uicc global cancer control

GTFRCC | UICC PRESIDENT'S PORTFOLIO GLOBAL TASK FORCE ON RADIOTHERAPY FOR CANCER CONTROL

Global Radiotherapy Investment: Cost, Benefit, and Action

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EVP, Technology and Innovation
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University of Toronto
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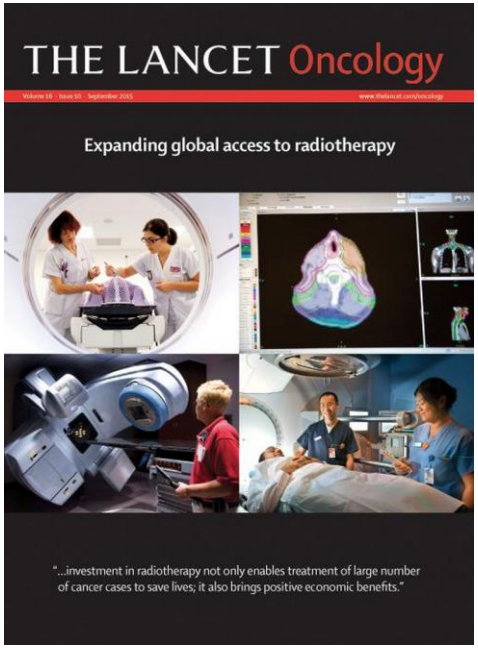

Atun et al., Lancet Oncology 2015

UNIVERSITY OF TORONTO FACULTY OF MEDICINE

TECHNA

UHN Toronto General Toronto Western Princess Margaret Toronto Rehab

NCPF Workshop 2016

Acknowledgements

- Members of the Global Task Force for Cancer Control
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ESTRO European Society for RADIOTHERAPY & ONCOLOGY

GTFRCC | UICC PRESIDENT'S PORTFOLIO GLOBAL TASK FORCE ON RADIOTHERAPY FOR CANCER CONTROL

UHN Princess Margaret Cancer Centre

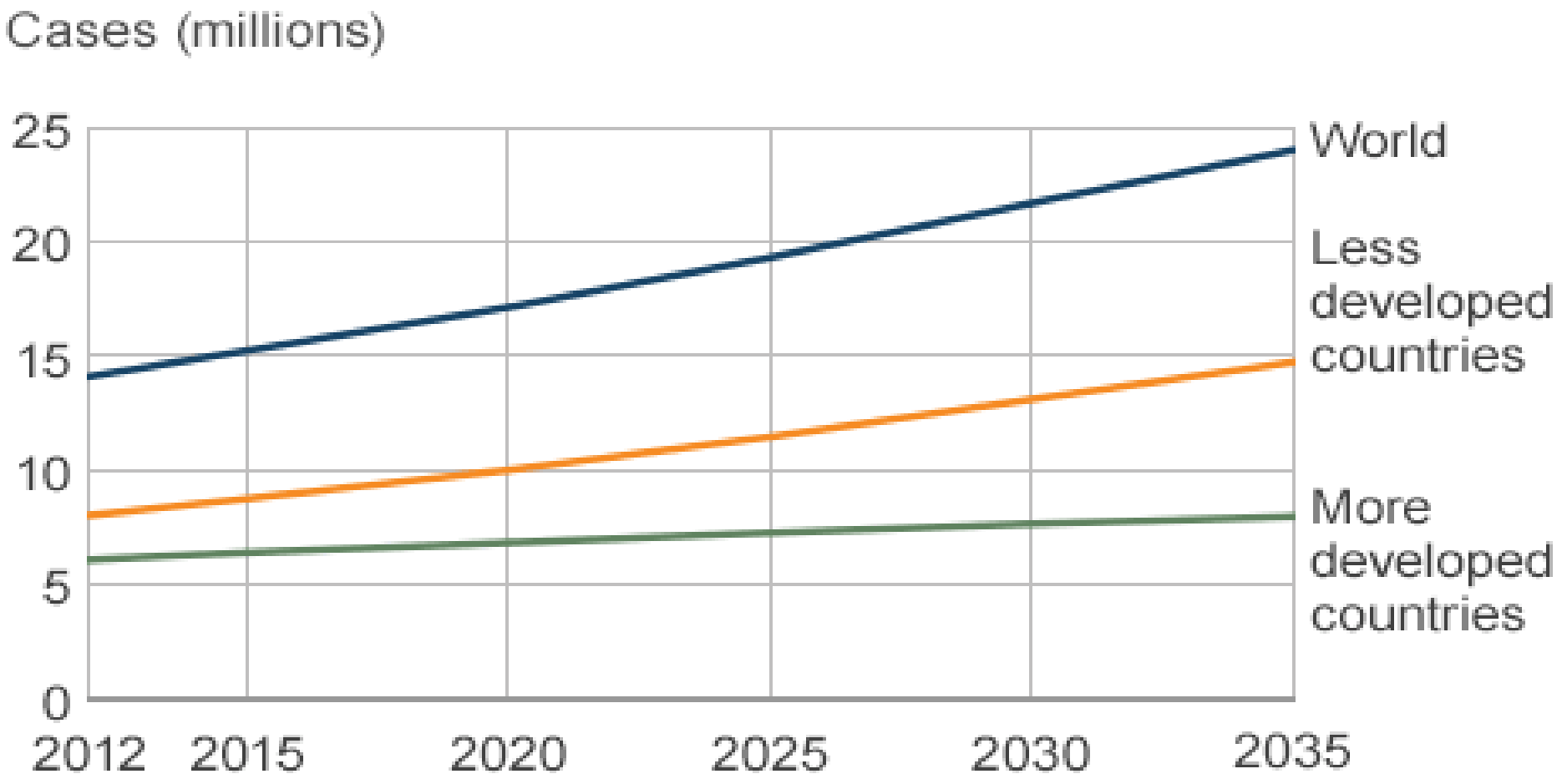
THE LANCET Oncology

CCORE Collaboration for Cancer Outcomes Research and Evaluation

IAEA International Atomic Energy Agency

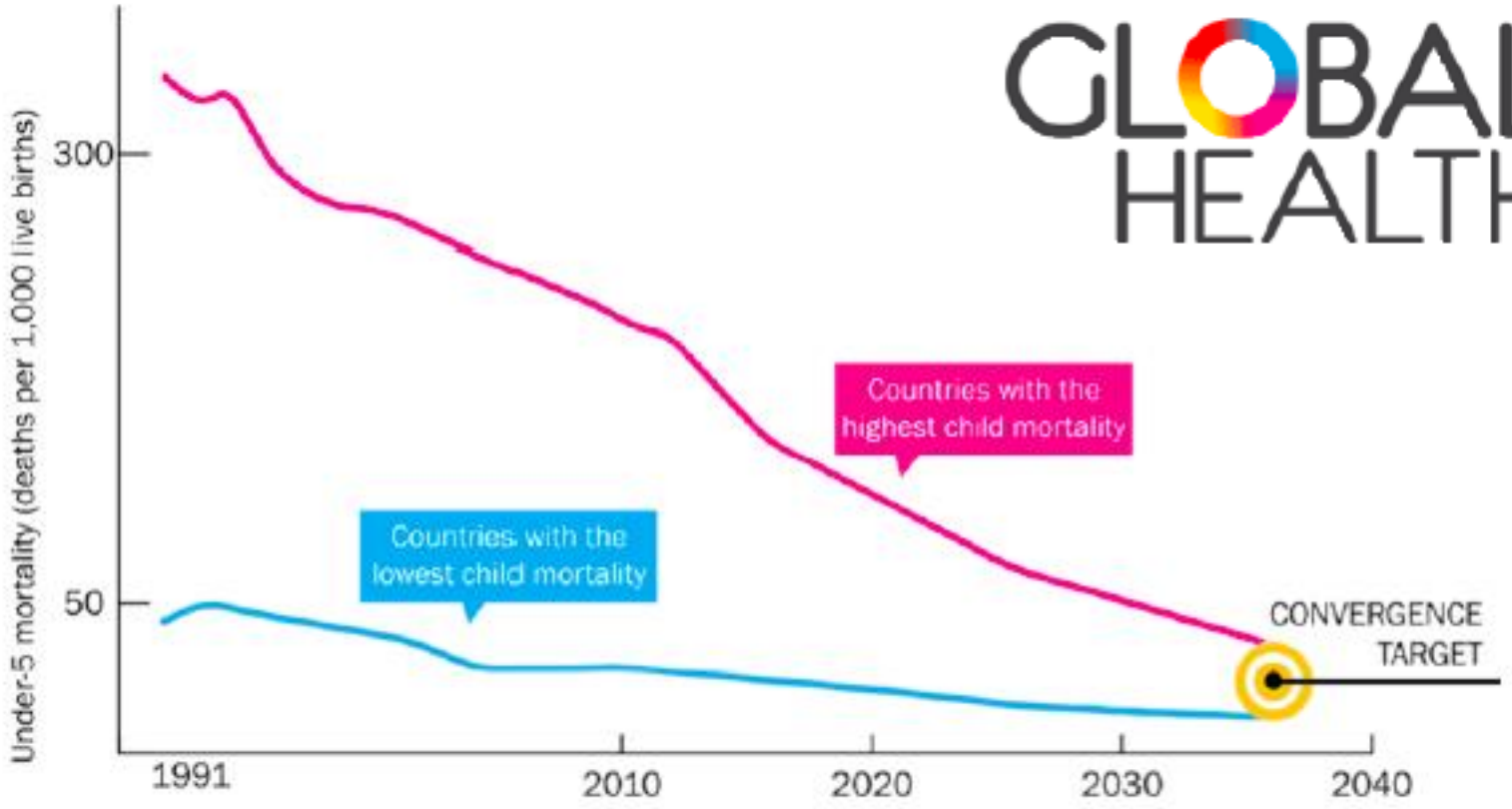
HARVARD T.H. CHAN

Predicted Global Cancer Cases



Source: WHO GloboCan

Grand Convergence in Health

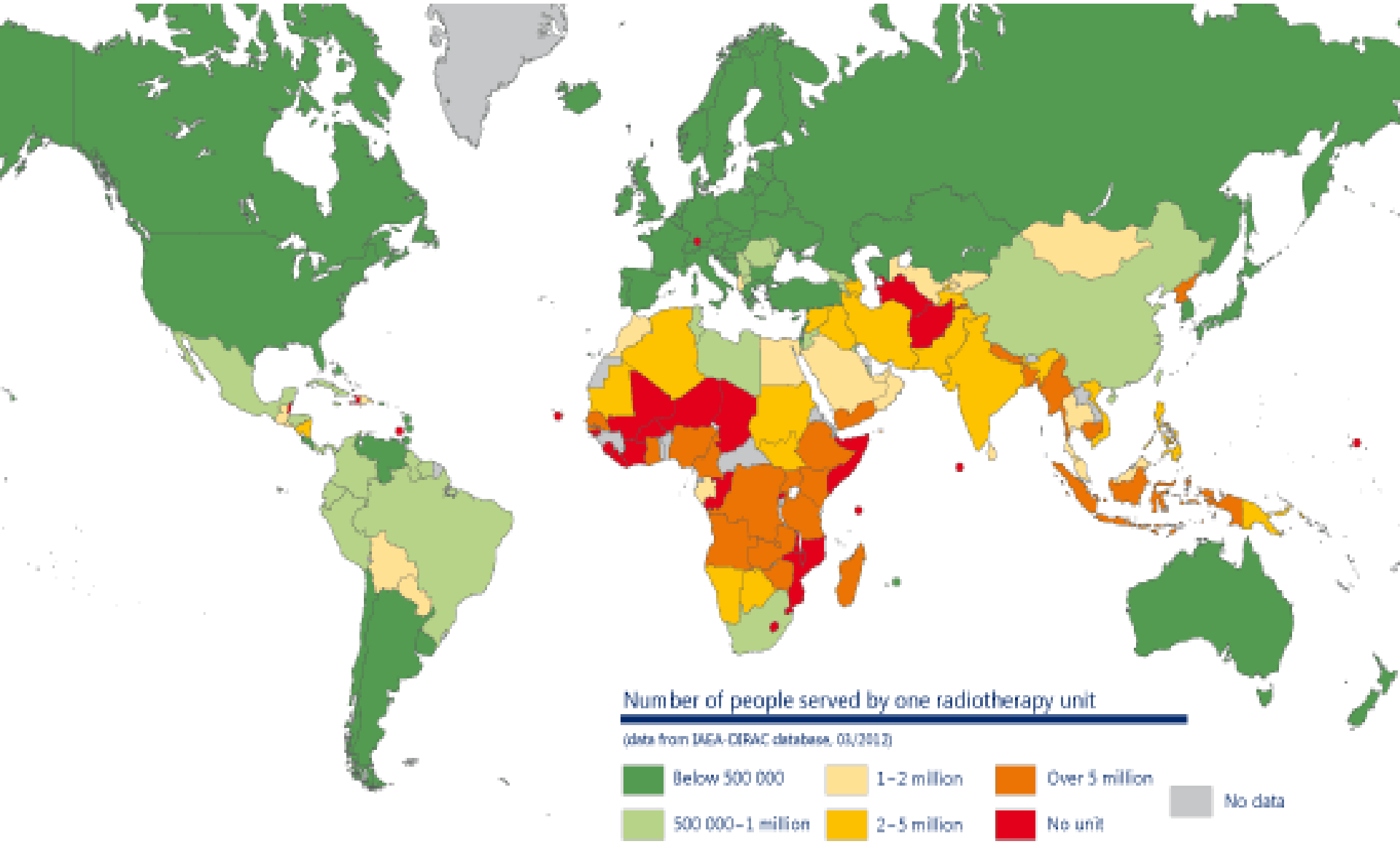


THE LANCET

Global health 2035: a world converging within a generation

The Lancet Commission on Investing in Health

Jamison et al., Lancet 2013



http://cancer.iaea.org/agart.asp

Radiotherapy: A missing but essential component of effective cancer control.

Charge from the UICC Board

"What is the investment needed to close the gap between what exists today and reasonable access to radiotherapy globally?“

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GLOBAL TASK FORCE ON RADIOTHERAPY FOR CANCER CONTROL

HARVARD SCHOOL OF PUBLIC HEALTH

Union for International Cancer Control
www.uicc.org

GTFRCC - Secretariat

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Honorary Chair:

Radiation oncologist and President of the Oriental Republic of Uruguay.

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Princess Margaret
Head of Secretariat

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Chief Executive Officer,
UICC

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Deputy Chief Executive Officer
UICC

Jake Van Dyk
Western University

Task Force Functionality

WG#1&3

Burden and Demand

- Global Burden of Cancer
- # of patients needing RT
- # of RT treatments (fractions) required

Outputs

Outcomes

- Survival benefit of radiotherapy

Survival (5yr)

Demand (#fx/yr)

WG#2

Cost to Build Capacity and Treat ($/fx)

Health Systems Readiness

Education

CORE INVESTMENTS

- Facilities
- Equipment
- Personnel

ENABLING SERVICES

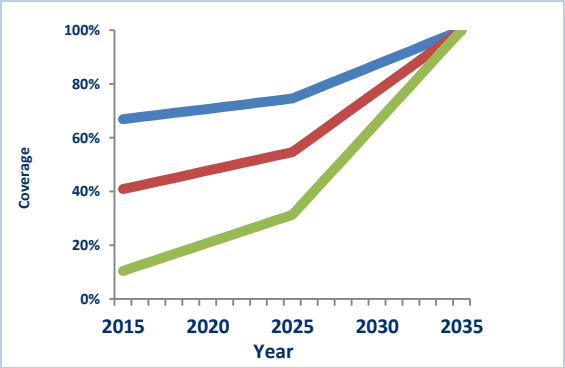
- Pathology
- Radiology
- Surgery
- Primary Care

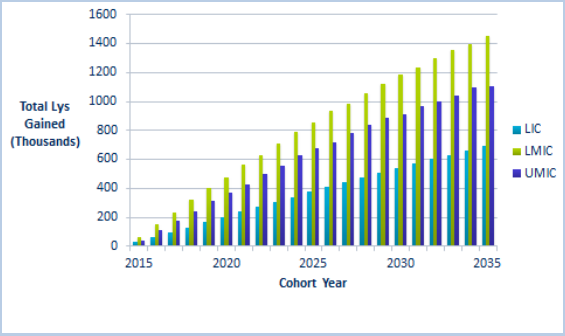
CONTEXTUAL READINESS

- Infrastructure
- Finances
- Awareness

Investment Framework

- Top ten cancers (75%) and benefits
- Scale by Total Cancer Burden
- Group countries by GNI
- Costs + benefits of treating cancer populations each year
- Accounting for increasing burden, based on IARC projections



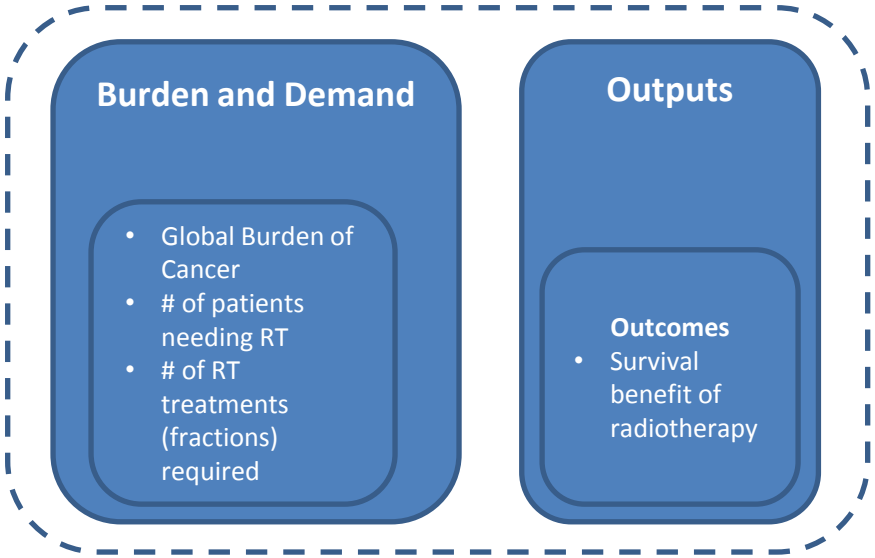


Key Broad Assumptions

1. Radiation therapy will continue to be part of cancer control in 2035

2. The cost of radiotherapy equipment and resources will not change substantially over the next 20 years

3. There is sufficient health system and societal infrastructure in place to enable radiation therapy



Combined Working Group 1 & 3: Burdens and Outcomes

*Authors: **M Barton**, M Yap, T Hanna, J Shafiq, F Bray, J Ferlay

*On behalf of Working Group 1

Objectives & Methods

Objectives

1. Number cases requiring RT at least once by country in 2012
2. Average number of RT fractions per country in 2012
3. Local control and survival benefit from RT (top 10 cancers) in 2012
4. Objectives 1,2, & 3 projected to 2035

Methods

1. Cancer numbers and distribution from GloboCAN (IARC)
2. RT Utilisation Approach (CCORE)
3. RT Fractions (Fx)
4. Published RT local control and survival benefit
5. Projections to 2035 from IARC

Global Demand and Benefit

2012

7 million indications
119 million fractions

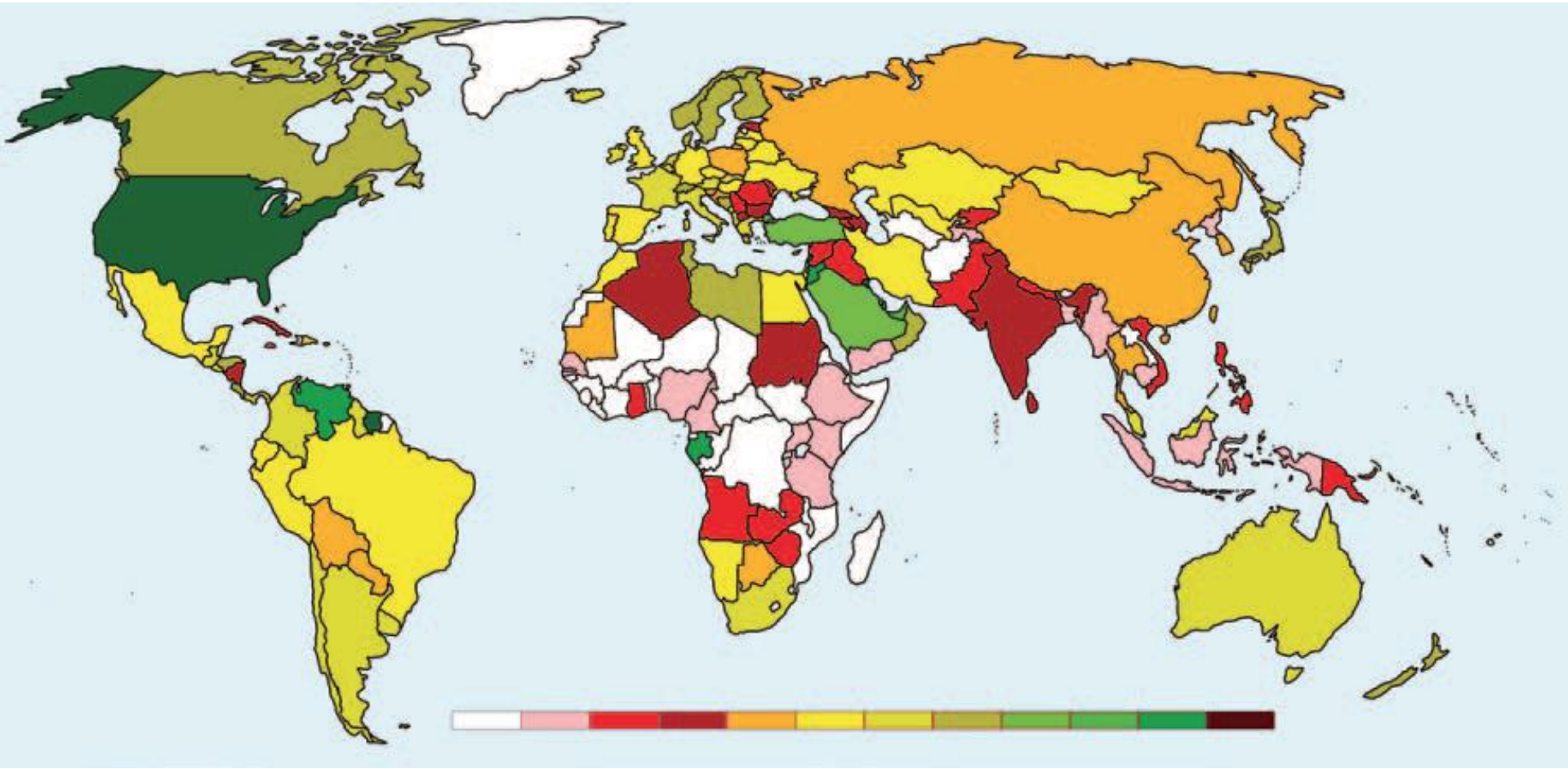
1.5 million local controls
580 000 lives

2035

12 million indications
204 million fractions

2.5 million local controls
950 000 lives

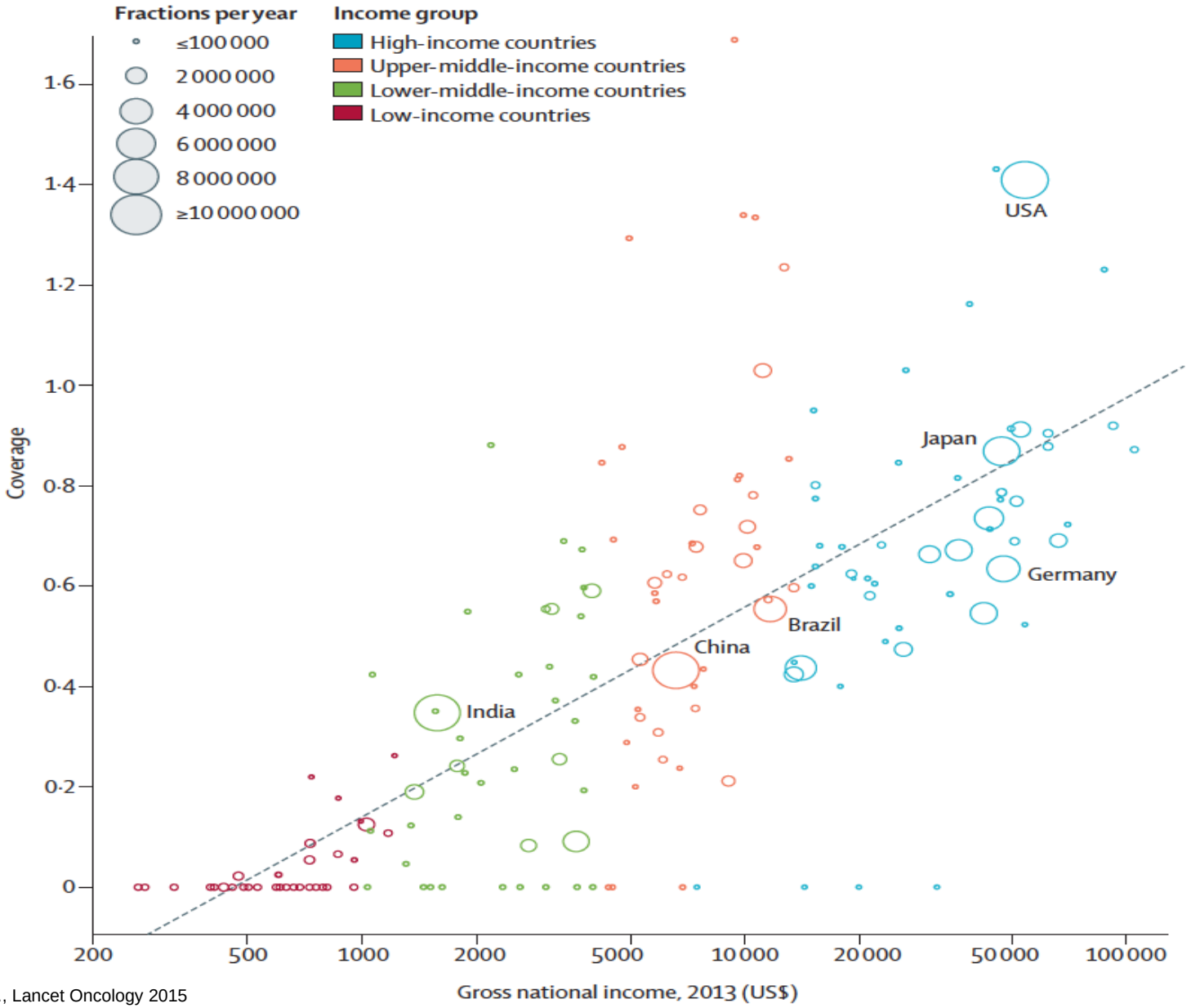
Global RT Coverage Map: Variation



8 h (%)	0	1	13	27	40	53	67	80	93	107	120	133
12 h (%)	0	1	20	40	60	80	100	120	140	160	180	200
16 h (%)	0	1	27	53	80	107	133	160	187	213	240	267

Atun et al., Lancet Oncology 2015

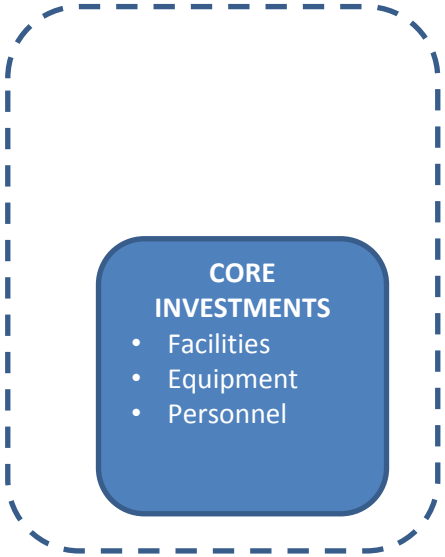
Global RT Coverage: Variation



Atun et al., Lancet Oncology 2015

Results for Input to Investment Framework

- 5-yr survival benefit for 10 highest incidence of cancer for use in detailed Markov Model
- Number of fractions/yr to deliver optimal use
- All broken down by non-disputed countries (184 in total)



Working Group #2: Core Investment Work Group

*Authors: Jake Van Dyk, E.H. Zubizarreta, Y. Lievens, D. Jaffray, T. Lui

*On behalf of Working Group 2

WG #2 Objectives

1. Definition of RT delivery model
   - Facilities, equipment, staffing, operations
2. Estimate current treatment capacity
3. Quantify current needed vs available
4. Determine operating cost per fraction
   - OpEx – US$/Fraction delivered
5. Determine investment required to generate a new fraction of capacity
   - CapEx – US$/fraction/yr

Costing: Components

CapEx: Upfront costs to develop a new facility

- investment in construction
- investment in equipment
- human-resource training costs

OpEx: Operating costs to deliver treatments

- human resources
- maintenance
- consumables
- overhead
- amortisation costs of equipment and facilities

Radiotherapy Costs per Fraction: OpEx and CapEx

	High-income countries	Upper-middle-income countries	Lower-middle-income countries	Low-income countries
Operating cost per fraction	235	86	65	60
Upfront cost per fraction	803	357	349	352

Estimated on the basis of the activity-based model. Data are cost in US$. Operating cost=cost / fractions delivered. Upfront cost=one-off cost required to create the capacity, after which operating costs are incurred.

Atun et al., Lancet Oncology 2015

What resources will be needed to deliver the 204M Fx/yr in 2035?

2035	High-income countries	Upper-middle-income countries	Lower-middle-income countries	Low-income counties
Fractions	76 424 000	77 014 000	40 974 000	13 268 000
Radiotherapy departments	4600	3700	2000	600
Megavoltage machines	9200	7400	3900	1300
CT scanners	4600	3700	2000	600
Radiation oncologists to be trained	15 500	16 800	9900	3300
Medical physicists to be trained	17 200	12 500	7200	2400
Radiation technologists to be trained	51 900	45 300	24 900	8100

Atun et al., Lancet Oncology 2015

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Investment Framework

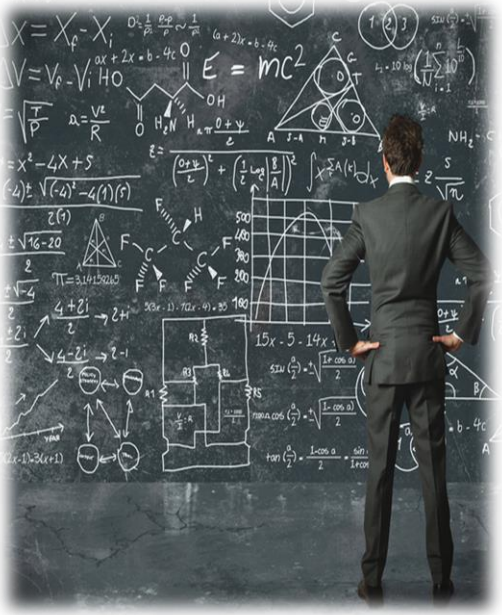
Authors: Danielle Rodin, Rifat Atun

HARVARD T.H. CHAN

How much to invest and what are the economic returns?

- Investment framework: A “formalized, structured, and numerically based” approach to decision-making and resource allocation.

  Sordoni N. Decision-making processes in equity investing: The case for investment frameworks. Lazard Report.



- Choosing the investment scheme.
- Platform to compare competing health priorities to guide future spending

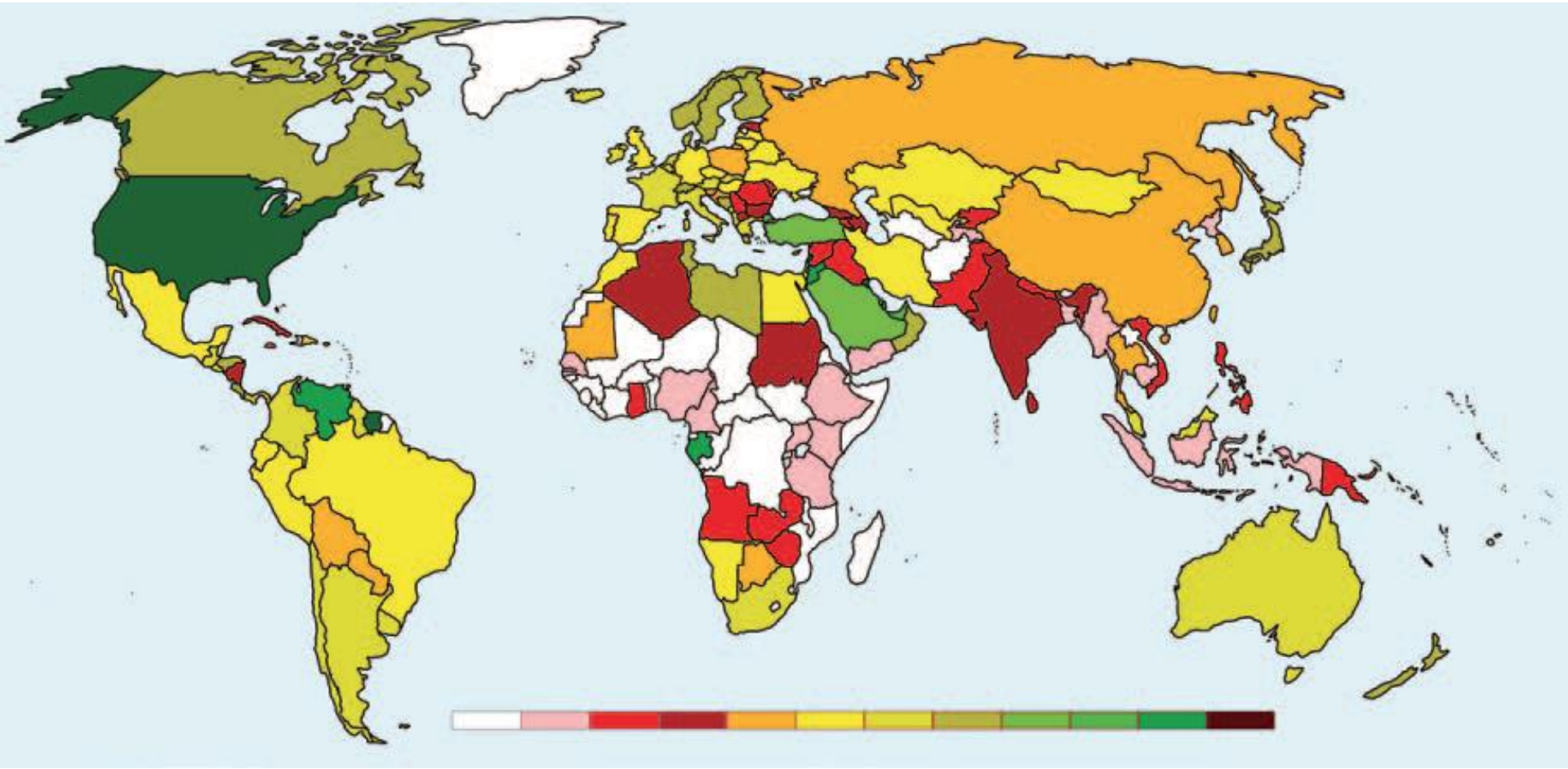
Modeling Approach (1/2)

- Cancer site-specific Markov models
  - Simulate the remaining lifetime following diagnosis

- Period of analysis: 2015-2035
  - Each year defined as a “cohort”, with given cancer population and RT coverage level

- RT coverage of each cohort year simulated in “scale-up” and “no scale-up” scenarios

Global RT Coverage Map: Current



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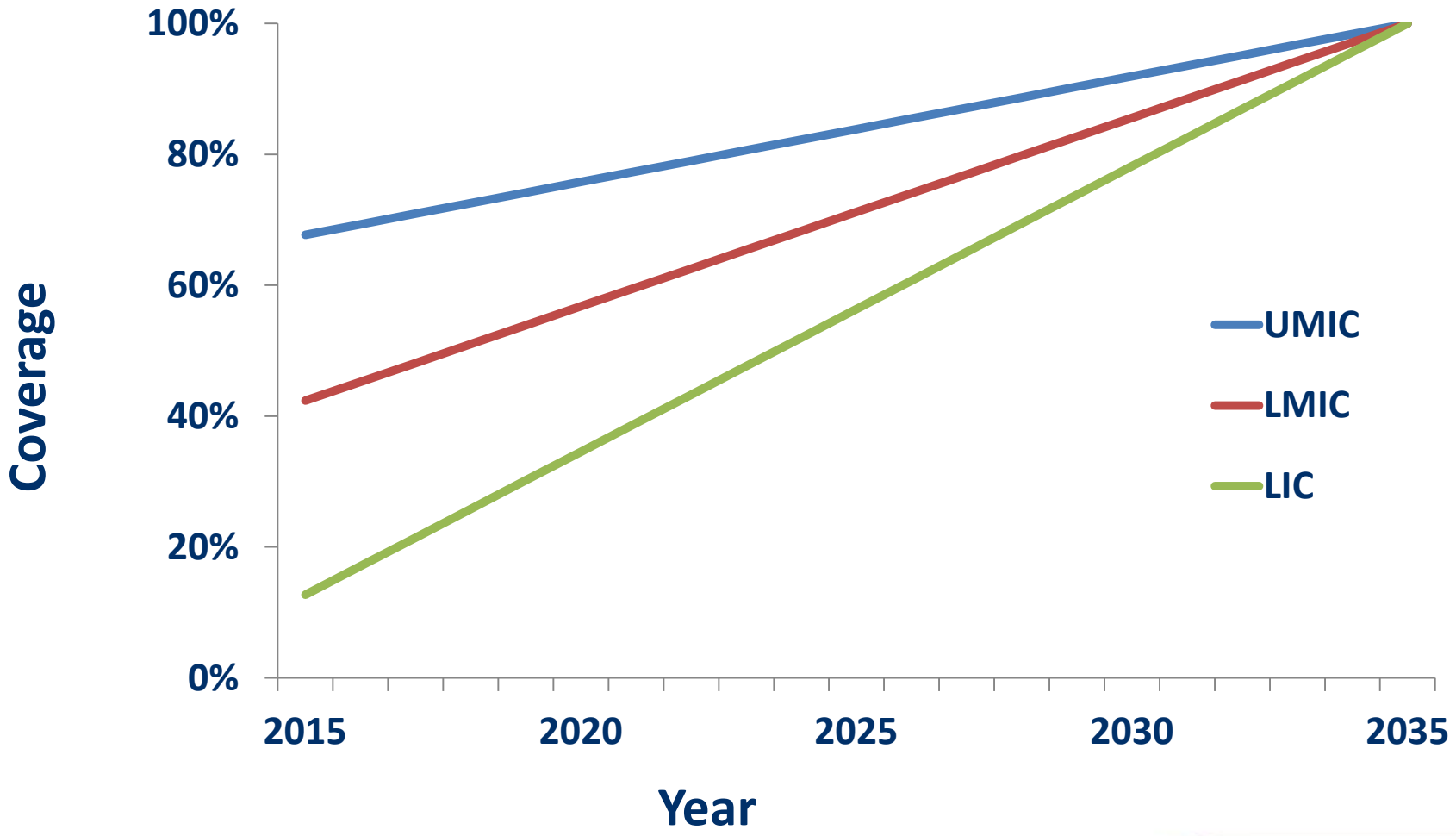
Atun et al., Lancet Oncology 2015

Linear Investment Scenario



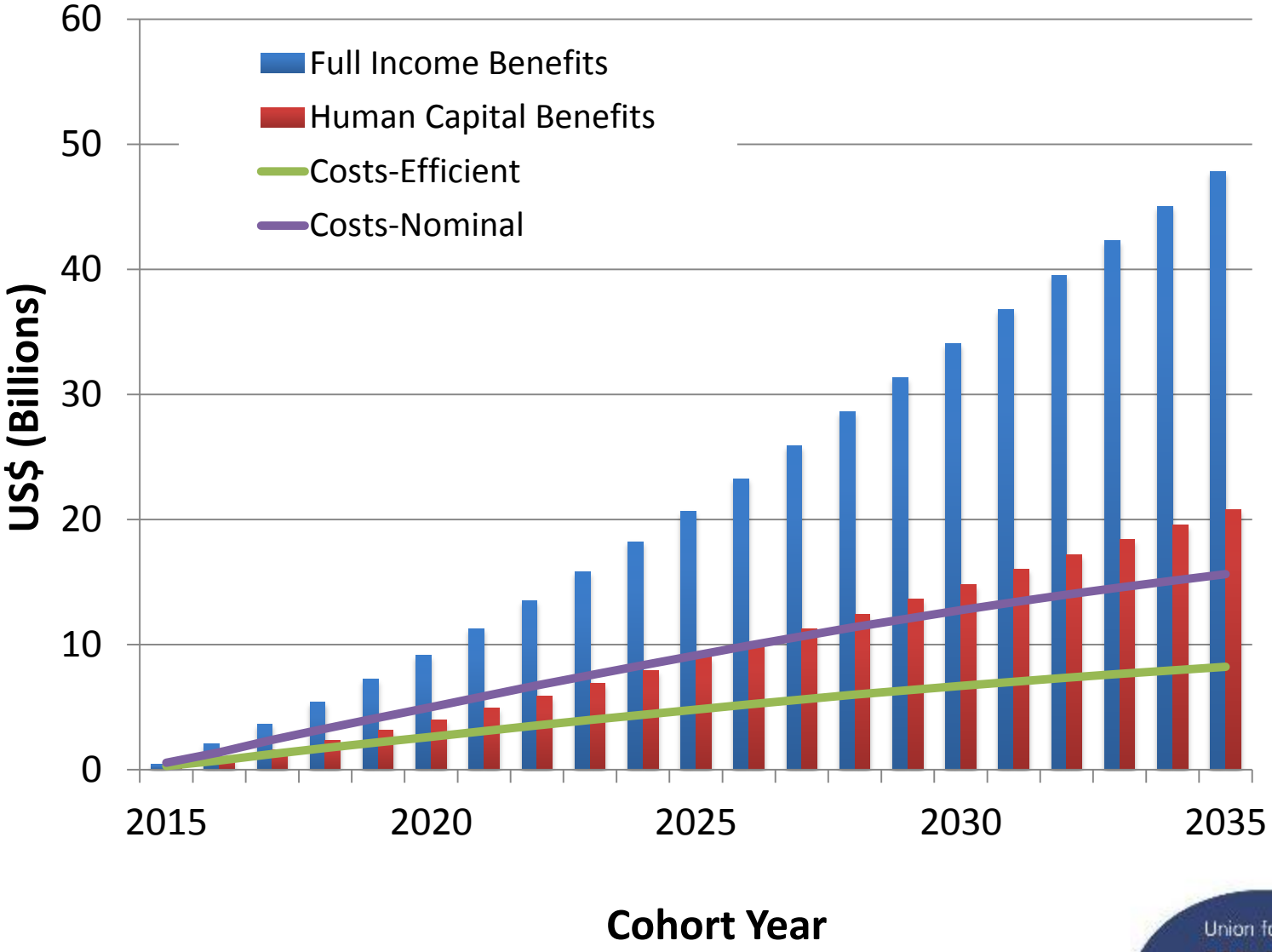
Modeling Approach (2/2)

- Model outcomes
  - Discounted life years (LYs), economic benefits (measured through GDP per capita), and costs
- Analysis
  - Each cancer and cohort year separately modeled
  - Stratified by World Bank income group regions
    - Low-income [LIC], lower middle-income [LMIC], upper middle-income [UMIC]
  - Sensitivity analysis

Translating lives saved into economic benefits

- Human Capital Approach
  - Benefits from labour force participation and productivity as a result of deaths avoided from cancer.
- Full Income Approach
  - “Value in a particular country or region of a 1-year [potential] increase in life-expectancy”
- Both calculated through effects on GNI-specific gross domestic product (GDP)

A Linear Investment in RT Coverage: Cost and Benefits in non-HIC



Total Cost:

$184.0 Bn

$96.8 Bn

Atun et al., Lancet Oncology 2015

Linear increase in RT Capacity in LMICs: Net Benefits

	Low-income countries		Lower-middle-income countries		Upper-middle-income countries	
	Nominal	Efficiency	Nominal	Efficiency	Nominal	Efficiency
Net monetary benefit (US$, billions)						
Human-capital approach	-14·9	-2·4	-18·7	10·7	50·5	95·9
Full-income approach	0·265	12·8	38·5	67·7	239·3	284·7
Return on investment						
Human-capital approach	-0·56	-0·17	-0·3	0·32	0·53	1·94
Full-income approach	0·01	0·91	0·62	2·03	2·52	5·77

Net monetary benefit=cost of investment−economic return. Return on investment=net monetary benefit/cost of investment. Costing models are described in the text and include both operational and capital costs.

Atun et al., Lancet Oncology 2015

Call to Action

Action 1: population-based cancer control plans
Radiotherapy must be incorporated into population-based comprehensive cancer plans in all countries with explicit targets for scaling up radiotherapy capacity to expand coverage.

Target: by 2020, 80% of the countries should have cancer plans that include radiotherapy.

Action 2: expansion of access to radiotherapy
We urge immediate action to establish additional radiotherapy capacity by creating at least one cancer centre in each low-income and middle-income country by 2020. In addition to providing treatments, these new centres should be used to train the radiotherapy workforce to enable further expansion of radiotherapy coverage.

Target: an increase of 25% in the 2015 radiotherapy treatment capacity by 2025.

Action 3: human resources for radiotherapy
We call for new approaches to train radiotherapy professionals globally, with the creation of new core curriculums, innovative learning methods, and international credentialing to expand the radiotherapy workforce. Training should become part of the mandate of each national radiotherapy centre to self-propagate the required skills, enabling national expansion of cancer therapies and providing the ability to replace staff as they leave or are recruited out of country.

Target: 7500 radiation oncologists, 20 000 radiation technologists, and 6000 medical physicists to be trained in low-income and middle-income countries by 2025.

Action 4: sustainable financing to expand access to radiotherapy
Domestic and international financing will be needed to expand radiotherapy capacity with substantial upfront investment. International development banks and the private sector should work in partnerships with countries to finance investments in infrastructure and radiotherapy services.

Target: $46 billion of investment by 2025 to establish radiotherapy infrastructure and training in low-income and middle-income countries.

Action 5: align radiotherapy access with universal health coverage
We call for inclusion of radiotherapy coverage in each country's universal health coverage plans to prevent catastrophic out-of-pocket expenditures and treatment abandonment.

Target: 80% of low-income and middle-income countries to include radiotherapy services as part of their universal health coverage by 2020.

Objective: Bring safe, high quality radiotherapy to the 12.5M cancer patients that will need it by 2035.

- Cost – not a problem.
- Value – not a problem.
- Methods – a problem.

We know what we need to do, we don't know how to do it.

Objective: Bring safe, high quality radiotherapy to the 12.5M cancer patients that will need it by 2035.

- Financial,
- social,
- and technological..

Encourage us to step back and take a 'multi-scalar view'.

The design of a radiotherapy treatment machine affects the entire system.

- Er … ne as
- Th … sts, the … ng de

"The Devil is in the details, but so is salvation."

— Admiral H.G. Rickover, USN

International Cancer Expert Corps

Partnering to transform global cancer care

Medical Physicists Without Borders

CERN

SYSTEMS THINKING

for Health Systems

World Health

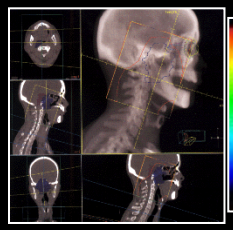
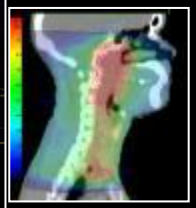
BOX 1.2 FOUR REVOLUTIONS THAT WILL TRANSFORM HEALTH AND HEALTH SYSTEMS

There are four revolutions currently underway that will transform health and health systems. These are the revolutions in: a) life sciences; b) information and communications technology; c) social justice and equity; and d) ***systems thinking to transcend complexity.***

Source: *Frenk J. "Acknowledging the Past, Committing to the Future". Delivered September 5, 2008. Available at: http://www.hsph.harvard.edu/multimedia/JulioFrenk/FrenkRemarks.pdf*
Italics added for emphasis.

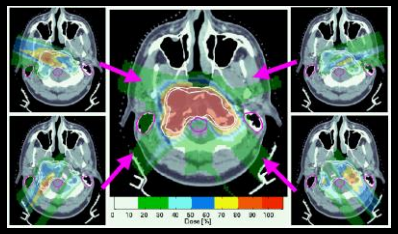
Cancer Care in Developed Nations is Very Complex


Diagnosis
Staging

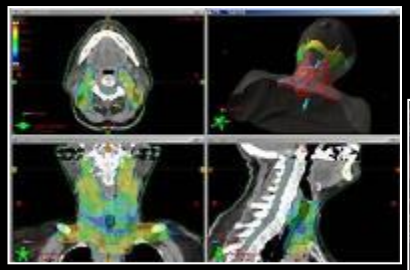
3D imaging
Target volume
Organ localization

Prescription
Segmentation

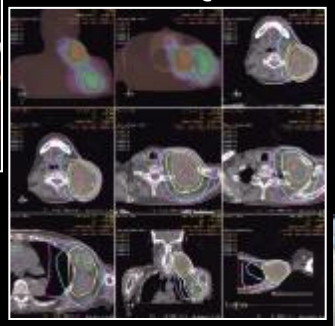


Dose calculation
Beam optimization

Beam shaping



QA of Plan



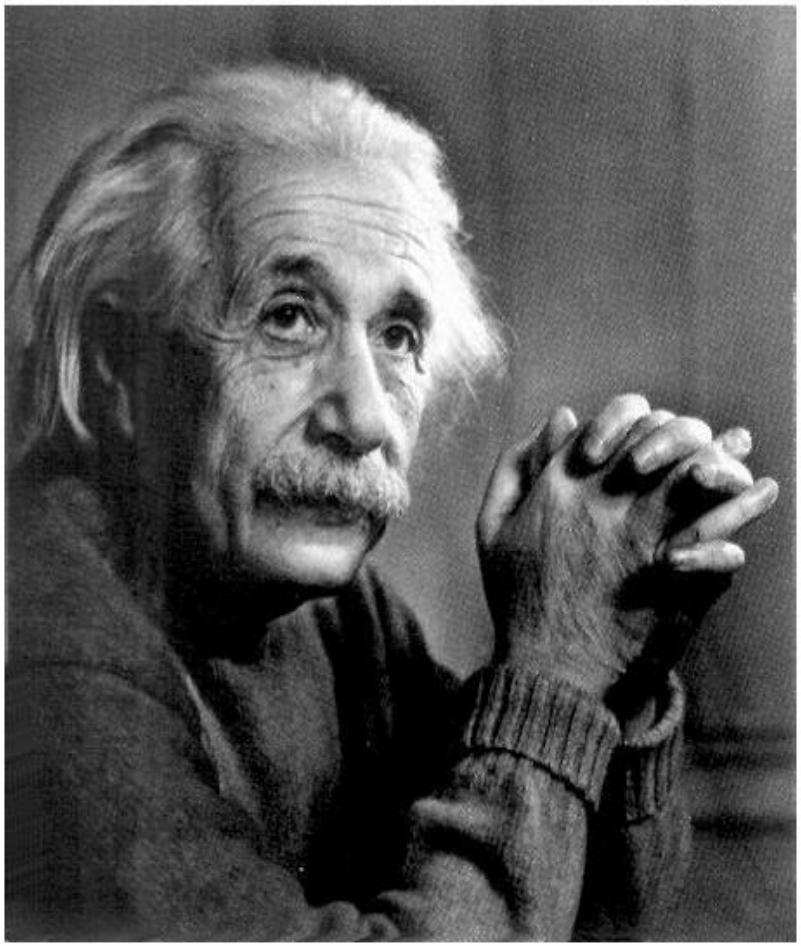
Plan Transfer

Treatment verification
Delivery


Monitoring
Clinical
Response

Follow-up

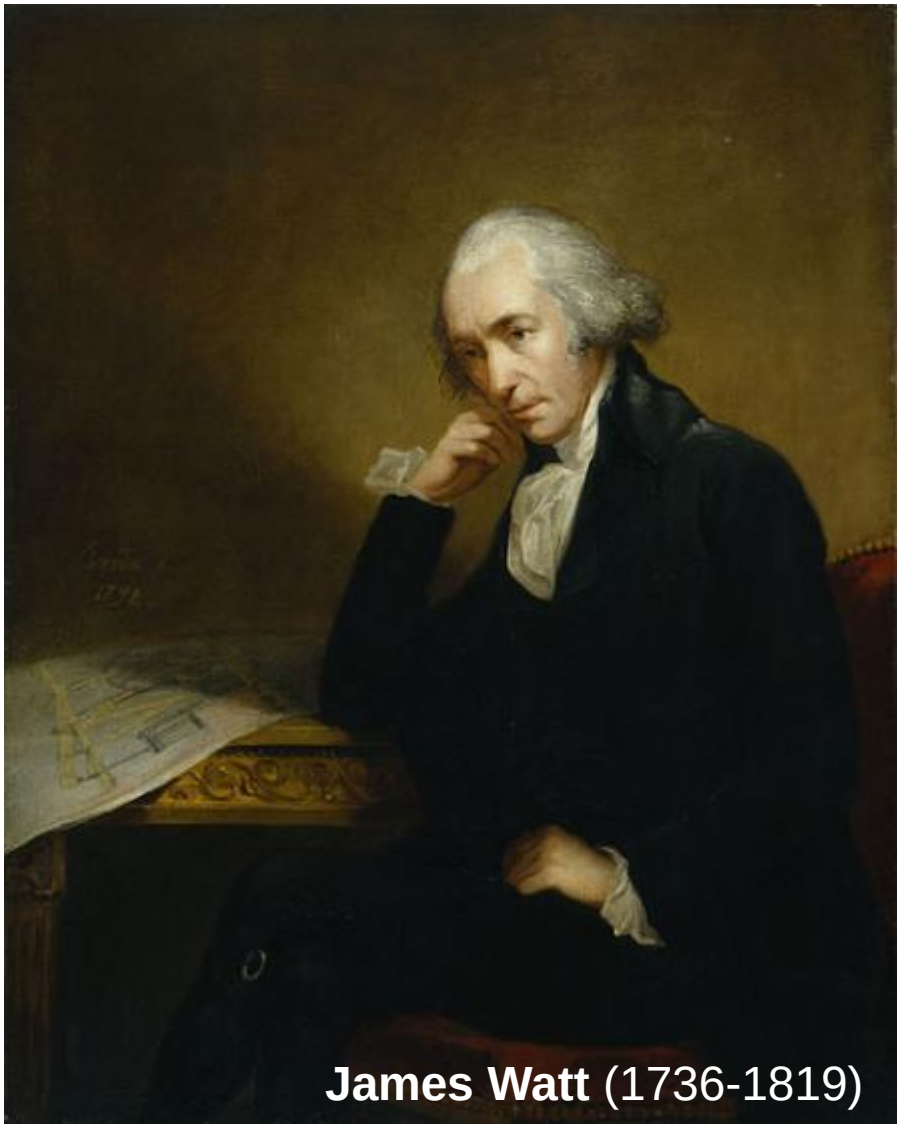
Burden of Complexity



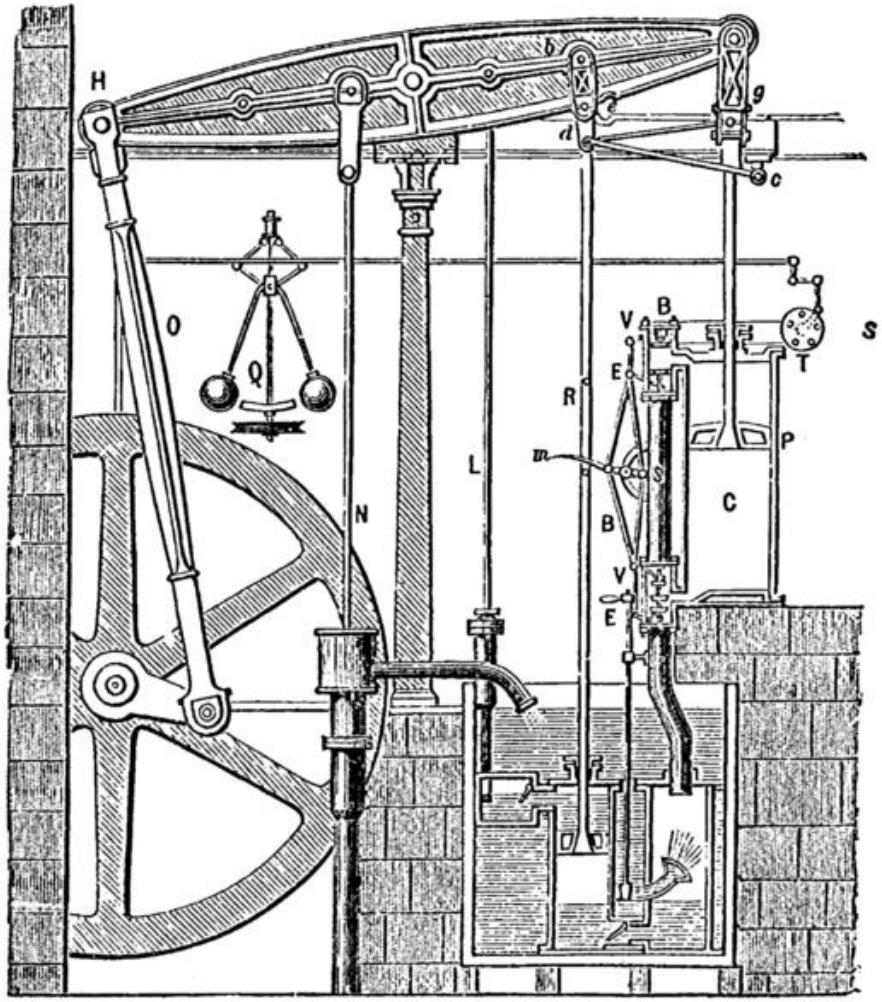
Things should
be made as simple as possible,
but not simpler.

Albert Einstein

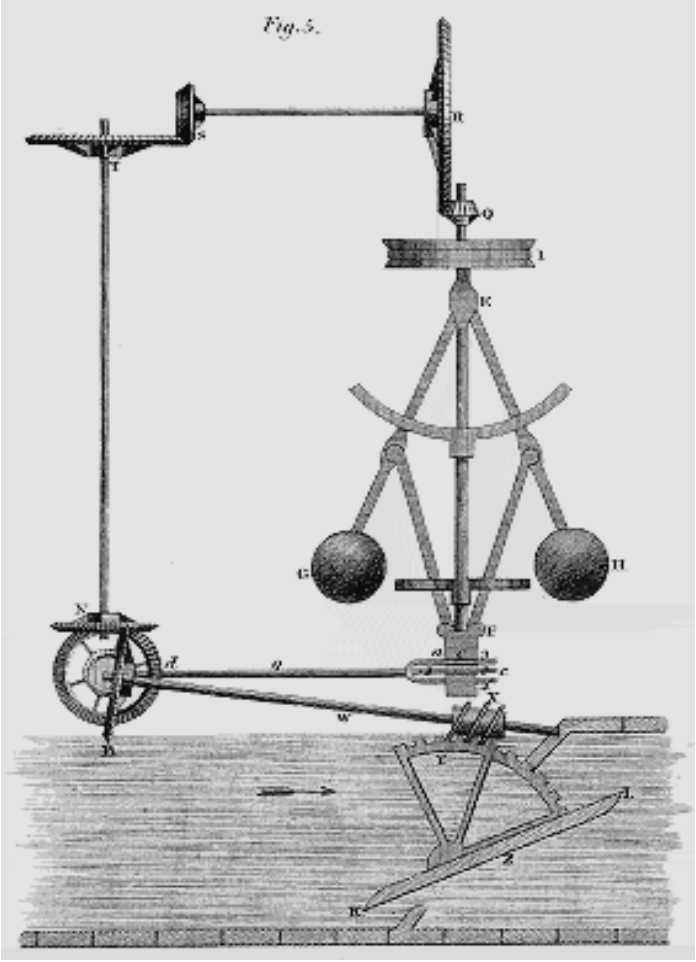
The Steam Engine



James Watt (1736-1819)



Complexity ‘Hide Thy Self’



Mr. Watt believed that throttling a steam valve by a human being was not the best way to maintain a constant speed of the steam engine.

The beginning of modern automatic control began, when James Watt in 1788 developed a mechanical device the flyball governor.

The flyball governor maintained the speed of the steam engine automatically by controlling the opening and closing of the steam valve.

Complexity Buried

Objective: Bring safe, high quality radiotherapy to the 12.5M cancer patients that will need it by 2035.

Exporting the cancer care that we can't even afford is not the solution.

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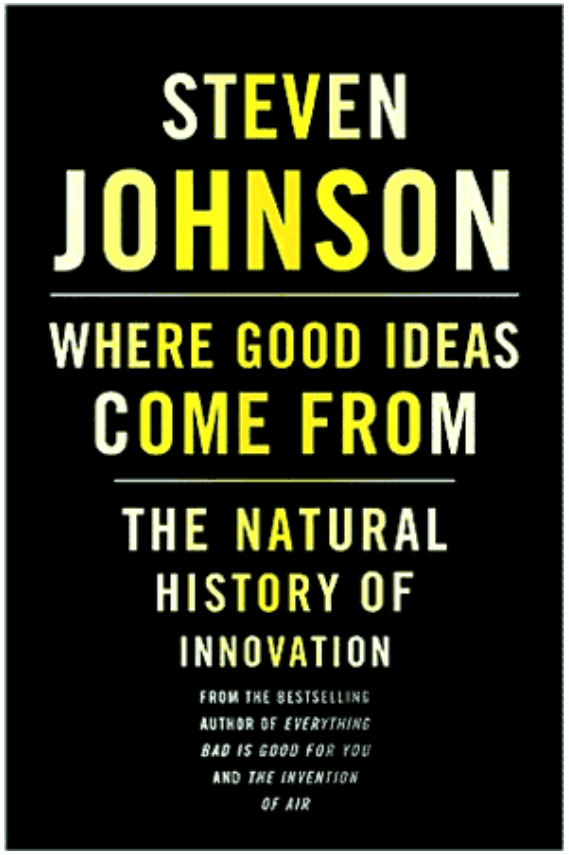
A MEMBERSHIP ORGANISATION
FIGHTING CANCER TOGETHER



"Connectivity as the primary engine of creativity and innovation over the past 600 years." – Steven Johnson

The report of the GTFRCC connects evidence-based practice, cost of care delivery, and financial benefit.

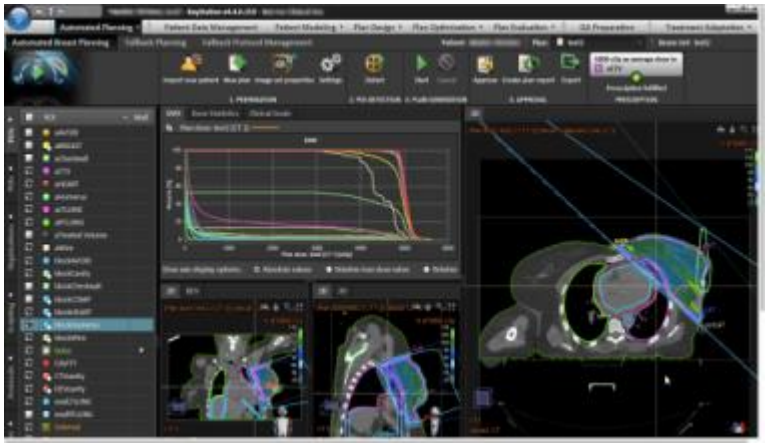
This connectivity has the capacity to stimulate innovation.

Innovating for the Global Expansion of High Quality RT

- Key Messages to Drive Innovation
  - Overwhelming Need and Impact
    - >24M/yr cancers in 2035
    - >200M fractions of RT need to be delivered
    - >900,000 lives saved per year
  - Long-term Market
    - RT is an essential part of effective cancer control in 2035
    - Infrastructure, Technology, Skills, Finance
  - Significant Emerging Investment
    - $184B in LMICs in the next 20 years

Atun et al., Lancet Oncology 2015

Innovative Technologies

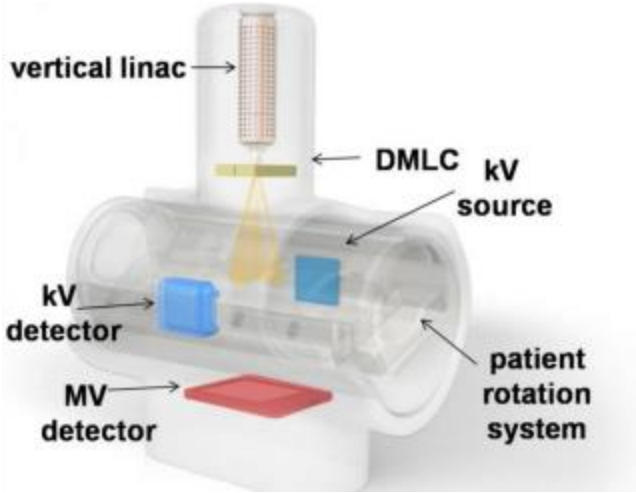


Software systems that automate the treatment planning process AND improve plan quality.

>Planning from 4 hours to 4 min.

Purdie et al. - Int J Radiat Oncol Biol Phys. 2011

Migration to the Cloud will enable shared learning and lower infrastructure costs.



NanoX radiotherapy system design including fixed linac and patient rotation system.

>Significant construction cost savings.

Keall et al.

http://dx.doi.org/10.1594/ranzcr2014/R-0142

Opportunity to 'bury the complexity' of RT.

Innovative Technologies

FEB
23
2012

German Radiotherapy Clinic Harnesses Sun to Run Systems, Cuts Dependence on Power Grid

During the summer, the array's output will be more than the Radiation Oncology Centre needs to run its two linear accelerators, a large bore CT system and the clinic's IT technology, lighting and air-conditioning.

Lake Constance Radiation Oncology Centre (Germany)

Innovation for Efficiency: Technology, Processes, Purchasing

	Operating cost per fraction: sensitivity analysis			Cost savings relative to base scenario			
	Automation: efficiency	Longer hours	Bulk purchase	High-income countries	Upper-middle-income countries	Lower-middle-income countries	Low-income countries
Combination 1	X	..	..	25%	21%	21%	21%
Combination 2	..	X	..	13%	18%	23%	25%
Combination 3	..	..	X	8%	16%	21%	23%
Combination 4	X	X	..	33%	34%	39%	40%
Combination 5	..	X	X	19%	34%	38%	42%
Combination 6	X	..	X	31%	34%	38%	39%
Combination 7	X	X	X	37%	43%	51%	53%

The operating cost model allows for improved efficiency, longer treatment hours per day, and bulk purchasing savings. These factors can occur alone or in combination, resulting in seven different combinations. X shows the inclusion of a factor in the sensitivity analysis.

***Table 3*: Sensitivity analysis to determine operational costs**

Capacity for significant savings while maintaining quality.

Educational Innovations: Needed

Result: >215,000 RT Professionals to be Trained by 2035

Education of Health Professionals for the 21st Century: A Global Independent Commission

THE LANCET

Health professionals for a new century: transforming education to strengthen health systems in an interdependent world Julio Frenk et al (2010)

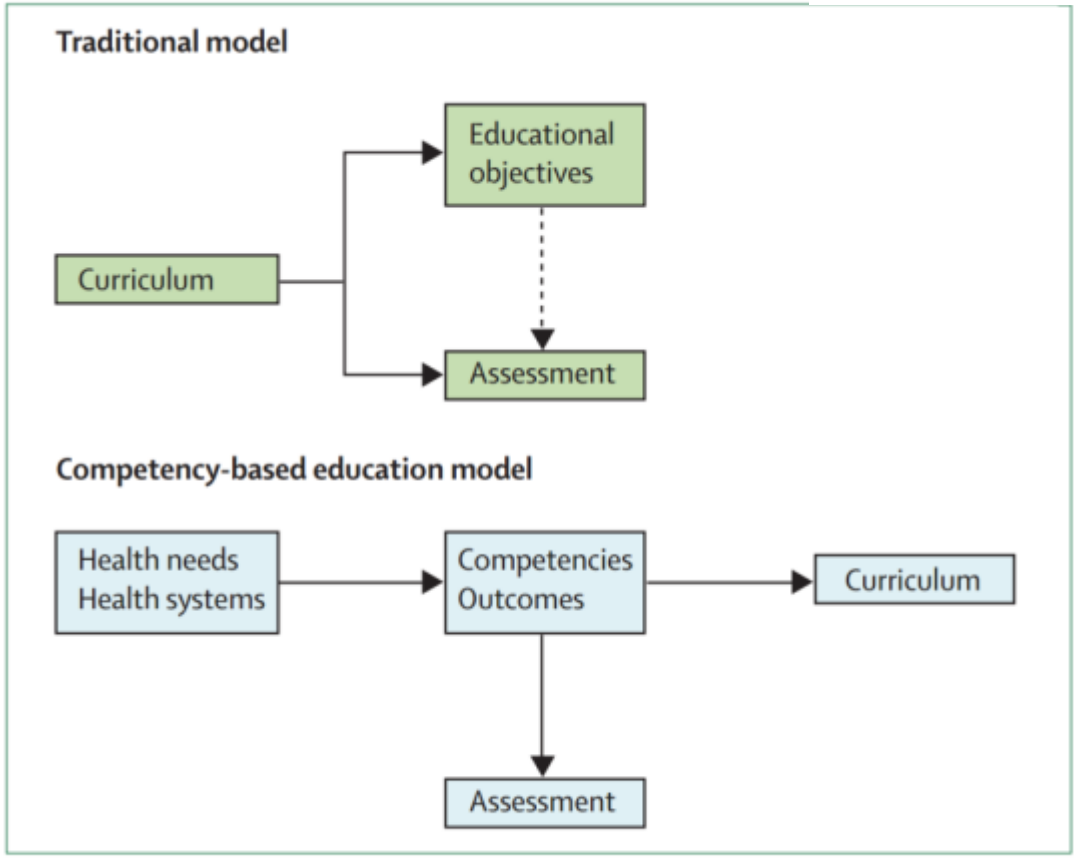


Figure 9: **Competency-based education**

"Health professionals have made enormous contributions to health and development over the past century, but complacency will only perpetuate the ineffective application of 20th century educational strategies that are unfit to tackle 21st century challenges."

Innovative Leadership and Stewardship

International Cancer Expert Corps

Partnering to transform global cancer care

…a mentoring network of cancer professionals who work with local and regional in-country groups to develop and sustain expertise for better cancer care.

http://www.iceccancer.org/

Medical Physicists Without Borders

…provide Medical Physics support with the goal of improving the effectiveness and safety in the use of physics and technologies in medicine, especially in LMICs.

http://www.mpwb.org/

GLOBALRT

…is a movement of young leaders to turn radiotherapy into a global health priority.

http://globalrt.org/

Financing Innovations

- Novel financing solutions for mobilising, pooling, channelling, and funding radiotherapy services

  Atun R et al. Lancet 2012; 380: 2044–49.

  - AIDS, tuberculosis, malaria, and children's immunisation programmes
- Leverage scale for cooperative approaches to supply and manufacturing
  - Brazil will source 40% of the RT system parts, accessories and software from within the country.
- Innovative financing instruments
  - Commitments (GAVI), Bonds (Diaspora), or Guarantees (World Bank)

Summary

- Global data permits the accurate projection of cancer burden.
- Evidence based benefit of radiation therapy demonstrates the opportunity to impact 5-yr survival for 950,000 people per year by 2035.
- While significant investment is required, a net financial benefit is projected.
- Five Calls to Action identify targets
- Investment is not enough – we need innovation.