Global Access to Radiotherapy for Lung Cancer

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Conquering Thoracic Cancers Worldwide

CME ACCREDITED

Global Access to Radiotherapy for Lung Cancer

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Disclosures

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Global RT capacity and challenges for treating lung cancer with RT in LMICs

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Cancer statistics

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- Global estimates of cancer incidence 19.3 M new cases and 10M deaths in 2020.
- Increasing to 30.2M new cases and over 17M deaths by 2040.
- Globally 1 in 5 people are being diagnosed with cancer
  - 1 in 8 men, 1 in 11 women die from cancer
  - 50M living within 5 years for cancer diagnosis
- **Lung cancer** is second in number of new cases (2.2M) and the leader in cases of death (1.8M)

Radiotherapy has a major role to play in the management of this patients

International Agency for Research on Cancer. Cancer today. 2020. https://gco.iarc.fr/today (accessed Sept 2, 2021).
Delaney G, et al. The role of radiotherapy in cancer treatment: estimating optimal utilization from a review of evidence-based clinical guidelines. *Cancer* 2005.
Atun R, et al. Expanding global access to radiotherapy. *Lancet Oncol* 2015.

Radiotherapy

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1 in 2 cancer patients worldwide would benefit from radiation	40% are curable with radiation
RT improves control and quality of life	Potential to save 1M live per year Potential to promote positive economical impact

The need for RT is clear

Abdel-Wahab M, et al. Global radiotherapy: current status and future directions. *J Glob Oncol* 2021.
2 Delaney G, et al. The role of radiotherapy in cancer treatment: estimating optimal utilization from a review of evidence-based clinical guidelines. *Cancer* 2005.
3 Atun R, et al. Expanding global access to radiotherapy. *Lancet Oncol* 2015.

GLOBAL RADIOTHERAPY AVAILABILITY

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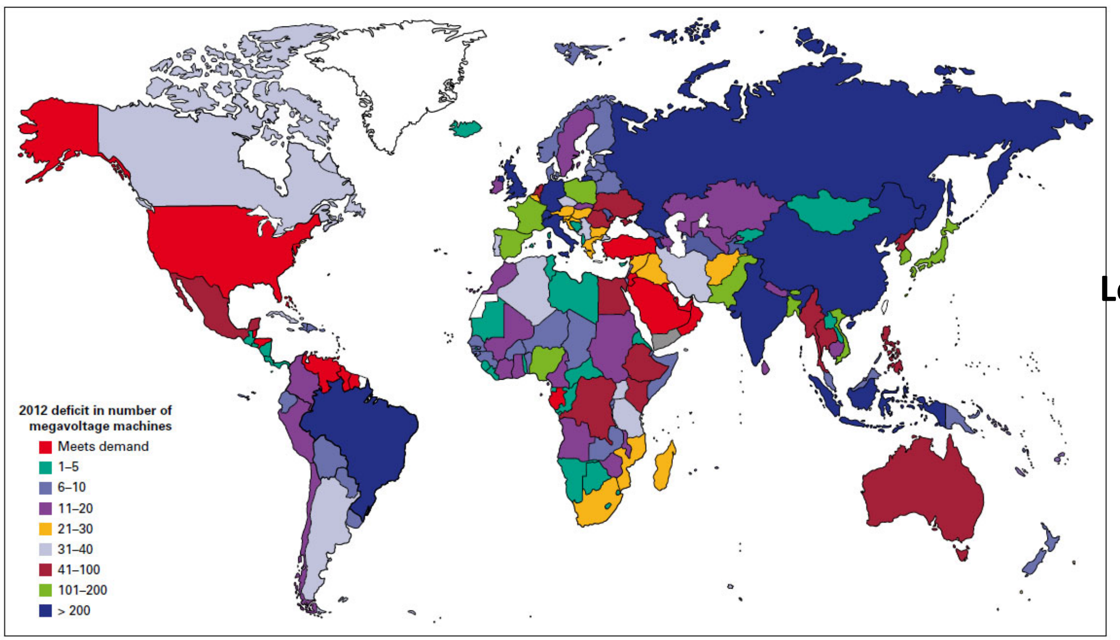
- By 2040, 67% of annual cancer cases will be in LMIC and there is no adequate resource mobilization to tackle this future challenge.

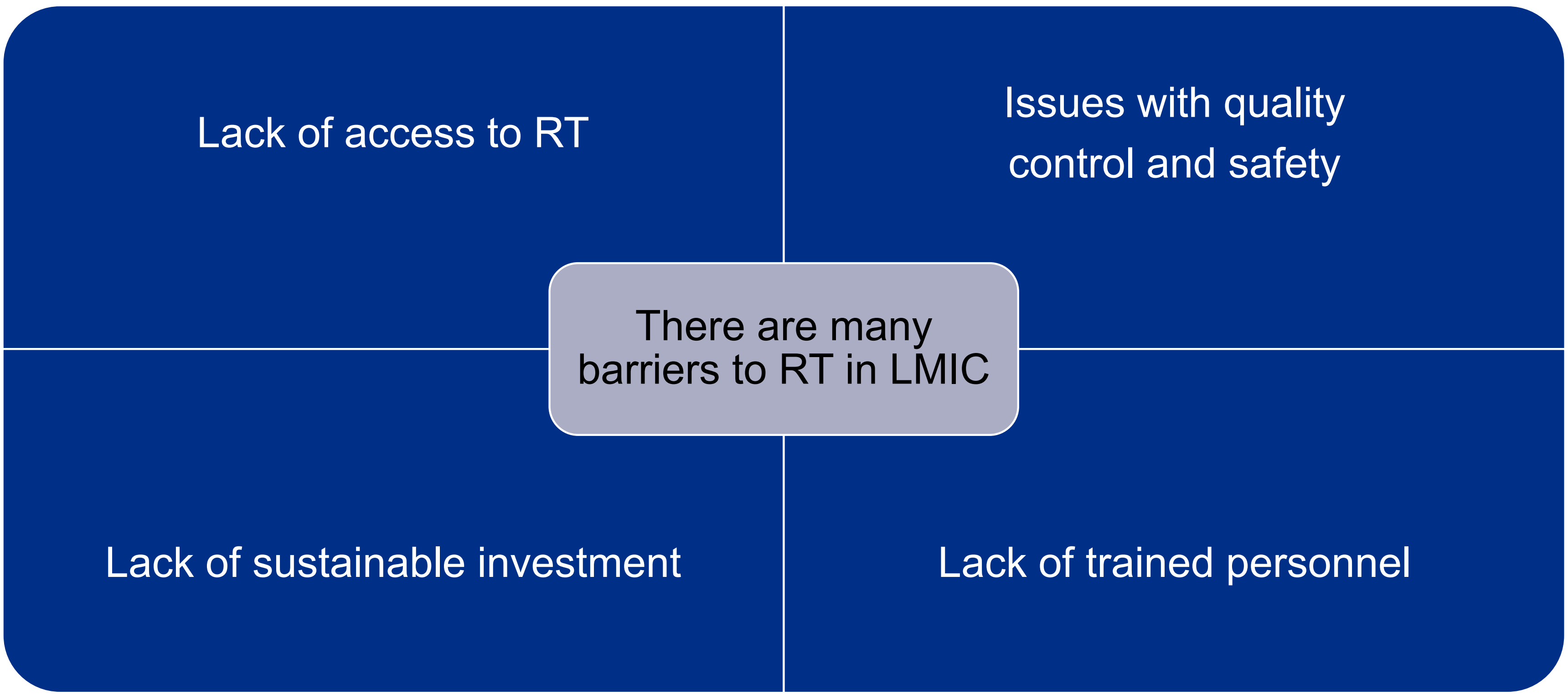
Abdel-Wahab M, Gondhowiardjo S, Rosa A, et al. Global radiotherapy: current status and future directions. *J Glob Oncol* 2021.



> 2 million people are unable to access RT
Low- and middle-income countries are particularly disadvantaged by this deficit.

Yap, ML et al. Global Access to Radiotherapy Services: Have We Made Progress During the Past Decade? JGO 2016.

Barriers to RT



Cost and benefits of scaling up RT in LMIC

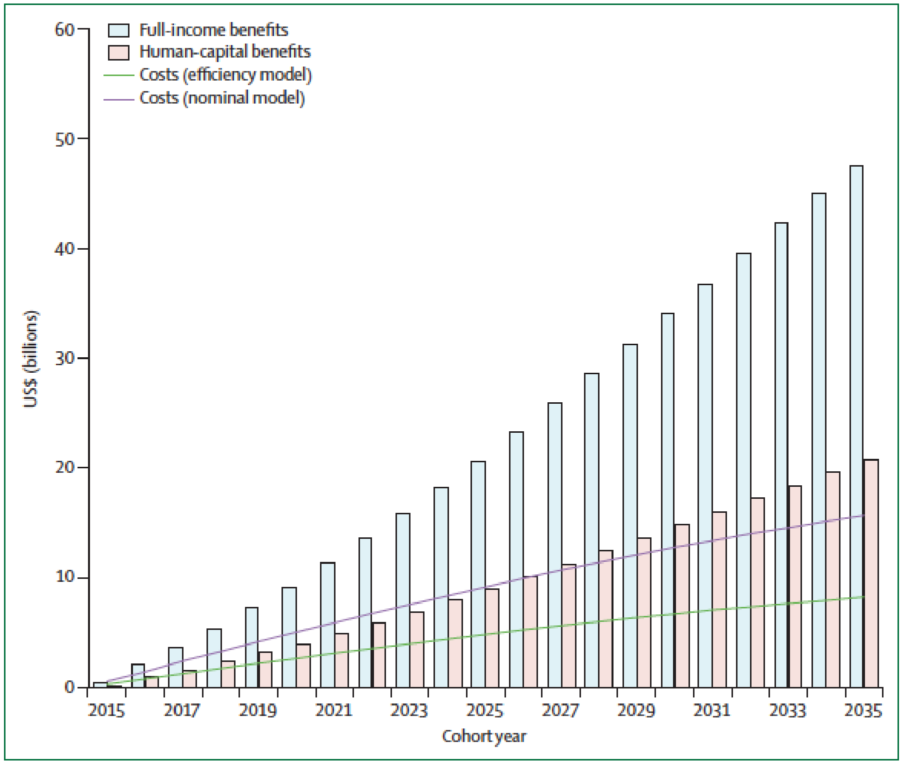


***Figure 11:* Cost and benefits of investments to scale up radiotherapy services in low-income and middle-income countries, 2015–35**

The costing models are described in the text and include both operational and capital costs.

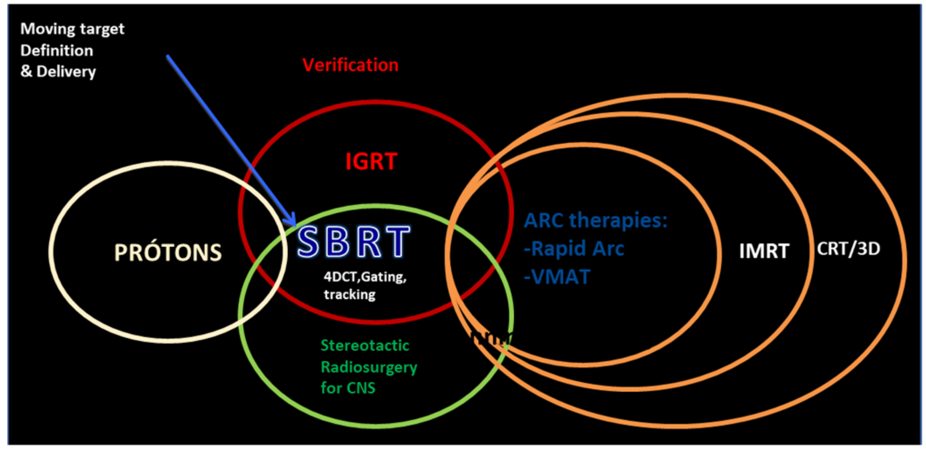
Atun R, et al. Expanding global access to radiotherapy. Lancet Oncol 2015.

RT use for Lung cancer in LMIC

- The standard of care for lung Ca treatment involves RT
  - curative-intent treatment of early-stage to locally advanced disease, as well as in palliation.
- The infrastructure, equipment, and human resources required for RT may be limited in LMICs.
- Priorities:
  - increase access to RT equipment and trained health care professionals
  - encouraging innovation to increase the economic efficiency of RT delivery.

1. Rodin D et al Radiotherapeutic Management of Non–Small Cell Lung Cancer in the Minimal Resource Setting. JTO 2016

RT technology



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- Before the mid-1990s, RT planning relied on two dimensional imaging
- The development of three-dimensional conformal RT (3D-CRT) and intensity-modulated RT (IMRT) (mid-1990s)
  - allowed better delineation of normal structures (termed organs at risk) and target volumes
- Recent improvement related to the assessment of patient positioning and the tumor.

Conventional versus SABR for early stage

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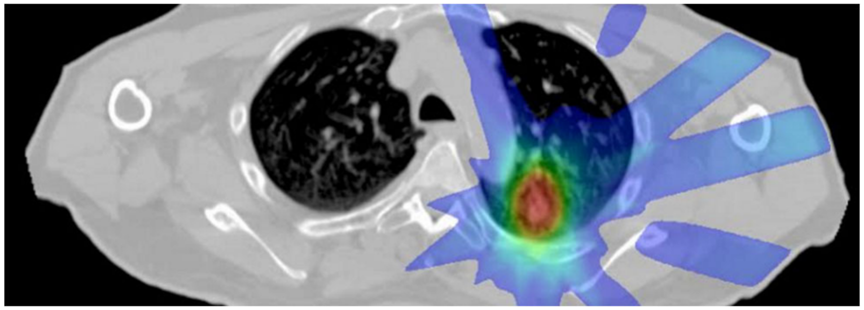

	Nyman *et al.*[9] SPACE		Ball *et al.*[10] CHISEL	
n	102		101	
Diagnosis and staging	63% Pathological confirmation 65% PET scan		100% Pathological confirmation 100% PET scan	
Randomization	70 Gy/35 fr	SABR 66 Gy/3 fr	60 Gy/30 fr or 50 Gy/20 fr	SABR 48 Gy/4 fr or 54 Gy/3 fr
Mean age (y)	75	73	75	74
Comorbidity	64% CVD 53% COPD	57% CVD 71% COPD	Median SCS = 9	Median SCS = 9
T stage	T1 75% T2 25%	T1 53% T2 47%	T1 69% T2 31%	T1 79% T2 29%
LC (%)	85.7	86.4	69	89
PFS	3 y 42%	3 y 42%	—	—
OS	2 y 72% 3 y 59%	2 y 68% 3 y 54%	2 y 59%[†]	2 y 77%[†]
Grade 1+ oesophagitis (%)	30[†]	8[†]	0	2
Grade 1+ pneumonitis (%)	34	19	3	18

[†]Statistically significant.

COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; fr, fractions; Gy, Gray; LC, local control; NSCLC, non-small cell lung cancer; OS, overall survival; PET, positron emission tomography; PFS, progression-free survival; SABR, stereotactic ablative body radiotherapy; SCS, simplified comorbidity score; y, years.

Nyman J, Hallqvist A, Lund JA, Brustugun OT, Bergman B, Bergstrom P, Friesland S, Lewensohn R, Holmberg E, Lax I. SPACE – a randomized study of SBRT vs conventional fractionated radiotherapy in medically inoperable stage I NSCLC. Radiother. Oncol. 2016; 121:1–8.

1Ball D, Mai GT, Vinod S, Babington S, Ruben J, Kron T, Chesson B, Herschtal A, Vanevski M, Rezo A et al. Stereotactic ablative radiotherapy versus standard radiotherapy in stage 1 non-small-cell lung cancer (TROG 09.02 CHISEL): a phase 3, open-label, randomised controlled trial. Lancet Oncol. 2019; 20 : 494.

Global RT capacity

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Table 1. Summary of radiotherapy capacity in Europe, Africa, Asia, Latin America and the Caribbean, and North America

	Infrastructure	Equipment	Human resources	Comments
Europe	1286 RT centers; more than two-thirds in Germany, Italy, France, the United Kingdom, and Spain	3157 MV machines represent 19% of unmet need; 92% of machines are linear accelerators	6000 radiation oncologists, 3000 medical physicists, and 10,000 RT technologists	Range of RT capacity follows GNI distribution; many centers perform advanced RT techniques (IMRT, SABR)
Africa	160 RT centers; 29 countries (20% of population) do not have any machines	277 MV machines, 68% linear accelerators; machines weighted heavily toward South Africa (33%) and Egypt (27%)	No up-to-date data on number of RT professionals; presence of training facilities noted in only 7 countries	Little known about types of plans delivered
Asia	1462 RT centers; 86% of centers located in Japan, China, and India	3051 MV machines identified, high country-to-country disparity in number of machines per million population	Radiation oncologists and therapists serve in multiple roles; only 17 countries meet human personnel guidelines	Little known about types of plans delivered
Latin America & Caribbean	470 RT centers, most densely available in Argentina, Chile, Panama, Uruguay, and Venezuela	710 MV machines, 44% linear accelerators; estimated 100 more machines needed	69% more radiation oncologists, 146% more medical physicists, and 109% more RT technologists needed	Only 3% of centers able to generate IMRT plans
North America	3388 RT centers between United States (3331) and Canada (57)	4240 MV machines between United States (3956) and Canada (284), 96% are linear accelerators	4236 radiation oncologists, robust medical physics training programs	Quality assurance measures not well described; many centers perform advanced RT techniques (IMRT, SABR)

RT, radiotherapy; MV, megavoltage; GNI, gross national income; IMRT, intensity-modulated radiotherapy; SABR, stereotactic ablative radiotherapy.

1. Rodin D et al Radiotherapeutic Management of Non–Small Cell Lung Cancer in the Minimal Resource Setting. JTO 2016

Strategies for RT delivery in minimal resource settings

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Table 2. Resource-tiered technological guidelines

Indications	Simulation	Treatment technique	Oncology center
Palliative treatment of locally advanced primary and metastatic lung tumors	2D and CT simulation	2D treatment (rectangular portals) and 3D CRT	Tier 1[a]
Routine radical radiotherapy and chemoradiation of lung cancers	CT simulation	3D CRT	Tier 2[b]
Complex cases of radical radiotherapy and chemoradiation	CT simulation	IMRT and IGRT	Tier 3[c]
Specialized techniques such as SABR	CT simulation, including 4D techniques	IMRT, IGRT, and 4D treatment	Tier 3[c]

[a]Tier 1, basic oncology center with cobalt machine.
[b]Tier 2, intermediate oncology center with basic linear accelerator and CT-based simulation.
[c]Tier 3: advanced- level oncology center with linear accelerators, CT simulation, and image guidance.
2D, two-dimensional; CT, computed tomography; 3D CRT, three-dimensional conformal therapy; 4D, four-dimensional; IMRT, intensity-modulated radiotherapy; IGRT, image-guided radiotherapy; SABR, stereotactic ablative radiotherapy.

1. Rodin D et al Radiotherapeutic Management of Non–Small Cell Lung Cancer in the Minimal Resource Setting. JTO 2016

Summary

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EXPANSION OF RT CAPACITY IS NEEDED NOW

SUSTAINABLE FUNDING FOR RT SHOULD BE PROVIDED

RT PROVIDE BOTH HUMAN AND ECONOMICAL BENEFIT

RT FOR LUNG CANCER:

- Invest in both human capacity and treatment resources,
- Ensure quality of care,
- Provide guidance on priority setting with limited resources, and
- Foster innovation to increase the economic efficiency of RT delivery.

Health Human Resources and Access to Thoracic Cancer Care

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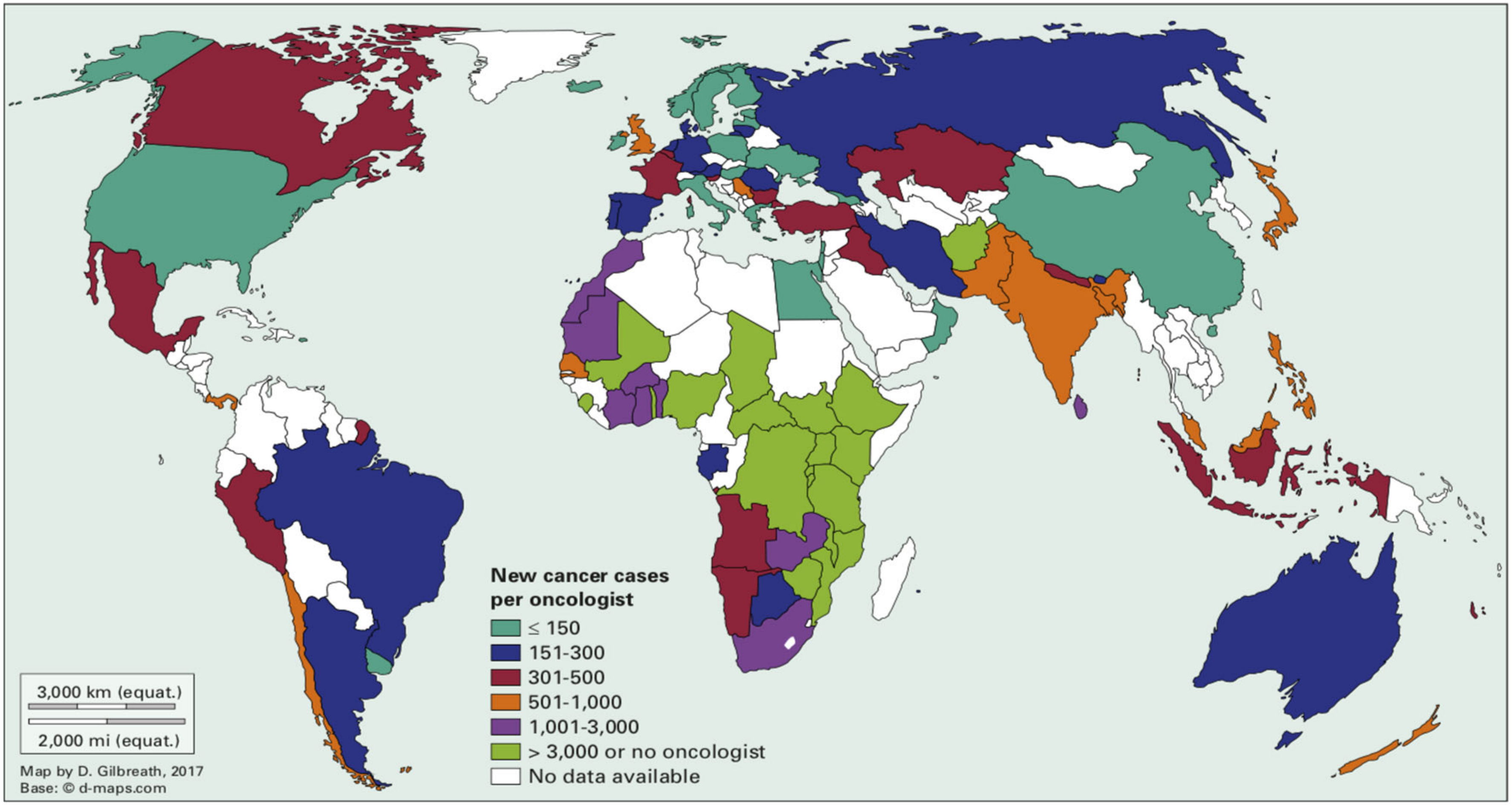
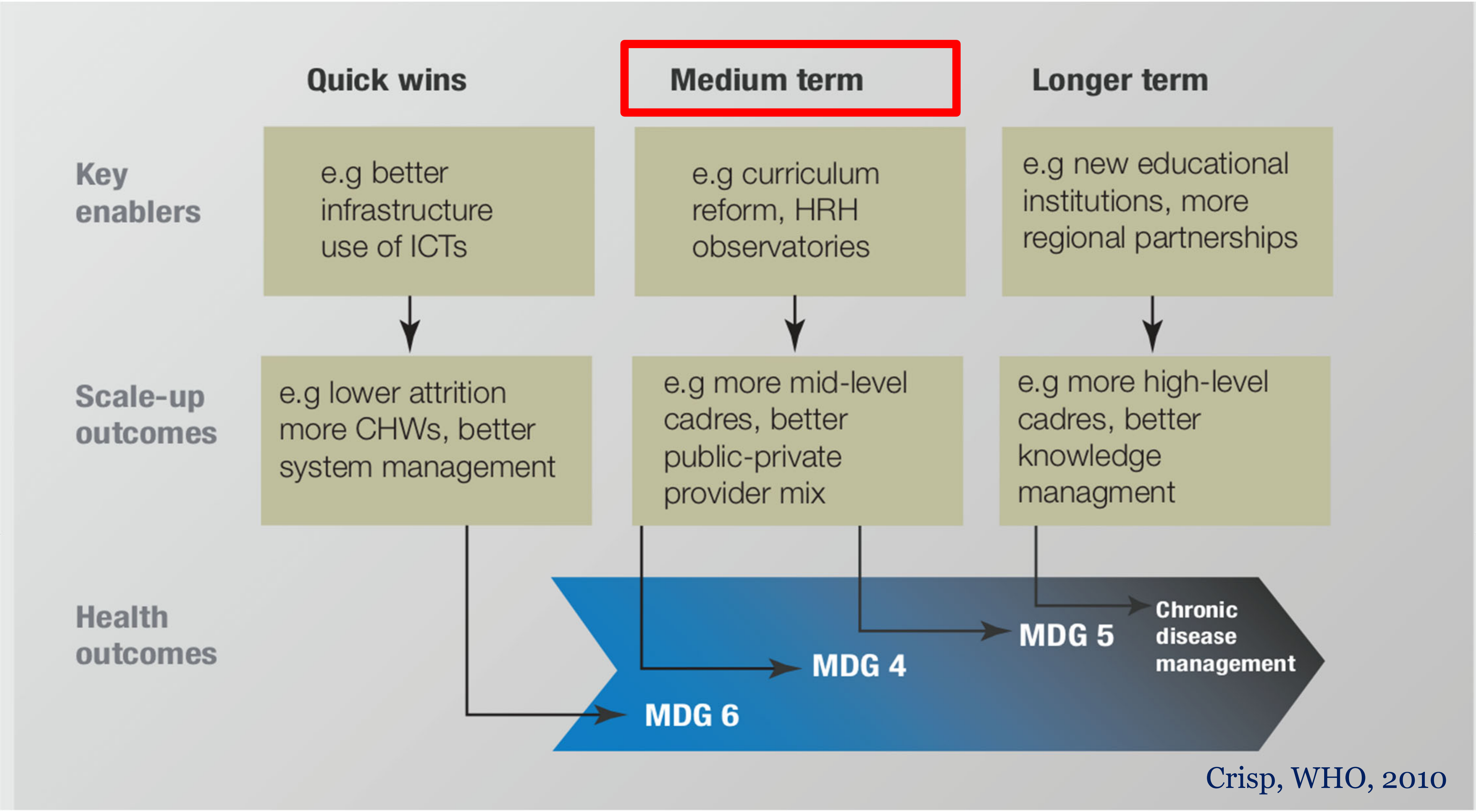


Mathew et al, JGO, 2018

No care without a workforce



Crisp, WHO, 2010

Global Curricula

Explore Multiple Alternatives

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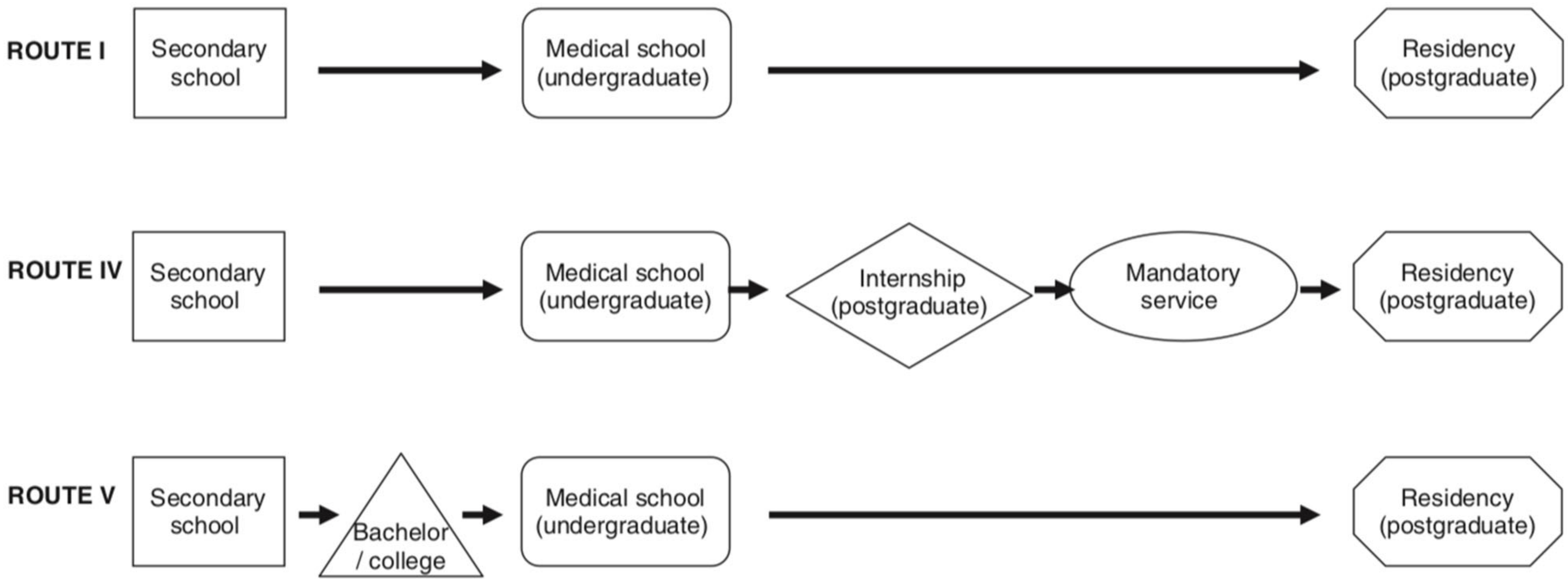

Wijnen-Meijer, Medical Teacher, 2013

"Healthcare crisis fuelled by mismatch between curricula and the needs of patients, families and the health-care system"

Frenk, Lancet, 2010

Mathew et al, JGO, 2018

Universalism

“International standards, which have general applicability for medical education, can be defined."

(World Federation for Medical Education 2003)

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“Curricula often become closely linked to historical legacy that codifies the traditions, priorities and values of the faculty in that profession. Over time the curriculum is rarely re-examined but is slowly modified to accommodate new information”

Frenk, Lancet, 2010

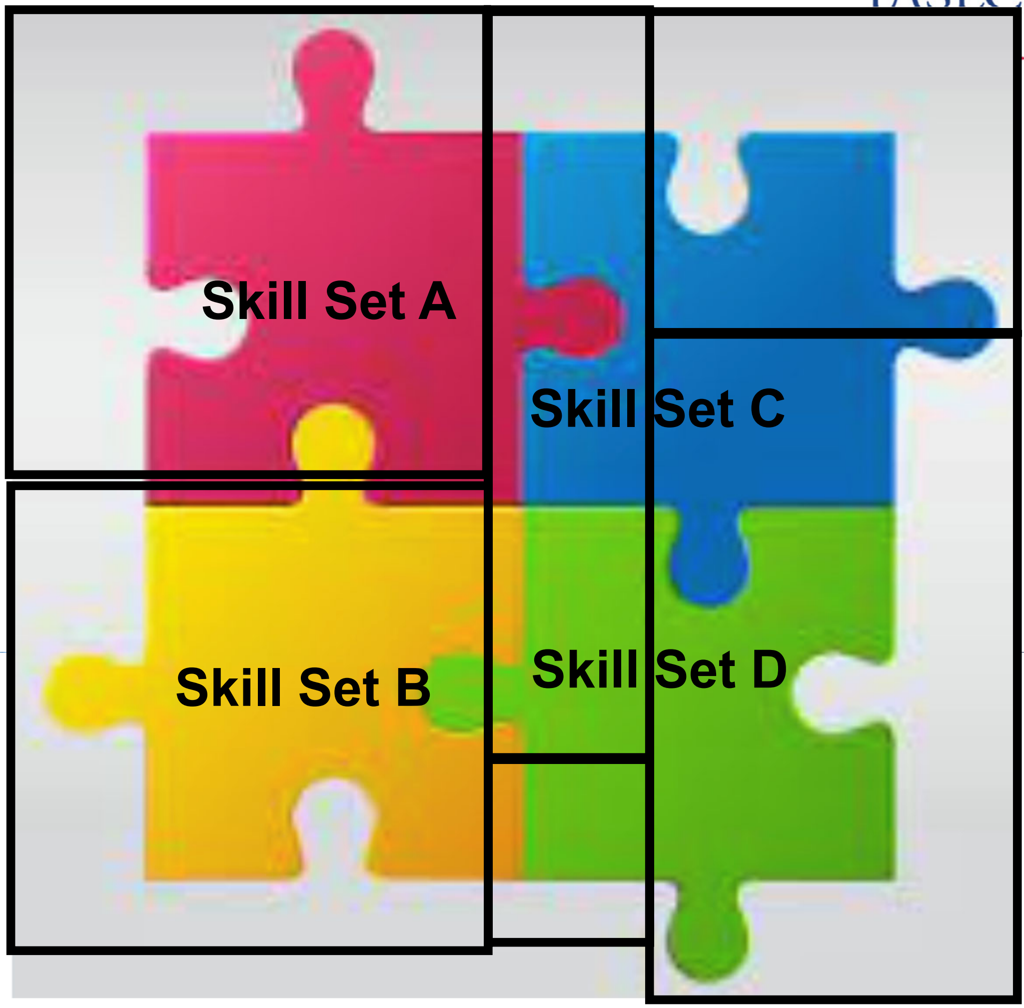
Mathew et al, JGO, 2018

Task Shifting

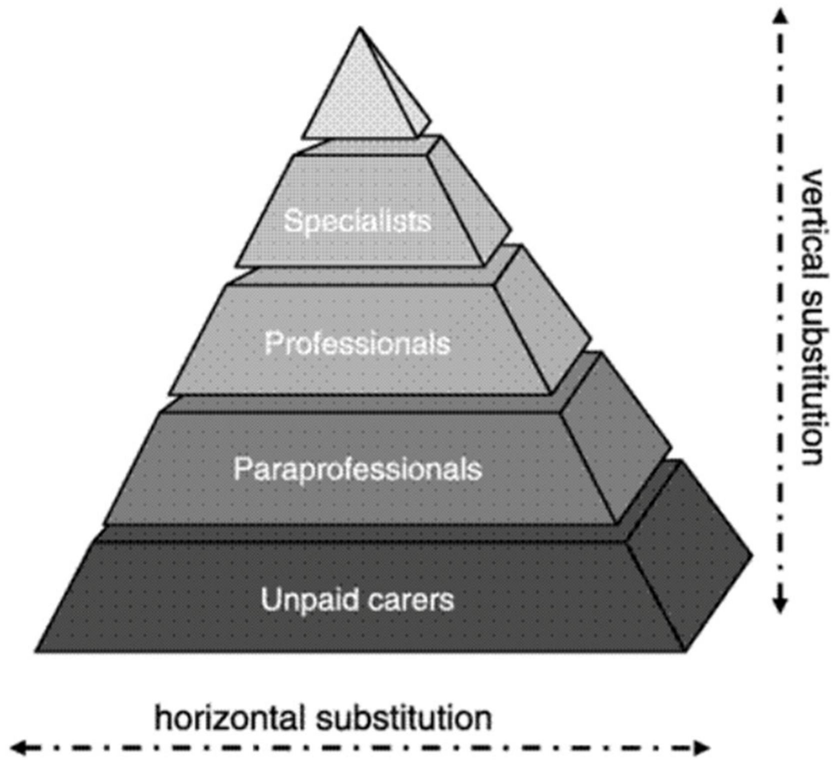
Skills Mix (vs Staff Mix)

Task Shifting

Skills Mix (vs Staff Mix)

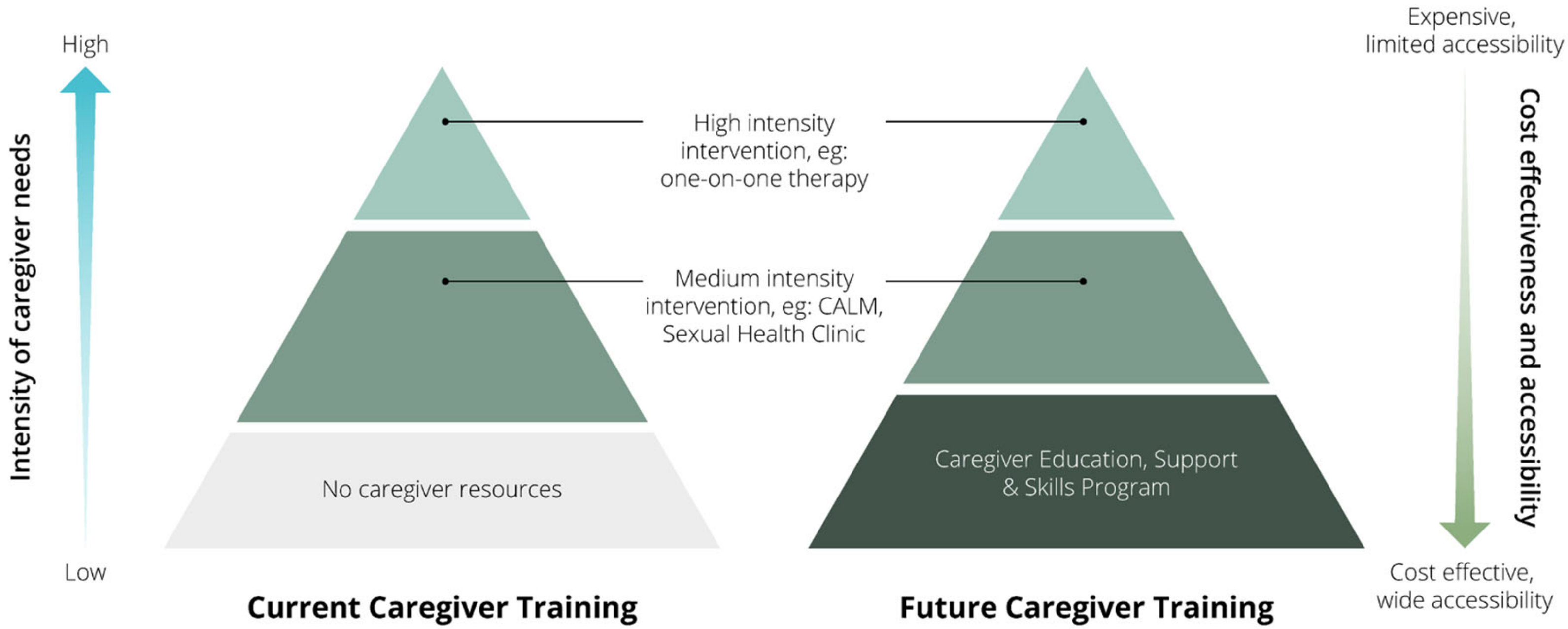


Vertical & Horizontal Substitution



Nancarrow SA, Borthwick AM. Sociology of Health & Illness, 2005

Integrated Caregiver Supports



Giuliani & Papadakos

Whose Priorities?

Global–Local Dynamics

Neocolonialism in medicine

Globalization + Technology

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Traditional

Future

Medical education must become both the vehicle and the object of reform.

Tina Martimianakis
(2016)

Innovation and research to increase access to RT

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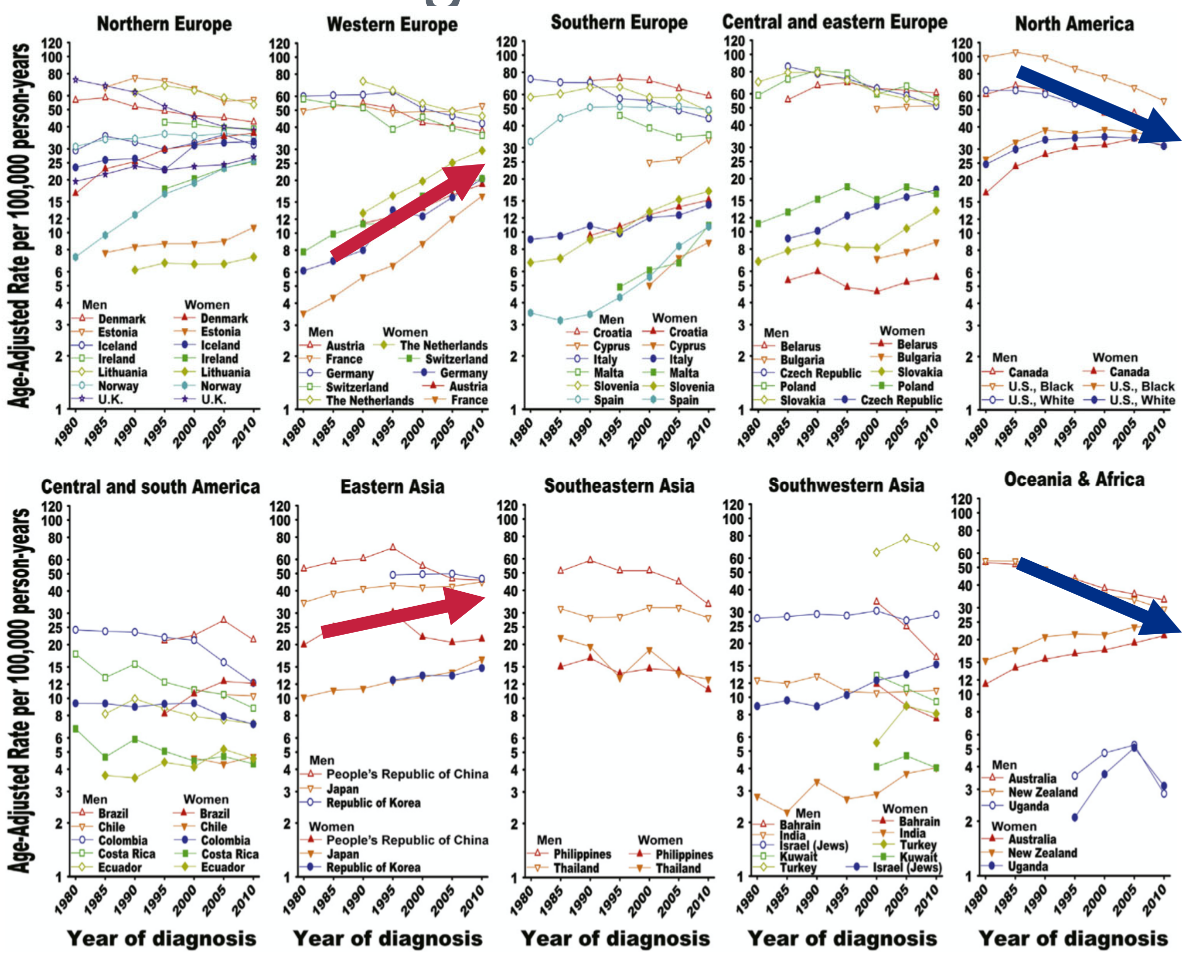
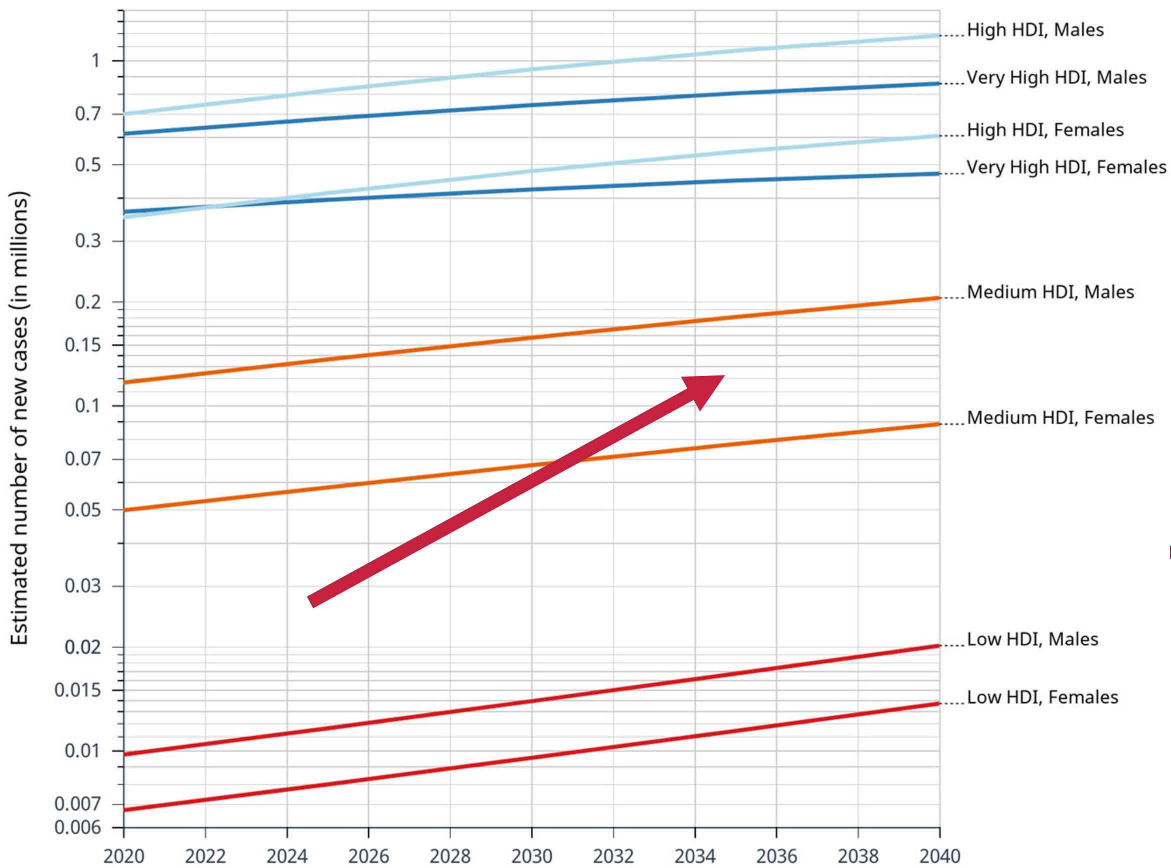
Global variations in Lung Cancer Incidence



Zhang Y, et al. JTO 2021; 16: 933

Increasing LC incidence driven by Low-Medium HDIs



IARC - GLOBOCAN 2021

- Funding
- Lacking cancer registries
- Health care systems
- Infrastructure
- Access to RT

Addressing RT utilization in Lung Cancer

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Author [year]	Diagnosis	Number diagnosed	Cancer registry	Year of diagnosis	Overall ARUR	Time of RT
Asli [2014]	Lung cancer	2,784	Norway	2009	44%	Within 1 year of diagnosis
Chalubinska-Fendler [2015]	Lung cancer	1,307	Central Poland	2009–2012	2009: 24%; 2010: 25%; 2011: 22%; 2012: 27%	2009–2012
Mackillop [2015]	Lung cancer	16,599	Ontario, Canada	November 2009–October 2011	45%	Within 1 year of diagnosis
[illegible]vens [2017]	Lung cancer	14,417	Belgium	2009–2010	39%	Within 9 months of diagnosis
					46%	Within 4–5 years of diagnosis
McLaughlin [2018]	Lung cancer	7,681	Ontario, Canada	January 2011–December 2012	46%	Within 1 year of diagnosis
					52%	Estimated lifetime ARUR using MCUT method
Seo [2018]	Lung cancer	50,384	South Korea	2011–2015	2011: 41%; 2014: 45%	2011–2015
Carrato [2014]	NSCLC	3,508	Prospective study of 182 cancer centres in Belgium, France, Germany, Turkey, Greece, Italy, Portugal and Spain	January–March 2009	Stage I–II: 23%; stage III: 50%; stage IV: 35%; overall: 37%	Followed prospectively for a minimum of 1 year or until death
Haque [2018]	NSCLC, stage IA	15,960	USA (SEER)	2009–2012	2009: 21%; 2010: 23%; 2011: 23%; 2012: 29%. Excludes patients who underwent surgery and RT	2009–2012
Ahmed [2017]	SCLC, stage I	1,902	USA (SEER)	2007–2013	2009: 49%; 2010: 53%; 2011: 47%; 2012: 44%; 2013: 50%	2007–2013

Actual RT Utilization Rate: 21% to 52%

Optimal RT Utilization Rate: 62% to 82%

What happens with LMICs?

Liu W, et al. Transl Lung Cancer Res 2019; 8: S163

Many organizations improving access to RT

- International Atomic Energy Agency (IAEA)
  - Program of Action for Cancer Therapy (PACT)
- Union for International Cancer Control (UICC)
  - Global Task Force on Radiotherapy for Cancer Control
- Several partnerships HIC academic - LMIC institutions
- Others
  - Above&Beyond Cancer, AMPATH, AORTIC, ALIAM, AAPM, ASTRO,…

International Atomic Energy Agency (IAEA)

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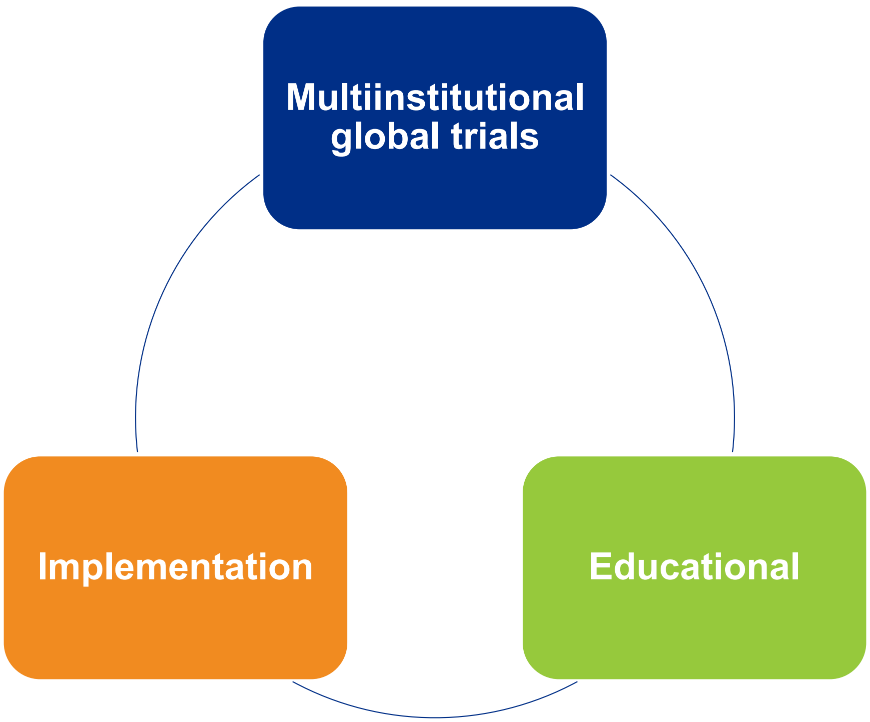
- Improving access to safe and efficient RT, diagnostic imaging, and nuclear medicine
- Coordinated Research Programs
- IRIS platform
- Directory of Radiotherapy centers
- Human Health Campus

IAEA
International Atomic Energy Agency

Abdel-Wahab M., et al. JCO Glob Oncol 2021; 7: 827

Research focusing on global access to RT



- Introducing RadOncs in LMICs to clinical research activities
- Minimize selection bias in clinical trials
- Knowledge gap between EBIs and delivery
- Innovation in education. Blended learning
- Hardware

Abdel-Wahab M., et al. JCO Glob Oncol 2021; 7: 827

Opportunities for innovation and collaboration

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- Telecommunication
- Automation
- Remote support
- Virtual collaborative spaces
- Blended learning

Implementation Research

	Process	Technology	Personnel
Preparation	Assessment and prescription		Radiation oncologist
	Imaging for treatment planning	CT simulator	Radiation technologist
	Treatment volume determination	Planning system	Radiation oncologist
	Treatment planning	Planning system	Dosimetrist
	Pretreatment review and quality-control checks	Recording and verification	Radiation oncologist
	Data transfer		Medical physicist
Treatment (X n fractions)	Treatment-related quality control	Guidance technology	Radiation technologist
	Pretreatment image guidance	Linear accelerate	Medical physicist
	Dose delivery	^{60}Co unit	Service engineer
	On-treatment care		Radiation oncologist
			Nurse
Follow-up	Ongoing follow-up		Radiation oncologist
			Nurse

- Implementation challenges
  - Quality and safety
- Local regulations
- Adapting guidelines
- Role of each RT professional

Atun R., et al. Lancet Oncol 2015; 16: 1153

Increasing access to EBRT

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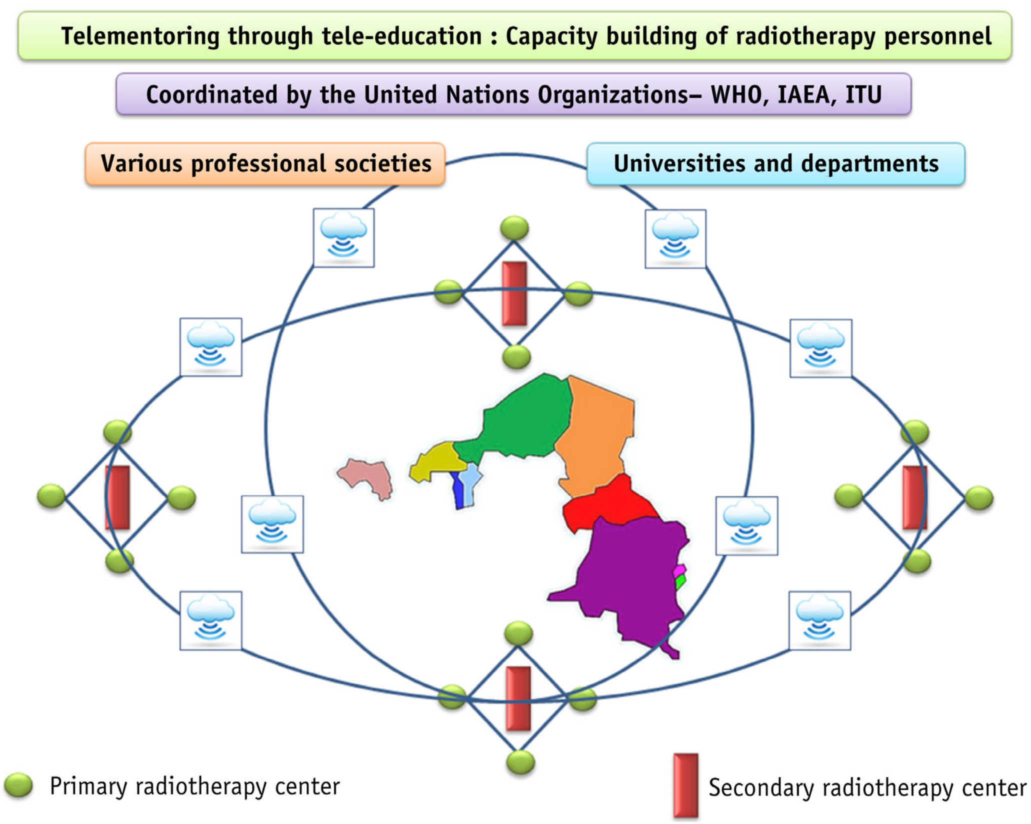
- Co60 units
  - Lack of machine development?
  - Improved RT delivery achievable with Co60-based IMRT
  - Security issues

- Simpler LINACs
  - Development is proprietary
  - Removal of parts that require frequent repair
  - e.g, fixed-beam radiotherapy

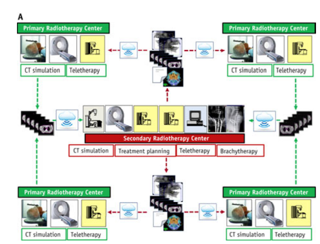
Rodin D., et al. JTO 2015; 11: 21

Tele-Radiotherapy



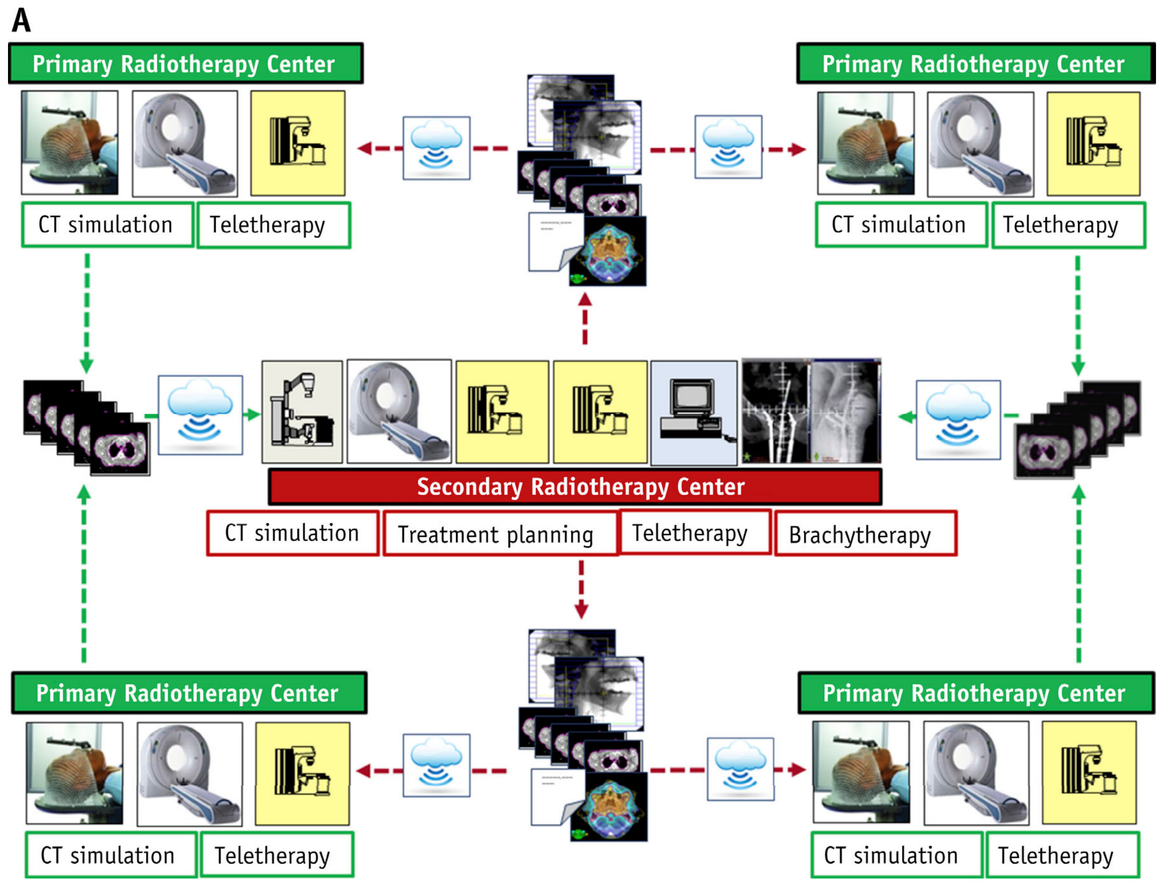
Datta N., et al. IJROBP 2016; 95: 1334

Coordinated knowledge transfer



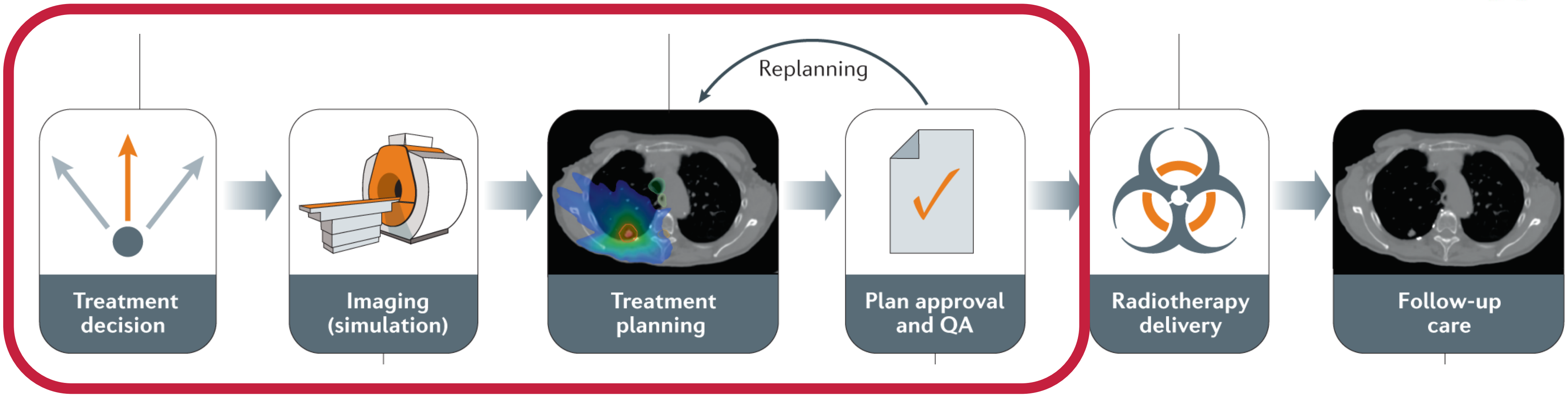
Tele-Radiotherapy

› Remote planning
› Automated quality assurance



Datta N., et al. IJROBP 2016; 95: 1334

Artificial intelligence in Global RT



- Alleviate workforce shortages
- Access to knowledge and experience across disease sites

- Impact on hardware shortages?

Huynh, E. et al. Nat Rev Clin Oncol 2020; 17: 771

Summary

- LMICs are driving the increase in the incidence of LC worldwide
- Global access to RT for LC must be tackled at many levels
  - Healthcare systems
  - Hardware shortages
  - Human resources
- Research and innovation to ↑↑ access to RT for LC
  - Implementation and adaptation
  - Global clinical trials
  - Education

Resources

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- Zhang Y, et al. JTO 2021; 16: 933
- IARC - GLOBOCAN
- Liu W, et al. Transl Lung Cancer Res 2019; 8: S163
- Abdel-Wahab M., et al. JCO Glob Oncol 2021; 7: 827
- Atun R., et al. Lancet Oncol 2015; 16: 1153
- Rodin D., et al. JTO 2015; 11: 21
- Datta N., et al. IJROBP 2016; 95: 1334
- Huynh, E. et al. Nat Rev Clin Oncol 2020; 17: 771