Cancer Prevention Across the Lifespan: What are the missed opportunities?

Mary C. White, ScD
Chief, Epidemiology and Applied Research Branch

MCC Board of Directors Meeting
September 27, 2017
Lessons Learned from the Cancer Prevention Across the Lifespan (CPAL) Workgroup

Source: www.cdc.gov/cancer/dcpc/prevention/lifetime.htm

## Increases in Cancer Incidence, 2009-2013

<table>
<thead>
<tr>
<th>MALE Site</th>
<th>AAPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanoma of the skin</td>
<td>+2.3%</td>
</tr>
<tr>
<td>Kidney and renal pelvis</td>
<td>+0.9%</td>
</tr>
<tr>
<td>Leukemia</td>
<td>+1.7%</td>
</tr>
<tr>
<td>Oral cavity and pharynx</td>
<td>+1.3%</td>
</tr>
<tr>
<td>Pancreas</td>
<td>+1.0%</td>
</tr>
<tr>
<td>Liver</td>
<td>+2.9%</td>
</tr>
<tr>
<td>Myeloma</td>
<td>+2.8%</td>
</tr>
<tr>
<td>Thyroid</td>
<td>+2.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FEMALE Site</th>
<th>AAPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>+0.4%</td>
</tr>
<tr>
<td>Uterus</td>
<td>+1.2%</td>
</tr>
<tr>
<td>Thyroid</td>
<td>+2.3%</td>
</tr>
<tr>
<td>Melanoma of the skin</td>
<td>+0.9%</td>
</tr>
<tr>
<td>Kidney and renal pelvis</td>
<td>+0.4%</td>
</tr>
<tr>
<td>Leukemia</td>
<td>+1.5%</td>
</tr>
<tr>
<td>Pancreas</td>
<td>+1.1%</td>
</tr>
<tr>
<td>Oral cavity and pharynx</td>
<td>+0.8%</td>
</tr>
<tr>
<td>Myeloma</td>
<td>+2.2%</td>
</tr>
<tr>
<td>Liver</td>
<td>+3.8%</td>
</tr>
</tbody>
</table>

What’s Missing?
What do we mean by cancer risk?

- Risk is the probability that an event will occur.
- Cancer incidence rates are measures of population risk.
- We reduce cancer risk in a population by reducing the number of new cancer cases.
- Risk reduction = cancer prevention.
Lung cancer rates follow trends in cigarette consumption
What do we mean by “prevention”?

• Prevention is a core task of public health, including health promotion.
• Like “natural,” lots of things get labeled as “prevention.”
• Primary prevention aims to reduce the incidence of disease by personal and communal efforts.*

# Comprehensive Approach to Prevention and Control

<table>
<thead>
<tr>
<th>PRIMARY PREVENTION HEALTH PROMOTION</th>
<th>MEDICAL INTERVENTIONS HEALTH CARE</th>
<th>DISEASE CONTROL HEALTH CARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Environment and policy change</td>
<td>• Vaccines</td>
<td>• Diagnosis</td>
</tr>
<tr>
<td>• Reduce exposure to carcinogens</td>
<td>• Screening</td>
<td>• Treatment</td>
</tr>
<tr>
<td>• Social determinants of health</td>
<td>• Chemoprevention</td>
<td>• Chronic disease management</td>
</tr>
<tr>
<td>• Healthy behaviors</td>
<td>• Prophylactic surgery</td>
<td>• Survivorship care plans</td>
</tr>
</tbody>
</table>

*Activities happen in parallel, not in sequence*
Multi-stage model of carcinogenesis

Complex-systems model of postmenopausal breast cancer causation

Source: Breast Cancer and the Environment: A Life Course Approach. Institute of Medicine, 2012
<table>
<thead>
<tr>
<th>Factors or class of factors</th>
<th>Doll &amp; Peto 1981 (deaths)</th>
<th>Harvard 1996 (deaths)</th>
<th>AACR 2017 (cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>30</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Alcohol</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Diet: Adult diet/obesity (30)/sedentary lifestyle (5)/obese or overweight (20)/insufficient physical activity(5)/poor diet (5)</td>
<td>35</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Food additives: Salt/other food additives/contam.</td>
<td>&lt;1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Reproductive and sexual behavior / and perinatal</td>
<td>7</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Occupation</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Pollution</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Industrial products: Socioeconomic status</td>
<td>&lt;1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Medicines and medical procedures</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Geographical factors: Ionizing/ultraviolet radiation</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Infection: Viruses/other biologic agents</td>
<td>10?</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Unknown: Family history of cancer</td>
<td>?</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**TOTAL** 100 100
Labeling Cancer Risk Factors as Lifestyle Limits Prevention Activities Across the Life Span

Mary C. White, ScD, Lucy A. Peipins, PhD, Dawn M. Holman, MPH

PEDIATRICS Volume 138, number s1, November 2016

http://pediatrics.aappublications.org/content/138/Supplement_1/S95
Attributing cancer to “lifestyle” emphasizes personal choice over environmental context

• Assumes decisions are informed and rational
• Ignores important social drivers and inequalities in access and opportunities
• Discounts the role of policy and environmental interventions to support healthy behaviors
• Unintended consequence: “blame the victim”

Environmental and social problems require environmental and social solutions
President’s Cancer Panel Report (2010)

Examination of cancer risk related to environmental contaminants, excess radiation, and other harmful exposures.

“The true burden of environmentally induced cancers has been grossly underestimated.”

“A precautionary prevention-oriented approach should replace current reactionary approaches to environmental contaminants in which human harm must be proven before action is taken to reduce or eliminate exposure.”

http://deainfo.nci.nih.gov/advisory/pcp/annualReports
Conceptual Shift for Environmental Health Sciences

**OLD**… chemicals act by overwhelming the body’s defenses by brute force at very high doses

**NEW**… chemicals can act like hormones and drugs to disrupt the control of development and function at very low doses to which the average person is exposed

Linda S. Birnbaum, Ph.D., Director
National Institute of Environmental Health Sciences
National Toxicology Program
March 15, 2010
The International Agency for Research on Cancer (IARC) has evaluated nearly 1,000 chemicals/processes for carcinogenicity.

This list is not fixed! Only a fraction of all chemicals in widespread use have been tested – even in animals.

The Health Impact Pyramid

Socioeconomic Factors

Changing the Context to make individuals’ default decisions healthy

Long-lasting Protective Interventions

Clinical Interventions

Counseling & Education

Examples

Health education, counseling

Changes in physician practices, rigorous accountability, incentives

Immunizations, smoking cessation, colonoscopy

Clean water, air, and food, elimination of exposures

Poverty reduction, improved education, social infrastructure

Reference: Frieden TR. *Am J Public Health* 2010;100:590-595
Overwhelming Body of Scientific Research

Keywords:
- diabetes
- sun exposure
- indoor tanning
- physical activity
- hepatitis C virus infection
- human papillomavirus
- obesity
- multiple chronic conditions
- mental health stress
- physical inactivity
- sleep
- life transitions
- alcohol
- caregivers
- weight maintenance
- personal care products
- communication
- radon
- cell phones
- medical radiation
- puberty
- endocrine disrupting chemicals
- the microbiome
- tobacco
- radiation
- dietary factors
- communication
Cancer Prevention Across the Lifespan

- Early Life (Ages 0-7)
- Adolescence (Ages 8-17)
- Early Adulthood (Ages 18-44)
- Midlife (Ages 45-64)
- Older Adulthood (Ages 65-100+)
The National Prevention Strategy

www.surgeongeneral.gov/priorities/prevention(strategy/index.html
Overarching Questions

- *Where is the evidence strongest linking specific risk factors with cancer causation?*

- *Which cancer causes or risk factors could be modified through environmental changes, health policies, or public health interventions?*

- *What specific public health activities have been demonstrated to be effective or to show promise at the community level to address cancer risk factors?*

- *How do these questions differ across the lifespan?*
Workgroup Activities and Products

- Reviewing the scientific literature
- Convening meetings with multidisciplinary groups of experts
- Reaching out to experts within and outside of CDC
- New project ideas (research, surveillance, etc.)
- Peer-reviewed publications
- CPAL-hosted seminars
- Resources for CDC grantees
- Content for the CDC website
Early life – prenatal period through early childhood
Factors during Early Life: Long- and Short-Term Effects

Preconception  Prenatal Period  Childhood  Adolescence  Adulthood
Opportunities for Cancer Prevention During Early Life

- A Supplement to *Pediatrics* (Nov. 2016)
- All content available open access (no cost) at: [http://pediatrics.aappublications.org/content/138/Supplement_1](http://pediatrics.aappublications.org/content/138/Supplement_1)
- Also link on CDC website: [www.cdc.gov/cancer/dcpc/prevention/childhood](http://www.cdc.gov/cancer/dcpc/prevention/childhood)
Opportunities During Early Life for Cancer Prevention: Highlights From a Series of Virtual Meetings With Experts

Dawn M. Holman, MPH, Natasha D. Buchanan, PhD, on behalf of the Cancer Prevention During Early Life Expert Group

http://pediatrics.aappublications.org/content/138/Supplement_1/S3
Early Life Risk Factors and Pediatric Cancers

- Maternal alcohol consumption
- Parental smoking & tobacco smoke
- Assisted reproductive technology
- High birth weight
- Chemical agents
- Chromosomal abnormalities
- Older parental age
- Genetic syndromes
- Ionizing radiation
- Viruses and bacteria
Early Life *Protective/Moderating* Factors and *Pediatric Cancers*

- Breastfeeding
- Maternal folic acid consumption
- Allergies, asthma, & atopy
- Early exposure to infection
  - (eg. via day care, older siblings)
Early Life Factors and **Risk for Adult Cancers**

- Adverse childhood events
- Body weight
- Parental & environmental tobacco smoke
- Chemical agents
- Older parental age
- Genetic syndromes
- Isolate cryptorchidism
- Placental phenotype
- Pubertal events
- Radiation
- Viruses and bacteria
Early Life *Protective/Moderating* Factors and *Adult Cancers*

- Breastfeeding
- Dietary factors
- Allergies, asthma, & atopy
- Physical activity during childhood
- Social support
Early Life Factors Associated with *Both Pediatric and Adult Cancers*

- **RISK FACTORS**
  - Ionizing Radiation
  - Chemical agents (e.g. DES, bisphenol A, pesticides, herbicides, Insecticides)
  - Viruses and bacteria (e.g. HPV)
  - Body weight
  - Older parental age
  - Smoking (parental smoking & environmental tobacco smoke)

- **PROTECTIVE**
  - Breastfeeding
  - Allergies, asthma, & atopy
  - Early exposure to infection (e.g. via day care, older siblings)
What is needed to support action?

- Scientific evidence linking risk factor
- Prevalence of the risk factor
- Association of risk factor with other outcomes
- Short- and long-term effects of intervention
- Unintended consequences
- Cost of intervention
- Potential impact on industry
- Future costs of failing to intervene
- Ease or difficulty of implementation
- Feasibility and sustainability
Childhood Leukemia: A Preventable Disease

Catherine Metayer, MD, PhD,¹ Gary Dahl, MD,² Joe Wiemels, PhD,³ Mark Miller, MD, MPH⁴

http://pediatrics.aappublications.org/content/138/Supplement_1/S45
Prudent to act on known risk factors of childhood leukemia

• Pesticides
• Tobacco smoking
• Paints and solvents
• Outdoor air pollution
• Nutrition at critical periods of development (folate supplementation)

Ref: Metayer C et al., *Pediatrics* 138 (S1) S45-S55, 2016
Trends in Rates of Pediatric Acute Lymphoblastic Leukemia, 2001-2014

Incidence by sex

Incidence by race/ethnicity

Environmental and Economic Strategies for Primary Prevention of Cancer in Early Life

David Kriebel, ScD, Polly J. Hoppin, ScD, Molly M. Jacobs, MPH, Richard W. Clapp, DSc

http://pediatrics.aappublications.org/content/138/Supplement_1/S56
Toxic use reduction is a potentially powerful cancer prevention strategy

- Since 1990, use of carcinogens by Massachusetts industries declined 32 percent
- Releases to the environment declined 93 percent

Concluding Commentary: Children in All Cancer Prevention Policy Decisions

Cynthia F. Bearer, MD, PhD, FAAP, a Lynn Goldman, MD, MS, MPH b

http://pediatrics.aappublications.org/content/138/Supplement_1/S98
Consider the health of fetuses and children and preconception health of parents

• For most cancers, causation involves multiple stages
• Genetic susceptibilities can be inherited or acquired
  • **Epigenetics**: modification of the expression of DNA (physical or social exposures)
• Need to focus on factors causing mutagens *and* harmful epigenetic changes
• Model of this complexity: kaleidoscope
• Overarching approach to cancer-prevention – consider early life in all policy decisions

Ref: Bearer CF, Goldman L. *Pediatrics* 138 (S1) S98-S100, 2016
Preadolescence and adolescence
Opportunities for Cancer Prevention During Preadolescence and Adolescence
August 9-10, 2011 ● Atlanta, Georgia
Opportunities for Cancer Prevention During Preadolescence and Adolescence

- A Supplement to *Journal of Adolescent Health* (May 2013)
- All content available open access (no cost) at: [http://www.jahonline.org/issue/S1054-139X(13)X0014-X](http://www.jahonline.org/issue/S1054-139X(13)X0014-X)
- Also link on CDC website: [http://www.cdc.gov/cancer/dcpc/prevention/youth](http://www.cdc.gov/cancer/dcpc/prevention/youth)
Commentary

Highlights From a Workshop on Opportunities for Cancer Prevention During Preadolescence and Adolescence

Dawn M. Holman, M.P.H.*, Juan L. Rodriguez, M.P.H., Lucy Peipins, Ph.D., Meg Watson, M.P.H., and Mary C. White, Sc.D.

Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia

Review article

Identifying Opportunities for Cancer Prevention During Preadolescence and Adolescence: Puberty as a Window of Susceptibility

Frank M. Biro, M.D. a, *, and Julianna Deardorff, Ph.D. b

a Department of Pediatrics, University of Cincinnati College of Medicine; Division of Adolescent Medicine, Cincinnati Children’s Hospital Medical Center, Cincinnati, Ohio
b Maternal and Child Health Program, King Sweesy and Robert Womack Endowed Chair in Medical Science & Public Health, School of Public Health, University of California, Berkeley, California

Review article

Exposure to Chemicals and Radiation During Childhood and Risk for Cancer Later in Life

David O. Carpenter, M.D. a,b,*, and Sheila Bushkin-Bedient, M.D., M.P.H. a

a Institute for Health and the Environment, University at Albany, Rensselaer, New York
b Department of Environmental Health Sciences, University at Albany, Rensselaer, New York

Conclusions: The early life onset of a lifelong exposure to mixtures of multiple environmental chemical carcinogens and radiation contributes significantly to the etiology of cancer in later life.

Early adulthood (≈ 18-44 years)
Expert Meeting on
Opportunities for Cancer Prevention during Early Adulthood
April 13-14, 2016  ●  Decatur, Georgia
Opportunities for Cancer Prevention During Early Adulthood

• A Supplement to *American Journal of Preventive Medicine* (Sep. 2017)

• All content available open access (no cost) at: [http://www.ajpmonline.org/issue/S0749-3797(17)X0003-2](http://www.ajpmonline.org/issue/S0749-3797(17)X0003-2)

• Also link on CDC website: [www.cdc.gov/cancer/dcpc/prevention/early-adulthood.htm](http://www.cdc.gov/cancer/dcpc/prevention/early-adulthood.htm)
CONCLUSIONS

Many modifiable cancer risk factors are common among young adults in the U.S. The implementation of policy and environmental strategies for these risk factors could prevent future cancers.


Breastfeeding and Breast Cancer Risk Reduction:
Implications for Black Mothers

Erica H. Anstey, PhD, Meredith L. Shoemaker, MPH, Chloe M. Barrera, MPH,
Mary Elizabeth O’Neil, MPH, Ashley B. Verma, MPH, Dawn M. Holman, MPH

Midlife (≈ 45-64 years)
Identifying Opportunities for Cancer Prevention Among Adults Ages 45-64: Workshop on Putting Scientific Evidence into Public Health Practice
October 17-18, 2012 - Atlanta, GA
Opportunities for Cancer Prevention During Midlife

• A Supplement to *American Journal of Preventive Medicine* (March 2014)

• All content available open access (no cost) at: [www.ajpmonline.org/issue/S0749-3797(14)X0013-9](http://www.ajpmonline.org/issue/S0749-3797(14)X0013-9)

• Also link on CDC website: [www.cdc.gov/cancer/dcpc/prevention/midlife.htm](http://www.cdc.gov/cancer/dcpc/prevention/midlife.htm)
Older adulthood (≈ 65 years and over)
Opportunities for Cancer Prevention during Older Adulthood
Decatur, GA April 26-27, 2017
Opportunities for Cancer Prevention During Older Adulthood

• A Supplement to *The Gerontologist* in development (Summer 2019)
• Topics:
  • Psychosocial factors and cancer prevention during older adulthood
  • Changing health behaviors at older ages
  • Attitudes toward aging
  • Promoting older adult health through multisector collaborations
  • Limited life expectancy and cancer screening
  • Special populations of older adults, disparities, health literacy
  • Financial well-being of older adults
Cross-cutting themes across the life course
Handoff from Knowledge to Action: 

*Doesn’t Just Happen*
Transdisciplinary approaches expand understanding

Need for Integrated Health Messages and Programs

Lessons from tobacco control

• The need for counter-marketing:
  • Tobacco industry promotes *personal responsibility and informed choice* (playbook for industries marketing of harmful products like sugar sweetened beverages, alcohol, junk foods, etc.)

• Comprehensive tobacco control programs operate at multiple levels, and include context-changing interventions such as
  • Tobacco taxes
  • Smoke-free environments
  • Elimination of advertising of tobacco products

Source: [www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2014/comprehensive](http://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2014/comprehensive)
Roles of clinicians in primary cancer prevention

- Tobacco cessation
- Weight management
- Behavioral counseling for skin cancer prevention
- Reduce unnecessary/excessive exposure to medical radiation
- Alcohol screening
- HPV, HBV vaccination
- Cancer survivorship care plans (to prevent second primary cancers)
Expanded definition of “modifiable”

<table>
<thead>
<tr>
<th>Non-modifiable</th>
<th>Potentially modifiable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Factors that accelerate aging</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>Policies that prohibit discrimination</td>
</tr>
<tr>
<td>Genetics</td>
<td>Gene expression (epi-genetics)</td>
</tr>
<tr>
<td>Poverty</td>
<td>Educational and economic opportunities</td>
</tr>
</tbody>
</table>
Seeing opportunities for prevention requires working across disciplines and sectors.
Public Health 3.0: Focus on the Social Determinants of Health
Cancer prevention is definitely possible!

• Most cancers result from a combination of factors operating over many years.
• More cancer risk factors are potentially modifiable than we recognize.
• It is possible to reduce cancer risk through actions taken at the population level.
• Individual behaviors can be influenced through changes in environmental and contextual factors.
Check out: www.cdc.gov/cancer/dcpc/prevention
Promising Policies & Practices Briefs

Source: www.cdc.gov/cancer/dcpc/prevention/lifetime.htm
Elimination of Preventable Cancers

Aspirations

Health in all community policies and places

Health systems that stop cancer before it starts

Health equity in all cancer prevention initiatives

Strategic Priorities

Increase the implementation of policies and practices to address environmental and behavioral risk factors for obesity

Scale our best practices to create health systems that facilitate cancer risk reduction

Increase the implementation of evidence-based cancer prevention strategies targeting vulnerable and underserved populations

Our Guiding Principles

Address Health Disparities

Define Expected Outcomes Upfront

Collaborate

Communicate: Tailor to a Specific Audience

Our Key Strengths

Data

Translation & Evaluation

Partnership
“The window of opportunity for effective interventions opens early and rarely, if ever, closes,”
— David Satcher, MD
thank you!
Go to the official federal source of cancer prevention information: www.cdc.gov/cancer

Follow DCPC Online! @CDC_Cancer

Contact info for Mary White: mxw5@cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.