International Atomic Energy Agency Scientific Forum

A Decade of Action on
Cancer Control
and the Way Forward

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

17—18 September 2019
Vienna International Centre
Board Room D, C Building, 4th Floor

Modern Radiation Therapy Opportunities for Improved Cancer Control

Mary Gospodarowicz MD

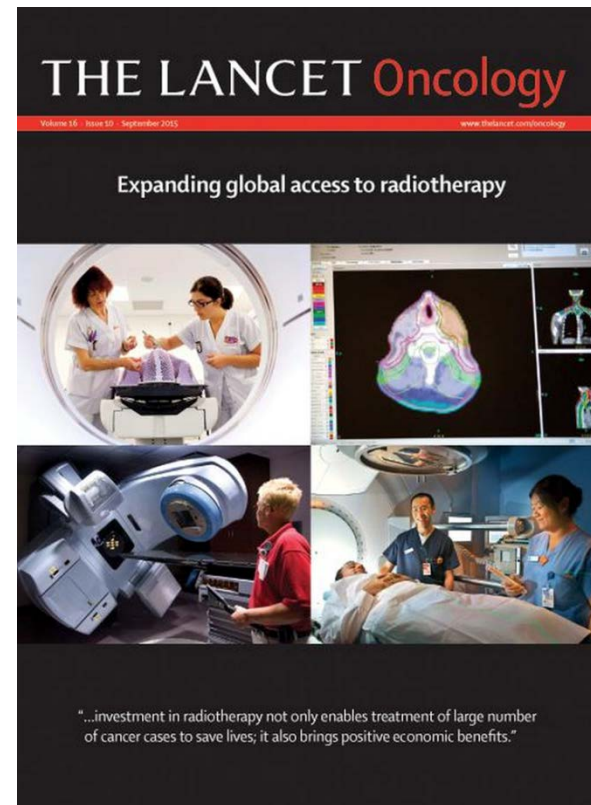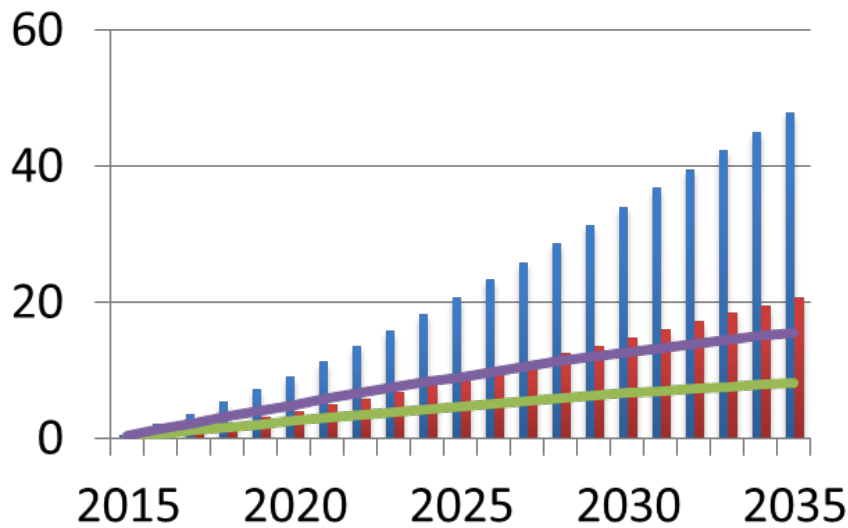Princess Margaret Cancer Centre, Canada

Progress in Radiotherapy for Cancer Control

- Recognition of enormous potential to save lives of cancer patients

- New tools giving unprecedented precision, adaptability, and increased applicability of radiotherapy

- Increase in safety of radiotherapy

- Power of radionuclide targeting and therapy

- New opportunities for the future

Life Yrs Saved	
Low income	6.3 million
Low-MIC	9.9 million
Upper-MIC	10.7 million
Total	**26.9 million**

Radiotherapy saves lives and results in economic benefit

THE LANCET Oncology

Expanding global access to radiotherapy

"...investment in radiotherapy not only enables treatment of large number of cancer cases to save lives; it also brings positive economic benefits."

Scale-up of radiotherapy for cervical cancer in the era of human papillomavirus vaccination in low-income and middle-income countries: a model-based analysis of need and economic impact

Cervix Cancer

Danielle Rodin, Emily A Burger, Rifat Atun, Michael Barton, Mary Gospodarowicz, Surbhi Grover, Timothy P Hanna, David A Jaffray, Felicia M Knaul, Yolande Lievens, Eduardo Zubizarreta, Michael Milosevic

Summary
Background Radiotherapy is standard of care for cervical cancer, but major global gaps in access exist, particularly in low-income and middle-income countries. We modelled the health and economic benefits of a 20-year radiotherapy scale-up to estimate the long-term demand for treatment in the context of human papillomavirus (HPV) vaccination.

Radiotherapy will remain an essential tool in fighting cervical cancer in the era of HPV vaccination

Figure 3: Effect of universal human papillomavirus vaccination strategy on cervical cancer incidence
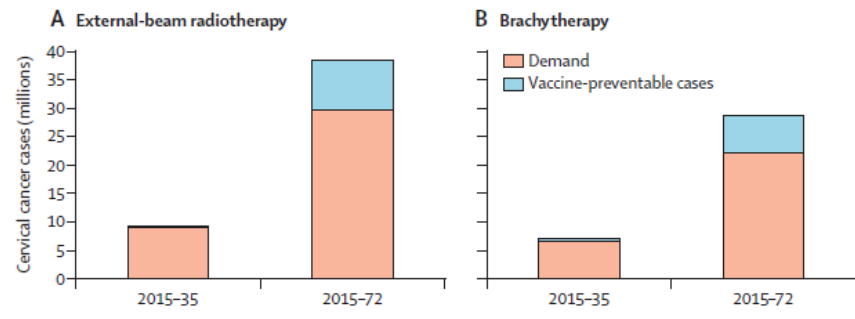

Figure 4: Effect of universal human papillomavirus vaccination strategy on demand for external-beam radiotherapy and brachytherapy in low-income and middle-income countries
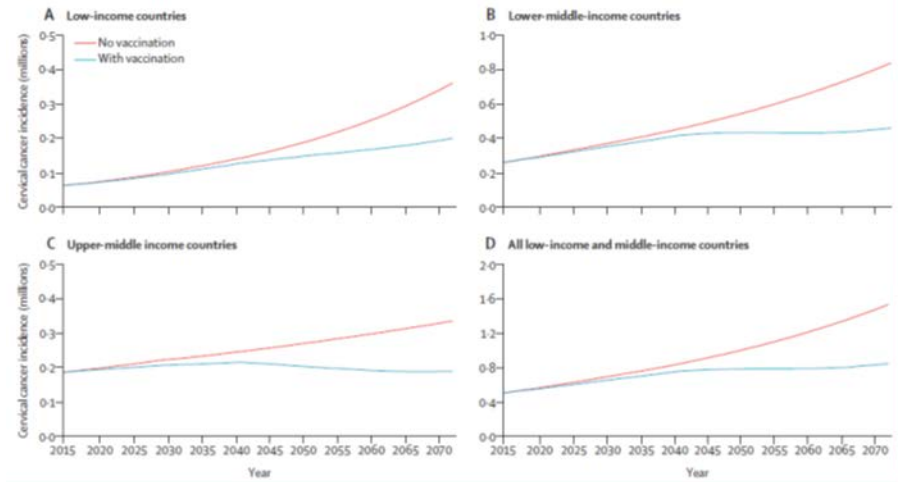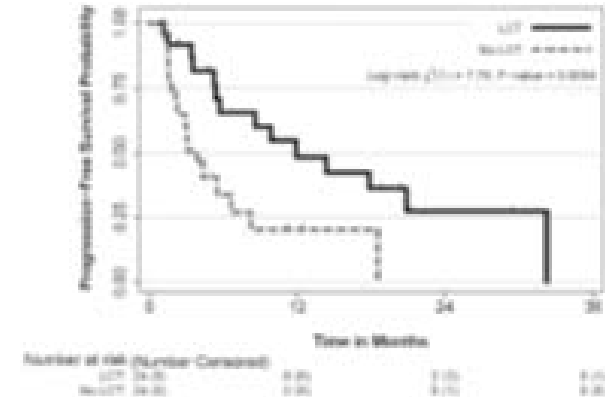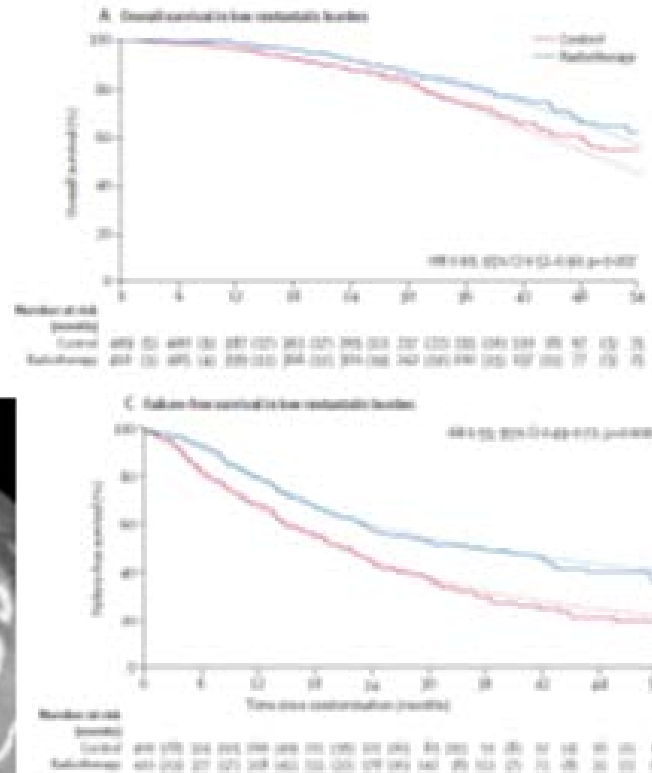
Explosion in new radiotherapy technologies

Benefits of radiotherapy in metastatic disease

New benefits of modern radiotherapy
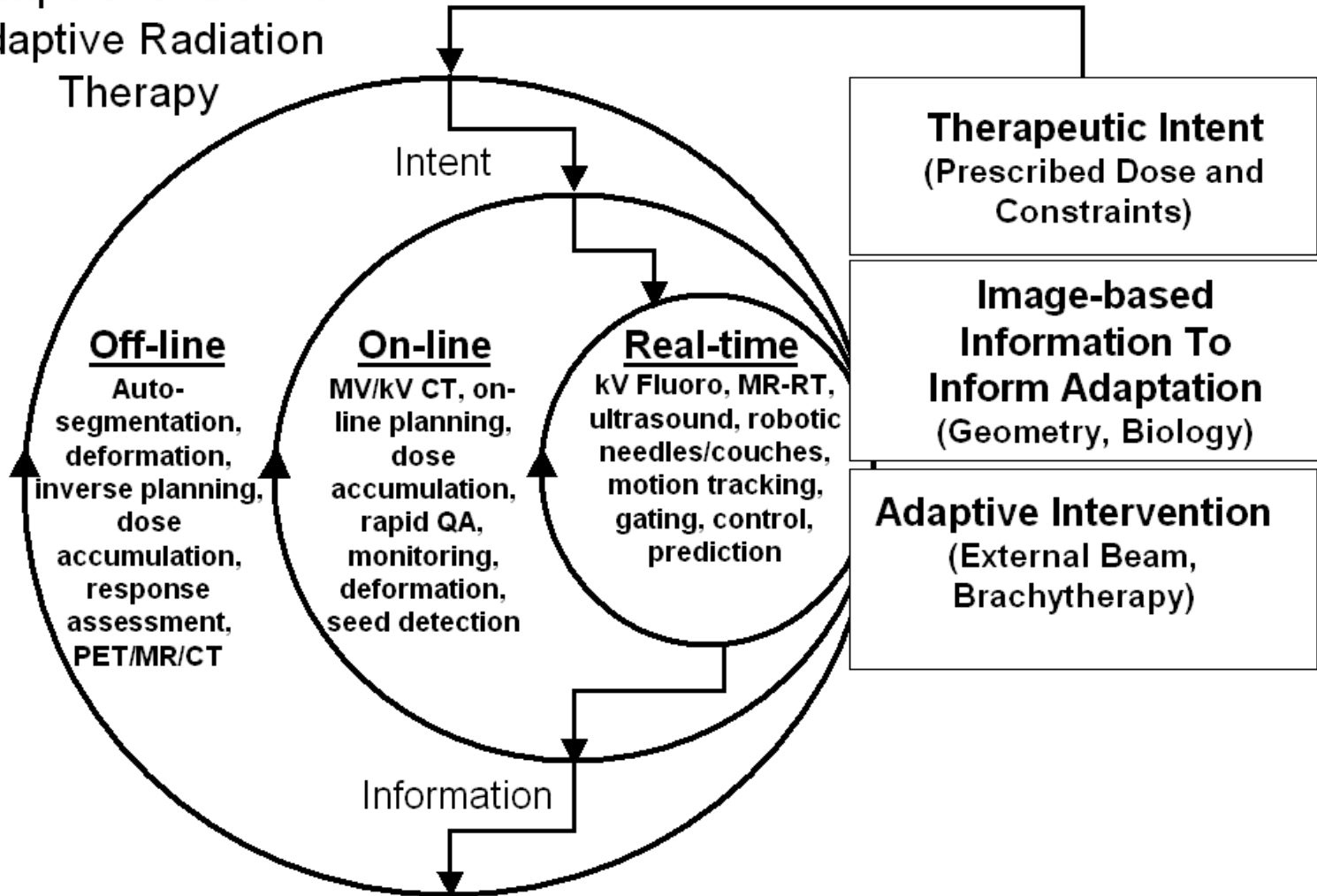
Parker et al. STAMPEDE Trial
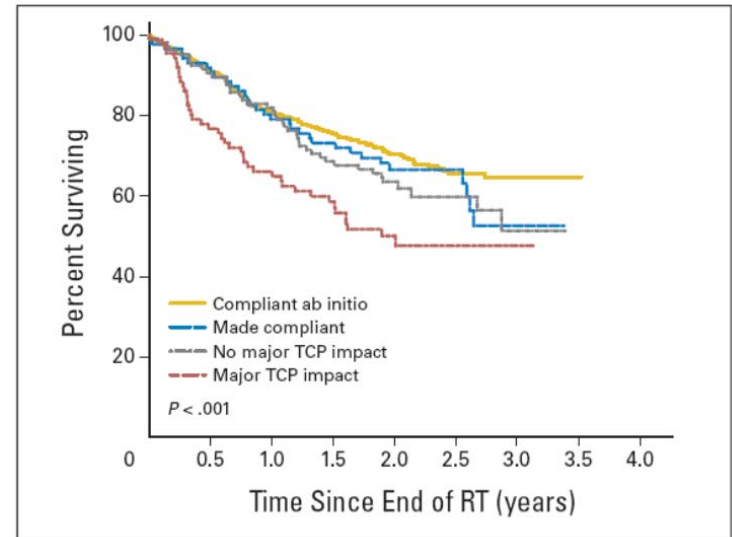The Lancet 2018

Gomez et al SBRT Lung ca
Lancet Oncology 2017

Adaptive Radiotherapy

# Planning
Dose delivery
Clinical application

Quality

Fig 2. Overall survival by deviation status: (1) compliant from the outset (n = 502), (2) made compliant following a review by the Quality Assurance Review Center (n = 86), (3) noncompliant but without predicted major adverse impact on tumor control (n = 105), and (4) noncompliant with predicted major adverse impact on tumor control (n = 87). Overall $P < .001$. Pair-wise tests: not statistically significant except for cohort 1 versus cohort 4 ($P < .001$), cohort 2 versus cohort 4 ($P = .041$), and cohort 3 versus cohort 4 ($P = .006$). TCP, tumor control probability; RT, radiotherapy.

#3

UHN's PSMA MRgRT Study:
## Target the PSMA locations with Precise Radiation
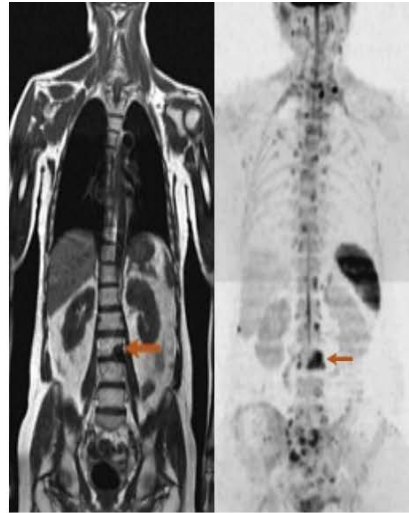
Clinical Problem

Recurrent PCa post Surgery + Radiotherapy

No evidence of disease In conventional studies (BS and CT)

Work Package 1: Diagnostics

$[^{18}F]$DCFPyL PET/MRI

Unveil and characterize new early molecularly-defined oligometastatic state

Work Package 2: Therapeutics

MRgRT SABR

Discover new curative-intent treatment Unprecedented precision and accuracy
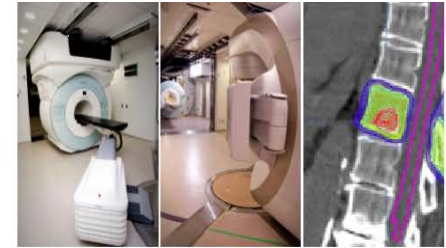
Work Package 3: Translational

PSA^2 liquid biopsy Tissue/Fluids samples

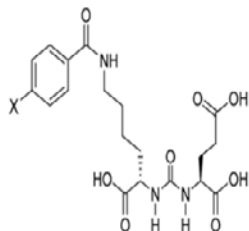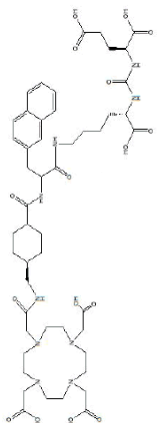Response monitoring and outcome prediction. **Seed** translational studies.

#4
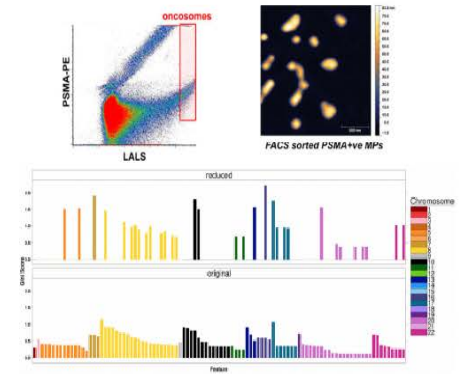
PSMA converging paradigms: Molecular RT

THERANOSTICS

Targeted therapeutics
^{177}Lu-PSMA-617 / ^{211}At-PyL

Diagnostic companion
^{68}Ga-PSMA-11 / ^{18}F-PyL

5 X = [^{131}I]
6 X = [^{211}At]

After 3 cycles
PSA 10.3 ng/mL

Before therapy
PSA 458.6 ng/mL
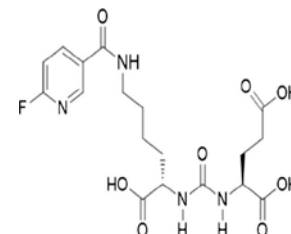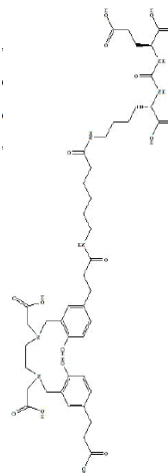
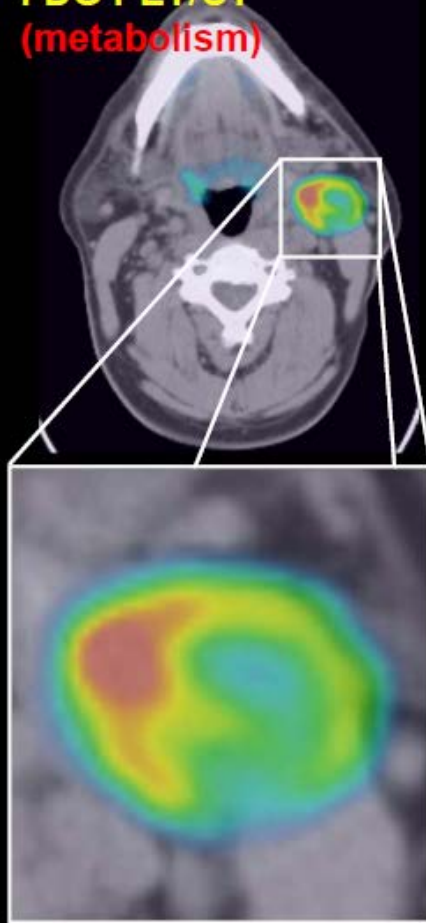**Attach a therapeutic electron emitter to the same chemistry**

RT: New opportunities
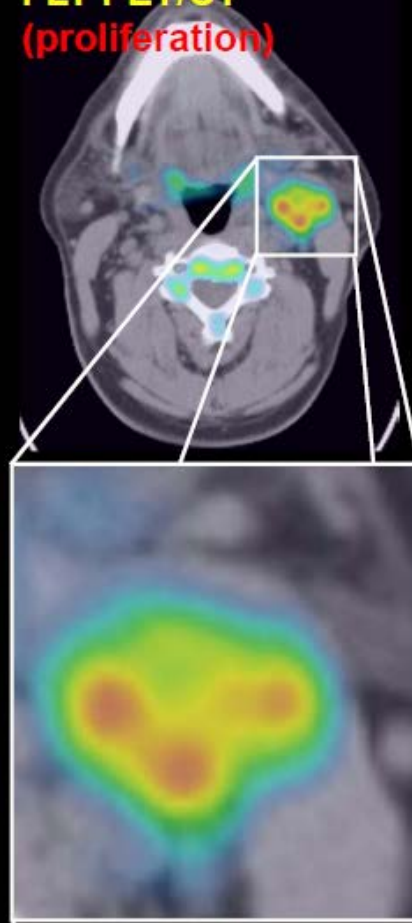

Spatial distribution of tumor phenotypes

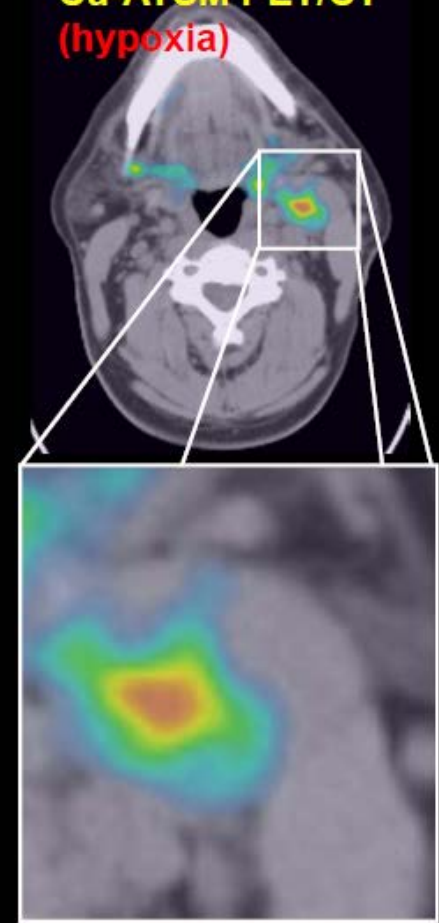FDG PET/CT (metabolism) — FLT PET/CT (proliferation) — Cu-ATSM PET/CT (hypoxia)

Courtesy of R. Jeraj, U. Wisconsin

Future Prognosis Development: Big Data to Big Machine

- Alignment of perspective and technologies
  - Big Data – 4 V's ++; Real-world data; Rapid expansion of low-cost measurement
  - Ontologies – Meaning with extensibility for future; OWL standards
  - Data Governance - Findable, Accessible, Interoperable, and Reusable (FAIR)
  - Scale - Need for large N through Multi-institutional Studies
  - Quality/Curation – accommodation of uncertainty; Outcomes
- Machine Learning (ML) for generalized consumption of 'features'
  - Generalizable; Extensible; Human-machine Hybrid Capable
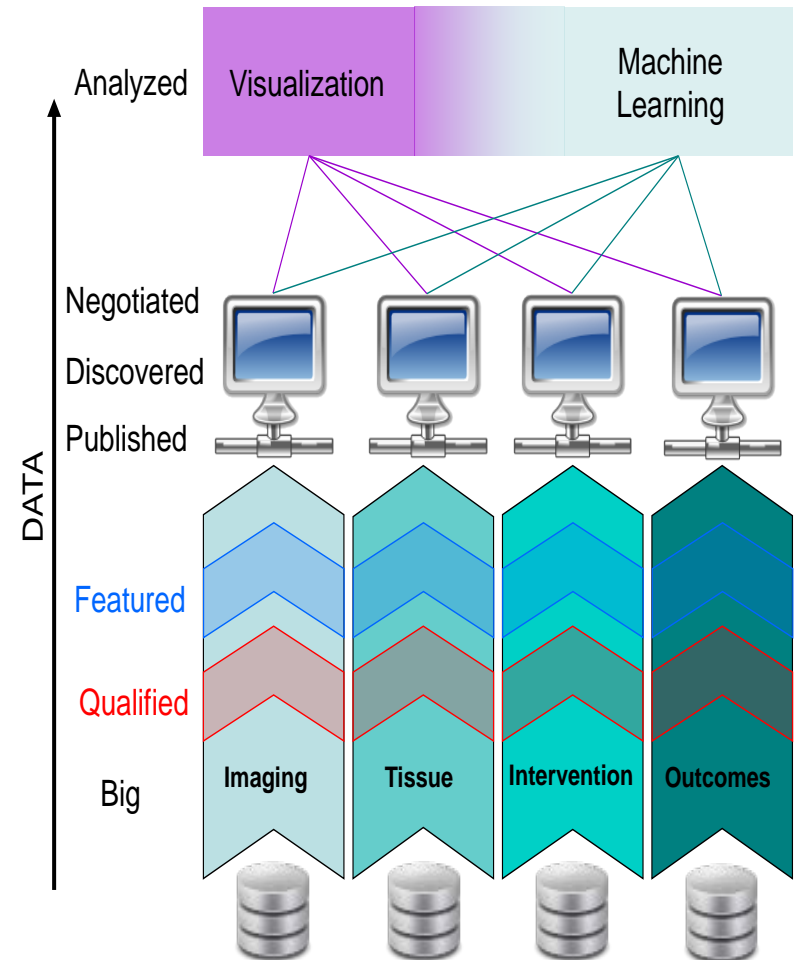
#5

Progress in Radiotherapy for Cancer Control

- Recognition of enormous potential to save lives of cancer patients

- New tools giving unprecedented precision, adaptability, and increased applicability of radiotherapy

- Increase in safety of radiotherapy

- Power of radionucleotide targeting / therapy

- New opportunities for the future

Thank you

- Acknowledgements

    May Abdel Wahab

    David Jaffray

    Brian O'Sullivan

    Alejandro Berlin