CANCER – Introduction and clinical challenges

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BRITISH GYNAECOLOGICAL CANCER SOCIETY

Format of talk

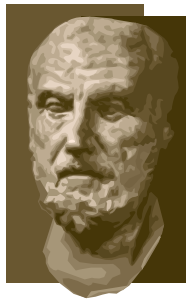
- Introduction to Cancer – cancer biology
- Introduction to Cancer treatment
- Current and projected cancer burden
- Clinical challenges – opportunities for ML

What is cancer?

Uncontrolled growth of abnormal cells in a tissue, invasive and spreading

Egyptian papyrus 3000-1500 BC – description of breast cancer

Hippocrates 400 BC – recognition of difference between malignant and benign tumours



Origins of cancer – tumours arise from normal tissues

Majority of tumours originate from epithelial tissues

Benign and malignant tumours

Squamous cell carcinomas and adenocarcinomas

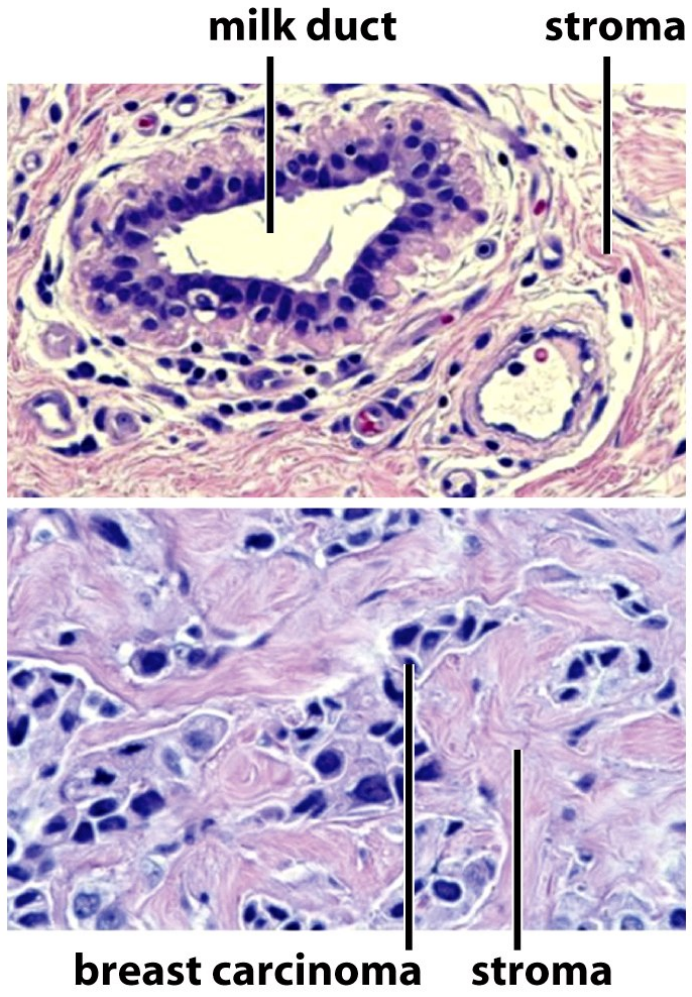


Figure 2.1b *The Biology of Cancer* (© Garland Science 2007)

Origins of cancer – tumours arise from normal tissues

Other tumours arise from non- epithelial cells

Sarcomas - from mesenchymal cells

Leukaemias and lymphoid and myeloid tumours - from haematopoietic tissue and cells of immune system

Neuroectodermal tumours -cells from central and peripheral nervous system

Brain tumours (eg gliomas, neuroblastoma)

Complexity of disease

"Microevolution" process leading to accumulation of

5-10 critical mutations requires many years.

Cancer is a genetic disease

Mutations causing cancer occur

- in germline
  and
- in somatic cells

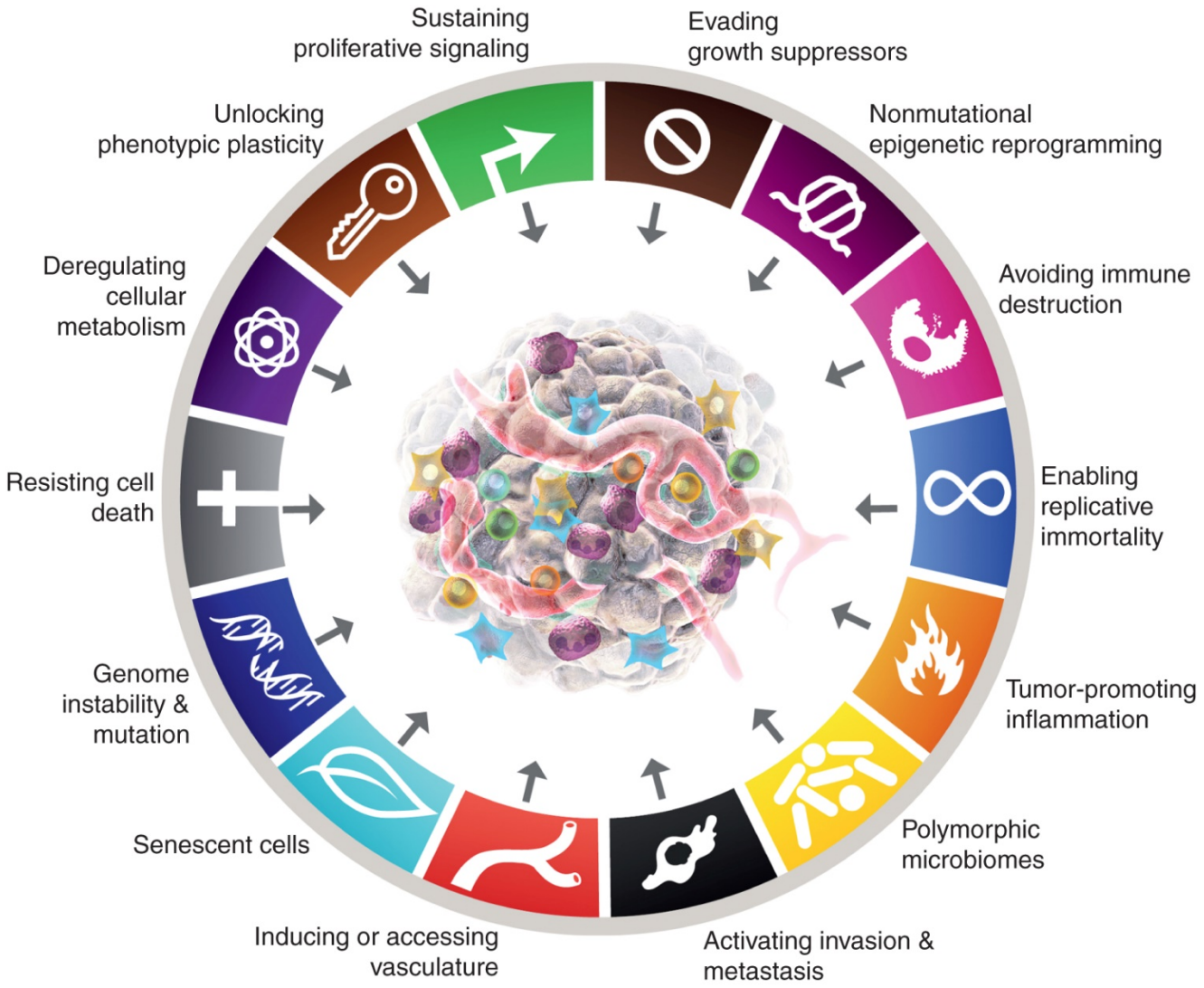
Mutations in different types of genes may initiate cancer

- **Genes that normally control**:
    - Growth
    - Passing on of signals from outside the cell
    - (receptors) across the cytoplasm to the nucleus
    - Programmed cell death (apoptosis)
    - The cell cycle
    - Stemness
    - The integrity of the genome- DNA repair

AACR American Association for Cancer Research

From: **Hallmarks of Cancer: New Dimensions**

Cancer Discov. 2022;12(1):31-46. doi:10.1158/2159-8290.CD-21-1059



Date of Download: 1/19/2023

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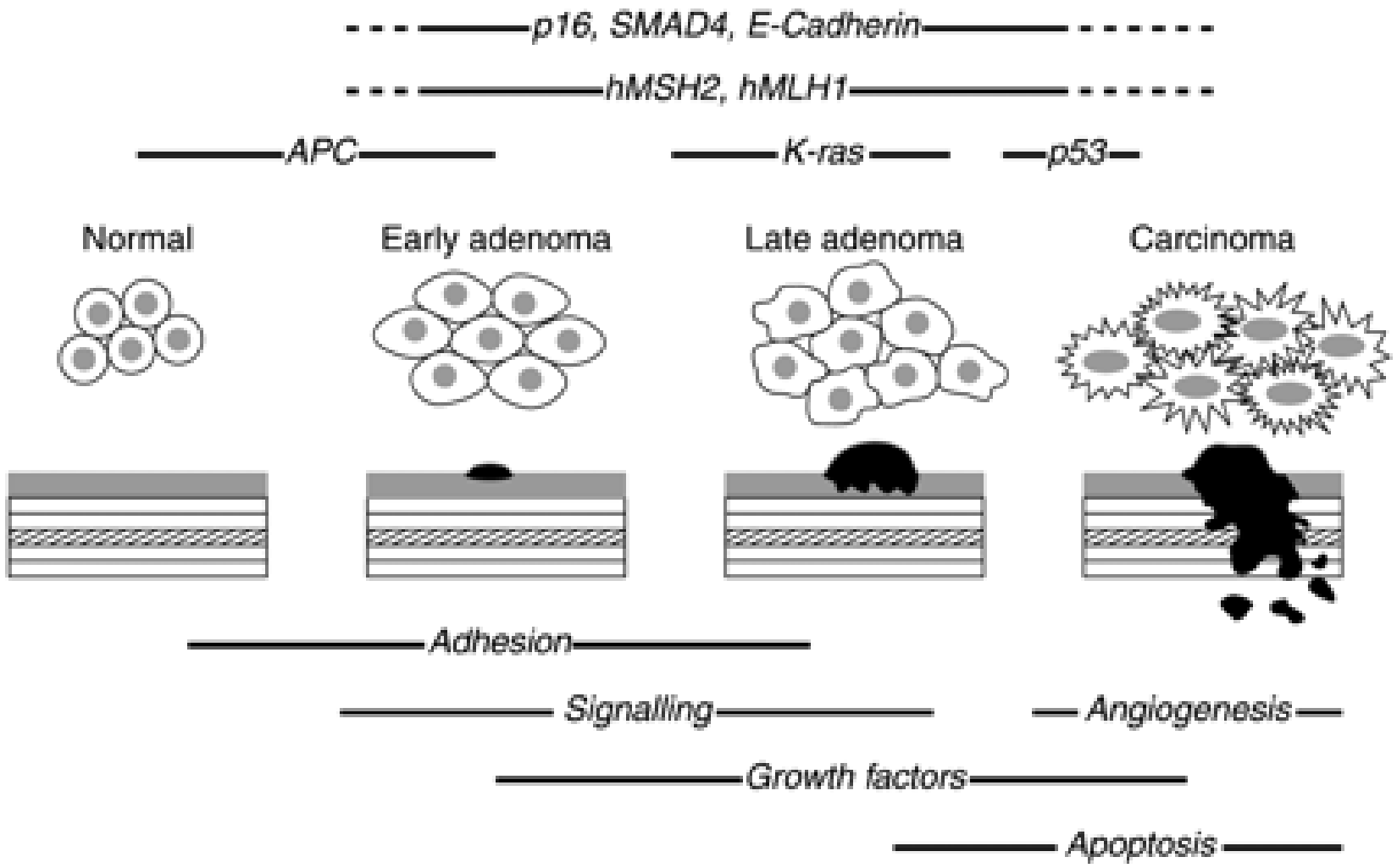
How do mutations arise?

- Copying errors during DNA replication – ageing

- Spontaneous depurination

- Exposure to different agents - carcinogens
- e.g. background ionising radiation
- UV light
- Tobacco products
- Human papilloma virus
- Obesity

Cancer is a progressive multistep disorder



Fearnhead et al, Br.Med. Bull. 64: 27-43 (2002)
http://bmb.oxfordjournals.org/content/64/1/27.full.pdf+html

Cancer can originate from any tissue

Cancer is a genetic disease driven by mutations in genes controlling vital cellular processes

Cancer is a progressive disorder resulting from multiple genetic steps

Cancer – fundamentals of treatment

Cancer characteristics

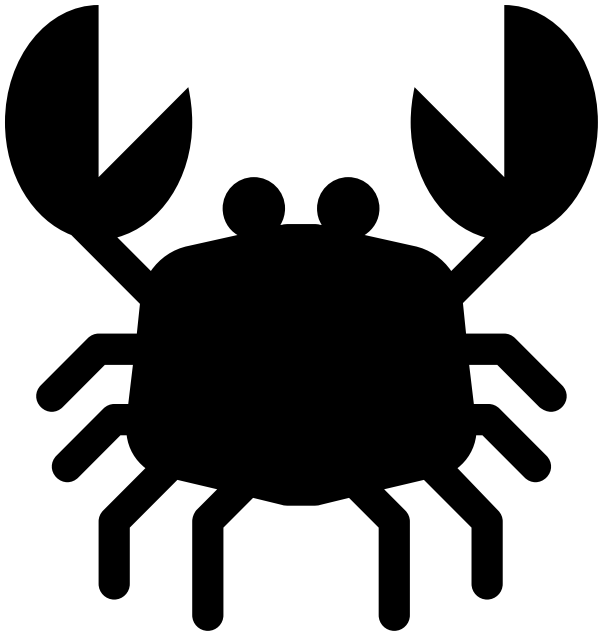
- Tissue of origin
  Stage
  Aggressiveness(grade)

Cancer tests

- Biopsy
  Imaging
  Fitness of patient

Treatments

- Surgery
  Radiotherapy
  Chemotherapy



Cancer outcomes

- Survival – cure
- Survival – living with cancer
- Progression to Death

- Priorities of cancer treatment are
  - Treat cancer adequately
  - minimizing side effects of treatment
  - Monitoring patient so can pick up recurrence early

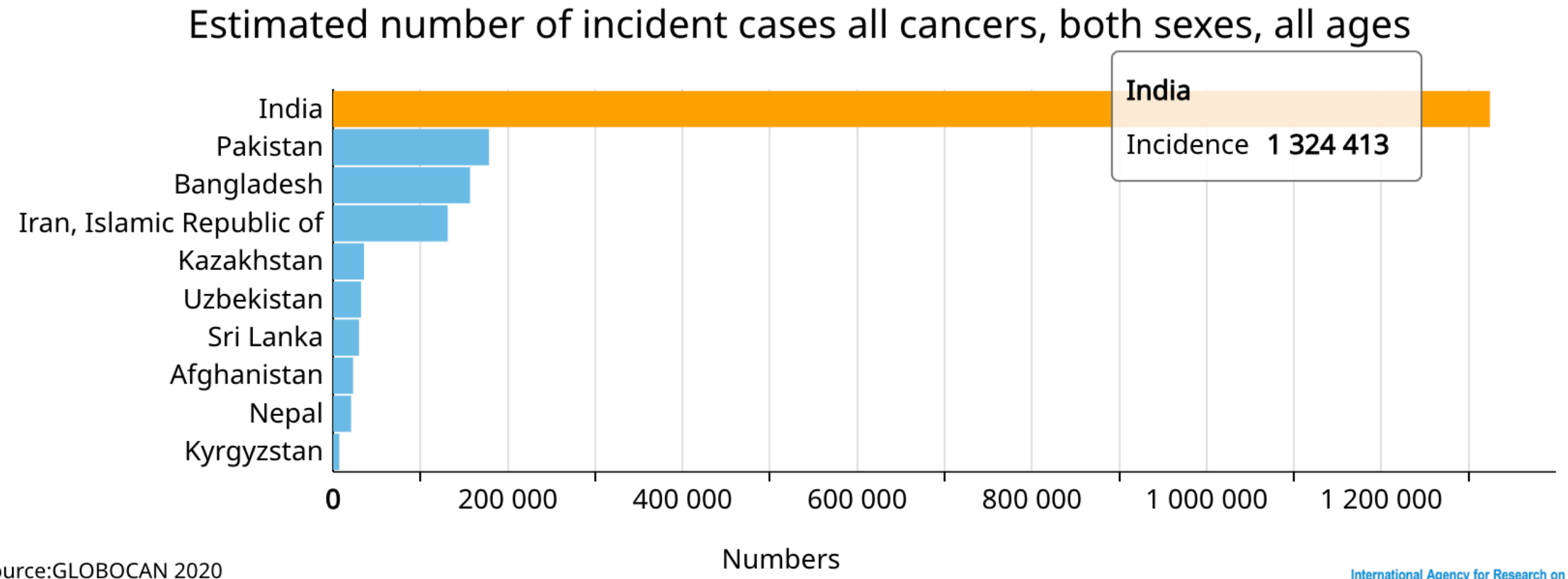
Summary of cancer care

- Rule of 3!

Cancer – Burden

Cancer India Burden – Globocan 2023

GRAPHIC TABLE



Data source:GLOBOCAN 2020
Graph production: Global Cancer Observatory (http://gco.iarc.fr/)
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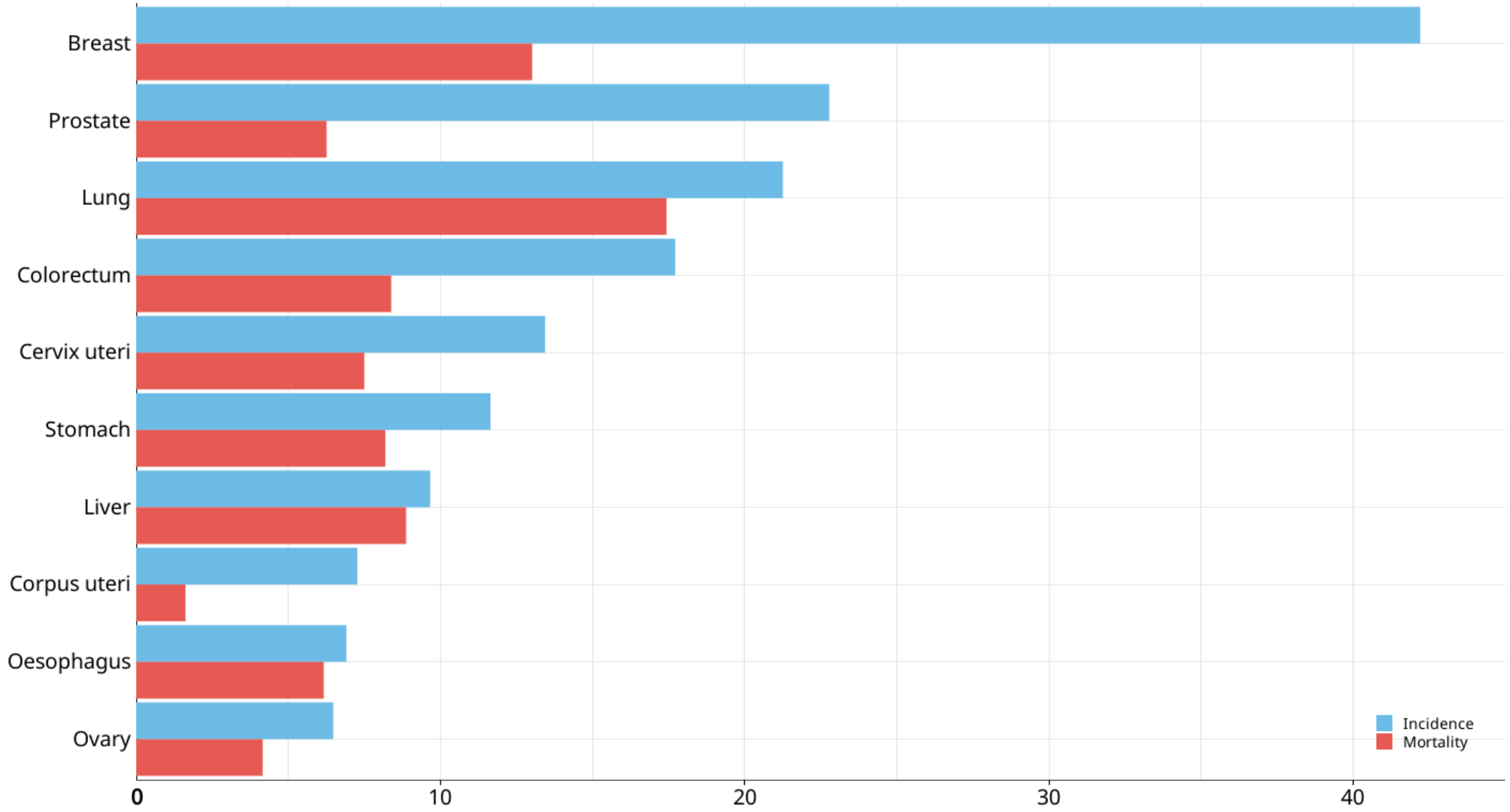
International Agency for Research on Cancer
World Health Organization

Estimated age-standardized incidence and mortality rates (World) in 2020, Asia, World, India, both sexes, all ages (excl. NMSC)

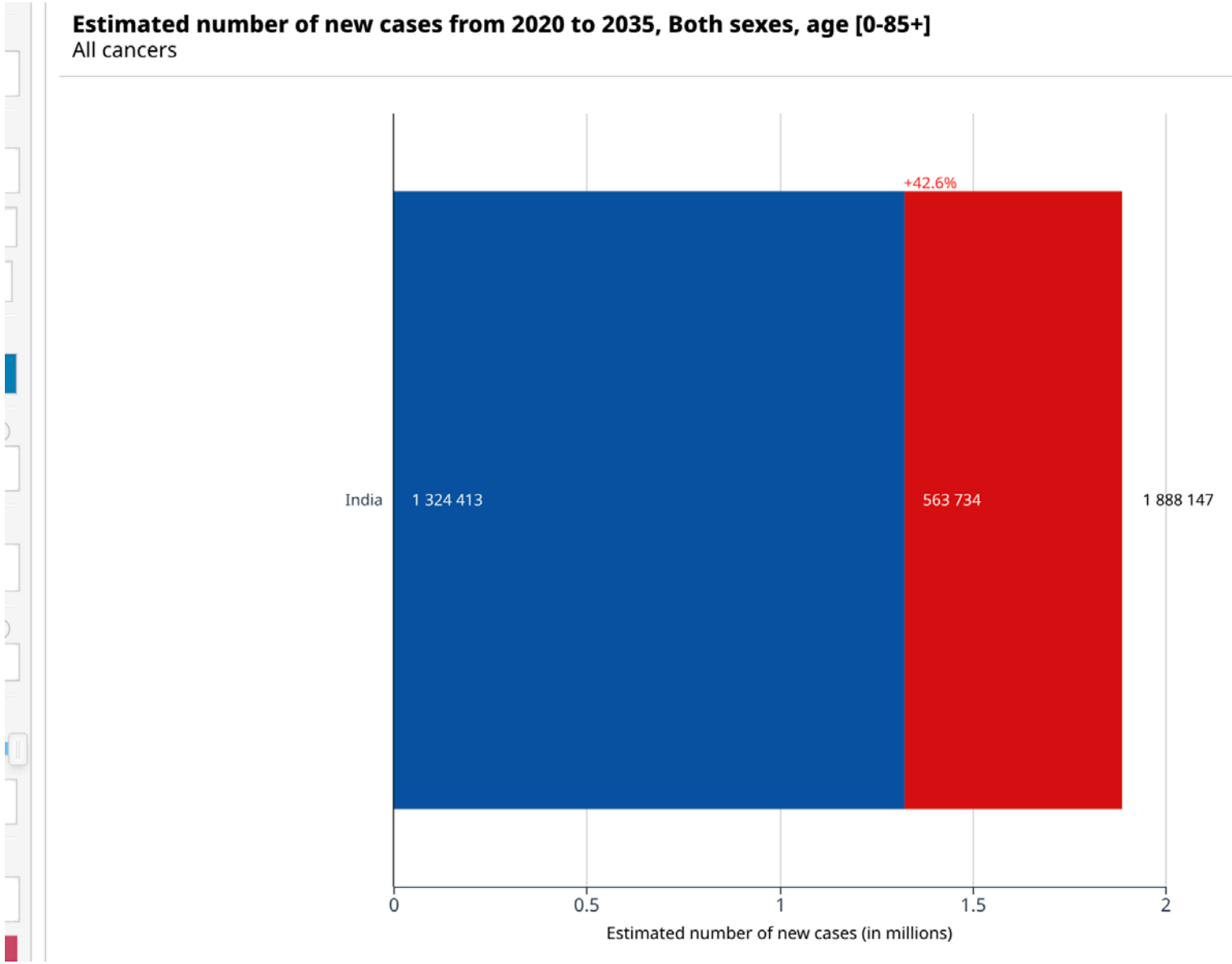


Data source: Globocan 2020
Graph production: Global Cancer Observatory (http://gco.iarc.fr)

International Agency for Research on Cancer
World Health Organization

Cancer burden India 2035 – 42% increase – Globocan

Most common
Breast,
Oral,
Cervical,
Gastric,
Lung cancers



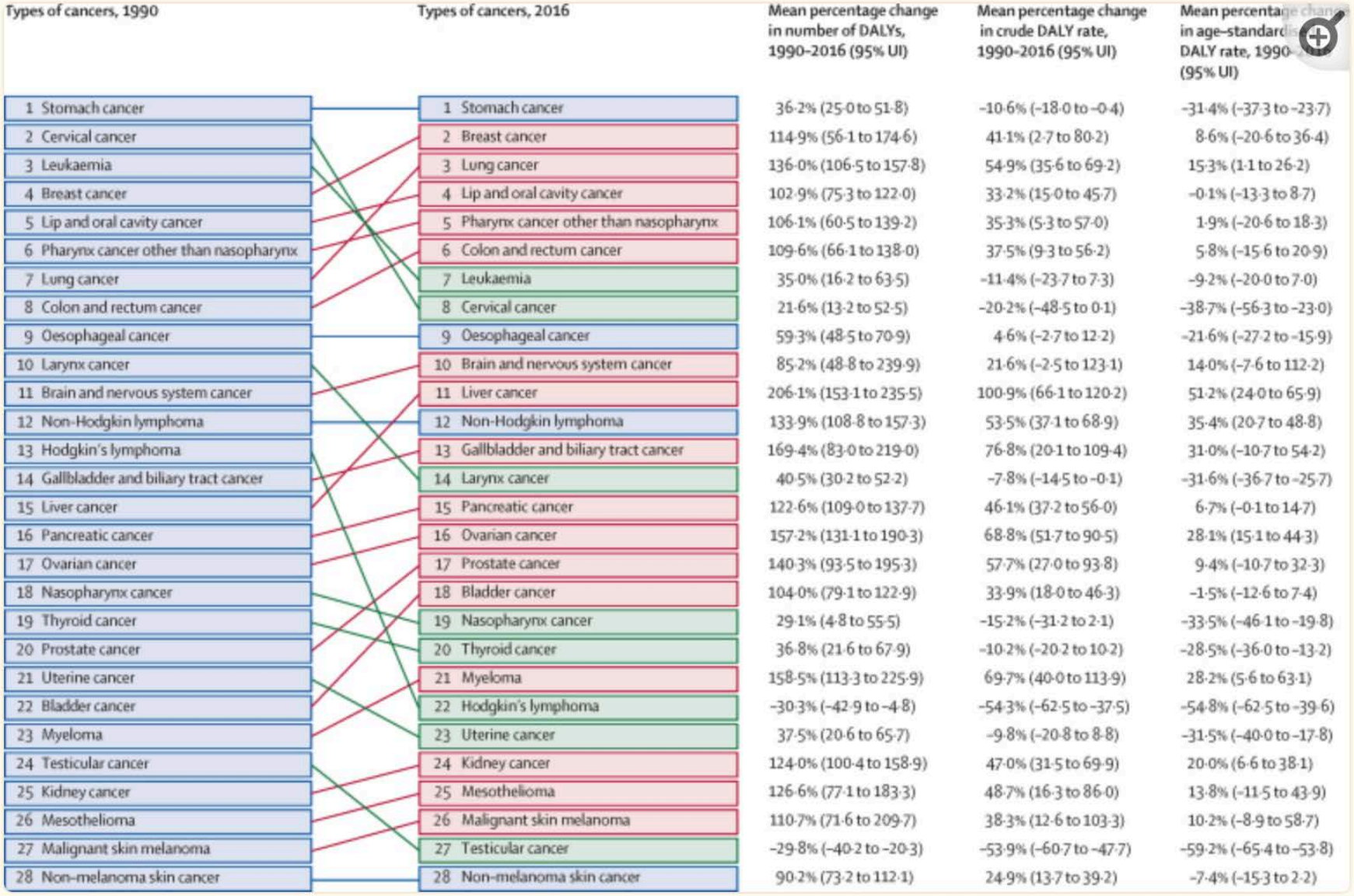


Figure 4

Change in DALYs for different types of cancers in India, 1990–2016

Lancet Oncol. 2018 Oct; 19(10): 1289–1306.
doi: 10.1016/S1470-2045(18)30447-9

The burden of cancers and their variations across the states of India: the Global Burden of Disease Study 1990–2016

India State-Level Disease Burden Initiative Cancer Collaborators†

Cancer

- Suffering
- Loss of life for patient
- Loss of income
- Side effects of treatment
- Financial toxicity for family
- Impact on carers
- Impact on society – economic productivity

Current cancer paradigm – a numbers game!

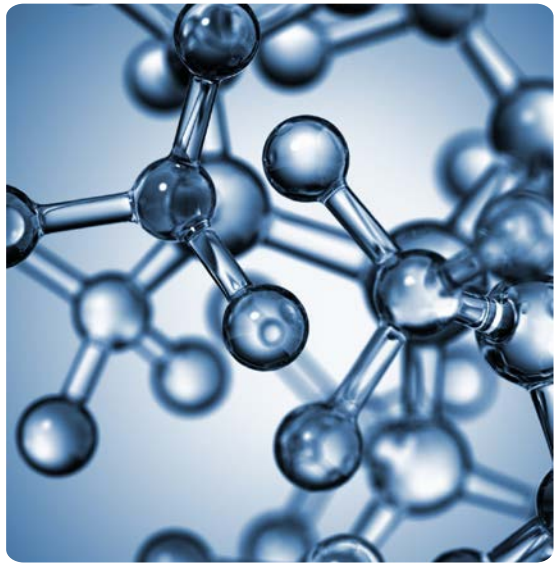
- Patient with symptoms goes to doctor
- Investigations – usually painful-invasive
- Biopsy – histology of a piece of tissue for definitive diagnosis
- Staging investigations – CT scan/imaging
- Determine site of tumour/stage/histology and aggressiveness of tumour
- Treatment options – surgery/chemotherapy/radiotherapy
- Outcome – relapse – further treatments - death or survival (usually with side effects of treatment)

Current cancer research

- Majority of research in HIC
- Majority of research in patients of Caucasian ethnicity
- Majority in drug discovery in advanced cancer
- Majority driven by pharma

- Analysis of benefit from FDA approved new cancer drugs : Novel pharmaceuticals increased patient survival by a median of 2.80 months (IQR, 1.97-4.60 months) for OS and 3.30 months (IQR, 1.50-5.58 months) for PFS. (Michaeli et al, JCO 2022)

Opportunities for Machine learning



Can we prevent cancer?

Novel screening methods

Can we diagnose cancer early? Supermarket loyalty card data*

Can we diagnose without invasive tests?*Genomics

Cancer metabolomics

Can we speed up testing?

Triaging

Can we treat cleverly?

Operating better - Robotics /Planning radiotherapy

Can we stratify cancers into those that will have poor outcome vs those that don't?

Can we minimise side effects ?

Shopping can save your life!

JMIR PUBLIC HEALTH AND SURVEILLANCE Brewer et al

Original Paper

Association Between Purchase of Over-the-Counter Medications and Ovarian Cancer Diagnosis in the Cancer Loyalty Card Study (CLOCS): Observational Case-Control Study

Hannah R Brewer[1], BA, PhD; Yasemin Hirst[2], BSc, PhD; Marc Chadeau-Hyam[3], BA, PhD; Eric Johnson[3], BA; Sudha Sundar[4], MPhil, MBBS; James M Flanagan[4], BSc, PhD

[1]Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, London, United Kingdom
[2]Department of Behavioural Science and Health, University College London, London, United Kingdom
[3]School of Public Health, Faculty of Medicine, Imperial College London, London, United Kingdom
[4]Division of Cancer, Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, London, United Kingdom

There is a difference in purchases of pain and indigestion medications among women with and without ovarian cancer up to 8 months before diagnosis. Facilitating earlier presentation among those who self-care for symptoms using this novel data source could improve ovarian cancer patients' options for treatment and improve survival.

Imperial – PI - Dr James Flanagan, Imperial, Dr Hannah Brewer
UCL/UCLAN – Dr Yasemin Hirst

Brewer HR, …Sundar S, .. Hirst Y.
Cancer Loyalty Card Study (CLOCS): feasibility outcomes for an observational case-control study focusing on the patient interval in ovarian cancer. BMJ Open. 2023 :

Genomics and metabolomics as diagnostic tests

- ROCkeTS GEN investigates ctDNA Joint PI – Prof James Brenton, Cambridge,
- Collaborators - Prof Nitzan Rosenfield, Cambridge, Prof Sue Mallett, UCL

- STEMOVA investigates urinary metabolomics in mucinous ovarian cancer
- Collaborators, Prof Weibke Arlt, UoB/MRC, Dr Paul Foster, Dr Alice Stitch, UoB
- PhD Dr David Jeevan completed

BWCH Global Research fund

Summary

- Many opportunities for ML research in cancer
- Transformative research is desperately needed
- Balancing cancer research towards prevention and diagnosis/ research in LMIC/research across different ethnicities

Thank you!

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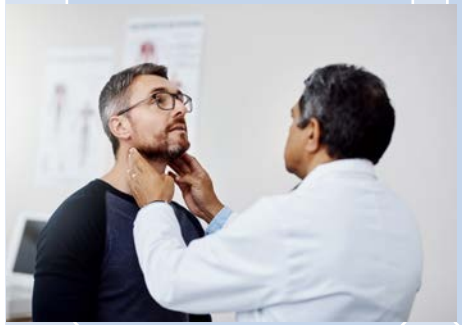
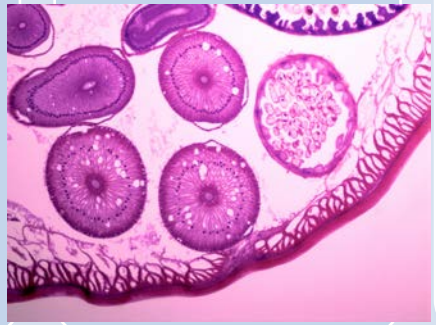


Patient with symptoms visits Dr

Undergoes investigations

Undergoes biopsy



Cancer treatment

Outcome - relapse or survival