Radiation Therapy in Indonesia: Estimating Demand as Part of a National Cancer Control Strategy

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Abstract

Purpose: The International Agency for Research on Cancer (IARC) predicts that the burden of cancer will continue to increase over the next few decades. Based on the Indonesia Basic National Health Survey (RISKESDAS) in 2018, cancer prevalence has increased 28% from 1.4 per 1,000 (2013) to 1.8 per 1,000 in 2018. Given the burden and challenges of the problems resulting from cancer over time, a comprehensive and systematic effort and response from various sectors is needed in the form of a National Cancer Control Plan (NCCP). Cancer treatment is the most expensive part of a cancer control program, and cancer-specific health facilities, human resources, specialized equipment, and therapy all contribute a high cost. Radiation therapy (RT) is a primary and priority medical treatment needed for cancer care; more than 50% of cancer patients will need RT.

Methods: Cancer incidences were extracted from the International Agency for Research on Cancer GLOBOCAN database. The total population was based on the Central Bureau of Statistics of Indonesia. Several models based on published literature were used to estimate the number of patients requiring RT in each province and the demand for megavoltage machines in Indonesia.

Results: Based on these models, the need for additional RT centers is evident. Through various estimation methods, Indonesia is expected to need 265 to 427 megavoltage machines to provide RT access to all cancer patients in the country. Using the Indonesian Radiation Oncology Society (IROS) estimation model (conventional and hypofractionated RT) and megavoltage/million, with the 82 megavoltage machines available in 2020, the coverage of RT services in Indonesia (available RT machines / RT required) is 21.7% (conventional RT), 27.7% (hypofractionated RT) and 31% (megavoltage/million).

Conclusions: Access to RT is a necessity and global priority. In addition to more facilities, implementing high-quality and safe RT services is essential. Hypofractionated radiation therapy (HRT) may be one innovation and solution for overcoming the RT shortage and preparing for a growing number of cancer cases in the future.

Keywords: Cancer, radiation therapy, access, cancer control

Cancer is one of the most prevalent noncommunicable diseases after cardiovascular disease, and is a worldwide problem.[1] Data from the Institute for Health Metrics and Evaluation (IHME) have shown that cancer prevalence ranked fourth among diseases in 2007 and second in 2017, excluding maternal and childhood diseases and infectious diseases.[1] A World Health Organization analysis concluded that 1 in 6 deaths is caused by cancer.[2] Also alarming is that a new case of cancer arises every 1.5 seconds and every 2 seconds is a cancer death. More than 50% of cancer cases occur in people from low- to middle-income countries (LMICs) where health systems are not well prepared or equipped to manage this growing burden,

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and where budget allocations and resource mobilization are severely insufficient.[3-5]

The International Agency for Research on Cancer (IARC) has assessed and estimated cancer incidence and mortality in Indonesia. In 2018, Indonesia was estimated to have 348,809 new cancer cases annually, which will increase by 65.1% to 575,814 in 2040. In addition, cancer deaths will increase by 76.9% from 207,210 to 366,567 in 2040.[6] This increase is also in line with a Basic Health Research (RISKESDAS) analysis that shows a significant rise of 28% in cancer prevalence from 1.4 per 1,000 in 2013, to 1.8 per 1,000 in 2018.[7] According to the national population-based cancer registry report in 2017 from the National Cancer Control Committee, which collected cancer data in Indonesia from 2008 to 2012, breast cancer and cervical cancer were the most common cancers in women, and lung cancer and nasopharyngeal cancer were the most common in men. Additionally, pediatric cancers represent 3% to 5% of all cancers in Indonesia.[8]

Cancer costs also increase annually, according to the National Health Insurance system, part of the Health Insurance Administration Agency. Reaching 1.5 trillion rupiah (110 million USD) in 2014 and 4.15 trillion rupiah (300 million USD) in 2019, these costs directly result from services at health facilities in collaboration with BPJS Health (Indonesian national health insurance) and do not include the cost of health services at private health facilities.[9] In addition, many indirect costs stem from the loss of productivity of patients and families, and travel expenses required due to lack of health facilities and facility infrastructure.

Radiation therapy (RT) is one of the main components of multidisciplinary cancer treatment. Recent data suggest that more than 50% of cancer patients will require RT throughout their disease, either as a single treatment or in combination with other treatment modalities.[10] RT may be given preoperatively to allow for less extensive surgical procedures to preserve organ function and to produce better results, or postoperatively to improve local control. For palliative purposes, RT can relieve symptoms associated with advanced or metastatic disease, improving quality of life.[11] As these benefits suggest, RT has an essential and indispensable role in the multidisciplinary management of cancer. Unfortunately, many barriers remain. Many countries or communities in various parts of the world have not been able to provide RT as one of the main therapeutic modalities in the course of disease management. Research by Abdel-Wahab et al has shown that only 9 out of 31 (29%) low-income countries and 34 out of 52 (65%) LMICs have RT services.[12]

Addressing the growing burden of cancer as a public health priority remains a challenge, and requires a flexible approach and strategies adapted to local circumstances. This is because cancer is not a single disease but is complex and multifactorial with an extensive impact. All strategic plans and decisions must be prepared and based on the best available evidence and accurate epidemiological data, and addressed in a cancer control program or a national cancer control program (NCCP). The International Atomic Energy Agency (IAEA) states in its publication, "Inequity in Cancer Care: A Global Perspective," that only through a well-designed, managed, and funded NCCP, with universal reach and accessibility, will these efforts impact cancer control.[13] Thus, it can be concluded that an NCCP is an excellent example of a whole-of-government and whole-of-society approach through leadership and cross-sectoral engagement. This is because cancer cannot be prevented or controlled by the health sector alone. In this literature review, we will discuss the role and strategy of RT in the NCCP to enable available resources to be used more rationally, with more optimal medical and social benefits.

Current Status of Cancer Care and Radiation Therapy Services in Indonesia

Indonesia is one of the largest archipelago countries in the world that has a decentralized government system divided into central, provincial and district governments with specific roles and responsibilities.[14] The Indonesian health system is a mix of government/public and private health facilities. The public system is managed in line with the decentralized government system in Indonesia, with the responsibility of the central, provincial and district governments. The Ministry of Health is responsible for managing several vertical/tertiary and specialized hospitals, providing strategic direction, standards, regulations, and ensuring the availability of financial and human resources. The provincial government is responsible for managing the provincial-level hospitals, providing technical supervision and monitoring of district health services, and coordinating cross-district health problems within the province. District/city governments are responsible for managing district/city hospitals, district public health networks from Puskesmas (Primary Health Care [PHC]), and other related health facilities. Several private service providers, including a network of hospitals and clinics, are managed by nonprofit and charitable organizations.[13]

This decentralization also affects how health services in Indonesia are carried out in its referral system. This referral system refers to staging according to medical needs, with Puskesmas acting as the first contact of access

Figure 1. Access to radiation therapy services at the end of 2020. (IROS database 2020)

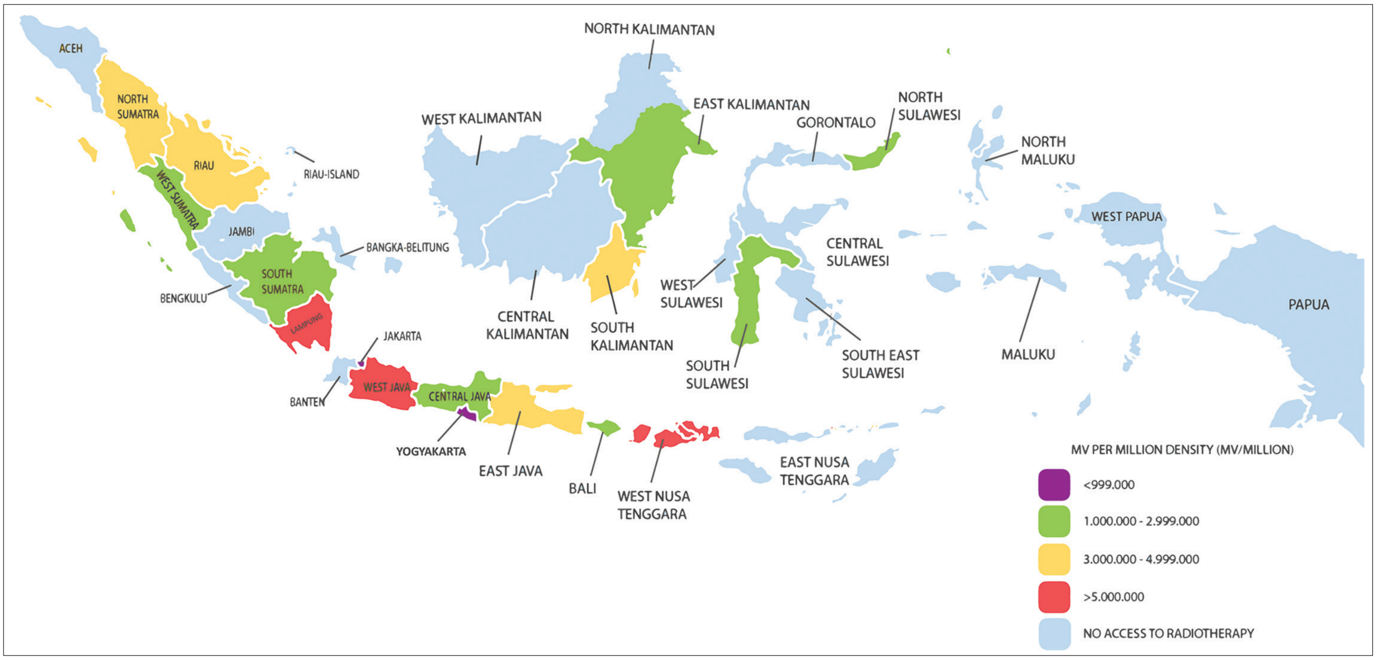

Table 1. Example of Calculating the Need for Radiation Therapy Using Mv/M

COUNTRY/PROVINCE	POPULATION*	NUMBER OF RT NEEDS MV/M#
Indonesia	265,015,300	265
North Borneo	716,400	1
West Java	48,638,700	48
Jakarta Capital Special Region	10,467,600	10

**Population data based on the Central Statistics Agency 2019;*[17]
#Number of Mv/M RT needs: population/1 million.
Key: Mv/M = megavoltage/million, RT = radiation therapy

to public health services. According to the Ministry of Health, there are approximately 9,993 PHCs, 8,841 clinics, and 2,724 hospitals, with most health care systems centralized around Java. The second or third contact of access consists of 15 specialized vertical hospitals with the capability of providing a broad spectrum of cancer care, including Dr. Cipto Mangunkusumo Hospital or Dharmais National Cancer Centers as top referral hospitals for cancer treatment in Indonesia.[15] This referral system in Indonesia was created due to geographical challenges and a widespread population. Distribution in rural areas appears to be the biggest challenge to the referral system, causing negative implications for time, and travel expenses that, in turn, hamper the overall process and adherence to treatment and follow-up care.

Along with its geographical situation (ie, Indonesia being the largest archipelago in the world), lack of supporting infrastructure poses a steep challenge in supporting the availability of RT centers, causing uneven and concentrated availability. In 2000, only 20 RT treatment units and 31 radiation oncologists were available in Indonesia. At the end of 2020, 16 out of 34 provinces had access to RT services, with 47 centers in operation. Currently, there are 82 megavoltage machines including 60 linear accelerators, 21 cobalt systems, and 1 tomotherapy unit. In addition, there are 135 radiation oncologists and 54 residents in training (**Figure 1,** IROS Database, 2020).

Estimating the Need for Radiation Therapy in Indonesia

The total population and population per province in Indonesia were obtained from the Central Bureau of Statistics of Indonesia. Cancer incidences were extracted from the International Agency for Research on Cancer (IARC) GLOBOCAN database. The number of existing machines was primarily obtained from the Indonesian Radiation Oncology Society (IROS) database. Several models based on published literature, as described below, were used to estimate the number of patients in the densest and less dense provinces and the capital of Indonesia, and estimate the demand for megavoltage machines.

Megavoltage/Million

The megavoltage/million (Mv/M) calculation method or 1 unit of radiation therapy/1 million population is the most common and easy-to-use RT availability indicator.[16] This calculation uses a simple method based

Table 2. The Estimated Need for Radiation Therapy

COUNTRY/ PROVINCE	POPULATION*	CANCER INCIDENCE BY GLOBOCAN 2020[20]@	NUMBER OF NEW CANCER PATIENTS/YEAR#	NUMBER OF CANCER PATIENTS REQUIRING RT^	RT REQUIREMENTS§
Indonesia	265,015,300	1.45	384,272	192,136	427
North Borneo	716,400	1.45	1,038	519	1
West Java	48,638, 700	1.45	70,526	35,263	78
Jakarta Capital Special Region	10,467, 600	1.45	15,178	7,589	16

**Population data based on the Central Statistics Agency 2019.[17]*
@Indonesian Cancer Incidence based on GLOBOCAN 2020[20]: 273,523,621/396,914 = 1.45/1,000.
#Number of new cancer patients/year: (Population) × (Indonesian cancer incidence/1,000 population).
^Number of cancer patients requiring RT: RTU 50%.
§RT requirement: (Number of cancer patients requiring RT)/450. Key: RT = radiation therapy

Table 3. Estimated Radiation Therapy Needs Based on Optimal Fractionation

COUNTRY/ PROVINCE	POPULATION*	CANCER INCIDENCE BY GLOBOCAN 2020[20]@	NUMBER OF NEW CANCER PATIENTS/YEAR#	REQUIRED AMOUNT OF FRACTIONATION 9,768/1,000^	NUMBER OF RT EQUIPMENT (8 WORKING HOURS/DAY)¢	NUMBER OF RT EQUIPMENT (10 WORKING HOURS/DAY)¥
Indonesia	265,015,300	1.45	384,272	3,753,569	361	289
North Borneo	716,400	1.45	1,038	10,139	1	1
West Java	48,638,700	1.45	70,526	688,898	66	53
Jakarta Capital Special Region	10,467,600	1.45	15,178	148,259	14	11

**Population data based on the Central Statistics Agency 2019.[17]*
@Indonesian Cancer Incidence based on GLOBOCAN 2020[20]: 273,523,621/396,914 = 1.45/1,000.
#Number of new cancer patients/year: (population) × (Indonesian cancer incidence/1,000 population).
^Number of required fractionation: (number of new cancer patients/year) × 9,768/1,000[21].
¢Number of fractions per year/1 linac (8 hours/day): (1 linac) × (5 fractions/hour) × (8 hours/day) × (5 days/week) × (52 weeks) = 10,400.
¥Number of fractions per year/1 linac (8 hours/day): (1 linac) × (5 fractions/hour) × (8 hours/day) × (5 days/week) × (52 weeks) = 13,000.
Number of RT equipment (8 working hours/day): (amount of fractionation needed) / 10,400.
Number of RT equipment (10 working hours/day): (amount of fractionation needed) / 13,000.
Key: RT = radiation therapy

on the latest population data without considering incidence of cancer or radiation therapy utilization units (RTUs) (**Table 1**). Provinces/local governments can use this method as the initial stage of planning the construction of RT facilities in their area. However, it is also necessary to consider access and geographical distribution as the next significant factors to assess.

ESTRO-QUARTS Method

The European Society of Radiotherapy and Oncology (ESTRO) developed a guideline for calculating RT needs through the Quantification of Radiation Therapy Infrastructure and Staffing needs (QUARTS).[18,19] The project compiled guidelines for infrastructure and staffing throughout Europe and formulated it into a general guideline. The result is a standard that suggests having 1 linear accelerator (linac) for 450 cancer patients, 1 radiation oncologist per 200 to 250 patients, and 1 medical physicist per 450 to 500 patients (population as follows in **Table 2**).

Use of Fractionation Needs Calculation

Another method for estimating RT need is to use the optimal number of fractions. Wong et al developed a model combining the calculation of the radiation therapy utilization rate (RUR) and the need for retreatment. RUR is defined as the proportion of a given population of cancer patients who received at least 1 course of RT during their lifetime.[21] From these results, it was found that 9,768 RT fractions were required for every 1,000 cancer patients. Estimating the optimal number of fractions has been recognized as valuable in planning RT services. The Global Taskforce on Radiotherapy for Cancer Control, founded by the Union for International Cancer, estimates that 119 million fractions were needed for all cancer patients worldwide in 2012.

From this amount, the need can be extrapolated to describe a population. In this scheme, the number of needs is greatly influenced by the addition of working hours. The higher the number of working hours per day, the higher the fractionation capacity of an RT device. **Table 3** estimates the need

Table 4. Estimated RT Needs Based on Zubizarreta et al Calculations

		INDONESIA	NORTH BORNEO	WEST JAVA	JAKARTA CAPITAL SPECIAL REGION
Population*	A	265,015,300	716,400	48,638,700	10,467,600
Number of new cancer patients/year#	B	384,272	1,038	70,526	15,178
Number of cases requiring RT/year%	C = B × (49.49%) × 1.25	237,720	642	43,629	9,389
Number of fractions/year	D = C × 16. 29	3,872,463	10,460	710,719	152,955
Number of fractions/1 linac	E	9,600 fractions/year with 10 hours/day[17] [applies to all columns]			
Total RT needed	F = D/E	403	1	74	16

**Population data based on the Central Statistics Agency 2019.[17]*
#Number of new cancer patients/year: (population)
**(Indonesian cancer incidence/1,000 population). Indonesian cancer incidence based on GLOBOCAN 2020[20]: 273,523,621/396,914 = 1.45/1,000.*
%RTUs (49.49%), mean fraction (16.29), and 25% retreatment rate in the Asia Pacific based on Zubizarreta et al.[16]
Key: RT = radiation therapy, RTUs = radiation therapy utilization units

Table 5. Estimated RT Needs Based on IROS Calculations (Standard Fractionation Scheme)

		INDONESIA	NORTH BORNEO	WEST JAVA	JAKARTA CAPITAL SPECIAL REGION
Population*	A	265,015,300	716,400	48,638,700	10,467,600
Number of new cancer patients/year#	B	384,272	1,038	70,526	15,178
Number of cases requiring RT/year%	C = B × (50%)	192,136	519	35,263	7,589
Number of fractions/year	D = C × (25.6)	4,918,682	13,286	902,733	194,278
Number of fractions/1 linac	E	13,000 (50 fractions/day × 5 days/week × 52 weeks) [applies to all columns]			
Total RT needed	F = D/E	378	1	69	15

*Population data based on the Central Statistics Agency 2019.[17]
#number of new cancer patients/year: (population)
*(Indonesian cancer incidence/1,000 population).
Indonesian cancer incidence by GLOBOCAN 2020[21]: 273,523,621/396,914 = 1.45/1,000. %RTU (50%), mean fraction (25.6)
Key: RT = radiation therapy, RTUs = radiation therapy utilization units

Table 6. Estimated RT Needs Based on IROS Hypofractionation Scheme

		INDONESIA	NORTH BORNEO	WEST JAVA	JAKARTA CAPITAL SPECIAL REGION
Population*	A	265,015,300	716,400	48,638,700	10,467,600
Number of new cancer patients/year#	B	384,272	1,038	70,526	15,178
Number of cases requiring RT/year%	C = B × (50%)	192,136	519	35,263	7,589
Number of fractions/year	D = C × (20)	3,842,720	10,380	705,260	151,780
Number of fractions/1 linac	E	13,000 (50 fractions/day × 5 days/week × 52 weeks) [applies to all columns]			
Total RT needed	F = D/E	296	1	54	12

**Population data based on the 2019 Central Statistics Agency.[17]*
#number of new cancer patients/year: (population) × (Indonesian cancer incidence/1,000 population).
Indonesian Cancer Incidence by GLOBOCAN 2020[20]: 273,523,621/396,914 = 1.45/1,000.
%RTU (50%), mean fraction (20).
Key: RT = radiation therapy, IROS = Indonesian Radiation Oncology Society

Table 7. Comparison of RT Needs Based on Estimated Calculations

	INDONESIA	NORTH BORNEO	WEST JAVA	JAKARTA CAPITAL SPECIAL REGION
Population*	265,015,300	716,400	48,638,700	10,467,600
Number of new cancer patients/year#	384,272	1,038	70,526	15,178
Mv/M Method[16]	265	1	48	10
ESTRO-QUARTS Method[18,19]	427	1	78	16
RT Optimal Fraction Method[21]	289	1	53	11
Zubizarreta et al Method[16]	403	1	74	16
IROS Method (standard fractionation)	378	1	69	15
IROS Method (hypofractionation)	296	1	54	12

**Population data based on the Central Statistics Agency 2019.[17]*
#Number of new cancer patients/year: (Population) × (Indonesian cancer incidence/1,000 population);
Indonesian cancer incidence by GLOBOCAN 2020[20]: 273,523,621/396,914 = 1.45/1,000.
Key: RT = radiation therapy; Mv/M = megavoltage/million,
ESTRO-QUARTS = European Society of Radiotherapy and Oncology - Quantification of Radiation Therapy Infrastructure and Staffing

for RT in several sample populations throughout Indonesia.

Use of Mean Fraction

Another method is to calculate the mean fraction of RT in an area. Zubizarreta et al in their publication, "Need for Radiotherapy in Low- and Middle-Income Countries: The Silent Crisis Continues," compiled a model that combines different RTUs, retreatment rates, and mean fractions on each continent. For example, there are differences in RTUs on each continent, namely Europe and Central Asia (50.05%), Africa (54.3%), Asia Pacific (49.49%), Latin America (53.27%), and for all LMICs (50.53%). There are also differences in the mean fraction on each continent, particularly Europe and Central Asia (15.95), Africa (16.44), Asia Pacific (16.29), Latin America (16.56), and for all LMICs (16.31).[16] This method can help determine the needs of RT in the population (**Table 4**).

Calculation Model of the Indonesian Radiation Oncology Society

The Indonesian Radiation Oncology Society (IROS) also analyzed RT needs using specific characteristics of Indonesia. This model explicitly utilized the reference from Zubizarreta et al,[12] using the mean fraction based on the internal IROS survey,[6,26] the mean fraction with the hypofractionated scheme (HRT), and RTU (50%) without considering the retreatment rate. **Tables 5 and 6** are a model and calculation of RT needs based on the scheme.

Table 7 is a summary of the need for RT in Indonesia from the various methods described above.

Hypofractionated RT as a Solution to Improve RT Access

Technology has an important role in the continuous development of RT. The long road to modern, high-tech radiation oncology has become a reality with technological discoveries and innovations resulting from the interaction of various disciplines (biology, physics, mathematics, computer science, and engineering).[22] Innovations in these fields enable faster, more customized radiation treatment, increasing the effectiveness, safety, and accessibility of RT.

From an economic point of view, Aneja et al provide an overview of the estimated cost of RT driven mostly by the total treatment time, calculated as daily treatment time multiplied by the number of fractions. As this suggests, hypofractionation can reduce the burden of increasing health care costs in the field of RT.[23,24] In a study of breast cancer treatment at the Leuven Radiotherapy Department in Belgium, there was a 60% reduction in the total cost of treatment with hypofractionated radiation therapy (HRT) compared with scheduled conventional fractionated (CF) therapy in the Belgian health treatment system. The decrease is a direct consequence of the decline in daily radiation costs. An Australian study reported a 24% to 32% reduction in medical costs in the Australian health care system for breast cancer patients on an HRT schedule and an increase in capacity of an additional 14 patients each month.[23,25,26] The same study was also conducted in Africa by Irabor et al, which reported a 40% reduction in the cost of providing whole-breast RT per patient for those receiving HRT compared with conventional fractions, and an increase in RT capacity of 25.4%.[24]

According to the IROS estimation methods, RT coverage in Indonesia (available RT machines / RT required) improves when using HRT (27.7%) vs conventional RT (21.7%). Among benefits, HRT utilization increases RT capacity and savings with regard to National Health Insurance. Reduced waiting lists and the resultant increase in capacity for access to RT are other notable advantages of HRT. In addition, HRT increases patient convenience by requiring fewer trips to the radiation therapy center. Thus, there is potential for reduced patient costs, including travel/parking costs and lost income/productivity associated with longer treatment schedules. Further savings on the care provision can be attributed to the reduced need for patient accommodations, nurse/doctor consultations, and transport schemes.[26] However, implementing HRT in daily practice requires support from all stages of RT services and a large investment, from RT equipment to human resources. This requires consistent and careful planning and transition.

Radiation Therapy and the National Cancer Control Plan

The National Cancer Control Program or National Cancer Control Plan (NCCP) refers to the broad implementation of programs and evidence-based strategies to actively address the national cancer burden. Methods based on the cancer continuum include health promotion, prevention, early detection (including early diagnosis and screening), management, rehabilitation, palliation and research support. Each stage of the cancer continuum also requires specific interventions and special support. Another component is use of a cancer registry as a basis for identifying cancer burdens and providing support for setting priorities for comprehensive cancer control policies and being the key to effective cancer program implementation and monitoring.[27]

Optimal estimates of RT need within the NCCP necessitate monitoring of both the national cancer burden (sites and staging) and determination of RUR. The shortfall in RT refers to the difference between currently available RT and what would be needed within the country to optimally deliver necessary RT services to cancer patients.[3]

As stated, access to RT for LMICs is a global concern. The 66th General Assembly of the United Nations (UN) has described cancer as an "increasing epidemic" of noncommunicable diseases and has determined that there is a shortage of RT service facilities, especially in developing countries.[28] Samiei et al in their publication, "Challenges of Making Radiotherapy Accessible in Developing Countries," stated that the reality in LMICs is very worrying. LMICs, despite being home to 85% of the world's population, have only about 4,400 megavoltage machines, fewer than 35% of the world's RT facilities, leaving most cancer patients in LMICs without access to potentially life-saving RT treatments.[29] The implication: RT access is a must. Zubizarreta et al said that it is impossible to establish a cancer control program in a country if RT facilities are not available.[16] In addition, in planning an NCCP, the accessibility of RT services in that country must be carefully considered. Atun et al also noted that RT is an important health care investment and should be embedded as a key part of an NCCP or broader national health strategy.[3]

In addition to RT, other services in the cancer care continuum must be considered, such as screening, early detection, surgery, and chemotherapy – the type and amount of which must be provided according to community needs. Having adequate and equitable services in a community is crucial to preventing waiting lists for cancer management. Waiting lists cause delays that can significantly impact tumor control probability (TCP) and ultimately survival. Wyatt et al predicted that delaying cancer treatment resulted in a decrease in TCP of 0.2 to 0.3% per week for small tumors (T1), and 0.5 to 0.7% delay per week for larger tumors. In a multidisciplinary treatment approach, the impact of delaying postoperative radiation initiation will reduce TCP by up to 1.5% per week in head and neck cancer patients.[30] Deviations during the cancer continuum such as delays in access to diagnosis and treatment, substandard cancer drugs, unavailability, and poor quality of RT can cause unnecessary suffering, death, and wasted resources.

National professional societies are key advocates and have specific roles in expanding RT access and implementing an NCCP. A society should have a roadmap and vision for increasing RT accessibility and affordability in its country. For example, to close the gap of RT services in Indonesia, IROS, as the only radiation oncology society in Indonesia, developed a roadmap in 2010 to incorporate into the NCCP and provide guidance for key stakeholders. IROS also established a reimbursement tariff for national health insurance to foster an investment in RT services. For now, IROS consistently advocates a framework of investment in RT (public-private partnership) and the need for RT to health facilities in Indonesia.[31]

The ability to estimate the demand for access to cancer services and understand the type and number of cancers in the community is crucial. However, problems related to RT are not only limited to availability of RT facilities; analysis of RT needs often focuses solely on equipment. A new RT department requires a significant investment in qualified human resources to run the RT department, and lack of resources remains a pressing challenge in LMICs. Forming and training RT teams takes years and is an expensive investment. As such, the construction of RT facilities, long-term planning, and careful analysis are critically important.[16]

Conclusion

Given the burden and challenges of cancer problems over time, a comprehensive and systematic effort and response are needed from various sectors; they are not the sole responsibility of the health system. Effective cancer control planning requires strategies appropriate to the needs and circumstances of a country's situation. Cancer control plans and interventions also must be integrated in a multisectoral, multidisciplinary manner and adapt to the capacity of available health services.

Optimal treatment can significantly improve cancer survival and quality of life. As such, access to RT is a global priority and a must. Availability of RT centers and technology is highly important. Additionally, the use of HRT and longer working hours can help overcome the shortage of RT facilities and increase access to RT in developing countries with a limited number of such centers.

References

1) Institute for Health Metrics and Evaluation. Global Burden of Disease. 2020. Accessed April 23, 2021. https://vizhub.healthdata.org/gbd-compare/

2) World Health Organization. WHO Report on Cancer. 2020.

3) Atun R, Jaffray DA, Barton MB, et al. Expanding global access to radiotherapy. *Lancet Oncol.* 2015;16(10):1153-1186.

4) Barton MB, Frommer M, Shafiq J. Role of radiotherapy in cancer control in low-income and middle-income countries. *Lancet Oncol*. 2006;7(7):584-595.

5) Prager GW, Braga S, Bystricky B, et al. Global cancer control: responding to the growing burden, rising costs and inequalities in access. *ESMO Open.* 2018;3(2).

6) Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: a Cancer Journal for Clinicians.* 2018;68(6):394-424.

7) Balitbang Kemenkes RI. Hasil Utama Riset Kesehatan Dasar Tahun 2018. Kementrian Kesehatan Republik Indonesia. Jakarta; 2019. Accessed March 9, 2021. http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf

8) Agustina J, Sinulingga DT, Suzanna E, Tehuteru E, Ramadhan R, Kadir A. Epidemiology of childhood cancer in Indonesia: study of 14 population based cancer registries. *J Glob Oncol*. 2018;(4_suppl_2):67s-67s.

9) BPJS Kesehatan. Accessed March 8, 2022. https://bpjs-kesehatan.go.id/bpjs/post/read/2021/2061/BPJS-Kesehatan-Dorong-Faskes-Optimalkan-Pelayanan-untuk-Pasien-Kanker

10) Barton MB, Jacob S, Shafiq J, et al. Estimating the demand for radiotherapy from the evidence: a review of changes from 2003 to 2012. *Radiother Oncol.* 2014;112(1):140-144.

11) Valentini V, Boldrini L, Mariani S, Massaccesi M. Role of radiation oncology in modern multidisciplinary cancer treatment. *Molec Oncol*. 2020;14(7):1431-1441.

12) Abdel-Wahab M, Fidarova E, Polo A. Global access to radiotherapy in low- and middle-income countries. *Clin Oncol.* 2017;29(2):99-104.

13) International Atomic Energy Agency. Inequity in Cancer Care: A Global Perspective. IAEA, editor. Vienna: IAEA; 2011.

14) Mahendradhata Y, Trisnantoro L, Listyadewi S, et al. The Republic of Indonesia health system review Asia Pacific observatory on health systems and policies. Vol. 7, Health Systems in Transition. World Health Organization; 2017. p.328.

15) Ministry of Health Indonesia. Profil Kesehatan Indonesia 2018 [Indonesia Health Profile 2018]. 2019;207-207.

16) Zubizarreta EH, Fidarova E, Healy B, Rosenblatt E. Need for radiotherapy in low and middle income countries - the silent crisis continues. *Clin Oncol.* 2015;27(2):107-114.

17) Badan Pusat Statistik. Statistik Indonesia 2019. Jakarta: Badan Pusat Statistik; 2019.

18) Bentzen SM, Heeren G, Cottier B, et al. Towards evidence-based guidelines for radiotherapy infrastructure and staffing needs in Europe: the ESTRO QUARTS project. *Radiother Oncol.* 2005;75(3):355-365.

19) Slotman BJ, Cottier B, Bentzen SM, Heeren G, Lievens Y, van den Bogaert W. Overview of national guidelines for infrastructure and staffing of radiotherapy. ESTRO-QUARTS: work package 1. *Radiother Oncol.* 2005;75(3):349.E1-349.E6.

20) Ferlay J, Ervik M, Lam F, et al. Global Cancer Observatory: Cancer Today. International Agency for Research on Cancer. Lyon, France; 2020.

21) Wong K, Delaney GP, Barton MB. Evidence-based optimal number of radiotherapy fractions for cancer: a useful tool to estimate radiotherapy demand. *Radiother Oncol.* 2016;119(1):145-149.

22) Fiorino C, Guckemberger M, Schwarz M, van der Heide UA, Heijmen B. Technology-driven research for radiotherapy innovation. *Molec Oncol.* 2020;14(7):1500-1513.

23) Aneja S, Pratiwadi RR, Yu JB. Hypofractionated radiation therapy for prostate cancer: risks and potential benefits in a fiscally conservative health care system. *Oncology.* 2012;26(6):512-518.

24) Irabor OC, Swanson W, Shaukat F, et al. Can the adoption of hypofractionation guidelines expand global radiotherapy access? An analysis for breast and prostate radiotherapy. *JCO Global Oncol*. 2020;(6):667-678.

25) Dwyer P, Hickey B, Burmeister E, Burmeister B. Hypofractionated whole-breast radiotherapy: impact on departmental waiting times and cost. *J Med Imag Radiat Oncol.* 2010 9;54(3):229-234.

26) Hunter D, Mauldon E, Anderson N. Cost-containment in hypofractionated radiation therapy: a literature review. *J Med Radiat Sci.* 2018;65(2):148-157.

27) World Health Organization. National cancer control programmes: policies and managerial guidelines. 2nd ed. World Health Organization. Geneva: World Health Organization; 2002.

28) Datta NR, Samiei M, Bodis S. Radiation therapy infrastructure and human resources in low- and middle-income countries: Present status and projections for 2020. *Int J Radiat Oncol Biol Phys*. 2014;89(3):448-457.

29) Samiei M. Challenges of Making Radiotherapy Accessible in Developing Countries Cancer Control. 2013. p. 85-94. Accessed December 19, 2021. http://cancercontrol.info/wp-content/uploads/2014/08/cc2013_83-96-Samiei-varian-tpage-incld-T-page_2012.pdf

30) Wyatt RM, Jones BJ, Dale RG. Radiotherapy treatment delays and their influence on tumour control achieved by various fractionation schedules. *Brit J Radiol*. 2008;81(967):549-563.

31) Indonesian Radiation Oncology Society. About Perhimpunan Onkologi Radiasi Indonesia. Accessed March 2, 2021. http://www.pori.or.id/about/