CHALLENGES IN DATA-DRIVEN GENOMIC COMPUTING

Personalised (secondary) prevention and prognosis in cancer

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Disclosure

- No personal, economical and financial interests
- Scientific Director of INT, a public Research Hospitals that receives economic supports by several public and privat (profit and non profit) organizations
- This lecture is in part based on the Opening Lecture“*The research to come*”, World Conference on Future of Science, 21-23 September 2017, Venice

Synopsis

- Research and Health Care in Italy
- Focus on Cancer
  - Cancer figures (USA, Europe and Italy)
  - Cancer achievements and unmet needs
- About prevention
- Personalised prevention
- Final remarks and Conclusion

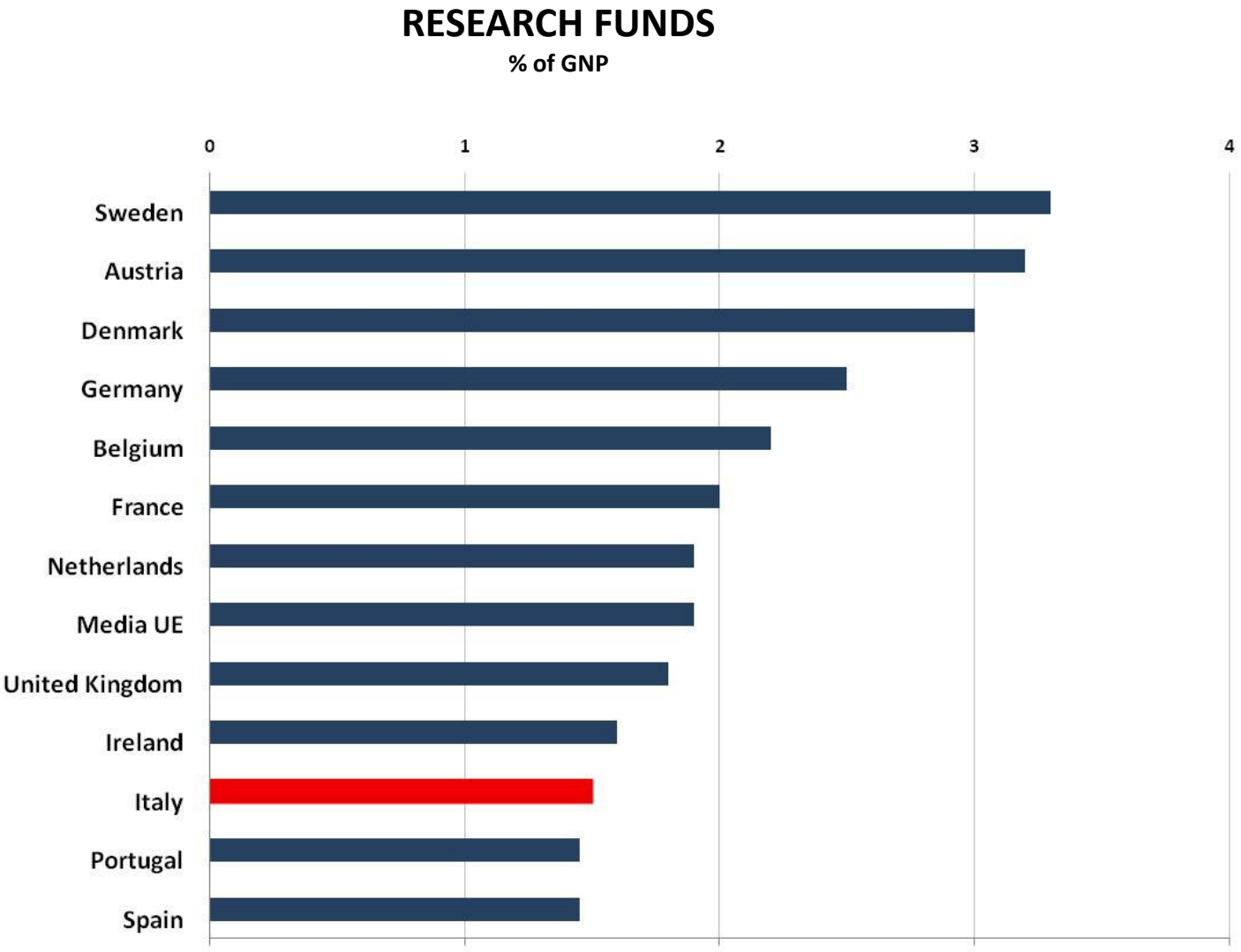
RESEARCH

Italy and Research

Despite the little amount of funds allocated to research, when compared to other high-income countries

- Italy performs well according to volume, citations, views and growth rate over time
- Data from 2005 to 2014 suggests that Italy is above the average in terms of focus on cancer research
- Italy performs poor when publication indexes are analysed according to patents (Technology Transfer)

Italy and Research

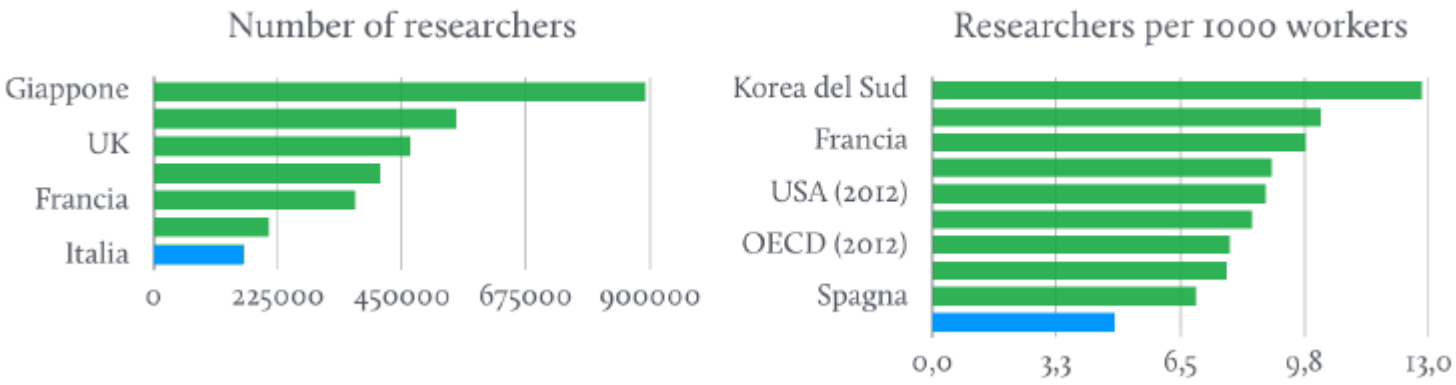


Italy and Research

- 1,3% of GNP(about 22 billions), 13% for life sciences (2.9 billions)
- 39% from public funds
- According to the Boomberg Index, Italy ranks 25th (among 50 countries) in terms of scientific research (36th as number of researchers and e 37th as to patents)

Researchers in Italy

- 4,8/1000 workers
- One of the lowest figures



- Salaries are also lower: half of those in Germany

Scientific output: Source of data and methods

Scopus data base (2005-2014) and publications metrics, such as number and type of publications, weighted citations index, etc

According to the field (All disciplenes, Medicine, Cancer) and to the countries

Cancer Research Output

- The final outputs of Research are knowledge, its application and implementation and health (outcomes)

- Publications and patents are the most relevant intermediate (surrogate) outputs

Relevant indicators (metrics)

- Volume of publications
- Quality of publications
  - Citations by others
  - Frequency of views
  - Citations in patents
- Country field-weighted Citation Index (CFWCI)
- Country field-weighted Views Index (CFVCI)
- Compound Annual Growth Rate (CAGR)

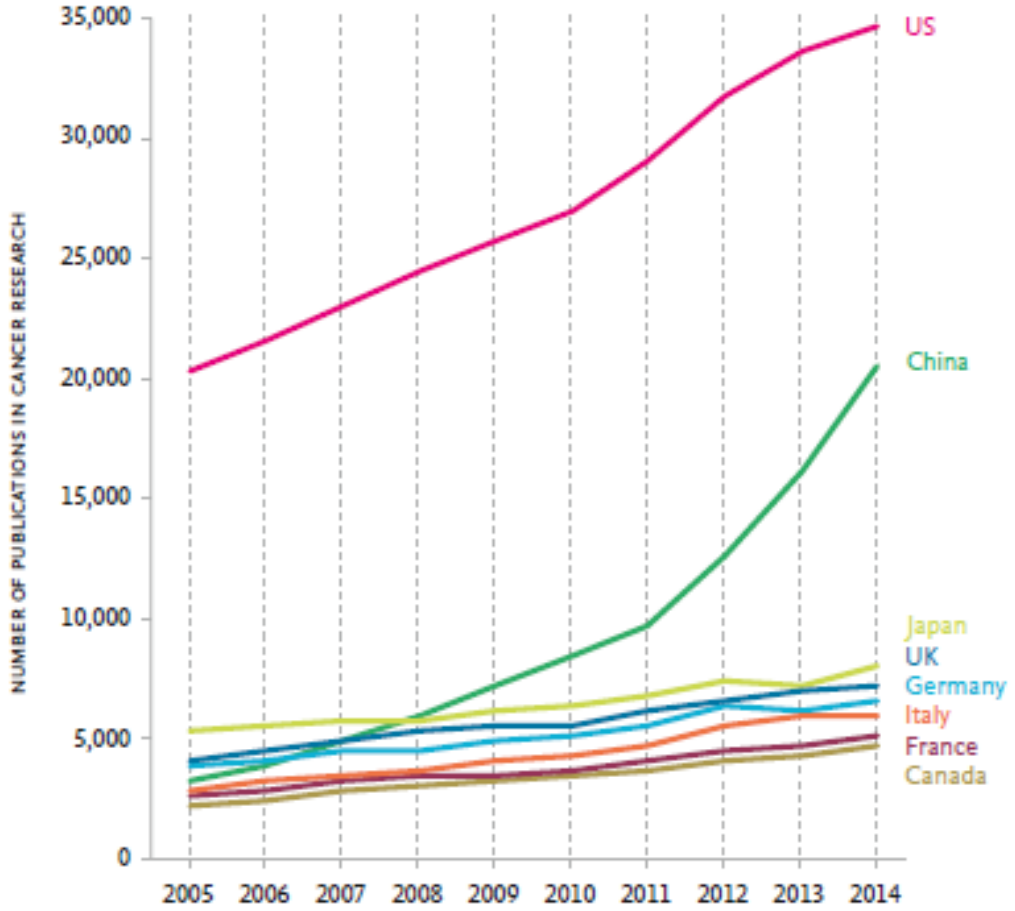
Country FWCI

- Citations for a given country compared to the world average (=1), corrected for a few relevant factors (such as age and types of papers)

- It may be used to compare countries and/or to evaluate trends

Volume: a general picture

Figure 2 — Number of Cancer Research publications for selected countries (2005–2014).
Source: Scopus



The Lancet Oncology, Vol 18, November 2017

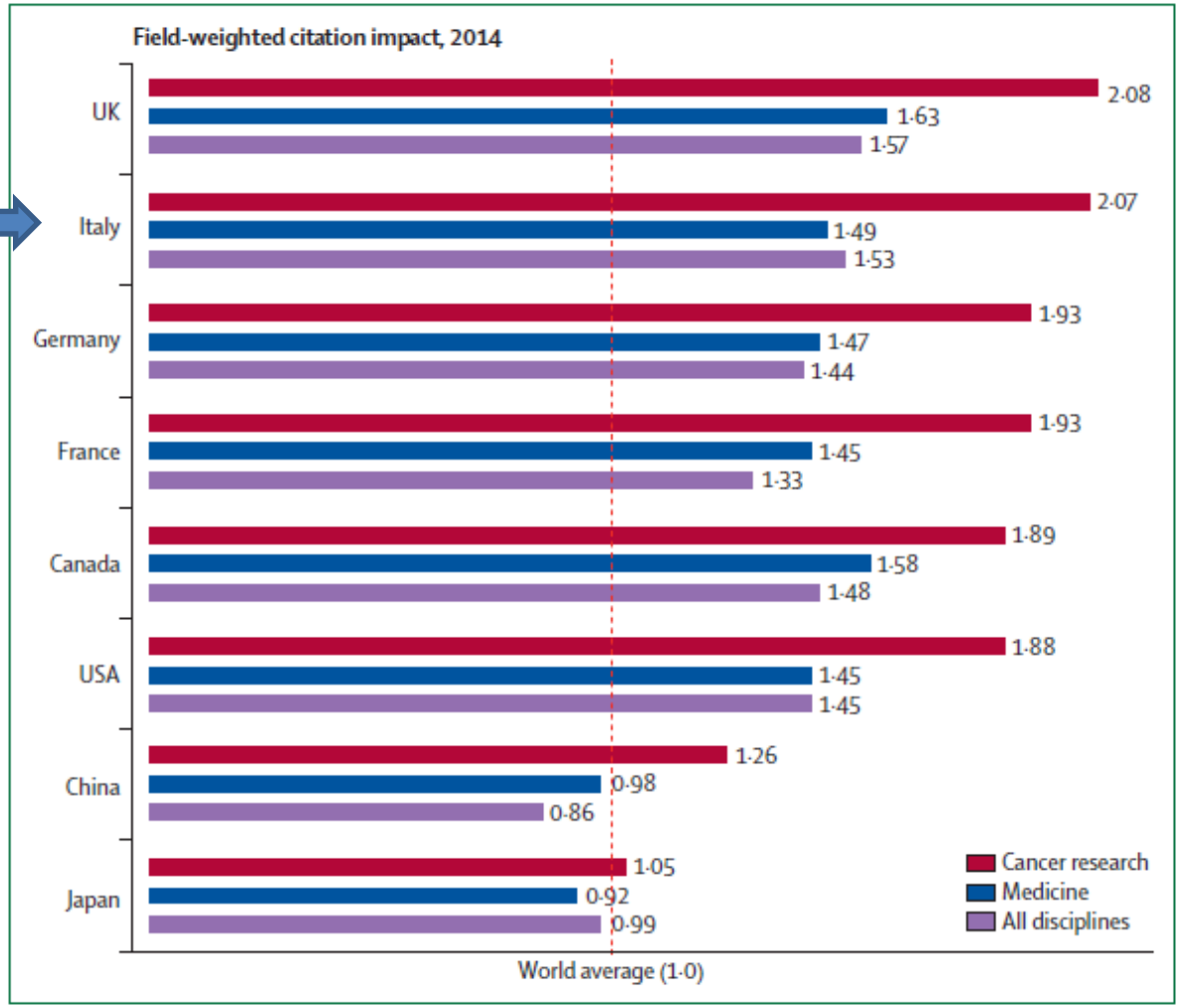
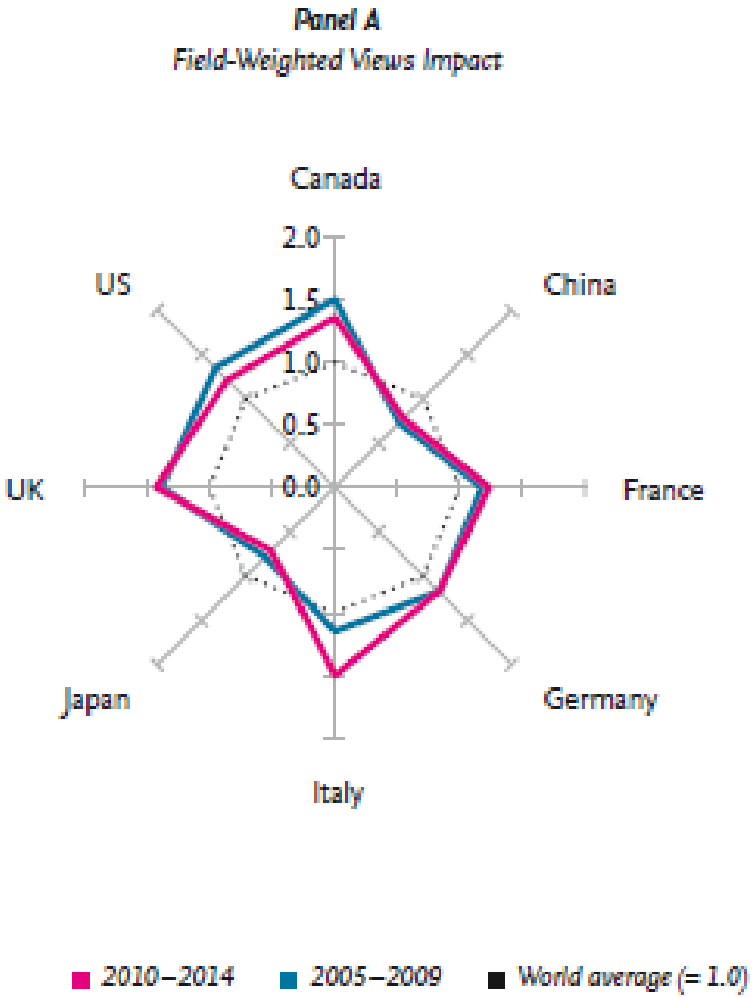


***Figure 2*: Field-weighted citation impact in cancer research, medicine, and all disciplines for selected countries in 2014**

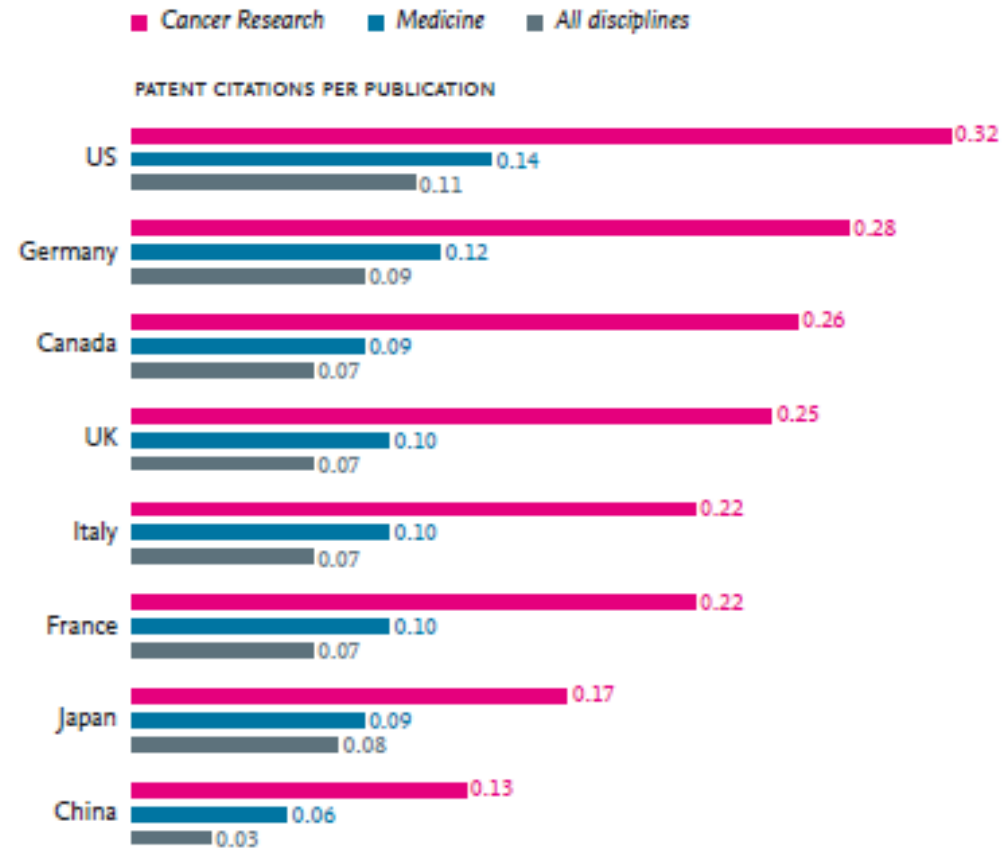
Source: Scopus. Adapted with permission from the Elsevier Cancer Research Report.[3]

Quality (views)



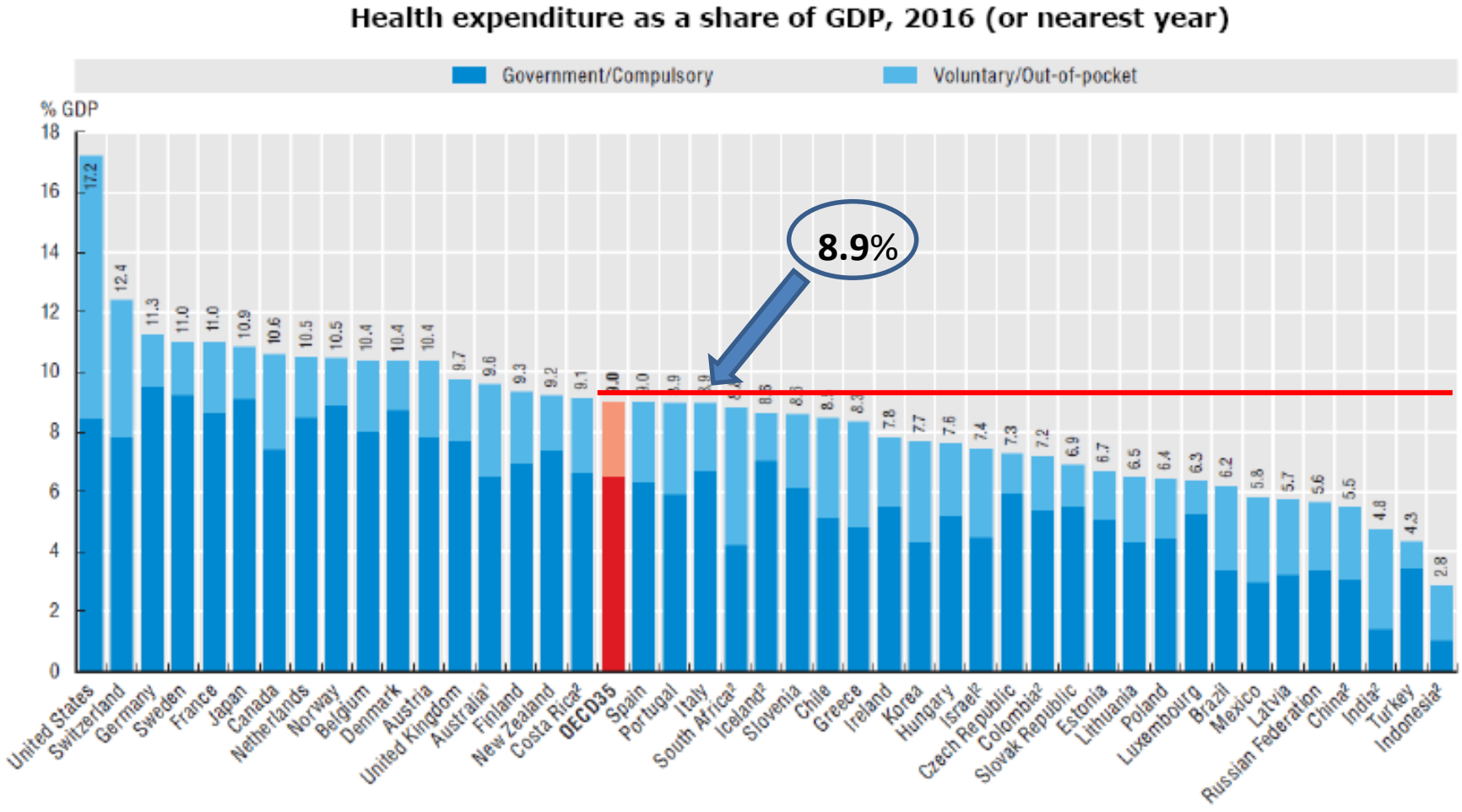
Quality (patents)

Figure 10 — Patent Citations per publication in Cancer Research, Medicine, and All Disciplines for selected countries in 2010. Source: Scopus



HEALTH CARE

Health spending was 9% of GDP on average in the OECD, ranging from 4.3% in Turkey to 17.2% in the United States



Note: Expenditure excludes investments, unless otherwise stated.
1. Australian expenditure estimates exclude all expenditure for residential aged care facilities in welfare (social) services.
2. Includes investments.

***Source*: Health at a Glance 2017.**

From “Il Sole 24 Ore” (December 5, 2018)

According to Eurostat

- The pro-capita amount for health care for each Italian citizen is about 2.450 euro,

- … in Germany 4.128, 3.622 in France and 2.914 in UK

Why Focus on Cancer

- Cancer is a significant and increasing challenge for society, healthcare systems, researchers, doctors, citizens, patients and relatives

- Primary prevention of cancer will prevent other non-communicable diseases (sharing common risk factors)

- Because of the numbers of cancer

Cancer Figures

- In Europe:
  - 3.6 milion of new cases in 2015 (expected 4.4 milion in 2035)
  - In the same period cancer deaths will increase from 1.28 to 1.67 million
- In Italy:
  - 1.000 new cases/day
  - About 3.400.000 people living after a diagnosis of cancer (27% cured)

Cancer achievements

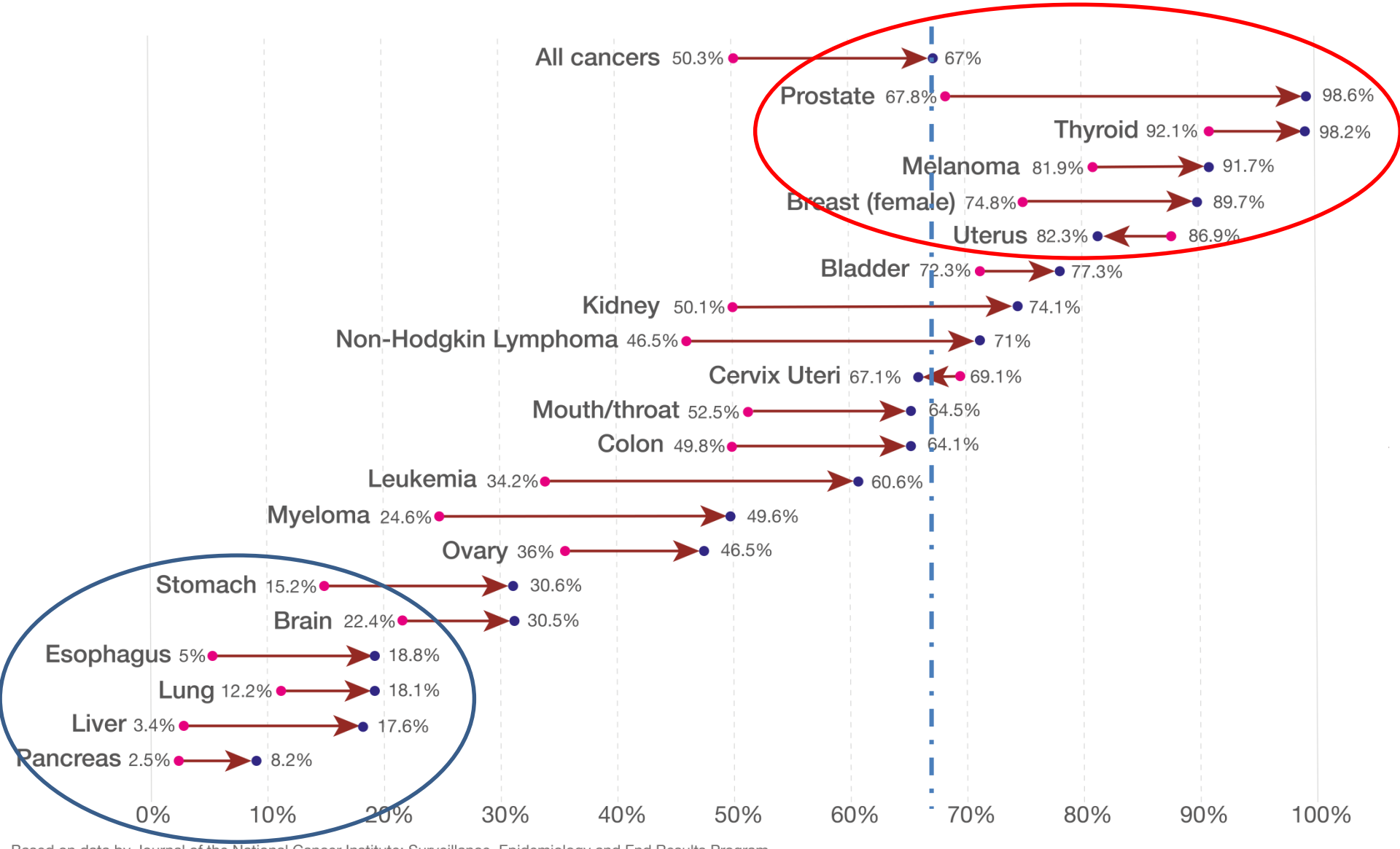
- Thanks to results from research (increasing knowledge) and the availability of new treatments/drugs, we have increased the number of patients who may be treated and cured
- In addition, large cohorts of cancer patients are living with a controlled/indolent disease (chronic cancer)

Five-year cancer survival rates in the USA

Average five-year survival rates from common cancer types in the United States, shown as the rate over the period 1970-77 [●] and over the period 2007-2013 [●]: 1970-77 → 2007-2013

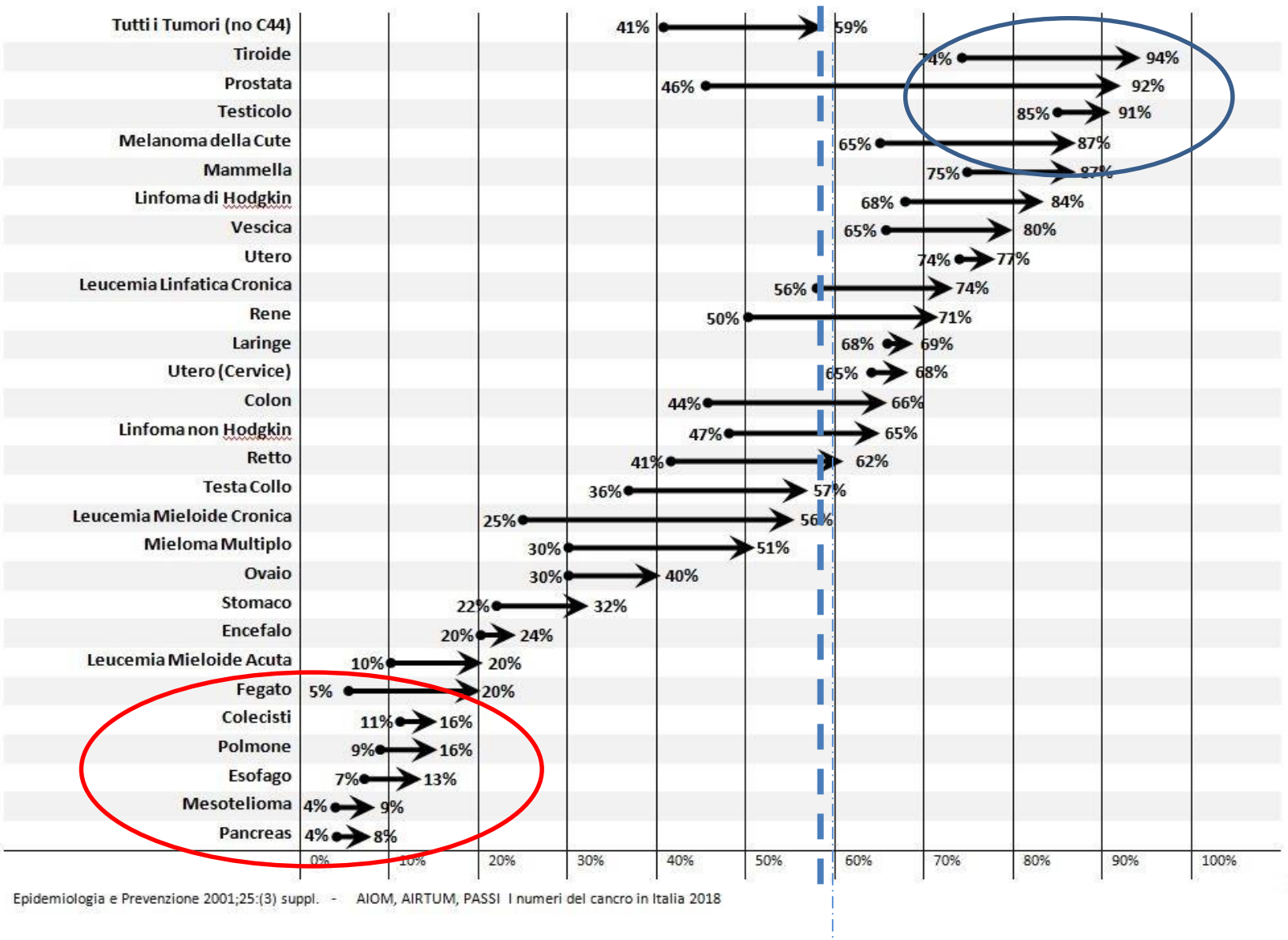
This five-year interval indicates the percentage of people who live longer than five years following diagnosis.

Our World in Data



Based on data by Journal of the National Cancer Institute; Surveillance, Epidemiology and End Results Program.
The data visualization is available at OurWorldinData.org. There you find research and more visualizations on this topic.

5 year cancer survival rates in the Italy over the period 1986-89 and 2005-2009



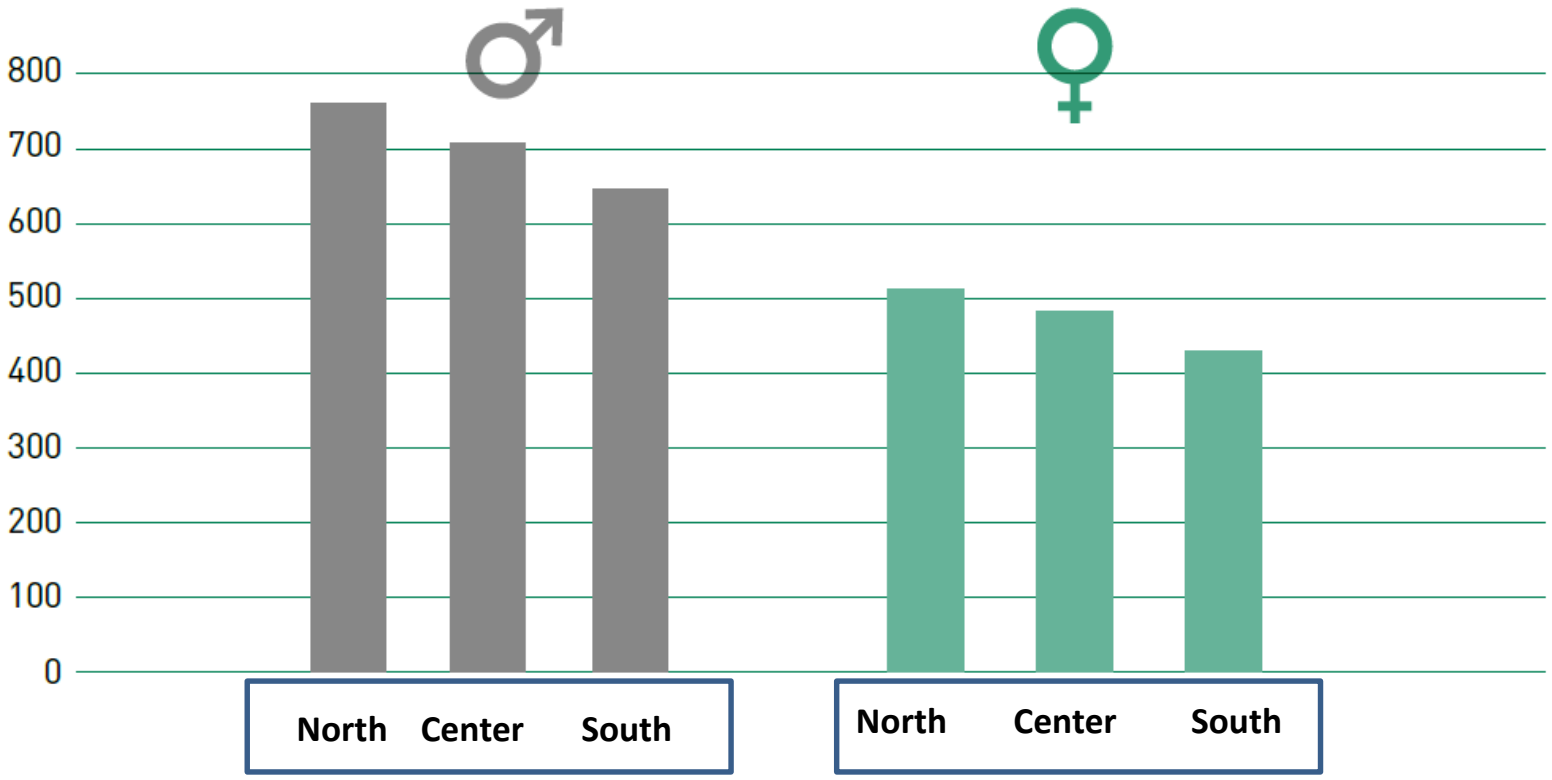
Epidemiologia e Prevenzione 2001;25:(3) suppl. - AIOM, AIRTUM, PASSI I numeri del cancro in Italia 2018

Within and between countries variability

- It is well known and very well documented that there is large variability within and between European countries according to structure, quality and outcome of care

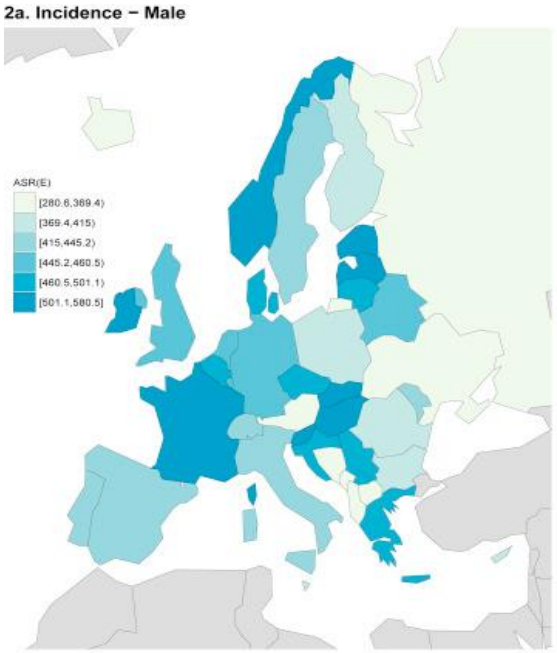
- This is mostly true for cancer

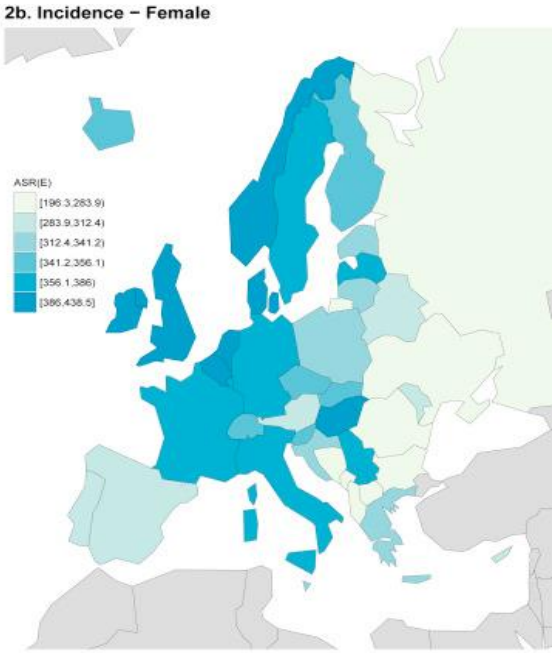
Italy: variability in incidence

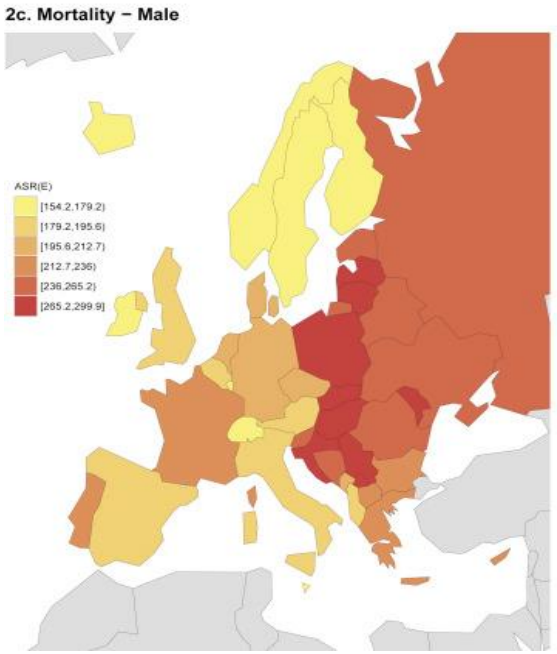


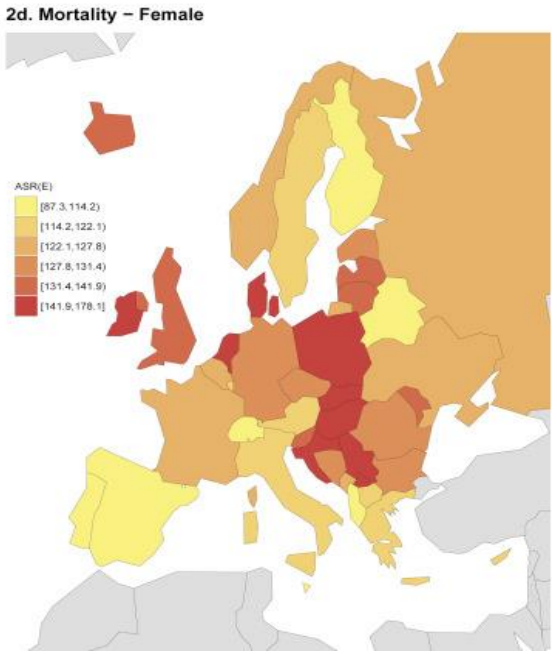
EPIDEMIOLOGY OF CANCER

Age standardised incidence and mortality rates for all cancers for men and women in Europe 2018 (excluding non-melanoma skin cancers)
J. Ferlay et al. Eur. J Cancer, 2018

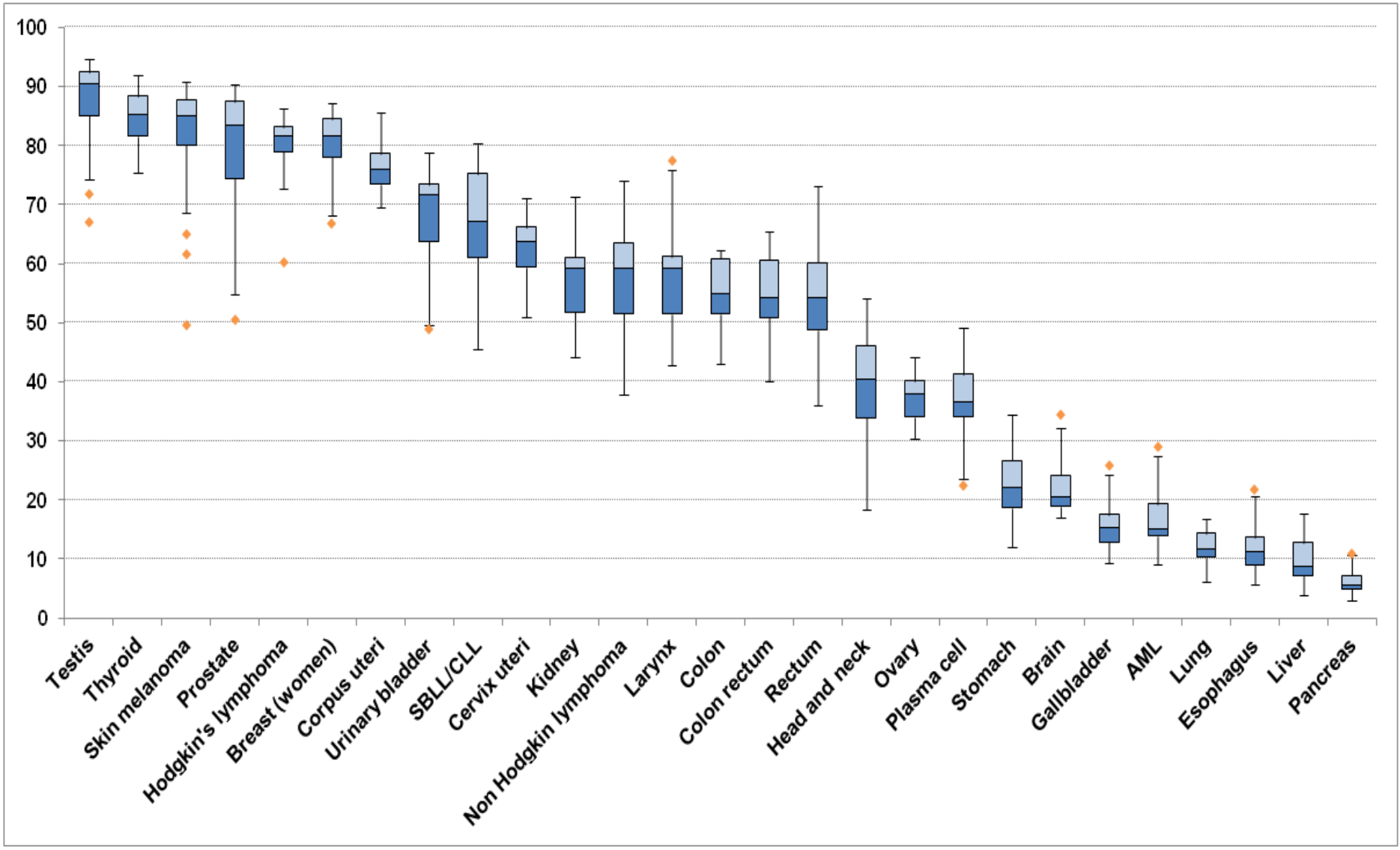








Between-country differences in cancer survival 2000-07



How we treat cancers

- Prevention
- Diagnosis and staging
- Treatment*
- Post treatment surveillance
- Rehabilitation

* a combination of surgery, radiotherapy, chemio, target and immunotherapy drugs

Where we failed

- In advanced/metastatic stages
- In early diagnosis
- In predictive medicine
- In assuring quality across socio-economic strata, regions and countries
- …In prevention

About prevention(s)

THE THREE LEVELS OF PREVENTION

Primary Prevention	Is designed to deter or avoid the occurrence of disease or injury
Secondary Prevention	Is designed to identify and adequately treat a disease or injury process as soon as possible, often before any symptoms have developed
Tertiary Prevention	Is designed to treat a disorder when it has advanced beyond its early stages, to avoid complications & limit disability, to address rehabilitative and palliative needs

Unmet needs and future risks

- Primary prevention of cancers for which we have knowledge of actionable risk factors (life style, alchool and smoking)

- Secondary prevention of cancer with late diagnosis and poor prognosis (lung, ovary)

- Tertiary prevention of the late effects of primary treatments in long survivors (with focus on PRO and PRE)

- Overdiagnosis (and over treatment) in cancers with inappropriate “screening” (prostate, lung and tyroid and, may be breast)

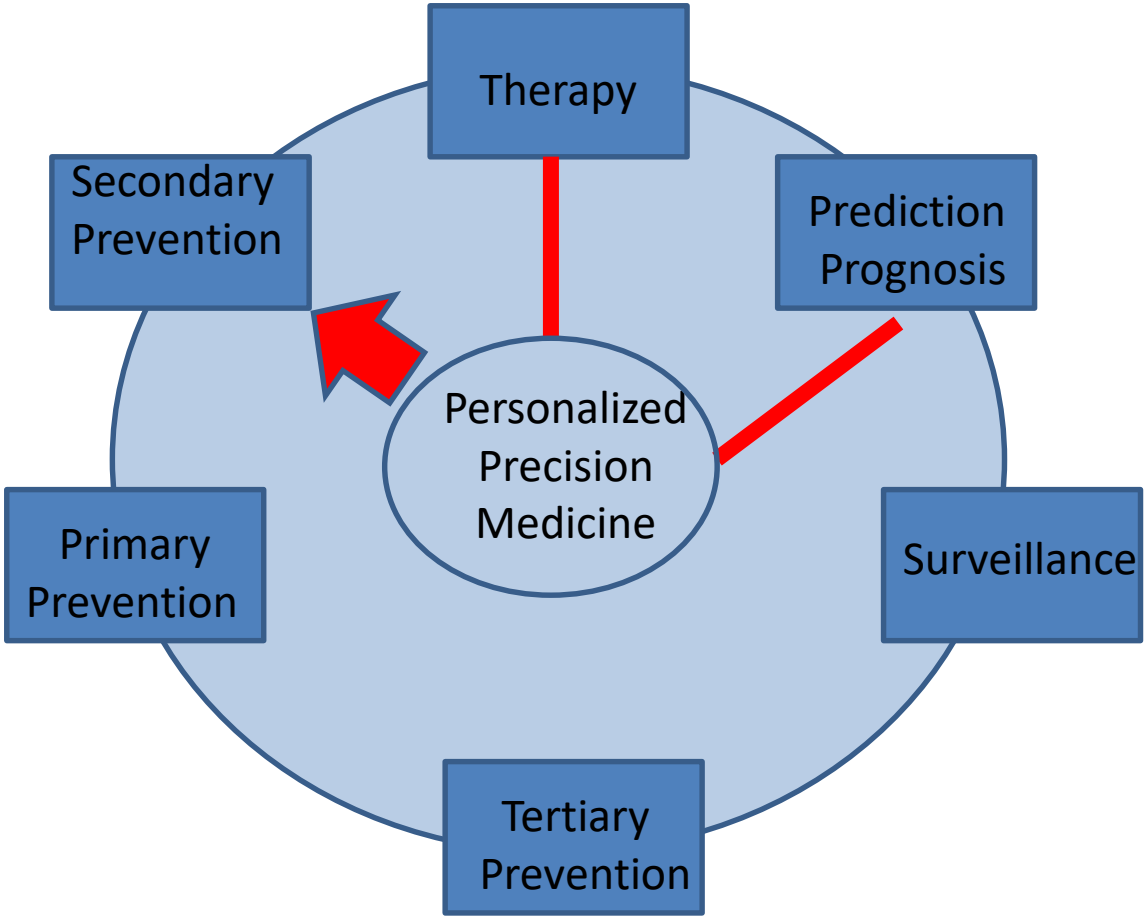
From Personalised to Precision Medicine (1)

From a first definition focalised on medical care designed to optimize therapeutic benefit for particular groups of patients, especially by using genetic or molecular profiling and targeted/personalised drugs…

From Personalised to Precision Medicine (2)

… to a new paradigm with a more comprehensive definition including personalised/precision prevention, early diagnosis, therapy and surveillance

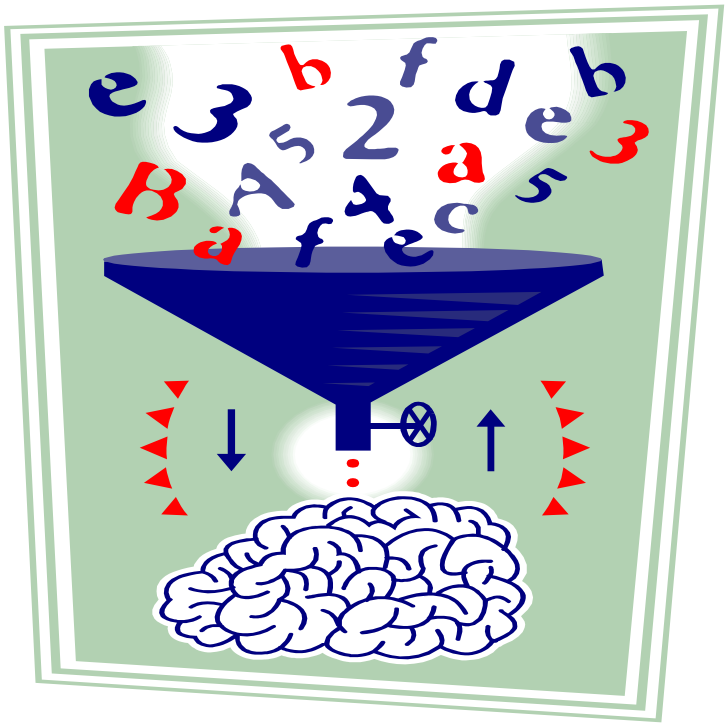
Research to produce evidence in order to stratify/personalise/individualize any actions delivered by the NHS… including prevention


Therapy
Secondary Prevention
Prediction Prognosis
Personalized Precision Medicine
Primary Prevention
Surveillance
Tertiary Prevention

Precision Research to…

- …persolanize not only drugs therapy but also
  - Non pharmacological interventions
  - Primary prevention (avoid disease)
  - Secondary prevention (early diagnosis)
  - Surveillance programs
  - Rehabilitation
  - …..

Role of Big Data and AI…



Data Driven

Hypothesis Driven

Data Sharing DL Longo, JF Drazen NEJM, January 21,2014

Start with a novel idea
Identify potential and relevant collaborators
Work together
Report findings with relevant coauthorship
…avoid the phenomenon of “research parasites*…

*people who had nothing to do with the design and execution of the study but use another groups’ data for thir own ends … concerns that the system will be taken over by others …

The new Cancer Mission

To make cancer a less frequent, more curable disease with better outcomes for all patients

- Less frequent: primary prevention
- More curable: secondary prevention and innovative technologies (among them immunotherapy)
- Better outcomes: decrease mortality, improve survival and QoL
- For all patients: improve quality and equity

The 5 Pillars

- Primary prevention on actionable known risk factors (shared with other non communicable diseases to produce overall benefit)
- Risk personalised Early Diagnosis (to increase efficiency of current and future screening programs)
- Translational precision research on innovative health interventions relevant to health care needs
- Research on outcomes that matter for patients
- Health Services Research (to identify obstacles and barriers for sustainable quality of care across Italy)

But…

- No single Institution and nation may reach this goal alone
- To keep going strong and wide regional, national and international collaborations will be necessary
- Networking should be implemented at Institutional and not at researcher level with well estasblished and long standing Consortium

Final Remarks

- Current available screening programs and more innovative drugs have increased our capability to detect earlier cancers, treat more patients and improve survival

- More effective and efficient primary and secondary prevention will decrease of about 30% new cases and increase of the same amount the diagnosis of cancer in ealier (asymptomatic) stages

- To do that the principle of precision medicine should be implemented in primary and secondary prevention research programs

- Accordingly, (cancer) primary and secondary prevention must be prioriterised when allocating funds to translational research projects and health care systems/service programs