MRO.ART
MODERN RADIATION ONCOLOGY
35° RESIDENTIAL COURSE

ESTRO HERO ECF ESTRO Cancer Foundation

Advanced Radiotherapy in Europe:
A Right for All or a Privilege for a few?

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GART Advanced Radiation Therapy

access to radiotherapy

access to innovative radiotherapy

reasons for inequitable access to innovation

possible solutions to support more equitable access

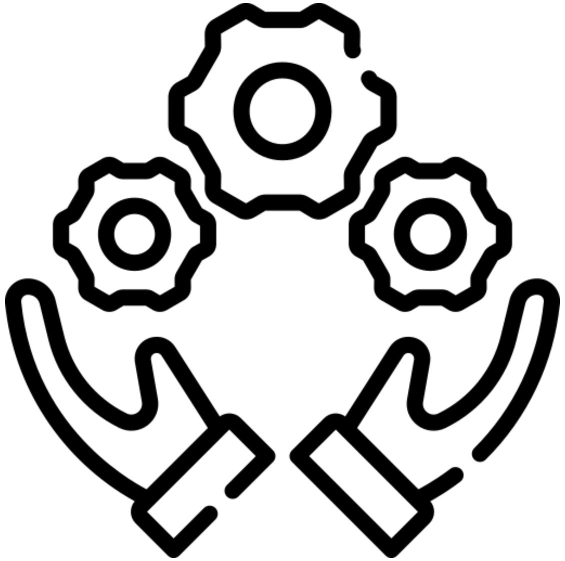
from innovation to clinical practice

evidence-based innovation

17–20 years

less than **50%**

80% \$ no impact



clinical practice

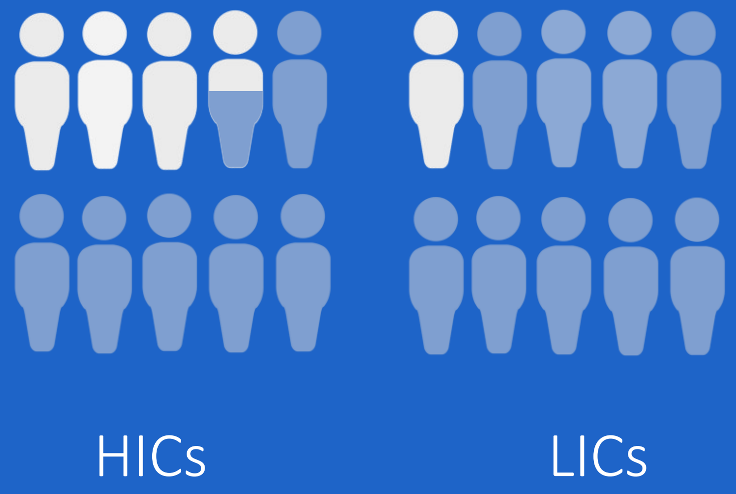
Bauer and Kirchner, Psychiatry Res 2020

access to innovation
to advanced radiotherapy

access
to radiotherapy

5 / 10 patients

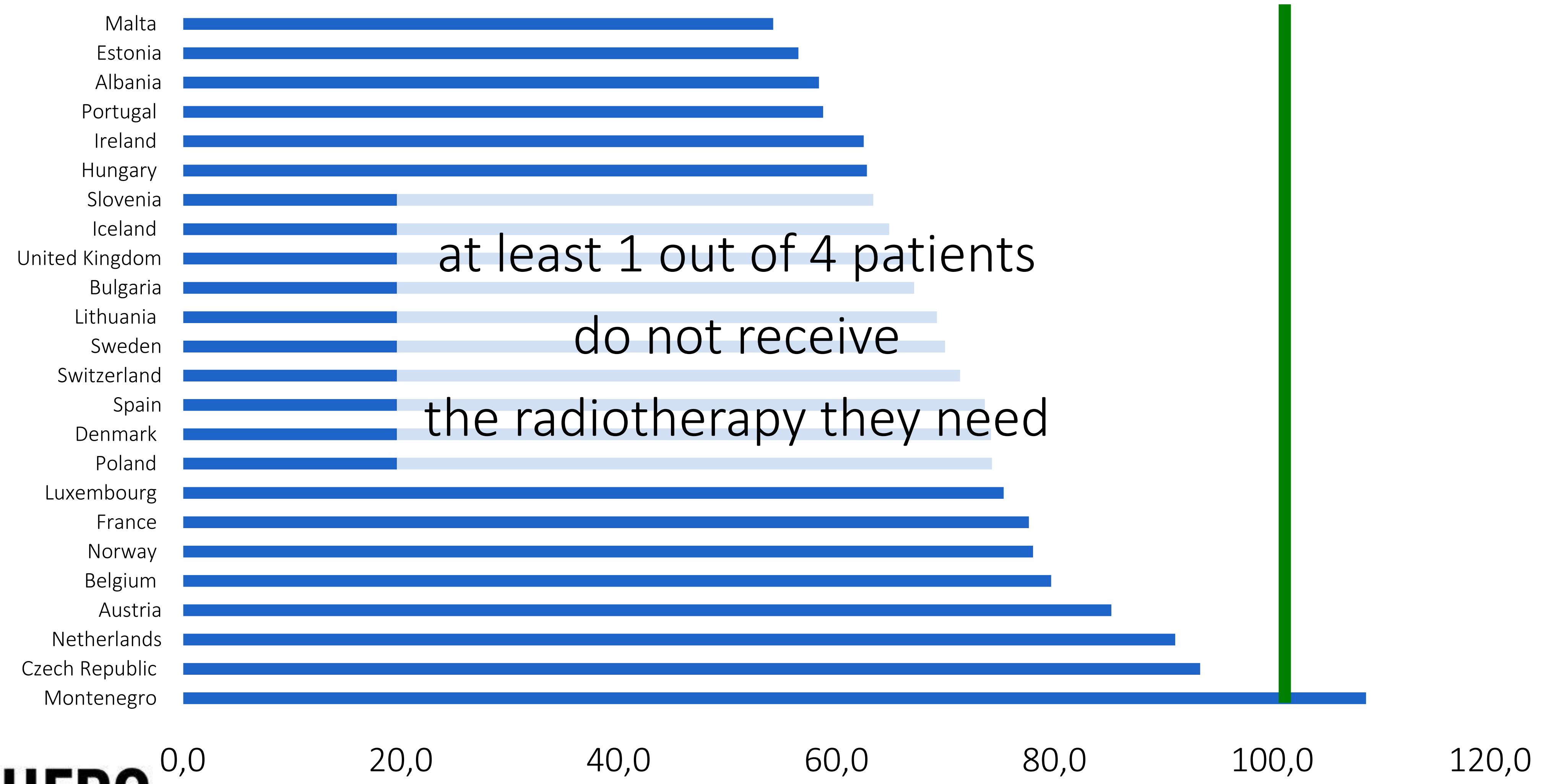
should receive radiotherapy



Atun et al, Lancet Oncology Commission 2015

do we provide optimal & equitable access?

to radiotherapy, in Europe



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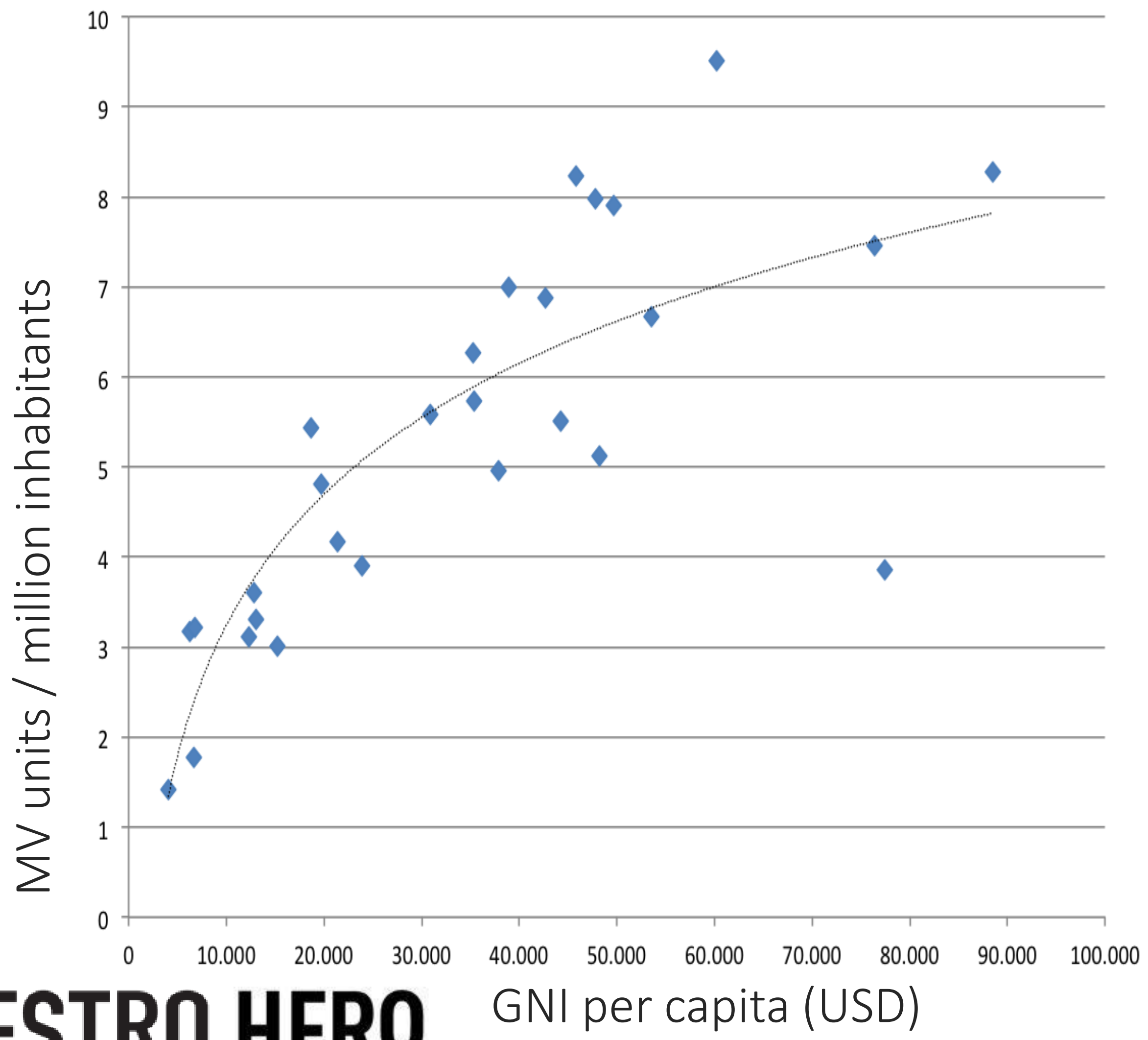
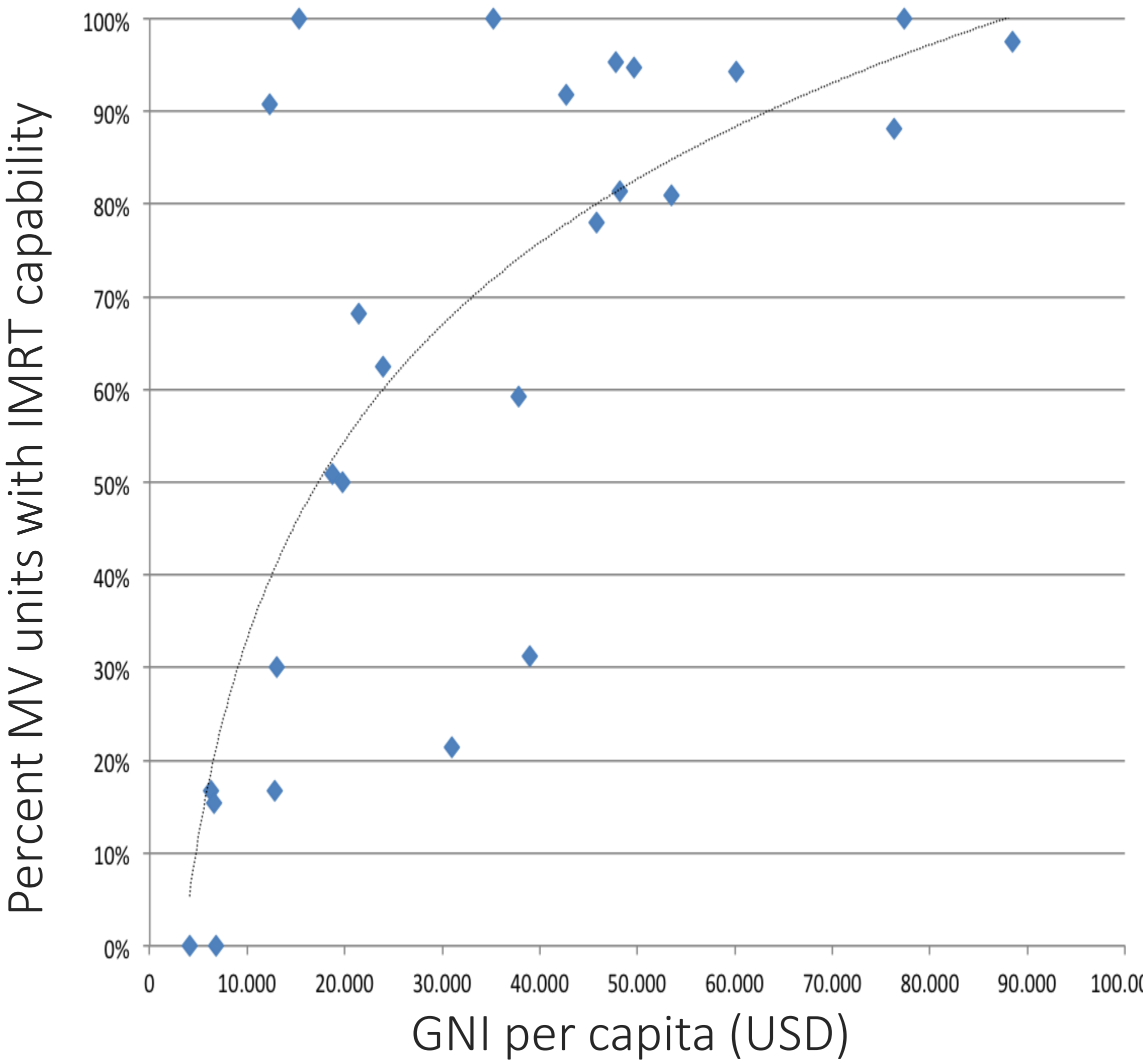
Borras et al, Radiother Oncol 2015

resource availability

variable availability of (IMRT capable) MV units in Europe





Grau et al, Radiother Oncol 2014

resource availability

variable availability of MV units and personnel in Italy

Macroregion	Old machines/ EBRT machines	Physicists/ EBRT machine	Radiation oncologists/ EBRT machine	RTTs/ EBRT machine	Treated patients/ EBRT machines
South	0.2	1.2	5.0	3.5	438.3
North-West	0.5	1.2	3.5	2.4	378.6
North-East	0.2	1.6	6.0	3.6	451.9
Central Italy	0.2	1.1	4.7	3.2	389.9
Islands	0.4	1.1	3.7	2.9	330.6

SUPER (System for sUrvey on radiotheraPy trEatments and data stoRage and analysis).

An AIRO Project

AIRO Associazione Italiana Radioterapia e Oncologia clinica

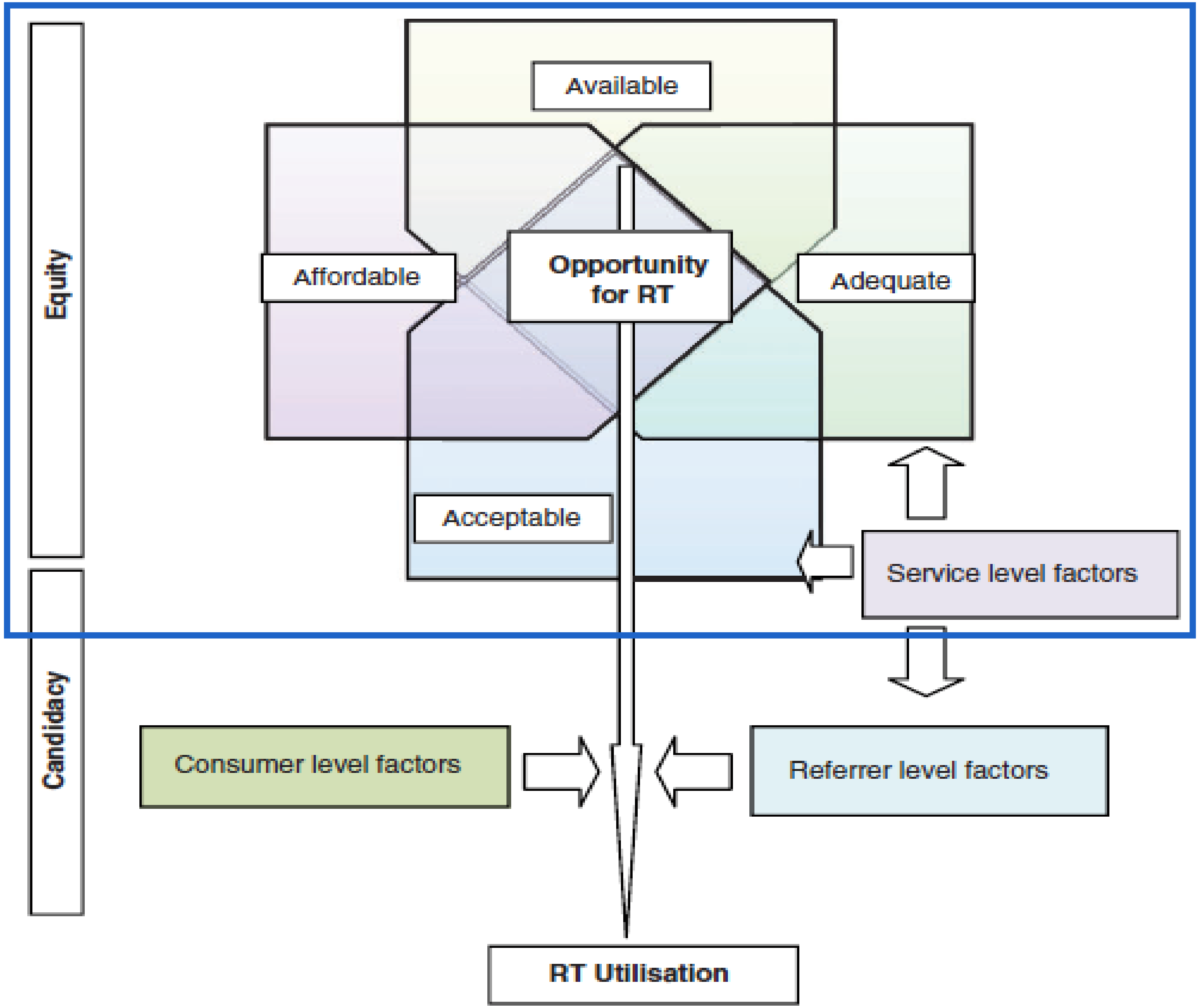
Courtesy Luca Tagliaferi

access

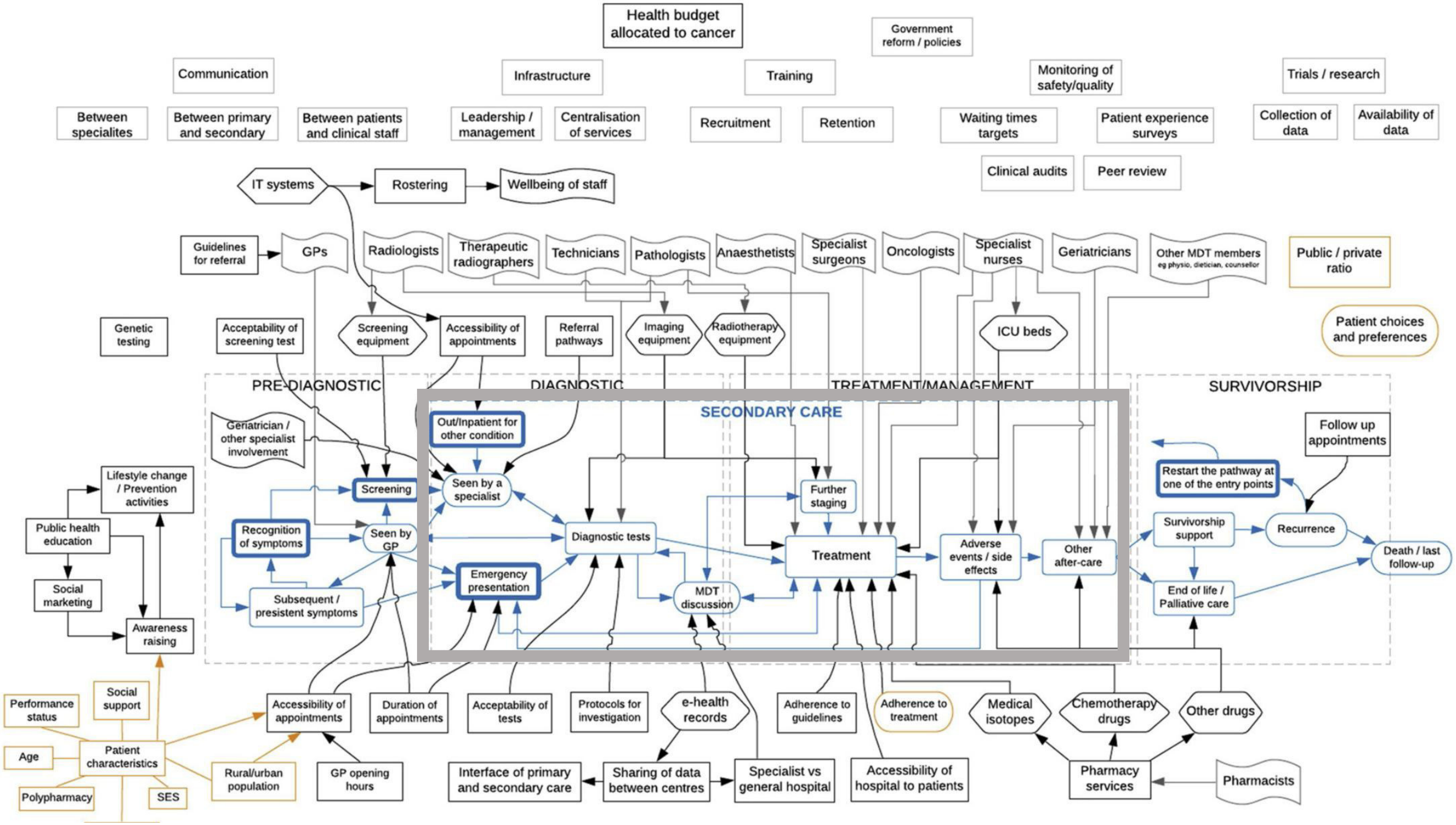
to radiotherapy

to advanced radiotherapy

= multifactorial



Sundaresan et al., Austral. Health Rev. 2015

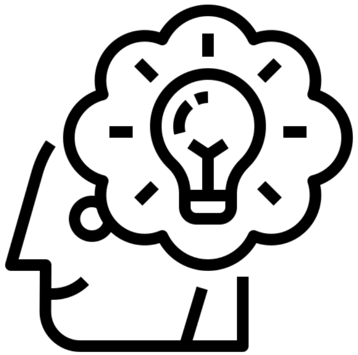


No innovation improves patient care and outcomes without first navigating its way through the health system!

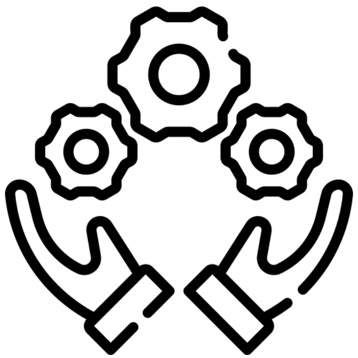
Morris et al, J Cancer Policy 2020

what is (radiotherapy) innovation?

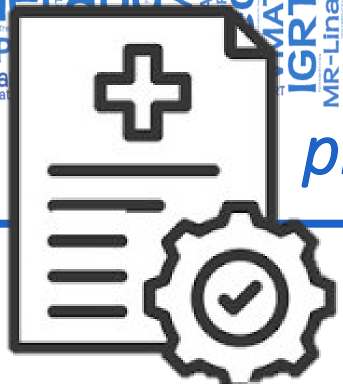
scientific discovery



clinical practice



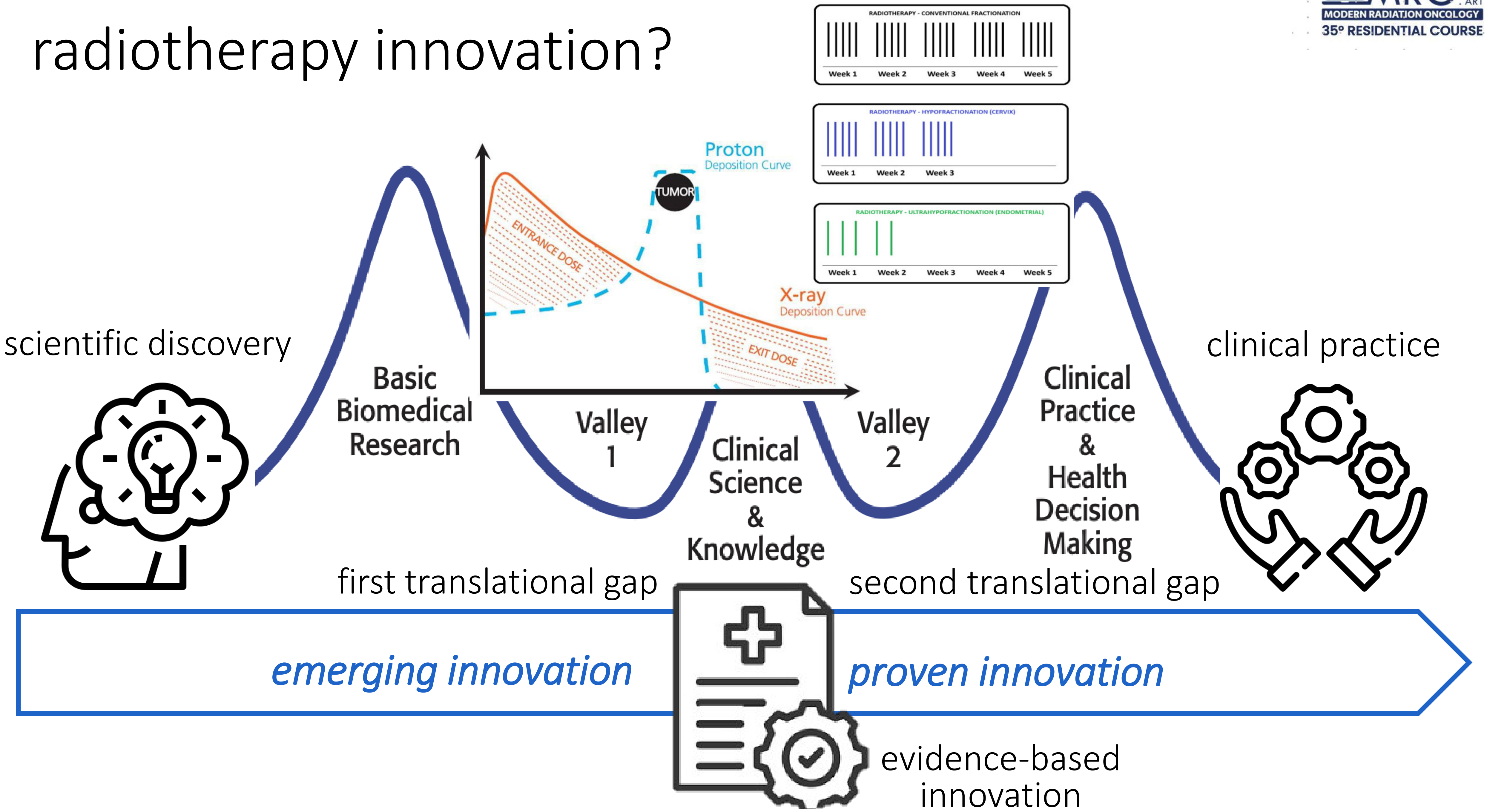
emerging innovation



proven innovation

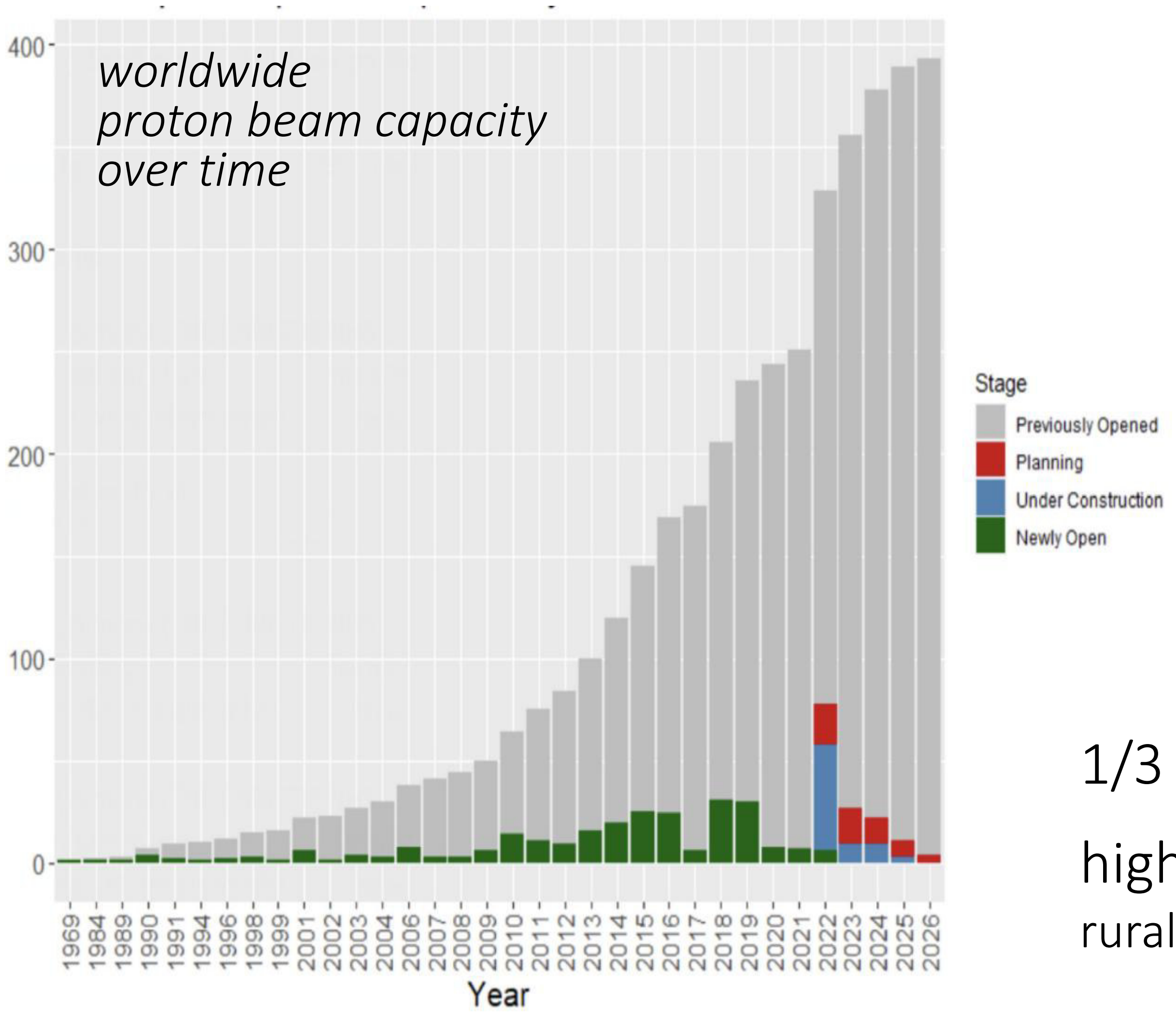
evidence-based innovation

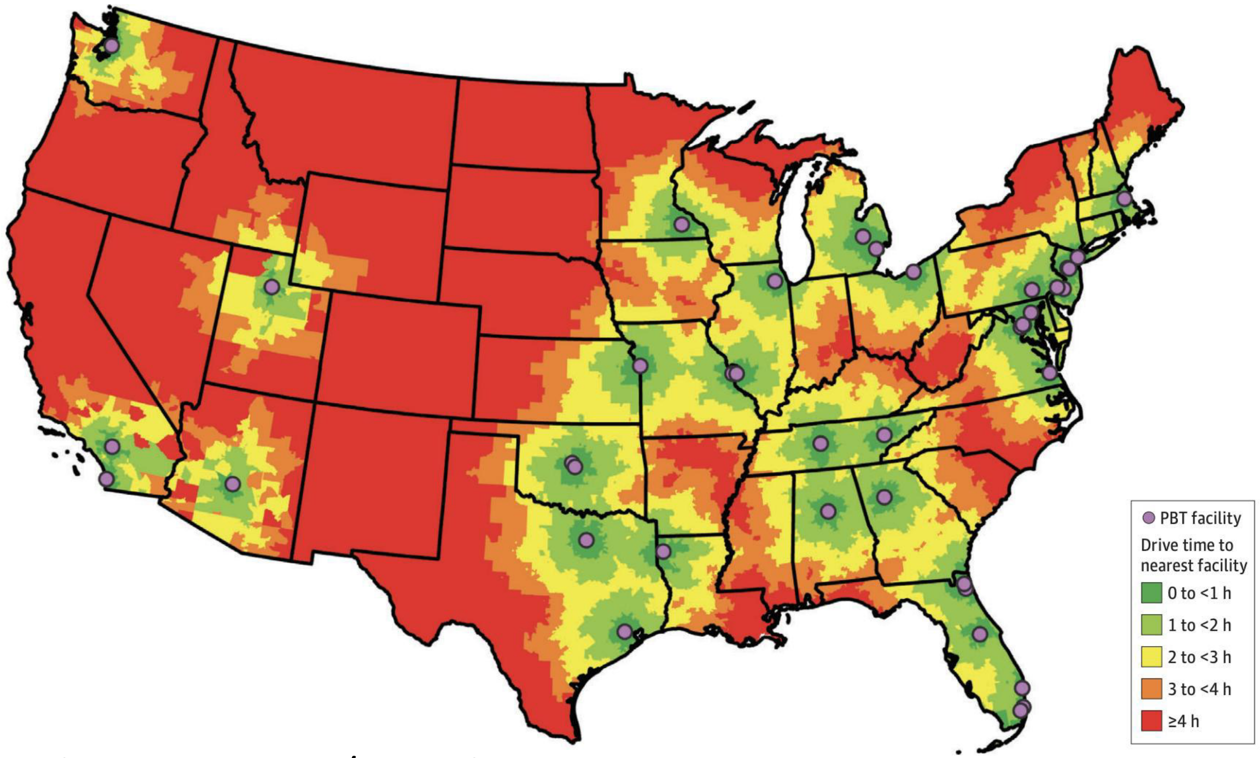
radiotherapy innovation?



particle therapy

growing, yet inequitable capacity and access





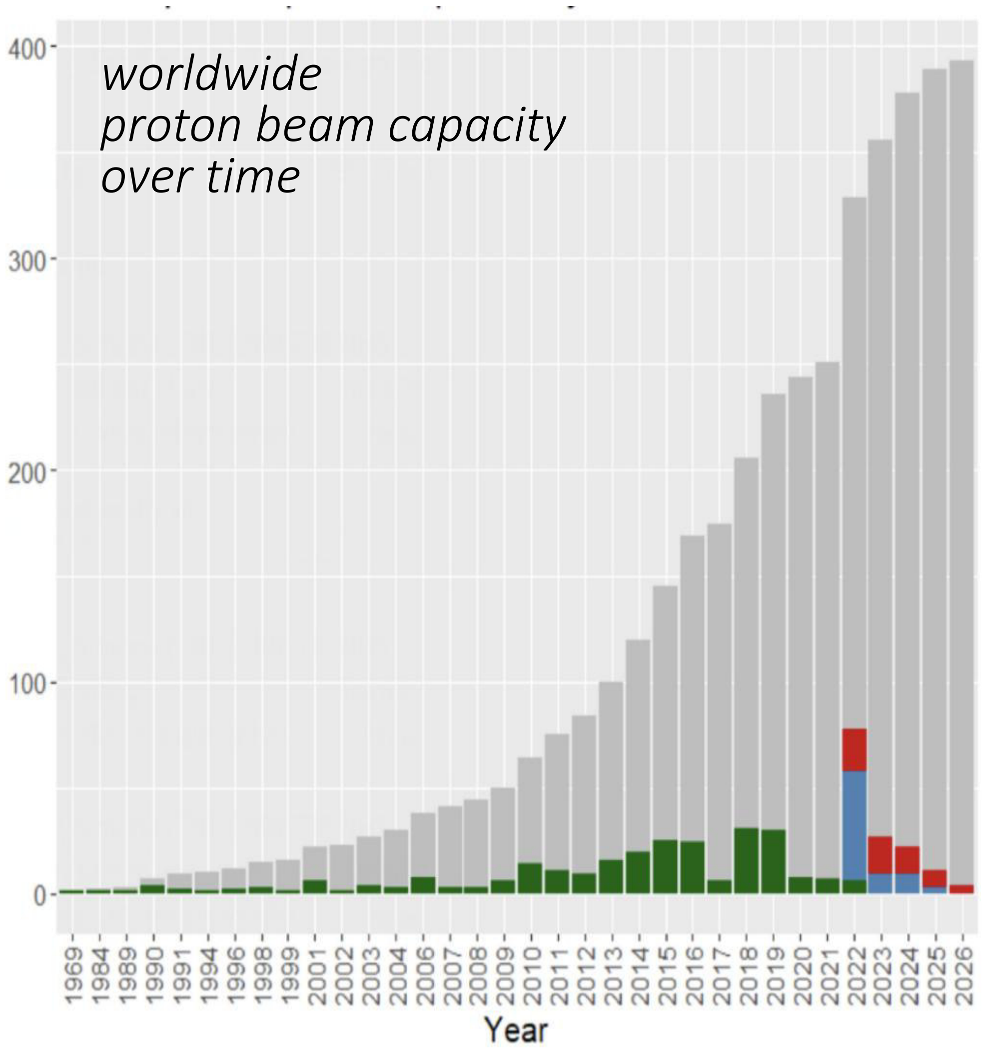
1/3 <1h – up to 1/6 >4h to nearest PBT centre

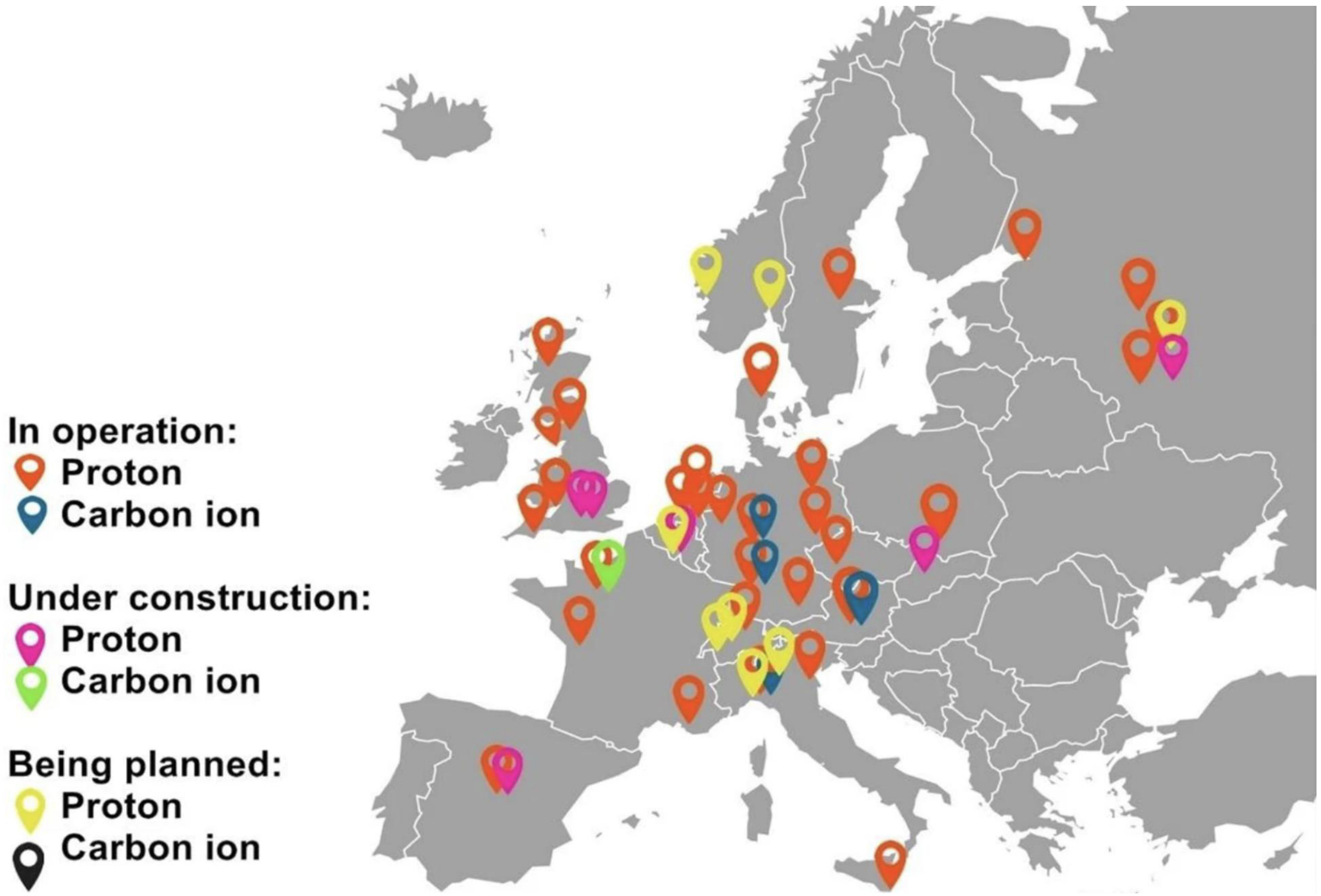
higher odds ratio for > 4 hours:

rurality (2.45), age > 65 years (1.09), poverty (1.22)

Gaito et al, Clin Oncol 2023
Burus et al., JAMA 2024

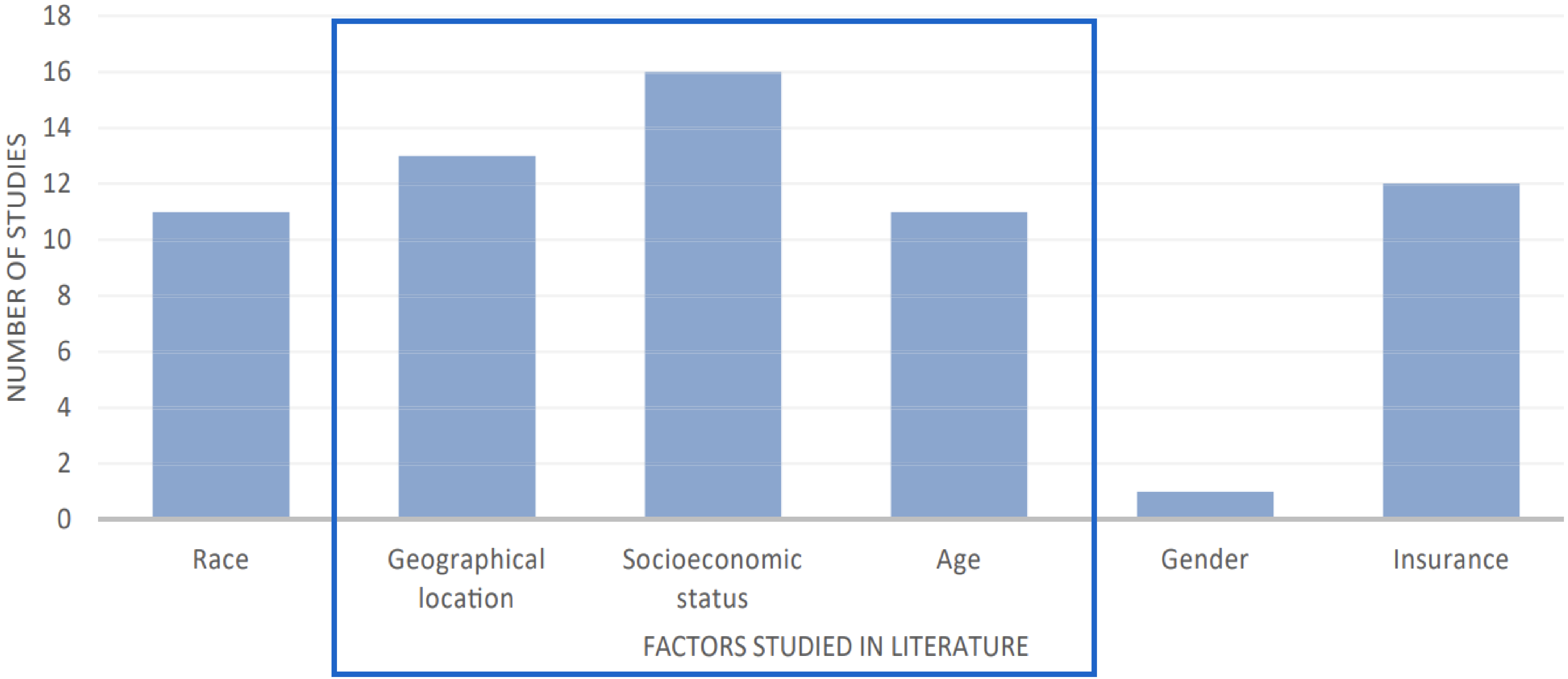
particle therapy
growing, yet inequitable capacity and access





Gaito et al, Clin Oncol 2023
Leander Litov. Health & Technology 2024

particle therapy
factors for inquity in access, literature



Gaito et al, Clin Oncol 2023

particle therapy

barriers to equitable access, Netherlands

Barriers	Subcategories	Interventions
Patient eligibility	Lack of knowledge	Educate and train ROs from referring RT centres; involve ROs from referring centres in developing NIPPs; make easily accessible information on eligibility
	Model-based indications	Add intuitive eligibility criteria; educate and train ROs from referring centres.
Logistics	Careful planning of concurrent chemo-and radiotherapy	Involve the other medical disciplines, such as medical oncologists, surgeons, pulmonologists, gastro intestinal oncologists.
	Increased lead time due to plan comparison	Submit the delineated planning CT immediately to the PTC, to enable simultaneous treatment planning of PT and photon plan; non-PTCs make a draft PT plan.
	Information exchange	Improve data exchange, reduce administration.
	Communication	Communication between non-PTC and PTC at several steps in the care-path: i.e. a priori eligibility, progress of plan comparison, developments during PT treatment, after PT treatment.
Travel	Information and burden	Assistance in travel and stay-arrangements, including a tool with overview of solutions.
Patients choice	Information and support	Install a case manager in the PTC; develop a decision aid; appoint a coordinating RO in the PTC for the referring RO.
	Shared Decision Making	Educate the referring RO, manage patient expectation by already mentioning PT early in the care-path, in the multidisciplinary team.
Perceived added value of PT	Scientific evidence	Collect more evidence by recording outcomes of treated patients, validation of the models; consider designing RCTs.
	Awareness	Knowledge-sharing between PTC and non-PTC, and also involve other medical professionals, such as medical oncologists, surgeons, pulmonologists, gastro intestinal oncologists.

micro- & meso-level

Thijssen et al, Radiother Oncol 2023

barriers & facilitators

Micro-level

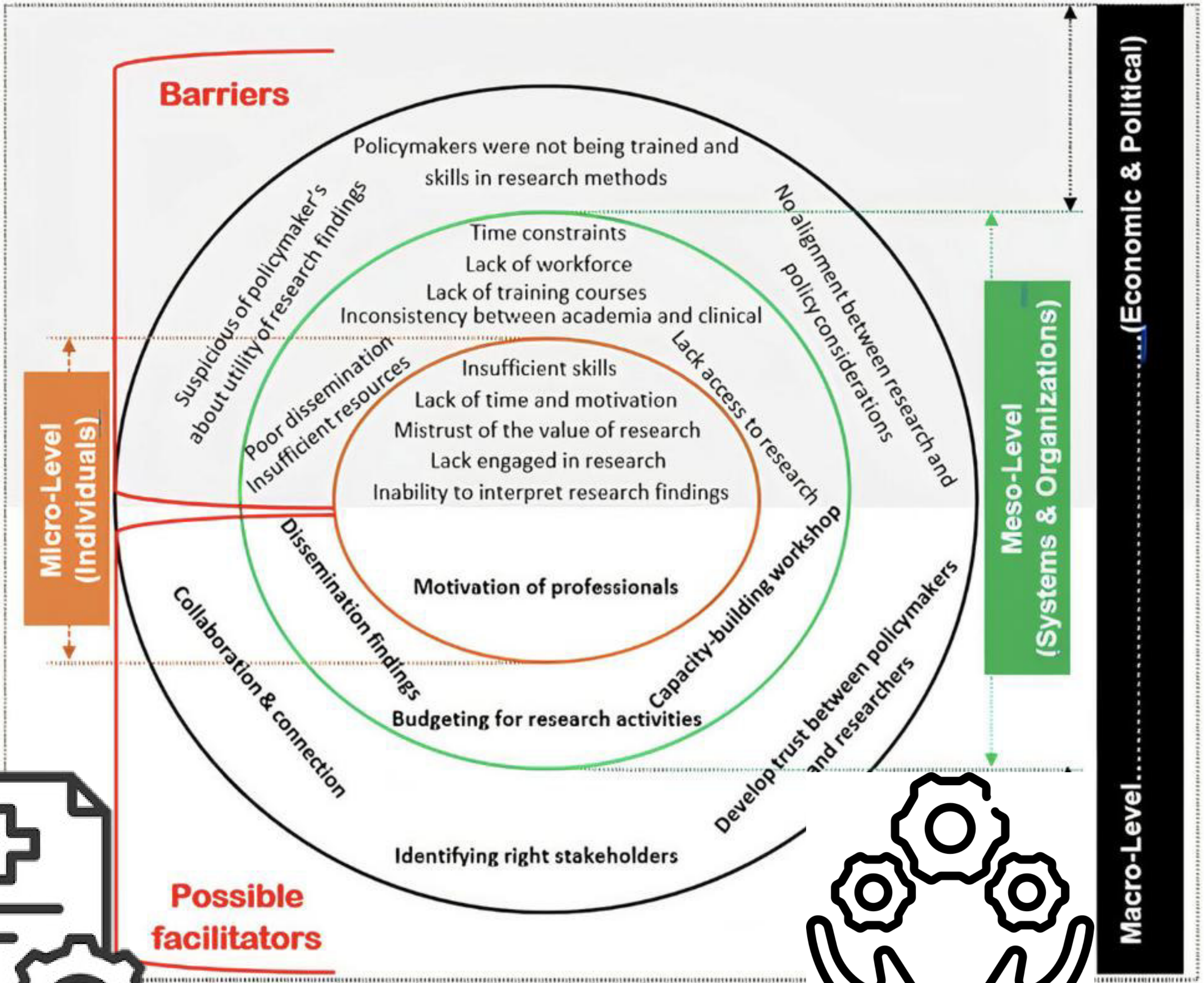
individuals

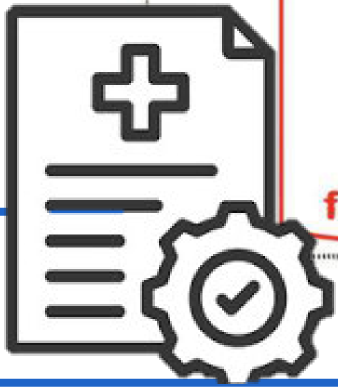
Meso-level

systems or organisations

Macro-level

economic and political





proven innovation

Abu-Odah et al, Health Soc Care Community 2022

hypofractionation
breast cancer, variation in utilisation

	Radiation oncology departments (D1-D11)										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
*Specific indications**											
Youngest patients' by protocol	< 45	45	50	50	50	70	-	70	50	50	-
"Low risk" patients[a]	Unified practice	Unified practice	Physician-dependent	Unified practice	Mostly indicated	Physician-dependent	Mostly indicated	Mostly indicated	Mostly indicated	Mostly indicated	Unified practice
Adjuvant chemotherapy	Unified practice	Unified practice	Physician-dependent	Physician-dependent	Mostly indicated	Not indicated	Physician-dependent	Not indicated	Physician-dependent	Not indicated	Unified practice
Neoadjuvant chemotherapy	Unified practice	Unified practice	Physician-dependent	Physician-dependent	Mostly indicated	Not indicated	Not indicated	Not indicated	Physician-dependent	Not indicated	Physician-dependent
Left sided breast	Unified practice	Unified practice	Physician-dependent	Physician-dependent	Mostly indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Physician-dependent
RNI	Physician-dependent	Mostly indicated	Physician-dependent	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Physician-dependent	Not indicated	Not indicated
Large/pendulous breasts	Mostly indicated	Mostly indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Physician-dependent	Not indicated	Not indicated
All biological BC sub-types	Unified practice	Unified practice	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Physician-dependent	Not indicated	Not indicated
Grade 3	Mostly indicated	Mostly indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Physician-dependent	Not indicated	Not indicated
Chest wall	Mostly indicated	Mostly indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated

Categories of use

- Not indicated
- Physician-dependent
- Mostly indicated
- Unified practice

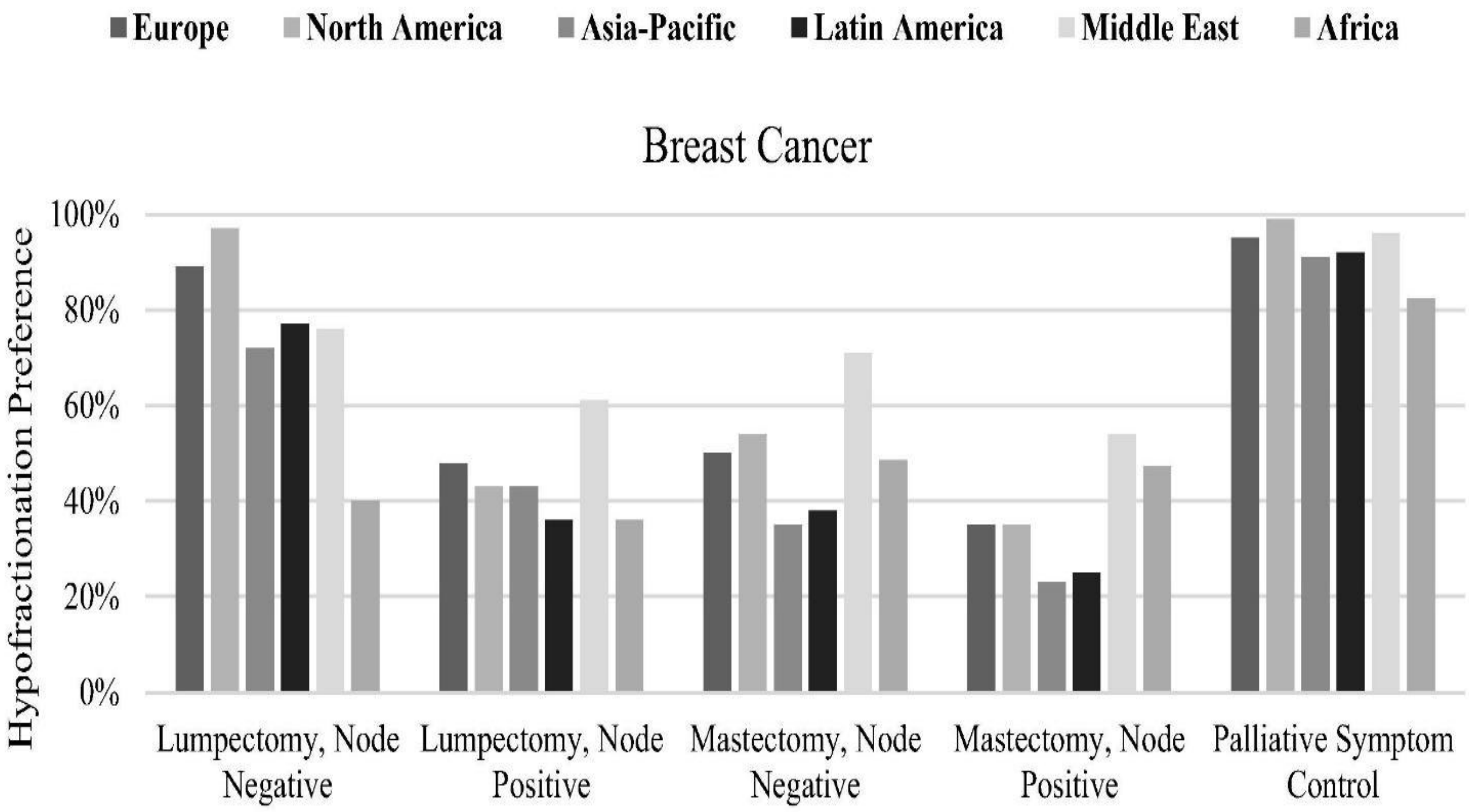
[a] Patient ≥70 year-old with conservative surgery, stages I-II, free margins, negative nodes, positive receptor, and no left-breast irradiation.

* Including exceptions related to each patient profile (e.g. neoadjuvant chemotherapy for left-sided breast) depending on the physician/department.

Note:
Ontario trial, first results: 2002
5-year START results: 2008
10-year results Ontario: 2010

Prades et al, R&O 2017

hypofractionation
utilisation, barriers & justifications



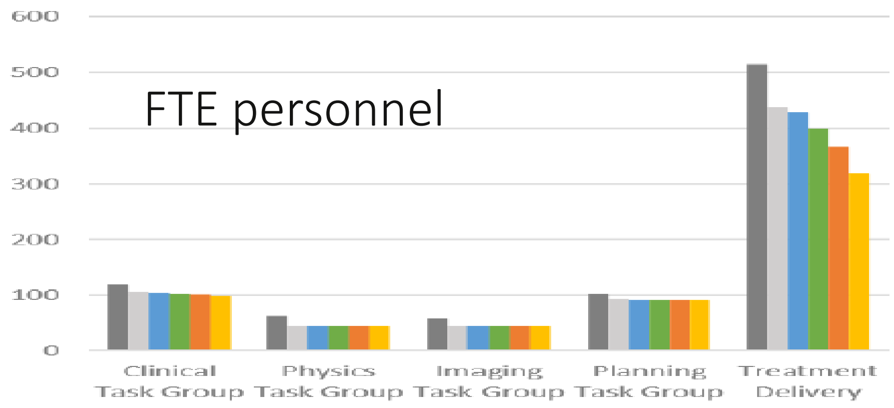
Barriers	N=858	No (%)
Clinical evidence	Lack of long-term data	299 (34·8%)
	Inferior local control	99 (11·5%)
	Acute toxicity	176 (20·5%)
	Late toxicity	300 (35·0%)
Economic and Resource Impact	Technology	72 (8·4%)
	Reimbursement	109 (12·7%)
Professional Culture	Personal preference	157 (18·3%)
	Peer preference	112 (13·1%)
Patient Considerations	Patient preference	119 (13·9%)

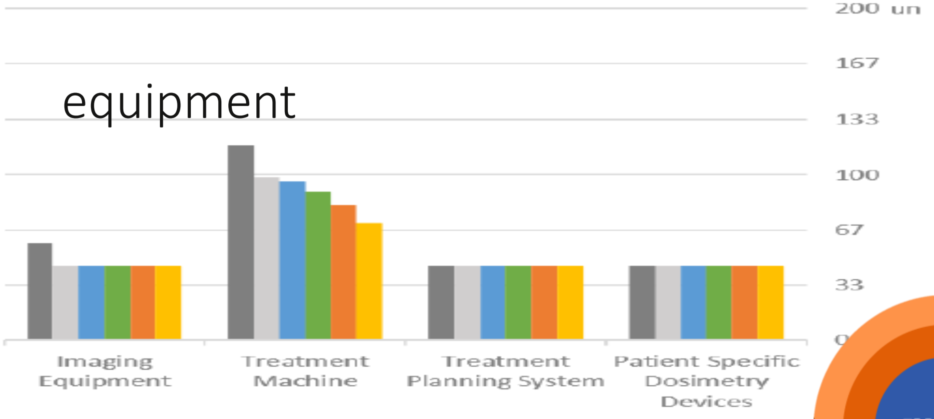
Justifications	N=755	No (%)
Clinical Evidence	Evidence	559 (74·0%)
	Equivalent local control	511 (67·7%)
	Equivalent toxicity	474 (62·8%)
Economic and Resource Impact	Resource optimization: machine	441 (58·4%)
	Resource optimization: expense	377 (49·9%)
	Reimbursement	24 (3·2%)
Professional Culture	Prior clinical experience	275 (36·4%)
	Personal preference	329 (43·6%)
	Peer-accepted	289 (38·3%)
Patient Considerations	Patient preference	222 (29·4%)
	Patient convenience	487 (64·5%)

Rodin et al, Radiother Oncol 2021

hypofractionation

resource use





ESTRO HERO

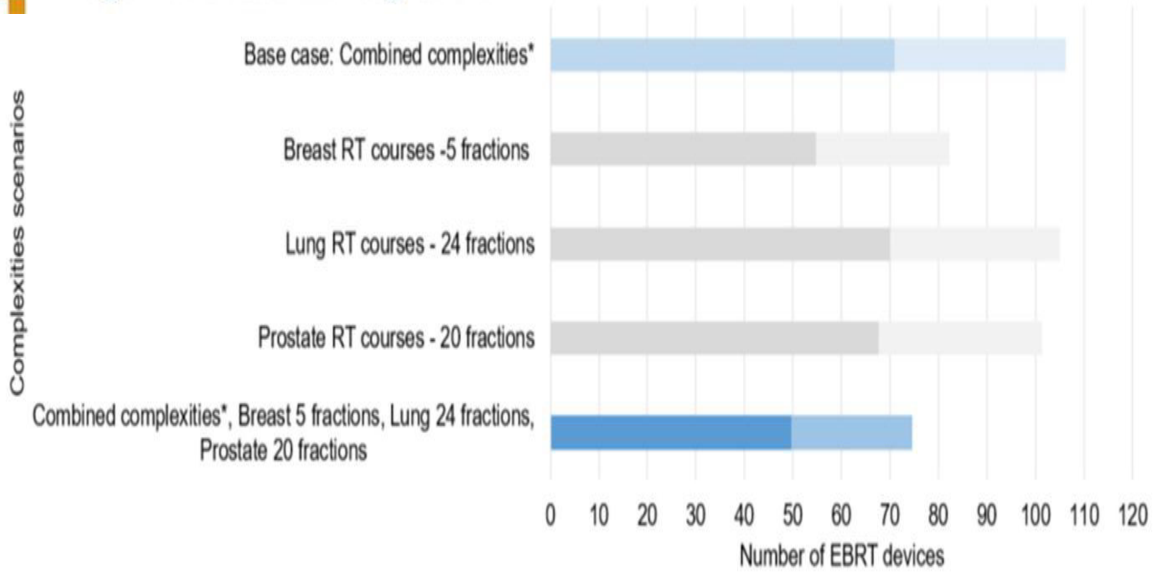
EBRT-Core

RO-Support

Beyond-EBRT

KCE

Belgian Health Care Knowledge Centre

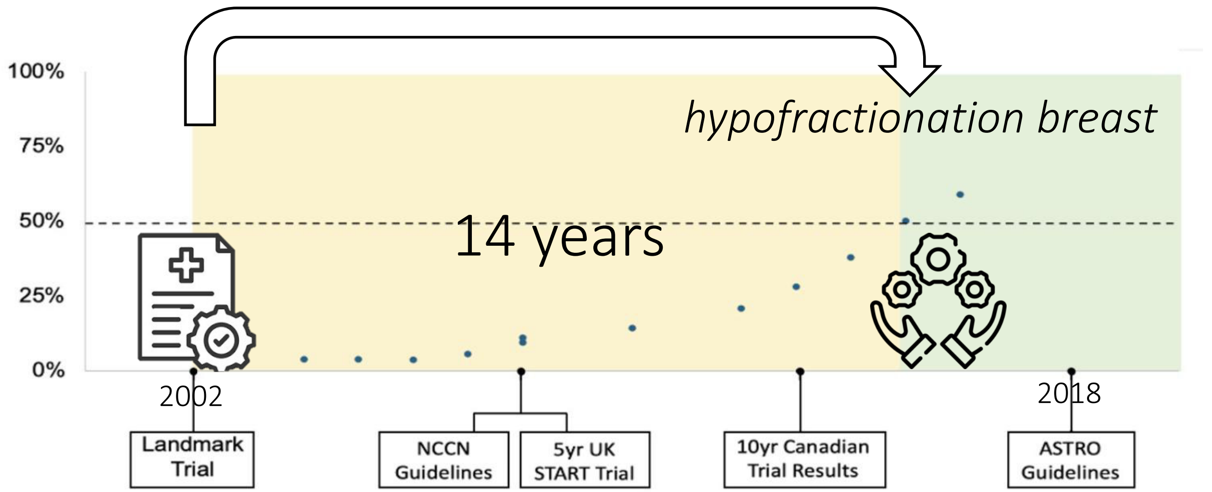


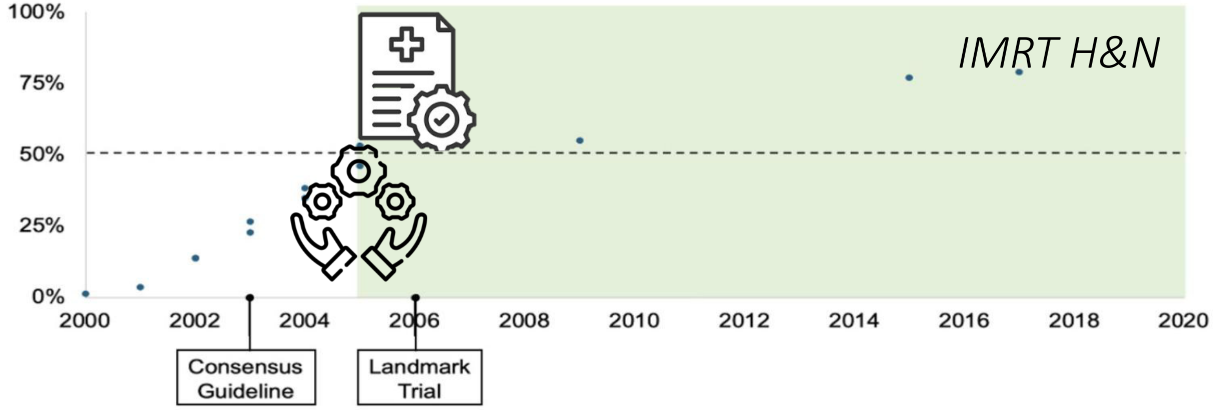
Defourny et al, Radiother Oncol 2019

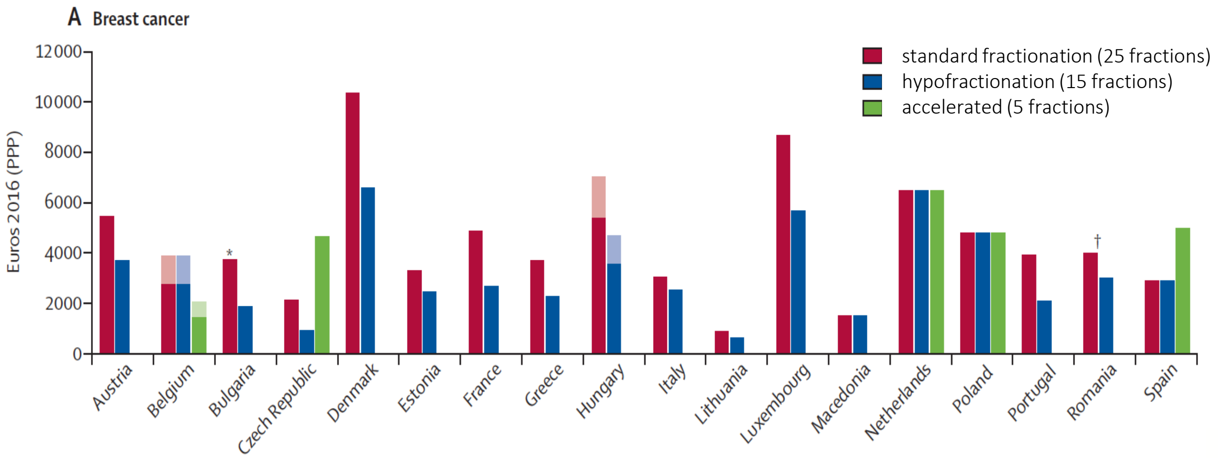
Van de Voorde C et al, KCE 2017. KCE Report 289. D/2017/10.273/45

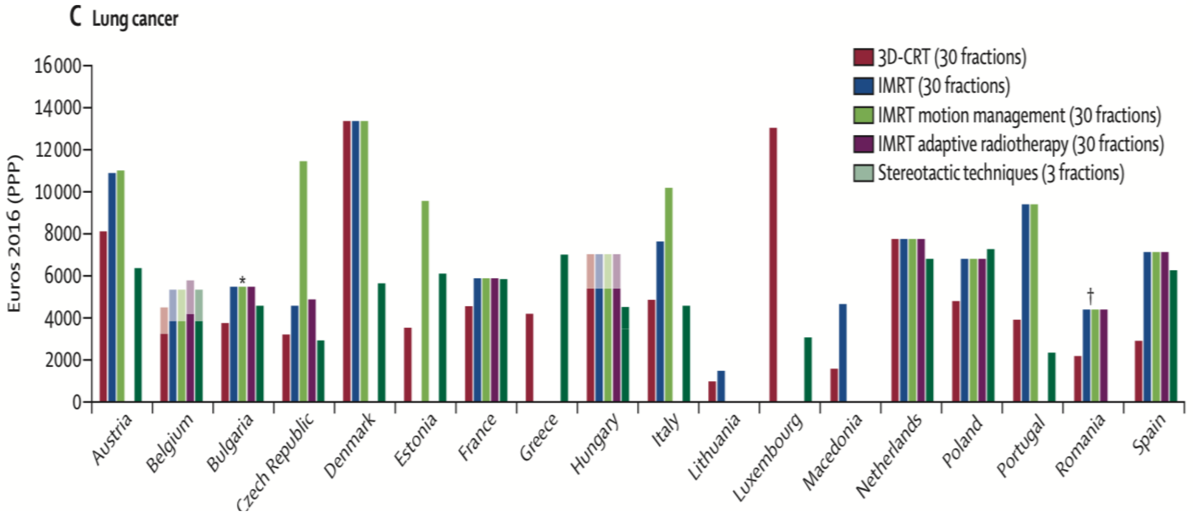
hypofractionation

uptake in clinical practice, financial (dis)incentives









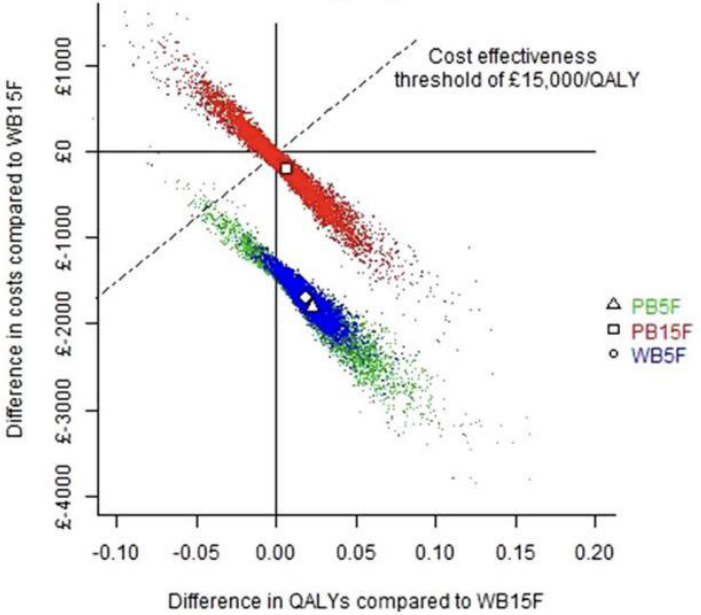
Santos et al, IJROBP 2025
Lievens et al, Lancet Oncol 2019

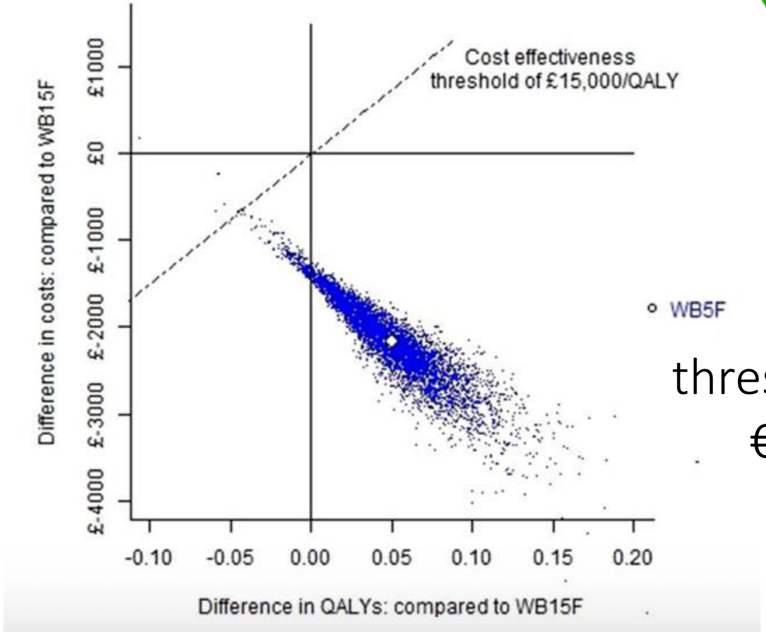
acceptability for the health system

$$\frac{\Delta \text{ costs}}{\Delta \text{ effects}}$$

incremental cost-effectiveness

cost-effectiveness hypofractionation, *breast*



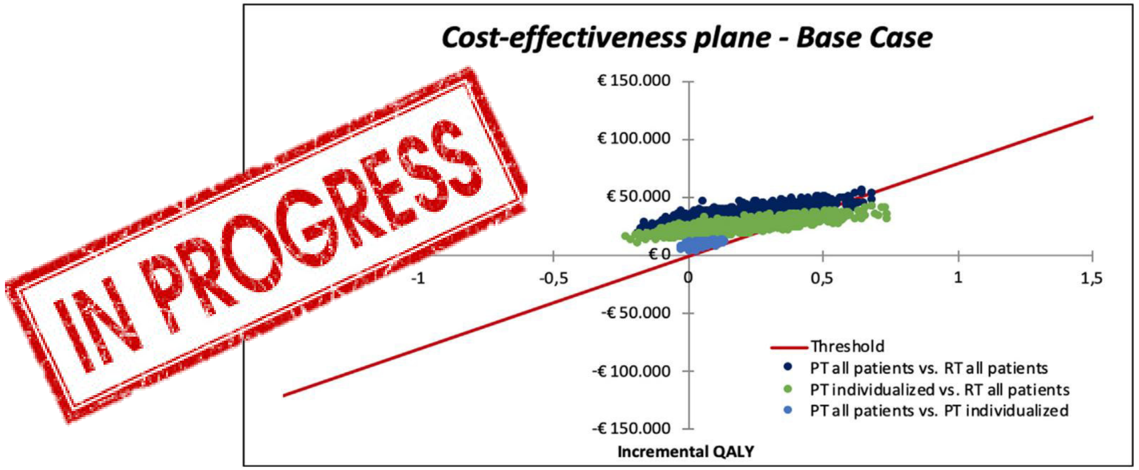


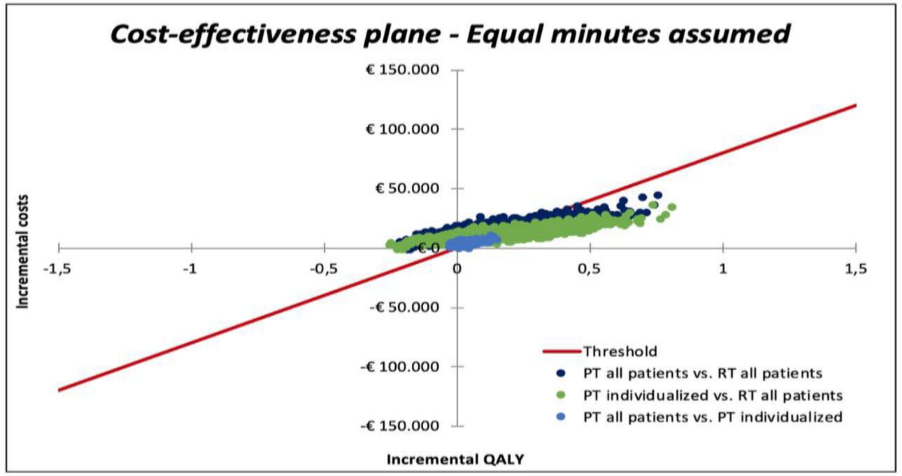
threshold value
€17,200

Scenario	Subgroup 1 (eligible for partial breast radiotherapy)				Subgroup 2 (not eligible for partial breast radiotherapy)	
	Whole breast 15 Fractions	Partial breast 15 Fractions	Whole breast 5 Fractions	Partial breast 5 Fractions	Whole breast 15 Fractions	Whole breast 5 Fractions
	ICER (probability treatment ICER < £15,000/QALY)					
0. Base case	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
1. Distant recurrence hazard ratio reported in FF and IL	Dom (14%)	£15,050 (24%)	Dom (25%)	£0 (37%)	£3,937 (76%)	£0 (23%)
2. All treatment effects maintained for 10 years	Dom (0%)	Dom (0%)	Dom (37%)	£0 (63%)	Dom (0%)	£0 (100%)
3. All treatment effects maintained for 5 years	Dom (0%)	Dom (0%)	Dom (35%)	£0 (65%)	Dom (0%)	£0 (100%)
4. Mortality rate following distant recurrence based on HER2+ population [26]	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
5. Mortality rate following distant recurrence based on TNBC (HR- & HER2-) population [26]	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
6. Distant relapse costs reduced to £8,934 per year [47]	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
7. Distant relapse costs increased to £16,111 per year (20% increase)	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
8. Disutility resulting from distant relapse reduced to 0.26 [48]	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
9. Disutility resulting from distant relapse increased to 0.3636 (20% increase)	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
10. Use of breath hold assumed to not increase cost to deliver one fraction of radiotherapy (£124)	Dom (0%)	Dom (0%)	Dom (40%)	£0 (60%)	Dom (0%)	£0 (100%)
11. Use of breath hold assumed to double the cost to deliver one fraction of radiotherapy (£248)	Dom (0%)	Dom (0%)	Dom (33%)	£0 (67%)	Dom (0%)	£0 (100%)
12. Rate of adverse skin reactions set equal across all treatment options	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
13. Health-related quality of life weight during radiotherapy set to zero	Dom (0%)	Dom (0%)	Dom (38%)	£0 (62%)	Dom (0%)	£0 (100%)
14. Log normal survival model in which each participant only contributes their 1st event[a]	Dom (2%)	Dom (2%)	Dom (46%)	£0 (51%)	Dom (17%)	£0 (83%)

Glynn et al, Breast Cancer Res Treat_2023

cost-effectiveness proton beam therapy, *lung*





threshold value
€80,000

Analysis	Strategy	Costs	Compared with XRT For all patients					Compared with next best
			QALY	NMB	ΔCosts	ΔQALY	ICER	ICER
Base Case	XRT_{All}	€45,912	1,769	€95,627	-	-	-	-
	$PT_{Individualized}$	€70,866	1,922	€82,885	€24,954	0,153	€163,467	€163,467
	PT_{All}	€79,695	1,951	€76,400	€33,783	0,182	€185,673	€301,396
Healthcare perspective	XRT_{All}	€41,231	1,769	€100,289	-	-	-	-
	$PT_{Individualized}$	€61,726	1,922	€92,034	€20,495	0,153	€134,256	€134,256
	PT_{All}	€68,904	1,951	€87,176	€27,673	0,182	€152,094	€245,053
Excluding productivity losses PT	XRT_{All}	€41,912	1,769	€95,608	-	-	-	-
	$PT_{Individualized}$	€69,662	1,922	€84,098	€23,750	0,153	€155,582	€155,582
	PT_{All}	€78,023	1,951	€78,057	€32,111	0,181	€176,485	€285,415
Equal minutes per fraction	XRT_{All}	€45,410	1,753	€97,794	-	-	-	-
	$PT_{Individualized}$	€57,416	1,910	€95,376	€12,007	0,157	€76,299	€76,299
	PT_{All}	€61,189	1,940	€94,023	€15,780	0,188	€84,106	€124,719

Glynn et al, Breast Cancer Res Treat_2023

acceptability & adequacy

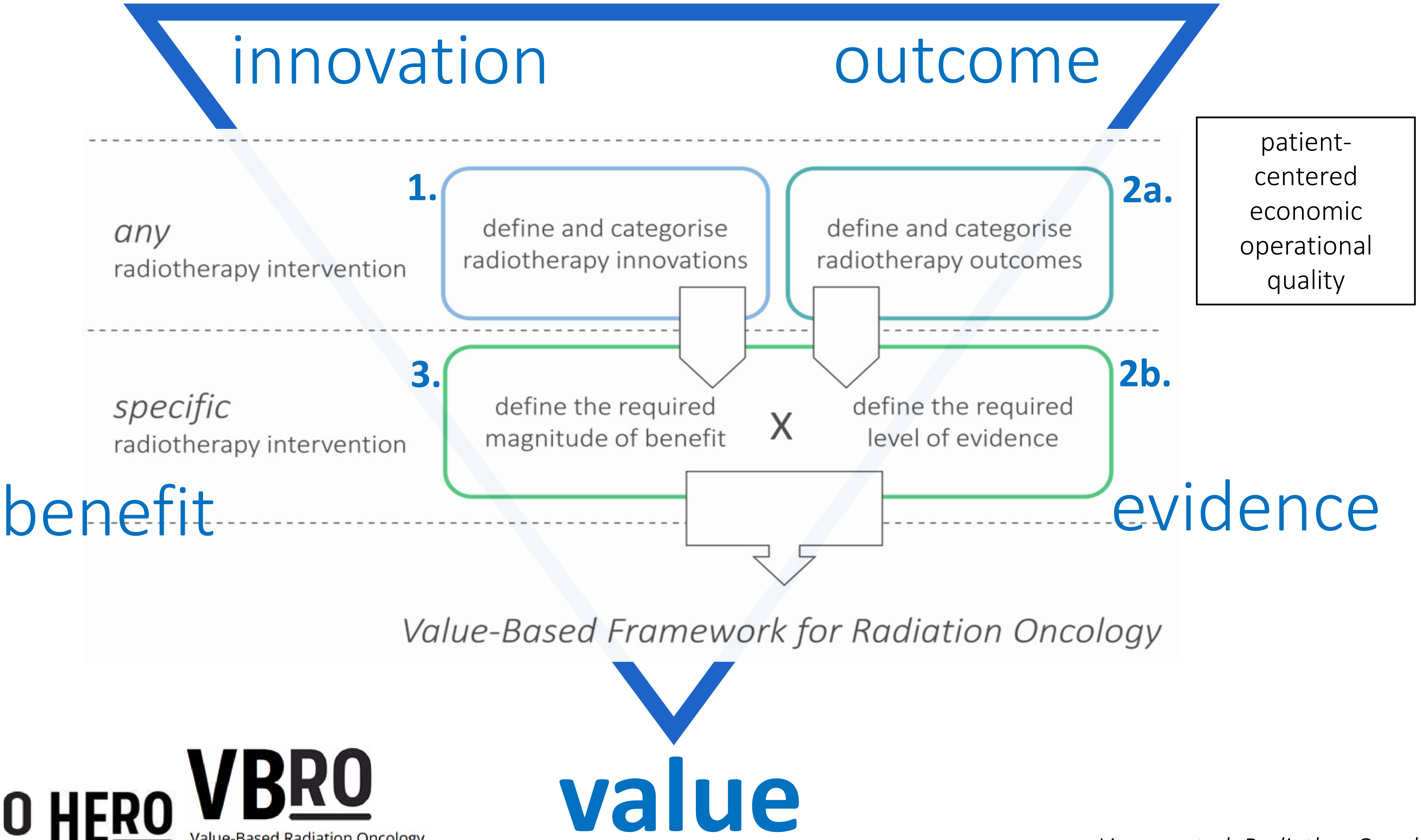
outcomes

costs

value

achieving the best outcomes
that matter most to patients
for the costs spent

Porter M. N Engl J Med 2010



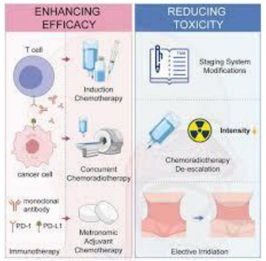
ESTRO HERO

VBRO
Value-Based Radiation Oncology

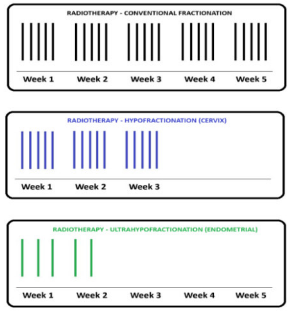
Lievens et al, Radiother Oncol 2021

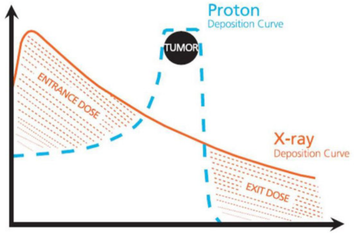
classification of RT innovation

drug-centred



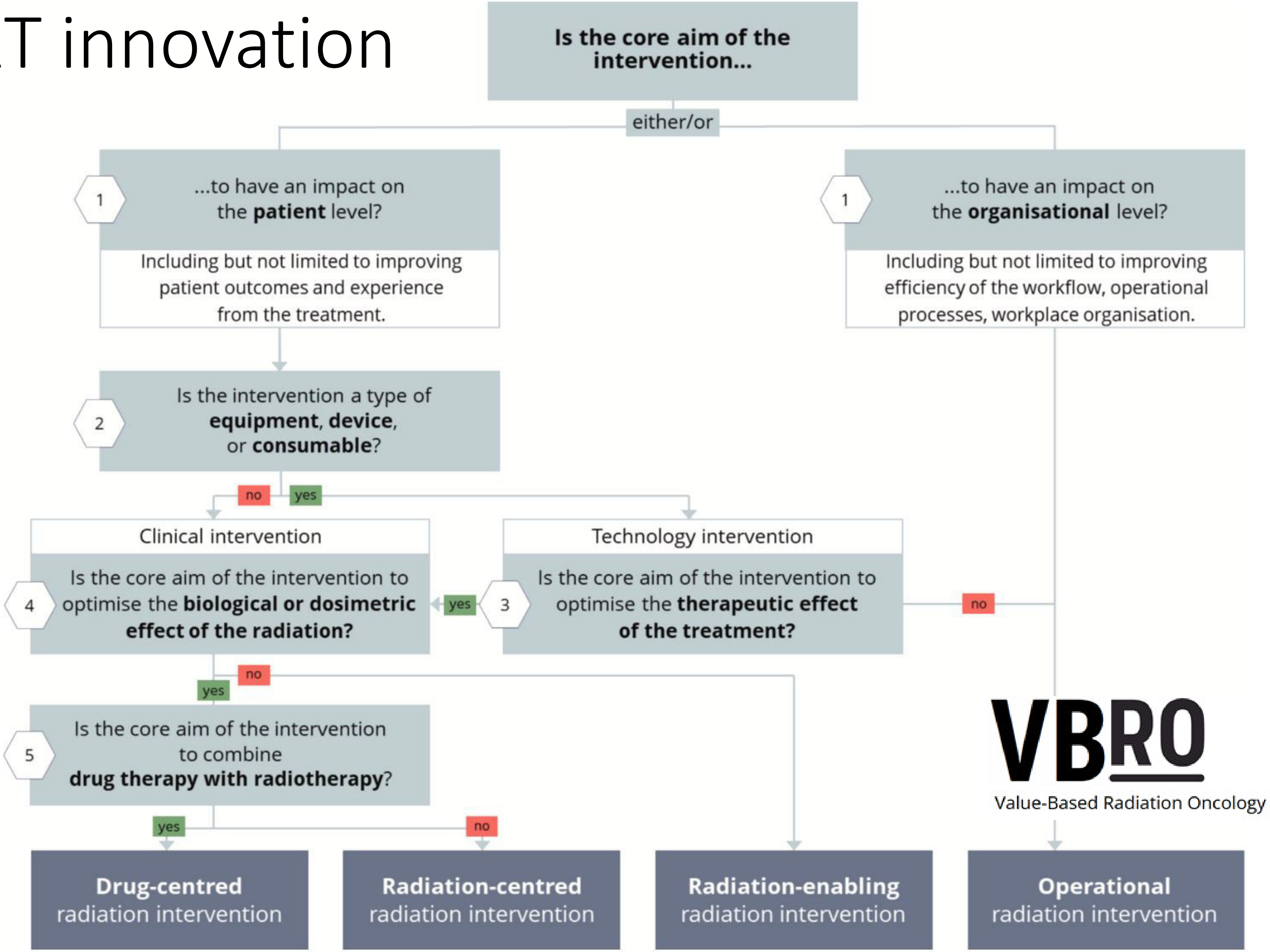
radiation-centred





radiation-enabling

operational



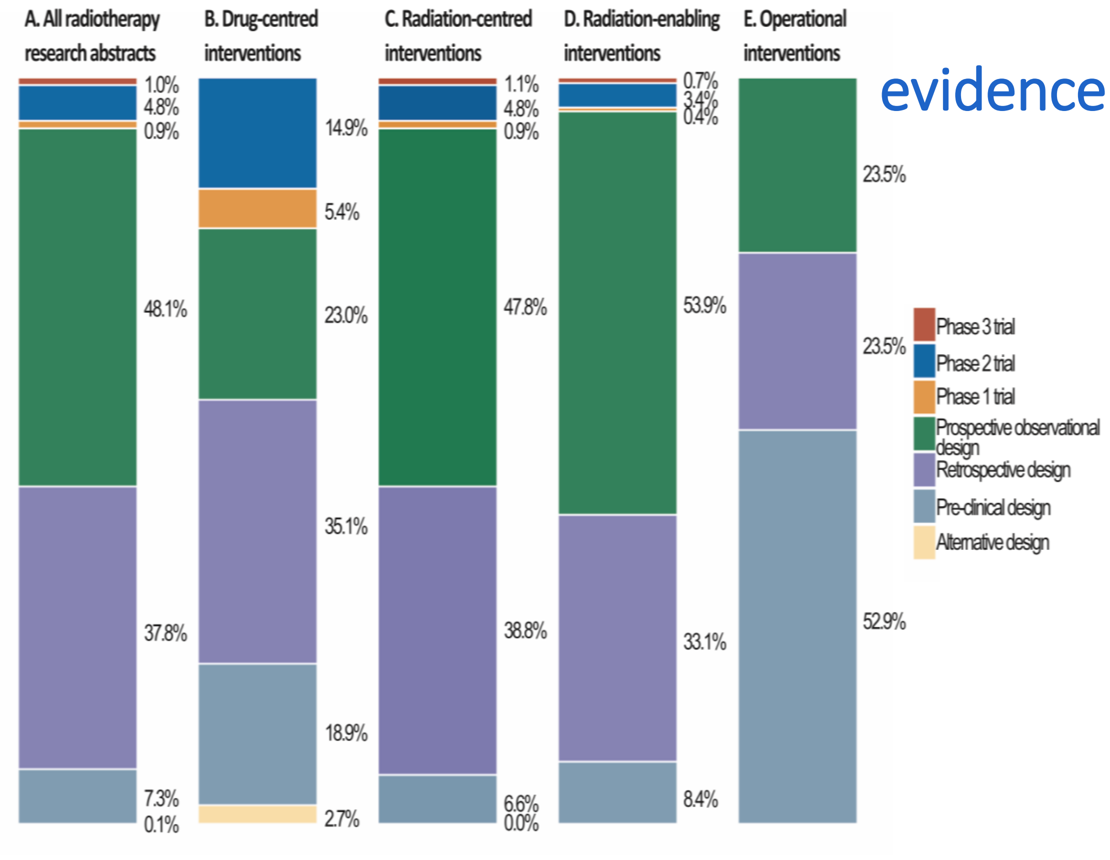
VBRO
Value-Based Radiation Oncology

Vandemaele et al, Radiother Oncol 2025

evidence & endpoints of RT innovation

Systematic literature review

- quantitative bibliometric approach
- a representative set of 23 radiotherapy innovations
- radiotherapy research published 2012 - 2022



evidence

Vandemaele et al, Radiother Oncol 2025
Courtesy M. Vandemaele, manuscript in preparation

scaling up the VBRO project!

Methodologic development

- statistical development
- integrate costing denominator

Practical application

- field testing!
- engage with national societies
- collaboration beyond ESTRO
- communication strategies
- …

ESTRO HERO VBRO Value-Based Radiation Oncology

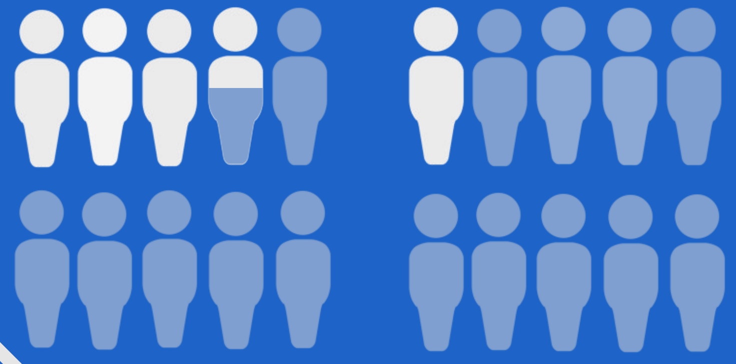
Università degli Studi di Padova

Dipartimento di Scienze Statistiche Department of Statistical Sciences

access to innovation
to advanced radiotherapy

access
to radiotherapy

5 / 10 patients
should receive radiotherapy



HICs LICs

value-based
radiation oncology

ESTRO HERO VBRO Value-Based Radiation Oncology

Atun et al, Lancet Oncology Commission 2015
Lievens et al, Radiother Oncol 2021

take home messages

availability of radiotherapy resources and **access** to radiotherapy in Europe is variable

it takes (too much) **time to implement** evidence-based innovation in radiotherapy practice

implementation of advanced radiotherapy **innovation** is variable

barriers and justifications for access to innovative radiotherapy are **multiple and multifactorial**

proving the balance between **outcomes and cost** is crucial in bridging the second translation gap from evidence-based innovation to general practice

value-based health care is one possible approach to bridge this gap

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acknowledgements

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Project supported by ESTRO Cancer Foundation
UGent Chair for Value-Based Radiation Oncology

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Thank you for your attention!

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