Building capacity for cancer care infrastructure in Karnataka – the present and the future

Kapacita pro výstavbu infrastruktury onkologické péče v oblasti Karnataka – současnost a budoucnost

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Summary

Background: Cancer mortality has doubled in India, a lower and middle-income country, from 1990 to 2016, depicting the ever-increasing burden of non-communicable disease. Karnataka, situated in the south of India, is one of the states with a rich medical college and hospital milieu. We present the status of cancer care across the state from the data collected by the investigators through public registries and personal communication to the concerned units to know the distribution of various services across the districts and give probable directives to improve on the present situation with emphasis on radiation therapy. This study may be taken as a bird's eye view of the situation across the country and form a basis based on which future planning of services and areas to emphasize on, may be considered. ***Purpose:*** The establishment of a radiation therapy center holds the key to the establishment of comprehensive cancer care centers. The existing situation of such centers and the need and scope for inclusion and expansion of cancer units is presented in this article.

Key words

cancer services – radiation therapy – LMIC

Souhrn

Východiska: Úmrtnost na nádorová onemocnění se v Indii, která patří k zemím s nízkým a středním příjmem, v letech 1990–2016 zdvojnásobila, což značí stále rostoucí zátěž nepřenosnými chorobami. Stát Karnataka na jihu Indie je jednou z oblastí s vysokým počtem lékařských fakult a nemocnic. V článku prezentujeme stav onkologické péče v tomto státu, a to na základě dat shromážděných z veřejných registrů a dat z osobní komunikace se zainteresovanými stranami. Cílem bylo získat přehled o rozložení různých typů onkologické péče v jednotlivých regionech a poskytnout směrnice, které pravděpodobně povedou ke zlepšení situace, především v oblasti radioterapie. Tato studie může být brána jako letmý pohled na situaci v zemi a jako základ pro budoucí plánování onkologické péče v různých oblastech. ***Cíl:*** Pro založení centra komplexní onkologické péče je klíčové zřídit centrum radioterapie. V tomto článku je popsána současná situace těchto center a potřeba i rozsah zavedení a rozšiřování jednotek onkologické péče.

Klíčová slova

onkologická péče – radioterapie – země s nízkým a středním příjmem

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Introduction

Cancer has received considerable attention in the Western countries since there has been a paradigm shift in prevalence of communicable to non-communicable diseases and the consequent shift of focus to the latter. Although relatively less prominent, cancer has been an increasing area of concern in lower- and middle-income countries (LMICs) as well. The LMICs follow the pattern of the high-income countries both in terms of disease incidence and treatment. Hence it is likely that the health behavior seen in the western population is going to soon reflect in the LMICs along with its deleterious effects [1].

India is battling an ever-increasing burden of cancer cases. Annual incidence of cancer in India is 115.6 per 100,000 people; however, this statistic is highly underreported. The incidence is expected to rise to 254 per 100,000 people by 2030. It is the second and fourth leading cause of adult deaths, respectively, in urban and rural India [2] with 1.16 million new cancer cases and 0.78 million cancer related deaths reported in 2018 [3]. Cancer mortality in India has doubled from 1990 to 2016 with a dramatic increase in cancer incidence and trailing public health care facilities [4]. The existing facilities are over-stretched and fall short of resources resulting in private facilities having mushroomed to cater to the demands. However, with poor coverage of health insurance many cancer patients find affordability at private hospitals a hindrance to seeking timely care.

Cancer care in the state of Karnataka is a prime example of the above predicament. According to 2011 census, the total population of the state is 61.1 million. In terms of population, the state ranks ninth in the country. For the sake of administration, the state is divided into 30 districts. There are 27,066 revenue villages and 2,127 and inhabited settlements in the state. Bengaluru urban district alone accounts for 15.69% of total population of the state. It is followed by Belgavi (7.82%), Mysuru (4.90%), Tumakuru (4.39 %), Kalburgi (4.2%) and Ballari (4.14%). Only Kodugu and Bengaluru rural districts have a population of less than 1 million and all others have more than 1 million. The state has one public comprehensive cancer care facility in the capital city of Bengaluru. Furthermore, Karnataka has 26 cities across 14 districts, and nearly 50% of cancer care centers are concentrated around the capital, requiring most patients to travel over 8 hours to access care. The lack of easy access to care results in patients delaying seeking help. The cause specific mortality due to cancer in Karnataka is over 65% [5].

Cancer care is a complex inter play of multiple clinical specialties such as medical, surgical and radiation oncology and trained para-clinical supportive branches such as pathology, radiodiagnosis, biochemistry, cytology etc. As a result of the complexity of the establishment, there is a tendency for comprehensive cancer care centers to be concentrated in urban areas because of which the rural population has to travel long distances to avail the specialized care which should ideally be available to them at every district.

Radiation therapy is a critical component in cancer care with approximately 50% of cancer patients requiring it at some point in their treatment [6]. The Global Task Force for Radiotherapy in Cancer Control has estimated that about 50% of patients with indications for radiotherapy do not have access to it in LMICs [7]. With the growing burden of cancer, there will be an increased demand for radiotherapy services which is largely unmet in India. The National Cancer Control Programme has published guidelines and encouraged new as well as existing colleges to upgrade or create oncology wings to resolve these issues. The costs involved in establishing a radiation therapy unit usually determines the feasibility of establishing a comprehensive cancer centre. Although Karnataka is one of the states in India with a robust medical college milieu with 60 out of 542 colleges in the country situated in Karnataka alone (MCIIndia.org), the focus on oncology has been rather low.

The annual incidence of cancers in Karnataka is estimated to be 87,303 in 2021 according to population-based cancer registry. Bangalore urban ranked first with 19.5% (base institute) followed with Belgaum (7.53%), Mysore (4.76%), Bellary (4.4%) and Kalburgi (4.2%). The remaining 25 districts constituted 60% of the incidence. Considering this, there are no clear recommendations for the number of oncology units required per population of cancer patients in the Indian scenario. This article is an attempt to throw light on this topic and report the present cancer care ecosystem in Karnataka with reference to the need and the availability of resources and compare them with the global counterparts.

Aims and objectives

The primary aim of this study was to estimate the actual need of oncology services, specifically radiation therapy in the various districts of Karnataka.

Although the distribution of oncology services seems to be adequate in number, many patients travel to the comprehensive cancer care centre in the capital city of Bengaluru to seek proper care. The purpose of this study is to see whether there is an unmet need for establishing radiation therapy units and to identify the geographical areas which would benefit from such establishments.

Data collection and methodology

Definitions of oncology services

Radiation oncology service: Defined as any set-up equipped with delivering teletherapy treatment under the purview of a qualified radiation oncologist and a radiation safety officer, either by telecobalt or linear accelerator. The availability of brachytherapy was noted but not included as a compulsory requirement.

Medical oncology service: Defined as a hospital or clinic with a qualified medical oncologist having completed a three-year super-specialty Doctor of Medicine degree or Diplomate of National Board (DNB) in medical oncology recognized by the Medical Council of India. The requirement of an intensive care unit and a bone marrow transplant unit were noted but not included as a compulsory requirement. Centers which had a practicing surgical oncologist/ radiation oncologist delivering chemotherapy were also included.

Surgical oncology service: Defined as a hospital or a unit with an operating

Tab. 1. Demographics of cancer patient distribution across the state of Karnataka.

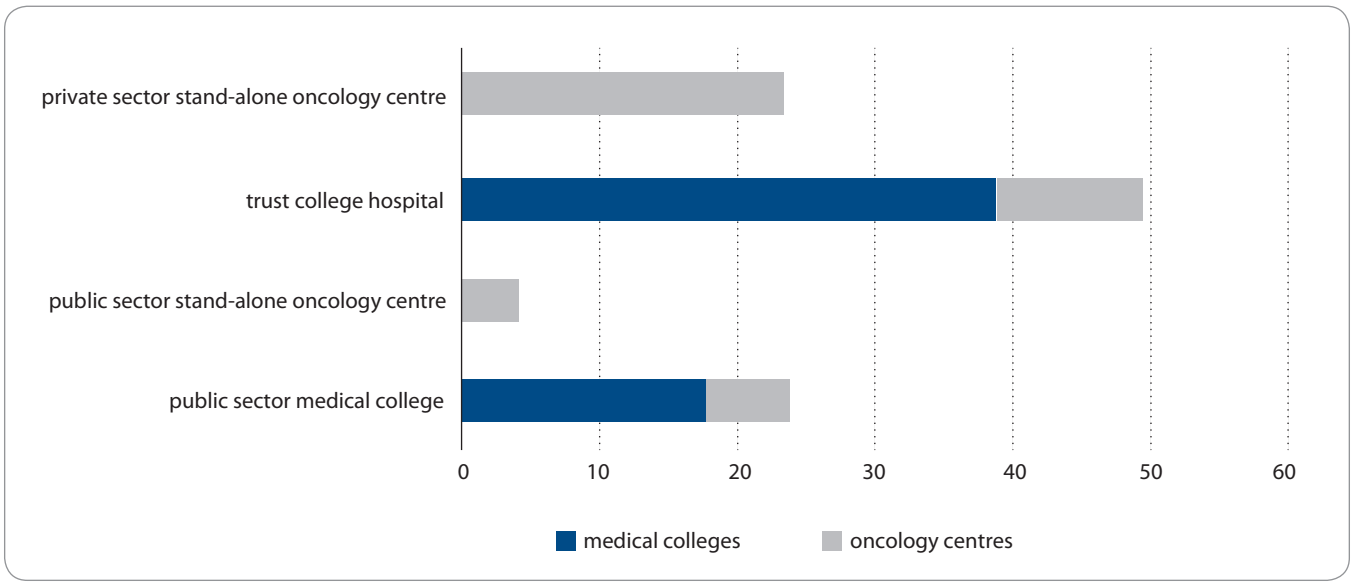
District	Male population in 2021	Female population in 2021	Total population in 2021	Male cancer incidence 2021	Female cancer incidence 2021	Total cancer incidence 2021	Total cancer incidence predicted 2025
Karnataka	**36,507,309**	**35,497,628**	**72,004,937**	**37,749**	**49,555**	**87,303**	**90,516**
Bangalore-Urban	7,418,844	6,754,336	14,173,180	7,671	9,429	17,100	19,330
Belgaum	2,741,656	2,681,505	5,423,161	2,835	3,743	6,578	6,895
Mysore	1,709,750	1,711,635	3,421,385	1,768	2,389	4,157	4,330
Bellary	1,592,986	1,573,653	3,166,639	1,647	2,197	3,844	4,020
Gulbarga	1,538,564	1,487,547	3,026,111	1,591	2,077	3,667	3,901
Tumkur	1,402,816	1,393,711	2,796,527	1,451	1,946	3,396	3,425
Bijapur	1,337,629	1,282,642	262,0271	1,383	1,791	3,174	3,400
Dakshina Kannada	1,173,538	1,195,547	2,369,085	1,213	1,669	2,882	2,887
Raichur	1,109,603	1,109,206	2,218,809	1,147	1,548	2,696	2,845
Bagalkote	1,091,761	1,080,288	2,172,049	1,129	1,508	2,637	2,761
Davanagere	1,068,633	1,052,024	2,120,657	1,105	1,469	2,574	2,652
Dharwad	1,072,296	1,057,442	2,129,738	1,109	1,476	2,585	2,719
Mandya	931,771	924,664	1,856,435	963	1,291	2,254	2,272
Bidar	985,417	942,411	1,927,828	1,019	1,316	2,335	2,451
Shimoga	932,092	944,818	1,876,910	964	1,319	2,283	2,335
Hassan	919,770	928,569	1,848,339	951	1,296	2,247	2,254
Chitradurga	917,687	90,233	1,007,920	949	126	1,075	2,281
Haveri	907,496	87,0531	1,778,027	938	1,215	2,154	2,242
Kolar	867,429	846,988	1,714,417	897	1,182	2,079	2,155
Koppal	815,617	802,824	1,618,441	843	1,121	1,964	2,075
Uttara Kannada	770,426	754,918	1,525,344	797	1,054	1,850	1,897
Yadgir	725,713	716,355	1,442,068	750	1,000	1,750	1,880
Chikkaballapura	698,638	678,904	1,377,542	722	948	1,670	1,721
Udupi	642,985	684,133	1,327,118	665	955	1,620	1,549
Chikmagalur	560,726	575,798	1,136,524	580	804	1,384	1,377
Gadag	587,515	580,291	1,167,806	607	810	1,418	1,467
Ramanagara	577,015	570,719	1,147,734	597	797	1,393	1,409
Bangalore Rural	595,055	563,682	1,158,737	615	787	1,402	1,474
Chamarajanagara	539,153	543,390	1,082,543	557	759	1,316	1,340
Kodagu	274,729	286,765	561,494	284	400	684	684

qualified surgeon holding a Master of Chirurgiae (MCh) or DNB degree in surgical oncology recognized by the Medical Council of India. Hospitals with sub-specialty fellows capable of doing site-wise onco-surgeries were included in the study if the patients were given comprehensive cancer care by tumour board discussions or referrals to near-by centers for chemotherapy and radiation as medically indicated.

Data collection

Data with regards to oncology services were collected in May 2019 by personally communicating with practicing doctors, telephonic interviews and site visits to gather the following information:

1. The number of radiotherapy centers in the district, the availability of services and the scope for upgradation;
2. the number of centers doing onco-surgeries, number of centers having qualified onco-surgeons and the



Graph 1. Distribution of oncology services in the public and private sectors.

patterns of referrals to allied specialties including the availability of an onco-pathologist;
3. the number of centers administering chemotherapy and the qualification of the doctors administering them;
4. the availability of palliative care defined as access to narcotic drugs, end of life care and oncology nursing.

The centers were taken into consideration only if they fulfilled the definitions of the oncology services mentioned. The centers with general surgeons and physicians practicing oncology was noted but not counted as an accountable service if they were not collaborating with allied services.

The availability of oncopathologists, nuclear medicine facility, oncology nursing and palliative care delivery were not collected in detail since in hospitals where oncology was being practiced by a qualified physician and surgeon, supporting palliative care was available.

The number of cancer patients were collected from the hospital and population-based cancer registries and tabulated district-wise and site-wise to know the burden of the disease.

Cancer estimation and projection

Incidence data derived from the most recent report of Population Based Cancer Registry (PBCR) has been taken as reference. PBCR in Karnataka covers Bruhath Bengaluru Maha nagara palike BBMP) which consists of 196 wards and it covers almost 16% of population of Karnataka. The Crude incidence rate was calculated by using cancer incidence as the numerator and by taking population of a defined area as the denominator. Population estimation census data of the years 2001 and 2011 were used as a base population, and population estimation was done by using different distribution method. Similar methodology was used for each district of Karnataka. For each district of Karnataka, cancer cases were estimated by using the estimated population and crude rate of BBMP area of Bengaluru. The limitation of the methodology is that it assumes constant incidence rate for future and in each district as a conservative approach. PBCR covers close to 14% of the population in Karnataka and all PBCR's (28 in number) covers 10% population of India and many parts of the districts are not covered. The influencing factors such as risk factors/behavior, case finding procedure, screening programme, improved technique for detecting cancer patients are likely to influence the projection of cancer cases.

Results

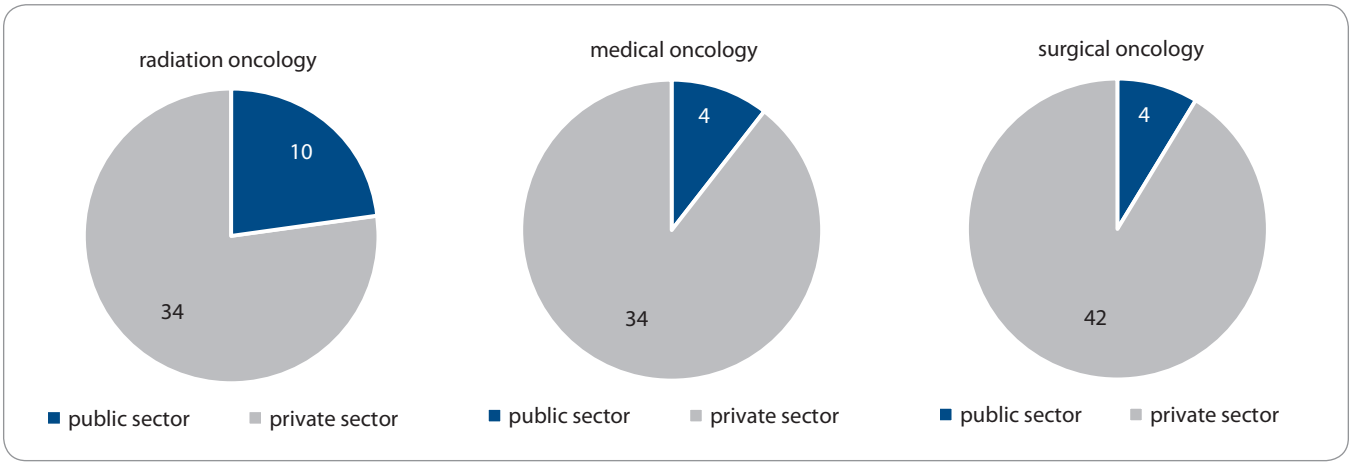
Status report of cancer centers in Karnataka

Karnataka has a total population of 67,285,794 out of which 34,143,618 are male and 33,142,176 are female. The total incidence of cancer in 2021 was 87,303 and the prevalence was 235,719. The district-wise male and female population distribution, and number of cancer patients and their projected increase is as shown in Tab. 1 – Karnataka cancer incidence projection using 2012–2014 incidence crude rates, Bengaluru. The projected increase in cancer incidence is around 7% of the incidence of cancer patients. Bangalore urban contributes to 19.6% of the cancer burden while the other districts of Karnataka contribute to 80.4% of the total cancer burden in Karnataka.

Radiation oncology centre distribution in Karnataka is as shown in Graph 1. Out of the 43 radiation oncology centers, 20 are present in Bangalore alone. Only 10 centers are present in the public sector, either as standalone centers or attached to a medical college. The situation is similar with medical and surgical oncology counterparts with only one government manned full-fledged medical and surgical oncology service at Kidwai Memorial Institute of Oncology, Bengaluru, as depicted in Fig. 1. The burden of the disease is largely handled by the private sector in other parts of Karnataka as well as depicted in Graph 2.

Table 2 and 3 depict the availability of radiotherapy machines according to regions and the deficits thereof. Ma-

Fig. 1. Mapping of the oncology services available in Karnataka state – red flags – surgical oncology, yellow flags – radiation oncology, and blue flags – medical oncology in the public and private sectors.



Graph 2. Distribution of oncology services in the public and private sectors.

jority of the districts in north Karnataka have no access to oncology centers with many districts having zero accessibility. The European School of Therapeutic Radiation Oncology (ESTRO) and the International Atomic Energy Agency (IAEA) have recommended that for every 1.6 to 1.8 lakh population, one linear accelerator is required. Alternately, for every 450 cancer patients per annum, one linear accelerator is required in LMICs.

It is estimated that for a population of 72,004,937 in Karnataka, the annual incidence of cancer is 87,303 in 2021. Presently, Karnataka State requires about 194 radiation therapy machines. By 2025, the projected incidence of cancer in the state is 90,516 and a machine requirement of 201. The state houses 56 radiation therapy machines at present, with a deficit of 138 machines. This deficit will increase to 145 by 2025.

The distribution of medical and surgical oncology services is presented in Tab. 2. Unlike radiation therapy set ups, these were distributed well in the peripheral districts of Karnataka without the backing of a full-fledged oncology unit. Palliative chemotherapies were delivered in the relevant districts whereas for advanced treatments of hematological malignancies, patients travelled to urban centers. The district-wise distribution of oncology services across Karnataka is shown in Fig. 2. The number of surgical oncology set-ups were 43 with more being added every year. We found that there was a lot of heterogeneity in this data and might not represent the true numbers since many non-oncology units had occasional visits by surgical oncologists and it is difficult to truly fathom the numbers based on this.

The number of exclusive pain and palliative care units were very low. There were four in Bengaluru, one in Shimoga and one in Northern Karnataka.

Discussion

Comprehensive cancer care consists of a multidisciplinary approach with surgical, radiation and medical oncology being the three pillars of the triad. Unlike radiation oncology, surgical and medical oncology services are available fulltime or on-call in small hospitals and nursing homes apart from tertiary units, mainly in the private sector based on availability of expertise. Hence, radiation oncology forms the backbone of an oncology unit from which other services fall into place. Patients are referred to major centers in the instance of a complex disease requiring advanced equipment or facility for treatment. Patients with limited financial means are referred to government centers or centers affiliated to government schemes where free treatment can be given.

There is wide variability in the geographical distribution of the centers. It is observed that Bangalore has the highest density of cancer patients as well as radiation therapy facilities. With increasing population and projected cancer incidence by 2025, there is already a deficit in care observed. Dakshina Kannada district follows Bangalore urban in availability of care. The existing private establishments nearly meet the need of the population. It is expected, however, that the existing telecobalt units in the state will be phased out in favor of linear accelerators which can deliver conformal treatments.

Establishment of radiation oncology wing is the key to any hospital being recognized as an oncology centre. A radiation therapy facility requires sizeable investment in setting up, as one has to account for land area required, bunker construction and machineries like linear accelerator, high dose rate brachytherapy setup along with mandatory qualified manpower to run the centre. The radiation work-force consists of radiation oncologist, radiation physicist, radiotherapy technologist and nursing staff as per Atomic Energy Regulatory Board. This might explain the skewed distribution of radiation therapy centers in Bangalore, mainly in the private sector.

A study conducted by a tertiary cancer centre in India in collaboration with international centers found that the ratio of medical oncologist to cancer patients was an astounding 1 : 3,000. Fifty-nine per cent of medical oncologists worked exclusively in private centers and 84% of them had access to radiotherapy [8]. Organizing the chemotherapy and systemic services can happen at various levels with low-risk chemotherapy being delivered at district hospitals and high risk being catered to at tertiary units [9]. This has been tried in other parts of India like Madhya Pradesh where peripheral chemotherapy units were set-up and manned by trained staff [10].

Tab. 2. Region wise availability of radiation therapy facility across Karnataka.

District	GOVT linear accelerator	Private linear accelerator	GOVT telecobalt	PVT telecobalt	Existing teletherapy facility	Region wise need for RT machine 2021	Region wise deficit in RT machine in Karnataka 2021
Bangalore-urban	7	21	3		31	38	7
Belgaum		1			1	15	14
Mysore		3	1		4	9	5
Bellary						9	9
Gulbarga	1	1	1		3	8	5
Tumkur						8	8
Bijapur						7	7
Dakshina Kannada		5			5	6	1
Raichur						6	6
Bagalkote		1			1	6	5
Davanagere		1			1	6	5
Dharwad	1	3			4	6	2
Mandya			1		1	5	4
Bidar						5	5
Shimoga		2			2	5	3
Hassan			1		1	5	4
Chitradurga						2	2
Haveri						5	5
Kolar				1	1	5	4
Koppal						5	5
Uttara Kannada						4	4
Yadgir						4	4
Chikkaballapura						4	4
Udupi		1			1	4	3
Chikmagalur						3	3
Gadag						3	3
Ramanagara						3	3
Bangalore Rural						3	3
Chamarajanagara						3	3
Kodagu						2	2

GOVT – government, PVT – private, RT – radiotherapy

Palliative care can be broadened to include peripheral, non-intensive units which can incorporate routine medical care, prescription of pain medication and end of life care to patients who are unable to travel by training non-oncologists and registered medical practitioners in the vicinity and equipping them with the necessary medications to do so. It is also important to increase awareness amongst physicians about the need for palliative treatments and avoid referrals to far off places.

Infrastructure related

Compared to its allied branches, the investment and complexity of establishing and maintaining a radiotherapy unit is substantial. Although the cost of setting up a radiotherapy unit seems huge, the relative cost of delivering one fraction of radiation over 20 years, which is considered an average lifespan of the machine is cheap [11]. However, purchasing a radiotherapy unit from a manufacturer who is in a different country is not only expensive but involves clearing many regulations. Continued maintenance and servicing of equipment is of utmost importance to avoid

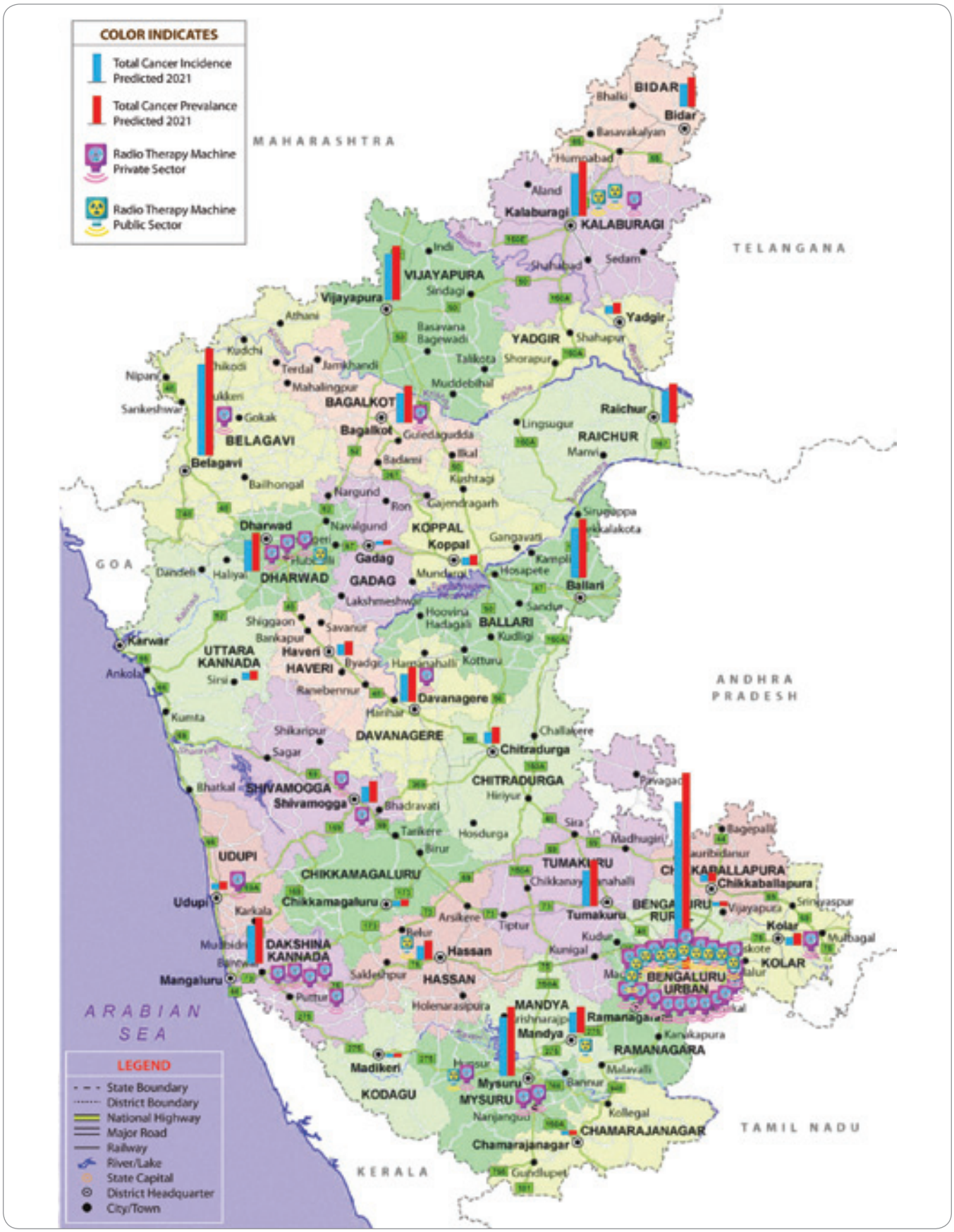


Fig. 2. The blue sticks represent the prevalence and the red ones represent the incidence of cancer in individual districts.

treatment interruptions and machine breakdowns.

Brachytherapy being an inseparable component of curative radiation therapy is fraught with challenges such as frequent source replacement. The procurement and changing of sources involve many clearances legally and requires adequately trained staff and personnel for operation and sustainable functioning of radiotherapy unit. Provision of electricity, cooling stability and high humidity in our part of the world are some of the challenges faced in maintaining a functional linear accelerator.

Patient related

With the tertiary cancer care centers being concentrated in the South of Karnataka, the travel times from the central and northern districts is significant. The unequal distribution of radiotherapy units compared to the population statistics is one of the most important hindrances for accessing radiotherapy.

The lack of education and hesitancy in seeking help in early stages of cancer result in the diagnosis of cancer in later stages at which point palliative radiotherapy becomes more relevant. It is estimated that the cost of a single fraction of radiotherapy in a country like ours is less than an equivalent cost of palliative chemotherapy since staff costs are also low [12]. It has been noted that around 80% of telecobalt machines available have concentrated on delivering palliative radiotherapy [13].

For every 1,000 cancer patients, 52% will require radiotherapy at some point and around 60% of these patients will require re-irradiation [11].

The below poverty line (BPL) patients are catered to under government health schemes like Vajpayee Arogyshree now, which is under Ayushman Bharat-Arogya Karnataka, under which all BPL patients are treated free of cost. There are some more central government schemes which provide affordable cancer care such as Employe state Insurance and Central Government Health Scheme.

Healthcare related

The diagnosis of cancer is generally made based on clinical examination, histopathology and base line investigations. After a suspicious lesion or malignant disease is detected, the local physician seeks further investigation himself or generally refers the patient to a known oncologist or an oncology centre in the vicinity. The patient is generally advised to consult and obtain further treatment at an established oncology centre nearest to them.

In the nearest oncology centre or by visiting an oncology consultant visiting the area, the patient undergoes further clinical evaluation, investigation and staging after which multidisciplinary treatment plans are schemed. By principle, if all the above three specialists are not available in one region or centre, which is most often the case, the responsibility of managing the poor and non-affordable patient will lie with the oncologist onsite who will use their skill and training with the available local facilities to deliver the cancer care in the same region. Patients who require further care are advised to obtain care from the allied branches at the nearest centre equipped with those facilities.

In an ideal scenario, all patients of cancer must be treated in a tertiary comprehensive cancer care centre. With the Government of Karnataka having established four such centers across Karnataka, there is a large unmet need to cater to the cancer burden in lower socio-economic strata.

The way forward

The cancer centers in LMICs like ours have similarities with the west in that they have a common ground of focus on the burden of the disease. However, they may differ in their approach to the structure and specific components of cancer care. The high-income countries are adequately equipped with infrastructure and human resources and tend to focus on basic research in addition to patient care and outreach programs. The development of systems with focus on cancer care management becomes the primary goal of LMICs. That being said, in places where cancer care is poorly developed, there is a compelling need to establish 'centers of excellence' that act as reference centers, training centers and perform leadership roles, pioneering new treatments and acting as a reference to the entire country.

In Karnataka, many medical colleges which run hospitals are functional. Since the ancillary support is already in place, we recommend public or private medical colleges to establish oncology units in the regional areas so that patients of remote regions get benefit of the services. There are 18 medical colleges in public sector, out of which 4–6 medical colleges should establish comprehensive oncology care wing to handle cancer patients. To start comprehensive cancer care in colleges where post-graduate courses are already established would be one way to expand region-wise patient care. The other medical college should have basic screening, diagnostic and referral system to comprehensive oncology centre. In these medical colleges, there should be a surgeon trained in oncology and oncologic update of the staff should happen.

Closing the gap between the needs and availability of radiotherapy, establishments requires more than speculation of challenges. In a country like ours, it is of paramount importance to innovate according to the inherent specific idiosyncrasies. The major expenditure in establishing and sustaining a radiotherapy unit in Karnataka is the machinery [14]. Dosanj et al in partnership with the International Cancer Expert Corps (ICEC), Science and Technology Facilities Council (STFC) collaborative effort described the design characteristics of a novel linear accelerator for challenging environments. Some of the changes suggested including reduction in the number of energy dependent components, simplifying machine design, training local engineers for servicing, permanent magnet beam delivery, cloud based electronic infrastructure for support and troubleshooting linac based radiotherapy. Indigenous cobalt machines like the Babatron could be the answer to establishing affordable centers.

The most important factor is the initiatives by the government to expand cancer care in a phased and affordable manner across the state. Public-private partnership with tax benefits may

be considered in view of huge purchase and establishment costs for such centers. These rebates and sops will help in reducing the economic burden caused by cancer which is of a much higher magnitude. The data generated from this study may be used as a bird's eye view of cancer care services available in Karnataka state. The regions with high incidence of cancer with deficit in care are zones encouraged to be considered for the development of newer oncology centers. Older centers need to be upgraded with simultaneous focus on the quality of service and increasing manpower. With increase in the awareness of cancer and lifestyles leading to it, it is hoped that the diagnosis of cancer in early stages will go up and this should be a case for developing tertiary centers with robust radiotherapy facilities by a population centre approach in the future.

References

1. Sloan FA, Gelband H. Cancer control opportunities in low- and middle-income countries. Washington (DC): National Academies Press (US) 2007.

2. Office of the Registrar General and Census Commissioner, India, Ministry of Home Affairs, Government of India. Causes of death statistics. [online]. Available from: https://censusindia.gov.in/census.website/data/SRSCOD.

3. Bray F, Ferlay J, Soerjomataram I et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancr J Clin 2018; 68(6): 394–424. doi: 10.3322/caac.21492.

4. India State-Level Disease Burden Initiative Cancer Collaborators. The burden of cancers and their variations across the states of India: The Global Burden of Disease Study 1990–2016. Lancet Oncol 2018; 19(10): 1289–1306. doi: 10.1016/S1470-2045(18)30447-9.

5. Sharma DC. Cancer data in India show new patterns. Lancet Oncol 2016; 17(7): e272. doi: 10.1016/S1470-2045(16)30202-9.

6. Atun R, Jaffray DA, Barton MB et al. Expanding global access to radiotherapy. Lancet Oncol 2015; 16(10): 1153–1186. doi: 10.1016/S1470-2045(15)00222-3.

7. Zubizarreta E, Van Dyk J, Lievens Y. Analysis of global radiotherapy needs and costs by geographic region and income level. Clin Oncol 2017; 29(2): 84–92. doi: 10.1016/j.clon.2016.11.011.

8. Sengar M, Fundytus A, Hopman WM et al. Medical oncology in India: workload, infrastructure, and delivery of care. Indian J Med Paediatr Oncol 2019; 40(1): 121–127. doi: 10.4103/ijmpo.ijmpo_66_18.

9. Gulia S, Sengar M, Badwe R et al. National cancer control programme in India: proposal for organization of chemotherapy and systemic therapy services. J Glob Oncol 2016; 3(3): 271–274. doi: 10.1200/JGO.2015.001818.

10. Pendharkar D, Ali A, Tripathi CM et al. Rural oncology mission in central Indian state: report from a unique cancer program. J Clin Oncol 2015; 33(15): e17526. doi: 10.1200/jco.2015.33.15_suppl.e17526.

11. International Atomic Energy Agency. Planning national radiotherapy services: a practical tool. [online]. Available from: https://www.iaea.org/publications/8419/planning-national-radiotherapy-services-a-practical-tool.

12. Samiei M. Challenges of making radiotherapy accessible in developing countries. [online]. Available from: http://cancercontrol.info/wp-content/uploads/2014/08/cc2013_83-96-Samiei-varian-tpage-incld-T-page_2012.pdf.

13. Allen BJ. Comparative cost analyses for Co-60 and linacs in developing countries. [online]. Available from: https://2018.iupesm.org/wp-content/uploads/2014/08/PalliativeRadioTherapy.pdf.

14. Dosanjh M, Aggarwal A, Pistenma D et al. Developing innovative, robust and affordable medical linear accelerators for challenging environments. Clin Oncol 2019; 31(6): 352–355. doi: 10.1016/j.clon.2019.02.002.