

Overview of Cancer Epidemiology and Control

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Cancer Epidemiology

Epidemiology is the study of the *distribution* and *determinants* of diseases in human populations.

Epidemiology is the *fundamental science* of public health that provides information on the risk factors (contributing causes) of diseases so that *exposure* to these causes can be *limited* or *eliminated entirely*.

Cancer Epidemiology is the identification and study of the risk factors for cancer, the second most common cause of death in the U.S. today.

Cancer Ranked #2 as a Cause of Death in the U.S. in 2018

- 1. Heart disease: 655,381 (23.1% of total deaths)
- 2. **Cancer: 599,274 (21.1%)**
- 3. Accidents (unintentional injuries): 167,127 (5.9%)
- 4. Chronic lower respiratory diseases: 159,486 (5.6%)
- 5. Stroke (cerebrovascular diseases): 147,810 (5.2%)
- 6. Alzheimer's disease: 122,019 (4.3%)
- 7. Diabetes: 84,946 (3.0%)
- 8. Influenza and pneumonia: 59,120 (2.1%)
- 9. Nephritis, nephrotic syndrome, nephrosis: 51,386 (1.8%)
- 10. Intentional self-harm (suicide): 48,344 (1.7 %)
- **Top 10: 2,094,893 deaths (73.8% of overall deaths)**
- **Overall: 2,839,205 deaths in 2018 (100%)**

Cancer Control

Cancer Control is the *application* of our knowledge about cancer *causes*, the means for detecting cancer *early*, and the means to better *survive* cancer, in order to “reduce the burden of cancer in the community.”

Measurable Goals are to:

- reduce incidence (occurrence of new cases)
- reduce mortality (deaths)
- increase survival of cancer survivors, and
- improve quality of life of cancer survivors.

Causes of Adult vs. Childhood Cancers

- ***Adult cancers*** have environmental causes that trigger uncontrolled cell growth when genes malfunction. Environmental triggers include tobacco, alcohol, diet, viruses, radiation, and occupational exposures.
- Adult cancers can be ***prevented*** by reducing exposure to these environmental causes.
- ***Childhood cancers*** are usually caused by genetic changes before birth or in infancy; there may be no environmental trigger.
- ***Prevention*** of childhood cancers is difficult.

Approaches to Cancer Control

- 1) Primary prevention: identify environmental risk factors (*contributing causes*) and reduce their prevalence in the population to reduce the incidence of cancer among adults

This is the ideal in public health . . . keep the cancer-free people cancer-free!

*Example: cigarette smoking avoidance or cessation → reduced prevalence of smoking
→ reduced incidence of lung cancer*

Primary Prevention of Adult Cancers Through Environmental & Lifestyle Changes

- Reduce tobacco use
- Increase vegetable and fruit consumption
- Increase physical activity
- Decrease overweight and obesity (control BMI)
- Decrease ultraviolet light exposure
- Decrease exposure to radon and other radiation
- Decrease exposure to certain viruses
- Decrease exposure to chemical carcinogens in the home and in the workplace
- **Have the “right” genes that are resistant to these environmental insults!**

Major Cancers in Adults Subject to Control Via Primary Prevention

- Tobacco-related cancers such as lung, head and neck, larynx, pancreas, cervix
- Cancers that may be related to obesity and diet, such as breast, prostate, and colorectal
- Cancers that may be caused by chemical and particulate exposures, such as lung, urinary bladder; and possibly breast and prostate
- Cancers caused by infections that may be vaccine-preventable such as liver (HB & HC), cervix (HPV), head & neck cancers (HPV)

Approaches to Cancer Control

2) Secondary prevention: among adults, detect cancer early (when it is “near normal”) in order to prevent sequelae, extend survival, reduce mortality (case fatality) and possibly cure cancer

For many types of cancer, early detection means that the chances for full recovery, cure, or extended survival are much *higher* than for late-diagnosed cases.

Three approaches to secondary prevention . . .

Secondary Prevention Approach #1

Health education about early recognition of signs (objective) and symptoms (subjective) so that adults will promptly seek medical evaluation when a sign or symptom of cancer occurs.

This passive approach, remaining aware of what your body is telling you, is effective for educated people who are enthusiastic about taking charge of their health, and for people who are unafraid of findings

Secondary Prevention Approach #2

Self-examination: train adults to systematically examine their bodies (especially, the female breast) to become familiar with the “normal” so that they can promptly seek medical evaluation for abnormal findings.

This ***active*** approach, searching for abnormalities, may work well for medically-oriented people, and people with self-examination skills

Secondary Prevention Approach #3

Screening: physical examination, X-ray, or lab test done on *asymptomatic* people who are members of *high-risk groups* (due to their age, race, sex, SES, occupation, family history, genetic profile, etc.) by a physician, nurse, or other clinician, that reliably identifies people having evidence of early disease

Screening is the most effective approach for secondary prevention of cancer and is recommended for high-risk adults.

Three Approaches to Secondary Prevention of Female Breast Cancer

- 1) education that breast lumps (as may be found incidentally), bleeding or discharge are abnormal and should be reported promptly to a physician or nurse for evaluation
- 2) practice of monthly breast self-examination (BSE) to systematically look for lumps and abnormalities and have them evaluated if found
- 3) annual or bi-annual breast X-rays (mammograms) to identify suspicious areas of the breast that need further examination

“*Screen-Detectable*” Cancers . . .

. . . are those cancers for which we have:

1. a ***screening test*** that accurately detects cancer early (with only a few FNs or FPs); ***and***
2. ***follow-up data*** demonstrating that screen-detected cases ***survive longer*** (with better quality of life) than symptom-diagnosed cases

Screen-detectable adult cancers (and tests):

- Breast (mammography)
- Cervix (Pap smear) [also vaccine-preventable]
- Colorectal (digital rectal exam + colonoscopy, sigmoidoscopy, barium enema, FIT, or FOBT)

Approaches to Cancer Control

3) Tertiary prevention: improve **access** to state-of-the-art medical and surgical treatment, rehabilitative services, and physical and psychologic follow-up, for adults diagnosed with cancer, in order to reduce morbidity, limit sequelae, lengthen survival, and improve quality of life of cancer survivors.

Example: participation in yoga by breast cancer survivors who have had mastectomies in order to build strength, confidence, and self – esteem, and to accept their medical status as it is.

Genetic Causes of Adult Cancers

- As we have seen, most adult cancers are “acquired,” caused by **environmental factors** such as tobacco, obesity, radiation, and viruses, causing genes to malfunction and uncontrolled cell growth.
- But 5-10% of adult cancers are caused by **inherited genetic mutations**.
- Gene mutations are associated with ~ 50 hereditary syndromes that predispose to certain cancers. These syndromes are uncommon or rare.
- If close family members have a defective gene, an adult may have increased risk for certain cancers, but getting cancer is by no means a certainty.

Breast and Ovarian Cancers Can be Caused by Mutations Detectable by Genetic Tests

- **Breast cancer** (ranks #1 in incidence in U.S. women) is the best example of a ***genetic cause*** of a common adult cancer. Women having the BRCA1 or BRCA2 gene have a 50-85% lifetime risk for developing breast cancer or ovarian cancer.
- **Ovarian cancer** (low incidence rate but high case fatality) can be caused by BRCA1 or BRCA2 gene.
- **Environmental** causes of breast cancer and ovarian cancer are unclear, so perhaps there are additional genetic causes of these cancers, not yet recognized.

Prostate, Colorectal Cancers Can be Caused by Mutations Detectable by Genetic Tests

- **Prostate cancer** (ranks #1 in incidence in U.S. men): environmental causes are unclear, so genetic causes may be responsible.
- **Colorectal cancer** (CRC, ranks #3 in incidence in U.S. men and women): dietary causes are known but ***hereditary*** familial polyposis may lead to CRC.
- **Lynch syndrome** (Hereditary Non-Polyposis Colon Cancer, HNPCC), is the most common cause of ***hereditary*** colorectal cancer; these women are at increased risk for ovarian and endometrial cancers.

Common Childhood Cancers

Children get a different “roster” of cancers than do adults. Most or all of these cancers are primarily caused ***genetically***, as opposed to environmentally:

- Leukemias
- Brain and spinal cord tumors
- Neuroblastoma
- Wilms tumor
- Lymphoma (Hodgkin and non-Hodgkin)
- Rhabdomyosarcoma
- Retinoblastoma
- Bone cancer (osteosarcoma and Ewing sarcoma)

Genetic Causes of Childhood Cancers

- **Childhood cancers** are not linked to **lifestyle or environmental risk factors** such as tobacco, diet, alcohol, and viruses, but radiation may play a role.
- A small percentage of childhood cancers are caused by **inherited mutations** passed from parent to child. DNA testing can detect these mutations. Some mutations cause developmental problems and cancer.
- **Most childhood cancers** are caused by **acquired mutations** that occur before birth or early in life. Rapid cell divisions during growth of a child can make DNA copying **errors** that code for tumor growth. The means of **preventing** acquired mutations are unclear.

Can Cancer be Controlled?

- ***Cancer mortality rates*** have declined but heart disease mortality rates have declined faster so cancer may soon become the ***leading*** cause of death!
- Only with improved ***primary, secondary, and tertiary*** prevention can we hope to control cancer.
- ***Primary*** prevention relies on epidemiologic research to find ***environmental*** carcinogens so exposure can be limited by public policy steps or behavior change.
- ***Genetic*** research and testing must advance.
- ***Secondary*** prevention relies on better screening tests and ways to increase participation in screening.
- ***Tertiary*** prevention relies on health care policy, health insurance, rehabilitative services for cancer survivors.

To Learn More About Cancer Epidemiology and Control . . .

- The *American Cancer Society (ACS)* website www.cancer.org includes “*Cancer Facts and Figures*” (large pdf file) and PowerPoint slideshows of the latest cancer statistics and information about diagnosis and treatment.
- ***EPI 713: Cancer Epidemiology and Control*** is offered every other year
- Email Dr. Waterbor at h2obor@uab.edu for more information on specific cancer topics.

--JW, 06/2021