and policies of the organization, which form the basis for defining the strategy and its implementation.

Boards are also expected to oversee the design of the organizational structure and select the top executives and key personnel. They review financial performance and give financial approval for various projects, reserves, distribution of profit, loan repayment, etc. Boards are a vital link between the cancer centre and external entities such as the government or economic institutions.

Both governance and control depend on the size and complexity of the organization and the nature of risk profiles and challenges. The chief executive or the head of the hospital management team reports to the Board.

Public sector cancer centres are overseen by the national government. A high level governance mechanism with representation from health, finance, education and other sectors of government can guide the work and take policy decisions. An operational committee with multidisciplinary team of technical officers and administrators is needed.

12.2. ADMINISTRATION

It is essential to balance all facets of care, quality and operations to ensure a sustainable, expandable and collaborative service model. This section provides a guiding structure for the various roles and responsibilities that need to be assigned while setting up and managing a cancer centre. This structure can be scaled down to suit smaller centres, whose focus may be prevention, health education, initial diagnosis, referral to a higher centre, provision of basic follow-up care and palliative services. This structure can further link a state or national level programme that aligns with their goals and specialty focus.

12.3. FINANCIAL MANAGEMENT

Oncology care requires capital, operational and staff investment for quality care delivery, and to meet the specialized needs of adults and children with cancer [122]. Financing of a cancer centre can be challenging, with overall costs increasing in line with the complexity and costs of products and equipment and the number of people seeking care at cancer facilities. Once capitalization is initiated, finance departments play a crucial role in ensuring that there are resources available for meeting the comprehensive cancer centre's objectives, and that fiduciary responsibilities are upheld. It is imperative to have a strong finance team from the conception stage, so that cash flows are estimated at every juncture of the journey in order to be able to make funds available [123].

This can only be achieved through strategic decisions and capital investments that bear in mind the cancer centre's vision and mission, and needs not only to have enough resources to set up the centre, but also to ensure that there is funding available for operations until the centre breaks even [124]. There should be a detailed budgeting exercise followed by a cash flow mechanism to ensure a viable project, including inputs from clinical planning, medical and non-medical equipment, design and the building contractor.

Sustainability requires a thorough analysis and adequate calculation for funds to pay salaries, purchase consumables, maintain and replace equipment in due time, maintain and expand the existing infrastructure, and train the current and new workforce. It is important to carry out a feasibility study upfront and estimate the gaps and the cost. Some important features include:

— *Planning to be efficient.* This involves answering questions such as how many beds, ICUs and OTs are required? What is the current bed occupancy rate and anticipated increase in volume? What technology will be used? How can facility guidelines be used to facilitate the planning and efficient

use of resources? It is important to both avoid unnecessary expenditures and assess the most cost effective purchases.

— *Innovative financing mechanism/identifying multiple donors.* It is the responsibility of the organization setting up the cancer centre (governmental/NGO/private) to make financial resources available and form partnerships, and there are several ways this can be done:
    - *Vendor financing.* This includes various modes of partnership with equipment manufacturers, including mechanisms such as:
        - Deferred payment over 8–10 years.
        - Vendor financed complementary equipment, where the vendor lends certain expensive equipment to a hospital, which purchases their inventory of services or consumables; for example, laboratory reagents and scans.
    - *Lease finance.* This can be adopted in cases where vendor financing is not possible. Cancer centres can reach out to finance companies to help them lease equipment. This permits the use of equipment by the centre without giving them ownership rights.
    - *Maximizing cost efficiency and revenues.*
        - Empanelment with government insurance schemes.
        - Staggered recruitment of human resources based on occupancy.
        - Bulk procurement for drugs and consumables.
        - Policy and advocacy.
    - *Philanthropic support.* Many cancer centres seek and receive philanthropic support, which has the potential to transform the future of cancer care and comprehensive cancer centres. The centre may work with donors and/or foundations to generate funds for strategic investments.

Lastly, financial systems should be able to record base data for analysis such as consumption subcategories, risk categorization of patients, and norms. The finance team should have capabilities in analytics to provide insights on deviations for ensuring timely measures for sustainability.

13. ADVOCACY, COMMUNITY ENGAGEMENT AND PARTNERSHIPS

13.1. ADVOCACY

Advocacy is a critical component to enhance all areas of cancer control. Cancer centres are best placed to provide the science and evidence for advocacy and to be the advocate for cancer control. As providers of cancer care in the community, cancer centres enjoy better credibility in communications.

13.2. COMMUNITY ENGAGEMENT AND PARTNERSHIPS

The cancer centre has an important role in forging connections with civil society organizations to facilitate access to important services and support throughout the care trajectory. Formalized partnerships at the local, national and international levels can allow the cancer centre to work with external organizations to resolve unmet patient needs and advocate for patient services and support that are outside the scope of the cancer centre, or best delivered in the community. Partnerships with foundations and industry are also important.

Civil society organizations, sometimes named the 'third sector' after government and commerce, refer to the private and family sphere and encompass a wide array of bodies, which include NGOs, society groups, indigenous groups, labour unions, charitable organizations, faith based organizations, professional associations, and foundations aiming for collective action around shared interests, purposes and values. When mobilized, civil society, as a non-State actor, has the power to influence the actions of elected policy makers and businesses and play crucial and diverse roles in societal development.

Civil society organizations can be engaged to:

— Support a cancer centre in ensuring that patient experience and outcomes are of central focus in the design and daily services of the centre.
— Help drive the vision of the first cancer centre in its role beyond that of a stand-alone treatment clinic to that of a 'reference cancer centre' for the country and community.
— Participate in realizing that vision in a multifaceted approach, holding institutions accountable and promoting transparency, raising awareness of consumer and societal issues, delivering services to meet public information, education and health needs, bringing experience and knowledge of experts to

shape policy and strategy, giving power to the marginalized and supporting citizen engagement.

— Promote the formation of community based groups, such as local cancer councils, which play important roles in engaging the target population to seek available services. Working hand in hand with the cancer centre, these groups can both shape and implement population based cancer management tailored in creative ways to the local context. Vehicles for community outreach and engagement, including the survey and linkage of disease rates to geographical areas, can enhance actions to reduce loco-regional health care disparities. They can also identify barriers to access, such as lack of transport. Without such grassroots collaboration and awareness campaigns, much of the marginalized target population may remain out of reach.

— Develop their expertise to support institutions and services, when requested by the Ministry of Health or the cancer centre, critical to the monitoring, evaluation and improvement of clinical outcomes, as well as providing trusted sources of information for the public, such as the national cancer control strategy through the development and publication of a national cancer control plan; cancer registry; national cancer research institute; cancer society; national cancer patient network and professional organizations involved in the disciplines of cancer care.

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Annex

CASE STUDY: A DISTRIBUTED CANCER CARE MODEL FOR PATIENT ACCESS BY TATA TRUSTS AND THE GOVERNMENT OF ASSAM, INDIA

A–1. TATA TRUSTS MODEL OF CANCER CARE

In India, there is a need to increase the allocation of trained personnel resources, coordinate multisectoral policy interventions, and enhance the engagement of the health system in activities related to cancer prevention and control [A–1]. The Tata Trusts model of cancer care aims to set up a dynamic, interdependent, cross-flowing, technology driven tiered model of care. While the tier definitions are described differently than those recommended in this publication, with level one being the highest level of service, the model can be considered as one example of a cancer centre set-up which enables the following:

(1) *Access through disaggregation.* This model features different levels of care with specific components (see Fig. A–1). Awareness, community screening and home based palliative care are presented in level 4, while the 3rd level (L3), situated adjacent to the District/Civil hospital, offers diagnostic

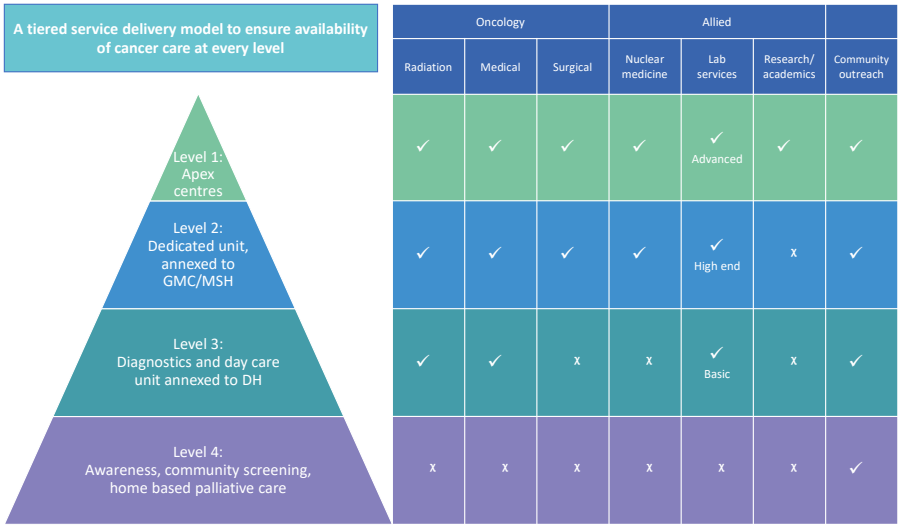

FIG. A–1. Model of cancer care with different levels of care offering specific components.

services (radiology and pathology) along with protocol driven day care management of chemotherapy and radiation. These centres will ease the burden of routine care currently managed by the few apex centres. The 2nd level (L2), located at a Government Medical College, offers comprehensive cancer services except highly technical procedures such as bone marrow transplantation, neurosurgery and complex surgical resections or reconstructive work, as well as advanced diagnostics (molecular, genomics and proteomic). The apex level (L1), which is where the supply is currently concentrated, will focus on complex care, education and research.

(2) *Technology driven integration.* Radiology, pathology and nuclear medicine reporting, as well as treatment planning, are enabled virtually and remotely in a location where oncology specialists are available (see Fig. A–2). This helps overcome the biggest bottleneck, namely insufficient specialized manpower at the delivery centres [A–2]. The central station will manage:

— Patient navigation and information dissemination through a multilingual call centre for patient queries, reminders and counselling.
— Collaboration between clinicians through virtual tumour boards, treatment planning, reporting and asset management and utilization.
— Standardization and down streaming of pathways using a ‘maker and checker’ mechanism for diagnostics, chemotherapy and radiation. This will support the ‘upskilling’ of posted resources.

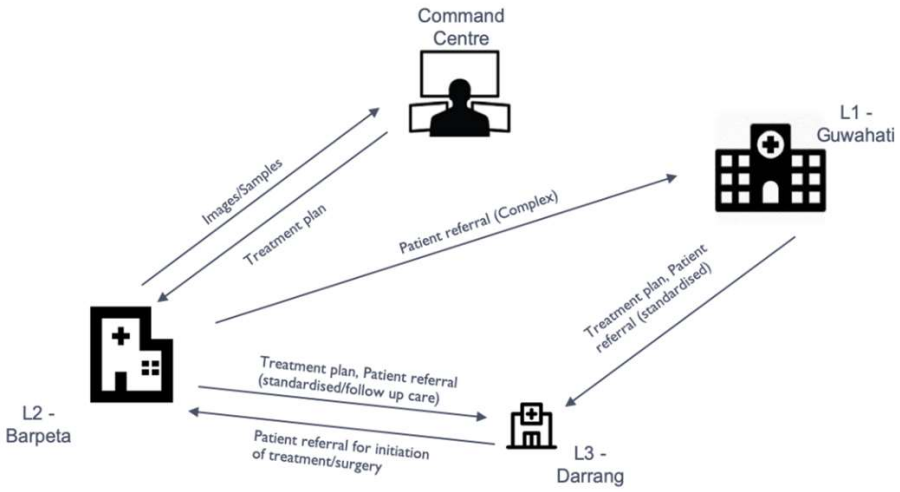

FIG. A–2. Relationship between the service centres and the central command.

— Tracking use of assets and movement of personnel in terms of bed utilization, emergency care, billing, quality assurance, shift management and leave support.

(3) *Standardization of care delivery.* Use of standardized clinical protocols in adherence to guidelines issued by the national cancer grid, operational hospital processes and aspects of patient experience [A–2]. Uniform infrastructure and facilities across all centres available close to home will eventually reduce the number of patients seeking large city based hospitals for their clinical reputation.

(4) *Patient care financing.* Financial barriers are often quoted as the reason for patients choosing to not access treatment or dropping out mid-treatment. Each centre is being equipped to educate and assist patients to take advantage of appropriate insurance schemes, such as Ayushman Bharat (Central Government scheme) or Atal Amrit Abhiyan (insurance scheme floated by the Government of Assam), etc. [A–3, A–4]. Other instruments under consideration to ease this problem are patent loans and subscriptions to the provider centres.

(5) *Personnel and training.* The staffing in these facilities will pilot a unique model well established in developed countries but in its nascent stage in India. A team of specialists and nurses are being developed through bespoke fellowship courses in oncology of three months and six months duration, respectively. The intent is to shift tasks that can be provided by specialist

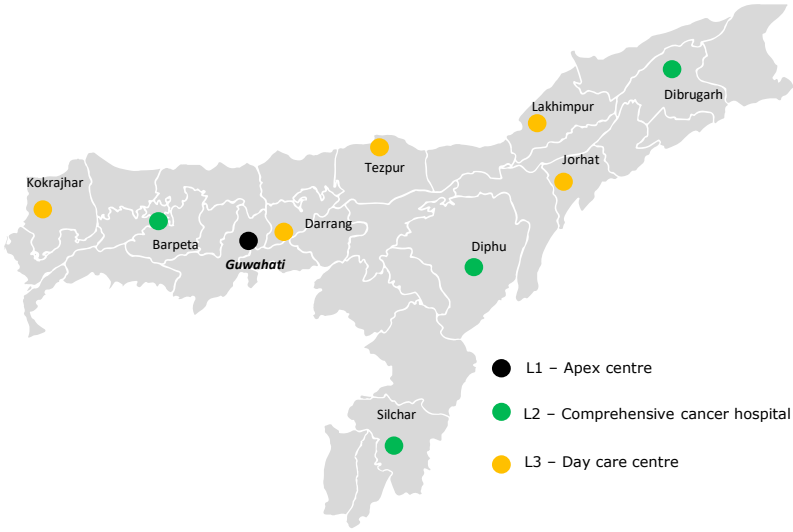

FIG. A–3. Map of Assam showing proposed locations for cancer centres.

medical personnel with adequate training away from oncologists, thereby addressing the requirement of capable human resources in a limited supply scenario. Such models have already been tried elsewhere across the world and in India [A–5 to A–9].

(6) *Early detection.* The proposed model adopts a 'catchment' approach going beyond infrastructure creation using the following vehicles:

- — Conducting screening camps. Population based screening for common cancers (oral, breast, cervix) based on Government of India guidelines for early detection of cancer and management of referral systems.
- — Community awareness about risk factors of cancer and prevention measures. Training of frontline health workers, such as the auxiliary nurse-midwife, Anganwadi worker, accredited social health activist, medical social workers and training of women's self-help groups.
- — Tobacco control. Outreach programme for students covering National Service Scheme students and teachers from colleges, school (class 8–10) students and teachers, nursing college students and teachers, Cigarettes and Other Tobacco Products Act sensitization workshop for district law enforcement and district education officers, working with the Education Department for the enforcement of tobacco free educational institutions.
- — Training of private practitioners for timely referrals (general practitioners (GPs), dentists, etc.), training allopathic practitioners (GPs, dentists, gynaecologists, etc.).
- — Cancer registry. Making cancer notifiable/reportable in every state, implementation of a hospital based cancer registry, implementation of a population based cancer registry in the relevant area.
- — Palliative care. Providing home based palliative care services to the community in the relevant area. Holding sensitization workshops with government departments to ensure availability of opioids in institutions.
- — Patient affordability. Spreading awareness among the population of government insurance schemes.

(7) *Research programmes*. In addition to clinical and training activities, an ambitious research programme was started which has attracted significant grant funding. These are in the areas of public health, cancer therapeutics and low cost technology. Management of collaboration with researchers in India from an interdisciplinary background, international organizations such as King's College London, the US National Cancer Institute and Harvard University, as well as industry partners in biotechnology and therapeutics around the world.

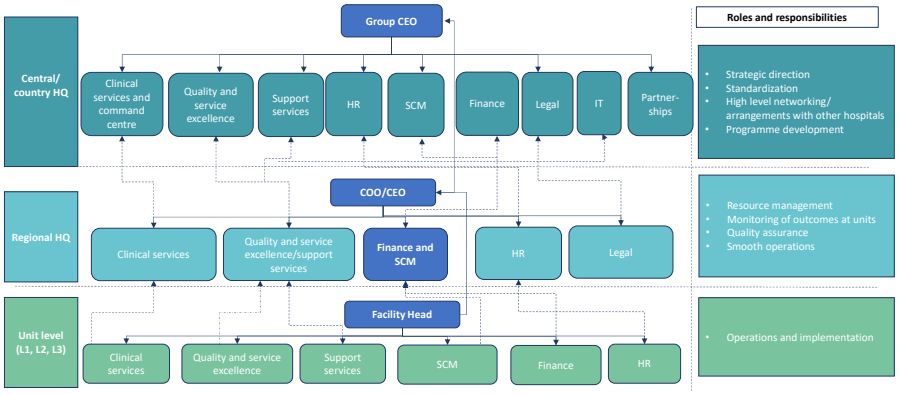

FIG. A–4. Organizational structure for a level 3 comprehensive cancer centre.

The model described above is being piloted in the State of Assam by Tata Trusts, in collaboration with the State Government, through a special purpose vehicle, the Assam Cancer Care Foundation, to set up a network of ten hospitals across the three levels initially. These hospitals are in different stages of construction and will be commissioned in a phased manner starting from the year 2021 after which care outcomes will be measured.

The locations of ten upcoming hospitals in this distributed network are mentioned below and shown in Fig. A–3, with the map of Assam. The State Cancer Institute at Guwahati is being strengthened to an L1 centre. A total of

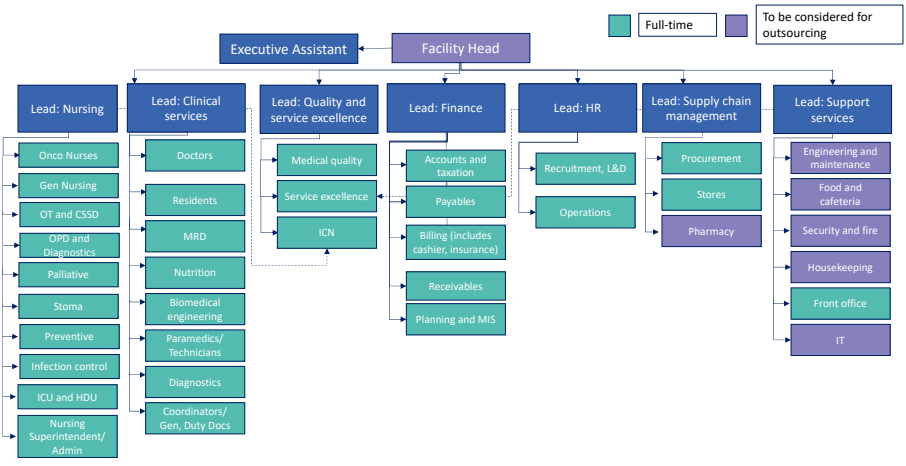

FIG. A–5. Organizational structure for a level 3 comprehensive cancer centre.

four L2 centres are being established adjacent to Government Medical Colleges at Dibrugarh, Barpeta, Silchar and Diphu. A total of five L3 centres are being set up, with four adjacent to Government Medical Colleges (existing and upcoming) at Tezpur, Jorhat, Lakhimpur and Kokrajhar, and one adjacent to the District Hospital in Darrang (see the organizational structure in Figs A–4 and A–5). Accommodation will be provided for staff at all facilities and for patients near L2 facilities. This network will reduce travel times to access cancer services to less than 2.5 h for every person in Assam (see Table A–1).

TABLE A–1. BROAD FACILITY CONFIGURATION LEVELS AND MULTIDISCIPLINARY CARE SERVICES

Department	L1	L2	L3
	Diagnostic		
X ray/fluoroscopy	1	1	0
X ray	2	1	1
Ultrasound	3	2	1
Mammography	1	1	1
CT	1	1	1
MRI	1	1	1
Interventional radiology (digital subtraction angiography, DSA)	1	0	0
Endoscopy	2	2	0
Audiometry and brainstem evoked response audiometry (BERA)	1	0	0
	OPD		
Consulting rooms	30	20	10

TABLE A–1. BROAD FACILITY CONFIGURATION LEVELS AND MULTIDISCIPLINARY CARE SERVICES (cont.)

Department	L1	L2	L3
	Day care		
Chemotherapy chairs	20	20	15
Chemotherapy beds	20	20	12
Day care beds	10	4	10
Total	50	44	37
	Treatment		
Linear accelerator	4	2	2
CT simulator	1	1	1
Brachytherapy	1	1	1
Minor OT	2	2	1
PET–CT	1	1	0
Gamma camera/SPECT	1	1	0
Cell irradiator	1	0	0
Preparation room in radiation therapy and radiology for paediatric sedation	1	0	0
	Surgery and in-patient		
Operating theatres	8	3	0
SICU/HDU/ICU beds	40	21	0

TABLE A–1. BROAD FACILITY CONFIGURATION LEVELS AND MULTIDISCIPLINARY CARE SERVICES (cont.)

Department	L1	L2	L3
Ward beds and palliative care beds	160	48	0
Bone marrow transplantation beds	8	0	0
Radioactive iodine beds	3	0	0
Pre-/post-op	18	7	0
Endoscopy, minor OT recovery and DSA	13	8	0
ER	8	4	0
Total beds	250	88	0
Other services			
Procedure and treatment rooms: OPD/chemo, wards and ICU	7	4	2
Dialysis/CRRT	2	1	0
TMT/ECG/Echo rooms	Yes	One each	One each
Telemedicine	Yes	Yes	Yes
Blood bank, complete	Yes	Yes	No
Blood bank, storage space	Yes	Yes	Yes
Tumour board	Yes	Yes	Yes
Home care orientation area	Yes	Yes	Yes

TABLE A–1. BROAD FACILITY CONFIGURATION LEVELS AND MULTIDISCIPLINARY CARE SERVICES (cont.)

Department	L1	L2	L3
Laboratory, basic — collection, haematology and biochemistry	Yes	Yes	Yes
Laboratory, advanced — immunology/histopathology	Yes, with flowcytometry	Yes	No
Central sterile services department	Yes	Yes	Yes
Physiotherapy	Yes	Home care	Home care
Mortuary	Yes	Yes	No

Mandatory inclusions in all facilities

- Preventive oncology, tumour board room, measurable residual disease, cancer registry, pharmacy and training facilities.
- Medical gas pipeline system, central monitoring system, nurse call bell system, modular OTs, biomedical waste disposal system. kitchen, laundry, café, dining, stores and administration.
- Heating, ventilation and air conditioning system, uninterrupted power supply and diesel generator sets, sewage treatment plants, water treatment plant and reverse osmosis plant, closed circuit television (CCTV) and public address system, access control system, power backup, fire detection and alarm system and detailed building signage plan.
- Patient centric design.
- Compliant with building standards and national clinical requirements.
- Energy efficient green building design.
- Indian context design.
- Digital nerve centre and central command centre.

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ABBREVIATIONS

CT	computed tomography
eP	electronic prescribing
HBCR	hospital based cancer registries
HIS	hospital information systems
ICU	intensive care unit
MDT	multidisciplinary team
MNT	medical nutrition therapy
MRI	magnetic resonance imaging
OT	operating theatre
PCR	polymerase chain reaction
QA	quality assurance
QMS	quality management system
SACT	systemic anticancer therapy

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Cancer centres are a major resource in ensuring a comprehensive approach to cancer treatment and its planning. This publication proposes a framework to develop a cancer centre and/or to strengthen the provision of services in an existing cancer centre. The framework provides the features of multidisciplinary cancer care and details the infrastructure, human resources and equipment for different services. This framework is expected to be used as a guide to developing cancer centres, taking into consideration the local context and resources.

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