Call for Action:
Expanding cancer care in India

July, 2015

EY
Building a better working world

Foreword

The world has seen significant improvements in the quality of cancer care over the last decade though it still remains one of the most dreaded ailments which instantly triggers a situation where the shadow of death becomes a constant companion. The risk ofcourse has been mitigated significantly with the advancement of care programs and medical technology, the most critical factor however being timely discovery and optimal treatment. Still the debilitating impact of a cancer incidence is catastrophic, not only to the patient but in the collective psyche of his near and dear ones, given its financial, emotional and social implications.

The context of cancer care in India is characterized by high incidence, late detection, lack of access to quality affordable care to majority of the populace and hence high mortality. It is agonising to observe high percentage of late detection owing to issues of access, affordability and awareness given that both the cost and success of treatment is favourably skewed towards earlier detection in a significant manner, leave alone the anguish of the family that has to negotiate with the reality of losing their loved one knowing that it is a travesty, not tragedy, of destiny. Further, it is of great concern to observe increasing deterioration of the key risk factors that contribute to the sickness, viz. use of alcohol/tobacco, obesity, environmental pollution etc. It is imperative for the stakeholders of Indian healthcare to address this growing menace before it becomes a national catastrophe.

This report is a humble attempt to understand the current context of cancer care in India with its complexities and constraints and comment on possible future scenario along with key imperatives for the effective management of the disease in the short to medium term. It has been an enriching experience for the team to work on this report and sincerely hope it further strengthens the mood, motivation and mandate for cancer management in India.

Executive summary (1/5)

Context - High disease burden of cancer in India

- Prevalence of cancer in India is estimated to be 3.9 million people with reported incidence of 1.1 million in 2015. This is however a conservative estimate, as the real incidence of cancer is expected to be at least 1.5 to 2 times higher at 1.6-2.2 million, as suggested by data from large screening studies and low coverage of Indian cancer registries. India's age-standardized cancer incidence estimated at 150-200 per 100,000 population is higher than Africa and on par with China.
- Breast and cervical cancers among women, and head and neck, lung and gastrointestinal cancers among men, represent >60% of the incidence burden. India has nearly three times the incidence of US and China for head and neck and cervical cancers.
- However, the profile of cancer in India is also changing, and is mirroring trends seen in more urbanized nations. In 2000, the most prevalent cancers in India were head and neck cancers in men (associated with all forms of tobacco use) and cervical cancer in women (associated with human papillomavirus infection, sexual hygiene and habits). Breast cancer has now surpassed cervical cancer as the most prevalent female cancer, and incidence rates of gastrointestinal cancers which have traditionally been low in India have also been showing an increasing trend.

Late detection of cancers impacting both survival rates and cost of treatment

- The gap between reported and real incidence can be primarily attributed to under-diagnosis of cancer in India, which is manifested in the relatively late stage of presentation of the disease. Data collected between 2009 and 2011 show that only 43% of breast cancer cases were diagnosed at an early stage (i.e. stage I or stage II) of the disease in India whereas 62%, 81% and 72% of breast cancers were diagnosed at an early stage in the US, UK and China respectively. Although this varies with the type of cancer, the stage of diagnosis in India is generally more delayed compared to other countries with only 20-30% of cancers being diagnosed in Stages I and II, which is less than half of that in the US, UK and China.
- Lack of awareness of cancer and screening for disease are significant contributory factors for the relatively late stage of the disease presentation and consequently low reported cancer incidences in India. Fewer than 1% of women in India aged between 40 and 69 years participated in recommended breast screening mammograms once in 24 months, as compared to 30% in China and 65% in the US in 2014.
- As a result, mortality rates are four to six times higher in India than the US and with baseline cost of treatment (estimated INR 3-4 lacs) being higher than the annual household income for over 80-85% of households in India – cancer poses a significant threat to the Indian population.

Executive summary (2/5)

Treatment landscape - Acute demand-supply gap for diagnosis and treatment

- **Diagnosis:** Lack of adequate infrastructure and absence of mass screening programs are key barriers to timely and accurate diagnosis in India.
  - There are an estimated 2,700 mammograms installed in India, which represents less than 5% of that in the US.
  - There are an estimated 120 PET-CT scanners installed in India, the majority of which are in metropolitan cities. Only 30% of the cancer centers in India have advanced imaging technologies such as PET-CT. PET-CT scanners are essential for accurate diagnosis, staging and response monitoring of cancer and are therefore critical to providing comprehensive cancer care.
- **Treatment:** Access to multi-modal treatment options is inadequate and 40-60% of the facilities and oncologists are concentrated in the top 7-8 metropolitan cities of India hampering equitable access to treatment.

Treatment modality	% patients undergoing treatment	
	India	International standards
Radiation therapy	15-20%	40-50%
Surgery	30-35%	60-65%
Chemotherapy	30-35%	65-70%

  - Only 40 out of 640 districts in India have Linac installations.
  - India has only 200-250 comprehensive cancer care centers (0.2 per million population in India vs 4.4 per million population in US), 40% of which are present in eight metropolitan cities and fewer than 15% are government operated.
  - In addition, there is a significant shortage of oncologists in India. India has only one oncologist per 1,600 new cancer patients in India, as against one per 100 and 400 new cancer patients in the US and UK respectively.

Executive summary (3/5)

Growth in disease burden - Real incidence is estimated to rise by 7-8% annually driven by changes in demographics and increasing deterioration of key risk factors

The prevalence of cancer in India is expected to increase from an estimated 3.9 million in 2015 to an estimated 7.1 million people by 2020. Real cancer incidence in India is expected to increase by 30-35% over the next five years driven by the following factors:-

- **Demographic changes:** Cancer incidence rates increase with age, and particularly so after the age of 50 years. India's population is ageing, and in particular the population over the age of 50 years is expected to increase from 228 million in 2015 to 262 million by 2020. Demographic factors alone are expected to result in an increase in cancer incidence of 100,000 to 350,000 cases a year.
- **Risk factor exposure:** Factors that have been associated with increased risk of cancer including tobacco use, rising alcohol consumption, increasing use of processed food and meat, reduced fiber content in the diet, rising incidence of obesity and environmental factors are anticipated to contribute to the rising cancer incidence in India. These high risk factors are expected to result in an increase in cancer incidence of 350,000 to 450,000 cases a year. India is witnessing a gradual deterioration of key risk factors, as evidenced below:
  - Prevalence of all forms of tobacco use in India in 2015 is ~17% compared to 21% and 19% in the UK and US respectively .
  - Alcohol per capita consumption in adults aged over 15 years has increased by ~55% between 1992 and 2012 . i.e. the third highest increase amongst 40 countries (OECD and partner countries).
  - India has the third highest number of obese individuals in the world, after the US and China.
  - According to a 2014 WHO report, 13 of the 20 most polluted cities in the world are in India.

Increase in reported incidence of cancer - The reported cancer incidence in India is expected to increase from an estimated 1.1 million in 2015 to 2.1 million by 2020 driven by a narrowing diagnosis gap. Growing cancer awareness, a greater public emphasis on screening and improvements in diagnosis of cancer are expected to result in timely and increased diagnosis of cancer. With the implementation of the XIIth five year plan, opportunistic screening services are expected to be provided at the sub-center, primary and district level centers in all 664 districts. While earlier diagnosis will potentially result in lower mortality rates, it is also expected to result in increased reporting of cancer incidence rates in the next five years.

Executive summary (4/5)

Outlook for the treatment landscape - Significant focus is needed to bridge the demand-supply gap

- To address the rising demand of reported incidence, India requires significant physical and human infrastructure addition with a focus on correction of the distribution inequity through increased investments in Tier 2 cities and below and in select states such as Bihar, Uttar Pradesh, Madhya Pradesh, North Eastern states, Chattisgarh, Rajasthan, Jammu and Kashmir, West Bengal, Uttarakhand.

Infrastructure	Current estimated numbers	Estimated requirement in 2020	Theoretical requirement (in absence of constraints of affordability and access)
Linac (No. of installations)	350	**750 - 900**	2,000
Dedicated cancer beds	5000-6000	**12000-13000**	32,000-37,000
Comprehensive cancer centers	200-250	**450-550**	1,500-1,600
Oncologists ▸ Medical ▸ Surgical	 750 500	 **2800-3000** **1900-2000**	 4,500 2,500

Executive summary (5/5)

Key imperatives for effective management of the disease in the short to medium term

Key themes	Key imperatives for cancer care delivery
A **Optimize care**	1. Cost effective and early diagnosis and screening 2. Focus on health outcomes by ensuring quality of treatment 3. National planning based on robust and granular cancer registry
B **Expand care**	4. Innovative integrated delivery care models to take care to where the patient is 5. Public private partnerships to decentralize cancer care delivery and nurture Centres of Excellence 6. Addressing physical and human infrastructure gap with focus on correcting distribution inequity 7. Strong focus on “cost of care” in areas of medical technology and drugs
C **Reduce the burden**	8. Primary and secondary prevention (awareness and advocacy)

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1. India faces a serious challenge of high incidence rates coupled with low detection

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3. Reported cancer incidence in India is estimated to increase from 90 per 100,000 population to 130-170 per 100,000 population by 2020, which will mirror incidence rates of China and other developing countries

Section 1: Cancer disease burden

1 **India faces a serious challenge of high incidence rates coupled with low detection**

2 India is exhibiting a deterioration of the key risk factors that contribute to cancer incidence

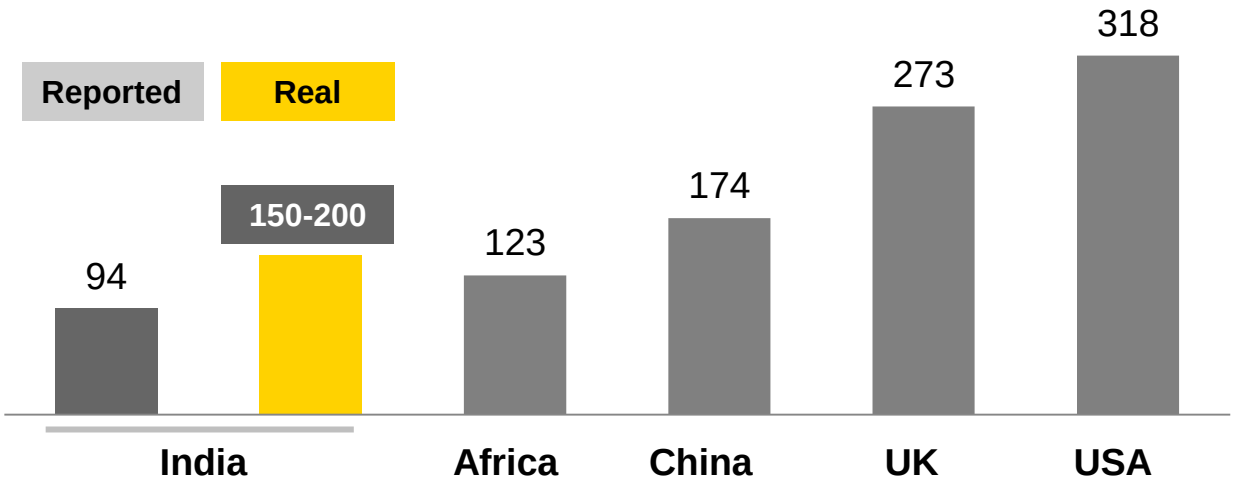
3 Reported cancer incidence in India is estimated to increase from 90 per 100,000 population to 130-170 per 100,000 population by 2020, which will mirror incidence rates of China and other developing countries

While cancer incidence in India is currently reported to be 94 per lac population, the real cancer incidence is estimated to be 150-200 per lac population

Estimated incidence,[1,2] 2015 (000's)

India	Africa	China	UK	USA
1,095	1,600-2,200	914	3,400	343	1,731

Estimated incidence,[1,2] (ASR-W*)



Source: Globocan 2012, EY analysis

The ASR-W is a weighted mean of the age-specific incidence rates. The weights are taken from the population distribution of the '*World Standard Population*' defined by WHO, and the estimated incidence rate is expressed per 100,000 population for comparisons between different geographies, as age is a key determinant of cancer incidence.

*ASR-W: Age-Standardized rate – Weighted per 100,000 population

The gap in reported and real incidence rate has been estimated and triangulated using the following basis

Real cancer incidence in India is conservatively estimated to be **1.5 to 2.0** times higher than the **reported incidence**. Some indicators include the following:-

01 Differences in cancer registry and randomized screening studies

- Studies that compared incidence data from cancer registries and large randomized screening trials demonstrated the **real incidence to be 1.5-2 times higher than the reported incidence.**[3,4]

  (Refer to **Annexure 1** for comparison between incidence rates as per screening studies and incidence rates as per cancer registries.)

02 Similarity in risk factor exposure between India, the UK and the US

- Upon comparison of incidence rates adjusted for differences in age and risk factor exposures between **India, the UK and the US**, India's **real incidence** is likely to be **2-3** times higher than the reported incidence.[5,6]

  (Refer to **Annexure 2** for methodology and comparison of risk factor exposures.)

- This gap in incidence is largely attributable **to under-diagnosis, delayed diagnosis, and a lack of screening efforts.**

Source: EY analysis

03 High under-diagnosis

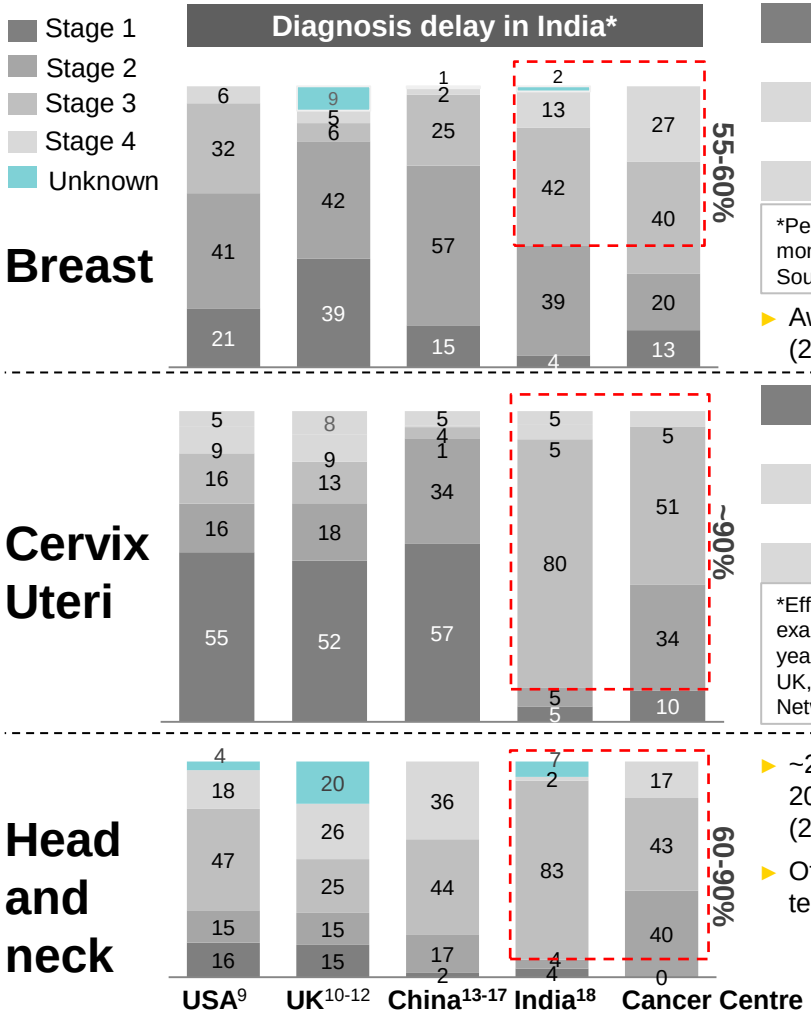
- Leading oncologists believe that the **under-diagnosis could be to the tune of 30-50%** due to **lack of diagnostic infrastructure, low patient awareness and low physician awareness.**

Source: EY primary interviews

04 Low population coverage of the Indian cancer registries

- Indian cancer registries **cover <10% of the population** vis-à-vis >90% in the US and the UK.[6]
- Estimates of cancer incidence at a population level are **extrapolated from the reported incidence in cancer registries** resulting in **a high margin of error**

India has a poor detection rate with only 20-30% of cancers being diagnosed in stages I and II, which is less than half of that in China, the UK and the US



*Data for stage of diagnosis - US, UK and China is from 2009-2013; for India from 2009-2011. Note: numbers rounded.

Country	Year initiated	Participation rate[7]*
US	1995	~65%
UK	1988	~50%
China	2009	~30%
India	Absent	<1%

*Percentage of eligible women (40-69 years) who have a screening mammogram at least once in 24 months. Data for the UK, the US for 2010; China for 2008-2010; India data reported in 2014. Source: International Cancer Screening Network; Rotary PR, March 2014

- Awareness of screening procedures in a Southern Indian population study (2014) was 16.5%, compared to 40% in the Chinese populations

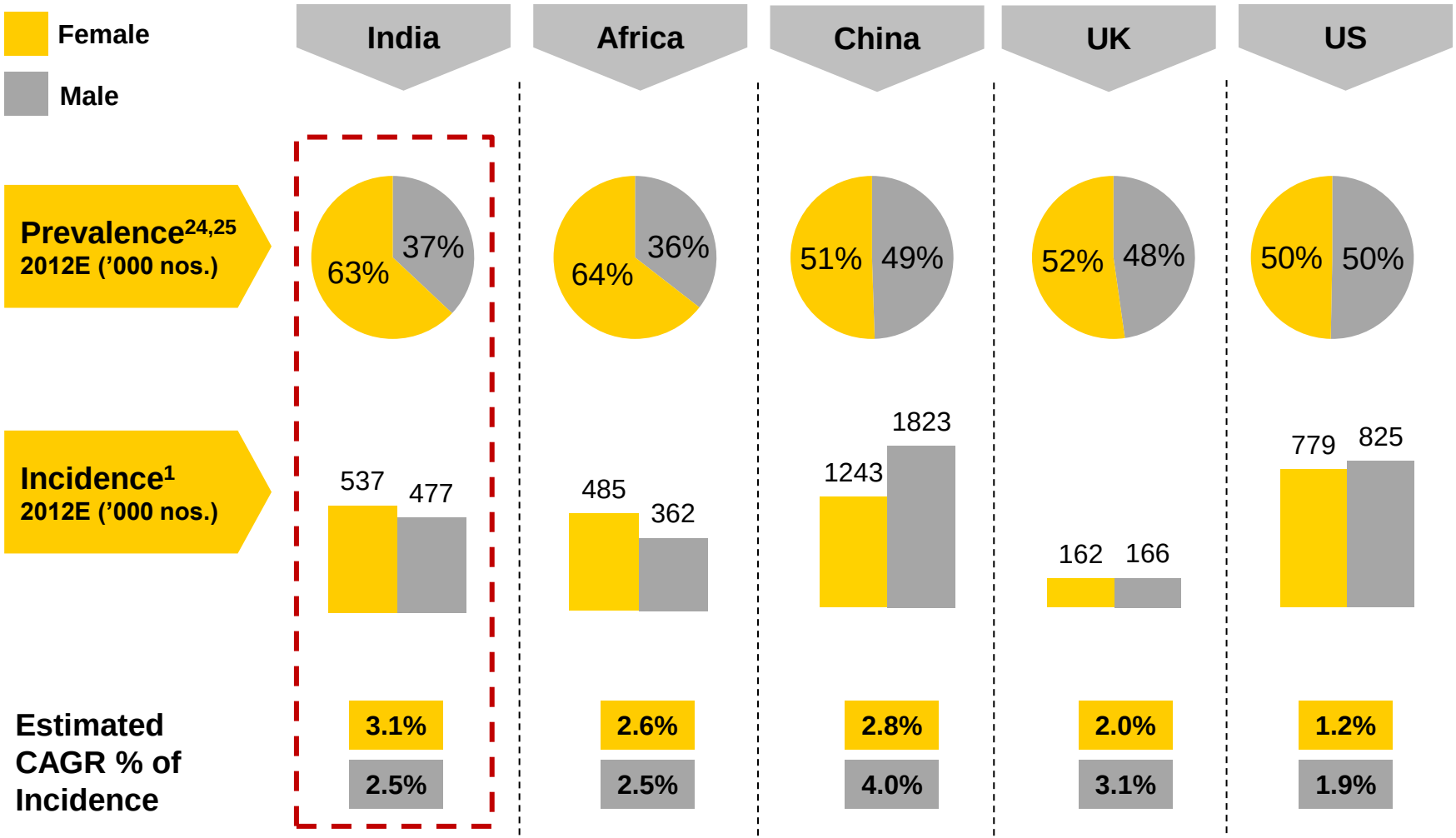
Country	Effective coverage*	Crude coverage[7,8]*
US	35-40%	NA
UK	78-80%	NA
China	~50%	~70%
India	~5%	~29%

*Effective coverage: The proportion of eligible women (25-64 years) who report having had a pelvic exam and Pap smear in the past three years; Crude coverage: The proportion of women (25-64 years) who report having had a pelvic exam (regardless of when the exam occurred). Data for the UK, the US for 2010; Data for India and China for 2008. Source: International Cancer Screening Network; Gakidou et al, 2008

- ~200,000-250,000 diagnostic PET/CT procedures were conducted in India in 2014, vis-à-vis >400,000 in China (2012) and nearly 1.62 million in the US (2014)[19-21]
- Of the 400 cancer centers in India in 2014, only 30% have molecular imaging technologies such as PET/CT to measure effectiveness of treatment[22,23]

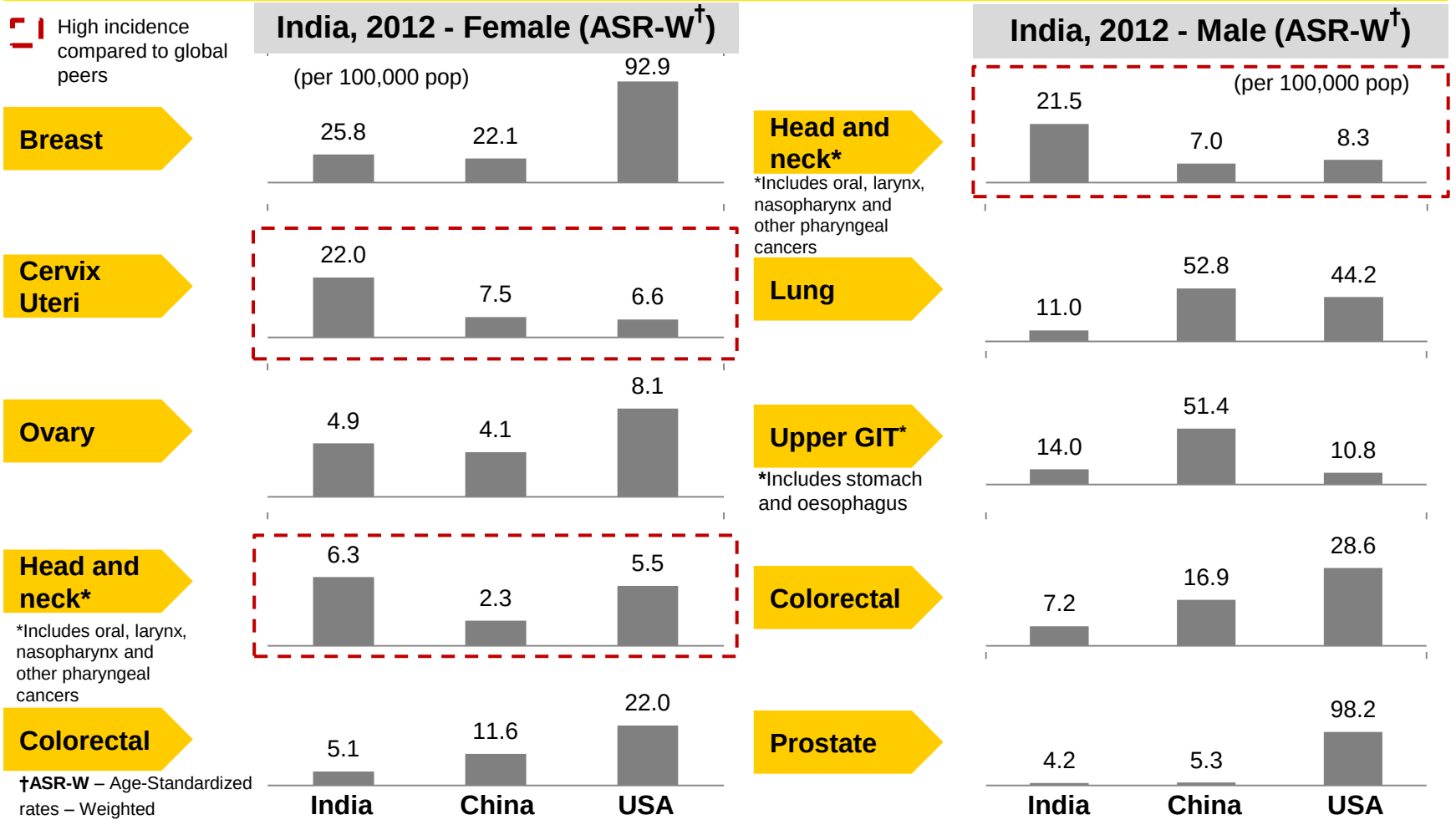
- Key opinion leaders (KOLs) stated that >70% of cancers diagnosed were advanced cancers, although increasingly, there is a trend of earlier diagnosis with nearly 30-40% of cancers being diagnosed in stages I and II

Prevalence, incidence and growth in incidence are proportionately higher in India amongst the female population, compared to its peers



Source: Globocan 2012, EY analysis

Breast and cervical cancers among women, and head and neck, lung, and GI cancers among men, represent more than 60% of the incidence burden of solid tumors



► Rising incidence rates of breast cancer among women was a trend that was reported by leading oncologists in primary interviews.

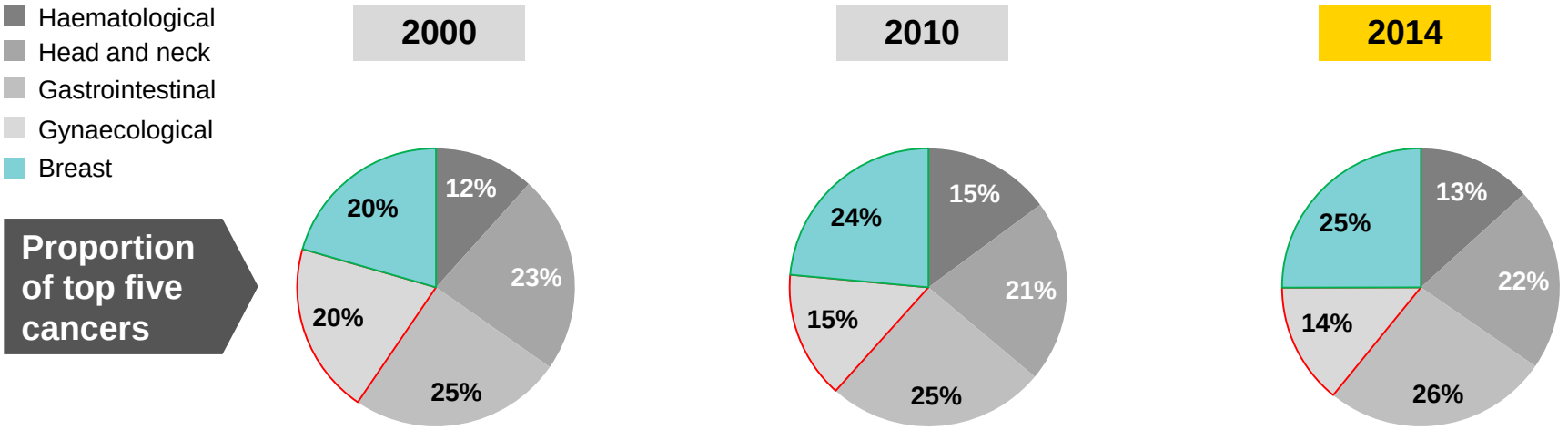
Source: Globocan 2012

Incidence of non-solid tumors is comparable to the incidence rates in China for both genders

*Includes both NHL and Hodgkin's lymphoma

†ASR-W – Age-Standardized rates – Weighted
Source: Globocan 2012, NCRP reports

Trends in cancer profile at an urban cancer chain in India reflect national trends of increasing breast cancer incidence and declining levels of gynaecological cancer



Source: Primary discussions with leading oncologists

- The proportion of breast cancers has increased from 20% in 2000 to a quarter of the top five cancers in 2014
- There has been a reduction in the proportion of gynaecological cancers (cervix, uterus, ovary) since 2000, which may be attributable to a reduction in cervical cancer incidence rates
- In 2014, gastrointestinal and breast cancers constituted more than 50% of the top five cancers indicating the changing profile of risk factor exposures

Section 1: Cancer disease burden

1

India faces a serious challenge of high incidence rates coupled with low detection

2

India is exhibiting a deterioration of the key risk factors that contribute to cancer incidence

3

Reported cancer incidence in India is estimated to increase from 90 per 100,000 population to 130-170 per 100,000 population by 2020, which will mirror incidence rates of China and other developing countries

India is exhibiting a deterioration of the key risk factors that contribute to cancer incidence

Key risk factor	Cancer type	Trends of exposure
Tobacco use	Head and neck, Lung and Bladder cancers	▸ Prevalence of all forms of tobacco use in India in 2015 is ~17% and approaching the levels of usage in the UK (21%) and the US (19%)[26]
Alcohol consumption	GI Cancers, Head and neck cancers	▸ Alcohol per capita consumption in adults aged over 15 years has increased by ~55% between 1992 and 2012[27]
Dietary factors	GI Cancers	▸ Consumption of chicken grew at a rate of 5.9% annually between 1992 – 2013 (fourth highest globally) vis-à-vis 1.63% for developed countries[28-29]
Lifestyle changes	Breast and GI Cancers	▸ India has the third highest number of obese individuals in the world, after the US and China[30]
Poor hygiene and sexual habits	Cervical Cancer	▸ Only 2-3% of women in rural areas use disposable sanitary napkins; ~70% of women cannot afford sanitary napkins[31]
Environmental pollution	Lung Cancer	▸ According to a 2014 WHO report, 13 out of the 20 most polluted cities in the world are now in India[32]

Tobacco use in India, a risk factor that is strongly associated with high risk of cancer, is fast approaching levels of use comparable to that in the UK and the US

1

Tobacco consumption

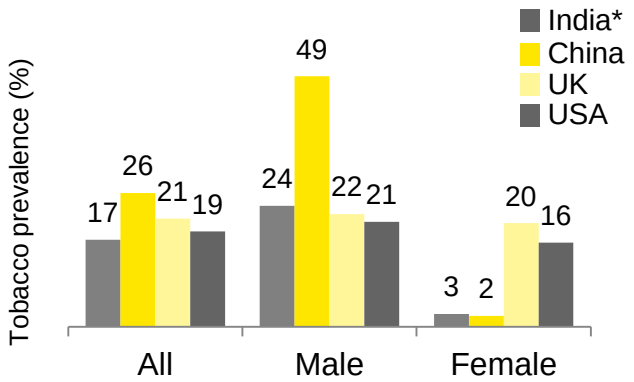
Risk factor for-

- Lung cancer
- Head and neck cancers

Head and neck, lung, and bladder cancers, that are linked with tobacco use, are estimated to constitute 33% of all cancers in 2015 (+8.8% from 2010)[33]

- WHO 2015 estimate of tobacco use in India is approaching the levels of usage in the UK and the US[26,34]
- A large cross-sectional study on tobacco use reported an overall 25.9% prevalence of smokeless tobacco users in India vis-à-vis 0.4% in China and 1.8% in the US[30]
- Higher incidence of head and neck cancers in India is attributable to the high prevalence of smokeless tobacco use

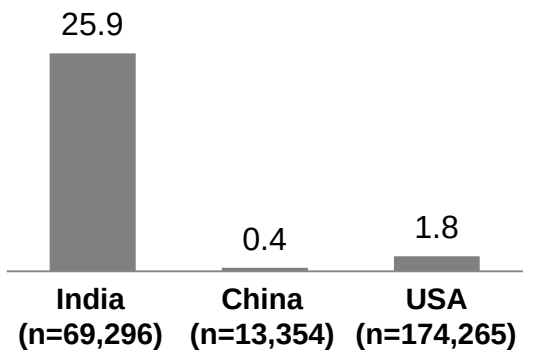
Tobacco prevalence (%)



*Includes smokeless tobacco use

Source: WHO global NCD report 2014; EY analysis

Smokeless tobacco use (% prevalence)*



*UK data unavailable

Source: Giovino et al. 2012; EY analysis

Similarly, increasing alcohol consumption in India is resulting in higher risk exposure for certain types of cancer

2

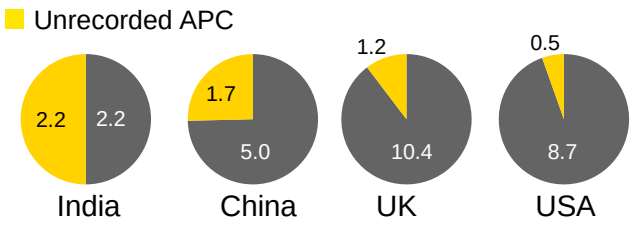
Alcohol consumption

Risk factor for-

- Head and neck cancers
- GI cancer

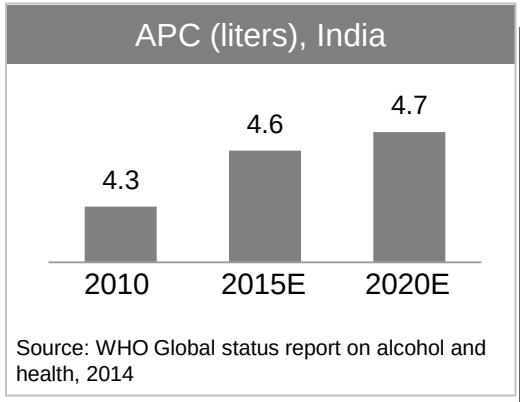
India had the third highest increase in alcohol per capita (APC) consumption between 1992 to 2012, amongst 40 countries[27]

- APC consumption in India increased ~55% in adults aged 15 and over between 1992 and 2012
- WHO estimates the average per capita consumption of alcohol in India to increase from 4.3 in 2010 to 4.7 liters in 2020[36]
- Unrecorded APC* (an indicator of low quality alcohol) contributes to ~50% of APC in India (25% in China; 10% in UK; 5% in USA)[36]



*Unrecorded alcohol refers to alcohol that is usually produced, distributed and sold outside the formal channels under government control. It includes consumption of home-made or traditional drinks, informally produced alcohol (legal or illegal), smuggled alcohol, alcohol intended for industrial or medical uses and alcohol obtained through cross-border shopping.

Source: WHO Global status report on alcohol and health, 2014



Source: WHO Global status report on alcohol and health, 2014

Prevalence (%), 2010*	Alcohol use disorders**	Alcohol dependence†
India		
Males	4.5	3.8
Females	0.6	0.4
Both sexes	**2.6**	**2.1**
WHO SEAR average	2.2	1.7

**12-month prevalence estimates (15+) **Including alcohol dependence and harmful use of alcohol. SEAR- South East Asia Region.*

† Alcohol dependence (also known as alcoholism or alcohol dependence syndrome) is defined as a cluster of behavioural, cognitive, and physiological phenomena that develop after repeated alcohol use and that typically include a strong desire to consume alcohol, difficulties in controlling its use, persisting in its use despite harmful consequences, a higher priority given to alcohol use than to other activities and obligations, increased tolerance and sometimes a physiological withdrawal state.

Also rapid changes in dietary factors and lifestyle factors are increasing the proportion of population “at risk” of cancer

3

Dietary factors

Risk factor for:

- GI cancer

A recent report suggested that India could see an 80% boom in the meat sector by 2022, and a tenfold rise in poultry consumption by 2050[37]

- A case-control study, conducted in Mumbai, in stomach cancer patients highlighted a 40% higher risk with consumption of poultry at least once a week[28]
- Per capita consumption of poultry in India has seen the fourth highest growth globally at a rate of 5.9% annually, between 1992 and 2013, vis-à-vis 1.63% for developed countries[29]

4

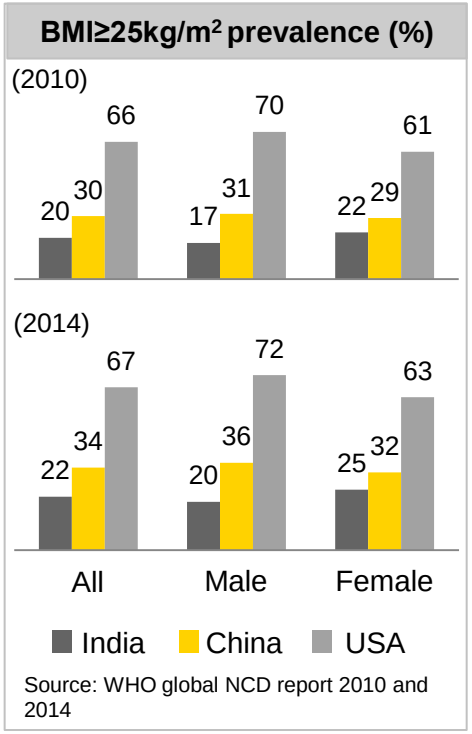
Lifestyle factors in urban areas

Risk factor for:

- Breast cancer

India has the third highest number of obese individuals in the world, after USA and China[30]

- 20% or an estimated *166 million* people aged above 18 years had a BMI ≥25kg/m^2 in 2010, which has increased to *198 million* in 2014[34,38,39]
- A recent study of 6,200 respondents conducted in 11 tier 1 cities reported a 45.2% prevalence of BMI ≥25kg/m^2 in women[34]
- Increase in the mean age of first childbirth and the reducing trend in breast feeding practices are also considered as risk factors, especially in urban areas
  - An increasing number of working women in urban areas (12% in 2011 v. 9% in 2001) is a driving factor for delayed child birth[41]



Source: WHO global NCD report 2010 and 2014

Poor living conditions, sexual habits, and multiparity in rural areas are risk factors impacting burden of cervical cancer in India

5

Poor hygiene and sexual habits

Risk factor for:

- Cervical cancer

Cervical cancer rates are higher in rural v. urban populations

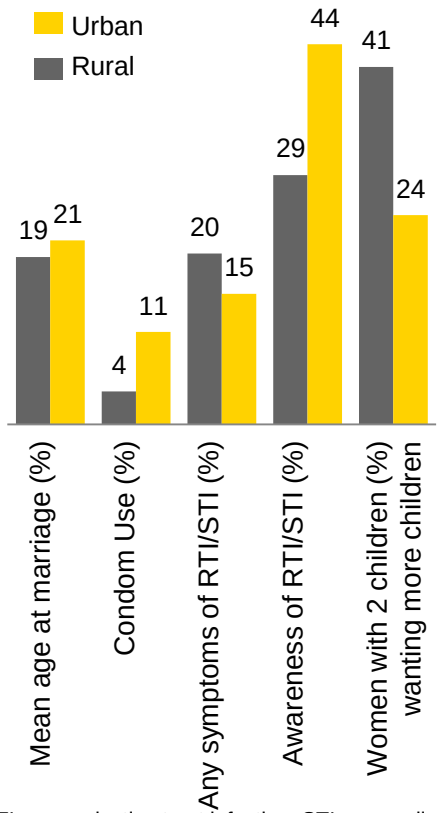
- Barshi rural registry had the highest incidence of cervical cancer (~ 30% of the total new cases among female v. ~9% in Mumbai, ~12% in Delhi, ~13% in Chennai)[18]
- Poor sexual hygiene, lower age at marriage and first intercourse, higher parity, and low condom usage are all associated with a higher risk of rural cervical cancer
- Only 2-3% of women in rural areas use disposable sanitary napkins and 70% of women in India cannot afford sanitary napkins[31]

Sexual promiscuity is a key reproductive risk factor that is linked with cervical cancer

- While reported prevalence of multiple sexual partners and high risk sexual behavior is low in India (0.1% among women and 2% among men), the prevalence is higher among select population sub-groups such as unmarried/widowed/deserted populations (4% among women and 12% among men)[41]

- Lack of awareness of risk factors, low socio-economic status, and poor education were cited as the key factors in cervical cancer risk, in rural populations, by leading oncologists

Risk factors for cancer cervix[41,42]



*RTI – reproductive tract infection; STI – sexually transmitted infection

Source: Ministry of Health and Family Welfare India DLHS3, EY Analysis

Increasing levels of pollution within urban areas is also enhancing the risk for increased cancer disease burden

6

Air and water pollution

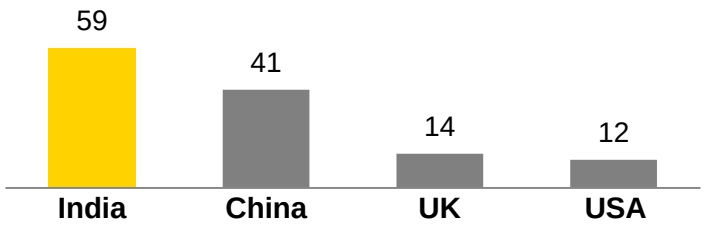
Risk factor for:

- Lung cancer
- GI cancer

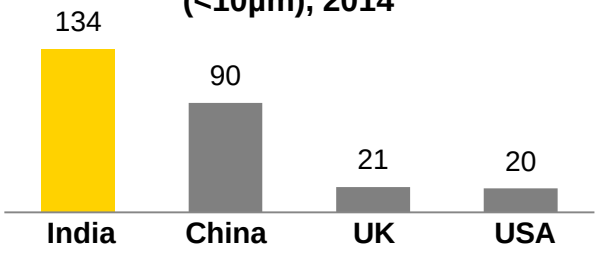
According to a 2014 WHO report, 13 of the 20 most polluted cities in the world are in India[32]

- Among 1600 cities across the globe, New Delhi was the most polluted city in the world with an average particulate matter (<2.5µm) level of 153, compared to 14 in New York and 56 in Beijing[32]
- Studies conducted in the state of Punjab highlight moderate to high correlation between cancer mortality and pesticide residues in water and soil (70-80% of cropped area in Punjab is treated with pesticides)[43,44]

Annual mean particulate matter (<2.5µm), 2014



Annual mean particulate matter (<10µm), 2014



Source: Ambient Air Pollution Database, WHO, May 2014

Rising incidence of cancers in India was attributed to several factors by key opinion leaders including:

- Increasing alcohol consumption
- Increasing levels of obesity combined with lack of physical activity
- Changes in diet such as low fiber diet, increased consumption of processed foods, and increased meat consumption
- Increasing levels of urban pollution
- Changing lifestyles resembling that of western populations

Section 1: Cancer disease burden

1 India faces a serious challenge of high incidence rates coupled with low detection

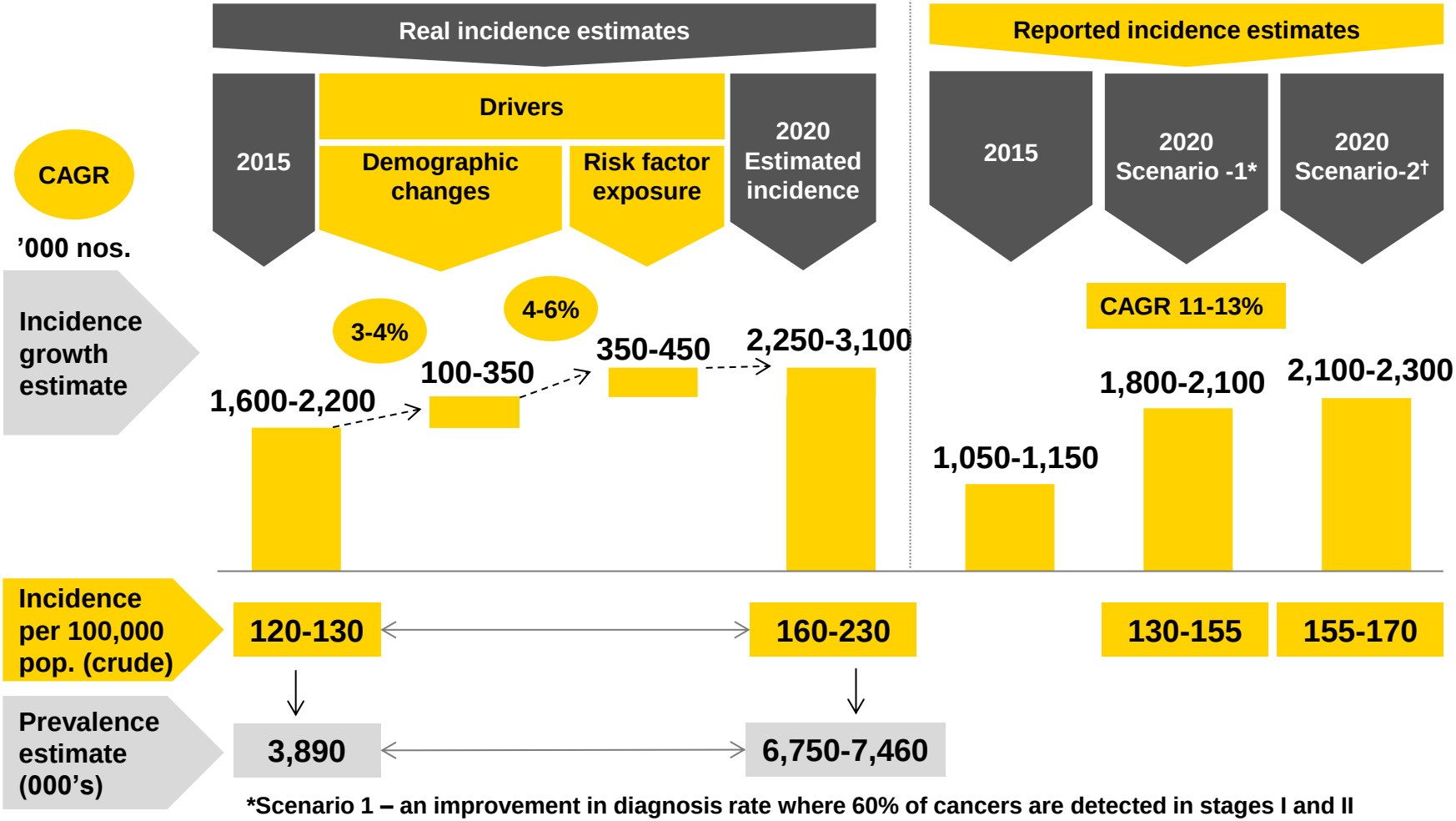
2 India is exhibiting a deterioration of the key risk factors that contribute to cancer incidence

3 **Reported cancer incidence in India is estimated to increase from 90 per 100,000 population to 130-170 per 100,000 population by 2020, which will mirror incidence rates of China and other developing countries**

Reported cancer incidence is expected to increase mainly due to three key factors – demographic changes, higher risk factor exposures, and an improvement in diagnosis

Driver	Effect
1. Demographic changes	► **Increase in population**: India's population is estimated to grow at a CAGR of 1.08% and reach 1.35 billion by 2020 ► **Age-composition**: The median age of the population is estimated to rise from 26.9 in 2015, to 28.4 in 2020. India's population over 50 years of age is forecast to increase from ~228 million in 2015 to ~262 million by 2020. ► **Sex-composition**: India's sex ratio is estimated to change from 107.0 in 2015 to an estimated 106.8 males per 100 females in 2020. **Population growth, an ageing population and changes in the sex ratio are expected to increase cancer incidence in 2020**
2. Risk factor exposure	► **Increasing risk factor exposure**: India's per capita alcohol consumption is projected to increase from 4.7 to 4.9 litres by 2020; *198 million* people aged above 18 years had a BMI ≥25kg/m^2 in 2014, and an estimated *249 million* Indians are expected to have a BMI ≥ 25kg/m^2 by 2020 **Increasing levels of air pollution, falling levels of physical activity and westernization of lifestyles and dietary habits are expected to increase the risk of cancer**
3. Gap in diagnosis	► The gap in early diagnosis in India is expected to show a reduction over the next five years owing to:- ► **Increasing shift towards early detection:** driven by increased patient awareness, affordability and access to cancer centers in 2020. The trends in these barriers have been discussed in **Section 2** of this report ► **Increased screening efforts for cancer** **Considering the above, we have projected reported cancer incidence in 2020 under two scenarios of improvement in diagnosis rate where (1) 60% of cancers are detected in stages I and II (2) 70%of cancers detected in stages I and II**

The reported incidence in 2020 is expected to be 150 per 100,000 population representing a growth rate of 11-13% annually over the next five years



*Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in stages I and II

†Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in stages I and II

Source: EY analysis

Refer **Annexure 3 and 4** for methodology used for estimating incidence and prevalence in 2020

Section 2: Treatment landscape

Section 2: Treatment landscape

1 Except for breast cancer, adverse mortality rates observed in India are attributable to poor diagnosis and inadequate treatment

2 Affordability, access and awareness are the three key barriers that are limiting adequacy of diagnosis and treatment in India

3 Going forward, the treatment landscape is expected to show a significant improvement as barriers are progressively addressed

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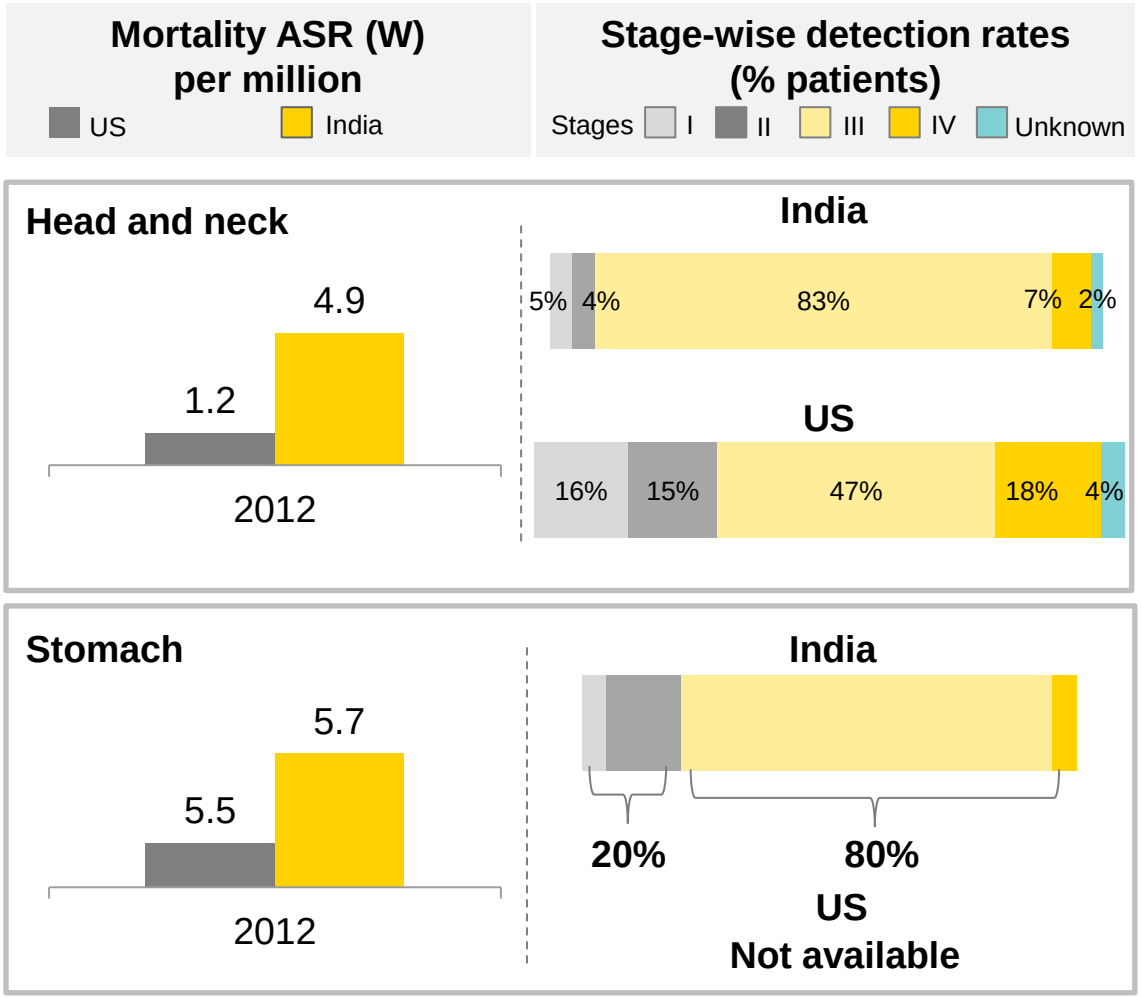
Except for breast cancer, adverse mortality rates observed in India can be attributed to poor diagnosis and inadequate treatment (1/2)



Source: NCRP reports; Seer Cancer fact sheets; Note: numbers rounded.

Key factors impacting mortality rates

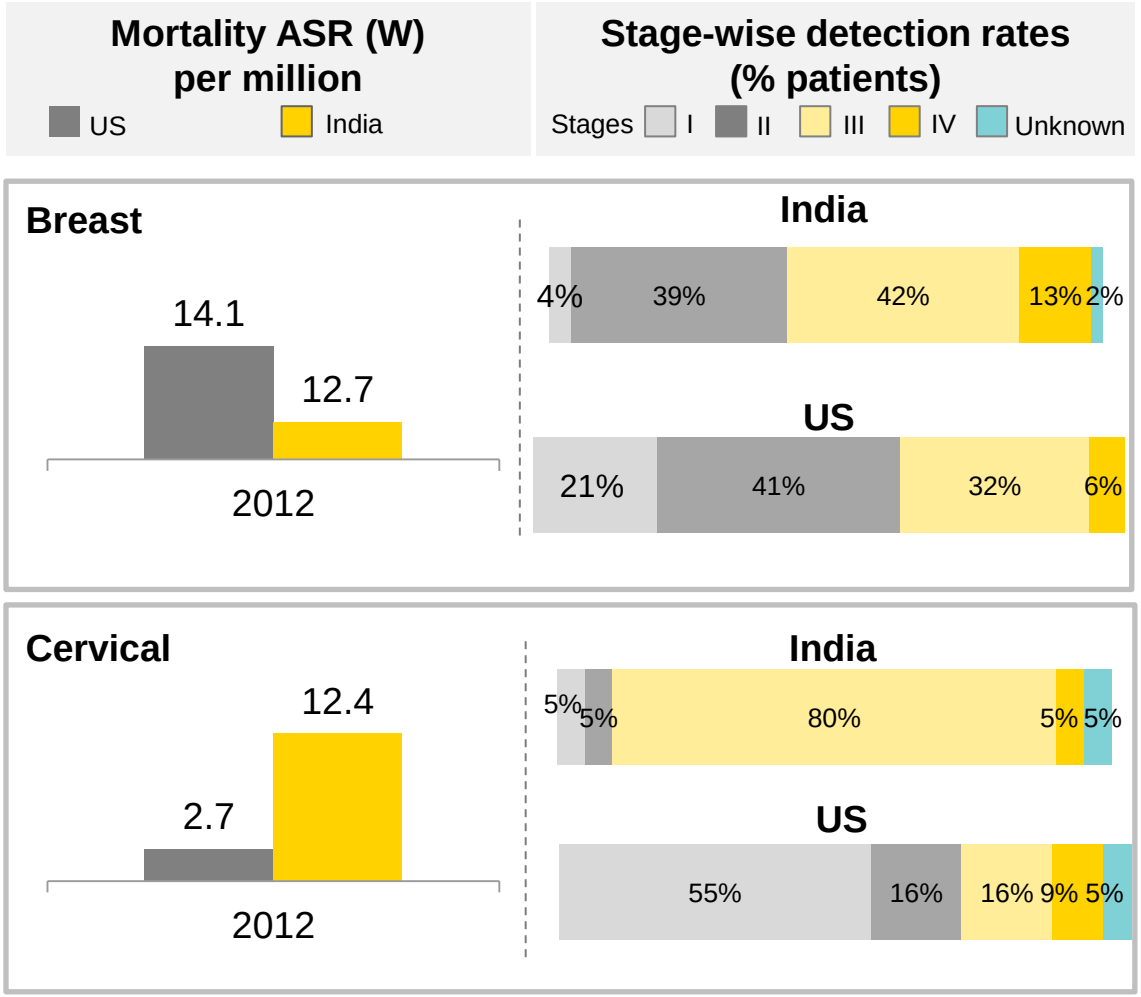
Higher mortality rates in head and neck cancer are attributable to:

- Poor awareness levels resulting in ulcers being ignored by many patients, consequently delaying diagnosis
- Limited inclusion of advanced diagnostic tools in treatment protocols, such as PET CT, that can enable improved staging, assessment and treatment planning

In case of stomach cancer:

- Lack of overt presentation of symptoms and standard screening tests results in poor detection rates
- In addition, general physicians and gastroenterologists, who are the first point of contact for such patients, may not be adequately aware or trained to detect and refer, or treat these patients

Except for breast cancer, adverse mortality rates observed in India can be attributed to poor diagnosis and inadequate treatment (2/2)



Source: NCRP reports; Seer Cancer fact sheets; Note: numbers rounded.

Key factors impacting mortality rates

Lower mortality rates in case of breast cancer is attributable to:

- Increasing awareness resulting in early detection and enabling the use of the right treatment modality
- Inclusion of adjuvant and neo-adjuvant chemo/radiotherapy, apart from concurrent chemo/radiotherapy in the treatment protocols
- A few private comprehensive cancer care centers in India are delivering outcomes comparable to the US by leveraging a multidisciplinary approach

With respect to cervical cancer, delayed presentation of the disease coupled with the lack of population based mass screening programs and HPV vaccination measures have resulted in relatively adverse mortality rates in India

Section 2: Treatment landscape

1

Except for breast cancer, adverse mortality rates observed in India are attributable to poor diagnosis and inadequate treatment

2

Affordability, access and awareness are the three key barriers that are limiting adequacy of diagnosis and treatment in India

3

Going forward, the treatment landscape is expected to show a significant improvement as barriers are progressively addressed

Affordability, access and awareness are the three key barriers that are limiting adequacy of diagnosis and treatment in India

1 Affordability[42]

- While the **cost of cancer treatment** in India is **5-6 times** lower than that in the US, treatment is unaffordable for a large section of society due to:
  - Low population coverage of public and private insurance programs (only **30% of population covered)**
  - Low average household income levels with **~20% of households (~52.6 million population)** having an annual income **>INR 200,000 p.a**

2 Access[42]

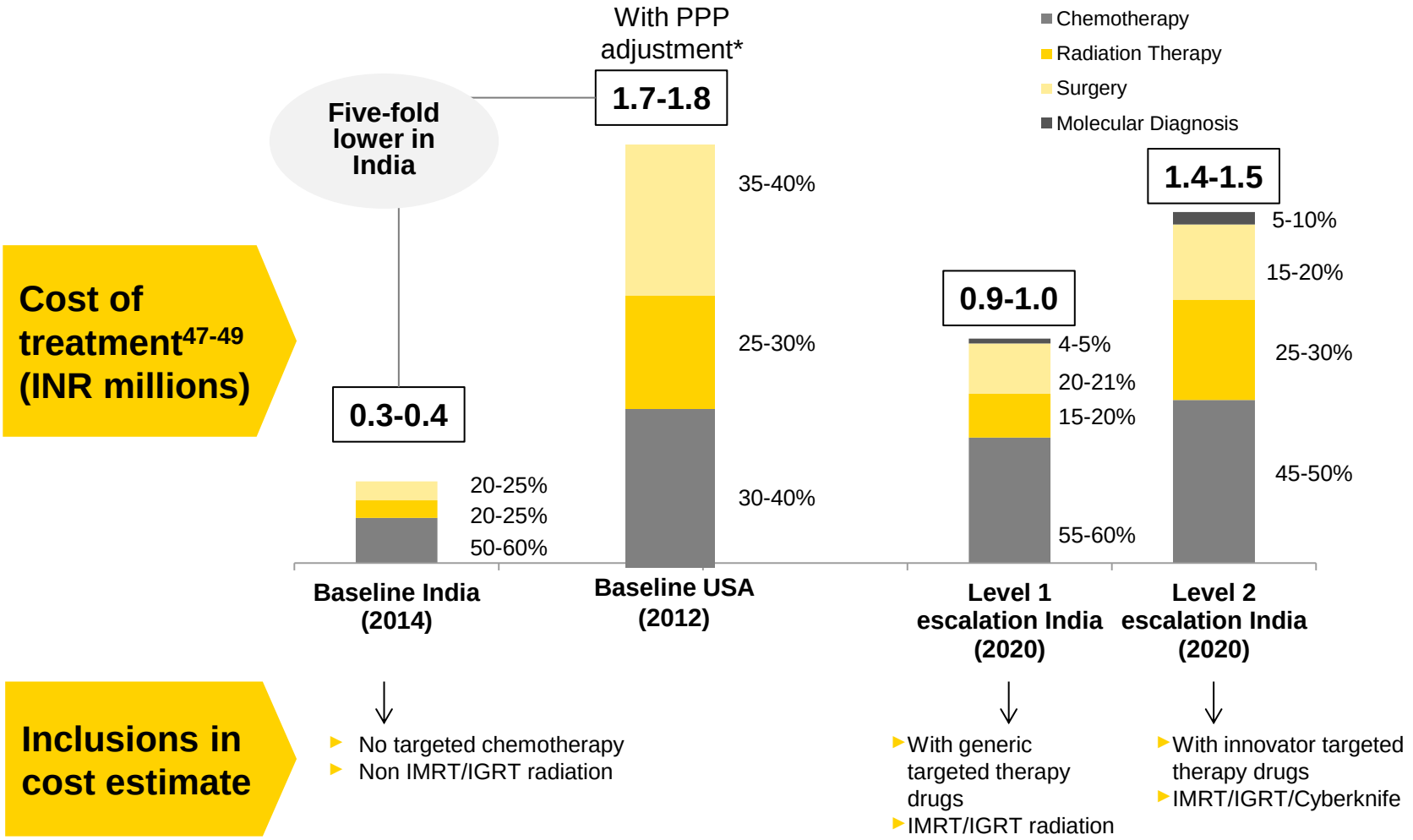
- Access to **physical infrastructure** (diagnostic and treatment facilities) and **human infrastructure** (oncologists) is low on account of low density and significant geographical skew (**40-60%** of the facilities and oncologists are present in the **top metros** of India)

	Key assessment parameter (Nos. as of 2014)	Density (No. of times India lower v. the US)
Diagnostics	Mammograms per million female population	20
	PET CT scanners per million population	62
Treatment	Linacs per million population	40
	Comprehensive cancer centers per million population	28
Oncologists	Oncologist to patient ratio	16

3 Awareness

- Awareness regarding disease, symptoms and screening practices is low
  - For instance, breast cancer studies in South India have revealed ~**55%** of women have **never heard** about breast cancer, **80-90%** were **not aware of symptoms** and **~65% did not practice** self examination[45,46]

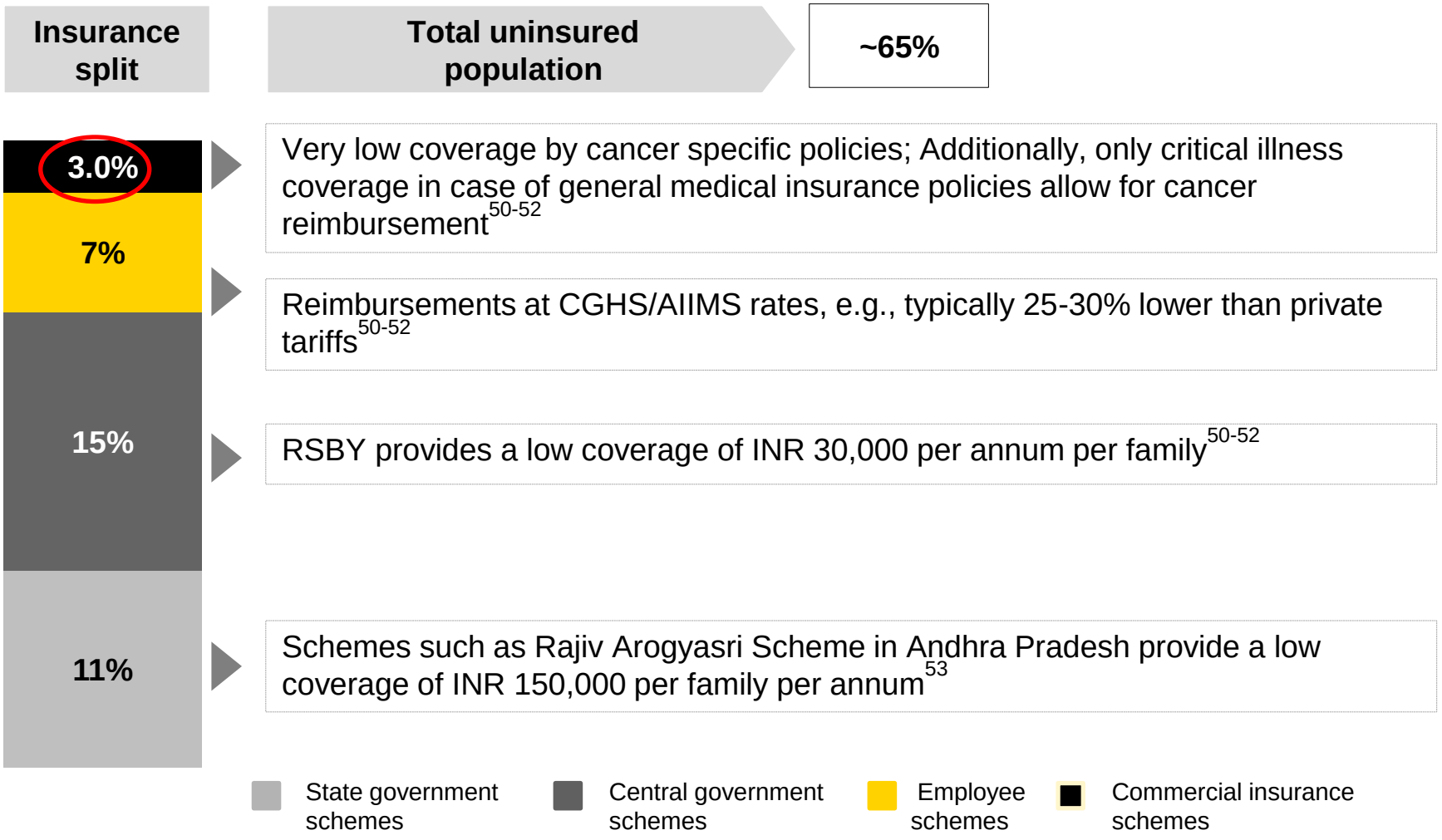
1 Cost of cancer treatment in India, even with the use of advanced diagnostic and treatment technologies, is lower than in the US



***Actual cost is ~INR 4.4-4.5 million**

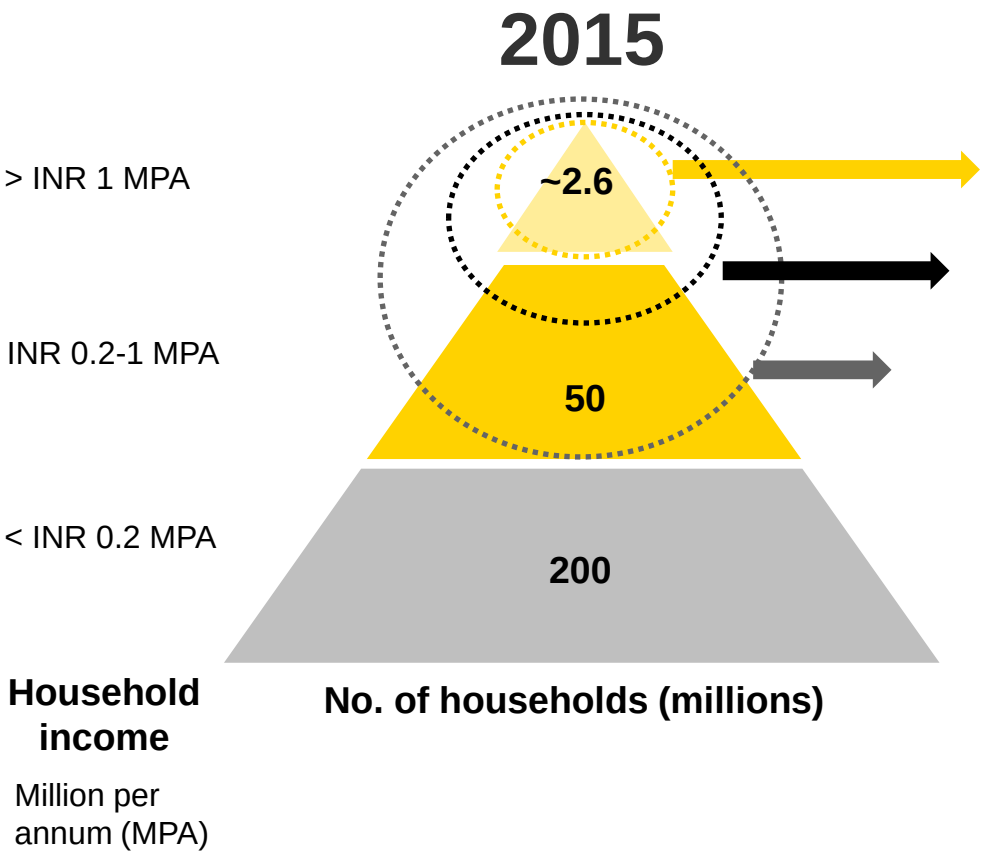
Source: Avalere Health LLC report, NAMCP Medical Directors Institute, Primary interviews, 1USD=INR 50

1 Affordability is a concern as less than 35% of the population is covered under some form of health insurance



Source: MGI, State and Central Government Websites

1 75% of households in India have an annual household income lower than the baseline cost of treatment



~1% of households can potentially afford all cost levels

5-6 % of households can potentially afford Level 1 escalated cost

20-25% of households can potentially afford baseline treatment cost

Source: MGI

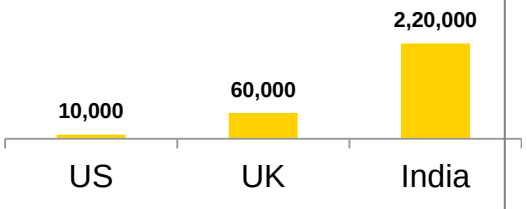
2 Low density of diagnostic facilities and absence of mass screening programs for key cancers in India is a major barrier for timely diagnosis

Mammography

Breast cancer

- Number of installed mammograms in India, as of 2014, is estimated at **~2700 units** which is **1/20th** that of the USA
- **<1%** women in India undergo an annual mammography exam[54]
- Efforts for breast cancer screening using methods such as mammography is very low with **<2%** coverage of the female population[45-46]

Number of females served per mammogram



Source: EY analysis

PAP Smear

Cervical cancer

- Based on an assessment conducted by **ICMR in association with WHO in 2006**, **mass screening for HPV using PAP Smear method lacks feasibility** due to high cost[55]
- Consequently, due to limited focus and allocation of public resources, **less than 2%** of female population can be covered **with** the **current facilities available for Pap smear screening**[56-57]

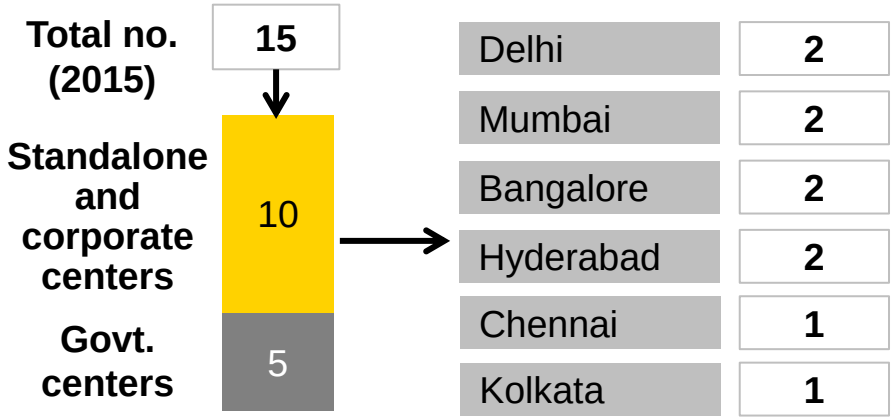
Screening coverage[8]

	Sample Size (N)	Effective coverage*
India	9762	5.3%
China	3993	23%

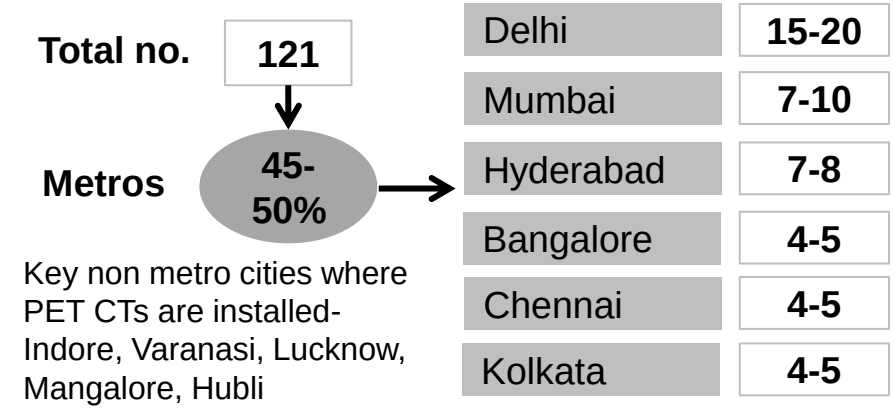
*Effective coverage: the proportion of eligible women (25-64 years) who report having had a pelvic exam and Pap smear in the past three years

2 Similarly, significant gap in the current density and geographic distribution of PET CT scanners in India limits access to advanced diagnostics

Distribution of cyclotrons by geography



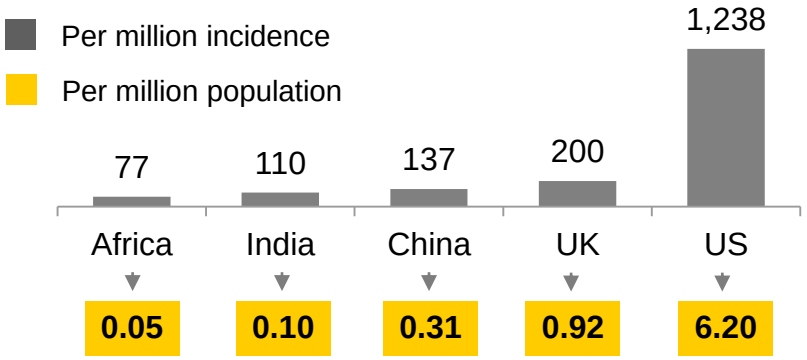
Distribution of PET CT scanners by geography



Key non metro cities where PET CTs are installed- Indore, Varanasi, Lucknow, Mangalore, Hubli

Source: Industry reports, primary interviews

Global comparison (PET CTs per million population and per million new cases)



India has an estimated 15 cyclotrons and 121 PET CT scanners, as of 2015, with significant geographic skew in distribution

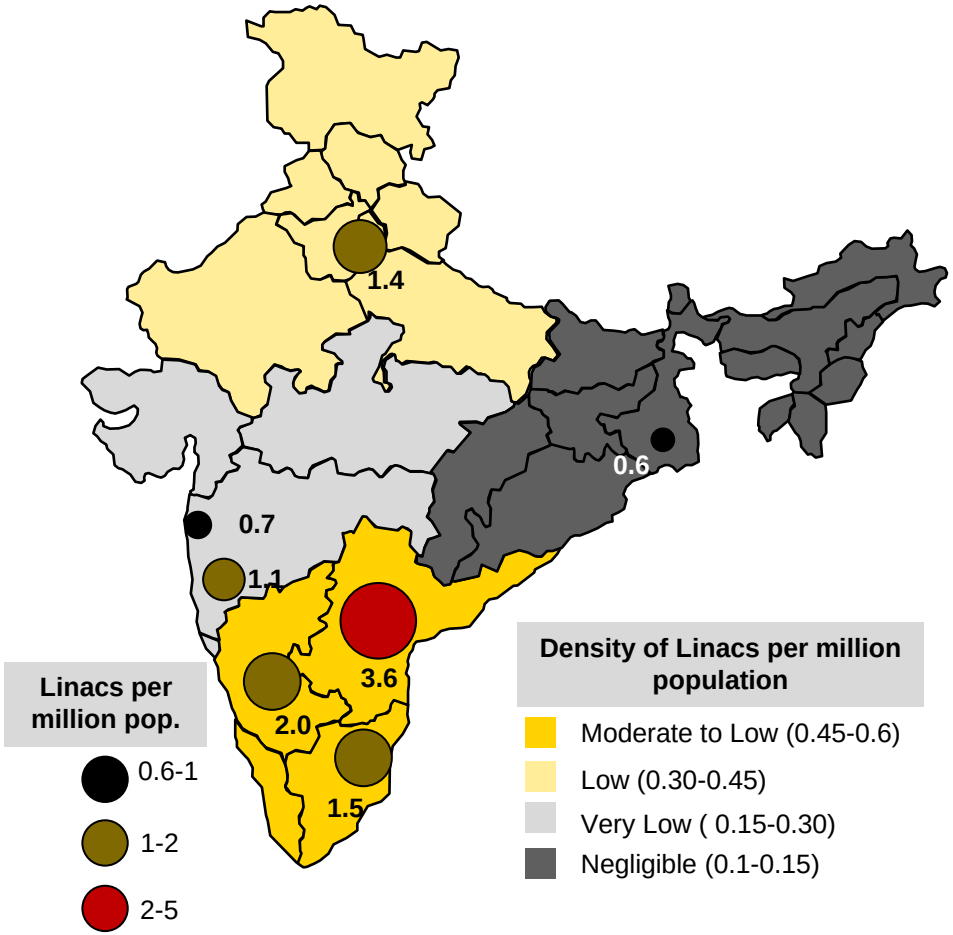
- All 15 cyclotrons are in metro cities and hence high efficiency is required in the delivery of Fludeoxyglucose (FDG) to Tier-1 cities
- ~50% of PET CT machines installed in the top six metro cities [58]

Density per million new cases is significantly low compared to most global peers highlighting a potential gap in the use of nuclear medicine for treatment planning

- Only 10-12% of new patients in India can potentially get PET CT scans done based on current installed capacity[58]

2 While radiation therapy is increasingly becoming a part of the treatment standards, there is a significant geographic skew in penetration of radiation equipment viz. Linacs in India

Distribution of Linacs by geography (2015)



Source: Industry reports, primary interviews.

Global comparison of availability of Linacs v. population, prevalence and incidence

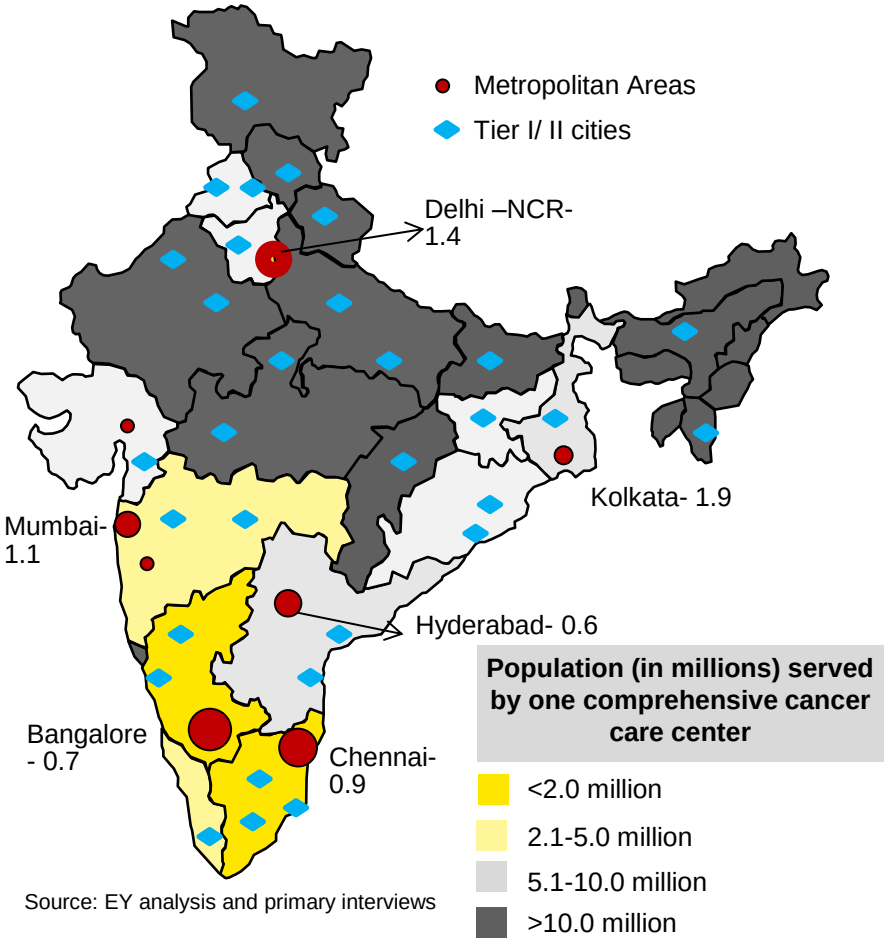
Region/ country	# Linacs (2015)	Linacs/ Population (million)	Prevalence/ Linac	Incidence/ Linac
US	3818	11.9	1572	419
UK	323	5.0	3096	929
China	986	0.7	6288	3144
India	342	0.3	7310	3216
Africa	89	0.1	33708	7865

India has an estimated 350 operational Linac installations as of 2015, and growing at 20-25%, with significant geographic skew in distribution

- ~ 1/3 rd of the total installations are concentrated in seven metro cities[58]
- Select metros have density of Linacs which is close to the levels in the UK and higher than in China
- As of 2015, only 40 out of the 640 districts have installations
- Due to poor access and affordability only 15-20% of the patients in India receive/opt for radiation treatment on an average, vis-à-vis international standards of 50-60%[58,59]

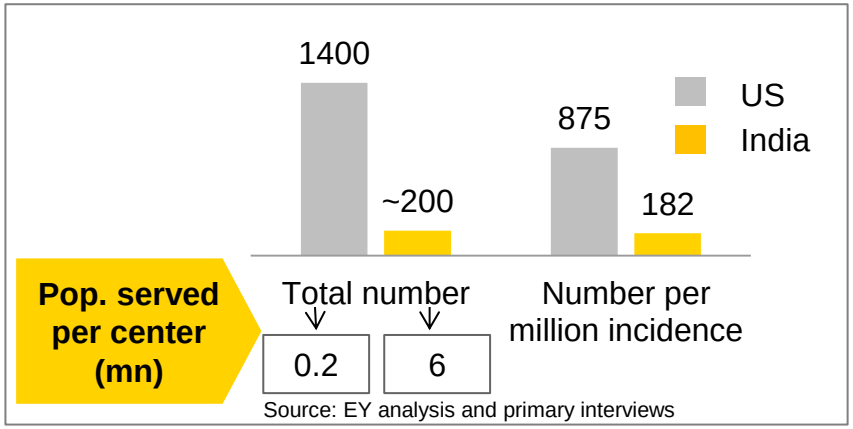
2 Access to multimodal treatment options provided by comprehensive cancer care centers is also limited

Distribution of comprehensive cancer centers by geography



Source: EY analysis and primary interviews

India v. the US comparison: density of comprehensive cancer centers[60,61]



Source: EY analysis and primary interviews

India, as of 2014, only has 200-250 comprehensive cancer centers offering multimodal treatment options with significant concentration in metro cities

- In 2014, ~40% of the comprehensive cancer centers were present in the top eight metro cities, and majority of the centers (~85%) are owned by trusts, private and corporate chains[60]
- Poor geographic distribution of such centers is limiting access to advanced and multimodal treatment options for patients

2 The leading cancer care providers are concentrated mostly in metro cities of India

Hospital Group	No. of cancer treatment centers			States of presence
	Metro cities	Other cities	Total	
HealthCare Global (HCG)	7	8	15	▸ Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Maharashtra, Jharkhand, Orissa, Delhi
Apollo Hospitals	5	2	7	▸ Tamil Nadu, Karnataka, Andhra Pradesh, Chattisgarh, West Bengal, Delhi
Manipal Hospitals	1	5	6	▸ Karnataka, Andhra Pradesh, Goa, Rajasthan
Comprehensive Blood and Cancer Centre (CBCC)	2	3	5	▸ Tamil Nadu, Gujarat, Madhya Pradesh, Chattisgarh
Fortis Healthcare	2	3	5	▸ Haryana, Punjab, Maharashtra
Max Healthcare	2	2	4	▸ Delhi, Punjab
International Oncology	1	3	4	▸ Maharashtra, Uttar Pradesh, Rajasthan
Roentgen Oncologic Solutions	1	2	3	▸ Delhi, Madhya Pradesh, Jharkhand
Yashoda Hospitals	3	-	3	▸ Andhra Pradesh
Others	90	233	323	
Total	**114**	**261**	**375**	

Metros: Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Secunderabad, Bangalore, Pune, Ahmedabad

Source: List of Cancer Treatment Centers licensed by AERB (as on 31-5-2015)

Note: While cancer treatment centers licensed by AERB are 375, comprehensive cancer centers (i.e. centers which provide radiation, medical and surgical oncology services within the same facility) are estimated at 200-250.

2 The provider landscape is also fragmented with few large cancer focused players (1/2)

Hospital	New patient registrations	Chemotherapy cycles	Radiation patients	No. of surgeries (Major OT procedures)
Private and Trust				
South based oncology chain	34,500-34,700	42,200-42,400	12,100-12,300	5,100-5,300
Pan- India based multi-specialty corporate chain	10,800-11,200	22,800-23,200	3,400-3,600	4,100-4300
North based multi-specialty corporate chain	10,000-10,400	25,000-27,000	2,000-2,200	2,800-3,200
South based large oncology institute	15,500-15,800	13,500-13,900	2,600-3,000	3,000-3,300
North based large oncology institute	14,000-15,000	40,000-42,000	2,000-2,200	4,300-4,500
East based trust hospital	6,800-7,200	14,200-14,600	450-550	1,450-1,650
Total (for above hospitals)	**0.92-0.95 lac**	**1.57-1.63 lac**	**0.22-0.24 lac**	**0.21-0.22 lac**
Estimated current treatments (pan India)	**~9-10 lac**	**~15-20 lac**	**~1.5-1.6 lac**	**~3.5-3.6 lac**

Please note the above list is indicative and not exhaustive

Source: Estimates based on (i) primary discussions with pharmaceutical players and equipment vendors (ii), company websites

2 The provider landscape is also fragmented with few large cancer focused players (2/2)

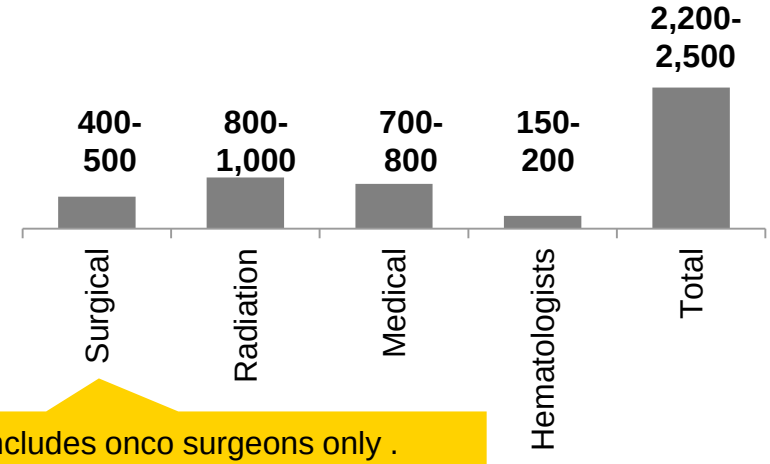
Hospital	New patient registrations	Chemotherapy cycles	Radiation patients	No. of surgeries (Major OT procedures)
Public				
West based large hospital (government autonomous body)*	35,000-35,400	81,300-81,700	8,600-9,000	10,900-11,200
RCC Thiruvananthapuram	13,800-14,200	6,000-6,500	4,300-4,700	2,400-2,800
RCC, Hyderabad	9,000-11,000	22,250-22,750	3,400-3,800	1,250-1,750
RCC, Bangalore	17,100-17,400	29,000-31,000	6,900-7,100	4,300-4,700
Total (for above hospitals)	**0.7-0.8 lac**	**1.35-1.4 lac**	**0.23-0.25 lac**	**0.18-0.20 lac**
Estimated current treatments (pan India)	**~9-10 lac**	**~15-20 lac**	**~1.5-1.6 lac**	**~3.5-3.6 lac**

Please note the above list is indicative and not exhaustive

Source: Estimates based on (i) primary discussions with pharmaceutical players and equipment vendors (ii), company websites

2 In addition, a gap also exists in the density and geographic spread of oncologists in India which further proliferates the risk of delivering improved outcomes

Estimated number of oncologists and hematologists in India (2015)



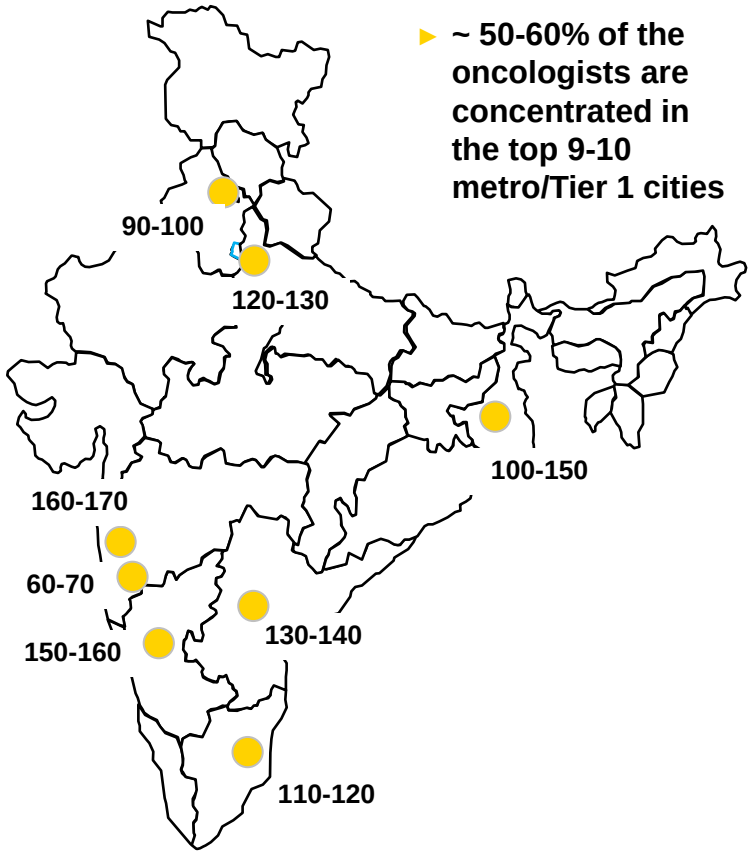
Includes onco surgeons only . Total surgeons with multidisciplinary practice is estimated to be ~1,200-1,500

Patients to Oncologist Ratio[62-67]	
USA	100:1
UK	400:1
India	1600:1

Source: American Cancer Society, Royal college UK websites, Industry reports, Primary interviews, EY analysis

- Annual addition of doctors is ~ 400-450 (includes MCH, DM and DNB courses)[67]
- Despite the increase in the number of seats, the gap in patient to oncologist ratio is likely to remain high (estimated 1,350: 1 by 2020) compared to developed nations[62-67]

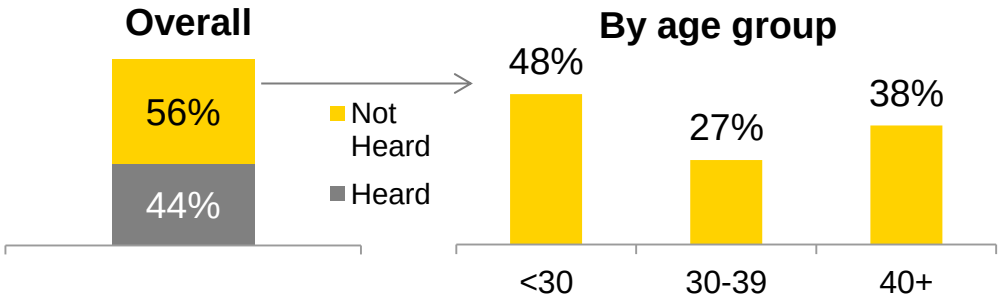
Distribution of oncologists in key metros



3 Lack of awareness about the disease, symptoms, and diagnostic practices further augments the challenge of improving mortality rates

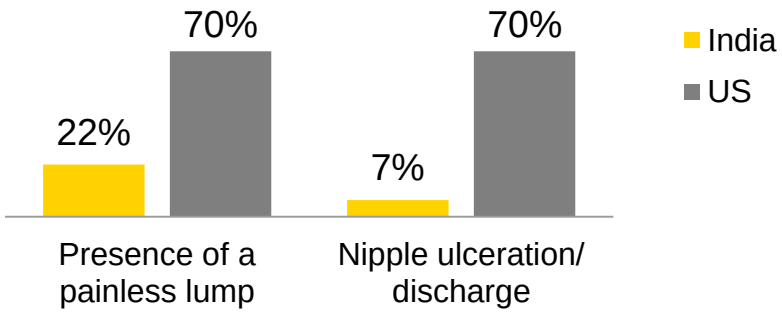
Key findings of studies on breast cancer awareness in India[67-69]

Awareness level



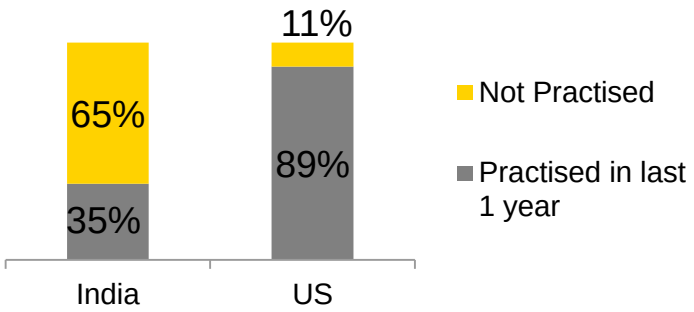
- Study conducted by Pfizer in the US, in 2014, revealed that 100% of women surveyed had heard of breast cancer and 40% had in depth understanding of the disease

Knowledge of symptoms



Screening practices

Breast self examination



- A Korean survey reported that 88% women were aware of breast self examination practices (2012)[70]

Section 2: Treatment landscape

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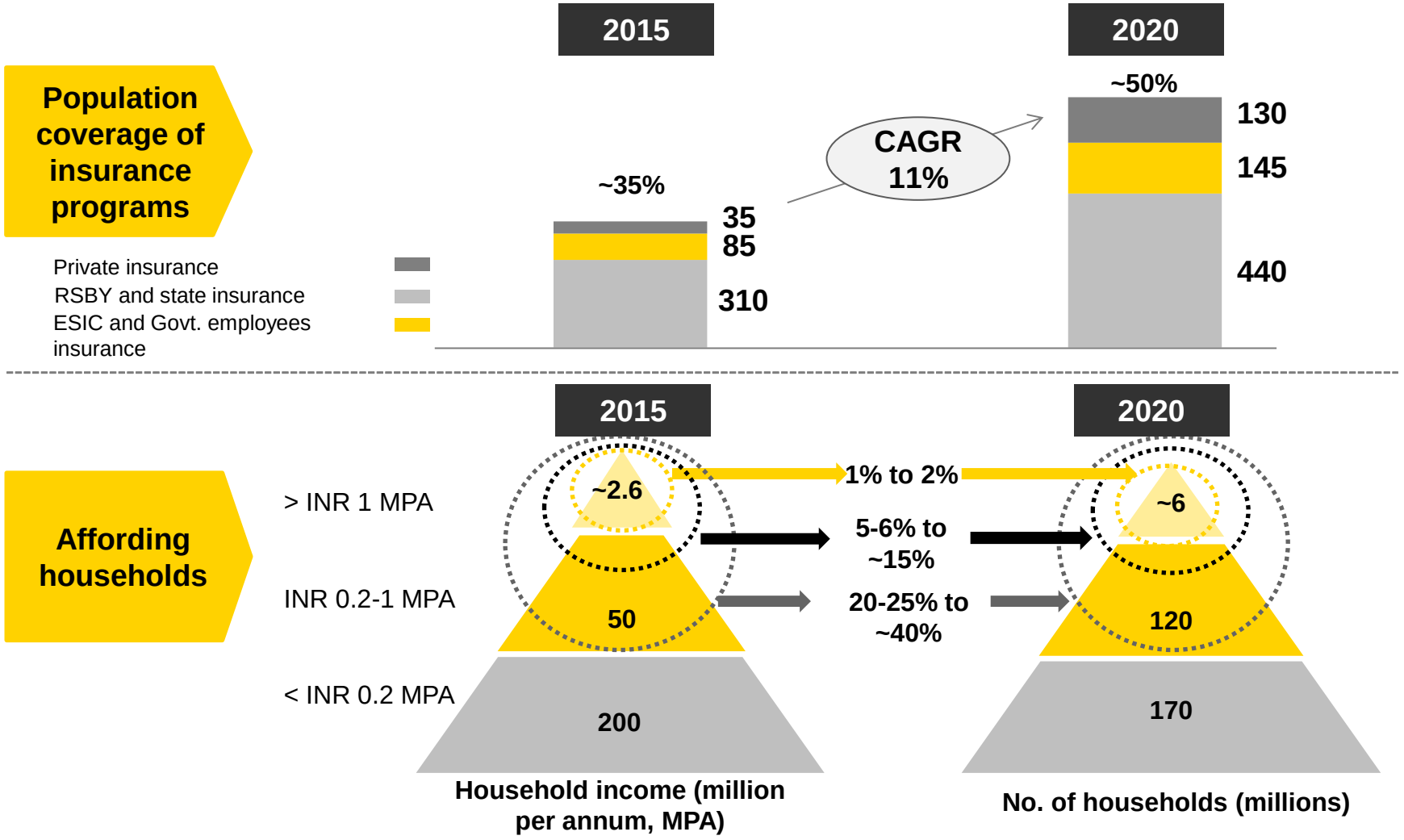
3 **Going forward, the treatment landscape is expected to show a significant improvement as barriers are progressively addressed**

By 2020, however, it is expected that affordability for cancer treatment is likely to rise with the increase in coverage of insurance programs and rising income levels



Source: MGI, 12th five year plan working group report, EY analysis

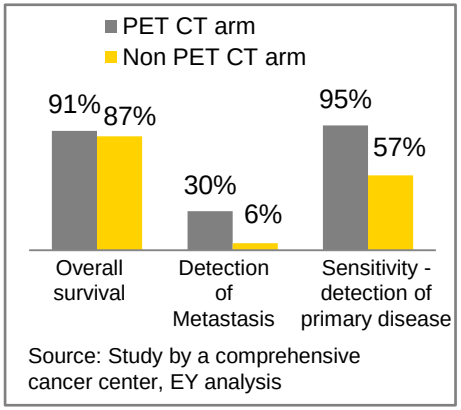
The technological landscape is evolving with the introduction of transformational platforms for diagnosis and treatment planning….

1

Nuclear medicine- PET CT

PET CT is beneficial in staging and prognostication

- PET CT enables the addition of anatomical and functional information towards treatment planning and has been commercially available since 2001
- PET CT scans facilitate improved tracing of disease in human organs and enable effective treatment planning as well as course correction when used for monitoring cancer treatment



Source: Study by a comprehensive cancer center, EY analysis

- A study by a comprehensive cancer care chain in India indicated better outcomes (Figure) using PET CT[71]. Key benefits identified include:
  - Median duration of survival increased by 26.5 months in the PET CT group compared to control group (who did not receive PET CT scans)
  - 35% patients moved into higher stages of cancer based on PET CT, leading to better treatment planning and cost effectiveness

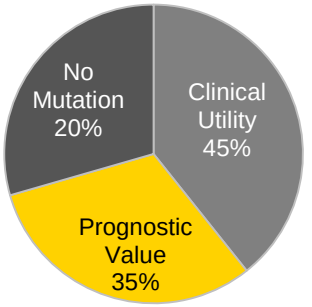
2

Molecular diagnostics- Genomics

Genomics facilitates improved understanding of the mutation profile of tumors and enables evidence based therapy

- A study on 450 patients by a comprehensive cancer care chain in India using genomics highlighted the following[72]:
  - 45% patients reported treatable mutations enabling selection or alteration of therapy
  - 35% patients had mutations that had clinical utility in terms of resistance to conventional therapy, sensitivity to targeted therapy and most importantly prognostication of the disease

Mutation profile by utility



…as well as in radiation and medical oncology, which is contributing towards an improvement in clinical outcomes

3

Radiation therapy- IGRT, Radiosurgery and Brachy-therapy

IGRT*- Increases precision and targets higher doses to smaller areas[73]

- Studies have demonstrated a significant improvement in tumors of prostate and head and neck with a positive impact on disease free survival rate with IGRT v. IMRT
- Recommended for treating mobile tumors and tumors close to sensitive areas such as paraocular tumors

Radiosurgery- allows treatment of small/difficult-to-treat tumors with improved survival rates

- A Korean study[74] demonstrated an improvement in the median overall survival for liver cancer by four months with stereotactic radiosurgery (SRS) vis-à-vis conventional radiotherapy

Brachytherapy- Increases treatment compliance and patient convenience

- A Kolkata based comprehensive cancer care center demonstrated an ultimate control rate of 100% and 78% for early and advanced disease respectively, with high dose brachytherapy [75]
- Additional benefits over conventional radiotherapy are optimal and precise dose delivery, tissues-sparing and shorter treatment duration

4

Targeted therapies

Targeted therapies improve overall survival, overall response rate, duration of response, safety and better quality of life

Addition of Herceptin to standard chemotherapy in 4,000 breast cancer patients with a median follow-up of 8.4 years revealed:[76]

- 37% improvement in overall survival rate; 40% boost in disease free survival rate
- 10-year overall survival rates improved from 75% to 84%

A study in a large government hospital in Mumbai demonstrated a significantly better response rate, improved progression free survival and overall survival in lung cancer patients treated with targeted therapies.[72] Overall survival rate improved from ~14% to ~30% with targeted treatment

* IGRT- Image Guided Radiation Therapy; IMRT: Intensity Modulated Radiation Therapy

Adoption level of advanced technology is improving in India with investments made largely by trust, private and corporate hospital chains

Distribution of external beam radiation equipment by technology

Technology	Nos. installed (%)	Level of advancement
Cyberknife	2%	High
SRS/SBRT	8-10%	High
IGRT	30-35%	High
Gamma	1%	Moderate to high
IMRT	20-25%	Moderate to high
3D CRT	15-20%	Moderate to high
Cobalt	10-12%	Low to moderate

Distribution of Linacs by ownership

Type of institution	Nos. installed (%)
Standalone (trusts and private)	50%
Corporate chains	30%
Government centers	20%

While the number of Linac installations in India is low, the level of technology used is reasonably advanced with **~90% of installations** being of **moderate to high technology** levels

Source: Primary interviews

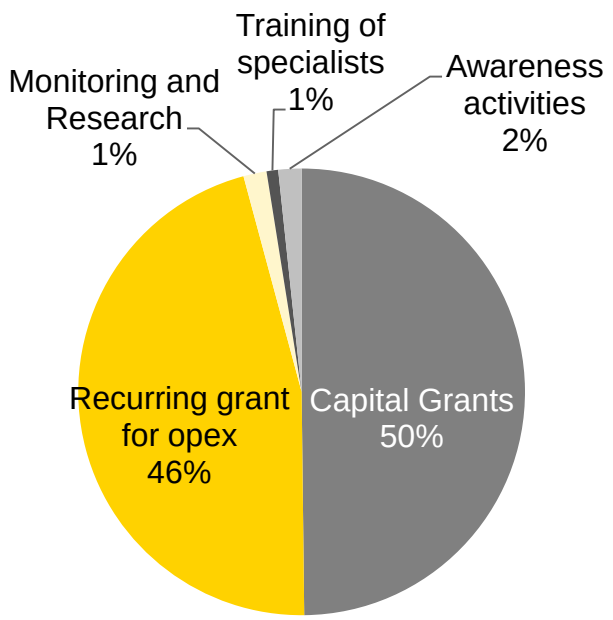
There is increasing government focus on improving access to diagnosis and treatment with a three-fold increase in outlay over the last plan period

Total outlay for cancer specific initiatives

XIth plan — INR 4,000-5,000 cr

XIIth plan — INR 15,000-16,000 cr

Allocation of outlay (XIIth plan)



Source: XIIth five year plan working group report

Focus activities (XIIth plan)

Capital grants[55]

- District cancer services – early diagnosis, opportunistic screening, health promotion, palliation, follow up of chemotherapy cases and rehabilitation, are to be expanded to all 640 districts by 2017
- Support for 100 Govt. Medical colleges/ private institutes/ erstwhile RCCs for upgradation to tertiary cancer centers (TCCs)
- Support for 20 centers to be established as state cancer institutes (SCI) and three national centers to be established as national cancer institutes (NCI)

Monitoring and research

- National cancer registry to be expanded to all TCCs and cancer treatment institutes
- Mass screening programmes on Cancer Awareness Day (7 November)
- Opportunistic screening for common cancers at district level (Cervical, breast and oral)

Skill building

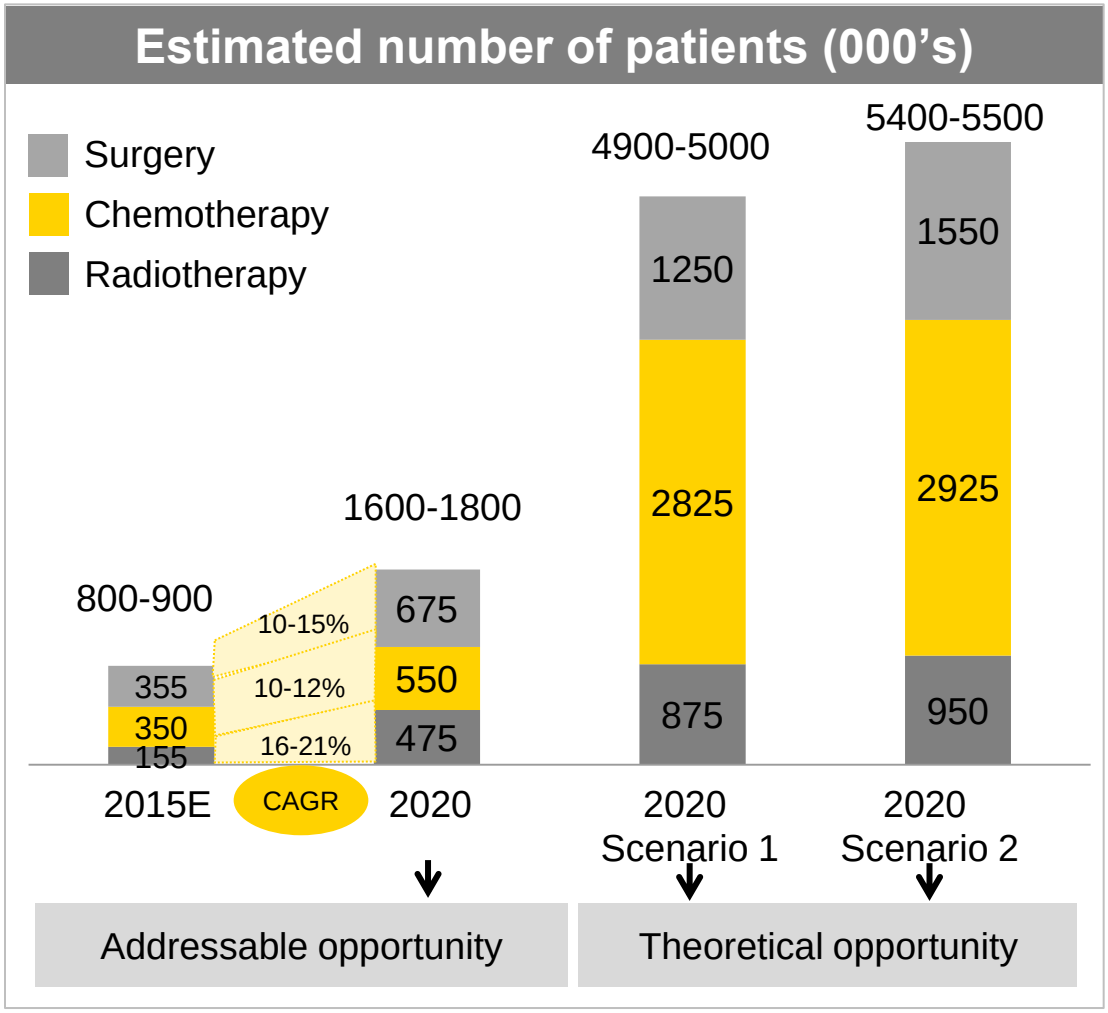
- Training for skill building at district cancer centers, tertiary care centers, state cancer institutes and nation cancer treatment institutes

Awareness activities

- Leverage channels such as inter-personal communication, education and mass media for awareness creation on tobacco use, dietary habits and physical activity

Section 3: Market opportunity

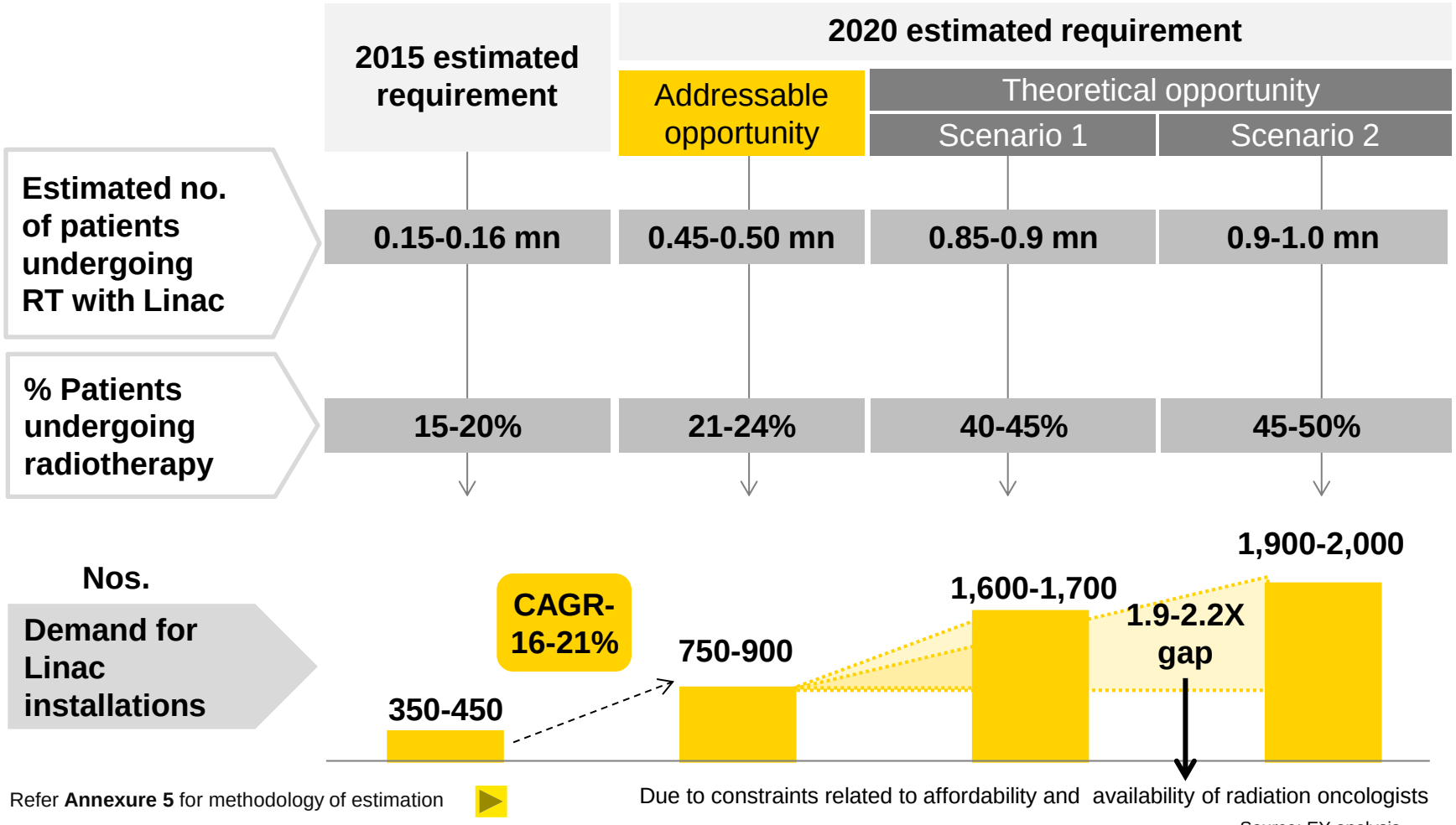
The estimated growth of patients seeking radiotherapy, chemotherapy, and surgery in 2020 is expected to be 16-21%, 10-12% and 10-15% respectively



The overall cancer treatment market in India is estimated at USD 1.7-2 billion in 2015, including all modalities of treatment.[77]

Source: EY analysis

While 2020 estimations for Linacs highlight significant potential demand due to increasing disease burden, realistic growth in installations is likely to be ~16-21%



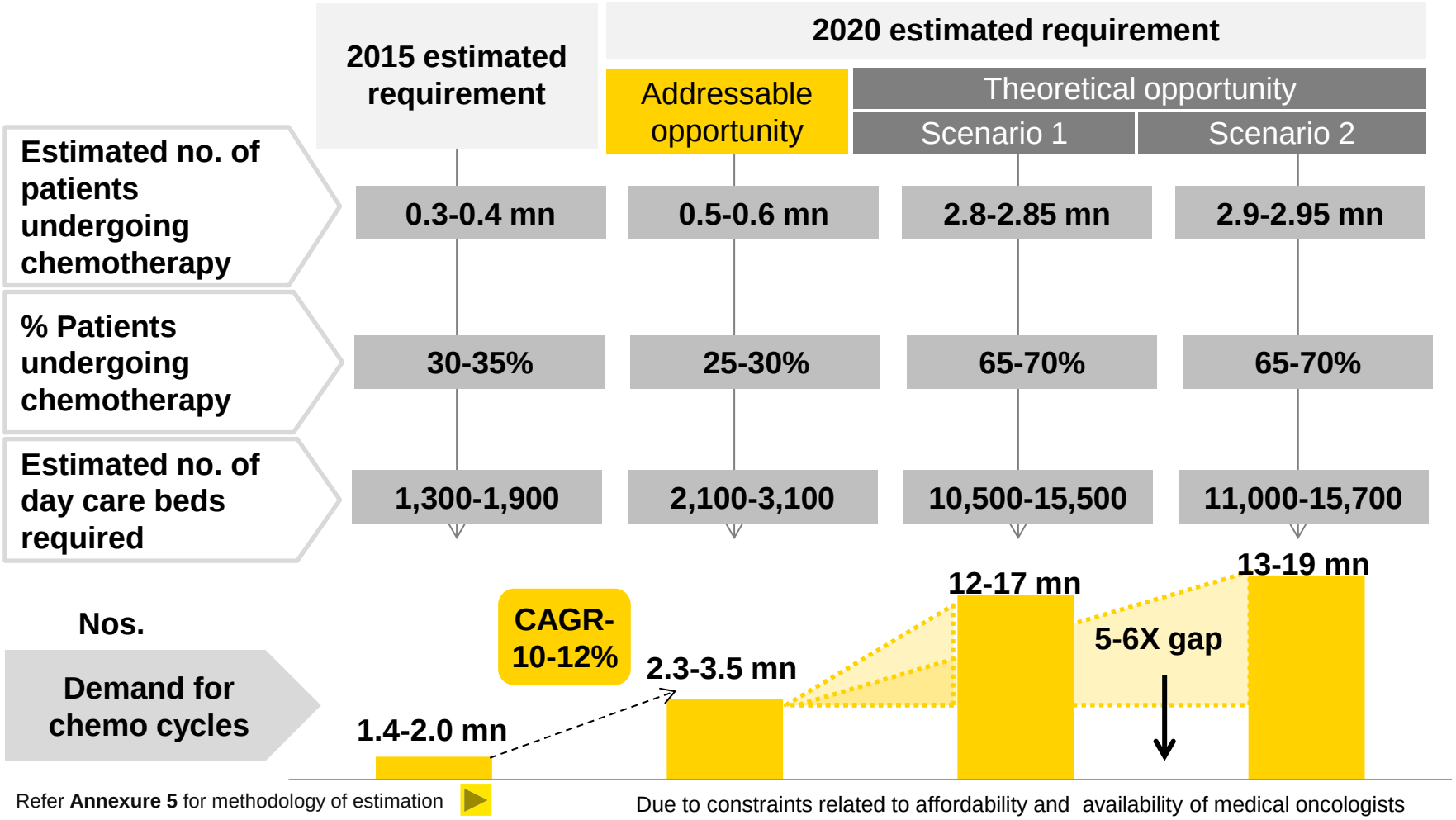
Refer **Annexure 5** for methodology of estimation

Due to constraints related to affordability and availability of radiation oncologists

Source: EY analysis

Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in stages I and II
Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in stages I and II

In line with radiation therapy, demand for chemotherapy in India is likely to grow by 10-12% on realistic basis resulting in demand for 800-1,300 additional day care beds



Refer **Annexure 5** for methodology of estimation

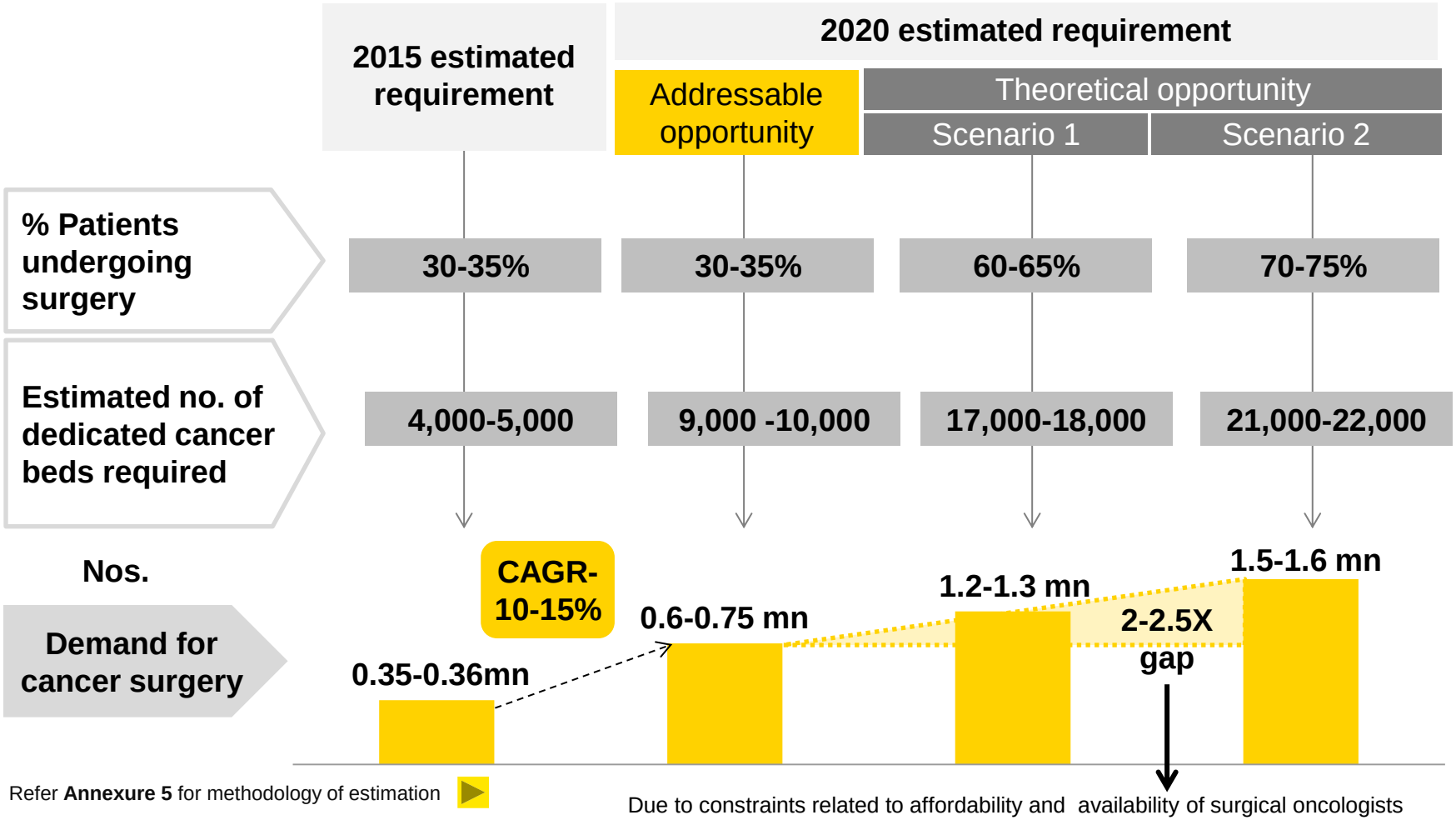
Due to constraints related to affordability and availability of medical oncologists

Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in stages I and II

Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in stages I and II

Source: EY analysis

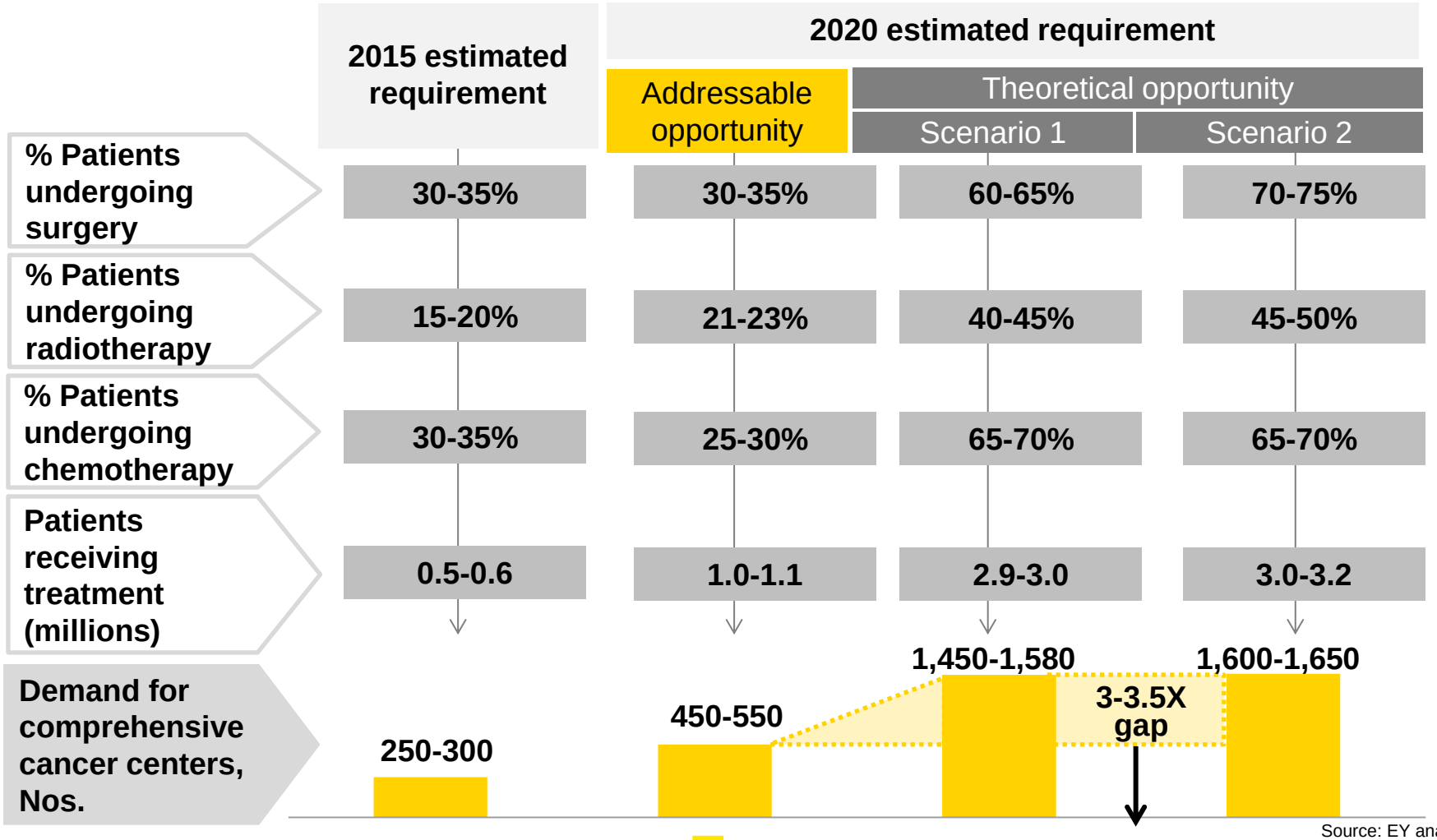
The demand for cancer surgery in India is likely to grow by 10-15% on a realistic basis resulting in demand for 5,000-6,000 additional dedicated cancer beds



Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in stages I and II

Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in stages I and II

Nearly 450-550 comprehensive cancer care centers will be required, in order to address the increased cancer incidence in 2020



Source: EY analysis

Refer **Annexure 5** for methodology of estimation ▶ Due to constraints related to affordability and availability of oncologists

Section 4: Key imperatives for industry stakeholders

Key imperatives for accessible, affordable and quality cancer care delivery

Key themes	Key imperatives for cancer care delivery
A Optimize care	1. Cost effective and early diagnosis and screening 2. Focus on health outcomes by ensuring quality of treatment 3. National planning based on robust and granular cancer registry
B Expand care	4. Innovative integrated delivery care models to take care to where the patient is 5. Public private partnerships to decentralize cancer care delivery and nurture Centres of Excellence 6. Addressing physical and human infrastructure gap with focus on correcting distribution inequity 7. Strong focus on “cost of care” in areas of medical technology and drugs
C Reduce the burden	8. Primary and secondary prevention (awareness and advocacy)

A. Optimize care

1. Cost effective and early diagnosis and screening

- **Early diagnosis and screening is imperative in India as less than 30% of cancers are diagnosed in stage I and II,** as a result of which survival rates are significantly lower when compared with its global peers. India does not have any organised national screening programs, as infrastructure and resource constraints make large-scale screening cost ineffective. Concerted effort is needed to leverage cost effective methods for diagnosis and screening
  - **Focus on cancers with high incidence:** Government screening efforts should be directed to cancers with a high disease burden such as breast and cervical cancers in women, and oral cancers in both sexes. Implementation of such measures would necessitate large scale training of public health workers, participation by local NGOs/self help groups for outreach, standard screening protocols and effective gatekeeping mechanisms. Examples of low cost screening initiatives are provided below:
    - **Cervical screening by visual inspection with acetic acid (VIA),** is a highly cost effective alternative to Pap-smear based screening (less than one-tenth of the cost) and has been shown to reduce cervical cancer mortality by 30%. Moreover, this can be administered by primary health workers with minimal training, and is particularly useful in the southern and eastern states which have high rates of cervical cancer
    - **Oral cancer screening by visual inspection** in high-risk populations is a cost-effective procedure that should be administered by trained para-medical staff of the primary health center for early detection and for providing health education
    - **Faecal occult blood testing in stool samples** is a simple cost-effective screening tool for GIT malignancies which can be performed at the district cancer centers, particularly in the north-eastern states and a few of the southern states which have a higher incidence of these cancers.

Focus on training the public health workers for providing effective counselling services to direct the suspected cases to the right practitioners for evaluation

A. Optimize care

2. Focus on health outcomes by ensuring quality of treatment

- Cancer is a complex disease that requires **a multimodal approach to treatment** with the involvement of several specialists and technology for accurate staging and treatment to ensure management of the disease and prevent recurrence. In order to achieve first time right treatment and improved patient survival, the following measures are proposed:
  - **Establish national standard treatment guidelines and protocols:** Periodical review of management protocols by a high-level panel of KOLs under the aegis of the Indian Council of Medical Research, to include new innovations in molecular diagnosis, targeted drugs, and radiological procedures in standard treatment guidelines. Institutional tumor boards should be set up to ensure implementation of these protocols, and conduct regular audits of treatment outcomes
  - **Multidisciplinary approach to treatment should be adopted:** Hospitals should constitute tumor boards consisting of a multidisciplinary panel of medical, surgical and radiation oncologist, radiologist, oncology nurse, dietician and palliative care physician for effective diagnosis, treatment planning and execution. Where feasible, molecular diagnosis, neoadjuvant radio-/chemotherapy and targeted modalities of treatment must be incorporated in patient management
  - **Training and education of nurses and providers of palliative care**, who play a pivotal role in provision of comprehensive cancer care, should be a key imperative for tertiary cancer centers and cancer institutes. Provision of training to district level doctors in palliative care, in conjunction with local NGOs, is also essential to ensure adequate service delivery at the grassroots level

A. Optimize care

3. National planning based on robust and granular cancer registry

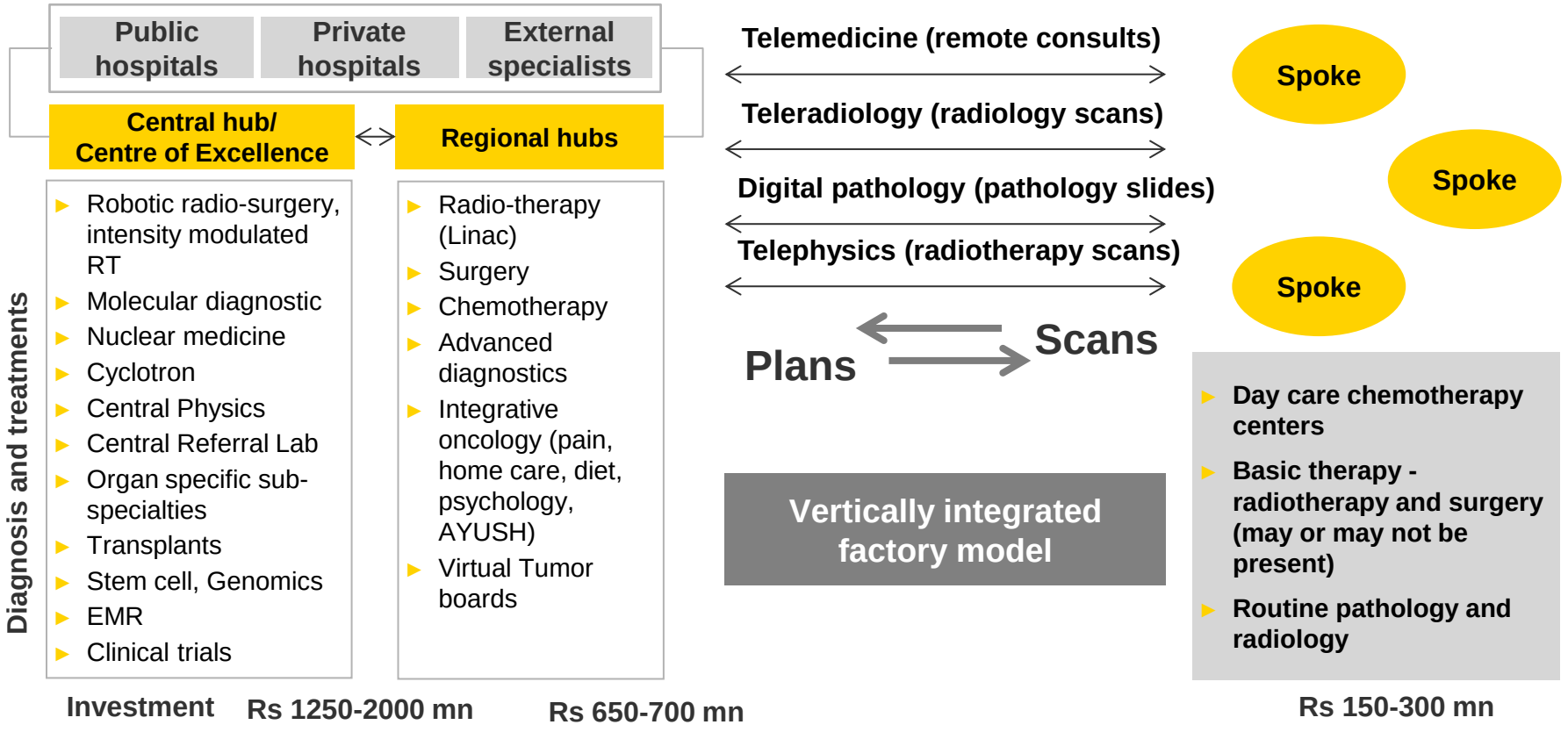
- Indian cancer registries (27 in number), are unevenly distributed within the population, and suffer from low coverage and under-reporting in the absence of mandates for reporting of cancer statistics. As national cancer control programs rely on the data provided by cancer registries, the following measures are proposed to improve the availability and quality of data in cancer registries
  - **The National Cancer Registry program including both hospital based and population based registries should ensure mandatory submission of cancer statistics** by all government and private institutes that treat cancer patients. This will ensure adequate population coverage of cancer-specific data and provide detailed information on the trends of specific cancers
  - **Each cancer center should maintain a database of all registrations** with detailed information including stage at diagnosis treatment offered and response rates, mortality and morbidity statistics, survival statistics, and any acute and chronic post surgical complications. This should be provided to policy makers periodically for review and decision making

  Policy decisions should be data-driven. Cancer registry data should be periodically reviewed and trends of disease burden, geographical distribution of site-specific cancers must be identified for determining resource allocation and cancer control measures

B. Expand care

4. Innovative integrated delivery care models to take care to where the patient is

- **Vertically integrated delivery to bridge acuity of supply** can be envisaged where a **"central hub"** performs high end imaging, therapy and complex procedures and **"low cost"** spokes provides basic therapy and follow-ups in patients' local communities. This entails a high quality model in urban areas with a trickling down effect over time to largely under-served regions. The hub can also service other public and private hospitals, external specialists who can be encouraged to utilize its technology and clinical capability.



B. Expand care

5. Public private partnerships to decentralize care and nurture Centres of Excellence

- **PPP models have been utilized by Central and State governments for improving access to healthcare** wherein the public sector provides physical infrastructure and patients, and the private sector infuses the necessary expertise for service delivery and implementation (human capital, medical technology, clinical capability) to create viable partnerships. The PPP model has been well explored in areas of imaging and diagnostic services but has not, as yet, been explored in delivery of cancer care. Complexity of cancer care delivery, presence of few specialist cancer chains and cancer care viability model for private sector has still not been well established to experiment PPP models. However the sheer volumes of the public health system which can provide private players a larger geographical footprint and leverage under-utilized capacities/capabilities can present distinct opportunities for partnerships in the following areas:
  - **Upgradation of RCCs:** <25% of government-funded cancer centers have Linac installations which provide high-quality radiotherapy, although all 27 RCCs have some form of radiotherapy facilities. Upgrading the remaining cancer centers is a capital intensive process, due to the higher installation and operational costs involved with Linacs vis-à-vis Cobalt installations. Upgradation of the RCCs may be achieved by outsourcing to private players utilizing a PPP model with clearly established framework of operations and responsibilities of the various partners involved.
  - **Setting up cancer centers in district hospitals and medical colleges:** Similar partnerships can also be explored with progressive state governments for expanding basic or/and comprehensive cancer care in select medical colleges and district hospitals, where feasible, for setting up oncology institutes. For e.g. the state of Bihar has plans for a large cancer cluster with private participation utilizing a build and operate concept for providing diagnostic, treatment and palliative services.
  - **Capacity tie-ups:** Partnerships that would leverage under-utilized clinical capacity in the private sector may be used to address the public sector overflow of patients at agreed reimbursement tariff thereby reducing waiting times in overstretched government cancer centers.

B. Expand care
6. Addressing physical and human infrastructure gap and inequity

- **Strong focus on filling the physical and human infrastructure gap is required to correct distribution inequity:**
  - Given the low density per million population of comprehensive cancer centers (0.2), there is a need for promoting investments to **build atleast additional 250 comprehensive cancer centers** in a constraint scenario and **1,350 additional centers** in an unconstrained scenario. Additional capacity creation should be focussed in Tier 2 cities and below and in select states such as Bihar, Uttar Pradesh, Madhya Pradesh, North Eastern states, Chattisgarh, Rajasthan, Jammu and Kashmir, West Bengal, Uttarakhand
  - By 2020, expansion in clinical bandwidth will be required to the tune of ~4,500 medical oncologists and ~2,500 surgical oncologists over and above the current pool, and expected additions from current postgraduate seats. This entails addition of ~7,000 post graduate medical seats by 2017 with higher focus on tier 2 and below cities
    To bridge the gap in human infrastructure, innovative models for capacity building may be explored-
    - Upgrading the skills of specialists and general physicians for early diagnosis by oncology specialists and creation of a robust network for referring patients to cancer treatment centers

Cancer site		Focus doctor speciality for skill upgradation
Oral cavity	⟷	ENT specialist , Dentist
Breast and Cervical	⟷	Gynaecologist
Lung	⟷	General physician
Gastro intestine	⟷	Gastro physician & surgeon

    - Tie-ups between cancer focused players and nursing colleges/ paramedic institutes to provide training and skill enhancement programs focused on management of cancer patients
    - Training programs for health professionals at district hospitals, medical colleges, CHCs and PHCs for awareness creation, early diagnosis and management of cancer patients

B. Expand care

7. Strong focus on “cost of care”

A. **Cost effective medical technology adoption in radiation therapy:** Considering that technology constitutes nearly 30-40% of radiation therapy cost, key levers of focus would include:

- **Optimization of available technology:** Providers need to explore cost effective variants of available technology instead of opting for high end models across all their centers. Basic linear accelerators (e.g. 6 MV photon energy) that deliver >90% care and are usually available at 50-70% of the cost of high end variants can be used in spokes to rationalize the cost of care delivered
- **Focused “Make In India” campaign through a large PPP program that will drive indigenization of medical technology:** Key enabler for increasing localization could be a large PPP program launched by the Central Government for large scale purchase of Linacs. Learnings can be derived from Ministry of Health Programs in China and Brazil where the governments released tenders for purchase of ~500 and ~80 Linac machines respectively. Cost of procurement was reduced by 30-35% which drove equipment manufacturers towards indigenous manufacturing in those countries. A recent tender by Tata Memorial Hospital has also mandated the manufacturer to commit atleast 20% localization in its latest generation high-end Proton Beam radiation equipment testifying potential for Make in India. Equipment manufacturers need to be encouraged to commence local assembly (Semi-knockdown) and then gradually move towards complete manufacturing of these high-end equipment to radically value-engineer costs.
- **Business model innovation:** Given the capital intensive nature of cancer care, risk sharing models need to be evaluated. Pay for use/subscription models instead of outright purchase will unleash a tremendous fillip to the industry as without capital constraints providers can simultaneously deploy technology at multiple centers at one go thereby bridging the acute demand-supply gap. Manufacturers can explore technology solutions i.e cloud based planning systems, record and verify systems and EMR to obviate installing such systems at each location thereby reducing costs.

B. **Drug pricing policy and generic adoption:** Considering that drugs constitute nearly 50-60% of the treatment cost for chemotherapy, measures to control the prices of drugs and mandating the adoption of generics will become crucial for cost-effective healthcare delivery

C. Reduce the burden

8. Primary and secondary prevention

It is estimated that **2/3rd of total cancer cases** are preventable by addressing risk factors such as tobacco consumption, dietary habits and control of infections such as HPV and hence focus of primary and secondary prevention initiatives need to be strongly directed towards these risk factors

- **Focus on awareness creation and advocacy** since primary prevention is the most cost effective method for the reduction of incidence and cost burden of cancer in India. This should include:
  - Continued impetus on health education initiatives such as anti-tobacco campaigns, bans on smoking in public spaces, and provision of tobacco cessation services to improve compliance
  - Educational efforts to promote physical exercise and diet management
  - Adept policies and taxation to curb environmental and occupational exposure to carcinogens
- **Secondary prevention strategies for early detection of disease are a key component of cancer prevention, where multisectoral partnerships between the government, NGOs and private sector can be leveraged such as:**
  - **Training of health care workers** at PHCs and CHCs and local NGOs to provide education to women regarding breast self examination, safe sex practices and genital hygiene
  - **Mandatory inclusion of vaccines such as HPV in national immunization programs.** Partnership to be forged with international agencies such as the Global Alliance for Vaccines and Immunization for securing funding to support purchase of HPV vaccines considering the high cost (INR 2,000-3,000 per vial). Strong measures to negotiate prices for supply of vaccines and focus on developing indigenous vaccines need to be continued for launching such nation-wide immunization programs
  - **Formal creation of patient groups** to share experiences and encourage community participation is essential for increasing awareness of the need for cancer prevention and screening. To this end online platforms such as cancer blogs and social media groups should be leveraged to create online cancer networks, share patient experience and publish patient testimonials
  - **Engaging health care providers trained in alternative systems of medicine** such as AYUSH doctors in health promotion activities involving behavioural change for risk factor modification, counselling of patients to promote healthy lifestyles, and for opportunistic screening of cancer

Annexures

Annexure 1 - Comparison between incidence data of cancer registries and that of large randomized screening trials

Study details	City of study	Site	Reference year	Study incidence (per 1000 pop)	Registry incidence (per 1000 pop)	Gap between study v. registry incidence (No. of times)
Tata Memorial Hospital Female age group: 35-64 years N = 75,360	Mumbai	Breast	First round	0.85	0.55*	**1.56**
			Second round	0.65	0.55*	**1.20**
			Third round	0.42	0.56ϕ	**0.75**
Tata Memorial Hospital Female age group: 35-64 years N = 75,360	Mumbai	Cervix	First round	0.66	0.33*	**2.01**
			Second round	0.82	0.33*	**2.49**
			Third round	0.46	0.28ϕ	**1.66**
Male and female age group: 35+ years N = 96,517	Trivandrum	Oral	1996-2004	2.12	0.23¶	**9.21**

Note: The trials for a large urban cancer center screening study for Breast and Cervical cancer were conducted in 3 rounds from 1998-2005

* Two-year report of the population based cancer registries 1999-2000

ϕ Population based cancer registry, Mumbai for 2001-2003

¶For oral cancer, incidence for lip, tongue and mouth have been considered from population based cancer registry, Thiruvananthapuram for 2009-2011

Source: NCRP reports, Mittra et al. 2010

Annexure 2 - Framework for adjusting incidence rates based on risk factor exposure (1/2)

Population attributable fraction (PAF) is the proportion of incident cases that can be attributed to one or more risk factor exposures

Risk factor profile¶	India	UK	USA	Population Attributable Fraction (PAF)			Difference	
				UK	India	USA	UK v. India	USA v. India
All tobacco prevalence (%, 2015)	17.4	21.1	25.5	19.4	11.9	23.4	7.5	11.5
Alcohol per capita consumption (Lts, 2015)	4.6	11.6	9	4.0	1.6	3.1	2.4	1.5
BMI >25 kg/m^2 (2014)	22.0	63.0	67.3	5.5	1.9	5.9	3.6	4.0
Physical inactivity prevalence (%, 2010)	13.4	37.3	32.4	1.0	0.4	0.9	0.6	0.5
Cumulative difference in exposure (ΔPAF%)							**14.1**	**17.5**

Parameter	Risk factor exposure correction
Age-adjusted incidence rate	Age-Adjusted incidence rate, India **X** (1+ ΔPAF), where PAF is expressed as a ratio

¶Multiple risk factor exposure is not factored in this calculation, nor are other risk factors for specific cancers such as infectious agents, low fiber diet etc. Source: WHO Global status report on non-communicable diseases 2014; Parkin et al, 2011

Annexure 2 - Comparative analysis of age-adjusted incidence rates following adjustment of risk factor exposures between USA, UK and India (2/2)

1

- Prevalence of major risk factors in India and the UK were compared
- Current levels of risk factor exposure in India are significantly different to those of the UK, and the US*

2

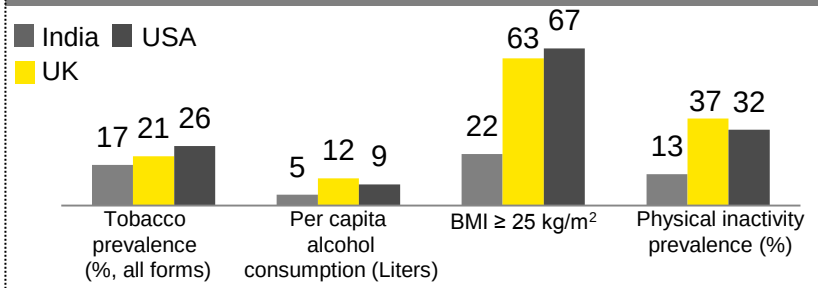
- The percentage of cancer cases due to each major risk factor* at the current level of exposure in India was determined
- The difference in the percentage of cancer cases due to major risk factors in UK and India was ~14% and between USA and India was ~18%

*Population attributable fraction is the proportion of cases that can be attributed to one or more risk factors

3

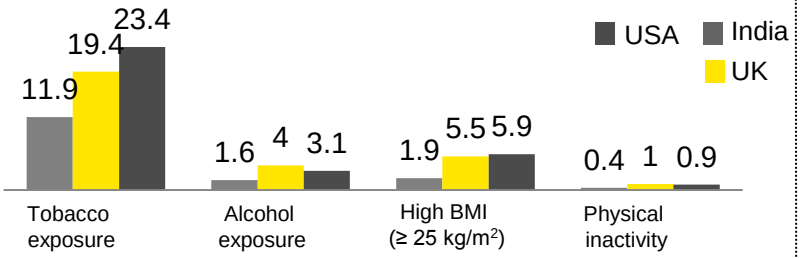
- If India was to have a risk factor exposure that was identical to the UK or the US, its incidence would be ~14% and ~18% higher, respectively
- The age-standardized incidence rate for India was adjusted to reflect this increase due to risk factor exposure

Prevalence of major risk factors



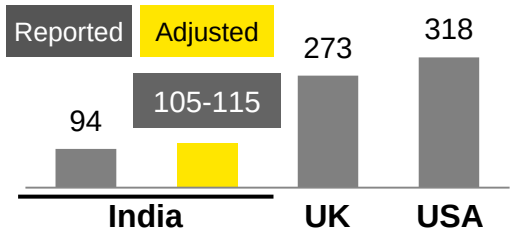
Source: Global NCD report 2014, WHO, EY analysis

Percentage of incidence due to risk factors*



Source: Parkin *et al*, 2011, EY analysis

Age-standardized incidence rate (per 100,000) population



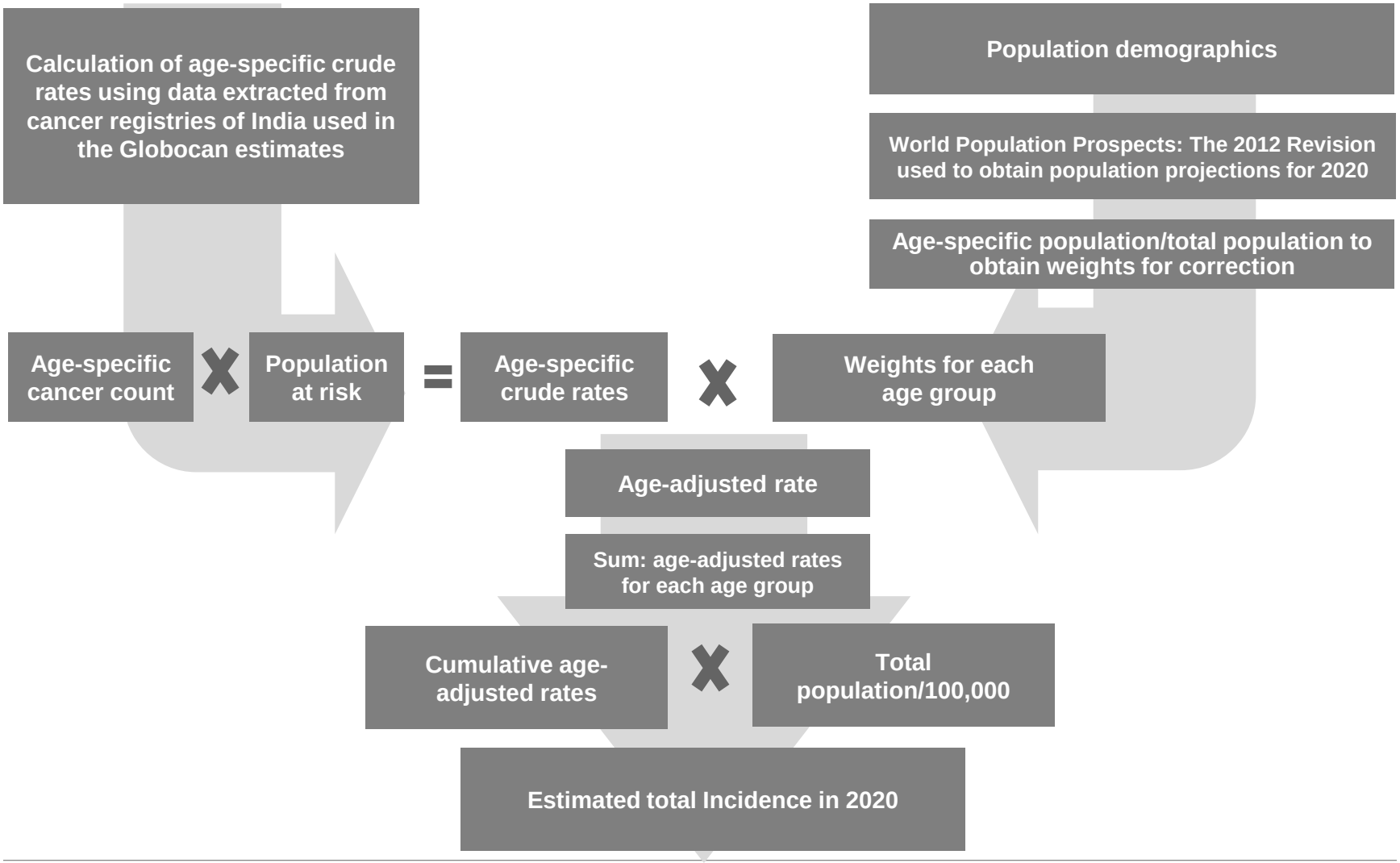
Source: Globocan 2012, EY analysis

Annexure 3 - Linear model for estimation of incidence, and mortality

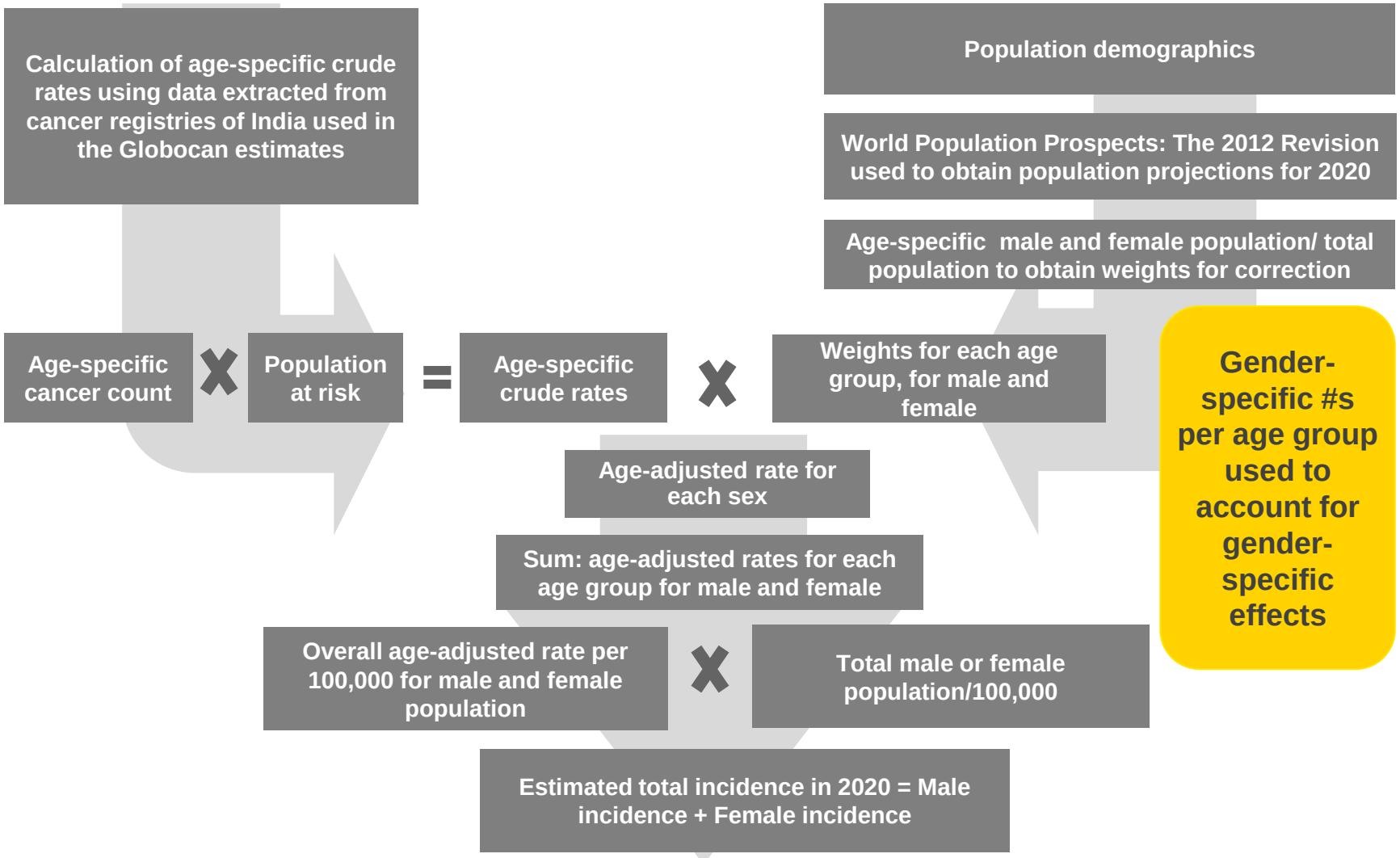
Parameter	Method of estimation
Population at risk	► Assuming static crude rates of cancer incidence, the population at risk was estimated by applying the population CAGR based on the census 2001-2011 decadal growth rate, to the 2012 population at risk ► CAGR for 2001-11 was 1.64% ► Linear growth assumes no demographic effects of age and gender differences in composition of population
Calculation of cancer burden	► Incidence = Cumulative Crude Incidence Rate(stable) X Population at risk

Source: Census 2011 (http://censusindia.gov.in/), Accessed May 2015; UN World Population Prospects: The 2012 Revision, Accessed May 2015

Annexure 4 - Framework for estimation of age-adjusted incidence in 2020 (1/5)



Annexure 4 - Framework for estimation of age and sex-adjusted incidence in 2020 (2/5)



Annexure 4 - Framework for adjusting age and gender-adjusted incidence for risk factor prevalence in 2020 (3/5)

Population attributable fraction (PAF) is the proportion of incident cases that can be attributed to one or more risk factor exposures

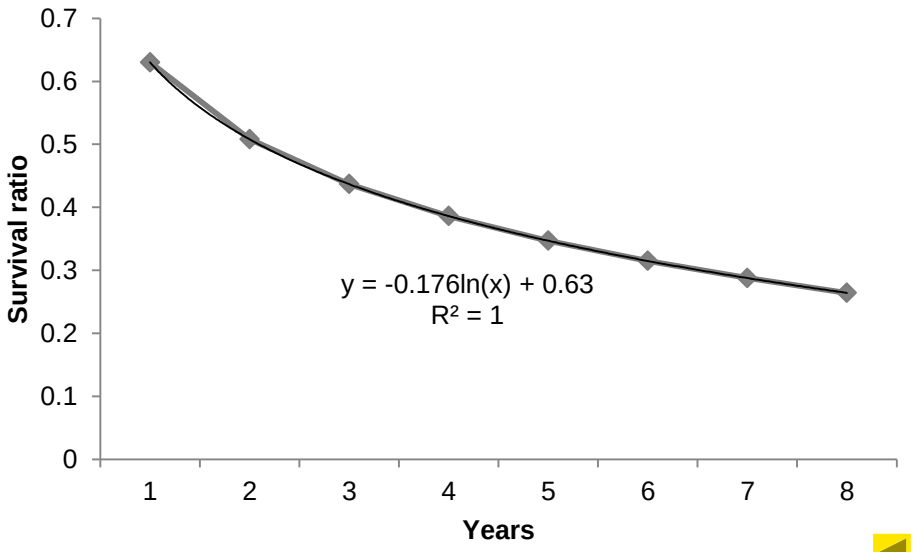
Parameter	Method of estimation
Cumulative difference in exposure, ΔPAF	▸ PAF for the UK population was used to compute comparable PAF for India as described in **Annexure 1** based on prevalence of risk factors in the respective years for each country (except physical exercise data was unavailable) ▸ $\Delta PAF\ (\%) = PAF_{UK}(\%) - PAF_{India}(\%)$ ▸ Pooled ΔPAF, expressed as a ratio, was then used to adjust incidence of India in 2020
Additional cases expected if PAFs mirror the UK levels in 2020	▸ $Estimated\ Incidence_{2020}$ X ΔPAF expressed as a ratio
$Adjusted\ Incidence_{2020}$	▸ $Estimated\ Incidence_{2020}$ + Additional cases expected if PAFs mirror the UK levels in 2020

Source: WHO Global status report on non-communicable diseases 2014; Parkin et al, 2011

Annexure 4 - Framework for estimation of prevalence in 2020- Estimation of survival ratio (4/5)

Parameter	Method of estimation
Survival ratio, 2005-09 Source: Allemani C et al. 2014; Takiar et al. 2013	► Pooled five-year survival of solid tumors was calculated from data ► Pooled survival in CONCORD-2 study, for India, was 0.3469 which is 0.7 more than that in 1999 ► Assuming a similar improvement in the one year survival a non-linear regression curve was fitted to obtain survival rates with the two known points ► Survival in 2020 was assumed to be unchanged

Curve-fit - Non-linear regression	
Survival	**Years**
0.630	1
0.508	2
0.437	3
0.386	4
0.347	5
0.315	6
0.288	7
0.264	8
0.244	9
0.225	10



Annexure 4 - Model for estimation of prevalence in 2020 (5/5)

Growth parameter	Method of estimation
Incidence Source: Globocan 2012, Accessed May 2015; NCRP Time Trend reports 2009-22	▸ CAGR from 2012-2020 was calculated from estimated incidences ▸ Incidence 2020 Estimated (Age-, sex- adjusted) = 1,359,814 ▸ Incidence 2020 Estimated (Globocan) = 1,242,925 ▸ Incidence 2020 Estimated (NCRP, India) = 1,148,692
Prevalence	▸ Estimated incidence and survival ratios were used in the prevalence model to predict prevalence in 2020

Source: Takiar et al. 2013

Incidence ('000s)	1015	1122	1240	1370	1515	1674	1850	2045	2260	CAGR:10.5%	
Survival ratio, 2020	2012	2013	2014	2015	2016	2017	2018	2019	2020	Additional cases from 2012	Total prevalence age-gender-adjusted ('000s)
	2012										1790.5
0.630	2013	639								639	2430
0.508	2014	707	516							1222	3013
0.437	2015	781	570	443						1794	3585
0.386	2016	757	630	398	392					2177	3968
0.347	2017	837	592	448	350	352				2579	4369
0.315	2018	1055	770	599	479	389	320			3610	5401
0.288	2019	1166	850	661	529	430	353	292		4282	6073
0.264	2020	1288	940	731	585	475	390	323	268	5001	6791

Annexure 5 - Model for estimation of required number of Linac installations in India by 2020 (1/4)

Parameters	2015	2020 Scenario 1*	2020 Scenario 2†
Incidence	10,95,000	19,90,200	21,30,000
Estimated % of patients who have access to and can afford treatment	40%	50%	50%
% new cases receiving radiotherapy (based on patient flow analysis of few private and public cancer players and IAEA guidelines which highlight that 50-60% of patients require radiation treatment)	35-40%	40-45%	45-50%
Number of radiotherapy patients (Theoretical)	4,10,625	8,45,835	10,11,750
Number of radiotherapy patients (Addressable) (A)	1,64,250	4,22,918	5,05,875
Number of radiation oncologists	900	2000	2000
Number of patients a radiation oncologist can treat per annum	540	540	540
Total number of patients who can be treated per annum (B)	4,86,000	10,41,120	10,41,120
Average number of patients treated with a Linac per annum	450	450	450
Number of Linacs required (Theoretical)	900	2000	2200
Current number of Linacs in India	350	-	-
Addressable number of patients (Lower of A and B)	1,64,250	4,22,918	5,05,875
Number of Linacs required to treat the addressable patient load	365	940	1124
Realistic Potential : Additional number of Linacs required (Including 150 Linacs need to be replaced by 2020)	**-**	**740**	**924**

*Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in Stage I and II

† Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in Stage I and II

Annexure 5 - Model for estimation of required number of day care beds for chemotherapy in India by 2020 (2/4)

Parameters	2015		2020 Scenario 1*		2020 Scenario 2†	
Incidence	10,95,000	10,95,000	19,90,200	19,90,200	21,30,000	21,30,000
Prevalence	38,90,000	38,90,000	71,05,000	71,05,000	71,05,000	71,05,000
Estimated % patients who have access to and can afford treatment	40%	40%	50%	50%	50%	50%
% new cases requiring/receiving chemotherapy (based on patient flow analysis of few private and public cancer players and discussion with pharma players)	70%	70%	70%	70%	70%	70%
% recurrent cases requiring chemotherapy	20%	20%	20%	20%	20%	20%
Number of chemotherapy patients (A)	6,17,800	6,17,800	14,07,070	14,07,070	14,56,000	14,56,000
Number of medical oncologists	750	750	1,200	1,200	1,200	1,200
Number of chemotherapy patients that can be treated by oncologist pool (B)	360,000	360,000	576,000	576,000	576,000	576,000
Realistic number of chemotherapy patients that can be treated (Lower of A and B)	360,000	360,000	576,000	576,000	576,000	576,000
Number of chemotherapy cycles per patient	4	6	4	6	4	6
Total number of chemotherapy cycles (Theoretical)	61,78,000	92,67,000	1,12,56,560	1,68,84,840	1,16,48,000	1,74,72,000
Total number of chemotherapy cycles (Addressable)	14,40,000	21,60,000	23,04,000	34,56,000	23,04,000	34,56,000
Number of chemotherapy cycles per day care bed/day	3	3	3	3	3	3
Number of day care beds required (Theoretical)	5,640	8,460	10,280	15,420	10,637	15,956
Number of day care beds required (Addressable)	**-**	**-**	**2,104**	**3,156**	**2,104**	**3,156**

*Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in Stage I and II
† Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in Stage I and II

Annexure 5 - Model for estimation of required number of dedicated surgery beds in India by 2020 (3/4)

Parameters	2015	2020 Scenario 1*	2020 Scenario 2†
Incidence	1,095,000	19,90,200	21,30,000
Estimated % patients who have access to and can afford treatment (given baseline treatment cost of surgeries)	60%	80%	80%
% new cases receiving/requiring treatment (based on patient flow analysis of few private and public cancer players)	55%	65%	75%
Number of new patients undergoing surgery (A)	361,350	10,34,904	12,78,000
Number of surgical oncologists	500	1,000	1,000
Number of surgeries that can be performed by pool of surgical oncologists (assuming 1-2 major surgeries per day)	2,10,000	4,20,000	4,20,000
Number of surgeons with multidisciplinary practice	1,200	1,440	1,440
Number of surgeries that can be performed by current pool of multidisciplinary surgeons	2,16,000	2,59,200	2,59,200
Total number of surgeries that can be performed by all category of surgeons (B)	4,26,000	6,79,200	6,79,200
Addressable number of surgical patients (Lower of A and B)	3,61,350	6,79,200	6,79,200
Average length of stay for surgeries	5	5	5
Number of dedicated beds required (Theoretical)	-	17,721	21,884
Number of dedicated beds required (Addressable)	**-**	**9,300**	**9,300**

*Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in Stage I and II
†Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in Stage I and II

Annexure 5 - Model for estimation of required comprehensive cancer care centers (CCCCs) in 2020 (4/4)

Parameters	2015	2020 Scenario 1*	2020 Scenario 2†
Incidence	10,95,000	19,90,200	21,30,000
Addressable number of chemotherapy patients that can be treated	3,60,000	5,76,000	5,76,000
Addressable number of radiotherapy patients that can be treated	1,64,250	4,22,917	5,05,875
Realistic number of surgical patients that can be treated	3,61,350	6,79,200	6,79,200
Number of patients treated by a CCCC per year	2000	2000	2000
Estimated number of CCCCs in India currently	225	225	225
% patients receiving multimodal treatment	35%	40%	40%
Theoretical demand adjusted for % receiving multimodal treatment	9,94,370	29,72,163	33,12,750
Number of centers required - Theoretical	495	1486	1656
Addressable number of patients corrected for % receiving multimodal treatment	5,75,640	10,06,871	10,56,645
Number of CCCCs - Addressable	**-**	**503**	**528**

*Scenario 1 – an improvement in diagnosis rate where 60% of cancers are detected in Stage I and II
† Scenario 2 – an improvement in diagnosis rate where 70% of cancers are detected in Stage I and II

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Abbreviations

ASR-W	Age standardized rate (weighted) per 100,000 population	**ESIC**	Employees' State Insurance Corporation
APC	Alcohol per capita	**FDG**	Fludeoxyglucose
AIIMS	All India Institute of Medical Sciences	**GI**	Gastrointestinal
BMI	Body mass index	**GIT**	Gastrointestinal tract
CGHS	Central government health scheme	**HPV**	Human papilloma virus
CT	Chemotherapy	**IGRT**	Image-guided radiation therapy
CAGR	Compound annual growth rate	**ICMR**	Indian Council of Medical Research
CCCC	comprehensive cancer care centers	**INR**	Indian rupee
CCC	Comprehensive cancer center	**IMRT**	Intensity-modulated radiation therapy
Cr/cr	Crore	**KOL**	Key opinion leader
DNB	Diploma national board	**Linac**	Linear particle accelerator
DFS	Disease-free survival	**MCH**	Master of Surgery (Postgraduate qualification)
DM	Doctor of Medicine (Postgraduate qualification)	**MPA**	Million per annum

Abbreviations

NCI	National cancer institute	**RCC**	Regional cancer centre
NCRP	National Cancer Registry Program	**RTI**	Reproductive tract infection
NSSO	National Sample Survey Office	**STI**	Sexually transmitted infection
NGO	Non-governmental organisation	**SEAR**	South east Asia region
OT	Operation theatre	**SCI**	State cancer institute
OECD	Organisation for Economic Co-operation and Development	**SRS**	Stereotactic radiosurgery
PAP smear	Papanicolaou smear	**SEER**	Surveillance, Epidemiology, and End Results Program
PAF	Population attributable fraction	**TCC**	Tertiary cancer centre
PET CT	Positron emission tomography	**UK**	United Kingdom
QoL	Quality of life	**USA**	United States of America
RT	Radiotherapy	**USD**	US dollar
RAS	Rajiv Arogyasri Scheme	**WHO**	World Health Organisation
RSBY	Rashtriya Swasthya Bima Yojna		

Contact us

Ahmedabad
2nd floor, Shivalik Ishaan
Near C.N. Vidhyalaya
Ambawadi
Ahmedabad - 380 015
Tel: + 91 79 6608 3800
Fax: + 91 79 6608 3900

Bengaluru
12th & 13th floor
"UB City", Canberra Block
No.24 Vittal Mallya Road
Bengaluru - 560 001
Tel: + 91 80 4027 5000
+ 91 80 6727 5000
Fax: + 91 80 2210 6000 (12th floor)
Fax: + 91 80 2224 0695 (13th floor)

1st Floor, Prestige Emerald
No. 4, Madras Bank Road
Lavelle Road Junction
Bengaluru - 560 001
Tel: + 91 80 6727 5000
Fax: + 91 80 2222 4112

Chandigarh
1st Floor, SCO: 166-167
Sector 9-C, Madhya Marg
Chandigarh - 160 009
Tel: + 91 172 671 7800
Fax: + 91 172 671 7888

Chennai
Tidel Park, 6th & 7th Floor
A Block (Module 601,701-702)
No.4, Rajiv Gandhi Salai, Taramani Chennai - 600113
Tel: + 91 44 6654 8100
Fax: + 91 44 2254 0120

Hyderabad
Oval Office, 18, iLabs Centre
Hitech City, Madhapur
Hyderabad - 500081
Tel: + 91 40 6736 2000
Fax: + 91 40 6736 2200

Kochi
9th Floor, ABAD Nucleus
NH-49, Maradu PO
Kochi - 682304
Tel: + 91 484 304 4000
Fax: + 91 484 270 5393

Kolkata
22 Camac Street
3rd floor, Block 'C'
Kolkata - 700 016
Tel: + 91 33 6615 3400
Fax: + 91 33 2281 7750

Mumbai
14th Floor, The Ruby
29 Senapati Bapat Marg
Dadar (W), Mumbai - 400028
Tel: + 91 022 6192 0000
Fax: + 91 022 6192 1000

5th Floor, Block B-2
Nirlon Knowledge Park
Off. Western Express Highway
Goregaon (E)
Mumbai - 400 063
Tel: + 91 22 6192 0000
Fax: + 91 22 6192 3000

NCR
Golf View Corporate Tower B
Near DLF Golf Course
Sector 42
Gurgaon - 122002
Tel: + 91 124 464 4000
Fax: + 91 124 464 4050

6th floor, HT House
18-20 Kasturba Gandhi Marg
New Delhi - 110 001
Tel: + 91 11 4363 3000
Fax: + 91 11 4363 3200

4th & 5th Floor, Plot No 2B, Tower 2, Sector 126,
NOIDA 201 304
Gautam Budh Nagar, U.P. India
Tel: + 91 120 671 7000
Fax: + 91 120 671 7171

Pune
C-401, 4th floor
Panchshil Tech Park
Yerwada
(Near Don Bosco School)
Pune - 411 006
Tel: + 91 20 6603 6000
Fax: + 91 20 6601 5900

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