The Future of Cancer

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Hong Kong

Session Number: WBR8
The Future of Cancer

Agenda

• Cancer – the basics
• Cancer – past and present
• Cancer – the future
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CANCER – THE BASICS
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Cancer – the basics

• What is Cancer?
  • Cells divide and multiply uncontrollably
  • Multiplying cells invade surrounding tissue
  • Capable of spread (metastasis) to other parts of the body via blood / lymph

• Not a single disease
  • Different causes and processes for different sites
  • Different causes and processes for different types in the same site (histotypes)
  • There may be as many types of cancer as different types of human cell (200+) or as many types of cancer as there are different people
What causes cells to divide and multiply uncontrollably?

- **Oncogenes** are genes that cause cells to multiply uncontrollably
- **Anti-oncogenes (tumour suppressor genes)** are genes that stop cells from multiplying uncontrollably
- **Accessory cancer genes** increase mutations in onco- or anti-oncogenes or facilitate production of intermediate cancer cells
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Cancer – normal to cancer cells

• Mutations can
  • cause some genes within cells (*proto-oncogenes*) to convert into *oncogenes* or
  • stop *anti-oncogenes* from performing their function

• Such mutations can be caused by
  • inherited genetic predisposition
  • exposure to environmental agents (*carcinogens*)
  • loss of cell replication capacity
  • random chance / unexplained reasons
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Cancer – diagnosis

• How has Cancer been detected?
  • Patient exhibits symptoms
  • Routine screening test
  • "Abnormal" finding triggers further investigation

• Confirmation of diagnosis
  • Take some sample cells (biopsy) and microscopic examination (histology)
  • Multiplying cells invade surrounding tissue
  • Capable of spread (metastasis) to other parts of the body via blood / lymph
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Cancer – treatment

• How has Cancer been treated?
  • Surgery
cut out cancerous cells (and surrounding tissue)
  • Chemotherapy
use drugs to destroy cells that grow quickly (including cancer cells and other cells)
  • Radiotherapy
use radiation to damage the DNA of cancer cells (and surrounding tissue), thereby destroying them
  • Bone Marrow / Stem Cell Transplant
to restore stem cells destroyed by chemo/radio
  • Combination therapy to overcome cancer cells that have built up natural resistance
CANCER – PAST AND PRESENT
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Cancer trends – Male

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Source: Cancer Registry Data using Insured Life Age Weights
Relative Incidence (recent data) V = very high, H = high, M = medium, L = low
Arrow shows incidence trend based on last 10-20 years
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## Cancer trends – Female

The table below shows the relative incidence of cancer in female for different regions and organs. The relative incidence is indicated by V (very high), H (high), M (medium), and L (low). Arrows show the trend based on the last 10-20 years.

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Relative Incidence (recent data) V = very high, H = high, M = medium, L = low
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Changes in Cancer incidence

• Changes in Definition
• Changes in Risk Factors
• Changes in Detection
  • Registration / reporting of new cancers
  • Rate of cancer screening
  • Effectiveness of cancer screening
  • Cancers in extreme old age
  • Effectiveness of "pre-detection"
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Changes in Cancer definition?

• Still some disagreement over what constitutes a malignant cancer
  • Polycythaemia vera
  • Myelodysplastic syndromes
  • Chronic myeloproliferative disease
  • Essential (haemorrhagic) thrombocythaemia
  • Intra-mucosal colon carcinoma
  • Non-invasive papillary bladder carcinoma
  Non-muscle invasive bladder cancer
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Changes in risk factors?

• Smoking
  • lung, oropharynx, oesophagus, stomach, breast, cervix, pancreas, liver, leukaemia

• Dietary Fat / Obesity
  • colon, rectum, breast, prostate, oesophagus, pancreas

• Chronic Infection
  • helicobacter pylori (stomach), hepatitis (liver), human papilloma virus (cervix and genitals), Epstein Barr virus (lymphoma, nasopharynx), HIV (many)
  • further links with infectious agents still being found
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How does smoking cause cancer?

Butane Lighter Fluid
Cadmium Batteries
Stearic Acid Candle Wax
Hexamine Barbecue Lighter
Toluene Industrial Solvent
Nicotine Insecticide
Ammonia Toilet Cleaner
Acetic Acid Vinegar
Methane Sewer Gas
Arsenic Poison
Carbon Monoxide
Methanol Rocket Fuel

Joint IACA, IAAHS and PBSS Colloquium in Hong Kong
www.actuaries.org/HongKong2012/
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Smoking & lung cancer

Japan Males – Smoking & Lung Cancer

Year


Smoker Prevalence [SP %]

Lung Cancer (LC % of 1975)

Sources:
Incidence from Japan Cancer Registry Data
Smoker Prevalence from Japan Tobacco
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Hepatitis B & liver cancer

Liver Cancer Incidence

Relative Liver Cancer Incidence

Estimated Prevalence of Hepatitis B

Sources:
Incidence from Cancer Registry Data using Insured Life Age Weights
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#### Screening & prostate cancer

**Prostate Cancer in Males 65-74**

<table>
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<tr>
<th>Studied Group</th>
<th>Estimated Screening Rate</th>
<th>Incidence / Prevalence</th>
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<td>US White Autopsy Study</td>
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</table>

Sources:
- Japan population from Japan Cancer Registry statistics
- Japan insured from Swiss Re client data
- US population from SEER data
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Screening & thyroid cancer

Korea - Female Thyroid Cancer Incidence

Sources:
Population Incidence from Cancer Registry Data – weighted by insured ages
Insured Incidence from Insurance Portfolios – weighted by insured ages
NB: Estimated population screening rate in 2009 was 15-25%
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Cancer at extreme old age

• What happens to cells in old age
  • Probability of spontaneous cell mutation increases with number of cell divisions (ie increases with age), leading to higher cancer incidence
  • But ability of cells to replicate may also slow at extreme old age, which might lead to fewer mutations and fewer cancers
  • Studies in mice suggest that cancer incidence flattens and might even decline at extreme old age

• But evidence in humans is mixed...
  • Possible underdiagnosis at older ages??
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Cancer at extreme old age

Male Cancer Incidence – mid to late 2000s

Age Group

70-74 75-79 80-84 85+

Incidence per 1000

AU 2006
HK 2007
JP 2005
KR 2008
SG 2003-07
TW 2007
US-W 2007
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Cancer at extreme old age

Female Cancer Incidence – mid to late 2000s

Incidence per 1000

Age Group

70-74 75-79 80-84 85+

70-74 75-79 80-84 85+

AU 2006
HK 2007
JP 2005
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TW 2007
US-W 2007
Cancer pre-detection

- Genetic testing for susceptibility
  - e.g., certain variations of the BRCA1 gene are associated with increased risk of breast and ovarian cancer
- Biomarkers of exposure or susceptibility
  - e.g., PSA is a biomarker for prostate abnormalities already in use and improving in specificity (insulin-like growth factor, kallikreins)
- Signs of DNA instability and damage
  - DNA testing can indicate susceptibility to cancer
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Cancer prevention and treatment

• Cancer vaccines
  • Identification of underlying cause of cancer is enabling development of cancer vaccines
eg HPV vaccine for teenage girls

• Targeted therapies
  • interfere with specific molecules needed for tumour growth or stimulate immune system response rather than interfering with rapid cell division
  • Monoclonal antibodies and small molecules
  • Herceptin, Rituxan, Interleukin-2, Interferon alpha, etc
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Cancer prevention and treatment

- Extensions of life expectancy
  - But for how long?
  - And at what cost?

Breast Cancer Treatments

- Gemcitabine
- Letrozole
- Exemestane
- Anastrazole
- Docetaxel
- Trastuzumab

Mean survival without intervention
- Gemcitabine: <$1,000
- Letrozole: >$10,000
- Exemestane: >$1,000
- Anastrazole: >$1,000
- Docetaxel: >$10,000
- Trastuzumab: >$50,000

Additional survival with intervention

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CANCER – THE FUTURE
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• Detection
  • Increased take-up of cancer screening
  • Further improvements in accuracy of screening tests
  • Large sample studies to identify and test the accuracy of new biomarkers
  • Earlier detection permits earlier intervention and improves mortality
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- Risk Factors and Pre-Detection
  - Further identification of carcinogenic agents, infections and mechanisms
  - Biobanks (e.g., UK, China) facilitating improved understanding of disease causes and pathways
  - Epigenetic studies tracking inheritable changes in gene expression
  - Continued campaigns to change behaviour in relation to controllable risk factors (but some behaviours will be difficult to change)
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• Personalised medicine
  • Cancer genome atlas project
  • Cheap and simple personal genome mapping
  • Targeted therapies directed at cancer-causing genes
  • Vaccines and therapies to generate immune system response to cancers
  • New drugs will be expensive and not always covered by government health insurance (or even private health insurance)