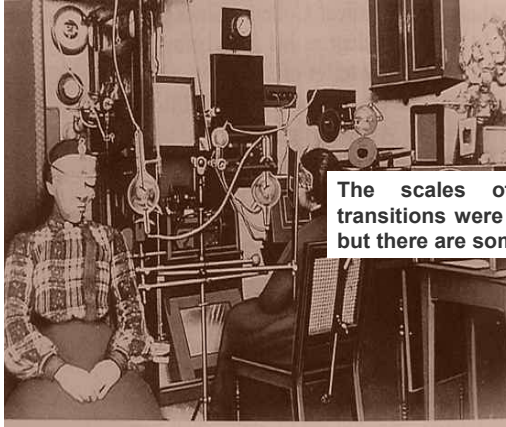


**"Integrating Emerging Technologies in Emerging Economies**

**"The Radiotherapy Scenario".**

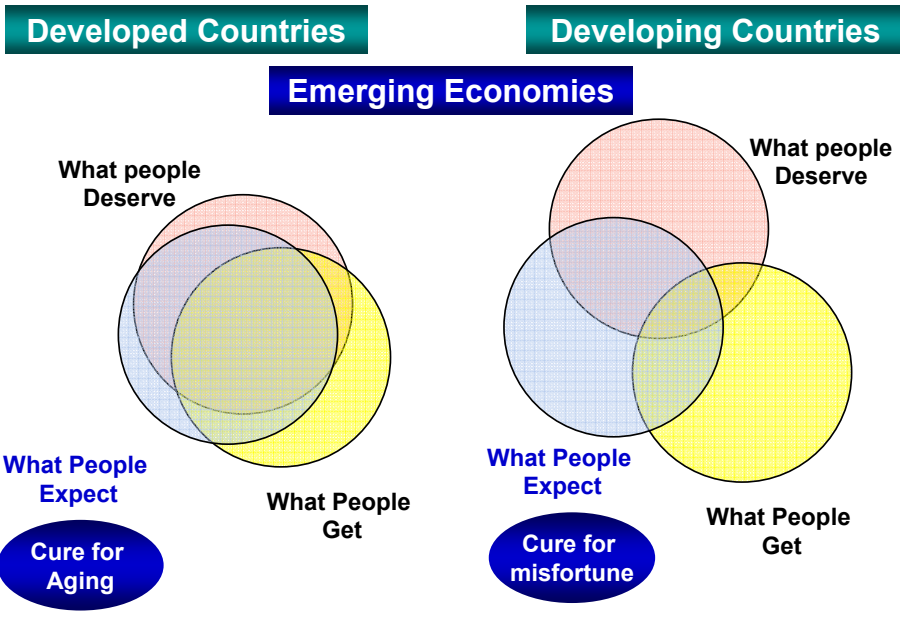


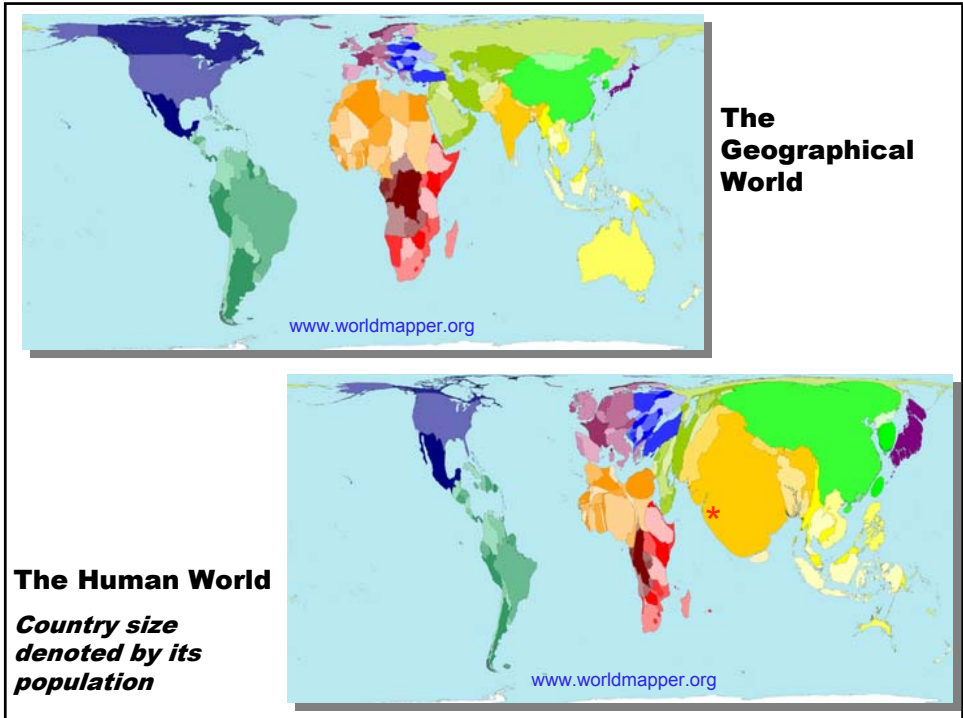
The scales of technological transitions were always different but there are some new issues



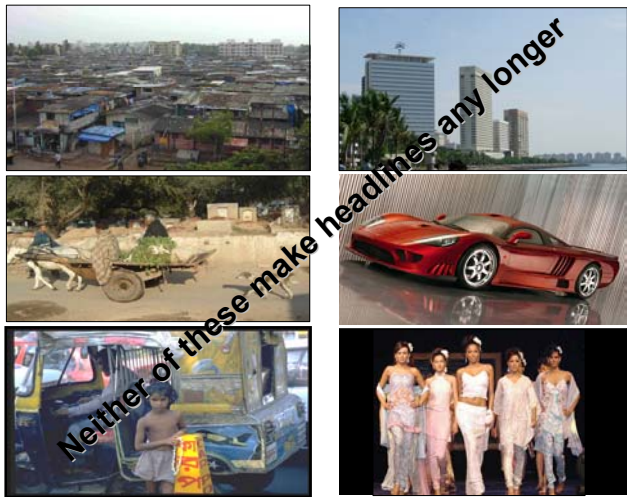
Rajiv Sarin  
ACTREC, Tata Memorial Centre, Mumbai  
INDIA ([rsarin@actrec.gov.in](mailto:rsarin@actrec.gov.in))

**Health Care Needs of a Society**





### Emerging Economies: The Balancing Act



*Transition phase of socio-economic development & Demography  
 Double Trouble of Infectious & Lifestyle Diseases..  
 Challenge of Optimizing limited resources for maximum benefit of the society*

# Chronic ailments to kill 400m by 2015: WHO

Geneva: Heart disease, diabetes and other chronic ailments will kill nearly 400 million people over the next 10 years, but many of those deaths can be prevented by healthier lifestyles and cheaper medication, the World Health Organisation said on Wednesday.

The financial burden from an increasing death toll from such non-communicable diseases will also be enormous, costing countries such as China and India billions of dollars, WHO said in a report.

"The lives of far too many people in the world are being blighted and cut short by chronic diseases," said Lee Jong-wook, WHO director-general. He was citing the latest WHO report to draw attention to the increasing threat from diseases that can be prevented in

## 'India, China May Have To Suffer Huge Financial Losses'

part by healthier diets and giving up smoking.

Until recent years, these chronic conditions were overshadowed by infectious diseases like HIV/AIDS, though they cause far more deaths. Chronic, or non-communicable diseases, account for three out of five deaths worldwide, the WHO says.

The 128-page WHO report estimated that 39 million deaths from chronic diseases in the next 10 years can be prevented through healthier lifestyles and relatively cheap medication, including 28 million in developing countries.

The projections were based on surveys conducted in countries that have already implemented



measures to encourage healthier habits. Exercise and better diets can help prevent 80% of premature cases of heart disease, strokes and diabetes, the report said. Although

other studies have predicted the number of deaths from individual diseases, the WHO report was the first to project the toll from all major chronic conditions.

It was also the first to quantify the economic burden of treating such conditions in individual countries. China could spend \$558 billion treating heart disease, strokes and diabetes over the next decade, the study said. Russia could spend \$303 billion and India \$236 billion.

"This is a preventable epidemic," said Robert Beaglehole, co-author of the study. "We know what to do, we know how to do it, preventions are very cheap."

The study urged developing

countries to adopt prevention policies that have helped cut death rates in industrialised countries.

Deaths related to heart diseases have fallen up to 70% in Canada, Australia, England and the US in the last three decades, the report said. It also cited Poland, which reduced deaths among young adults by 10% in the 1990s, in part by making fruit and vegetables more available and removing subsidies on dairy products like butter.

"There is no question that low-income countries can follow the example of industrialised countries," Beaglehole said.

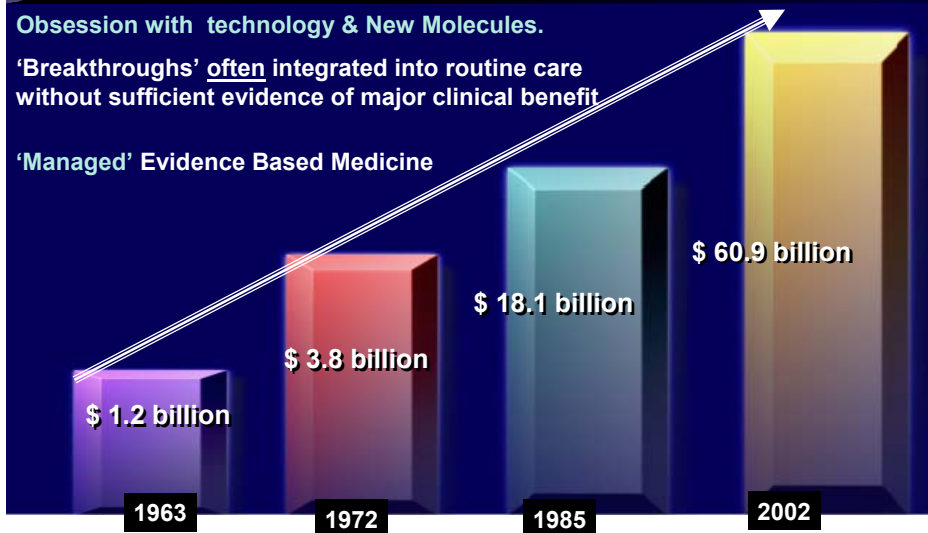
"Most of their success stems from population-wide campaigns. For example, to reduce the intake of saturated fats, sugar and salt and to encourage activity." <sup>AP</sup>

## The rising costs of cancer

Obsession with technology & New Molecules.

'Breakthroughs' often integrated into routine care without sufficient evidence of major clinical benefit

'Managed' Evidence Based Medicine



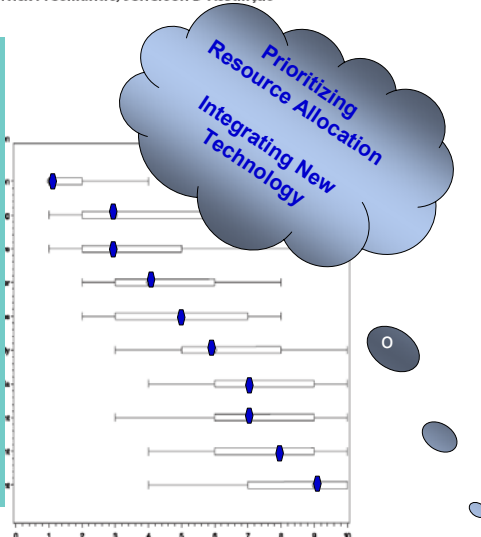
Direct costs of cancer in USA : American Cancer Society 2003

# What Drives Health-Care Spending Priorities? An International Survey of Health-Care Professionals

Glenn Salkeld<sup>1</sup>, David Henry<sup>2</sup>, Suzanne Hill<sup>3</sup>, Danielle Lang<sup>4</sup>, Nick Freemantle<sup>5</sup>, Jefferson D'Assunção<sup>6</sup>

## Box 1. Median Rankings of Health-Care Spending Priorities Across All Countries, in Order of Importance

1. Childhood immunisation
2. Anti-smoking education for children
3. GP care for everyday illness
4. Screening for breast cancer
5. Intensive care for neonates
6. Support for carers of the elderly
7. Treatment for people with schizophrenia
8. Hip replacement
9. Heart transplant
10. Cancer treatment for smokers



## Millions in developing world deprived of radiotherapy

Developing countries do not have sufficient radiotherapy facilities to adequately treat the 10 million annual cases of cancer expected by 2015, warns the International Atomic Energy Agency (IAEA) in Vienna, Austria.

"At least 50–60% of patients with cancer in the developing world could benefit from radiotherapy but most developing countries do not have enough radiotherapy machines or sufficient numbers of specialised doctors and other health professionals", says Mohamed ElBaradei, Director-General of the IAEA. However, the agency adds that these countries will need US\$2.5bn over the next 10 years



Radiotherapy is inadequate in many countries.

are suitably trained often relocate to more affluent countries.

Andreas Ullrich of the WHO Cancer Programme in Geneva, Switzerland, believes that the IAEA report is particularly important because

it highlights that there is an urgent need to react to the increasing cancer threat. He says, "Cancer has to be put on the health agenda of countries in the developing world. Developing countries with low and very low resources have to make choices based on priorities. [They need to decide] which intervention might have the most important impact on cancer control in a specific setting." WHO proposes a comprehensive approach including prevention, early detection, treatment, and palliation will be needed to stem the rising incidence of cancer in the developing world.

**Khabir Ahmad**

Figure 1: 40-year-old cobalt machine in Lae, Papua New Guinea  
 This machine was the only radiotherapy machine in Papua New Guinea and has been out of service for more than 5 years because of its poor condition.



## Health-care Research

### Role of radiotherapy in cancer control in low-income and middle-income countries

Michael B Barton, Michael Frommer, Jesmin Shafiq

Lancet Oncol 2006;7:584-95

Collaboration for Cancer Outcomes Research and Evaluation, Liverpool Health Service, University of New South Wales, Liverpool BC, NSW, Australia

(Prof M B Barton FRACR, J Shafiq MPH), and Sydney Health Projects Group, School of Public Health, University of Sydney, Sydney, NSW, Australia (Prof M Frommer FAFPHM)

Correspondence to: Prof Michael Barton, Collaboration for Cancer Outcomes Research and Evaluation, Liverpool Health Service, University of New South

More than half the cases of cancer in the world arise in people in low-income and middle-income countries. This proportion will rise to 70% by 2020. These are regions where the annual gross national income per person is less than US\$9386. Radiotherapy is an essential part of the treatment of cancer. In high-income countries, 52% of new cases of cancer should receive radiotherapy at least once and up to 25% might receive a second course. Because of the different distribution of tumour types worldwide and of the advanced stage at presentation, patients with cancer in low-income and middle-income regions could have a greater need for radiotherapy than those in high-income countries. Radiotherapy for cure or palliation has been shown to be cost effective. Many countries of low or middle income have limited access to radiotherapy, and 22 African and Asian countries have no service at all. In Africa in 2002, the actual supply of megavoltage radiotherapy machines (cobalt or linear accelerator) was only 155, 18% of the estimated need. In the Asia-Pacific region, nearly 4 million cases of cancer arose in 2002. In 12 countries with available data, 1147 megavoltage machines were available for an estimated demand of nearly 4000 megavoltage machines. Eastern Europe and Latin America showed similar shortages. Strategies for developing services need planning at a national level and substantial investment for staff training and equipment. Safe and effective development of services would benefit from: links with established facilities in other countries, particularly those within the same region; access to information, such as free online journal access; and better education of all medical staff about the roles and benefits of radiotherapy.

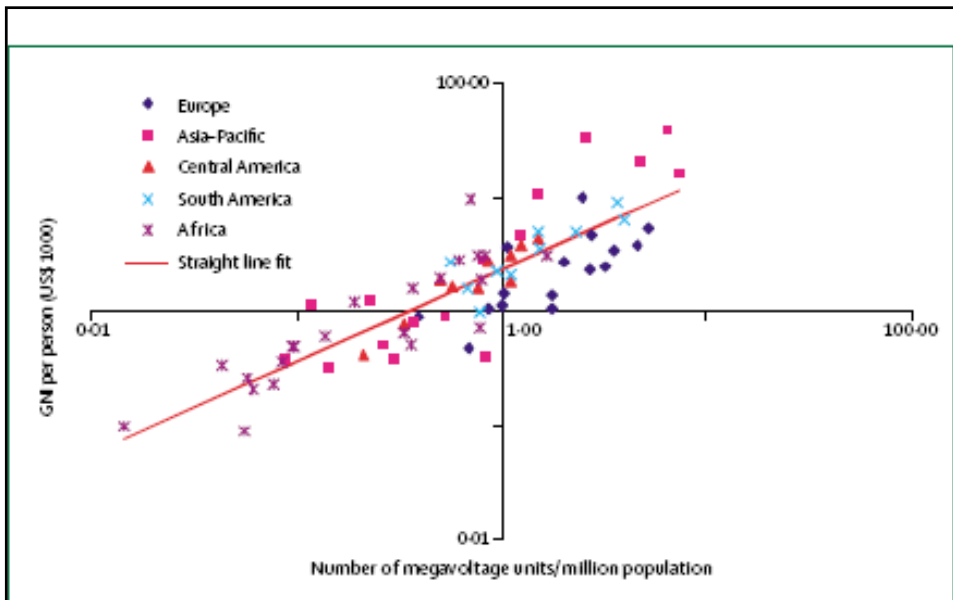


Figure 3: Correlation between gross national income (GNI) per person and number of megavoltage machines per million population, in IAEA member states  
 Data taken from reference 22, with permission.

## Radiotherapy might not be the answer in Africa

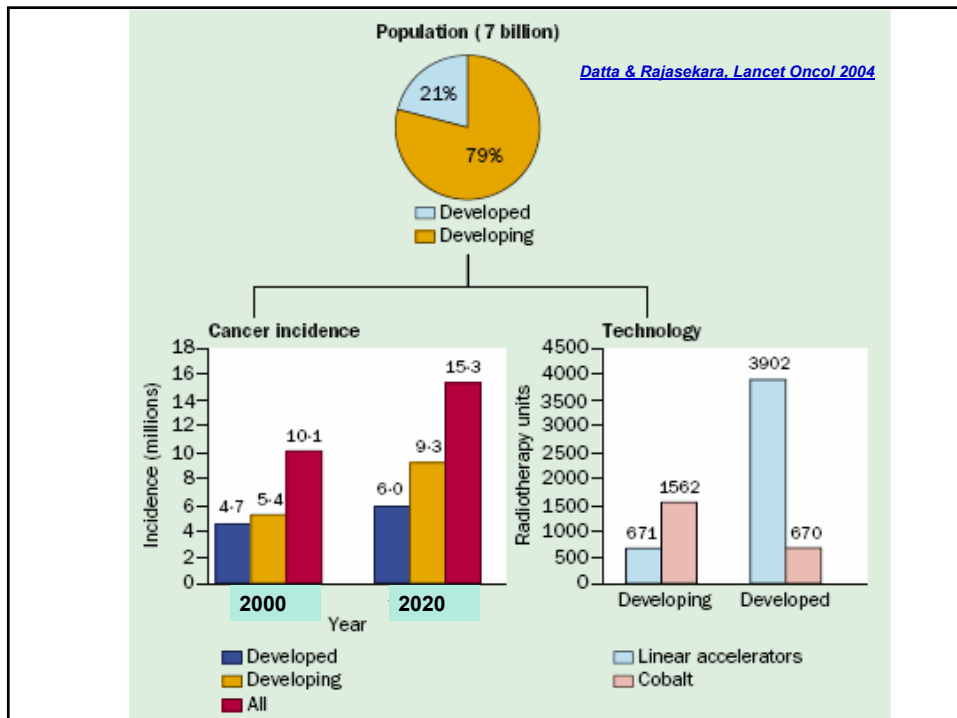
We write in response to the *Health-care Research* article by Barton and colleagues<sup>1</sup> on the role of radiotherapy in developing countries. Although we applaud them for highlighting the gap in radiotherapy provision in many areas of the world, we think that their report contains several assumptions and weaknesses, especially with respect to the management of cancer in sub-Saharan Africa.

First, we have some reservations about their data: table 2 does not mention Kaposi's sarcoma, of which more than 120 000 cases per year are expected in Africa,<sup>2</sup> and which is known to respond to radiotherapy.<sup>3</sup> Its omission is therefore puzzling.

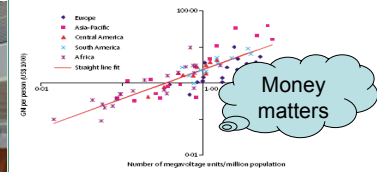
Second, their argument for radiotherapy as being cost effective is debatable; their stated figure of AUS\$100 (around US\$75) per quality-adjusted month of life for palliative radiotherapy is clearly substantial in a continent where the average yearly income per head is US\$315, and their assertion that "the cost of providing



Radiotherapy in Africa should focus on basic cancer care

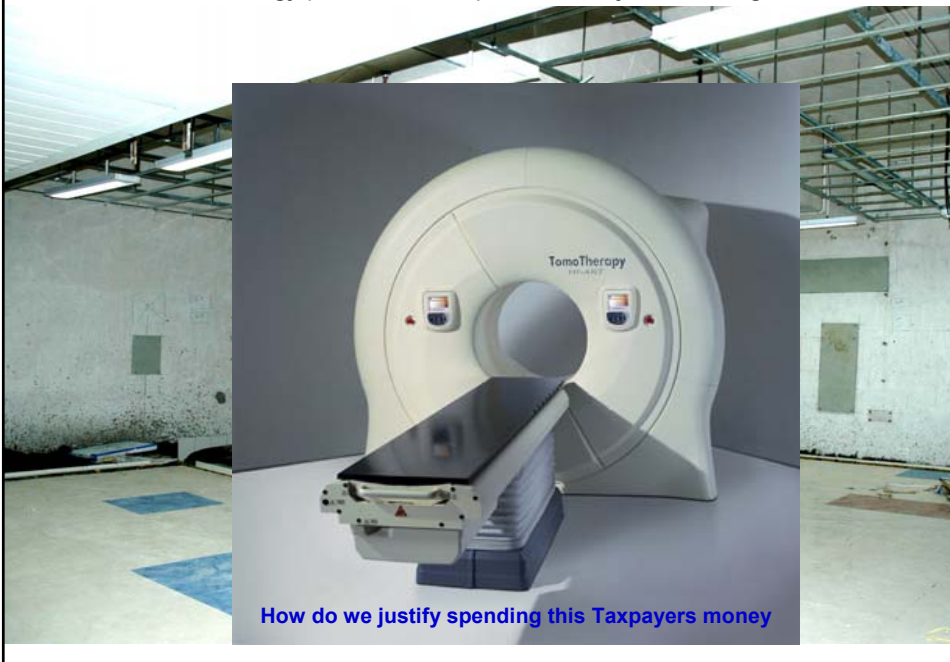


**BHABHATRON: The Indigenous Indian Telecobalt << cost effective >>**



**Developed in a Govt. R & D Centre (Bhabha AtomB Research Centre)  
**Manufactured & marketed by Pvt. Enterprise (Panacea Tech. Ltd. Bangalore)  
Dosimetric / clinical evaluation at ACTREC, Tata Memorial– Further Refinements  
Penetrating Indian Market, Integrated in National Cancer Control Programme****

**State-of-the-art technology (TOMOTHERAPY) in a room adjacent to Indigenous Telecobalt**



**How do we justify spending this Taxpayers money**

## OVERPRICED TECHNOLOGY IN RADIATION ONCOLOGY

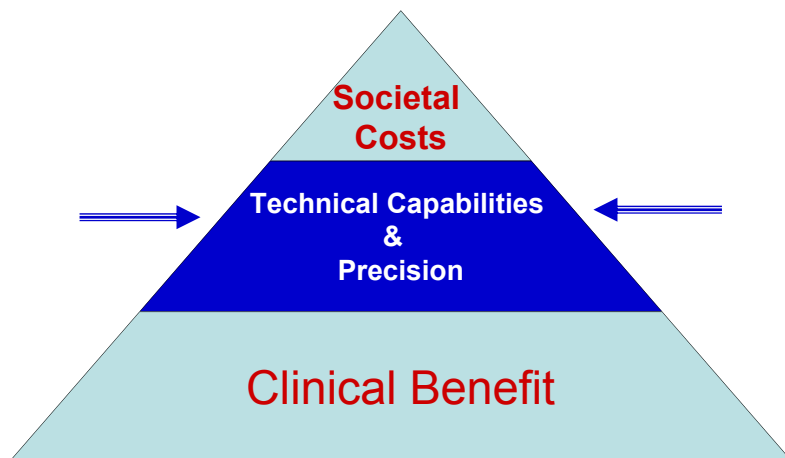
EDWARD C. HALPERIN, M.D.

tions. Multimillion dollar radiosurgery devices were developed for the treatment of arteriovenous malformations, acoustic neuromas, functional disorders, and a selected number of localized tumors. We now find some physicians using this technology to treat multiple brain metastases to ensure that investments will return a profit in 2 years. Proton therapy facilities, priced at US \$20–70 million, are being extensively used to treat prostate cancer—a highly tenuous indication (3–5). Seated in front of computer consoles, physicians are doing elaborate conformal non coplanar three-dimensional treatment plans for off-protocol treatment of patients with glioblastoma multiforme and unresectable pancreatic adenocarcinoma—pocketing hefty fees for multicolored computer printouts of therapy equivalent in efficacy to comparatively low-priced parallel-opposed photon beams.

Radiation oncology, as a specialty, is guilty of encouraging profligate spending, we will engender a backlash, and we'll deserve it.

*Halperin, IJROBP, 2006*

## Evidence Based Assessment & Integration of Technology in Radiation Oncology



Research (*Clinical and Health Economic Evaluation*) in Emerging Technology becomes a necessity in Emerging economies to provide a solid foundation

## Emerging Technology Promises

- Lower toxicity
- Improved Patient and Personnel Safety
- Better documentation and validation
- Improved cure rates

May be Higher Throughput & Cost effectiveness

## Emerging Technology Generally Entails

- Higher initial and maintenance Cost
- Uncertainty of clinical benefits
- Uncertainty of sturdy performance
- Human resource implications
- Skepticism of the critics & health economists

May prove to be expensive experimental tool in emerging economies

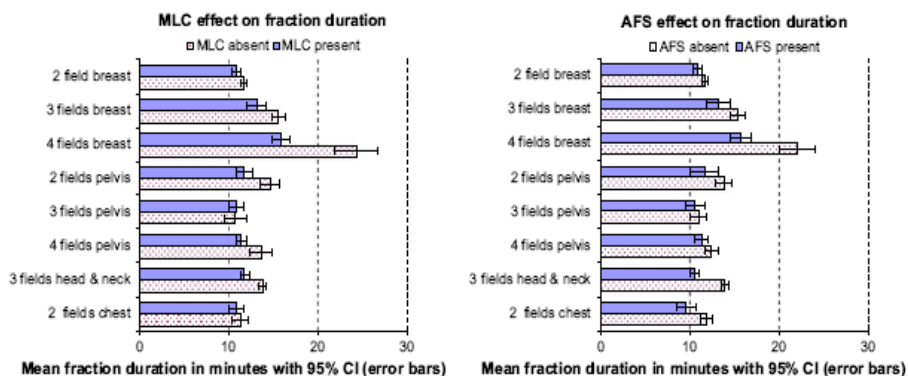
# How can we tame the beast of New Technology?

## WHEREVER POSSIBLE

- Demonstrate clinically meaningful benefits of Technology (if any) in the shortest possible time before it is pushed through and becomes the 'standard of care'
- Use technology solutions to Increase throughput
  - Robust performance with less downtime
  - Exploit better conformal delivery for accelerated schedules
- Use it for Reducing wastage of resources
  - Better case selection - newer biological/radiological tools (e.g. PET)
- Decrease the Cost of new or existing technology
  - Indigenous equipment
  - Resource sharing (Tele – Radiotherapy planning)

## Integrating Technology to Increase Throughput

Effect of MLC and automatic field sequencing on mean fraction duration



Comparison of 1996 and 2003 productivity data (Delaney, Clinical Oncology, 2005).

31% increase in number of fields treated per hour

11% increase in number of patients treated per hour

Mean fraction duration decreased by 13% for routine treatments & 27% for complex fields

## Integrating Technology to Reduce Costs

*Initial Capital Investments in technology are high.*

*LINAC (Varian with and without MLC difference of 376,923 Australian Dollars)*

*Reduced Costs over a prolonged period due to increased Throughput*

Linear accelerator	March	April	May	Total fields (3 months)		Cost per Treatment field with MLC (A\$)	Cost per Treatment field without MLC (A\$)
LA1 (no MLC)	1,724	1,367	1,451	4,542	Labor (radiation therapists and physicists)	\$ 33.29	\$ 36.46
LA2 (no MLC)	1,947	1,215	1,402	4,564	Total labor	\$ 63.52	\$ 69.53
LA4 (MLC)	1,791	1,689	1,717	5,197	Service costs	\$ 7.25	\$ 6.29
LA5 (MLC)	2,025	1,437	1,679	5,141	Total recurrent costs*	\$ 75.43	\$ 80.93
					Total capital cost	\$ 26.26	\$ 26.05
					Total costs	\$101.69	\$106.98

Annual Savings of A\$ 680,000 due to increase in throughput...

much more than the incremental cost of technology Foroudi, IJROBP, 2000

## Cost Comparison Conventional vs. Conformal Irradiation

**Saving on the Cost of managing fewer recurrences offsets the initial higher cost (e.g. Prostate Cancer)**

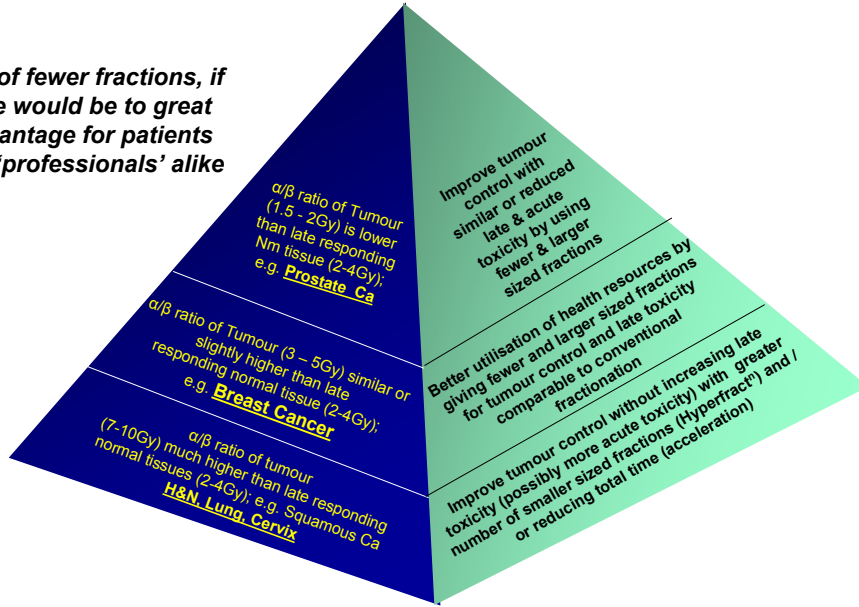
Follow up Year	Conventional (US \$)	Conformal (US \$)
1	9800	17259
2	14917	17720
3	17693	21553
4	13577	18845
5	20000	23732
6	25000	24250

Horwitz et al, 1999

# Evidence Based Clinico-Radiobiological Fractionation Pyramid

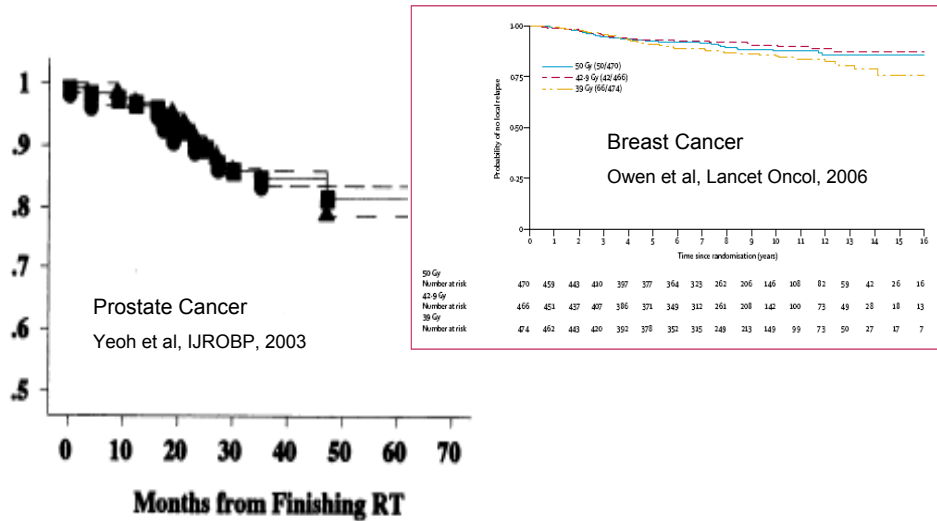
Sarin R, Lancet Oncol. June 2006 (7); 445-47

Use of fewer fractions, if safe would be to great advantage for patients and 'professionals' alike

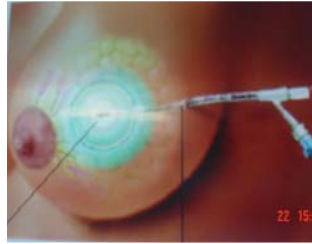


# Integrating Technology to Increase Throughput

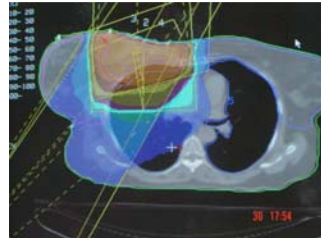
Hypofractionated or Abbreviated RT = Conventional Fractionation



## Technology Permits a new Treatment Approach:- APBI



TMH



TMH

# Partial-breast treatment for early breast emergence of a new paradigm

Rajiv Sarin

## SUMMARY

Although hailed as a paradigm shift, the breast conservative treatment that emerged in the 1980s was in fact an extension of the Halstedian concept, wherein whole-breast irradiation (WBI) compensated for the limited surgery. Observations that 80–90% of breast recurrences after breast conservative surgery and WBI occur in the tumor bed questions the need for protracted elective WBI, and provides the rationale for accelerated-partial-breast irradiation (APBI) of small cancers without adverse features predisposing to multicentric recurrence. APBI can be given over a week with various external beam, intraoperative or brachytherapy (interstitial or MammoSite®) techniques. Since the approval of MammoSite® by the US FDA in May 2002, a surge of interest has been evident, with 4,000 cases treated using this technique in the past 2 years. Several phase II APBI brachytherapy studies show that 4 to 7-year breast control rates

## INTRODUCTION

The radical surgical championed by Wi 100 years ago was more than 80 years, tions. This operation of women with adv cially in the pre-me Breast-conserving su protracted course o (WBI) became popu the changing times, dissatisfaction over small cancers, and r

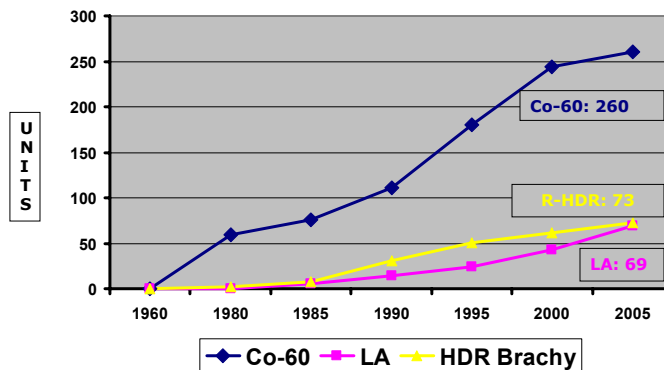
## Indian National Cancer Control Programme: Setting sight on shifting targets

Along with other chronic non communicable diseases, cancer is gaining increasing importance as a public health issue and affects approximately 0.8 million new cases every year in India.<sup>1,2</sup> WHO in the year 2000 conducted a global burden of disease study evaluating the Disease Adjusted Life Years (DALY) lost from various chronic non communicable diseases. DALY was used as a combined measure of the years of life lost due to premature mortality in the population and the years of life lost due to disability. The findings of this study<sup>3</sup> showed that in India the 8.7 million Disease Adjusted Life Years lost from cancer was second only to ischaemic heart disease (14 million) and more than stroke (6 million) and diabetes (2 million). Anticipating the emergence of can-

Cancer Registry Programme (NCRP),<sup>4</sup> initiated by ICMR in 1982. Despite some deficiencies in coverage and accuracy, the NCRP data gives us reasonable estimate of the cancer burden in selected urban and rural areas of the country. Very few countries outside the western world have such information on the cross section of their population. Thanks to the NCRP, today we can make emphatic statements such as stomach cancer is more common in Chennai; cancer incidence is much lower in rural Barshi; and that breast cancer has overtaken cervical cancer in most metropolitan cities. We now have trends in cancer incidence over time and also some indicators, though somewhat incomplete, on cancer mortality in selected registries. The NCRP data from selected

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### Growth of RT infrastructure in India over the years



1962-1986 -- 76 Telecobalt units (> 20 years old)  
1987-1991 -- 35 Telecobalt units (> 15 years old)  
Pre 1991 LA -- 12 units (>15 years old)

## **11<sup>th</sup> Five yr Plan for Indian National Cancer Control Programme (NCCP)**

### **➤ Adopt & Implement 3-tier network**

Ensure existence of 1 primary referral RT centre in 4 adjacent districts

Ensure existence of 1 secondary referral RT centre in every 2<sup>nd</sup> Govt. Med College

Ensure existence of 1 tertiary referral RT centre in each state

### **➤ Support & sustain indigenous technology**

Support installation of indigenous Telecobalt & low energy LA

Accelerate the process of indigenization of other RT equipment (Simulator, HDR, Dual Energy LA)

### **➤ Train, recruit & retain human resource**

Increase seats for training (Radiation Oncologists, Med Physicists, RTT)

Improve work conditions and remuneration

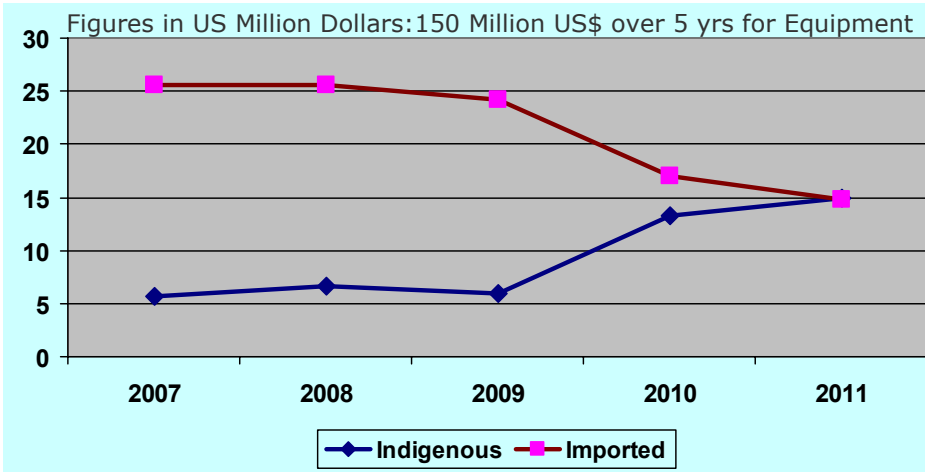
**Prevent and downstage cancer  
Reduce morbidity and mortality from cancer and its therapy**

## **Indigenous Linear Accelerators & other equipment**

Department of Atomic Energy, Information Technology, CSIO, SAMEER, MOH

- Indigenous TPS is US FDA approved and is being used in many Indian centres
- Indigenous low energy LINAC was developed in 1990s and used in 2 centres with variable success and little enthusiasm
- Programme renewed & the 1<sup>st</sup> upgraded Low Energy LINAC installed at Wardha in 2006. Early performance satisfactory
- Many more indigenous LINACS proposed in the next 5 yr
- Programme for development of Indigenous Simulator and HDR machines

Proposed year wise increase in supporting indigenous teletherapy equipment which is more cost effective and would permit increasing annual installations from the NCCP funds



Add 160 Telecobalt; 70 Linacs, 60 Simulators, 50 TPS, 24 HDR from the NCCP.  
Additional machines from other government funds and private / charity funds

Essay

## Improvement of radiotherapy facilities in developing countries: a three-tier system with a teleradiotherapy network

Niloy Ranjan Datta and David Rajasekar

Incidence of cancer has been projected to rise in developing countries. To face this unprecedented challenge, strategies for radiotherapy—a main component of cancer care—must be developed. This requires a major capital investment that can pose difficulties for developing countries. To meet the projected requirements and to find the global explosion of telecommunication technology, a teleradiotherapy service, which consists of primary, secondary, and tertiary radiotherapy centres coordinated through a teleradiotherapy network, will provide patients access to the state-of-the-art technology.

Lancet Oncol 2004; 5: 695-98

### Proposed three-tier system for radiotherapy centres using a teleradiotherapy network

#### Primary radiotherapy centres

External-beam therapy unit

#### Secondary radiotherapy centres

External-beam radiotherapy

Brachytherapy

Supplemented by simulator and treatment-planning system

#### Tertiary radiotherapy centres

Virtual simulation

Three-dimensional treatment planning

Conformal radiotherapy

Stereotactic radiotherapy

Stereotactic radiosurgery

Intensity-modulated radiotherapy

# Telemedicine

Sanjit Bagchi

In a developing country such as India, there is huge inequality in health-care distribution. Although nearly 75% of Indians live in rural villages, more than 75% of Indian doctors are based in cities [1]. Most of the 620 million rural Indians do not have access to basic health care facilities [2]. The Indian government spends just 0.9% of the country's annual domestic product on health, and only 1% of this spending reaches remote rural areas [3]. The poor infrastructure of rural health centers makes it difficult to retain doctors in villages, who feel that they become professionally isolated and outdated if stationed in remote areas.

In addition, poor Indian villagers spend most of their out-of-pocket health expenses on travel to the specialty hospitals in the city and

## Telemedicine Complements Effective Health-Care Delivery but Is Not a Panacea

Rajiv Sarin

Like most health researchers in India, I share Sanjit Bagchi's enthusiasm and optimism about the potential of telemedicine in improving health-care delivery in our diverse country [1]. However, it is important to maintain a balanced perspective and debunk overstatements such as those used by Bagchi in his conclusion "This potential was well summed up by Dr. Devi Shetty: 'In terms of disease management, there is [a] 99% possibility that the person who is unwell does not require [an] operation. If you don't operate you don't need to touch the patient. And if you don't need to touch the patient, you don't need to be there. You can be anywhere, since the decision on healthcare management is based on history and interpretation of images and chemistry ... so technically speaking, 99% of health-care problems can be managed by the doctors staying at a remote place—linked by telemedicine.'"

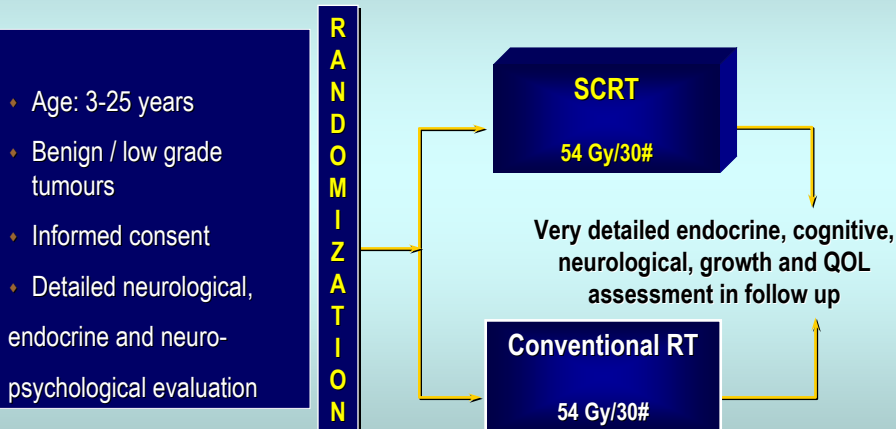
Maybe Devi Shetty, well known in telemedicine circles, has been quoted out of context, but it is not evident as such. In the wider context of the story, such conclusions as "If you don't operate you don't need to touch the patient"; "And if you don't need to touch the patient, you don't need to be there"; and "so technically speaking, 99% of health-care problems can be managed by the doctors staying at a remote place" are misleading. In the near future, online physicians or health professionals cannot replace the onsite ones for even 30% of all health problems, let alone 99% as pointed out by Shetty. Even for providing essential and readily accessible health services, we need to augment the number of onsite



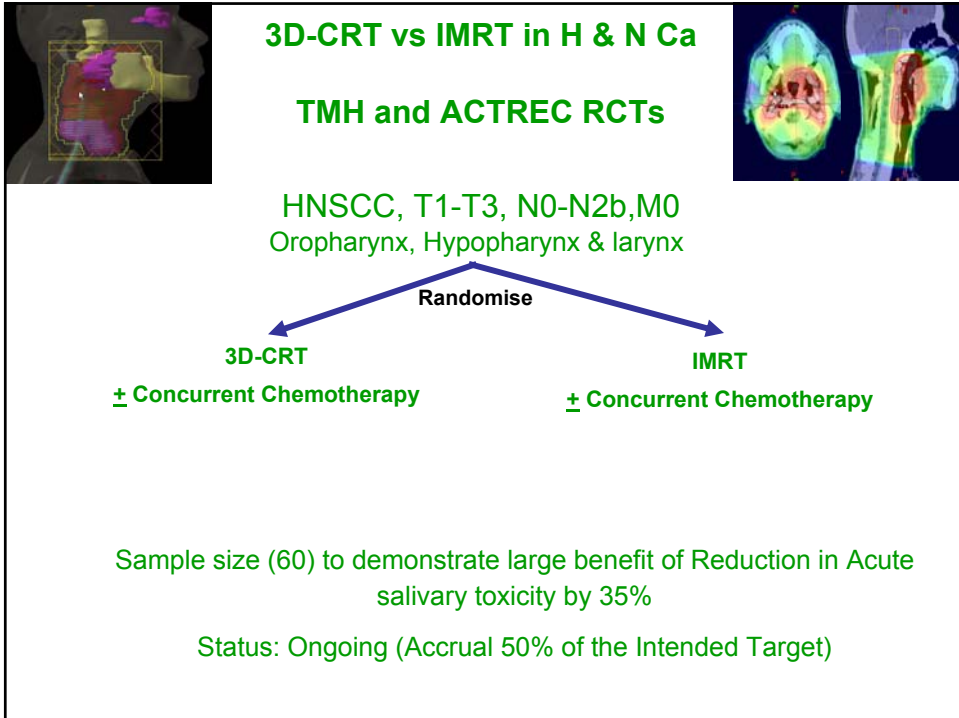
11  
on at the Apollo Gleneagles  
eneagles Hospital)

## TMH RCT of SCRT vs Conventional RT in Children / young adults with Benign / Low Grade Brain Tumours

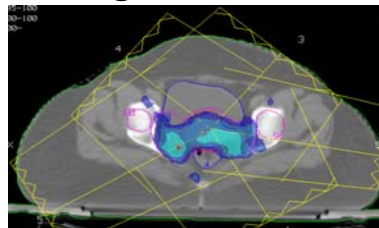
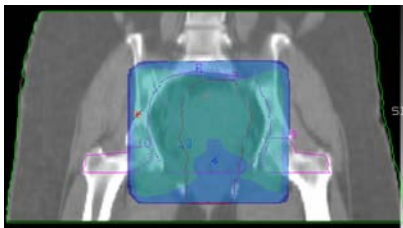
Planned accrual = 200 (96 accrued till date)



**Hypothesis: SCRT can reduce late sequelae of RT as compared to conventional RT**



**TMH RCT of Conventional RT vs IMRT for Cervical Cancer Stage IIB**



Intended Accrual: 100 in each arm  
 Reduction in Acute and Late RT toxicity's by: 15-25%  
 Power of detection: 80% (alpha error: 0.05)  
 Accrual Till Date: 25% of the intended target.

**ONGOING**

## How do we integrate new technology in routine clinical practice

- *Overwhelming superiority in the clinical outcome with new technology OR*
- *Modest but definite clinical benefit*
- *Results are generally reproducible*
- *Possible (or make it possible) to integrate new technology in the health care system*

*A developing nation and an emerging economy*



*Creating a fair society where everyone shares the fruits (& pains) of economic development*